INVASIVE SPECIES FACT SHEET

Curlyleaf pondweed (*Potamogeton crispus* L.)

Description, Distribution, and Management

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INTRODUCTION

Fig. 1. Nuisance growth caused by curlyleaf pondweed. Photo by John Madsen.

Curlyleaf pondweed (*Potamogeton crispus* L.) is a submersed herbaceous perennial plant. Oversummering as a turion or hardened bud, it can form a dense nuisance canopy on the surface in the spring and early summer, impeding recreation and increasing flood risk (Figure 1). When it senesces in mid-summer, it can cause oxygen depletion and encourage algal blooms from decompositional release of nutrients.

A member of the Potamogetonaceae (Pondweed Family), it is distinguished by alternate leaves that are minutely toothed, and tend to be undulating along their length (Figure 2). Flowers are born on a short stem that rises above the water's surface, though the rest of the plant is submersed (Figure 3). While seeds are produced that may be fertile, vegetative reproduction tends to be more important for both the dispersal and dormancy of this species. An individual stem may spread locally by the growth of rhizomes. Rhizomes may also play a role in "oversummering," or perennation, of the plant. The most significant propagule is the turion. Turions are a dormant shoot segment that is thickened and resistant to many environmental stressors. Turions are produced from apical buds, axillary buds, or segments of the rhizome. Because of the variation in their origin, they may look quite different depending on the source (Figure 4).

HABITAT AND LIFE HISTORY

Fig. 2. Curlyleaf pondweed leaves curl or undulate, and have fine teeth on the margins. Photo by John Madsen.

Curlyleaf pondweed grows in lakes and streams across the United States, but does favor cooler water habitats. It is not tolerant of salinity, but can tolerate fluctuating water levels. It typically grows in 1 to 12 feet water depth, with some plants recorded in deeper water of high clarity. Curlyleaf pondweed tolerates a variety of water alkalinity, and is typically found in mesotrophic to eutrophic lakes.

Curlyleaf pondweed has a life history that is unique among submersed aquatic plants. While most native and nonnative aquatic plants come out of dormancy in early to mid-spring and reach their maximum growth in late summer or early fall, curlyleaf pondweed has adapted to a timeframe that largely evades competition with these other plant species. Curlyleaf pondweed actually begins a new year in late summer, when its turions sprout in response to either shortening daylength or decreasing water temperature (Figure 5).

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ADDITIONAL READING

Bolduan, B.R., G.C. Van Eeckhout, H.W. Quade, and J.E. Gannon. 1994. *Potamogeton crispus*-the other invader. Lake and Reservoir Management 10:113-125.

Catling, P. M. and I. Dobson. The biology of Canadian weeds. 69. *Potamogeton crispus* L. Canadian Journal of Plant Science 65:665-668.

Madsen, J.D. and W. Crowell. 2002. Curlyleaf pondweed (*Potomogeton crispus* L.). LakeLine 22(1):31-32. Spring 2002.

Netherland, M.D., J.D. Skogerboe, C.S. Owens, and J.D. Madsen. 2000. Influence of water temperature on the efficacy of diquat and endothall versus curlyleaf pondweed. Journal of Aquatic Plant Management 38:25-32.

Poovey, A.G., J.G. Skogerboe and C.S. Owens. 2002. Spring treatments of diquat and endothall for curlyleaf pondweed control. Journal of Aquatic Plant Management 40:63-67.

Woolf, T.E. and J.D. Madsen. 2003. Seasonal biomass and carbohydrate allocation patterns in southern Minnesota curlyleaf pondweed populations. Journal of Aquatic Plant Management 41:113-118.

Table 1. Management techniques for the control of curlyleaf pondweed.

CATEGORY	TECHNIQUE	NOTE	RATING
BIOLOGICAL	Grass Carp	A preferred food, but use of grass carp has many drawbacks	Good
CHEMICAL	Endothall	Contact, works at lower temperatures	Excellent
	Diquat	Contact	Good
	Fluridone	Slow-acting systemic	Good
MECHANICAL	Harvesting	Target prevention of turion formation	Good
	Raking	Small to moderate areas	Fair
	Hand Cutting	Small areas	Fair
	Suction harvesting	Small areas	Good
PHYSICAL	Winter Drawdown	Large-scale	Excellent
	Dredging	Large-scale, expensive	Excellent
	Bottom barrier	Small scale, expensive	Fair

Table 2. Herbicides recommended for managing curlyleaf pondweed.

Chemical	Trade Name	Formulation	Concentration in Water	Rate of Formulation Application	Notes
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 Super K	Granular	2-4 ppm a.i.	8.8 – 17.6 lbs per acre-foot	Broad spectrum contact
Fluridone	Sonar AS	Liquid	5 to 20 ppb a.i.	0.42 to 1.7 ounces per acre-foot	Broad spectrum systemic
	Sonar SRP Sonar PR Sonar Q	Pellets	5 to 20 ppb a.i.	0.27 to 1.1 lbs per acre-foot	Broad spectrum systemic

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HABITAT AND LIFE HISTORY, continued

The new growth continues until water temperatures reach their winter minima. At this point, curlyleaf pondweed stems may be a few inches to several feet tall, and they are either quiescent or slowly growing during the winter months, depending on light availability and water temperature. Once the ice is off and temperatures warm to 5 C (40 F), curlyleaf pondweed begins to elongate more rapidly. Curlyleaf pondweed has the highest metabolic activity in cold water of any aquatic plant species. The stems of this species reach the water's surface well in advance of any other species, and often before the other species break their spring dormancy. By late spring, a dense canopy of curlyleaf pondweed can be formed, which may restrict the growth of other species. Curlyleaf pondweed may then begin the formation of turions in early summer; followed by flowering, seed formation, and finally senescence or death of the upright stems. The turions, however, will fall to the bottom and survive until the following fall. The entire growth cycle is completed before midsummer, often before the fourth of July. The turions may lie dormant, sprout more than one time, or sprout at other times in the year if conditions allow.

Fig. 3. Curlyleaf pondweed inflorescences are small and barely noticable. The flowers are wind pollinated. Photo by John Madsen.

Fig. 4. Curlyleaf pondweed turions are hardened stem buds, forming either at the apical tip of the plant or at branching points. Photos by John Madsen, top, and Thomas E. Woolf, Idaho State Department of Agriculture.

SPREAD AND DISTRIBUTION

Curlyleaf pondweed is predominantly spread by turions. A single plant can produce a large number that can then be carried by wave action, water movement, and on boats and trailers. Secondarily, the seeds are moderately viable, and are consumed by waterfowl; so it is feasible that waterfowl could spread it as well.

Originally introduced from Eurasia in the mid-nineteenth century, it was thought to be a contaminant in fish imported from that region. While native to freshwaters of Eurasia, Africa, and Australia, it is now common throughout southern Canada, the United States, Central America, and South America. In the United States, it has been reported in all but two of the contiguous 48 states (Figure 6). While present in Mississippi, it does not typically form nuisance stands.

MANAGEMENT

Most management activities are successful in removing nuisances caused by curlyleaf pondweed during the first year of treatment. The two main challenges associated with management of curlyleaf pondweed are to minimize damage to native plants and to produce long-term control. Curlyleaf pondweed is a monocot, biologically similar to many valuable and common native aquatic plants. Thus, selective chemical control of curlyleaf pondweed is not generally possible (i.e., killing curlyleaf pondweed without harming adjacent native vegetation) unless it is the only aquatic plant species growing in a treated area. Curlyleaf pondweed can be managed using habitat manipulation, mechanical harvesting, and herbicides. Since curlyleaf pondweed is generally gone by mid-July management activities should be undertaken in spring or very early

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summer to have the maximum benefit. Long-term management requires the reduction or elimination of turions to interrupt the life cycle.

Biological

Curlyleaf pondweed does not currently have any operational biological control options, other than the use of grass carp (Table 1).

Chemical

Only a few of the aquatic herbicides can be used to control curlyleaf pondweed (Tables 1, 2). Good to excellent control of curlyleaf can be obtained using formulations of diquat (e.g., Reward®) and endothall (e.g., Aquathol®). Whole lake treatment with fluridone can also be used to control curlyleaf pondweed. Diquat and endothall (especially the former) are contact herbicides that can be used in small areas. Endothall has been shown to be effective at lower temperatures, and is being used experimentally in large-scale applications on entire beds of curlyleaf pondweed. Fluridone is a systemic herbicide that usually has to be applied to whole lakes or bays and requires over 60 days to control curlyleaf pondweed. Potential problems are failure of the herbicides to control curlyleaf, a lag time between treatment and plant knock down, regrowth of curlyleaf the following year, and the removal of beneficial native plants.

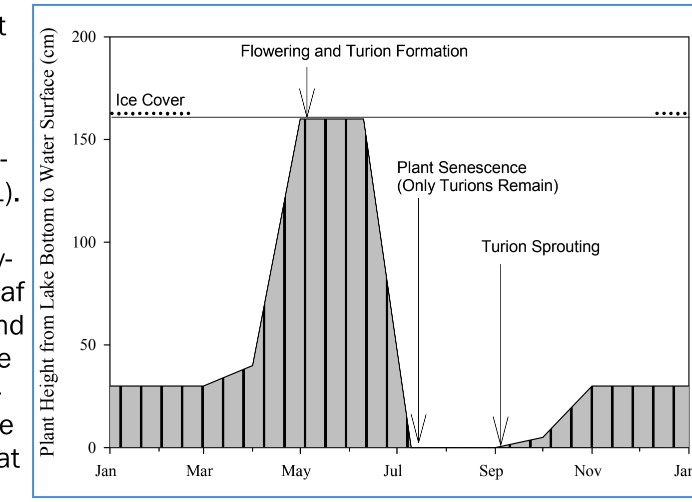

Fig. 5. Life history of curlyleaf pondweed diagrammed for a Minnesota population. The timing of this cycle varies with location. Revised from Woolf and Madsen, 2003.

Mechanical

Curlyleaf pondweed can be managed mechanically by raking, hand cutting, or harvesting vegetation. Raking and hand cutting generally remove the plants at the sediment surface, while harvesting generally removes the top five feet of the plants. Diver-operated suction harvesting allows for the removal of both stems and turions, but is slow and costly. Mechanical methods control plants in the specific areas where they are causing a nuisance and there is immediate relief from the nuisance.

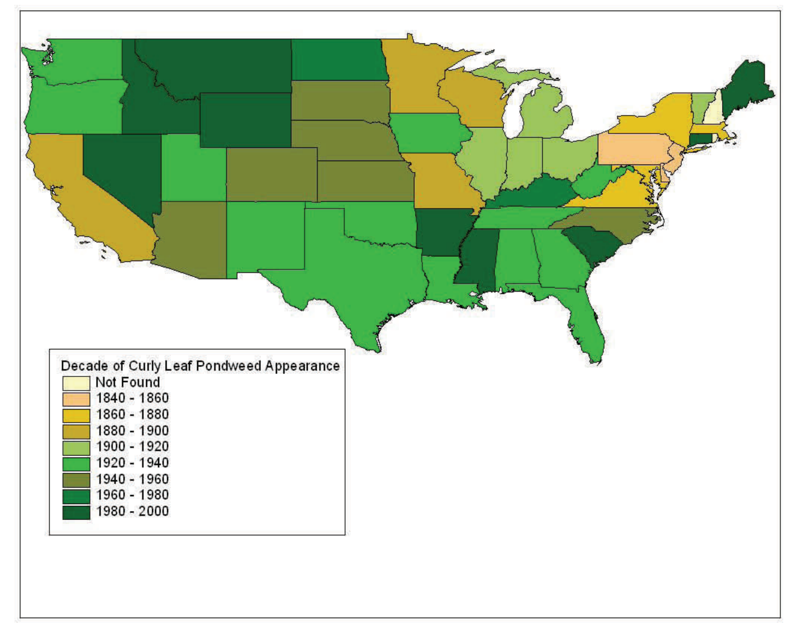

Fig. 6. Distribution of curlyleaf pondweed in the United States by year of first sighting. Data from Bolduan et al. 1994.

Physical

Habitat manipulations such as water level drawdown, dredging, or bottom barriers can be used to manage curlyleaf pondweed. Fall drawdown can prevent curlyleaf pondweed from growing the following summer by exposing turions to freezing temperatures and desiccation. Dredging can be used to control curlyleaf pondweed by increasing water depth. In deep water rooted plants do not receive enough light to survive. Depending upon how much material is removed, dredging can prevent all rooted macrophytes from growing for many years. Bottom barriers can be used to prevent the growth of rooted aquatic macrophytes in small areas. Control of all rooted species is immediate and lasts as long as the barriers are well maintained. Barriers are expensive to install and maintain.

RELATED WEB SITES

Aquatic Ecosystem Restoration Foundation (Herbicide Information) http://www.aquatics.org

Mississippi State University, GeoResources Institute, Invasive Species page http://www.gri.msstate.edu/lwa/invspec.php

Sea Grant Nonindigenous Species Site http://www.sgnis.org

University of Florida's Center for Aquatic and Invasive Species http://aquat1.ifas.ufl.edu

USACE Aquatic Plant Control Research Program http://www.wes.army.mil/el/aqua

US Geological Survey Nonindigenous Aquatic Species http://nas.er.usgs.gov