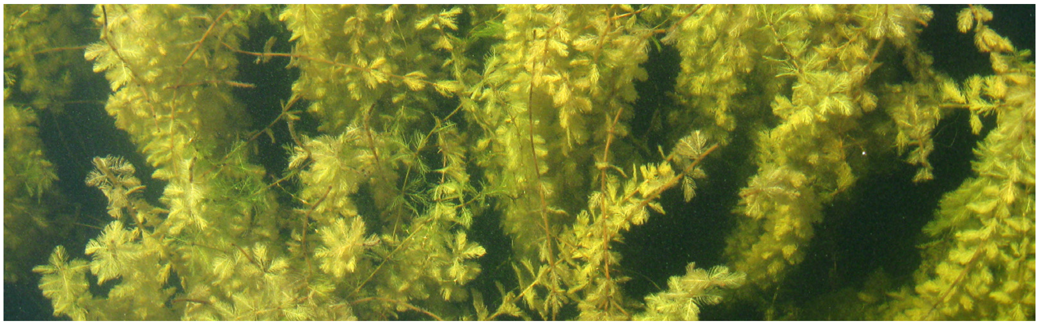
michiganlakeinfo
michiganlakeinfo.com



Weevil Stocking to Control Eurasian Milfoil

April 2019 - Update January 2023

The Water Resources Group
Progressive AE

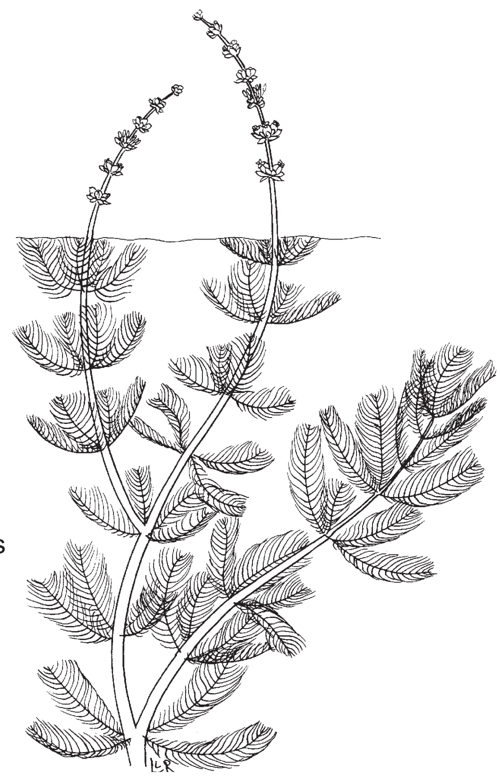
Milfoil weevils (*Euhrychiopsis lecontei*) have been stocked in a number of lakes in Michigan to control the growth of the nuisance aquatic plant Eurasian milfoil (*Myriophyllum spicatum*). This article examines the use of weevils as a long-term Eurasian milfoil control alternative.

Eurasian Milfoil

Eurasian milfoil is an invasive exotic aquatic plant that is currently widespread in Michigan. The plant is problematic in that it becomes established early in the growing season and can grow at greater depths than most native plants.[1,2] Eurasian milfoil often forms a thick canopy at the lake surface that can degrade fish habitat and seriously hinder recreational activity.[3] Eurasian milfoil can spread rapidly by "vegetative propagation" whereby small pieces break off, take root, and grow into new plants.[1,4,2] Once introduced into a lake, Eurasian milfoil may outcompete and displace more desirable plants and become the dominant species.[1,2] Controlling the spread of Eurasian milfoil is a primary focus of plant control projects on many Michigan lakes.

Eurasian milfoil is not the only type of milfoil found in Michigan. There are several native milfoil species that also grow here, such as northern milfoil (*Myriophyllum sibiricum*). Some native species closely resemble Eurasian milfoil and are commonly mistaken for it. However, the native milfoils rarely form dense, impenetrable plant beds like Eurasian milfoil often does. In some lakes, hybridization between Eurasian milfoil and northern milfoil has occurred.[5]

Eurasian milfoil can form a dense canopy at the lake surface.



Eurasian milfoil (*Myriophyllum spicatum*).
Aquatic plant line drawing is the copyright property of the University of Florida Center for Aquatic Plants (Gainesville). Used with permission.

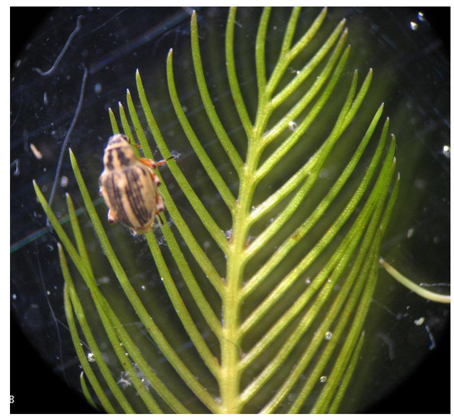
The Milfoil Weevil

The milfoil weevil is an aquatic insect that is native to North America and appears to be common in the Midwest.[6] The weevil has been found to feed almost exclusively on milfoil species, especially Eurasian milfoil.[6,7] Researchers have documented declines in Eurasian milfoil populations as the result of weevil feeding.[8,9] These declines have been attributed largely to the burrowing and tunneling action of weevil larvae that cause the milfoil plant to lose buoyancy and fall from the water column. In addition, weevil burrowing can reduce the plant's ability to translocate nutrients and carbohydrates which can further reduce milfoil's competitive edge and ability to regrow the next spring.[8,6] Stem fragments damaged by weevils have reduced viability and ability to produce new roots.[8] Weevil burrowing may also increase the susceptibility of milfoil to infection by pathogens.[8,10]

Weevils spend the summer submersed on milfoil plants and can produce several generations per summer season. The last generation produces flight wings and migrates to shore to overwinter in organic matter.

While weevils may reduce Eurasian milfoil populations, milfoil is not eradicated and the overall biomass of Eurasian milfoil may not decline substantially as a result of weevil feeding[11]. In laboratory tests conducted at the U.S. Army Corps of Engineers Research and Development Center, plants exposed to the weevils showed marked reductions in shoot length but the measured plant biomass showed little if any reduction.[11] Based on this observation, Cofrancesco et al.[11] concluded "[b]ecause the amount of biomass of the treated plants was essentially unchanged by weevil feeding, it appears that damage to the plant was controlled more by tunneling than by measurable consumption of plant biomass." Although the weevils did not consume large amounts of plant biomass, their feeding caused a significant decline in viable standing stems.

While weevils are native to the Midwest, many lakes do not have weevil densities sufficient to control Eurasian milfoil.[6] Milfoil weevils have been stocked in many lakes to control Eurasian milfoil growth, but results have been variable.[12,13,3] Many factors may limit weevil effectiveness including overwinter habitat, fish predation, water depth, plant nutrient content, and milfoil hybridization.



Milfoil weevils (*Euhrychiopsis lecontei*). Photos courtesy of Tom Alwin and Michigan State University Department of Fisheries and Wildlife.

progressive ae

Factors Limiting Weevil Success

Adult weevils require dry sites near shore consisting of leaf litter or organic matter to overwinter.[14,6] In studies of Wisconsin lakes, Jester et al.[15] noted that weevil densities increased with the percentage of natural shore and decreased with the percent of sand shore. Lillie[16] noted that conditions at overwinter sites may be extremely important in influencing weevil survivability rates, and that the annual redistribution of weevils in a lake following the spring migration is likely dependent upon a combination of spatial distribution and location of overwinter habitat, and wind direction during migrations. By contrast, Newman et al.[14] noted that in-lake factors such as fish predation may be more limiting than overwintering conditions. More research is needed to understand the importance of overwintering conditions to weevil success.

Adult milfoil weevils overwinter in dry sites near shore with leaf litter and organic matter, and prefer natural shoreline to sand shore.

Fish predation may impact weevil populations. In lakes with high numbers of sunfish (*Lepomis* spp.), adult weevil density can be substantially reduced.[17] Sunfish predation likely accounts for the observed failure of weevils to control milfoil in many lakes.[17] With weevils, adult longevity is important to end-of-summer population size. Fish predation, which directly affects adult longevity, may be an important factor limiting weevil success[6]. Ward and Newman[17] speculate on a self-reinforcing feedback loop in which dense growth of Eurasian milfoil causes overpopulation of sunfish which, in turn, feed on adult weevils, thereby reducing weevil numbers below a level that can suppress milfoil growth. Sutter and Newman[18] predicted that "sunfish predation could be most significant for low density [weevil] populations and high density sunfish populations," but in lakes with high and medium weevil densities, sunfish predation may not cause a significant decline in the weevil population.

Water depth may also influence weevil effectiveness. Lillie[16] observed higher weevil density and greater milfoil damage in the shallow and mid-depth portions of milfoil beds and lower weevil densities at the deep edges of plant beds. In Wisconsin lakes, Jester et al.[15] observed that weevil abundance decreased with depth. Newman[6] noted that deeper milfoil beds may be more difficult for adult weevils to reach, and the deeper plants may hold more fish and allow more efficient fish-feeding on weevils. Johnson et al.[19] found that weevil densities were negatively correlated with lake size and depth and suggested that weevils may be more effective in smaller and shallower lakes.

Water quality variables do not appear to affect weevil density.[15,20] However, Creed[10] noted that plants with low nutrient levels may not provide adequate nutrition to sustain weevils.

Newman[6] noted that weevils perform better on Eurasian milfoil than native milfoils, and reported that Eurasian milfoil provides better nutrition for both larval growth and development as well as long-term adult fecundity (i.e., increased egg-laying capability). Roley and Newman[21] reported weevil survival rates were lowest on northern milfoil, intermediate on hybrid milfoil, and highest on Eurasian milfoil. Hybrid milfoils showed resistance to weevil predation intermediate between northern and Eurasian milfoil.[21] Moody and Les[5] documented that invasive milfoil hybrids are widely dispersed across the northern portion of the United States. In lakes with abundant hybrid milfoil, weevil efficacy may be diminished.


Hybrid milfoil.

Management Implications

In a multiple-year study of weevil and milfoil abundance in Fish Lake, Wisconsin, Lillie[16] observed a significant decline and resurgence of Eurasian milfoil. Jester et al.[15] noted that this type of fluctuation suggested predator-prey cycles in which an increase in Eurasian milfoil is followed by an increase in the milfoil weevil and then subsequent decrease in Eurasian milfoil and decrease in the milfoil weevil. It is reasonable to expect that weevil and Eurasian milfoil populations will cycle up and down over time as is typical of predator-prey relationships.[8,15,16,13] Newman[6] noted that because of the potentially cyclic nature and the lower predictability of control over time, “biological control is most useful for long term control in lower priority sites and over large areas where other management alternatives would be less feasible or less cost effective.” In high priority areas where rapid and effective control is needed, other control approaches should be used.

It is important to consider the factors that may limit or promote success of weevils as a Eurasian milfoil management tool. To better gauge the potential impact of weevil stocking, lake-specific evaluations should be conducted prior to stocking to assess the presence of indigenous weevil populations, overwinter habitat, the occurrence of native and hybrid milfoils, milfoil distribution within the lake, fish populations, and other factors that could influence weevil effectiveness. Some lakes may not be good candidates for weevil stocking. For example, lakes with a high sunfish density may require a different stocking strategy or may not be suitable for the use of weevils for Eurasian milfoil control.[13] Given the multitude of factors that can influence weevil efficacy, it may not be possible to predict with confidence whether weevils will thrive and whether milfoil will be controlled in a particular lake.

The effectiveness of weevils "has been mixed, with good results at some sites and poor results at others".[3] Due to the unpredictability of results, some state regulatory agencies have declined to award grants to fund weevil stocking programs. The State of Vermont spent more than $800,000 in state and federal funds toward weevil research. Weevil introductions and augmentations were conducted in nine lakes with over 100,000 weevils introduced. However, while weevil-induced plant damage was evident at many sites, significant declines attributable to weevils did not occur.[22] The Vermont Department of Environmental Conservation (VTDEC) administers a grant program that provides financial assistance to municipalities for Eurasian milfoil control. One of the evaluation criteria for prioritizing projects is the "likelihood of success." The VTDEC considers the use of weevils to be experimental and does not believe there is currently enough data to show that weevils can be used reliability or predictably, which results in a low priority being given to weevil stocking projects based on the likelihood of success.

The Idaho State Department of Agriculture (ISDA) also administers a financial assistance program for Eurasian milfoil control. Based on work performed in both Minnesota and Vermont, the ISDA does not believe that there is currently enough data to show that the weevil can be used as a reliable or predictable control alternative. In evaluating projects for funding assistance, the ISDA uses a likelihood of success criterion similar to Vermont's. The ISDA will consider using state funds for Eurasian milfoil control with weevils only if it can be demonstrated that the technique can be used successfully. In a report to the Minnesota Department of Natural Resources, Newman[23] noted that fish predation was an important limiting factor in Minnesota lakes and that weevil stocking or augmentation should not be conducted in lakes with abundant sunfish populations.

Cuda[24] discussed different types of success in biocontrol:

> Defining success in biocontrol of weeds is usually subjective and highly variable. A project may be considered successful in an ecological sense when a biocontrol agent successfully establishes in an area and reduces the target weed's population. However, the severity of damage inflicted by the biocontrol agent may not result in the level of control desired by lake managers, boaters and homeowners. Recently, a clear distinction has been made between "biological success" and "impact success." Biocontrols can be biologically successful (they establish and maintain high population densities on the target weed), but may not realize impact success (they do not provide the desired level of control or impact on the weed).

Monitoring techniques must be standardized and refined to evaluate the success of weevil stocking projects.[25] Timing of sample collection is important to help differentiate between weevil impacts and the natural die-back of milfoil at the end of the growing season.[12] Several years of monitoring are required to evaluate sustained impacts.[12]


Weevil surveying.

Integrated management in which weevil stocking is performed in conjunction with herbicide applications for Eurasian milfoil control should be conducted with caution. Weevil stocking and herbicide treatment locations should be sufficiently isolated from one another to avoid the potential for herbicide drift into stocking areas. Integrated weevil stocking and herbicide treatment programs may be more successful in lakes with isolated bays and coves that could help provide a natural partition between stocking and treatment areas. Another way to isolate herbicides and weevils would be to use the different approaches in separate years. That is, herbicides could be used the first year and weevils could be used in later years if milfoil re-infestation occurs. Mechanical harvesting of Eurasian milfoil is ill-advised in that it promotes the fragmentation and spread of the plant. Mechanical harvesting would also remove the upper portion of the milfoil plants where weevils live.[26,27]

In reviewing Eurasian milfoil management options, Madsen[28] noted:

> Numerous studies have been conducted to evaluate the utility of native insect herbivores as potential biocontrol agents of Eurasian watermilfoil, but none have proven to be predictable or effective to date. Also, if native insects were able to effectively control introduced populations of Eurasian watermilfoil, new introductions of the weed would not result in population development and expansion to weedy proportions. Historical accounts of the introduction and spread of Eurasian watermilfoil suggest that this has not occurred.

In a comprehensive review of research on biological control of Eurasian milfoil, Newman[6] summarized his findings as follows:

> The milfoil weevil . . . can be effective . . . if adequate densities can persist through the summer and among years. However, many of the sites investigated have failed to sustain sufficient herbivore [weevil] density to effect control. We currently cannot predict when and where herbivore populations will reach sufficient densities nor when or where declines and suppression will occur.[10,29] Both adequate agent [weevil] densities and proper plant response are required for predictable control[30] . . . Further identification and prioritization of factors limiting herbivore populations is needed and methods to ameliorate these limiting factors must be developed before biological control of milfoil can be reliably applied on a large scale.

The idea of using a native insect to control an exotic plant is attractive, but milfoil weevils do not yet provide predictable or reliable Eurasian milfoil control. Additional research is needed to evaluate the full potential of weevil stocking as a long-term Eurasian milfoil control technique.

References

1 Grace, J.B., and R.G. Wetzel. 1978. The production biology of Eurasian watermilfoil (*Myriophyllum spicatum L.*): A review. Journal of Aquatic Plant Management 16: 1-11.

2 Smith, C. S., and J.W. Barko. 1990. Ecology of Eurasian watermilfoil. Journal of Aquatic Plant Management 28: 55-64.3 Getsinger, K., M.D. Moore, E. Dibble, E. Kafcas, M. Maceina, V. Mudrak, C. Lembi, J. Madsen, R.M. Stewart, L. Anderson, W. Haller, C. Layne, A. Cofrancesco, R. Newman, F. Nibling, K. Engelhardt. 2005. Aquatic Plant Management: Best Management Practices in Support of Fish and Wildlife Habitat. Aquatic Ecosystem Restoration Foundation.

3 Getsinger, K., M.D. Moore, E. Dibble, E. Kafcas, M. Maceina, V. Mudrak, C. Lembi, J. Madsen, R.M. Stewart, L. Anderson, W. Haller, C. Layne, A. Cofrancesco, R. Newman, F. Nibling, K. Engelhardt. 2005. Aquatic Plant Management: Best Management Practices in Support of Fish and Wildlife Habitat. Aquatic Ecosystem Restoration Foundation, Lansing, MI.

4 Aiken, S.G., P.R. Newroth, and I. Wile. 1979. The biology of Canadian weeds. 34. *Myriophyllum spicatum L.* Canadian Journal of Plant Science 59: 201-215.

5 Moody, M.L., and D.H. Les. 2007. Geographic distribution and genotypic composition of invasive hybrid watermilfoil (*Myriophyllum spicatum* x *M. sibiricum*) populations in North America. Biological Invasions 9: 559-570.

6 Newman, R.M. 2004a. Invited Review – Biological control of Eurasian watermilfoil by aquatic insects: Basic insights from an applied problem. Archiv für Hydrobiologie 159 (2): 145-184.

7 Marko, M.D., R.M. Newman, and F.K. Gleason. 2005. Chemically mediated host-plant selection by the milfoil weevil: A freshwater insect-plant interaction. Journal of Chemical Ecology 38 (12): 2857-2876.

8 Sheldon, S.P., and R.P. Creed. 1995. Use of a native insect as a biological control for an introduced weed. Ecological Applications 5: 1122-1132.

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

10 Creed, R.P. 2000. The weevil-watermilfoil interaction at different spatial scales: What we know and what we need to know. Journal of Aquatic Plant Management 38: 78-81.

11 Cofrancesco, A.F., D.G. McFarland, J.D. Madsen, A.G. Poovey, and H.L. Jones. 2004. Impacts of *Euhrychiopsis lecontei* (Dietz) from different populations on the growth and nutrition of Eurasian watermilfoil. APCRP Technical Notes Collection (APCRP-BC-07) U.S. Army Engineer Research and Development Center, Vicksburg, MS.

12 Reeves, J.L., P.D. Lorch, M.W. Kershner, and M.A. Hilovsky. 2008. Biological control of Eurasian watermilfoil by *Euhrychiopsis lecontei*: Assessing efficacy and timing of sampling. Journal of Aquatic Plant Management 46: 144-149.

13 Alwin T. and K. Cheruvelil. 2009. Biological control of Eurasian watermilfoil: A review of the native watermilfoil weevil. Michigan State University Extension Bulletin WQ 61.

14 Newman, R.M., D.W. Ragsdale, A. Milles and C. Oien. 2001. Overwinter habitat and the relationship of overwinter to in-lake densities of the milfoil weevil, *Euhrychiopsis lecontei*, a Eurasian watermilfoil biological control agent. Journal of Aquatic Plant Management 39 (1): 63-67.

15 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 of Aquatic Plant Management 38: 88-97.

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

17 Ward, D.M. and R.M. Newman. 2006. Fish predation on Eurasian watermilfoil (*Myriophyllum spicatum*) herbivores and indirect effects on macrophytes. Canadian Journal of Fisheries and Aquatic Sciences 63: 1049-1057.

18 Sutter, T.J. and R.M. Newman. 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 (2): 255-234.

19 Johnson, R.L., P.J. Van Dusen, J.A. Toner, and N.G. Hairston, Jr. 2000 Eurasian watermilfoil biomass associated with insect herbivores in New York. Journal of Aquatic Plant Management 38: 82-88.

20 Tamayo, M., C.E. Grue, and K. Hamel. 2000. The relationship between water quality, watermilfoil frequency, and weevil distribution in the State of Washington. Journal of Aquatic Plant Management 38: 112-116.

21 Roley, S.S. and R.M. Newman. 2006. Developmental performance of the milfoil weevil, *Euhrychiopsis lecontei* (Coleoptera: Curculionidae), on northern watermilfoil, Eurasian watermilfoil, and hybrid (northern x Eurasian) watermilfoil. Environmental Entomology 35 (1): 121-126.

22 Madsen, J.D., H.A. Crosson, K.S.Hamel, M.A. Hilovsky, and C.H. Welling. 2000. Panel discussion – Management of Eurasian milfoil in the United States using native insects: State regulatory and management issues. Journal of Aquatic Plant Management 38: 121-124.

23 Newman, R.M. 2004b. Biological control of Eurasian watermilfoil: Completion report for 2001-2004. Minnesota Department of Natural Resources. St. Paul, MN. 80pp.

24 Cuda, J. 2009. Introduction to biological control of aquatic weeds. In: Biology and Control of Aquatic Plants – A Best Management Practices Handbook. L.A. Gettys, W.T. Haller, and M. Bellaud, Eds. Aquatic Ecosystem Restoration Foundation, Marietta, Georgia.

25 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 submersed aquatic weeds. Journal of Aquatic Plant Management 46: 15-32.

26 Sheldon, S.P., and L.M. O'Bryan. 1996. The effects of harvesting Eurasian watermilfoil on the aquatic weevil *Euhrychiopsis lecontei*. Journal of Aquatic Plant Management 34: 76-77.

27 Newman, R.M. and W.G. Inglis. 2009. Distribution and abundance of the milfoil weevil, *Euhrychiopsis lecontei*, in Lake Minnetonka and relation to milfoil harvesting. Journal of Aquatic Plant Management 47: 21-25.

28 Madsen, J. Eurasian watermilfoil. In: Biology and Control of Aquatic Plants – A Best Management Practices Handbook. L.A. Gettys, W.T. Haller, and M. Bellaud, Eds. Aquatic Ecosystem Restoration Foundation, Marietta, Georgia.

29 Newman, R.M. and D.D. Biesboer. 2000. A decline of Eurasian watermilfoil in Minnesota associated with the milfoil weevil, *Euhrychiopsis lecontei*. Journal of Aquatic Plant Management 38 (2): 105-111.

30 Newman, R.M., D.C. Thompson, and D.B. Richman. 1998. Conservation strategies for the biological control of weeds. In: Conservation Biological Control. P. Barbosa, Ed. Academic Press, New York, pp. 371–396.

About the Authors:

Progressive AE's Water Resources Group has provided lake and watershed management services to both public and private sector clients for over 35 years. Progressive's multi-disciplinary team consists of aquatic biologists, civil engineers, landscape architects, and geographic information systems specialists.