

Table 2. Herbicides recommended for managing Eurasian watermilfoil

Chemical	Trade Name	Formulation	Concentration in Water	Rate of Formulation Application	Notes
2,4-D	Aqua-Kleen	Granular		100 to 200 lbs per acre	Selective systemic
	Navigate	Granular		100 to 200 lbs per acre	Selective systemic
	DMA 4	Liquid	2-4 ppm a.e.	1.42 to 2.84 gallons per acre-foot	Selective systemic
Diquat	Reward	Liquid		1-2 gallons per acre	Broad spectrum contact
	Weedtrine-D	Liquid		5-10 gallons per surface acre	Broad spectrum contact
Endothall	Aquathol K	Liquid	2-4 ppm a.i.	1.3 to 2.6 gallons per acre-foot	Broad spectrum contact
	Aquathol SuperK	Granular	2-4 ppm a.i.	8.8 – 17.6 lbs per acre-foot	Broad spectrum contact
Fluridone	Sonar AS	Liquid	5 to 45 ppb a.i.	0.42 to 3.8 ounces per acre-foot	Broad spectrum systemic
	Sonar SRP Sonar PR Sonar Q	Pellets	5 to 45 ppb a.i.	0.27 to 2.5 lbs per acre-foot	Broad spectrum systemic
Triclopyr	Renovate 3	Liquid	0.75 to 2.5 ppm a.e. in	0.7 to 2.3 gallons per acre-foot	Selective systemic

ADDITIONAL READING:

Aquatic Ecosystem Restoration Foundation (AERF). 2004. Best Management Practices Handbook for Aquatic Plant Management in Support of Fish and Wildlife Habitat. Aquatic Ecosystem Restoration Foundation, Flint, MI. http://www.aquatics.org/aquatic_bmp.pdf.

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: Workshop Summary. ERDC/EL TR-02024, U.S. Army Engineer Research and Development Center, Vicksburg, MS. <http://el.erd.usace.army.mil/elpubs/pdf/trel02-24.pdf>.

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

Jacono, C.C. and M.M. Richerson. 2003. *Myriophyllum spicatum* L. Nonindigenous Aquatic Species web page, U.S. Geological Survey, Gainesville, FL. 15 December 2003. http://nas.er.usgs.gov/plants/docs/my_spica.html.

FOR MORE INFORMATION:

Aquatic Ecosystem Restoration Foundation (Herbicide Information) <http://www.aquatics.org/>
Mississippi State University, GeoResources Institute, Invasive Species Page: www.gri.msstate.edu/invasives

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Published by the GeoResources Institute in cooperation with the United States Geological Survey (USGS). This info is to be published as part of the GeoResources Institute's Invasive Species Spotlight program with the Extension Service at MSU.



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INVASIVE SPECIES FACT SHEET

Eurasian watermilfoil (*Myriophyllum spicatum* L.) Description, Distribution, and Management

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INTRODUCTION

Eurasian watermilfoil (*Myriophyllum spicatum* L.) is a nonnative aquatic plant from Europe and Asia that is green throughout the year. Growing completely underwater with only the inflorescences above the water's surface, it can often be difficult to notice in early stages. Once mature, its dense canopy can interfere with boating, swimming, fishing, or other aquatic activities. Ecologically, it suppresses native plants and changes the equilibrium between predators, like bass, and their prey. Eurasian watermilfoil nuisance growths cost lake users millions of dollars a year to manage, and even more in other economic losses.

DESCRIPTION

Eurasian watermilfoil grows completely under water (Figure 1), but can form a canopy of leaves and branches very close to the surface (Figure 2). It is a submersed evergreen perennial plant with green shoots present throughout the year. Eurasian watermilfoil grows in water depths from 1 to 15 feet, from which it can grow to near the surface; but occasionally can grow in even deeper water if water clarity is particularly high. Eurasian watermilfoil forms a dense root crown from which numerous shoots grow towards the surface (Figure 3). The root crown and associated new shoots are the primary means by which Eurasian watermilfoil overwinters. As it grows to the surface, it branches repeatedly to form a very dense canopy with a profusion of leaves. The leaves are pinnately compound, with 14 to 24 pairs of thin tubular leaflets. These leaves typically occur in groups of four whorled at each node of the stem, though some variation can occur (Figure 4). The plant forms a short inflorescence, or flowering spike, above the surface of the water composed of pollen-forming flowers on top and seed-producing flowers below. The flowers are wind pollinated. Stems and apical tips of Eurasian watermilfoil tend to be reddish, but variation in this color also occurs. Since Eurasian watermilfoil looks like some of the native *Myriophyllum* species, confusion in the identification of this nuisance invader frequently occurs.



Figure 1. Underwater view of the canopy of Eurasian watermilfoil in 12 feet water depth, in the clear waters of Lake George, NY. Photo by John Madsen, PhD.



Figure 2. Eurasian watermilfoil growing close to the surface in Lake Hortonia, Vermont. Photo by John Madsen, PhD.



Figure 3. The dense root crown of Eurasian watermilfoil is how the plant grows and overwinters. Photo by John Madsen, PhD.



Figure 4. Close-up of Eurasian watermilfoil showing four feather-like leaves per node and the inflorescences above the water. Photo by John Madsen, PhD.

Eurasian watermilfoil (*Myriophyllum spicatum* L.)

Description, Distribution, and Management

HABITAT

Eurasian watermilfoil grows in a diverse range of aquatic habitats, including rivers, reservoirs, and natural lakes, freshwater and brackish estuaries. Eurasian watermilfoil can tolerate salinity as high as 13 ppt (approximately 33% of seawater), and growth is undiminished below salinities of 6 ppt (approximately 15% of seawater). In freshwater, it tolerates environments ranging from soft water, low alkalinity systems to hard water lakes, and trophic states from oligotrophic to eutrophic. Its growth can vary across its range from being winter dormant in northern lakes to dormant in both winter and mid-summer mainly from heat stress in the south.

While seeds are produced, they generally do not appear to be an important source of new colonies. Seeds do resist desiccation, so one possible mechanism of reproduction by seed is after drawdown. Reproduction is almost entirely by vegetative means, either spread by stolons or fragments. The plants produce fragments seasonally that act as dispersal units and can survive for long periods of time before establishment.

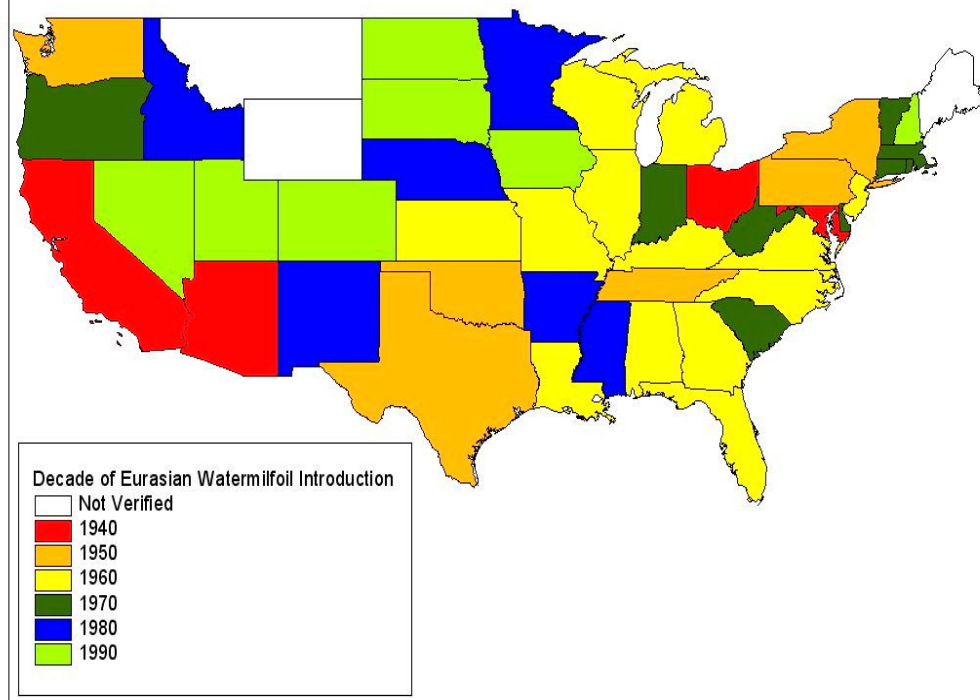
SPREAD

Eurasian watermilfoil spread throughout the United States is a combination of human intervention and natural processes depending on the scale of dispersal. Some possible theories include the use of Eurasian watermilfoil as an aquarium plant, use as solid ballast in ships, or in the aquatic nursery trade. Interstate transfer of Eurasian watermilfoil was also predominantly human-vectored. The most likely carrier of Eurasian watermilfoil between states or watersheds is on boats and boat trailers. Eurasian watermilfoil is a prolific former of autofragments, fragments created by an abscission layer in the stem, which are stem segment propagules. Thus, once Eurasian watermilfoil is in a lake or a watershed, it is difficult to prevent its spread by natural means. Wave action, boating, or other mechanical stresses that break the stem may also form stem fragments which may form new colonies of Eurasian watermilfoil.

DISTRIBUTION

Eurasian watermilfoil was first found in the United States in the 1940's, with almost simultaneous introductions to California, Arizona, Ohio, and the Chesapeake Bay (Figure 5). Apparently, all these states acted as loci for spread, with populations found in a number of northeastern, midwestern, southwestern, and southeastern states by 1960. By the 1980s, numerous sites occurred throughout the United States with the apparent exception of the northern plains states. Currently, it is one of the most widespread invasive aquatic plants occurring in at least 45 states and in three Canadian provinces. Once established in a new state, it continues to spread to new lakes. In Mississippi, Eurasian watermilfoil is currently found in the Tennessee-Tombigbee waterway and TVA reservoirs.

Figure 5. Estimated decade of Eurasian watermilfoil introduction to each state in the United States. Data from Couch and Nelson (1985) and Jacono and Richerson (2003).



Eurasian watermilfoil grows completely under water...in depths from 1 to 15 feet...even deeper water if water clarity is particularly high.

MANAGEMENT

A number of biological control organisms have been utilized for Eurasian watermilfoil (Table 1). Grass carp do not prefer Eurasian watermilfoil so they are a poor control option at best. Native insects and a native pathogenic fungus have both shown some promise but are still under development. The bottom line is that there is not currently an operational biocontrol agent for Eurasian watermilfoil.

Herbicides are the most commonly used control technique for Eurasian watermilfoil. New herbicides have been approved or are in the process of registration by U.S. E.P.A for use in aquatic environments for control of Eurasian watermilfoil. Currently, approved systemic aquatic herbicides are 2,4-D, fluridone, and triclopyr. The contact herbicides diquat and endothall are also used on small infestations or along shorelines as a "spot" treatment (Table 1,2).

Mechanical control is also widely used for managing Eurasian watermilfoil. Of these, hand harvesting or hand implements are used on small segments of shoreline. Harvesters are commonly used to relieve the nuisance growth (Table 1) in larger areas offshore with the plant material removed from the lake. While users get immediate relief from plant growth, this technique will not result in long-term control. Other techniques in use include rotovating, using an underwater tilling apparatus, and diver-operated suction harvesting, where SCUBA divers use a vacuum lift to remove plants by their roots.

Physical control techniques include a number of approaches, such as shading or dredging, to decrease the light available to plants (Table 1). Of the physical techniques, the most affordable and effective is drawdown, particularly winter drawdown, in which the lakes are drained during the winter period to desiccate and freeze the plant. Obviously, this technique is only feasible if the lake has a water control structure.

Table 1. Management Techniques for control of Eurasian watermilfoil

Category	Technique	Note	Rating	
Biological	Grass Carp	Not a preferred food	Poor	
	Native Herbivores	Not operational	Poor	
Chemical	2,4-D	Selective systemic	Excellent	
	Carfentrazone	Selective contact	Good	
	Diquat	Contact	Good	
	Endothall	Contact, works at lower temperatures	Good	
	Fluridone	Slow-acting systemic	Excellent	
Mechanical	Triclopyr	Selective systemic	Excellent	
	Harvesting		Fair	
	Raking	Small to moderate areas	Fair	
	Hand Cutting	Small areas	Good	
	Suction harvesting	Small areas	Excellent	
	Physical	Winter Drawdown	Large-scale	Excellent
		Dredging	Large-scale, expensive	Excellent
Bottom Barrier		Small scale, expensive	Excellent	