Report of Milfoil Weevil Monitoring and Eurasian Water-milfoil Management for the Little Quinnesec Falls Hydroelectric Project for 2013

FERC Hydro Project No. 2536, Little Quinnesec Falls

Susan Fawcett photo

Specimens from the Menominee River on the Little Quinnesec Falls Hydroelectric Project.
On left: Adult and larval Milfoil Weevil *(Euhrychiopsis lecontei)*
Below: Eurasian water milfoil (*Myriophyllum spicatum*)

Dean Premo photo

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WHITE WATER ASSOCIATES, INC.

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INTRODUCTION AND BACKGROUND

Monitoring for Eurasian water-milfoil (*Myriophyllum spicatum*) has been conducted on the Little Quinnesec Falls Project (FERC Hydro Project No. 2536) from 1998 through 2013 as required by Article 409 of the FERC order issuing a project license. This monitoring has shown that small sub-populations (several plants) of Eurasian water-milfoil come and go. The reasons for this are unknown, but may be due to difficultly invading a thriving native plant community. The 2010 milfoil weevil monitoring documented presence of this native species (*Euhrychiopsis lecontei*) in the project area. It potentially plays a role in Eurasian water-milfoil control. No beds of Eurasian water-milfoil existed in the project area prior to 2009. The 2009 survey revealed that two Eurasian water-milfoil sites had numbers large enough that they could be referred to as "beds." One of these "beds" resulted from the rebound of Eurasian water-milfoil in an area where two years of herbicide treatments had depressed the native vegetation. The other bed was never treated with herbicide, but Eurasian water-milfoil numbers had increased in size from previous years. The surface area of Eurasian water-milfoil in 2009 and 2010 in the 349 acre project area was less than 0.04 acres (Premo and Premo, 2010). In 2011, despite careful inspection, Eurasian water-milfoil was found at only one site, whereas 25 sites had the invasive plant in 2010. Only five Eurasian water-milfoil plants were found in 2011 compared to 739 plants found in 2010.

Eurasian water-milfoil 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 water-milfoil have been treated by several methods. The Michigan Department of Natural Resources and Environment (MDNRE) is concerned with the management of Eurasian water-milfoil in Michigan's waters. It is further interested in potential use of biological control agents, specifically the milfoil weevil (*Euhrychiopsis lecontei*) in managing Eurasian water-milfoil. 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. This plan was completed and submitted to the responsible agencies in April 2010.

At the recommendation of the MDNRE, Northbrook Wisconsin, LLC (the licensee) adopted an ***adaptive management*** (Walters, 1986) approach to Eurasian water-milfoil in the project area. This approach uses findings from monitoring activities to inform management actions and periodic refinement of the plan. This annual report on milfoil weevil monitoring and Eurasian water-milfoil management is presented in six sections: (1) Introduction and Background, (2) Study Area, (3) Milfoil Weevil Ecology, (4) Survey for Milfoil Weevil, (5) Eurasian Water-milfoil Management at the Little Quinnesec Falls Project, and (6) Literature Cited.

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 water-milfoil. 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.

The study area has consistently displayed a robust diversity of native aquatic plants. Native water-milfoils 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. zosteriformis, P. robbinsii, Heteranthera dubia, Ceratophyllum demersum, Ranunculus longirostris, Utricularia vulgaris,* and *Bidens (Megalodonta) beckii*.

Eurasian water-milfoil was first documented in 2002 by observation of a few plants at two locations. Most locations where the plant has been found since 2002 have been small areas containing small numbers of individual plants mixed within a diverse community of native aquatic plants. In 2009, we documented an increase in Eurasian water-milfoil density and dominance at Site D (estimated 200 plants) and Site K (400 plants). This was the first time that we referred to a “bed” of Eurasian water-milfoil in the study area. These two sites were identified as sites to monitor for milfoil weevils in 2010, but since Eurasian water-milfoil at Site D was greatly diminished in 2010, weevil monitoring occurred only at Site K. In 2011, sampling for weevils was not done at either site, due to lack of Eurasian water-milfoil. In 2013, weevil sampling was conducted at Site K only.

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 water-milfoil 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 water-milfoil. Three North American insect species have been considered as agents of biological control for Eurasian water-milfoil. Of these, the milfoil weevil (*Euhrychiopsis lectontei*) has shown the greatest promise (Newman, 2004). For this reason it is under consideration as a biological control agent in the study area.

Euhrychiopsis lectontei specializes in using water-milfoil as its host plant and food. This native weevil feeds solely on native and Eurasian water-milfoils with the native Northern water-milfoil comprising its principal food source (Newman, 2004; Herman, 2009). Milfoil weevils over-winter in the organic material (leaves and other organic debris) in the vegetation of the near-shore riparian area. Weevil populations are reported to be higher where natural riparian zone exists (Herman, 2009). 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 water-milfoil leaves and spend their time clinging to plants underwater (Newman et al., 2001). 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 eggs hatch in a few days and 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. At the end of their development, the larvae burrow into the lower and thicker part of the milfoil stem and pupate. 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).

Adult milfoil weevils feed on the meristems (the growing tips of the plant), leaves, and stems of the milfoil plant and can suppress the growth of the plants (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 which cause the plant to become less buoyant, and sink out of the upper water column (Creed et al., 1992).

Although the milfoil weevil has been associated with numerous milfoil declines in the field, many are poorly documented. 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 water-milfoil, it is not known what dynamic is in play between weevils and milfoil in small Eurasian water-milfoil 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.

Successful biological control results in a suppression of the pest plant, not its elimination (Getsinger 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).

MILFOIL WEEVIL MONITORING

The *Milfoil Weevil Monitoring and Eurasian Water-milfoil Adaptive Management Plan for the Little Quinnesec Falls Hydroelectric Project* (Premo, 2010a) called for investigating presence and abundance of the milfoil weevil in the study area. The milfoil weevil is common and can be abundant in lakes of the Great Lakes states (Newman, 2004). Its distribution in riverine systems is less well known, but it has been found as a native in Menominee River impoundments upstream of the study area (Grisar, pers. com, 2010). In this section, we describe 2010 monitoring methods, review the 2010 and 2011 monitoring results, and present the 2013 monitoring results.

Methods

We developed the survey protocol for the study area by researching scientific literature and contacting experts (outlined in Premo, 2010a). The plan called for us to monitor for weevils at Eurasian water-milfoil beds of size similar to the two "beds" identified in the study area in 2009 (Sites D and K). In 2010, only a single bed in the study area (Site K) met this criterion (Premo and Premo, 2010; Premo, 2010b). In 2011 and 2013, no beds met this criterion. In 2010, we mapped the aquatic plant at Site K bed using a hand-held GPS unit. Three parallel transects were established in the bed that were oriented along the long axis of the bed. One transect was established through the center of the bed and the flanking transects were positioned half-way between the middle transect and the edges of the bed (the three transects divide the bed into parallel quarters). Five collection points were 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 is a generalized layout of transects and sampling points. Exhibit 2 shows an aerial photograph with the actual size and shape of the plant bed at Site K.

The water depth and substrate required the use of a boat to sample the fifteen collection points at Site K. At each point, we collected one rooted Eurasian water-milfoil stem from each side of the boat (randomly selected by collecting the first rooted stem contacted with the hand). On a few occasions a rake was used to collect stems. With the two stems in the boat, we collected the top 24 inches of each and placed both in a plastic sample bag marked with transect letter and point number. The plant samples thus collected were stored in a cooler on wet ice. The unused portion of the Eurasian water-milfoil stems were placed in a plastic bag and retained for proper disposal (composting). After all fifteen points were sampled, a total of 30 plant stems were collected and transported back to the White Water Associates' laboratory for examination.

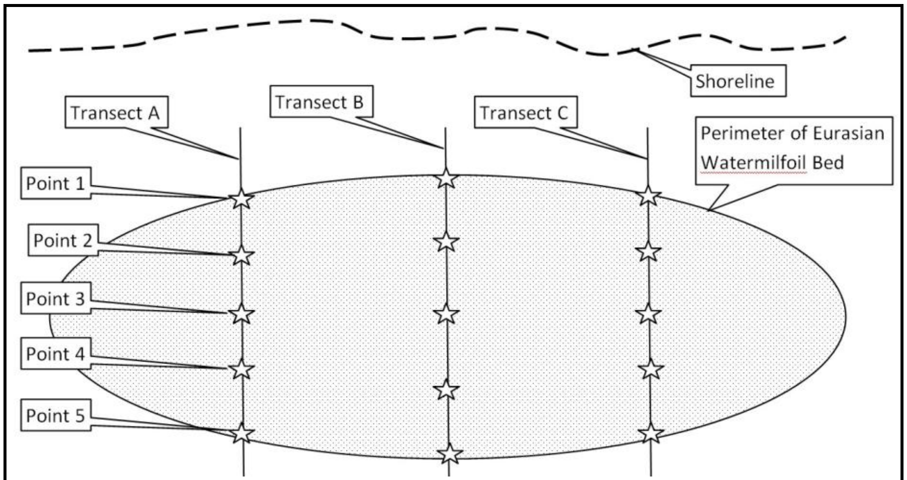

Exhibit 1. Generalized layout of sampling transects.

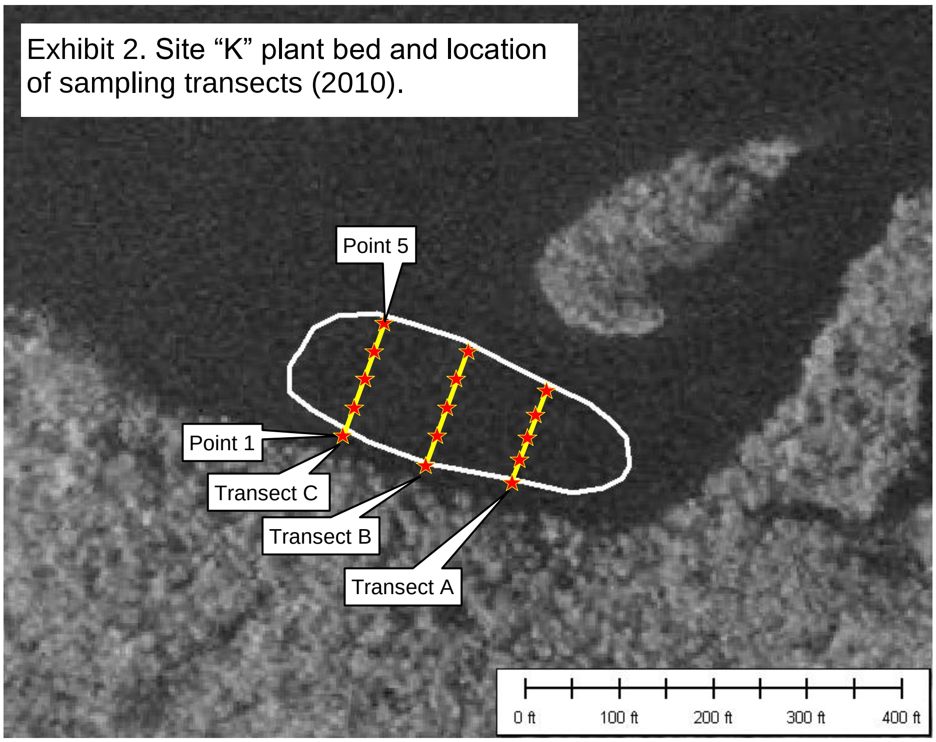

Exhibit 2. Site "K" plant bed and location of sampling transects (2010).

We measured a Secchi transparency depth at the subject Eurasian water-milfoil bed. We also measured temperature, dissolved oxygen, pH, and conductivity at the water surface. We recorded substrate type in the bed. We used a laser range-finder to measure distance to the nearest shore from the shoreward edge of the bed. We recorded a description of the shoreline and riparian area vegetative cover. We also recorded qualitative observations regarding the overall health of the Eurasian water-milfoil, presence of weevils or weevil damage, and native plants present.

At sampling Point 3 of each transect (A, B, and C) we used a double-sided fourteen-tine rake to make a one meter tow to collect vegetation. All plants on the rake were identified and a rake fullness rating was applied for each species. The rake fullness values were 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 approach provides a baseline estimate of Eurasian water-milfoil density in the bed.

In order to compare to other Eurasian water-milfoil stands in the Menominee River Basin, we will also applied the "estimated density rating" used by We Energies in their annual monitoring (We Energies 2009 Annual Report – Nuisance Plant Control). The ratings are: (1) Sparse: 0-5% cover; (2) Moderately Sparse: >5-25% cover; (3) Moderate: >25-75% cover; (4) Moderately dense: >75-95% cover; and (5) Dense: >95% cover.

In the laboratory, Eurasian water-milfoil samples were examined for presence of all milfoil weevil life stages using magnification. Quantitative data are reported as number of weevils per stem. Voucher specimens were sent to Wisconsin scientist Amy Thortenson to verify identification.

For the 2010 weevil monitoring, field work was conducted on July 28, 2010. We predicted that Eurasian water-milfoil (and potentially milfoil weevils) would be at maximum population size around that date. In 2011, we conducted the fieldwork on August 3. In 2013, field work took place on August, 19.

2010 Monitoring Results Review

The 2010 water-milfoil weevil monitoring results have been previously reported (Premo, 2010b) and are reviewed here for context. We planned to monitor for weevils at the two Eurasian water-milfoil subpopulations identified as "beds" in the study area in 2009 (Sites D and K) and any other subpopulations that were recognized in 2010 to have reached a similar size. The 2010 Eurasian water-milfoil monitoring revealed that only one site (Site K) still met this size criterion (Premo and Premo, 2010). The aquatic macrophyte bed that constitutes Site K was 370 feet by 134 feet and had a surface area of just under one acre. We judged good quality overwintering habitat for weevils was available in the nearby shoreline and riparian area. The plant bed at Site K was comprised of a diverse assemblage of native plant species and Eurasian water-milfoil.

During the 2010 field sampling, we observed one adult milfoil weevil **(***Euhrychiopsis lecontei***)** and one larva on Eurasian water-milfoil stems. In the laboratory and under better magnification we found a total of twelve adults, seventeen eggs, and thirty-nine larvae. The density of water-milfoil weevils (all life stages) over the entire bed was 2.27 per stem. Newman (2004) indicated that densities of one or more weevils per stem can control Eurasian water-milfoil.

2011 Monitoring Results

In 2011, we planned to monitor for weevils at Site K and any other site with a sufficiently large subpopulation of Eurasian water-milfoil. On the August 3, 2011 survey of the entire project area, we were surprised to find that of the 25 sites that had Eurasian water-milfoil in 2010, only one site had Eurasian water-milfoil in 2011. The plant bed at Site K, the largest subpopulation of Eurasian water-milfoil in 2010, had none in 2011. The one site that had Eurasian water-milfoil in 2011 had five relatively small plants (down from 15 in 2010). We saw no sign of weevil herbivory on these plants. As result of the lack of Eurasian water-milfoil, the sampling protocol for milfoil weevil as outlined in the methods section could not be carried out in 2011.

2013 Monitoring Results

Similar to 2011, we planned to monitor for weevils at Site K and any other site with a large enough population of Eurasian water-milfoil. Upon searching the project area, Site K had the highest number of Eurasian water-milfoil plants, with approximately 20 rooted plants. Nevertheless, this was too few for the sampling protocol. Instead, field biologist adapted the protocol and collected approximately 13 plants for further weevil inspection. The Eurasian water-milfoil plants were scattered throughout a 20x20 foot area among other native milfoils and aquatic vegetation. In this estimated area, Eurasian water-milfoil coverage was approximately 0-5%. Other patches of aquatic vegetation near Site K were dense with native milfoils and it is possible that a few plants of Eurasian water-milfoil were dispersed there as well.

Thirteen two-foot Eurasian water-milfoil plants were collected from Site K for further inspection of weevils. Under a microscope, six adult weevils, thirteen pupae, twenty-three larvae, twelve eggs, and twelve blast holes were observed. There were also three areas on the plants where herbivory damage was obvious. A total of 54 weevils (all life stages) were present on the thirteen collected Eurasian water-milfoil plants. On average, 0.46 adult weevils, 1.0 pupa, 1.8 larvae, and 0.94 eggs were present on each two-foot Eurasian water-milfoil plant. This is an average of 4.23 weevils, of all life stage, per two-foot stem. As stated by Newman (2004), “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.” In the case of Site K in 2013, these numbers are consistent with controlling Eurasian water-milfoil.

BIOLOGICAL CONTROL AT LITTLE QUINNESEC FALLS PROJECT

After reviewing the extensive literature on Eurasian water-milfoil and speaking with experts on the subject, we recognized in 2010 that the relatively small population of the invasive Eurasian water-milfoil in the Little Quinnesec Falls study area was "under control" by most standards. Our observations in the 2011 survey could accurately be characterized as a population crash for Eurasian water-milfoil. To what extent this is attributable to water-milfoil weevils remains unknown, but in 2010 they had sufficient density at Site K to affect control. In 2013, the number of Eurasian water-milfoil plants at Site K was small; however, the native weevil population was flourishing with an average 4.23 weevils (all life stages) per two-foot stem. Again, this density of weevils was capable of affecting control of the Eurasian water-milfoil.

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 water-milfoil. Laura Herman (University of Wisconsin Extension Lakes program) expressed that a bed of at least four or five acres was needed before weevil treatment (that is, introduction of weevils) was warranted (pers. com 2010). Raymond Newman (Professor, Fisheries, Wildlife and Conservation Biology, University of Minnesota) offered the opinion that the Eurasian water-milfoil 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). The 2010 study found a native population of milfoil weevils in fairly high densities at Site K despite the small size of the Site K bed (about one acre). The high density of weevils was again present during this 2013 survey.

The adaptive management plan (Premo, 2010a) calls for augmentation of biological control of Eurasian water-milfoil by introducing milfoil weevils in the Little Quinnesec Falls study area if two criteria are met:

1. The Eurasian water-milfoil 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).

In 2010, neither of these criteria was met. In 2011, the first criterion was not met since Eurasian water-milfoil had greatly decreased from the previous year. In 2013, Eurasian water-milfoil numbers increased from zero plants to 20 plants at site K, but this number does not constitute a "bed." It was also found that the population of milfoil weevils in this area was greater than 0.1 weevil/stem. There is no need for artificial augmentation of the water-milfoil weevil population at this time. Future monitoring will follow the status of both the Eurasian water-milfoil and the milfoil weevil at this location, as well as subpopulations in other parts of the study area.

In his review paper, Newman (2004) states that although the milfoil weevils 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 water-milfoil will occur. The Little Quinnesec Falls project area has demonstrated a dramatic and interesting suppression of Eurasian water-milfoil, some of which might be attributed to the water-milfoil weevil. Given the complexity of this ecosystem, it is likely that additional factors play a role in the population dynamics of the Eurasian water-milfoil as well.

Follow-up monitoring will track the 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 water-milfoil management.

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