Northbrook Energy, LLC

FILED ELECTRONICALLY
December 15, 2009

Office of the Secretary
Federal Energy Regulatory Commission
888 1st Street, NE
Washington, DC 20426

Re: Little Quinnesec Falls Hydroelectric Project, FERC No. 2536
Milfoil Weevil Monitoring and Eurasian Watermilfoil Adaptive Management Plan

Northbrook Wisconsin, LLC ("Northbrook") engaged White Water Associates, Inc. to develop a plan to address the specific Eurasian watermilfoil circumstances at the Little Quinnesec Falls Hydroelectric Project in consultation with resource agencies, researchers, and others knowledgeable in Eurasian watermilfoil and the milfoil weevil. The resulting plan, titled *Milfoil Weevil Monitoring and Eurasian Watermilfoil Adaptive Management Plan for the Little Quinnesec Hydroelectric Project* ("Plan"), was submitted to the resource agencies for comments by letter dated April 13, 2010. Comments were received and incorporated into the final Plan. The Plan is enclosed for filing herewith.

Very truly yours,
For Northbrook Wisconsin, LLC

Chuck Ahlrichs
President

14550 N Frank Lloyd Wright #210
Scottsdale, Arizona 85260
480-551-1221/Fax 480-551-1991

Northbrook Energy, LLC

May 17, 2010

Ms. Jessica Mistak
Senior Fisheries Biologist
Michigan Department of Natural Resources
Marquette Fisheries Station
484 Cherry Creek Road
Marquette, MI 49855

Nicholas J. Utrup
Wisconsin Hydropower Coordinator
U.S. Fish & Wildlife Service
Green Bay Field Office
2661 Scott Tower Drive
New Franken, WI 54229

Mr. Michael Donofrio
Lower Fox/Upper Green Bay Fisheries Supervisor
Wisconsin Department of Natural Resources
Peshtigo Service Center
101 N. Ogden
Pestigo, WI 54157

Re: Little Quinnesec Falls Hydroelectric Project, FERC No. 2536
Milfoil Weevil Monitoring and Eurasian Watermilfoil Adaptive Management Plan

Northbrook Wisconsin, LLC ("Northbrook") engaged White Water Associates, Inc. to develop a plan to address the specific Eurasian watermilfoil circumstances at the Little Quinnesec Falls Hydroelectric Project in consultation with resource agencies, researchers, and others knowledgeable in Eurasian watermilfoil and the milfoil weevil. The resulting plan, titled *Milfoil Weevil Monitoring and Eurasian Watermilfoil Adaptive Management Plan for the Little Quinnesec Hydroelectric Project*, was submitted to you for comments by letter dated April 13, 2010. Your comments have been received and incorporated into the final plan, enclosed herewith.

If you have any questions, please feel free to contact me at (480) 551-1771, or Dean Premo of White Water Associates at (906) 822-7889.

Sincerely,
For Northbrook Wisconsin, LLC

Chuck Ahlrichs
President

14550 N Frank Lloyd Wright #210
Scottsdale, Arizona 85260
480-551-1221/Fax 480-551-1991

Chuck Ahlrichs

From: Donofrio, Michael C - DNR [Michael.Donofrio@wisconsin.gov]
Sent: Monday, May 17, 2010 5:27 AM
To: Chuck Ahlrichs; Nick Utrup
Cc: Jessica Mistak; dean.premo@white-water-associates.com
Subject: RE: Little Quinnesec Milfoil Plan

WDNR concurs with MDNRE comments and have no further issues with the Plan.

P Michael Donofrio
Lower Fox/ Upper Green Bay Fisheries Supervisor Bureau of Fisheries Management Wisconsin Department of Natural Resources Peshtigo Service Center
101 N Ogden Rd
Peshtigo, WI 54157
(*) phone: (715)582-5050
(*) fax: (715) 582-5005
(*) e-mail: Michael.Donofrio@Wisconsin.gov

-----Original Message-----
From: Chuck Ahlrichs [mailto:cahlrichs@nbenergy.com]
Sent: Thursday, May 13, 2010 5:18 PM
To: Nick Utrup; Donofrio, Michael C - DNR
Cc: Jessica Mistak; dean.premo@white-water-associates.com
Subject: RE: Little Quinnesec Milfoil Plan

Messrs. Utrup and Donofrio,

Do you have any comments before we finalize the Plan?

Chuck Ahlrichs
Northbrook Energy, LLC
14550 N Frank Lloyd Wright Blvd, Suite 210 Scottsdale, AZ 85260
Email: cahlrichs@nbenergy.com
Voice: +1 (480) 551-1771
Mobile: +1 (312) 550-5827

-----Original Message-----
From: Jessica Mistak [mailto:mistakj@michigan.gov]
Sent: Thursday, May 06, 2010 7:11 AM
To: Chuck Ahlrichs; dean.premo@white-water-associates.com
Cc: Nick Utrup; Mike Donofrio
Subject: Little Quinnesec Milfoil Plan

Chuck and Dean,
The MDNRE has reviewed the April 13, 2010 Milfoil Weevil Monitoring and Eurasian Watermilfoil Adaptive Management Plan for the Little Quinnesec Project. Overall, the plan is very well written. Our minor recommendations are:

- Baseline survey for milfoil weevil, page 12- It appears that it would make more sense to first collect water quality data prior to collecting Eurasian water milfoil, especially if personnel will be wading in the water to collect plant samples.

- Please provide a schedule for correspondence with the resource agencies.

Thanks,
Jessica

Jessica Mistak, Senior Fisheries Biologist DNRE Marquette Fisheries Station
488 Cherry Creek Rd
Marquette, MI 49855
906-249-1611 ext. 308
FAX 906-249-3190
mistakj@michigan.gov

Chuck Ahlrichs

From: Nick_Utrup@fws.gov
Sent: Friday, May 14, 2010 6:23 AM
To: Chuck Ahlrichs
Subject: RE: Little Quinnesec Milfoil Plan

Hi Chuck,

I have no further comments beyond what Jessica has already stated.

Nick

Nicholas J. Utrup
Wisconsin Hydropower Coordinator
U.S. Fish and Wildlife Service
Green Bay Ecological Services Field Office
2661 Scott Tower Drive
New Franken, WI 54229

Office: (920) 866-1736
Mobile: (920) 530-9937
FAX: (920) 866-1710
Email: Nick_Utrup@fws.gov

Chuck Ahlrichs <cahlrichs@nbenergy.com>
05/13/2010 05:17 PM

To: Nick Utrup <Nick_Utrup@fws.gov>, Mike Donofrio <michael.donofrio@wisconsin.gov>
cc: Jessica Mistak <mistakj@michigan.gov>, "dean.premo@white-water-associates.com" <dean.premo@white-water-associates.com>
Subject: RE: Little Quinnesec Milfoil Plan

Messrs. Utrup and Donofrio,

Do you have any comments before we finalize the Plan?

Chuck Ahlrichs
Northbrook Energy, LLC

14550 N Frank Lloyd Wright Blvd, Suite 210 Scottsdale, AZ 85260
Email: cahlrichs@nbenergy.com
Voice: +1 (480) 551-1771
Mobile: +1 (312) 550-5827

-----Original Message-----
From: Jessica Mistak [mailto:mistakj@michigan.gov]
Sent: Thursday, May 06, 2010 7:11 AM
To: Chuck Ahlrichs; dean.premo@white-water-associates.com
Cc: Nick Utrup; Mike Donofrio
Subject: Little Quinnesec Milfoil Plan

Chuck and Dean,
The MDNRE has reviewed the April 13, 2010 Milfoil Weevil Monitoring and Eurasian Watermilfoil Adaptive Management Plan for the Little Quinnesec Project. Overall, the plan is very well written. Our minor recommendations are:

- Baseline survey for milfoil weevil, page 12- It appears that it would make more sense to first collect water quality data prior to collecting Eurasian water milfoil, especially if personnel will be wading in the water to collect plant samples.

- Please provide a schedule for correspondence with the resource agencies.

Thanks,
Jessica

Jessica Mistak, Senior Fisheries Biologist DNRE Marquette Fisheries Station
488 Cherry Creek Rd
Marquette, MI 49855
906-249-1611 ext. 308
FAX 906-249-3190
mistakj@michigan.gov

Northbrook Energy, LLC

April 13, 2010

Ms. Jessica Mistak
Michigan Department of Natural Resources
484 Cherry Creek Road
Marquette, MI 49855

Ms. Louise Clemency
U.S. Fish & Wildlife Service
Green Bay Field Office
2661 Scott Tower Drive
New Franken, WI 54229

Mr. Michael Donofrio
Wisconsin Department of Natural Resources
101 N. Ogden
Pestigo, WI 54157

Re: Little Quinnesec Falls Hydroelectric Project, FERC No. 2536
Milfoil Weevil Monitoring and Eurasian Watermilfoil Adaptive Management Plan

Northbrook Wisconsin, LLC ("Northbrook") engaged White Water Associates, Inc. to develop a plan to address the specific Eurasian watermilfoil circumstances at the Little Quinnesec Falls Hydroelectric Project in consultation with resource agencies, researchers, and others knowledgeable in Eurasian watermilfoil and the milfoil weevil. Enclosed is the resulting plan, titled *Milfoil Weevil Monitoring and Eurasian Watermilfoil Adaptive Management Plan for the Little Quinnesec Hydroelectric Project.* Please review the plan and provide comments at your earliest convenience.

If you have any questions, please feel free to contact me at (480) 551-1771, or Dean Premo of White Water Associates at (906) 822-7889.

Sincerely,
For Northbrook Wisconsin, LLC

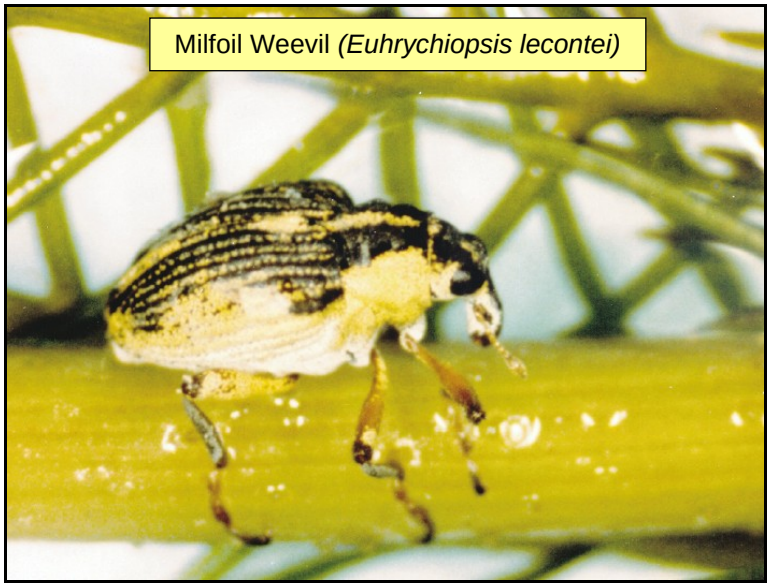
Chuck Ahlrichs
President

Cc: Dean Premo, White Water Associates

14550 N Frank Lloyd Wright #210
Scottsdale, Arizona 85260
480-551-1221/Fax 480-551-1991

Milfoil Weevil Monitoring and Eurasian Watermilfoil Adaptive Management Plan for the Little Quinnesec Falls Hydroelectric Project

FERC Hydro Project No. 2536, Little Quinnesec Falls



Prepared for:

Northbrook Wisconsin, LLC (the licensee)
14550 N Frank Lloyd Wright Blvd, Suite 210
Scottsdale, AZ 85260
Contact: Chuck Ahlrichs
Voice: (480) 551-1771

Prepared by:

White Water Associates, Inc.
429 River Lane, P.O. Box 27
Amasa, Michigan 49903
Contact: Dean B. Premo, Ph.D., Senior Ecologist
Voice: (906) 822-7889

Date: April 2010

Milfoil Weevil Monitoring and Eurasian Watermilfoil Adaptive Management Plan for the Little Quinnesec Falls Hydroelectric Project

FERC Hydro Project No. 2536, Little Quinnesec Falls

April 2010

Prepared By: Dean Premo, Ph.D., Senior Ecologist
White Water Associates, Inc.

Cite as: Premo, Dean. 2010. Milfoil Weevil Monitoring and Eurasian Watermilfoil Adaptive Management Plan for The Little Quinnesec Falls Hydroelectric Project (FERC Hydro Project No. 2536, Little Quinnesec Falls). Prepared for Northbrook Wisconsin, LLC (the licensee) by White Water Associates, Inc.

TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND

Annual monitoring for Eurasian watermilfoil (*Myriophyllum spicatum*) has been conducted on the Little Quinnesec Falls Project (FERC Hydro Project No. 2536) from 1998 through 2009 as required by Article 409 of the FERC order issuing a project license. There have been reports of Eurasian watermilfoil within the Menominee River basin since 1990 although none from the Little Quinnesec Falls project area prior to 2002. This monitoring work has been conducted by White Water Associates, an independent ecological consulting firm.

Over the years of monitoring at the Little Quinnesec Falls Project we have noted that small sub-populations of Eurasian watermilfoil come and go. The reasons for this are unknown, but may be because Eurasian watermilfoil finds it difficult to invade the thriving native plant community in the impoundment. No large beds of Eurasian watermilfoil exist in the project area.

The 2009 Eurasian watermilfoil survey revealed that two Eurasian watermilfoil sites in the impoundment had increased in number of plant stems and surface area coverage. This was the first time in twelve years of monitoring that we referred to a "bed" of Eurasian watermilfoil in the Little Quinnesec Falls project area. One of these beds resulted after the rebound of Eurasian watermilfoil after two years of herbicide treatments. The other bed had not been treated in any way, but had increased in size from previous years. It should be noted that the total2009 surface area coverage of Eurasian watermilfoil in the 349 acre project area was much less than an acre.

Eurasian watermilfoil occurs in much larger populations in the Menominee River watershed in reservoirs upstream and downstream of the Little Quinnesec Falls Project and in lakes. These multi-acre areas of Eurasian watermilfoil have been treated by several methods. The Michigan Department of Natural Resources and Environment (MDNRE) is concerned with the management of Eurasian watermilfoil in Michigan's waters. It is further interested in potential use of biological control agents, specifically the milfoil weevil (*Euhrychiopsis lecontei*) in managing Eurasian watermilfoil. Because of this interest, the MDNRE requested that Northbrook Wisconsin, LLC (the FERC licensee for the Little Quinnesec Falls Project) prepare a milfoil weevil monitoring and treatment plan for the Little Quinnesec Falls Hydroelectric Project.

At the recommendation of the MDNRE, Northbrook Wisconsin, LLC (the licensee) has adopted an ***adaptive management*** (Walters, 1986) approach to Eurasian watermilfoil in the Little Quinnesec Falls Hydroelectric Project. Adaptive management is an appropriate model to use in this dynamic ecosystem. Simply stated, it uses findings from planned monitoring activities to inform management actions and periodic refinement of the plan. An adaptive management plan

accommodates new findings by integrating this information into successive iterations of a dynamic plan. A central premise of adaptive management is that scientific knowledge about natural ecosystems and how to manage them is uncertain. It follows that a practical management plan allows for ongoing adjustments in management designed to "adapt" to changing conditions and new information or understanding. Monitoring the outcomes of plan implementation is essential to the process of adaptive management. Well-designed monitoring should indicate how effectively management measures are working and provide novel insights into ecosystem structure and function. Monitoring should provide needed information to adapt management goals. Adaptive management benefits from communication with other managers who confront similar environmental management issues, especially those that reside in the same or similar ecoregion. Northbrook Wisconsin's approach in preparation of this plan has included consultation with MDNRE, Wisconsin Department of Natural Resources (WDNR), university researchers, and lake and reservoir managers knowledgeable in Eurasian watermilfoil and the milfoil weevil.

This plan is presented in six sections: (1) Introduction and Background, (2) Study Area, (3) Milfoil Weevil, (4) Baseline Survey for Milfoil Weevil, (5) Biological Control at the Little Quinnesec Falls Project, and (6) Literature Cited. Appendix A contains a figure and two tables.

STUDY AREA

The Little Quinnesec Falls Hydroelectric Project is located on the Menominee River approximately ninety miles upstream from where it flows into Lake Michigan (in Menominee, Michigan). The Menominee River is a border stream between Michigan and Wisconsin. The study area of interest to this plan is the impounded area from the Little Quinnesec Falls Dam upstream approximately 4.4 miles to the Big Quinnesec Falls Dam. The surface area of this riverine impoundment is 349 acres. The shoreline is about 15 miles long and nearly all is vegetated in forested riparian area. Just a little more than one-half mile of the shoreline is developed (principally manifested by the Big Quinnesec Falls Dam and the Little Quinnesec Falls Dam and mill site). Very little residential development exists along the river in the study area.

In this section, we describe two components of the biota in the study area. In the first subsection, we discuss the aquatic plant community with emphasis on Eurasian watermilfoil. In the second subsection, we discuss the fish community of the study area since some fish have particular importance as predators of the milfoil weevil.

Eurasian watermilfoil in the Study Area

Over the several years of monitoring, the study area has consistently displayed a robust diversity of native aquatic plants. Native watermilfoils in the flowage include *Myriophyllum heterophyllum* and *M. sibiricum*. The most abundant species throughout the flowage are *Vallisneria americana* and *Potamogeton richardsonii*. Other species comprising the aquatic plant community include *Elodea canadensis, Elodea nuttallii, Potamogeton spirillus, P. epihydrus, P. diversifolius, P. zosterformis, P. robbinsii, Zosterella dubia, Ceratophyllum demersum, Ranunculus longirostris, Utricularia vulgaris,* and *Megalodonta beckii*.

Eurasian watermilfoil was not reported from the Little Quinnesec Falls project area during surveys conducted for the license application process (1990) and was not confirmed during specific monitoring in 1998, 1999, 2000, or 2001. It was first documented in 2002 by observation of a few plants at two locations. At that time, several specimens of Eurasian watermilfoil and both native watermilfoil species (*M. sibiricum* and *M. heterophyllum*) were collected from the Little Quinnesec Falls project area and sent to experts Drs. Donald Les and Michael Moody of the University of Connecticut for further identification by genetic analysis. Their analysis indicated that no hybrids were present, only the pure forms of each of the three species.

Most locations where Eurasian watermilfoil has been found since 2002 have been small areas containing small numbers of individual plants mixed within a diverse community of native aquatic plants. Since 2006, a couple of relatively small areas hosted larger numbers of Eurasian watermilfoil (one to two hundred individual plants). "Beds" or "colonies" where Eurasian watermilfoil is the dominant plant were not observed in the project area through 2008.

In the 2009 survey, we detected sixteen sites in the project area with rooted Eurasian watermilfoil. Eleven of the sixteen sites had twenty or fewer Eurasian watermilfoil plants. In 2009, Site D had an estimated 200 plants and Site K had an estimated 400 plants. Both sites had increased in Eurasian watermilfoil density and dominance from the previous year and each could be reasonably labeled a "bed" of Eurasian watermilfoil at this time.

The number and surface area of Eurasian watermilfoil decreased in 2008 (relative to 2007). Much of this difference resulted from the entire loss of Eurasian watermilfoil plants from three areas that were chemically treated in 2007 and 2008 by the previous owner of the Little Quinnesec Falls Hydroelectic Project. In 2009, Eurasian watermilfoil plants were present at Site D and L in greater numbers than had previously been observed (one year post chemical treatment). This increase was most dramatic at Site D. In fact, 44% of the increase of plant numbers and surface area observed in the study area in 2009 was due to the re-establishment of Eurasian watermilfoil at those two sites.

The aerial photo shown in Figure 1 shows all sites where Eurasian watermilfoil has been detected in the Little Quinnesec Falls project area since 2002. Table 1 presents additional information about these areas, including the latitude/longitude, estimated number of plants observed, and plant surface area involved. Table 2 summarizes the data over all monitoring years since the discovery of Eurasian watermilfoil in the study area (2002 to 2009).

As can be gleaned by the last several years of Eurasian watermilfoil monitoring in the study area, small sub-populations of the invasive species come and go and (sometimes) come back again. This phenomenon is documented in Table 1. The reasons for this rather tenuous hold of these small sub-populations of Eurasian watermilfoil are unknown, but may indicate the relative difficulty of invading a thriving native plant community.

The actual surface area coverage of Eurasian watermilfoil relative to the size of the impoundment remains very small (see Table 2 for summary). We used 349 acres as the size of the project area when calculating percentages. Clearly not all of the impoundment is suitable to Eurasian watermilfoil because of depth or water current. Using aerial photo interpretation and in-the-field ground-truthing, we roughly estimate that between 100 and 150 acres of the project area

might be suitable Eurasian watermilfoil habitat (primarily consisting of shoreline areas and quiet backwaters). Even if this more conservative estimate of habitat is used the relative amount of coverage of existing Eurasian watermilfoil is miniscule. The sites where Eurasian watermilfoil has been found in the study area have been fairly shallow backwaters and areas with little current. In all cases, the species is part of a diverse and healthy community of native aquatic plants including *Potamogeton foliosus, Ranunculus longirostris, Utricularia vulgaris, Ceratophyllum demersum* and the native milfoil, *Myriophyllum sibiricum*. In most of the sites where it is found as a rooted plant, the number of plants is very low. With exception of Sites K and D, Eurasian watermilfoil does not appear to be "taking over" the locations in which it is found. The previously chemically treated Site D shows indications of dominance by Eurasian watermilfoil. In 2009, Site L (chemically treated in 2007 and 2008) also demonstrated a larger number of Eurasian watermilfoil than in the past. Future observations of these chemically treated sites will provide interesting insight regarding the persistence of both the native flora and Eurasian watermilfoil.

Fish Community of the Study Area

The study area offers a large diversity of aquatic habitat. This ranges from quiet shallow backwaters with dense beds of native aquatic vegetation to deep river pools with significant current and cobble bottom. The natural shoreline of the study area continuously contributes large woody material to the river edges forming good habitat for invertebrates and fish. A variety of fish spawning habitat is also present in the study area. For these reasons, the fish community in the study area is also diverse. It includes species that are known predators of the milfoil weevil.

Game fish species present in the study area include: Northern Pike (*Esox lucius*), Muskellunge (*Esox masquinongy*), Smallmouth Bass (*Micropterus dolomieui*), Largemouth Bass (*Micropterus salmoides*), Pumpkinseed (*Lepomis gibbosus*), Bluegill (*Lepomis macrochirus*), Rock Bass (*Ambloplites rupestris*), Black Crappie (*Pomoxis nigromaculatus*), Walleye (*Stizostedion vitreum*), and Yellow Perch (*Perca flavescens*). Pumpkinseed and Bluegill are known to be significant predators of the milfoil weevil (Newman 2004; Sutter and Newman 1997). A large variety of cyprinid and other minnows and darters exist in the study area (Becker 1983). Some of these are potential, but not yet documented, predators of the milfoil weevil.

MILFOIL WEEVIL

Eurasian watermilfoil is one of North America's most noxious and aggressive weeds. It represents an ecological threat to native aquatic plants and the animals that use these native plants as habitat. As a result, tremendous effort has been applied to control and management of Eurasian watermilfoil. Three North American insect species have been considered as agents of biological control for Eurasian watermilfoil: (1) *Acentria ephemerella* (a naturalized pyralid moth caterpillar), (2) *Cricotopus myriophylli* (a native midge species), and (3) *Euhrychiopsis lecontei* (the native milfoil weevil). A forth insect form (weevils in the genus *Phytobius*) has been documented in Wisconsin and is known to eat Eurasian watermilfoil. Of these insects the milfoil weevil has shown the greatest promise for controlling Eurasian watermilfoil (Newman 2004). For this reason it is under consideration as a biological control agent in the study area. We describe its life cycle and ecology in the following subsection. This is followed by a discussion of its efficacy as a biological control agent.

Milfoil Weevil Life History and Ecology

Euhrychiopsis lectontei specializes in using water milfoil as its host plant and food. This native weevil feeds solely on native and Eurasian watermilfoils with the native Northern watermilfoil comprising its principal food source (Newman 2004; Herman 2009). There is growing evidence that the milfoil weevil performs as well or better on the exotic Eurasian watermilfoil than it does on native water milfoils suggesting that Eurasian watermilfoil provides better nutrition to the weevil (Cuda et al. 2008; Newman 2001; and Sheldon and Jones 2001). Laboratory studies show that the weevil prefers the exotic Eurasian watermilfoil (Newman 2001).

Milfoil weevils over-winter in the organic material (leaves and other organic debris) in the vegetation of the near-shore riparian area. They crawl, swim, or fly to this overwintering habitat and return to milfoil beds by the same means in spring (Creed and Sheldon 1994). Adults feed on watermilfoil leaves and spend their time clinging to plants underwater (Newman et al. 2001). Weevil populations are reported to be higher where natural riparian zone exists (Herman 2009).

Once back in the water in spring, the female milfoil weevil lays one or two eggs per day on the tips of water milfoil plants and may lay more than a hundred eggs over the course of a season. The 0.5mm long, elliptical eggs are cream-colored and hatch in a few days. The grub-like larvae feed on the tips of the milfoil plant working their way down the stem feeding on vascular tissues.

The larvae use the upper three feet of the milfoil plant and burrow (by chewing) in and out of the plant, leaving small pin-holes. Larval development takes 8-15 days in 20-25°C (Cofrancesco and Crosson 1999). At the end of their development, the larvae burrow into the lower and thicker part of the milfoil stem and pupate. After 9-12 days, the adult emerges from the pupa and exits the stem through a "blast hole" (larger than the pin hole entrances of the larvae). The complete life cycle is completed in a little less than four weeks and three or four generations are possible during the summer (Cofrancesco and Crosson 1999; Newman 2004). In late August to mid-September (in Minnesota and Vermont) adults stop laying eggs and move to shore to overwinter (Sheldon and O'Bryan 1996; Newman et al. 2001).

Milfoil Weevil as Biological Control Agent

In this subsection, we discuss the milfoil weevil as an agent of biological control of Eurasian watermilfoil. We first discuss how the weevil affects milfoil and then go on to research that documents field observations and experiments that characterize weevil control of milfoil. Finally, we consider examples from nearby the study area where the milfoil weevil has been introduced as a method of biological control of Eurasian watermilfoil.

Adult milfoil weevils feed on the meristems (the growing tips of the plant), leaves, and stems of the milfoil plant and can suppress growth (Creed and Sheldon 1993). The larvae, however, have the greater impact on the milfoil plant. Young larvae feeding on the meristem suppress plant growth and elongation (Creed and Sheldon 1993). Older larvae mine the stems and consume vascular tissue thus inhibiting transport of nutrients (Newman et al. 1996) which may affect root carbohydrate stores and reduce vigor and ability to overwinter (Creed and Sheldon 1995). Larval mining of stems can cause the plants to leak gasses and become less buoyant and sink out of the upper water column (Creed et al. 1992).

Although milfoil weevil has been associated with numerous milfoil declines in the field, many are poorly documented (summarized by Newman 2004). Some examples of milfoil decline in association with the weevil, however, have been well documented. In a Vermont lake Eurasian watermilfoil declined from dense levels in the mid 1980s to very low levels within four or five years. The milfoil population rebounded, but was again suppressed by the weevils in a rather cyclical phenomenon (Creed and Sheldon 1995, Sheldon 1997). A similar cyclical example of the interaction between weevil and Eurasian watermilfoil occurred in a Wisconsin lake, prompting the researcher there to suggest that declines and resurgence may be the norm in

weevil-milfoil interactions (Lillie 2000). In a Minnesota lake, Eurasian watermilfoil decline was directly associated with weevil activity and remained suppressed for five years (Newman et al. 2002). This decline was initially associated with very high weevil density (100 per m^2) and persisted with weevil density from 0.02 to 3 per milfoil stem (Newman 2004). Another Minnesota example showed major decline of Eurasian watermilfoil when weevil density was 0.1-0.5 per milfoil stem (Newman et al. 2002). Newman (2004) summarizes the literature and states that "densities of 1 or more weevils per stem can control milfoil and densities of <0.1 per stem are not likely to control the plant." Since most of this reported work has been done on very large and dense populations of Eurasian watermilfoil, it is not known what dynamic is in play between weevils and milfoil in small Eurasian watermilfoil populations. In fact, R.M. Newman indicated (pers. com. 2010) that no one has looked at the minimum water milfoil bed size needed to maintain a viable weevil population and stated that if the overall plant density is less than a few stems per square meter it would probably be hard to support a significant weevil population.

Although the milfoil weevil can control Eurasian watermilfoil when sufficient weevil densities persist through the summer and among years, many lakes fail to develop sufficiently high or persistent weevil populations (Newman 2004). What factors contribute to this condition? Suitable overwintering habitat is required to sustain weevil populations. In-lake weevil densities are positively associated with percent natural shore (Jester et al. 2000). Water temperatures could limit weevil populations by suppressing egg laying and development time thus reducing the number of generations possible in a summer and the overall possible population size (Newman 2004). Water less than 18°C (64.4°F) would likely result in weevil populations too small to affect milfoil control (Newman 2004). Water depth may also be a factor. Milfoil weevil abundance was negatively associated with water depth in Wisconsin (Jester et al. 2000). Johnson et al. (2000) reported that weevil densities were negatively correlated with lake depth and size and suggested that the milfoil weevil is more effective in smaller and shallower lakes.

Predators may also be important in limiting population size of the milfoil weevils. Invertebrate predation on weevils has not been well-studied but may be significant (Newman 2004). Newman (2004) reviews the literature of fish predation on milfoil weevils and summarizes that sunfish (bluegills and pumpkinseeds) can limit weevil populations mainly through predation on adult weevils.

Successful biological control results in a suppression of the pest plant, not its elimination (Gettsinger et al. 2002; Newman 2004). Because this control is potentially cyclical, it is more useful for long term control in lower priority sites and over large areas. If biological control is

implemented, at least several years must be provided to determine if suppression will take place (Newman 2004).

In his review paper, Newman (2004) states that although the milfoil weevil can be effective control agents if adequate densities can persist (through summers and years), many sites investigated have failed to sustain this density. In spite of significant research, it is not yet possible to predict when suppression of Eurasian watermilfoil will occur.

Because the aggressive invasive Eurasian watermilfoil is of high ecological and recreational concern, control has been attempted by a variety of means (harvesting, herbicides, and biological control). Artificially augmenting the milfoil weevil population by introducing cultured weevils is being applied in numerous water bodies, including some that are in the same region as the Little Quinnesec Falls Hydroelectric Project. Examples are reviewed in subsequent paragraphs of this subsection. Milfoil declines are reported with weevil stocking programs, however, data have not generally been reported in peer-reviewed publications (Newman 2004). A recent review (Gettys et al. 2009) reports that research studying the value of augmenting existing milfoil weevil populations with purchased weevils has been inconclusive.

Sawyer Lake[1] is a 240 acre lake located in Dickinson County, Michigan and about 25 miles north of the Little Quinnesec Falls Project. In 2002, approximately 80 acres of the lake were affected by dense Eurasian watermilfoil. The Sawyer Lake Association hired a commercial company to introduce the milfoil weevil to the lake. Approximately $150,000 were spent over a five year period, with most applied to planting weevils at ten locations from 2003 to 2006 (in all about 100,000 weevils). Monitoring was conducted to gauge weevil presence, milfoil damage, and milfoil density. The first weevils were introduced in 2003 and continued annually to 2006. During the first 3 years from 2003 through 2005, the Eurasian watermilfoil continued to spread across the lake and increase in density even though weevils and weevil damage on milfoil stems increased in occurrence. In 2006, monitoring indicated a 50% reduction of Eurasian watermilfoil reduction on average throughout the lake. No weevils were planted after 2006. By 2008 an additional 25% Eurasian watermilfoil reduction had occurred. Three original planting sites showed no measurable presence of Eurasian watermilfoil. It should also be noted that herbicide treatments were applied to Eurasian watermilfoil in Sawyer Lake in 2006 (5 acres) and 2008 (20 acres). According to Ann Hruska of the Dickinson Conservation District (pers. com 2010),

[1] *This summary is from a 2009 report by Rick Conn, President, Sawyer Lake Association.*

Sawyer Lake Association members are happy with the results although report a nuisance level of the native macrophyte water-shield (*Brasenia schreberi*) has developed in the lake.

The Dickinson County Conservation District tracks Eurasian watermilfoil infestations and management in several lakes besides Sawyer Lake. Lake Antoine (750 acres) was treated with 6,000 weevils in 2008 along with herbicide treatment (no results reported). An area of the Sturgeon River (just upstream of its confluence with the Menominee River) was treated with weevils on two acres of an eight acre bed in 2008 (no results reported). Information from these sites will be tracked as part of the adaptive management approach being undertaken with Eurasian watermilfoil on the Little Quinnesec Falls Hydroelectric Project.

We Energies is a hydroelectric operator on the Menominee River with projects located upstream of the Little Quinnesec Falls Project. The company has undertaken five years of annual monitoring and mapping of the invasive species and has mapped approximately 1,000 acres of the Eurasian watermilfoil at various projects in the Menominee River basin. They have conducted several management trials using manual removal, herbicide application, and weevil introduction (Mike Grisar, We Energies, 2010, pers. com.; and We Energies 2009 Annual Report - Nuisance Plant Control). We Energies experience with two trials of chemical control was that the Eurasian watermilfoil responded by dying back during the season of application, but came back the following year to pretreatment levels. Manual removal trials also showed only temporary results. We Energies experience with biological control of Eurasian watermilfoil by both native and introduced milfoil weevils reveals a variety of outcomes, the complexity of which We Energies continues to investigate. They continue to monitor milfoil weevil and Eurasian watermilfoil density and have studied bluegill and pumpkinseed gut contents for the milfoil weevil.

BASELINE SURVEY FOR MILFOIL WEEVIL

A crucial starting point in considering the use of the milfoil weevil as a biological control agent for Eurasian watermilfoil management at the Little Quinnesec Falls study area is to know whether it is present as an endemic member of the aquatic fauna. In this section, we present our protocol for a baseline survey of the milfoil weevil to be implemented in the study area in 2010.

The milfoil weevil is common in lakes of the Great Lakes states and can be quite abundant (Newman 2004). Its distribution in riverine systems is less well known, but it has been found as a native in the Menominee River impoundments upstream of the study area (Grisar, pers. com, 2010). No formal survey for milfoil weevils has been conducted in the study area.

Survey protocols that aim at quantitative information about weevil density typically place transects through Eurasian watermilfoil beds perpendicular to the shoreline. Three to five sampling points are placed along each transect and their locations recorded. In this array, some points tend to be near the edge of the bed and some near the center; some in deep water and some in shallow water. A set number of Eurasian watermilfoil stems (range from 2 to 10) are randomly collected at each point with a thirty specimens typically taken from each bed. The top two feet of each stem (the area most used by weevils) is retained and bagged for analysis of beetle adults, eggs, larvae, and pupae. Results are typically reported as the number of weevils per stem (all life stages). The University of Minnesota Department of Fisheries, Wildlife, and Conservation Biology website on milfoil weevils[2] states that searching for milfoil weevils is easiest by snorkeling, followed by wading and lastly by boat. Nevertheless, all methods are used depending on circumstances. The University of Wisconsin-Extension has developed a survey protocol for milfoil weevils (Herman 2009) that uses a boat for survey. Other Wisconsin surveys also use a boat or canoe (Amy Thorstenson, pers. com. 2010). We draw from these methods as well as those used by Sawyer Lake Association and We Energies in the protocol we have outlined for the study area. This will allow comparison of results between studies and a level of standardization between monitoring efforts.

We plan to monitor for weevils at the two Eurasian watermilfoil beds identified in the study area in 2009 (Sites D and K) and at other subpopulations that are recognized in 2010 to have reached a similar size to Sites D and K. We will map the Eurasian watermilfoil bed using a hand-held global positioning system (GPS) unit. Three parallel transects will be established in each

[2] *http://fwcb.cfans.umn.edu/research/milfoil/milfoilbc/Doyouhaveweevils.html (Copyright 1997-2001 by Ray Newman, University of Minnesota, Department of Fisheries, Wildlife, and Conservation Biology)*

bed that are oriented perpendicular to the shoreline. One transect will run through the center of the bed and the flanking transects will be positioned half-way between the middle transect and the edge of the bed (the three transects essentially divide the bed into quarters). Five collection points will be established equidistant along each transect with one located at the shoreward edge of the bed, one at the outside edge, one in the middle, one between the middle and outside edge, and one between the middle and shoreward edge. Exhibit 1 illustrate the layout of transects and sampling points. It should be noted that all of the surveys for milfoil weevils reported in the literature have been conducted on large beds of Eurasian watermilfoil (much larger than is present in the Little Quinnesec Falls study area). On the smaller sized beds in the study area, the positioning of transects and sampling points will be in fairly close proximity.

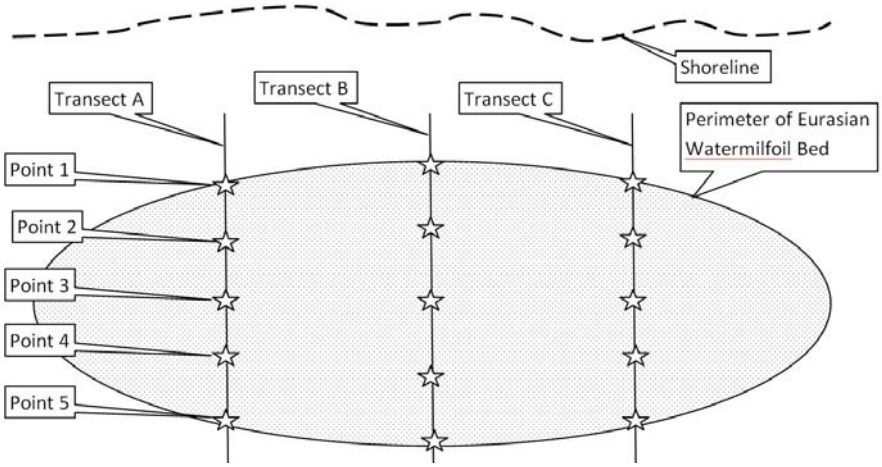


Exhibit 1. Layout of sampling transects.

Depending on water depth and substrate we will wade or boat from shore to Point 1 on Transect A and collect one rooted Eurasian watermilfoil stem from each side of the boat (randomly selected by collecting the first rooted stem contacted with the hand). If depth of plants dictate, we will use a rake to collect stems. With the two stems in the boat, we will collect the top 24 inches of each and place both samples in a plastic sample bag marked with transect letter and point number and stored in a cooler on wet ice. The unused portion of the stem will be retained for proper disposal (composting). We will move on to the next sample point on the transect and continue similarly for all points and transects. In this way, a total of 30 stems (two each contained in 15 sample bags) will be sampled from each bed for later analysis at the laboratory.

At each of the two subject Eurasian watermilfoil beds, we will measure a Secchi transparency depth. We will also measure temperature, dissolved oxygen, pH, and conductivity at

the water surface. We will record substrate type in the bed. We will measure and record distance to the nearest shore from the shoreward edge of the bed. We will record a description of the shoreline and riparian area vegetative cover. We will also record notes on our qualitative observations regarding the overall health of the Eurasian watermilfoil, presence of weevils or weevil damage, and native plants present.

At sampling Point 3 of each transect (A, B, and C) we will use a double-sided fourteen-tine rake to make a one meter tow to collect aquatic vegetation. All plants contained on the rake head will be identified and a rake fullness rating will be applied for each species. The rake fullness value will be based on the Wisconsin Department of Natural Resources Point-Intercept Protocol for aquatic plant surveys as follows: (1) rake fullness rating 1 is given when plant is present and occupies less than one-half of tine space, (2) rating 2 is given when plant is present and occupies more than one-half of tine space, (3) rating 3 is given when plant is present and occupies all or more than tine space. This will provide a baseline estimate of Eurasian watermilfoil density in each bed.

For purposes of comparison to other Eurasian watermilfoil stands in the Menominee River basin, we will also apply the "estimated density rating" used by We Energies in their annual Eurasian watermilfoil monitoring (We Energies 2009 Annual Report – Nuisance Plant Control). The ratings will be as follows:

1. Sparse: 0-5% cover
2. Moderately Sparse: >5-25% cover
3. Moderate: >25-75% cover
4. Moderately dense: >75-95% cover
5. Dense: >95% cover.

In the laboratory, Eurasian watermilfoil samples will be examined for presence of all milfoil weevil life stages. Quantitative data will be reported as number of weevils per stem. Field work will be conducted in August when both Eurasian watermilfoil beds (and likely milfoil weevils) will be at maximum population size.

BIOLOGICAL CONTROL AT LITTLE QUINNESEC FALLS PROJECT

After reviewing the extensive literature on Eurasian watermilfoil and speaking with experts on the subject, we recognize that the relatively small population of the invasive plant in the Little Quinnesec Falls study area is "under control" by most standards. Nevertheless, it is present and did show some increase in 2009. At least one area of increase occurred in a subpopulation previously treated with an herbicide. For this reason, we have focused on the potential for biological control in our adaptive management of the Eurasian watermilfoil in the study area.

In keeping with an adaptive management approach to Eurasian watermilfoil in the study area, Northbrook Wisconsin, LLC (the licensee) will continue the annual monitoring of the population of Eurasian watermilfoil and more carefully characterize the density and size of subpopulations that comprise beds. In addition, it will begin in 2010 a regimen of monitoring for the milfoil weevil (as outlined in the previous section). Results from the 2010 (and subsequent years) will provide information relevant to the next steps with Eurasian watermilfoil management in the study area.

Part of the adaptive management approach involves increasing the ecological knowledge base for the system being managed. The Little Quinnesec Falls study area provides a potential opportunity to test the efficacy of biological control in very small populations of Eurasian watermilfoil. Laura Herman (University of Wisconsin Extension Lakes program) expressed that a bed of at least four or five acres was needed before weevil treatment was warranted (pers. com 2010). Raymond Newman (Professor, Fisheries, Wildlife and Conservation Biology, University of Minnesota) offered the opinion that the Eurasian watermilfoil population at the Little Quinnesec Falls study area might be too small to support milfoil weevils, but indicated that no one has researched this topic (pers. com. 2010).

A necessary mantra of the ecosystem manager is to "do no harm." Ideally, a native population of weevils would be adequate to keep the Eurasian watermilfoil under control. A nationally known expert in milfoil weevils and Eurasian watermilfoil (Raymond Newman) states that there are legitimate concerns about moving weevils between and within states and does not advocate this approach.[3] Cofrancesco (2000) states that movement of native species must be considered in management programs and that movement may alter the ecological balance or stress the agent being moved. Further, moving large numbers of agents might inadvertently move

[3] *http://fwcb.cfans.umn.edu/research/milfoil/milfoilbc/Doyouhaveweevils.html (Copyright 1997-2001 by Ray Newman, University of Minnesota, Department of Fisheries, Wildlife, and Conservation Biology)*

other organisms as well and an agent moved to a different part of its range may not interact with the endemic target population in the anticipated way (Cofrancesco 2000).As part of Eurasian watermilfoil treatment programs, milfoil weevils have been introduced to lakes in the vicinity of the study area and to the Menominee River immediately upstream of the study area. Locally native milfoil weevils are present upstream as well. With this nearby source, we would not be surprised to discover a population of weevils in the Little Quinnesec Falls study area, if a sufficient food base is present. Part of our adaptive management program will be to continue to follow new findings in the scientific and applied ecosystem management literature that apply to the study area.

Our adaptive management plan will call for augmentation of biological control of Eurasian watermilfoil in the Little Quinnesec Falls study area if two criteria are met:

1. The Eurasian watermilfoil population increases in size for two consecutive years (2010 and 2011) in areas that constitute beds; and
2. The population of milfoil weevils in these beds is less than 0.1/stem, the lower threshold for likely effective control according to Newman (2004).

If these criteria are met after the 2011 summer monitoring season, we will plan to stock milfoil weevils in the affect areas in 2012, if no other scientific findings or regulatory concerns counter-indicate this action. Follow-up monitoring will track success of the adaptive management process. Part of this adaptive process will be to communicate with other ecosystem managers in the region, resource agency technical staff, and scientists with expertise in Eurasian watermilfoil management.

We will submit annual reports of weevil monitoring and Eurasian watermilfoil management at the same time the annual report of Eurasian watermilfoil survey activities is submitted (December 31 of the year that the field work is conducted).

LITERATURE CITED

Becker, George C. 1983. Fishes of Wisconsin. The University of Wisconsin Press. 1052 pages.

Cofrancesco, A. F. 2000. Factors to consider when using native biological control organisms to manage exotic plants. Journal Aquatic Plant Management. 38:117-120.

Cofrancesco, Alfred F. and Holly Crosson. 1999. Euhrychiopsis lecontei (Dietz) as a Potential Biocontrol Agent of Eurasian Watermilfoil (Myriophyllum spicatum L.). Aquatic Plant Control Research Program. US Army Corps of Engineers. Volume A-99-3, August 1999.

Creed, R.P. Jr. and S.P. Sheldon. 1993. The effect of feeding by a North American weevil, Euhrychiopsis lecontei, on Eurasian watermilfoil (Myriophyllum spicatum). Aquatic Bot. 45: 245-256.

Creed, R.P. Jr. and S.P. Sheldon. 1995. Weevils and watermilfoil: did a North American herbivore cause the decline of an exotic plant? Ecological Applications. 5: 1113-1121.

Creed, R. P., Jr., and Sheldon, S. P. 1994. Potential for a native weevil to serve as a biological control agent for Eurasian watermilfoil. Technical Report A-94-7, U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Creed, R. P., Jr., S.P. Sheldon, and D.M. Cheek. 1992. The effect of herbivore feeding on the buoyancy of Eurasian watermilfoil. J. Aquatic Plant Management. 30: 75-76.

Cuda, J.P., R. Charudattan, M.J. Grodowitz, R.M. Newman, J.F. Shearer, M.L. Tamayo, and B. Villegas. 2008. Recent advances in biological control of submerged aquatic weeds. Journal Aquatic Plant Management. 46:15-32.

Getsinger, K.D., A.G. Poovey, W.F. James, R.M. Stewart, M.J. Grodowitz, M.J. Maceina, and R.M. Newman. 2002. Management of Eurasian watermilfoil in Houghton Lake, Michigan: Worship Summary. US Army Corps of Engineers Aquatic Plant Control Research Program (ERDC/EL TR-02-24). 88 pages.

Gettys, L.A., W.T. Haller, and M. Bellaud, editors. 2009. Biology and control of aquatic plants: a best management practices handbook. Aquatic Ecosystem Restoration Foundation, Marietta, GA. 210 pages.

Herman, Laura. 2009. Aquatic Invasive Species Monitoring Procedures. Chapter 12-Water milfoil weevil monitoring protocol. Pages 259-282. Citizen Lake Monitoring Network, University of Wisconsin-Extension.

Jester, L.L., M.A. Bozek, D.R. Helsel, and S.P. Sheldon. 2000. Euhrychiopsis lecontei distribution, abundance, and experimental augmentations for Eurasian watermilfoil control in Wisconsin lakes. Journal Aquatic Plant Management. 38:88-97.

Lillie, R. A. 2000. Temproal and spatial changes in milfoil distribution and biomass associated with weevils in Fish Lake, WI. Journal of Aquatic Plant Management. 38:98-104.

Newman, R.M. 2004. Biological control of Eurasian watermilfoil by aquatic inscects: basic insights from an applied problem. (Invited Review). Arch. Hydrobiol.

Newman, R.M., K.L. Holmberg, D.D. Biesboer, and B.G. Penner. 1996. Effects of a potential biocontrol agent, Euhrychiopis lecontei, on Eurasian watermilfoil in experimental tanks. Aquatic Bot. 53: 131-150.

Newman, R.M., D.W. Ragsdale, and D.D. Biesboer. 2002. Factors Influencing the Control of Eurasian Watermilfoil with Native or Naturalized insects. Final Report for 1999-2001 to the Minnesota Department of Natural Resources, Ecological Services, St. Paul, MN, 71 pages.

Newman, R.M., Ragsdale, D.W., Milles, A. and Oien, C. 2001. Overwinter habitat and the relationship of overwinter to in-lake densities of the milfoil weevil Euhrychiopsis lecontei, a Eurasian watermilfoil biological control agent. J. Aquat. Plant Management. 39: 63-67.

Sheldon, S.P. 1997. Investigations on the potential use of an aquatic weevil to control Eurasian watearmilfoil. Lake Reserv. Management. 13: 79-88.

Sheldon, S.P. and K.N. Jones. 2001. Restricted gene flow according to host plan in an herbivore feeding on native and exotic watermilfoils (Myriophyllum: Haloragaceae). Int. Journal Plant Science. 162: 793-799.

Sheldon, S.P. and O'Bryan, L.M. 1996. Life history of the weevil Euhrychiopsis lecontei, a potential biological control agent of Eurasian watermilfoil. Entomological News 107: 16-22.

Sutter, T.J. and Newman, R.M. 1997. Is predation by sunfish (Lepomis spp.) an important source of mortality for the Eurasian watermilfoil biocontrol agent Euhrychiopsis lecontei? Journal of Freshwater Ecology. 12: 225-234.

Walters, C. 1986. Objectives, constraints, and problem bounding. In W.M. Getz, ed., Adaptive Management of Renewable Resources. Macmillan Publishing Company. New York. p. 13+.

Document Content(s)