2011 Progress Report of Milfoil Biological Control Research for the Menominee River

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INTRODUCTION

Since 2008 EnviroScience has been contracted to further investigate the milfoil weevil (*Euhrychiopsis lecontei*) and its potential to control Eurasian watermilfoil (*Myriophyllum spicatum*) (EWM) within the Menominee River watershed. In 2010 the Dickinson Conservation District was awarded an MEF (Mitigation and Enhancement Fund) grant focusing on the genetic profiles of populations of watermilfoil found within the Upper Menominee River watershed. EnviroScience participated in the plant collection for that study on the Menominee River in conjunction with the weevil study. Results revealed hybrid milfoil (Northern watermilfoil X Eurasian watermilfoil) found in numerous locations of the We Energies reservoirs. Resources were used to further investigate EWM genetics in each reservoir in addition to the weevil distribution and its' ability to utilize hybrid milfoil were the main focus of the investigation for the 2011 season.

1.0 WEEVIL DISTRIBUTION AND MILFOIL COLLECTION METHODS

The distribution study has been consistently performed during the second week of July for the past three years. In 2008, all nine reservoirs were surveyed as a base for the study. It was decided to survey only half the reservoirs in 2009. Based on the drastic changes observed over the two years, all nine reservoirs were surveyed in 2010 and 2011.

Stems of EWM were collected along the same transects taken in 2008. This was achieved by collecting pairs of plants along a transect line running perpendicular to shore and 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. Additional stems (4-5) were collected at selected sites as part of the milfoil genetics study. Plants for the distribution study were shipped overnight to EnviroSciences Ohio lab after collection for assessment of all weevil life stages while the remaining stems were shipped to the Annis Water Resource Institute of Grand Valley State University in Muskegon, Michigan for genetic analysis.

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.

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1.1 Weevil Distribution and Milfoil Genetics Results

1.1.1 Big Quinnesec Reservoir

On July 9, 2011, no EWM was found throughout the reservoir with the exception of the last site, transect 7, finding 19 weevil life stages on the 10 stems collected (Figure 1-1). The weevil population in this site has been fluctuating over the last four years (Table 1-1). Weevil eggs, adults and moderate larval damage were observed in the field.

During the 2011 survey a reduction in conductivity and pH was recorded at every site, the lowest recorded in all four years. The temperature readings this season were more comparable to that in 2008 and 2009. However, these changes are not drastic to correlate the reduction of EWM at the majority of the sites.

Four additional stems were collected at T7 at the time of the survey for the milfoil genetics study resulting hybrid milfoil. This was the same results as last year from T1, T3, and T6.

Table 1-1 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	Ave. Weevils/ Stem
1	0.162	22.78	8.31	7.54	10	25	2.5	14	1.40
1	0.205	22.96	8.25	9.56	10	8	0.8	10	1.00
1	0.180	24.44	7.90	6.61	10	27	2.7	3	0.30
1	0.152	23.29	7.61	7.13	-	-	-	-	-
2	0.161	23.25	8.09	8.33	9	26	2.9	23	2.56
2	0.196	22.97	8.37	9.69	-	-	-	-	-
2	0.183	25.48	7.97	7.02	9	11	1.2	7	0.80
2	0.152	23.48	7.66	7.26	-	-	-	-	-
3	0.162	23.14	8.06	7.86	10	23	2.3	30	3.00
3	0.205	23.68	8.78	11.90	10	14	1.4	4	0.40
3	0.182	25.81	8.45	8.45	10	15	1.5	13	1.30
3	0.152	23.41	7.72	7.94	-	-	-	-	-
4	0.159	22.50	8.14	7.53	10	30	3.0	49	4.90
4	0.191	23.08	8.38	9.12	10	23	2.3	10	1.00
4	0.179	24.16	7.98	5.98	10	14	1.4	3	0.30
4	0.154	24.07	7.65	7.78	-	-	-	-	-
5	0.162	22.86	8.04	7.58	10	18	1.8	11	1.10
5	0.205	23.00	8.29	9.16	10	22	2.2	15	1.50
5	0.180	25.00	8.29	6.98	-	-	-	-	-

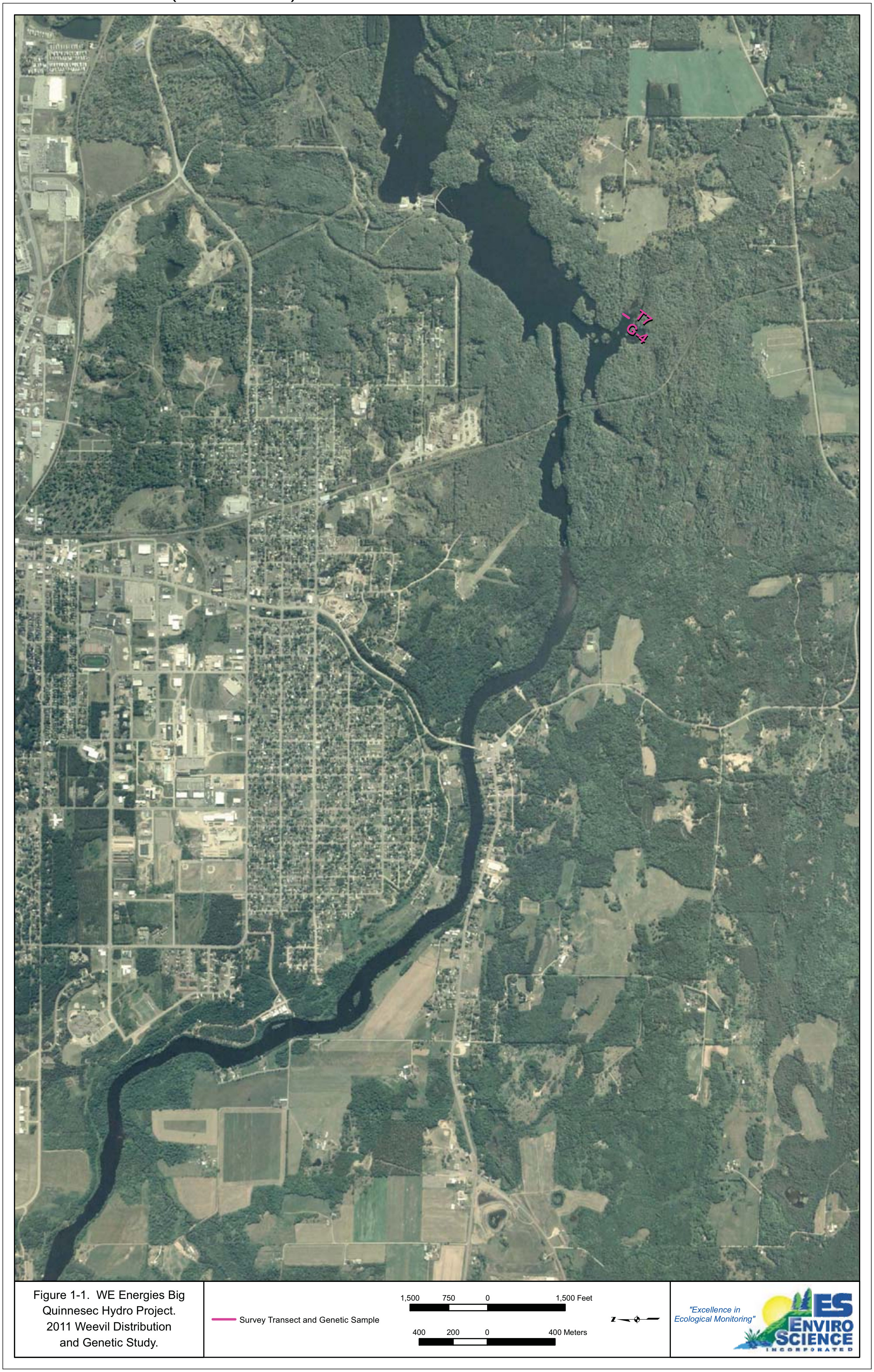

Figure 1-1. WE Energies Big Quinnesec Hydro Project. 2011 Weevil Distribution and Genetic Study.

5	0.153	23.81	7.58	7.59	-	-	-	-	-
6	0.164	23.32	8.14	8.70	10	23	2.3	17	1.70
6	0.208	23.45	8.41	9.20	10	15	1.5	7	0.70
6	0.182	25.74	8.27	7.31	10	15	1.5	15	1.50
6	0.155	24.08	7.66	7.16	-	-	-	-	-
7	0.163	23.33	8.12	9.11	10	28	2.8	27	2.70
7	0.187	23.56	8.41	10.70	10	15	1.5	15	1.50
7	0.182	25.74	8.41	7.82	10	25	2.5	24	2.40
7*	0.153	23.81	7.62	7.49	10	17	1.7	19	1.90
				2008 TOTAL	**69**	**173**	**2.5**	**171**	**2.48**
				2009 TOTAL	**60**	**97**	**1.6**	**61**	**1.02**
				2010 TOTAL	**59**	**107**	**1.8**	**65**	**1.10**
				2011 TOTAL	**10**	**17**	**1.7**	**19**	**1.90**

*Genetic sample
2008 (Gray), 2009 (White), 2010 (Yellow) and 2011 (Green)

1.1.2 Kingsford Reservoir

Over the last few seasons the EWM has been decreasing within the river channel. On July 10, 2011 EWM was collected from T1, T3, T7 and T10 from the channel (Figure 1-2). The milfoil was recorded sparse and sporadic mixed in with natives. The milfoil in Cowboy Lake was moderate to dense but not as dense as observed in previous years. A total of 126 weevil life stages were found on 77 stems collected throughout the reservoir (Table 1-2). Lab analysis revealed weevil life stages from every location sampled.

The conductivity, D.O and pH readings within the main river channel were the lowest recorded in four years. All the readings, with the exception of conductivity, were relatively comparable to previous years in Cowboy Lake.

Milfoil stems were collected from nine locations, four previously tested in 2010 and five not yet tested. During the survey, few stems were found in the areas of T2 and T11 which was decided only for the use of the genetic study (Figure 1-2). The 20 viable stems were all found to be hybrid milfoil.

Figure 1-2. WE Energies Kingsford Hydro Project. 2011 Weevil Distribution and Genetic Study.

Table 1-2 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	Ave. Weevils/ Stem
1	0.165	25.61	8.24	7.60	10	25	2.5	48	4.80
1	0.192	21.94	8.49	9.36	10	7	0.7	2	0.20
1	0.190	27.07	8.65	8.90	10	18	1.8	19	1.90
1	0.150	22.21	7.54	6.86	10	25	2.5	46	4.60
2	0.161	24.40	7.90	7.44	10	30	3.0	51	5.10
2	0.188	21.36	8.32	9.07	10	7	0.7	2	0.20
2	0.181	25.45	8.09	7.19	10	25	2.5	31	3.10
2*	0.151	22.63	7.56	6.85	-	-	-	-	-
3	0.165	25.66	7.99	7.16	10	21	2.1	29	2.90
3	0.177	21.36	8.21	8.92	10	6	0.6	2	0.20
3	0.188	26.00	8.30	7.68	10	27	2.7	20	2.00
3*	0.148	22.71	7.60	7.24	10	20	2.0	31	3.10
4	0.165	25.54	7.92	7.40	10	26	2.6	26	2.60
4	0.191	21.49	8.24	8.97	10	6	0.6	1	0.10
4	0.186	26.13	8.32	7.78	9	19	2.1	25	2.80
4	0.150	22.86	7.63	7.50	-	-	-	-	-
5	0.164	25.37	8.09	9.43	9	15	1.7	24	2.67
5	0.192	21.44	8.27	8.87	10	25	2.5	11	1.10
5	0.192	27.87	8.91	-	10	21	2.1	5	0.50
5	0.150	22.94	7.67	7.25	-	-	-	-	-
6	0.169	25.02	7.81	12.60	10	19	1.9	29	2.90
6	0.193	21.99	8.27	9.29	10	23	2.3	24	2.40
6	0.174	25.62	8.15	7.34	10	14	1.4	24	2.40
6	0.149	22.71	7.61	7.30	-	-	-	-	-
7	0.192	30.15	8.38	9.65	10	22	2.2	26	2.40
7	0.195	22.28	8.30	9.15	10	26	2.6	3	0.30
7	0.191	29.72	9.32	11.37	10	21	2.1	12	1.20
7*	0.151	23.42	7.76	8.04	10	30	3.0	11	1.10
8	0.172	27.01	8.35	9.83	10	18	1.8	6	0.60
8	0.196	21.80	8.25	9.00	10	16	1.6	4	0.40
8	0.193	29.43	9.27	9.47	9	13	1.4	3	0.30
8	0.154	23.39	7.73	7.82	-	-	-	-	
9	0.186	28.19	8.19	8.58	10	15	1.5	36	3.60
9	0.196	21.63	8.19	8.89	10	22	2.2	2	0.20
9	0.191	27.71	8.85	8.74	9	24	2.7	17	1.89
9	0.154	23.65	7.74	7.71	-	-	-	-	-

10	0.175	28.62	8.17	8.50	9	14	1.6	17	1.89
10	0.203	22.84	8.46	9.67	10	23	2.3	2	0.20
10	0.192	28.21	8.37	7.70	10	20	2.0	28	2.80
10*	0.156	24.12	7.77	7.75	9	28	3.1	17	1.80
11	0.174	29.52	8.69	8.92	10	15	1.5	16	1.60
11	0.196	22.88	8.50	9.62	10	13	1.3	4	0.40
11	0.190	28.00	8.51	7.98	9	18	2.0	13	1.40
11*	0.144	24.75	8.38	8.63	-	-	-	-	-
12	0.170	28.34	8.75	9.03	10	22	2.2	0	0.00
12	0.188	22.91	8.81	9.73	10	18	1.8	3	0.30
12	0.185	27.74	8.86	8.11	10	24	2.4	7	0.70
12*	0.143	24.33	8.45	8.76	9	10	1.1	9	1.00
13	0.171	28.25	8.73	9.17	10	19	1.9	11	1.10
13	0.189	23.07	8.79	8.76	10	5	0.5	0	0.00
13	0.191	28.70	8.86	8.11	10	27	2.7	6	0.60
13*	0.144	24.73	8.59	8.50	10	22	2.2	7	0.70
14	0.166	27.13	8.85	9.51	9	18	2.0	3	0.30
14	0.187	22.27	8.80	10.01	10	2	0.2	0	0.00
14	0.189	28.31	8.95	7.84	10	28	2.8	1	0.10
14*	0.144	24.68	8.60	8.87	10	23	2.3	1	0.10
15	0.172	28.94	8.83	9.35	10	14	1.4	3	0.30
15	0.184	22.38	8.82	10.19	10	17	1.7	2	0.20
15	0.183	27.97	9.04	8.71	10	23	2.3	0	0.00
15*	0.142	24.10	8.65	8.82	9	25	2.8	4	0.40
				2008 TOTAL	**147**	**293**	**2.0**	**329**	**2.24**
				2009 TOTAL	**150**	**216**	**1.4**	**62**	**0.41**
				2010 TOTAL	**146**	**322**	**2.2**	**211**	**1.45**
				2011 TOTAL	**77**	**183**	**2.3**	**126**	**1.63**

*Genetic sample
2008 (Gray), 2009 (White) 2010 (Yellow) and 2011 (Green)

1.1.3 Michigamme Falls Reservoir

On July 8, 2011, a total of 170 stems were collected from 18 of the 21 transects in Michigamme Falls Reservoir; stems were not collected at transects 10, 15 and 12 (Figure 1-3). In 2010 the lowest weevil population was recorded in T18 finding one weevil life stage however this year it was the highest finding 44 life stages on 10 stems. This season was the second highest overall weevil population recorded, 1.39 weevils/ stem (Table 1-3). The overall density of the EWM was recorded to be sparse to moderate. Some of the stems observed were black but rooted with new growth with

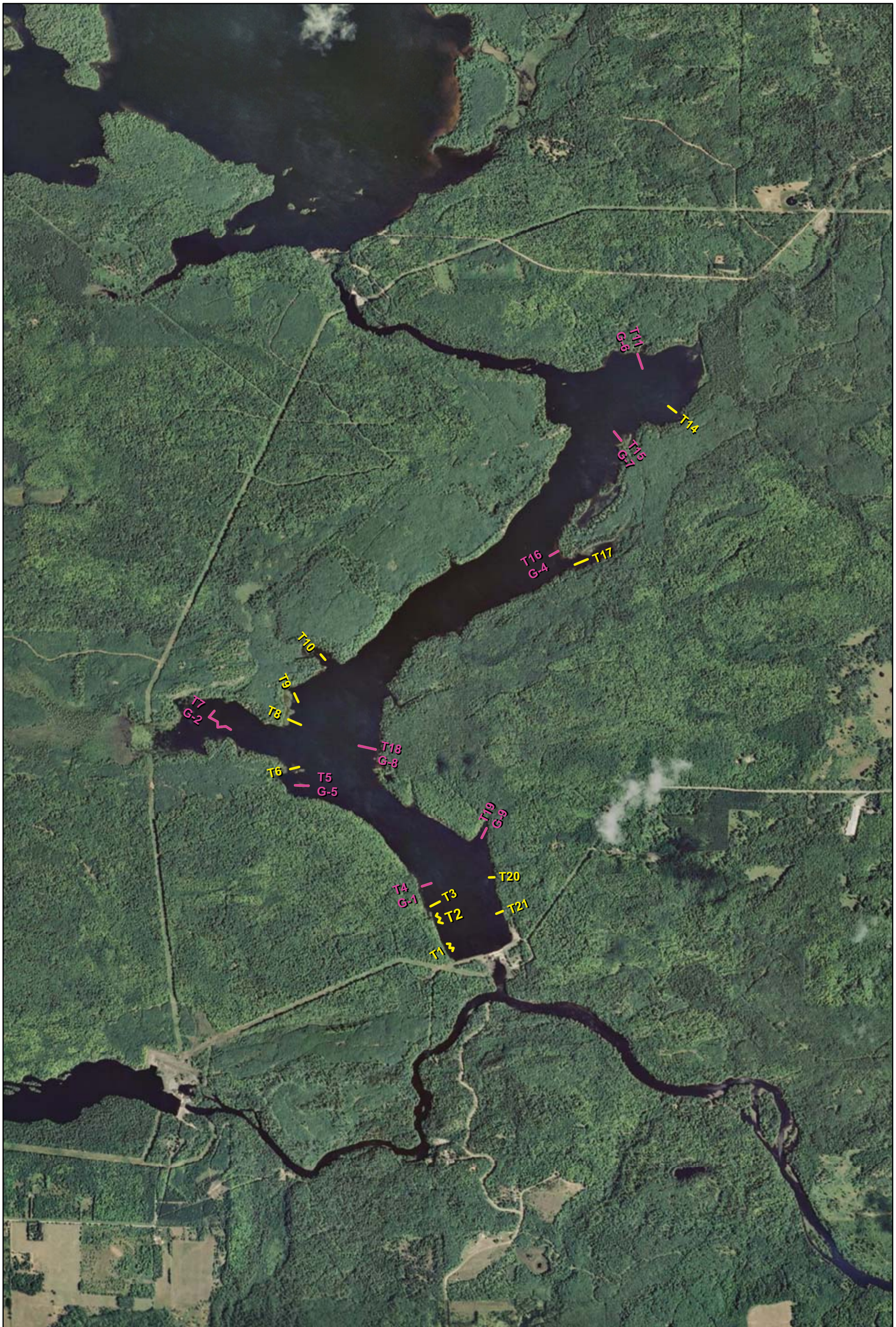

Figure 1-3. WE Energies Michigamme Falls Hydro Project. 2011 Weevil Distribution and Genetic Study.

Survey Transect
Genetic Sample
Survey Transect and Genetic Sample

1,300 650 0 1,300 Feet
340 170 0 340 Meters

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adventitious roots starting. This is typically seen early in the season around May or June, not early July.

The water quality readings are comparable to previous years.

The 21 viable stems collected for the genetic study were all hybrid milfoil. The same results were found in 2010.

Table 1-3 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	Ave. Weevils/ Stem
1	0.094	22.70	8.37	8.45	10	18	1.8	27	2.70
1	0.113	19.31	8.12	8.97	10	7	0.7	1	0.10
1	0.118	22.29	7.88	6.02	9	14	1.6	9	1.00
1	0.105	22.72	8.34	9.05	10	28	2.8	8	0.80
2	0.094	22.60	8.19	8.48	10	11	1.1	2	0.20
2	0.113	19.64	8.01	9.44	10	6	0.6	1	0.10
2	0.123	22.56	7.69	6.25	10	17	1.7	10	1.00
2	0.104	22.60	8.14	9.33	10	31	3.1	12	1.20
3	0.093	22.59	8.01	8.02	10	13	1.3	13	1.30
3	0.111	19.22	7.97	9.51	10	11	1.1	1	0.10
3	0.123	22.55	7.69	6.51	10	23	2.3	7	0.70
3	0.104	22.76	8.01	9.25	10	17	1.7	23	2.30
4	0.093	22.46	7.89	7.78	10	13	1.3	4	0.40
4	0.113	19.60	7.97	9.47	10	25	2.5	2	0.20
4	0.123	22.53	7.64	6.30	10	22	2.2	23	2.30
4*	0.104	22.70	7.90	9.06	10	23	2.3	7	0.70
5	0.092	22.04	7.92	7.98	9	11	1.2	5	0.56
5	0.113	19.88	7.90	9.33	10	18	1.8	3	0.30
5	0.124	23.23	7.80	6.97	9	16	1.8	13	1.44
5*	0.104	22.72	7.80	8.82	10	37	3.7	7	0.70
6	0.092	21.88	7.83	7.85	10	13	1.3	21	2.10
6	0.113	19.92	7.86	9.18	10	21	2.1	10	1.00
6	0.125	23.45	7.89	7.04	9	23	2.6	23	2.56
6	0.105	23.19	7.90	9.17	10	36	3.6	22	2.20
7	0.091	20.93	7.80	7.50	8	12	1.5	0	0.00

7	0.105	19.86	7.89	9.17	10	19	1.9	0	0.00
7	0.127	23.70	7.94	7.94	-	-	-	-	-
7*	0.105	22.00	7.81	8.44	10	21	2.1	15	1.50
8	0.091	22.25	8.02	7.91	10	15	1.5	11	1.10
8	0.114	20.11	7.89	9.38	10	24	2.4	1	0.10
8	0.125	23.42	7.88	6.65	10	34	3.4	19	1.90
8	0.106	23.39	7.88	9.35	10	26	2.6	21	2.10
9	0.093	22.12	7.83	7.49	10	22	2.2	9	0.90
9	0.115	20.67	8.08	9.96	10	25	2.5	0	0.00
9	0.125	23.52	7.91	6.57	9	36	4.0	12	1.33
9	0.107	24.00	7.86	8.51	10	24	2.4	13	1.30
10	0.092	22.00	7.71	7.76	10	23	2.3	13	1.30
10	0.114	20.47	8.06	9.49	10	23	2.3	2	0.20
10	0.124	23.61	7.85	6.76	10	27	2.7	19	1.90
10*	0.107	23.60	7.86	9.24	-	-	-	-	-
11	0.101	22.87	7.77	7.88	10	28	2.8	9	0.90
11	0.114	20.00	7.92	9.11	10	27	2.7	3	0.30
11	0.128	24.54	7.98	6.87	10	25	2.5	11	1.10
11*	0.105	23.17	7.87	9.27	10	17	1.7	12	1.20
12	0.103	22.70	8.37	8.45	10	18	1.8	27	2.70
12	0.116	19.60	7.93	9.05	10	22	2.2	9	0.90
12	0.130	24.56	8.04	6.91	10	27	2.7	9	0.90
12	0.160	23.61	8.01	9.38	-	-	-	-	-
13	0.107	22.10	7.87	8.23	10	15	1.5	40	4.00
13	0.122	20.13	7.97	9.65	10	11	1.1	1	0.10
13	0.127	24.44	8.02	6.71	10	22	2.2	18	1.80
13	0.160	23.73	8.13	9.46	-	-	-	-	-
14	0.096	22.75	7.91	8.28	10	19	1.9	22	2.20
14	0.116	20.60	7.99	9.46	10	7	0.7	1	0.10
14	0.127	24.52	8.06	7.07	10	36	3.6	13	1.30
14	0.106	23.71	8.00	9.25	10	18	1.8	8	0.80
15	0.094	22.61	7.88	7.92	10	23	2.3	21	2.10
15	0.113	20.14	7.60	9.54	10	5	0.5	1	0.10
15	0.128	24.09	7.93	6.80	10	17	1.7	9	0.90
15*	0.105	23.45	7.94	7.92	10	19	1.9	13	1.30
16	0.095	22.99	7.97	8.00	9	10	1.1	12	1.33
16	0.113	20.29	7.93	9.44	10	7	0.7	1	0.10
16	0.128	24.34	7.95	6.97	10	26	2.6	15	1.50
16*	0.105	23.44	7.96	9.01	10	29	2.9	11	1.10

17	0.095	23.11	7.88	7.79	10	26	2.6	17	1.70
17	0.113	20.99	8.99	9.27	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-
17	0.106	23.65	7.89	8.98	10	23	2.3	13	1.30
18	0.093	22.27	7.70	7.80	10	27	2.7	37	3.70
18	0.115	20.46	7.98	9.59	10	17	1.7	9	0.90
18	0.126	23.66	7.96	7.32	10	16	1.6	1	0.10
18*	0.104	22.91	7.80	8.88	10	27	2.6	44	4.40
19	0.094	23.47	7.80	8.07	10	22	2.2	15	1.50
19	0.114	19.95	7.86	9.26	10	16	1.6	4	0.40
19	0.123	23.12	7.91	6.73	10	28	2.8	5	0.50
19*	0.103	22.10	7.45	7.06	10	18	1.8	6	0.60
20	0.094	22.96	7.80	8.12	10	25	2.5	25	2.50
20	0.116	20.80	7.96	9.42	10	10	1.0	1	0.10
20	0.119	23.01	7.84	6.68	10	26	2.6	11	1.10
20	0.104	22.72	7.68	8.49	8	18	1.0	2	0.25
21	0.093	22.79	7.77	7.92	5	6	1.2	11	2.20
21	0.117	21.03	8.02	9.53	10	17	1.7	3	0.30
21	-	-	-	-	-	-	-	-	-
21	0.104	22.37	7.76	8.71	2	5	2.5	0	0.00
				2008 TOTAL	**199**	**378**	**1.9**	**326**	**1.63**
				2009 TOTAL	**200**	**318**	**1.6**	**54**	**0.27**
				2010 TOTAL	**168**	**435**	**2.5**	**227**	**1.30**
				2011 TOTAL	**170**	**417**	**2.5**	**237**	**1.39**

*Genetic sample
2008 (Gray), 2009 (White), 2010 (Yellow) and 2011 (Green)

1.1.4 Peavy Falls Reservoir

Two hundred eighty five stems were collected from 29 of the 34 transects in Peavy Falls on July 7, 2011 (Figure 1-4). There was a huge decline in the milfoil density found during the 2009 survey. In 2010, the EWM was on the rise but the overall weevil population was low. Given these results, EnviroScience biologists would expect an increase in EWM and decrease in the weevil population for the 2011 survey. Contrary there was in an increase in EWM but the weevil population was considerably high. Five hundred and fifty three weevil life stages were found on the stems for an overall count of 1.94 weevils/stem (Table 1-4). Two dominant native species were found prevalent along the western/northwestern shore: Northern watermilfoil (*Myriophyllum sibiricum*) and Whorled watermilfoil (*Myriophyllum verticullatum*). Other native species seen were Yellow Lily (*Nuphar sp.*), Eel grass (*Vallisneria americana*), Buttercup (*Ranunculus longirostris*) and various other *Potamogeton* species. Another observation made during the survey was the “new” growth of EWM only being 12” to 18” long and flowering.

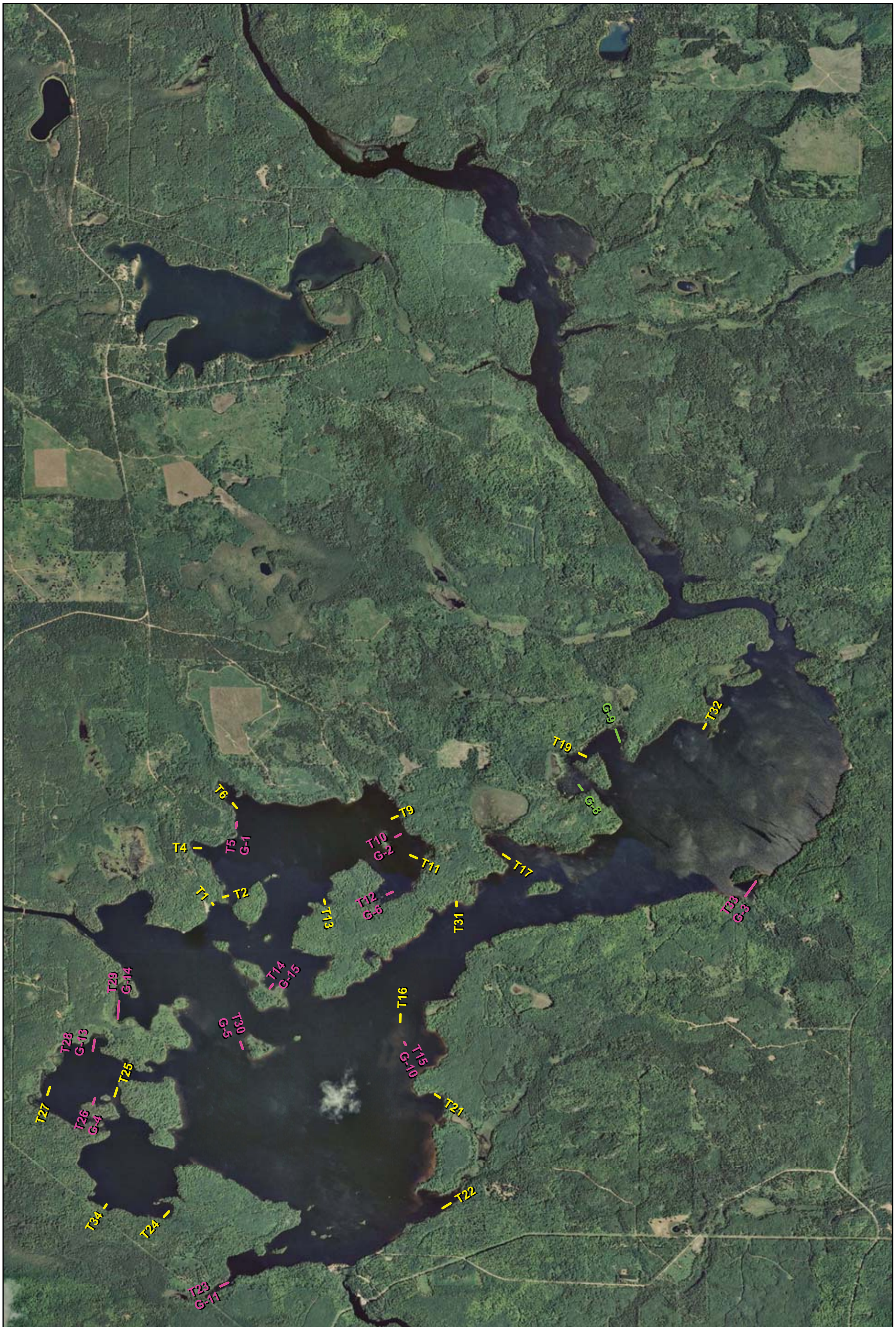

Figure 1-4. WE Energies Peavy Falls Hydro Project. 2011 Weevil Distribution and Genetic Study.

Survey Transect

Genetic Sample

Survey Transect and Genetic Sample

1,800 900 0 1,800 Feet

500 250 0 500 Meters

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The 2011 survey was comparable to the 2008 survey in many ways: the EWM was considered sparse to moderate in density throughout the whole reservoir, the overall weevil population was high and water quality readings were close to what was found in 2008. Difference in 2011 was an increase in the temperature and D.O. at most sites.

Milfoil genetic samples were taken from 13 sites in 2011. Lab analysis resulted two stems of Northern watermilfoil, found in Transects 12 and 14, and 20 stems of hybrid milfoil from Transects 5,10, 26, 30, 33, 23, 28, 29, 31, 12, 18 and 20.

Table 1-4 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	Ave. Weevils /Stem
1	0.095	22.10	8.48	7.64	10	26	2.6	25	2.50
1	-	-	-	-	-	-	-	-	-
1	0.107	24.05	8.75	9.56	10	36	3.6	44	4.40
2	0.095	21.94	8.22	7.67	10	18	1.8	14	1.40
2	-	-	-	-	-	-	-	-	-
2	0.106	24.34	8.29	9.12	7	15	2.1	6	0.86
3	0.094	21.99	7.92	7.78	10	34	3.4	15	1.50
3	0.131	24.11	8.07	11.69	-	-	-	-	-
3	0.103	24.42	8.22	9.01	-	-	-	-	-
4	0.092	22.14	7.74	7.56	10	36	3.6	31	3.10
4	-	-	-	-	-	-	-	-	-
4	0.105	24.18	8.12	8.90	10	31	3.1	26	2.60
5	0.093	22.26	7.85	8.25	9	14	1.55	10	1.11
5	0.129	24.47	8.13	12.25	10	18	1.8	2	0.20
5*	0.104	23.91	8.13	9.43	10	33	3.3	8	0.80
6	0.092	22.24	7.94	7.73	10	14	1.4	17	1.70
6	-	-	-	-	-	-	-	-	-
6	0.082	24.14	8.04	9.19	10	38	3.8	28	2.80
7	0.094	22.33	7.98	7.47	10	21	2.1	33	3.30
7	-	-	-	-	-	-	-	-	-
7	0.105	24.04	8.01	9.15	-	-	-	-	-
8	0.094	22.60	7.87	7.35	10	16	1.6	24	2.40
8	0.128	24.64	8.03	12.03	10	20	2.0	20	2.00
8	0.103	23.76	8.03	9.00	-	-	-	-	-
9	0.094	22.61	7.82	7.45	10	17	1.7	46	4.60
9	0.132	25.13	8.12	4.16	8	32	4.0	2	0.25

9	0.105	24.07	8.01	8.97	8	24	3.0	8	1.00
10	0.093	22.73	7.75	7.41	10	14	1.4	24	1.90
10	0.129	25.49	8.30	7.58	10	28	2.8	1	0.10
10*	0.105	24.09	7.96	9.26	10	31	3.1	24	2.40
11	0.083	22.66	7.80	7.46	10	13	1.3	22	2.20
11	0.130	25.69	8.29	7.35	10	29	2.9	2	0.20
11	0.097	24.46	7.99	9.12	10	24	2.4	30	3.00
12	0.093	22.67	7.78	7.20	10	15	1.5	4	0.40
12	-	-	-	-	-	-	-	-	-
12*	0.106	24.32	7.93	8.79	7	29	4.1	29	4.14
13	0.096	22.44	8.02	8.14	10	39	3.9	30	3.00
13	0.108	19.23	7.73	9.80	10	24	2.4	12	1.20
13	0.127	25.12	8.16	7.56	9	28	3.1	20	2.22
13	0.106	24.55	7.98	9.60	10	37	3.7	15	1.50
14	0.092	22.44	8.01	8.15	10	22	2.2	11	1.10
14	-	-	-	-	-	-	-	-	-
14*	0.108	24.46	7.97	9.10	10	33	3.3	22	2.20
15	0.095	22.44	7.85	7.93	10	28	2.8	12	1.20
15	0.137	25.76	8.15	7.49	10	21	2.1	6	0.60
15*	0.106	23.99	7.92	8.93	10	31	3.1	5	0.50
16	0.092	21.44	7.11	8.53	10	28	2.8	6	0.60
16	0.136	25.64	8.17	7.46	10	19	1.9	3	0.30
16	0.104	24.00	7.92	8.75	10	27	2.7	2	0.20
17	0.091	21.67	7.35	7.91	10	32	2.8	36	0.60
17	-	-	-	-	-	-	-	-	-
17	0.094	24.50	7.94	8.84	10	17	1.7	22	2.20
18	0.089	21.18	7.43	6.97	10	25	2.5	12	1.20
18	0.108	20.08	7.59	8.75	10	13	1.3	2	0.20
18	0.129	25.82	8.19	7.36	10	32	3.2	7	0.70
18*	0.101	24.85	7.86	8.15	-	-	-	-	-
19	0.091	21.53	7.39	7.31	10	31	3.1	18	1.80
19	0.127	25.24	7.92	6.53	10	25	2.5	0	0.00
19	0.101	24.49	7.88	8.43	10	27	2.7	26	2.60
20	0.090	21.70	7.44	7.78	10	22	2.2	19	1.90
20	-	-	-	-	-	-	-	-	-
20*	0.102	24.79	7.88	8.59	-	-	-	-	-
21	0.094	21.52	7.70	7.57	10	16	1.6	16	1.60
21	0.139	26.65	8.18	7.35	9	27	3.0	2	0.22
21	0.107	24.34	7.88	8.66	10	21	2.1	16	1.60
22	0.092	21.72	7.79	7.52	10	20	2.0	27	2.70
22	-	-	-	-	-	-	-	-	-

22	0.108	24.70	7.97	8.94	10	21	2.1	20	2.00
23	0.091	21.79	7.76	7.71	9	17	1.9	15	1.67
23	-	-	-	-	-	-	-	-	-
23*	0.107	24.61	7.67	8.01	10	32	3.2	9	0.90
24	0.091	21.93	7.71	8.06	10	17	1.7	13	1.30
24	0.135	27.55	8.30	7.47	-	-	-	-	-
24	0.108	24.09	8.00	8.76	10	25	2.5	23	2.30
25	0.091	21.44	7.60	8.07	10	30	3.0	20	2.00
25	-	-	-	-	-	-	-	-	-
25	0.108	24.38	8.04	8.75	10	27	2.7	26	2.60
26	0.092	21.80	7.66	7.53	10	22	2.2	15	1.50
26	0.098	26.93	8.27	7.03	10	17	1.7	3	0.30
26*	0.108	24.35	8.06	8.65	10	25	2.5	22	2.20
27	0.091	21.15	7.70	7.93	10	43	4.3	75	7.40
27	-	-	-	-	-	-	-	-	-
27	0.107	24.04	8.22	9.27	10	18	1.8	15	1.50
28	0.090	21.46	7.59	7.55	10	13	1.3	15	1.50
28	0.133	26.78	8.29	7.51	10	21	2.1	5	0.50
28*	0.106	23.94	7.98	8.80	10	24	2.4	33	3.30
29	0.097	22.27	7.72	8.16	8	19	2.38	36	4.50
29	0.149	25.39	7.89	6.49	10	24	2.4	0	0.00
29*	0.116	24.27	7.71	8.00	10	19	1.9	16	1.60
30	0.095	22.43	7.80	8.40	10	24	2.4	21	2.10
30	-	-	-	-	-	-	-	-	-
30*	0.104	23.35	7.87	8.94	10	23	2.3	9	0.90
31	0.108	19.88	7.60	9.60	10	24	2.4	40	4.00
31	0.126	26.30	8.33	7.76	10	25	2.5	7	0.70
31	0.102	23.95	7.98	9.45	10	27	2.7	10	1.00
32	0.108	20.42	7.70	8.23	10	21	4.1	28	2.80
32	-	-	-	-	-	-	-	-	-
32	0.101	24.50	7.99	8.61	10	18	1.8	20	2.00
33	0.110	20.48	7.64	7.97	10	41	4.1	28	2.80
33	0.133	27.13	8.47	8.08	10	19	1.9	1	0.10
33*	0.102	24.86	8.06	8.58	10	20	2.0	23	2.30
34	0.112	20.90	7.90	6.01	10	11	1.1	9	0.90
34	-	-	-	-	-	-	-	-	-
34	0.107	24.64	7.91	8.74	10	28	2.8	15	1.50
				2008 TOTAL	**296**	**686**	**2.3**	**656**	**2.23**
				2009 TOTAL	**60**	**134**	**2.2**	**107**	**1.78**
				2010 TOTAL	**156**	**385**	**2.5**	**79**	**0.52**
				2011 TOTAL	**285**	**771**	**2.7**	**553**	**1.94**

*Genetic sample
2008 (Gray), 2009 (White) 2010 (Yellow) and 2011 (Green)

1.1.5 White Rapids Reservoir

White Rapids Reservoir was surveyed July 6, 2011. Ninety one stems were collected from 10 locations within the reservoir (Figure 1-5). The highest weevil population was found in Transects 1, 4, 6 and 7 with 45 or more weevil life stages on 8-10 stems (Table 1-5). Evidence of weevils was observed at every site including visually seeing eggs, adults, larvae damage and pupae holes within the stems. Algae covered the majority of the plants. Coontail (*Ceratophyllum demersum*) and Elodea (*Elodea canadensis*) were the dominant native species throughout the reservoir.

The only significant change in the water quality this year was the decrease in conductivity readings. All other measurements are similar to the other two years. The higher temperature and D.O. readings at T4 were due to native species at the surface.

Stem collection for the 2010 MEF study were from T3, 5, 6, 8 and 10 (Figure 1-5). Twenty one stems were identified as pure Eurasian watermilfoil while one stem (from T3) was identified hybrid. These areas were sampled again this season find the same results but the hybrid stems were found in transect 6, not 3. The remaining five locations (T1, 2, 4, 7, 9) were sampled in 2011, all were hybrid stems.

Table 1-5 Stem Analysis and Water Quality Data at Each Transect in White Rapids Reservoir

	Water Quality				Stem Counts			Weevil Count	
Transect	Cond	Temp	pH	DO	Stems	Meristems	Ave. Meristem/ Stem	Total Weevils	Ave. Weevils/ Stem
1	0.231	24.85	8.26	6.97	10	21	2.1	9	0.80
1	0.246	25.29	7.98	11.50	10	14	1.4	11	1.10
1*	0.196	24.41	8.56	8.70	10	15	1.5	45	4.50
2	0.237	24.82	8.16	7.80	10	10	1.0	7	0.70
2	0.255	25.23	7.78	9.10	10	14	1.4	27	2.70
2*	0.198	24.34	7.89	7.26	9	25	2.7	17	1.80
3	0.254	25.66	8.05	5.38	8	8	1.0	3	0.38
3	0.252	25.46	7.59	6.30	10	16	1.6	1	0.10
3*	0.202	24.43	7.82	7.50	10	9	0.9	10	1.00
4	0.235	24.66	8.10	8.39	10	26	2.6	13	1.30
4	0.252	24.87	7.75	10.17	10	11	1.1	16	1.60
4*	0.197	26.22	8.95	14.33	8	18	2.2	45	5.60
5	0.237	24.47	8.08	6.48	7	11	1.57	7	0.64

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Figure 1-5. WE Energies White Rapids Hydro Project. 2011 Weevil Distribution and Genetic Study.

5	0.258	25.59	8.00	11.55	10	10	1.0	11	1.10
5*	0.206	24.42	8.62	8.29	6	7	1.2	8	1.30
6	0.236	24.48	8.10	7.92	10	18	1.8	28	2.80
6	0.261	24.53	7.77	10.30	10	28	2.8	91	9.10
6	0.205	24.66	7.65	7.67	10	19	1.9	45	4.50
7	0.238	25.31	8.10	7.46	10	16	1.6	52	5.20
7	0.260	25.51	7.84	10.83	10	20	2.0	64	6.40
7*	0.201	24.94	8.09	9.45	10	13	1.3	74	7.40
8	0.237	25.37	8.23	9.49	10	16	1.6	3	0.30
8	0.252	25.33	7.94	10.32	10	17	1.7	31	3.10
8*	0.201	25.03	7.93	8.94	8	14	1.7	11	1.40
9	0.230	25.70	8.34	9.30	10	14	1.4	4	0.40
9	0.252	25.78	7.96	10.64	10	27	2.7	33	3.30
9*	0.199	24.61	7.73	7.75	10	10	1.0	9	0.90
10	0.238	25.07	8.12	8.03	10	23	2.3	16	1.60
10	0.248	25.74	8.00	11.12	10	20	2.0	30	3.00
10*	0.200	24.78	7.82	8.33	10	9	0.9	17	1.70
2008 TOTAL					**95**	**163**	**1.7**	**141**	**1.48**
2010 TOTAL					**100**	**177**	**1.8**	**315**	**3.15**
2011 TOTAL					**91**	**139**	**1.5**	**281**	**3.10**

*Genetic sample
2008 (Gray), 2010 (Yellow) and 2011 (Green)

1.1.6 Chalk Hill Reservoir

On July 6, 2011 the EnviroScience field team collected 129 stems from 14 locations that were originally established in 2008 (Figure 1-6). Although the milfoil was considered sparse in all areas but one, little weevil activity was observed in the field. The overall weevil population decreased from 2010 to 2011 but was exceptionally higher than 2008 (Table 1-6). The highest amounts of weevils were found in transects 6 and 14 finding 44 and 76, respectively.

The water quality readings for the 2011 survey were similar to what was found in 2008 but like that in White Rapids, there was a decrease in conductivity.
Milfoil was collected from 10 sites for the genetic study. Two pieces of Northern watermilfoil and one hybrid milfoil was found in T3. The rest of the sites contained hybrid milfoil.

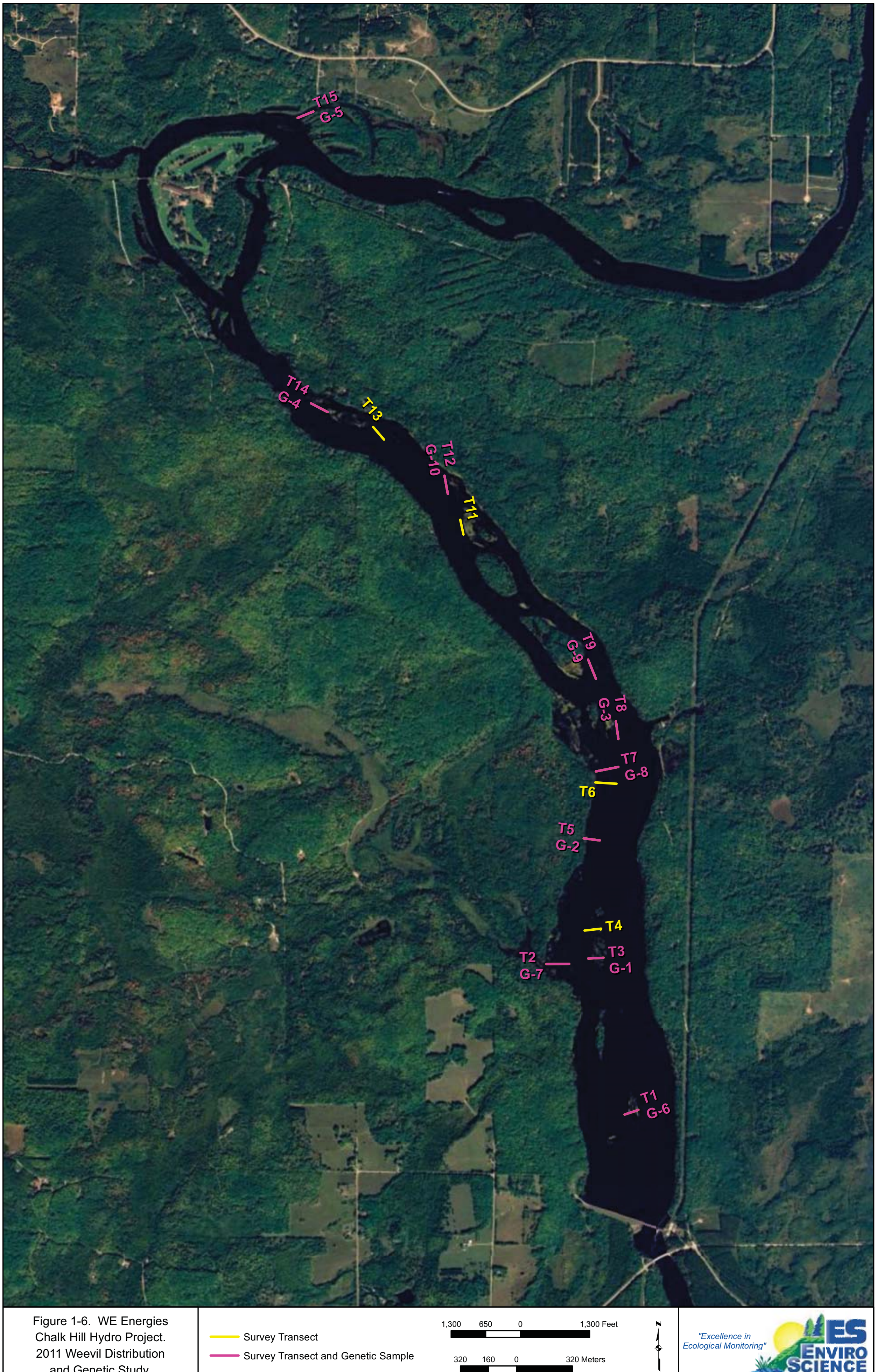

Figure 1-6. WE Energies Chalk Hill Hydro Project. 2011 Weevil Distribution and Genetic Study.

Table 1-6 Stem Analysis and Water Quality Data at Each Transect in Chalk Hill Reservoir

	Water Quality				Stem Counts			Weevil Count	
Transect	Cond	Temp	pH	DO	Stems	Meristems	Ave. Meristem/ Stem	Total Weevils	Ave. Weevils/ Stem
1	0.236	25.90	8.39	8.89	10	16	1.6	8	0.80
1	0.261	26.67	8.23	13.62	10	40	4.0	14	1.40
1*	0.208	25.23	8.01	8.62	10	23	2.3	12	1.20
2	0.233	25.64	8.40	8.56	10	13	1.3	3	0.30
2	0.264	26.05	8.15	11.53	9	19	2.1	47	5.22
2*	0.209	25.46	7.77	8.12	7	29	4.1	19	2.71
3	0.233	26.14	8.27	8.17	8	14	1.75	1	0.13
3	0.264	26.62	8.17	11.59	10	23	2.3	30	3.00
3*	0.200	24.43	7.75	8.49	10	40	4.0	10	1.00
4	0.237	26.44	8.25	8.23	10	31	3.1	11	1.10
4	0.265	26.42	8.14	11.52	8	7	0.9	26	3.25
4	0.201	24.44	7.77	8.20	2	8	4.0	0	0.00
5	0.231	25.76	8.12	7.95	10	16	1.6	10	1.00
5	0.264	26.47	8.60	15.30	10	16	1.6	14	1.40
5*	0.202	24.86	7.80	9.25	10	23	2.3	18	1.80
6	0.228	25.18	8.31	8.29	10	27	2.7	22	2.20
6	0.245	28.12	9.18	9.06	9	15	1.7	39	4.33
6	0.206	25.50	7.89	8.49	10	28	2.8	44	4.40
7	0.226	26.17	8.43	7.57	10	19	1.9	7	0.70
7	0.263	27.29	8.82	8.54	8	15	1.9	30	3.75
7*	0.211	26.73	8.00	9.04	10	42	4.2	23	2.30
8	0.230	25.88	8.35	8.44	10	15	1.5	23	2.30
8	0.271	25.67	8.47	7.30	10	18.5	1.9	24	2.40
8*	0.203	24.98	7.86	8.40	10	29	2.9	6	0.60
9	0.235	26.50	8.36	9.50	10	15	1.5	10	1.00
9	0.273	25.49	8.16	6.97	7	16	2.3	36	5.14
9*	0.200	24.26	7.72	7.74	10	22	2.2	1	0.10
10	0.231	24.40	8.11	7.03	10	29	2.9	4	0.40
10	0.278	24.27	7.80	10.88	8	31	3.9	8	1.00
10	0.207	25.89	7.91	8.38	-	-	-	-	-
11	0.236	25.66	8.26	7.32	10	24	2.4	55	5.50
11	0.279	24.36	7.81	10.47	10	18	1.8	19	1.90
11	0.201	24.21	7.77	7.85	10	20	2.0	1	0.10
12	0.233	25.56	8.18	7.50	10	31	3.1	25	2.50
12	0.281	24.51	7.84	11.31	7	17	2.4	31	4.43
12*	0.202	24.14	7.77	7.85	10	22	2.2	38	3.80

13	0.235	25.32	8.26	8.50	10	16	1.6	15	1.50
13	0.271	26.77	8.95	15.36	10	13	1.3	26	2.60
13	0.201	23.61	7.68	7.86	10	18	1.8	7	0.70
14	0.244	26.28	8.37	7.80	10	43	4.3	25	2.40
14	0.280	24.26	7.77	10.94	9	30	3.3	38	4.22
14*	0.202	23.66	7.73	7.87	10	27	2.7	76	7.60
15	0.255	27.00	8.66	9.88	10	29	2.9	12	1.20
15	0.279	24.99	8.00	12.30	8	12	1.5	4	0.50
15*	0.207	25.11	7.75	8.75	10	16	1.6	9	0.90
16	0.245	25.06	8.40	8.28	10	24	2.4	4	0.40
16	0.276	24.69	8.03	12.82	10	21	2.1	12	1.20
16	0.205	23.83	7.76	8.34	-	-	-	-	-
2008 TOTAL					**158**	**362**	**2.3**	**234**	**1.48**
2010 TOTAL					**163**	**311.5**	**2.2**	**398**	**2.86**
2011 TOTAL					**129**	**347**	**2.6**	**264**	**2.05**

*Genetic sample
2008 (Gray), 2010 (Yellow) and 2011 (Green)

1.1.7 Brule Reservoir

Due to the increase of EWM found in 2010, two new sampling sites were made for a total of 10 sites. The 2011 survey was conducted on July 9 and only three floating stems were found throughout Brule Reservoir. No milfoil was found or collected for the distribution or genetics study in July of 2011, a drastic change from 2010 (Table 1-7).

The data for the water quality measurements coincide more with the 2008 readings as the 2010 reading fluctuated a lot.

On August 4, 2011 a weevil follow up survey was conducted. Sparse EWM was found at 5 locations and 17 stems were collected for the genetics survey (Figure 1-7). All 17 stems were found to be hybrid milfoil.

Figure 1-7. WE Energies Brule Hydro Project. 2011 Genetic Study.

Table 1-7 Stem Analysis and Water Quality Data at Each Transect in Brule Reservoir

	Water Quality				Stem Counts			Weevil Count	
Transect	Cond	Temp	pH	DO	Stems	Meristems	Ave. Meristem/ Stem	Total Weevils	Ave. Weevils/ Stem
1	0.169	24.42	8.48	9.03	10	13	1.3	0	0.00
1	0.162	24.68	7.78	6.98	9	20	2.2	6	0.67
1	0.167	24.72	8.40	8.60	-	-	-	-	-
2	0.159	24.85	8.41	9.27	10	17	1.7	4	0.40
2	0.117	23.21	7.39	6.44	9	20	2.2	11	1.22
2	0.165	24.46	8.05	8.38	-	-	-	-	-
3	0.157	24.20	8.34	8.19	10	15	1.5	13	1.30
3	0.164	28.13	8.45	7.56	9	29	3.2	2	0.22
3	0.151	24.10	8.02	8.13	-	-	-	-	-
4	0.163	24.71	8.27	8.85	10	21	2.1	14	1.40
4	0.160	27.55	8.39	7.54	10	21	2.1	4	0.40
4	0.153	24.18	7.95	8.26	-	-	-	-	-
5	0.163	23.94	8.35	9.32	10	13	1.3	7	0.70
5	0.159	25.75	7.98	6.68	10	23	2.3	12	1.20
6	0.177	23.58	8.30	8.75	10	14	1.4	4	0.40
6	0.168	26.63	8.07	12.01	9	16	1.8	0	0.00
6*	0.148	24.19	7.61	7.02	-	-	-	-	-
7	0.171	23.18	8.08	7.69	10	14	1.4	2	0.20
7	0.183	22.28	7.31	12.59	9	25	2.8	14	1.56
7*	0.174	24.26	7.95	8.39	-	-	-	-	-
8	0.173	23.21	8.15	7.83	10	23	2.3	7	0.70
8	0.165	25.73	7.82	11.52	8	28	3.5	16	2.00
8*	0.169	24.41	7.92	8.26	-	-	-	-	-
9	0.175	27.42	8.82	11.65	10	26	2.6	13	1.30
9*	0.147	24.26	7.49	6.55	-	-	-	-	-
10	0.165	26.00	7.94	13.56	8	21	2.6	18	2.25
10*	0.168	24.67	7.93	8.11	-	-	-	-	-
				2008 TOTAL	**80**	**130**	**1.6**	**51**	**0.64**
				2010 TOTAL	**91**	**229**	**2.5**	**96**	**1.08**
				2011 TOTAL	**0**	**0**	**0.0**	**0**	**0.00**

*Genetic sample
2008 (Gray) 2010 (Yellow) and 2011 (Green)

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1.1.8 Lower Paint Reservoir

Eurasian watermilfoil was only found in 9 of the 13 transect locations on July 7, 2011 (Figure 1-8). A total of 87 stems were collected. Lab analysis revealed 89 weevil life stages on the stems for a total of 1.02 weevils/stem which is the lowest the weevil population has been of the three years surveyed (Table 1-8). Field observations found weevil evidence to be prevalent in transects 3 and 4 while being minimal in the T7-12. This is evident in the lab analysis as well.

From the three years of monitoring the water quality measurements in Lower Paint Reservoir, nothing from the 2011 readings stand out.

Nineteen stems were collected from Transects 3, 6, 7, 8, 10 and 12 all of which are of hybrid milfoil species.

Table 1-8 Stem Analysis and Water Quality Data at Each Transect in Lower Paint Reservoir

	Water Quality				Stem Counts			Weevil Count	
Transect	Cond	Temp	pH	DO	Stems	Meristems	Ave. Meristem/ Stem	Total Weevils	Ave. Weevils/ Stem
1	0.162	21.97	7.97	7.28	10	11	1.1	10	1.00
1	0.161	25.17	7.71	6.37	9	29	3.2	17	1.89
1	0.151	24.63	7.99	8.90	-	-	-	-	-
2	0.162	21.46	8.02	7.98	10	14	1.4	12	1.20
2	0.160	25.26	7.77	6.72	10	29	2.9	16	1.60
2	0.149	24.56	7.98	8.49	-	-	-	-	-
3	0.160	20.77	8.15	7.77	10	14	1.4	6	0.60
3	0.148	25.97	7.74	6.49	9	25	2.8	27	3.00
3*	0.153	24.62	7.95	8.54	10	32	3.2	25	2.50
4	0.161	20.96	8.09	7.70	10	14	1.4	3	0.30
4	0.156	24.66	7.69	5.95	8	16	2.0	14	1.75
4	0.155	24.99	8.01	8.98	10	31	3.1	24	2.40
5	0.162	20.83	8.12	7.90	10	11	1.1	12	1.20
5	0.160	25.42	7.82	11.41	10	35	3.5	29	2.90
5	0.155	24.98	8.01	8.79	-	-	-	-	-
6	0.165	21.27	8.25	8.58	10	12	1.2	12	1.20
6	0.162	24.64	7.89	12.83	10	31	3.1	30	3.00
6*	0.156	24.79	8.01	8.88	-	-	-	-	-
7	0.158	20.01	8.29	8.06	10	18	1.8	25	2.50
7	0.160	24.52	7.67	12.20	10	20	2.0	21	2.10
7*	0.155	25.21	7.98	8.60	10	17	1.7	13	1.30

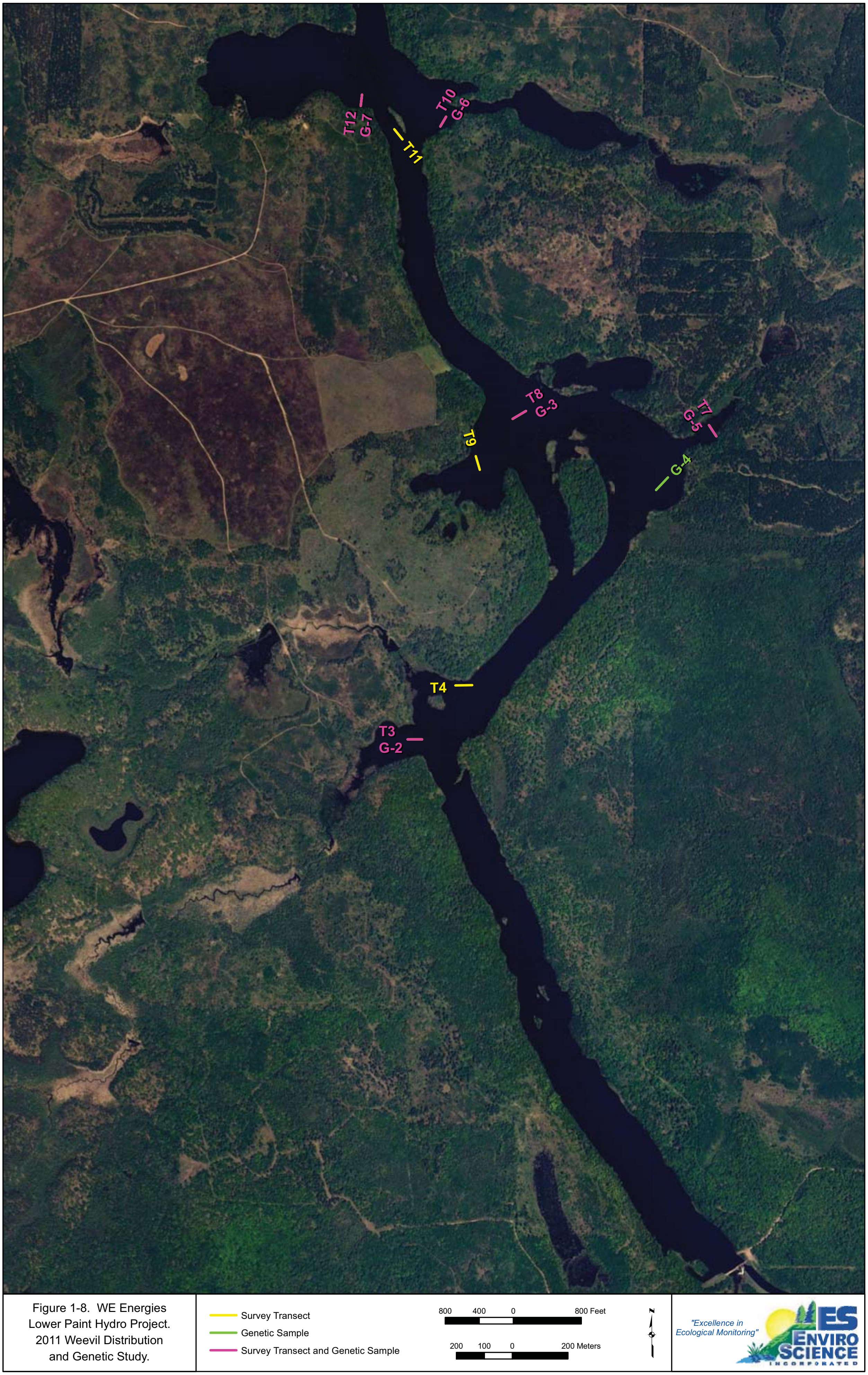

Figure 1-8. WE Energies Lower Paint Hydro Project. 2011 Weevil Distribution and Genetic Study.

8	0.167	21.46	8.31	8.56	10	26	2.6	37	3.70
8	0.155	23.10	7.46	10.66	10	22	2.2	54	5.40
8*	0.155	24.72	7.90	9.60	10	10	1.0	1	0.10
9	0.163	20.58	8.15	7.59	10	27	2.7	10	1.00
9	0.153	24.65	8.15	12.35	10	23	2.3	7	0.70
9	0.147	24.99	8.00	9.06	8	9	1.1	14	1.70
10	0.163	19.24	8.13	7.35	10	27	2.7	13	1.30
10	0.160	23.22	7.54	10.93	10	24	2.4	13	1.30
10*	0.156	23.75	7.75	8.34	10	17	1.7	2	0.20
11	0.161	20.59	8.12	6.67	10	26	2.6	16	1.60
11	0.164	23.87	7.61	11.93	10	13	1.3	25	2.50
11	0.155	24.10	7.93	8.43	10	15	1.5	6	0.60
12		20.37	8.54	7.49	10	22	2.2	14	1.40
12	0.148	22.30	8.29	11.30	10	19	1.9	2	0.20
12*	0.145	24.70	8.05	8.15	9	18	2.0	1	0.10
13	0.160	25.21	7.91	6.48	10	10	1.0	15	1.50
13	0.153	24.69	7.85	8.37	-	-	-	-	-
2008 TOTAL					**120**	**222**	**1.85**	**170**	**1.42**
2010 TOTAL					**135**	**314**	**2.3**	**277**	**2.00**
2011 TOTAL					**87**	**179**	**2.0**	**89**	**1.02**

*Genetic sample
2008 (Gray), 2010 (Yellow) and 2011 (Green)

1.1.9 Twin Falls Reservoir

A new site, T25, was established during the July 8 survey (Figure 1-9). Lab analysis revealed increases as well as decreases in all the sites for an overall total of 178 weevil life stages on 236 stems (Table 1-9). Field notes indicate the EWM beds in the northern part of the river (T1-9, 25) was found to be sparse and sporadic while the other beds were recorded as sparse to moderate and even dense.

The DO readings in Badwater Lake were still considerably high this year. However, the weevil numbers increased in most of these sites except for T23 and T24.

All 41 stems collected from Twin Falls Reservoir were genetically tested as hybrid milfoil. The same results were found in 2010.

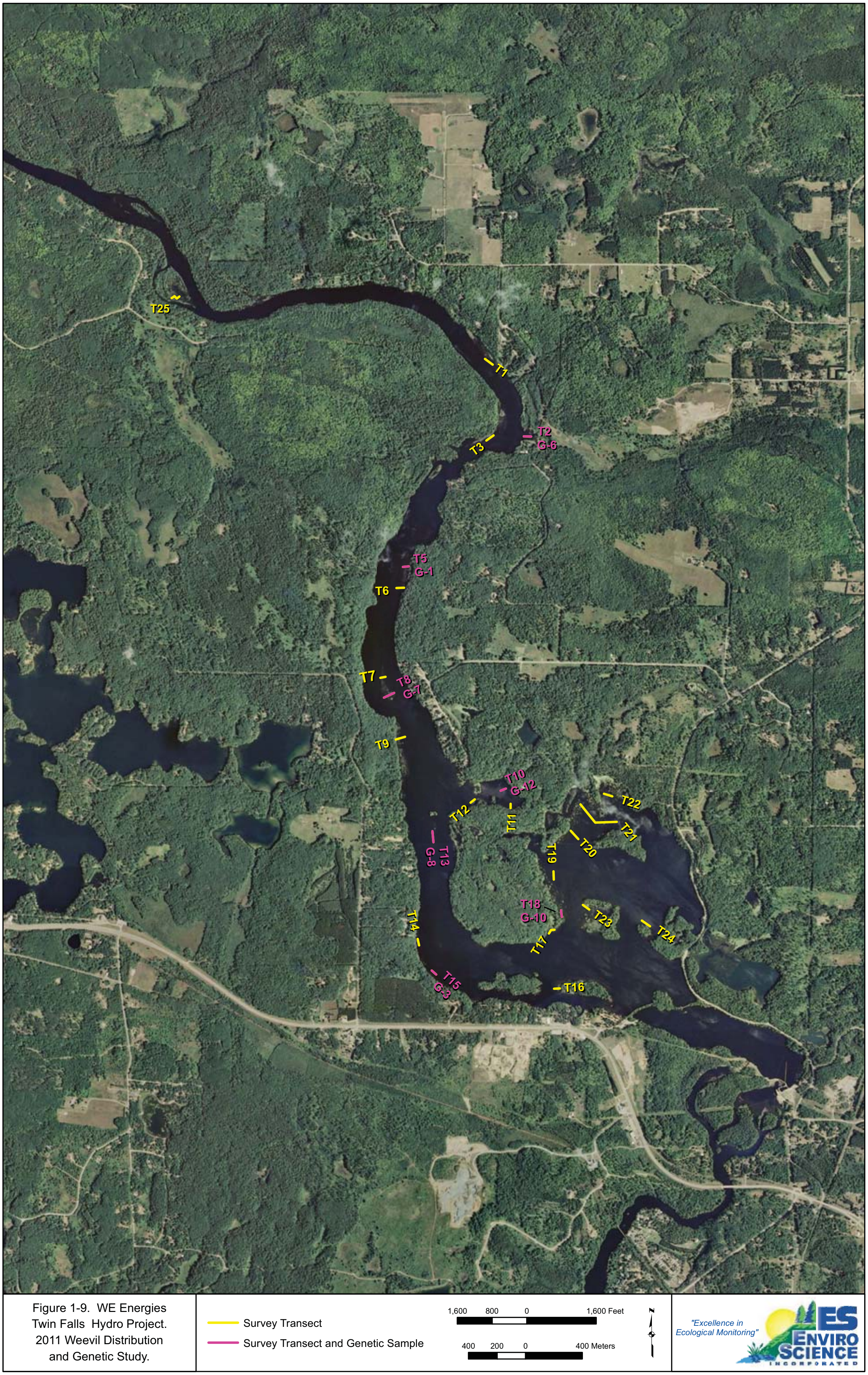

Figure 1-9. WE Energies Twin Falls Hydro Project. 2011 Weevil Distribution and Genetic Study.

Table 1-9 Stem Analysis and Water Quality Data at Each Transect in Twin Falls Reservoir

	Water Quality				Stem Counts			Weevil Count	
Transect	Cond	Temp	pH	DO	Stems	Meristems	Ave. Meristem/ Stem	Total Weevils	Ave. Weevils/ Stem
1	0.156	22.68	8.00	7.50	10	26	2.6	17	1.70
1	0.158	23.08	8.04	6.24	10	24	2.4	15	1.50
1	0.157	23.63	7.72	8.04	9	23	2.5	4	0.40
2	0.153	22.68	7.82	7.68	10	30	3.1	17	1.50
2	0.160	22.85	7.76	6.45	10	31	3.1	0	0.00
2*	0.155	25.05	7.84	8.01	10	29	2.9	16	1.60
3	0.154	23.30	7.83	8.02	10	22	2.2	22	2.20
3	0.162	23.83	7.85	7.26	10	19	1.9	6	0.60
3	0.147	22.23	7.72	7.75	10	22	2.2	14	1.40
4	0.151	22.66	8.03	7.46	10	24	2.4	21	2.10
4	0.160	23.41	7.83	6.87	10	16	1.6	3	0.30
4	0.144	23.64	7.90	8.90	-	-	-	-	-
5	0.146	23.80	7.96	8.39	10	23	2.3	17	1.70
5	0.164	23.91	7.75	6.31	10	17	1.7	4	0.40
5*	0.145	22.72	7.77	8.07	10	23	2.3	14	1.40
6	0.144	23.45	7.89	7.68	10	29	2.9	15	1.50
6	0.172	24.23	8.81	10.50	10	17	1.7	15	1.50
6	0.144	22.90	7.72	8.21	9	30	3.3	16	1.70
7	0.148	23.65	7.95	8.92	10	32	3.2	5	0.50
7	0.161	23.35	7.86	6.13	10	33	3.3	1	0.10
7	0.145	23.45	7.78	8.55	10	32	3.2	17	1.70
8	0.144	23.36	7.99	8.32	10	21	2.1	20	2.00
8	0.163	23.60	8.19	6.91	10	18	1.8	6	0.60
8*	0.146	23.73	7.79	8.30	10	20	2.0	17	1.70
9	0.152	23.62	7.95	8.18	10	23	2.3	7	0.50
9	0.160	22.75	7.89	6.17	10	25	2.5	4	0.40
9	0.146	23.08	7.74	8.86	9	32	3.5	15	1.60
10	0.151	22.31	7.81	7.78	10	19	1.9	9	0.90
10	0.188	27.50	8.66	7.62	10	21	2.1	0	0.00
10*	0.153	27.36	8.23	8.73	10	18	1.8	1	0.10
11	0.152	22.45	7.78	7.93	10	8	0.8	3	0.30
11	0.187	27.10	8.61	8.04	9	21	2.3	0	0.00
11	0.155	27.48	8.18	9.13	10	23	2.3	1	0.10
12	0.148	22.35	7.75	7.41	10	23	2.3	9	0.90
12	0.192	27.14	8.39	12.03	10	36	3.6	5	0.50

12	-	-	-	-	10	16	1.6	2	0.20
13	0.149	22.20	7.86	7.71	10	29	2.9	13	1.30
13	0.170	24.47	7.83	12.81	10	25	3.5	4	0.40
13*	0.151	24.08	7.77	8.49	10	31	3.1	5	0.50
14	0.151	22.78	7.82	7.60	10	19	1.9	10	1.00
14	0.181	26.21	8.00	13.41	9	28	3.1	5	0.56
14	0.162	26.41	8.04	9.75	10	22	2.2	9	0.90
15	0.151	22.52	7.85	7.77	10	16	1.6	7	0.70
15	0.176	25.05	7.94	12.39	10	36	3.6	1	0.10
15*	0.163	26.81	8.22	9.68	10	13	1.3	2	0.20
16	0.152	22.68	8.01	8.12	10	24	2.4	20	2.00
16	0.192	26.48	8.01	13.35	9	23	2.6	4	0.44
16*	0.156	26.56	8.30	9.91	10	24	2.4	7	0.70
17	0.150	22.59	8.08	7.84	9	16	1.78	1	0.11
17	0.181	25.00	8.12	12.92	10	21	2.1	5	0.50
17	0.152	25.86	8.09	9.08	10	16	1.6	7	0.70
18	0.147	23.26	8.09	7.57	10	13	1.3	5	0.50
18	0.184	27.32	8.94	13.78	10	22	2.2	3	0.30
18*	0.151	28.27	8.81	9.32	10	18	1.8	7	0.70
19	0.151	23.09	8.19	8.48	8	15	2.5	6	0.88
19	0.181	27.04	8.99	15.53	10	26	2.6	0	0.00
19	0.149	27.31	8.78	10.09	10	18	1.8	5	0.50
20	0.154	24.06	8.21	8.12	10	20	1.4	7	0.00
20	0.181	27.60	9.24	15.71	10	20	2.0	0	0.00
20	0.150	27.57	9.00	10.32	9	20	2.2	8	0.80
21	0.151	23.86	8.35	8.89	9	14	2.22	0	0.00
21	0.180	27.27	9.23	15.98	10	18	1.8	1	0.10
21*	0.149	26.95	8.72	10.22	10	33	3.3	3	0.30
22	0.153	23.77	8.48	9.07	7	15	2.14	4	0.57
22	0.185	27.51	9.06	11.50	10	21	2.1	0	0.00
22	0.146	25.32	8.47	9.88	10	25	2.5	3	0.30
23	0.152	23.55	8.36	8.91	9	19	2.0	5	0.56
23	0.184	26.39	8.89	15.39	10	24	2.4	5	0.50
23	0.150	27.94	8.76	10.36	10	14	1.4	0	0.00
24	0.155	24.42	8.17	8.14	10	22	2.1	6	0.60
24	0.186	26.46	8.60	13.43	10	22	2.2	1	0.10
24*	0.147	26.08	8.19	9.42	10	20	2.0	0	0.00
25	0.153	25.53	7.92	8.53	10	30	3.0	5	0.50
2008 TOTAL					**232**	**506**	**2.2**	**236**	**1.02**
2010 TOTAL					**237**	**564**	**2.4**	**102**	**0.43**
2011 TOTAL					**236**	**552**	**2.3**	**178**	**0.75**

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*Genetic sample
2008 (Gray), 2010 (Yellow) and 2011 (Green)

1.1.10 Pine Reservoir

For many years, the genetic makeup of the plants in Pine Reservoir were questionable as; Northern, Eurasian or Hybrid. Stems were collected on July 7, 2010 from three areas for a total of 21 stems all of which were identified as Northern watermilfoil (Figure 1-10). Samples were collected from transects 1 and 2 on July 6, 2011 for a total of 8 stems. Six were genetically tested as Northern watermilfoil and the last two were hybrid. The hybrid was collected from Transect 1.

1.2 Weevil Distribution and Genetic Discussion

The EWM decreased in Brule and Lower Paint which resulted in the overall weevil population decreasing. The EWM population decreased in Big Quinnesec, and the overall density of weevils on the remaining EWM increased. However, the total weevil population size decreased due to the lack of EWM. Other reservoirs where the weevil population decreased were Chalk Hill, although the number was higher than what was found in 2008, and a slight decrease in White Rapids reservoir. An increase was seen in weevil populations in Twin Falls, Peavy Falls, Michigamme Falls and Kingsford Reservoirs. Since 2009, the EWM in Peavy Falls has increased in density, and the weevil population has decreased. Although the density of EWM increased in 2011, the weevil population also increased, reversing the previous trend. The total population in 2011 was 1.94 weevils/stem, the second highest recorded (highest was 2.23 in 2008).

Hybrid milfoil was identified this season in Pine Reservoir through genetic testing. In 2010 all of the sampled plants were identified as Northern watermilfoil. However, it is possible that hybrid milfoil was present in the reservoir, but was not detected due to the low number of stems tested (4-5 stems per site). Since EWM has never been found in Pine Reservoir, the most likely source of hybrid introduction is waterfowl or watercraft.

This particular survey has been performed during the same week annually for four years. In this time EnviroScience biologists have observed fluctuations in the density of EWM (and hybrid milfoil), the weevil population in each reservoir as well as all water quality parameters. There are other possible factors such as environmental variations (e.g. onset of spring or snow melt), nutrient fluctuation or other populations of herbivorous insects (e.g. *Phytobius leucogaster*) that may contribute to the unpredictability of changes from year to year. Performing this same survey on a monthly basis during the growing season rather than yearly basis may be more effective in capturing the EWM/ weevil relationship.

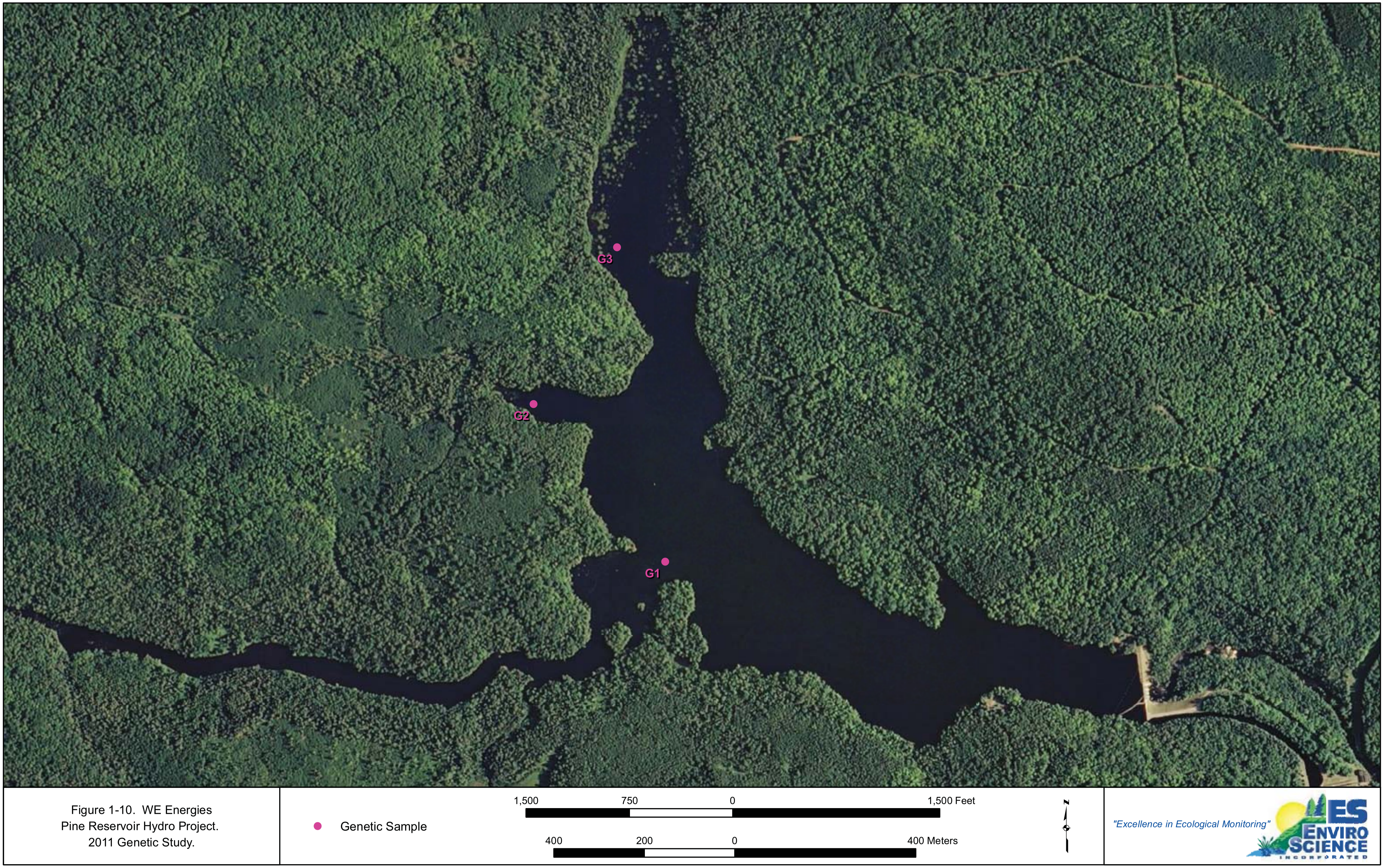

Figure 1-10. WE Energies
Pine Reservoir Hydro Project.
2011 Genetic Study.

2.0 MILFOIL SOLUTION® PROGRAM

During the summer of 2007, a Milfoil Solution® (formerly MiddFoil®) program began and 25 units (1,000 weevils = 1 unit) of milfoil weevils were stocked on Eurasian watermilfoil (EWM) in three reservoirs in the Menominee River system: Brule, Twin Falls (Badwater), and Lower Paint. The discovery of an indigenous weevil population that year led to the start of a weevil distribution study in 2008. It was decided to further implement the Milfoil Solution® program in 2009 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 2010, surveys were conducted in Badwater, Brule, Cowboy and Lower Paint. In addition to surveys in Lower Paint, 12,000 weevils were stocked for a second consecutive year.

In 2011, both initial and follow-up surveys were conducted in Badwater, Brule, Cowboy, and Lower Paint. 10,000 weevils were stocked in Lower Paint for a third consecutive year of biological control augmentation. Qualitative and quantitative data were recorded to evaluate weevil and EWM densities, weevil damage, and the identification and distribution of native macrophytes and their relative densities within the study sites.

2.1 MILFOIL SOLUTION® RESULTS

Both quantitative and qualitative data collection were completed at the time of the initial and follow-up surveys in each site. Quantitative data collection included collecting EWM stems along three transect lines to microscopically analyze the presence of weevil life stages and determine the number of weevils per stem in a survey area. EWM plant density was determined by collecting all stems within a 0.09 m^2 PVC quadrat and converting this to the number of EWM stems per square meter. The data will serve as an indicator of fluctuations in EWM density across multiple survey years.

Qualitative measurements include visual analysis of the milfoil plants, the presence of a weevil population and weevil-induced damage, and native plant species abundance in the survey areas.

2.1.1 Brule Reservoir – S1B

Initial survey

No EWM was found at the time of the June 14, 2011 initial survey at S1B in Brule Reservoir, located where the Brule River meets the Menominee River (Figure 2-1). Transect and density data were not recorded due to the absence of EWM at this site and no weevils were stocked.

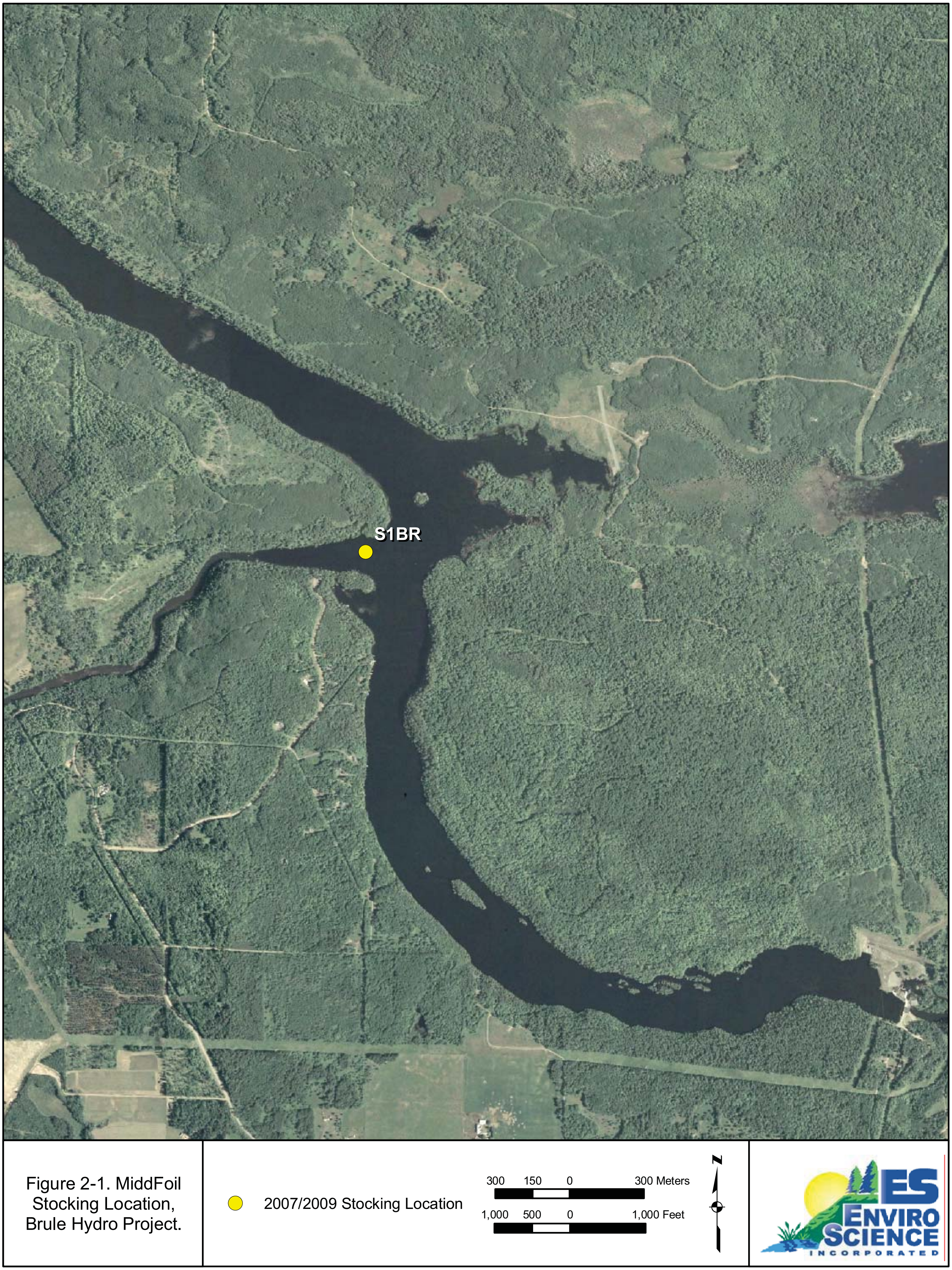

Figure 2-1. MiddFoil Stocking Location, Brule Hydro Project.

Follow-up survey

EWM density had increased slightly at the time of the August 4, 2011 follow-up survey but was still considered sparse, composing about 10% of the plant community. Other species identified were Clasping-leaf pondweed (*Potamogeton richardsonii*), Coontail (*Ceratophyllum demersum*), and Sago pondweed (*Potamogeton pectinatus*). No weevil life stages or damage to the EWM was observed in the field. No weevil life stages or weevil-induced damage was found during lab analysis (Table 2-1A). EWM density at this site has decreased from 133.34 stems/m^2 in 2007 to undetectable in 2011 (Table 2-1B).

Table 2-1A Summary Data from Site Transect Analysis of EWM During 2007, 2009, 2010, and 2011 Initial and Follow-up Surveys of Brule Reservoir

Site #	Parameter Measured	Initial Survey 6/27/07	Follow-up Survey 8/8/07	Initial Survey 6/23/09	Follow-up Survey 8/18/09	Initial Survey 6/15/10	Follow-up Survey 8/5/10	Initial Survey 6/14/11	Follow-up Survey 8/4/11
S1B	Total weevils	18.00	15.00	0.00	12.00	24.00	23.00		0.0
	Total stems	30.00	30.00	30.00	30.00	30.00	29.00	*NP	30.00
	Total weevils/stem	**0.60**	**0.50**	**0.00**	**0.40**	**0.80**	**0.79**		**0.00**
	Average meristems/stem	2.13	2.73	3.07	3.13	2.87	1.38		2.10

*NP= EWM Not Present

Table 2-1B Average Seasonal Densities of Eurasian Watermilfoil Collected During 2007, 2009, 2010, and 2011 Initial and Follow-up Surveys of Brule Reservoir (stems/m^2)

Site #	2007	2009	2010	2011
S1B	133.34	72.22	42.40	*NP

*NP= EWM Not Present

2.1.2 Kingsford Reservoir (Cowboy Lake) – S1C

Initial survey

Initial surveys were conducted on June 14, 2011 at S1C in northwest corner of Cowboy Lake, located in Kingsford Reservoir (Figure 2-2). At the time of the survey the EWM was below the surface and was considered sparse to moderate, composing about half of the plant species composition. Native plant species present included: Common waterweed (*Elodea canadensis*), Coontail, Flat-stem pondweed (*Potamogeton zosteriformis*), and Robbins pondweed (*Potamogeton robbinsii*). EWM was coated in algae and epiphytes and occurred in sporadic patches, becoming denser further from shore.

Numerous weevil adults and eggs were observed in the field with an estimated 40% damage to the EWM. Laboratory analysis of these extensively damaged stems revealed the greatest density of weevils in any survey location to date at 115 life stages averaging to 3.97 weevils/stem (Table 2-2A).

Follow up survey

EWM density had increased at the time of the follow-up survey on August 4, 2011 and was considered moderate. Lab analysis of the transect stems revealed three weevil life stages, though at a lower density than the initial 2011 survey (Table 2-2A). EWM density has decreased in S1C by approximately 95% from 69.45 stems/m^2 in 2009 to 9.70 stems/m^2 in 2011 (Table 2-2B).

Table 2-2A Summary Data from Site Transect Analysis of EWM During 2009, 2010, and 2011 Initial and Follow-up Surveys of Cowboy Lake

Site #	Parameter Measured	Initial Survey 6/23/09	Follow-up Survey 8/19/09	Initial Survey 6/15/10	Follow-up Survey 8/5/10	Initial Survey 6/14/11	Follow-up Survey 8/4/11
S1C	Total weevils	0.00	2.00	23.00	4.00	115.00	3.00
	Total stems	30.00	30.00	28.00	30.00	29.00	27.00
	Total weevils/stem	**0.00**	**0.07**	**0.82**	**0.13**	**3.97**	**0.11**
	Average meristems/stem	1.13	1.90	2.04	1.97	2.07	2.11

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

2009 Stocking Location

100 50 0 100 Meters

300 150 0 300 Feet

N

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Table 2-2B Average Seasonal Densities of Eurasian Watermilfoil Collected During 2009, 2010, and 2011 Initial and Follow-up Surveys of Cowboy Lake (stems/m^2)

Site #	2009	2010	2011
S1C	69.45	15.89	9.70

2.1.3 Lower Paint Reservoir – S1LP, S2LP, S3LP, S4LP

Initial survey

No EWM was found in S1LP and S4LP at the time of the initial survey in Lower Paint Reservoir on June 14, 2011. Two sites were surveyed (S2LP and S3LP) and 10,000+ weevils were stocked south of S3LP (Figure 2-3). EWM was sparse to moderate in both sites and composed 15-35% of the plant species in S2LP and S3LP, respectively.

Native plant species throughout the survey sites included: Bladderwort (*Utricularia subulata*), Clasping-leaf pondweed, Common waterweed, Coontail, Northern watermilfoil, Whorled watermilfoil, Flat-stem pondweed, Large-leaf pondweed (*Potamogeton amplifolius*), Robbins pondweed, Thin-leaf pondweed (*Potamogeton pusillus*), Water marigold (*Bidens beckii*) and Yellow water lily (*Nuphar sp.*).

EWM at both survey sites was overall healthy and some stems were indicative of new growth. Adult weevils and eggs were seen at both sites and a majority of weevil activity was observed in the stocking area south of S3LP. Quantitative analysis revealed the presence of multiple weevil life stages and extensive damage on stems from both sites with weevil density ranging from 1.00 to 1.66 weevils/stem (Table 2-3A).

Follow up survey

A follow-up survey was conducted at three sites (S1LP, S2LP, and S3LP) on August 4, 2011. EWM density in S1LP was considered sparse, S2LP was sparse to moderate, and S3LP was moderate. No EWM was found in S4LP. The percentage of EWM to native plant species ranged from 12-35%. Native species identified throughout the sites include: Chara (*Chara* sp.), Clasping-leaf pondweed, Common waterweed, Coontail, Eel grass (*Vallisneria americana*), Flat-stem pondweed, Large-leaf pondweed, Naiad (*Najas sp.*), Northern watermilfoil, Robbins pondweed, Whorled watermilfoil,Thin-leaf pondweed , Water lily and Water marigold.

A weevil population was not observed in the field but life stages and damage were found at all three survey sites during laboratory analysis (Table 2-3A). From the initial

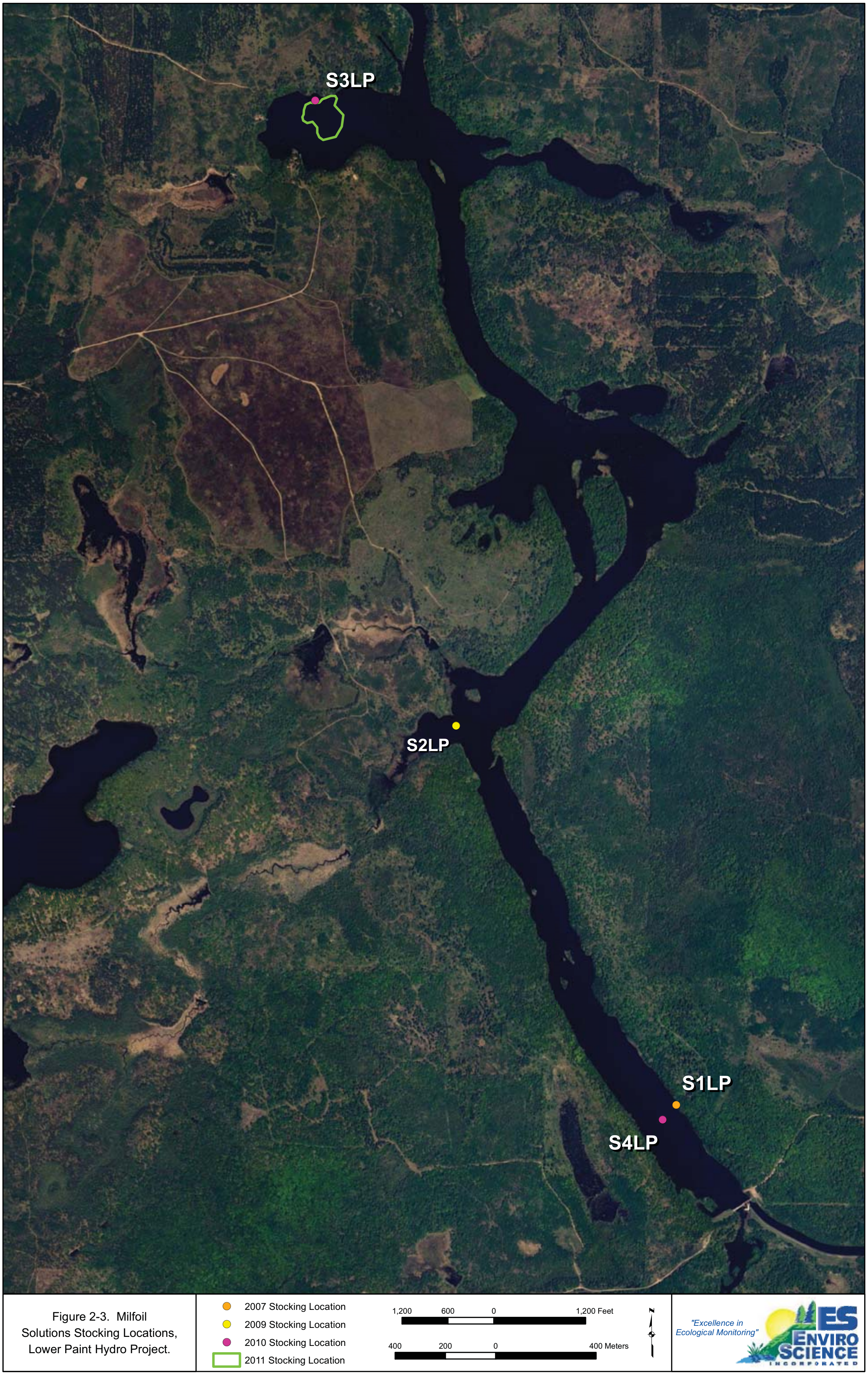

Figure 2-3. Milfoil Solutions Stocking Locations, Lower Paint Hydro Project.

surveys to present, quantitative EWM density has decreased in S2LP and S3LP by 62% and 80% respectively (Table 2-3B). EWM at S1LP was sparse and did not warrant collecting a density sample.

Table 2-3A Summary Data from Site Transect Analysis of EWM During 2007, 2009, 2010, and 2011 Initial and Follow-up Surveys of Lower Paint Reservoir

Site #	Parameter Measured	Initial Survey 6/27/07	Follow-up Survey 8/8/07	Initial Survey 6/22/09	Follow-up Survey 9/18/09	Initial Survey 6/15/10	Follow-up Survey 8/5/10	Initial Survey 6/14/11	Follow-up Survey 8/4/11
S1LP	Total weevils	77.00	25.00	45.00	8.00	--	--	*NP	3.00
	Total stems	30.00	30.00	30.00	30.00	--	--		10.00
	Total weevils/stem	**2.57**	**0.67**	**1.50**	**0.27**	--	--		**0.3**
	Average meristems/stem	1.37	2.47	2.80	2.10	--	--		1.8
S2LP	Total weevils	n/a	n/a	11.00	20.00	95.00	20.00	28.00	20.00
	Total Stems	n/a	n/a	47.00	30.00	27.00	28.00	28.00	28.00
	Total weevils/stem	n/a	n/a	**0.23**	**0.67**	**3.52**	**0.71**	**1.00**	**0.71**
	Average Meristems/stem	n/a	n/a	2.83	2.00	4.04	2.32	2.78	2.32
S3LP	Total weevils	n/a	n/a	n/a	n/a	84.00	14.00	50.0	14.00
	Total stems	n/a	n/a	n/a	n/a	30.00	30.00	30.00	30.00
	Total weevils/stem	n/a	n/a	n/a	n/a	**2.80**	**0.47**	**1.66**	**0.47**
	Average meristems/stem	n/a	n/a	n/a	n/a	4.04	1.77	2.73	1.77
S4LP	Total weevils	n/a	n/a	n/a	n/a	151.00	11.00	*NP	*NP
	Total stems	n/a	n/a	n/a	n/a	60.00	28.00		
	Total weevils/stem	n/a	n/a	n/a	n/a	**2.52**	**0.39**		
	Average meristems/stem	n/a	n/a	n/a	n/a	2.67	2.64		

*NP= EWM Not Present

Table 2-3B Seasonal Densities of Eurasian Watermilfoil Collected During 2007, 2009, 2010, and 2011 Initial and Follow-up Surveys of Lower Paint Reservoir (stems/m^2)

Site #	2007	2009	2010	2011
S1LP	63.89	31.95	--	*NP
S2LP	n/a	33.34	65.70	12.89
S3LP	n/a	n/a	47.23	9.23
S4LP	n/a	n/a	58.34	*NP

n/a = site not established
*NP= EWM Not Present

2.1.4 Twin Falls Reservoir (Badwater Lake) – S1BT

Initial survey

Initial survey was conducted at S1BT in Badwater Lake in Twin Falls Reservoir (Figure 2-4) on June 14, 2011 and no weevils were stocked. EWM density was considered moderate at the time of the initial survey and very little weevil-induced damage was observed. No weevil life stages or damage were observed in the field. One weevil adult and two eggs were found on the transect stems analyzed in the lab and minimal damage was seen (Table 2-4A).

EWM composed less than half of the plant community and native plant species present included: Flat-stem pondweed, Large-leaf pondweed, and White-stem pondweed (*Potamogeton praelongus*).

Follow up survey

EWM density had increased at this site at time of the follow-up survey on August 4, 2011 but the average seasonal density (28.89 stems/meter^2) had decreased by about 75% from the 2009 measurement (Table 2-4B). No weevil life stages were found on the transect stems analyzed in the lab and minimal damage was observed (Table 2-4A).

Figure 2-4. MiddFoil Stocking Locations, Twin Falls Hydro Project.

Table 2-4A Summary Data from Site Transect Analysis of EWM During 2007, 2010, and 2011 Initial and Follow-up Surveys of Badwater Lake

Site #	Parameter Measured	Initial Survey 6/23/07	Follow-up Survey 8/18/07	Initial Survey 6/15/10	Follow-up Survey 8/5/10	Initial Survey 6/14/11	Follow-up Survey 8/4/11
S1BT	Total weevils	0.00	0.00	1.00	3.00	10.00	0.00
	Total stems	29.00	30.00	29.00	30.00	29.00	30.00
	Total weevils/stem	**0.00**	**0.0**	**0.03**	**0.10**	**0.35**	**0.00**
	Average meristems/stem	1.93	1.77	1.97	1.23	3.14	1.77

Table 2-4B Average Seasonal Densities of Eurasian Watermilfoil Collected During 2009, 2010, and 2011 Initial and Follow-up Surveys of Badwater Lake (stems/m^2)

Site #	2009	2010	2011
S1BT	116.11	36.11	28.89

2.2 MILFOIL SOLUTION® DISCUSSION

All four reservoirs/lakes surveyed in 2011 have been stocked with milfoil weevils at some point: Badwater in 2007; Brule in 2007 and 2009; Cowboy Lake in 2009; and Lower Paint in 2007, 2009, 2010, and 2011. Overall trends have been detected in the 2011 survey results:

- EWM density has decreased at every survey site when comparing data from the onset of the program to 2011 with many sites experiencing a decrease of over 50%. Both weevil populations and seasonal variability are likely contributing factors to these trends observed.
- Weevil life stages were found in all but one survey sites during laboratory analysis. A majority of measured weevil densities are well above what the literature cites as contributing to significant decreases EWM, between 0.5 and 1.5 weevils/stem (Newman and Biesboer, 2000).

Brule Reservoir –EWM density has drastically decreased from the time of the initial survey in 2007 which in turn results the weevil population to decrease in number as well.
Cowboy Lake – this site contains the highest density of weevils compared to all other survey sites. EWM in the stocking location has been reduced to almost 95% from the initial year of stocking to present.
Lower Paint Reservoir –two of four sites have diminished and the remaining sites maintain a weevil population.
Badwater Lake – although weevil density has decreased, EWM density has also decreased by half between 2007 and 2010. EWM was observed to be denser in the lake than in the nearby river.

Biological control organisms require adequate time to build their populations to a critical density before an effective program can be realized. Control using the Milfoil Solution® process is defined as reduction in the density of EWM, maintaining the exotic plant at non-nuisance levels, an increase in native plants, and often elimination of entire milfoil beds. Recently completed and ongoing Milfoil Solution® programs in the United States and Canada have demonstrated that three years of stocking typically result in effective lake-wide control. Multiple-year stocking of milfoil weevils allows for local environmental variations and an adequate time to for the weevils to increase in number. In addition, stocking lakes that maintain an ample native weevil population serves as an important component in successful programs.

References:

Newman, R.M. and Biesboer, D.D. 2000. A Decline of Eurasian Watermilfoil in Minnesota Associated with the Milfoil Weevil *Euhrychiopsis lecontei* J Aquat. Plant Manage. 38: 105-111.

Document Content(s)