

# MANAGEMENT

**Biological Control:** A few biological control agents exist for the potential control of giant salvinia including an aquatic grasshopper (*Paulinia acuminata* De Geer), the pyralid moth (*Samea multiplicalis* Guenee). The moth and the grasshopper were primarily investigated in Australia and currently are not approved for use in the United States. Herbivorous fish including the grass carp (*Ctenopharyngodon idella* Val.), and tilapia (*Oreochromis niloticus* Trewavas); the last has shown promise as a biological control agent (Table 1). However, the salvinia weevil (*Cyrtobagous salviniae* Calder and Sands) is the most notable and only organism that has demonstrated success in giant salvinia control. Both adult and larval damage can reduce giant salvinia infestations when conditions are optimal for weevil growth. Optimal conditions include water temperatures between 61 and 86 °F. Water temperatures outside this range results in decreased weevil performance. Similarly, feeding and larval damage depend on levels of nitrogen in plant tissues; low levels of plant nitrogen result in low densities of the salvinia weevil.

**Mechanical Control:** Manual (hand pulling) or mechanical (wire nets and floating booms) control of giant salvinia is only practical during the early stages of growth (Table 1). After giant salvinia is established in a given area, increased biomass and rapid growth makes harvesting and hand pulling unfeasible. Manual and mechanical control measures are very expensive and need frequent deployment for acceptable results.

**Chemical Control:** Herbicides are the most widely used and effective method for controlling infestations of giant salvinia. Herbicide use is restricted to those herbicides and herbicide formulations approved by the USEPA for aquatic environments. Systemic herbicides such as 2,4-D and triclopyr are not effective in controlling infestations. Fluridone has been effective however high rates are needed which may be cost prohibitive as a large scale treatment. Currently, diquat and glyphosate have been the most effective for giant salvinia control (Table 2). Copper formulations such as Komeen and Clearigate have had success in controlling infestations. To aid in successful giant salvinia control apply herbicides to actively growing plants; ensure even distribution of spray material to plant surfaces; repeat applications may be necessary if plant stand is dense; and always consult the product label for use restrictions. Always use a non-ionic surfactant with these herbicides.

Table 1. Biological and other control techniques deployed to control giant salvinia infestations.

Category	Technique	Deployment	Effectiveness
Biological Control	grass carp ( <i>Ctenopharyngodon idella</i> )	prior to mat formation	not effective
	tilapia ( <i>Oreochromis niloticus</i> )	prior to mat formation	not enough data
	salvinia weevil ( <i>Cyrtobagous salviniae</i> )	on established salvinia mats	excellent to fair
Mechanical Control	manual (hand pulling)	early in growing season	effective, expensive, labor intensive
	mechanical (wire nets and floating booms)	early in growing season	effective, expensive
Physical Control	water drawdown	winter	fair

Table 2. Recommended aquatic herbicides and rates for use in controlling giant salvinia.

Herbicide	Trade Name	Application Rate <sup>1</sup> (gal/acre)	Type of Chemical	Effectiveness <sup>2</sup>
Diquat	Reward	0.5-0.75	Broad Spectrum	Excellent
Glyphosate	Rodeo	1.0-2.0	Broad Spectrum	Excellent
	AquaMaster AquaPro AquaStar			
Copper	Komeen	5.0	Broad Spectrum	Good to Fair
	Clearigate	4.0-9.0	Broad Spectrum	Good to Fair

<sup>1</sup>Rates expressed as gallons of product per surface acre  
<sup>2</sup>Excellent = ≥ 95% control of sprayed plants  
 Good = 80% control of sprayed plants  
 Fair = < 80% control of sprayed plants; re-growth can be expected  
 \*\*Use the higher rates for dense plant infestations

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## FURTHER READING

Jacono, C.C. and M.M. Richerson. 2004. The distribution and spread of *Salvinia molesta* (giant salvinia). United States Geological Survey giant salvinia web page <http://salvinia.er.usgs.gov/>.

McFarland, D.G., L.S. Nelson, M.J. Grodowitz, R.M. Smart, and C.S. Owens. 2004. *Salvinia molesta* D. S. Mitchell (giant salvinia) in the United States: A review of species ecology and approaches to management. Special Report, SR-04-2. Army Engineer Research and Development Center, Vicksburg, MS.

Oliver, J.D. 1993. A review of the biology of giant salvinia (*Salvinia molesta* Mitchell). Journal of Aquatic Plant Management 31:227-231.

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# INVASIVE SPECIES FACT SHEET

## Giant Salvinia (*Salvinia molesta* D. S. Mitchell)

### Description, Distribution, and Management

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## INTRODUCTION

Giant salvinia (*Salvinia molesta* D.S. Mitchell) is an aquatic fern native to southern Brazil. Giant salvinia is free-floating and can form thick mats of up to 3 feet thick when plant densities are high. The dense mats fill in water-bodies resulting in decreased density and diversity of native aquatic plants and animals. Similarly, giant salvinia mats clog irrigation canals, interferes with rice production, and impedes access to waterways for humans and livestock. Giant salvinia is considered one of the world's worst weeds. The ecological consequences of giant salvinia introduction have prompted the United States Department of Agriculture and the Mississippi Department of Agriculture and Commerce to list this species on both the federal and state Noxious Species List.

## DESCRIPTION

Giant salvinia is a rootless, free-floating fern that can be identified by its broadly rounded green fronds (Figure 1). Pairs of these emergent fronds are produced at each node of a horizontal stem that floats just beneath the water surface (Figure 1). The upper surfaces of the emergent fronds display a prominent midrib that is covered with stiff white hairs that aid in leaf buoyancy (Figure 2). The hairs of giant salvinia differentiate this species of *Salvinia* from others such as *Salvinia minima* Baker and *Salvinia auriculata* Aubl. by forming cage-like or egg-beater-shaped hairs (Figure 3). Giant

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Fig. 1. An individual giant salvinia plant displaying fronds (A), horizontal stem (B), and submersed fronds (C). Submersed fronds resemble a root mass. Photo by Ryan M. Wersal.





Fig. 2. Giant salvinia fronds showing the rows of stiff hairs that aid in the buoyancy of the plant. Photo by Ryan M. Wersal.



Fig. 3. A magnified view of the cage-like or egg-beater-shaped hairs on the surfaces of giant salvinia fronds. Photo by Julie Graham.

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salvinia also produces a brown submersed leaf that is often mistaken for roots. Similarly, stalks extend beneath the water surface where sessile sporocarps are produced (Figure 4). Giant salvinia sporocarps are uniquely egg-shaped and occur in straight chains among the submersed fronds. Although mature plants can produce a great number of sporocarps the sporangial sacs are most often void of spores. Giant salvinia can produce reproductive structures (spores) however; when the spores are present they are generally deformed and non-viable. It is believed that the primary means of reproduction is solely asexual.

Giant salvinia has three different phenotypes or growth forms. The survival stage occurs when growing conditions are less than optimum (e.g. when nutrients are low). During this stage the plant grows slowly and bears 4 to 5 pairs of flattened fronds that are each approximately one half inch in diameter. In the colonizing stage, plants can be found in open water with fronds 1-1.5 inches in diameter. During the mat stage the plant is present in established mats where growth is restricted and slow; with plants having erect pairs of fronds on a 6-8 inch rhizome (Figure 5). When plants are transferred from one environment to another, they adapt their growth stage to better suit the new conditions and maximize dominance in the new environment.



Fig. 4. The male sporocarps of giant salvinia. Sporocarps are attached directly to individual plants. Photo by Ryan Wersal.



Fig. 5. The mat forming stage of giant salvinia displaying the erect pairs of curled, emergent fronds. Photo by Ryan M. Wersal.

## DISTRIBUTION

Giant salvinia was likely introduced in the United States via the nursery trade as an ornamental species in the late 1970's or early 1980's. Records from Florida indicate that giant salvinia was in cultivation in nurseries as early as 1983. The first recorded natural population of giant salvinia was discovered in 1995 in South Carolina. Since then this species has spread through the southern United States infesting waters in Texas, Mississippi, Louisiana, Georgia, Florida, Alabama, California, Hawaii, Arizona, North Carolina, and Virginia (Figure 7). In Mississippi, giant salvinia was first observed in 1999 growing in a wetland in the central portion of the state. In 2004, giant salvinia was observed near Hattiesburg, Mississippi on a 40-acre lake close to the Leaf River (Figure 8).



Fig. 6. Mat formation of giant salvinia on a small pond at the Lewisville Aquatic Ecosystem Re-

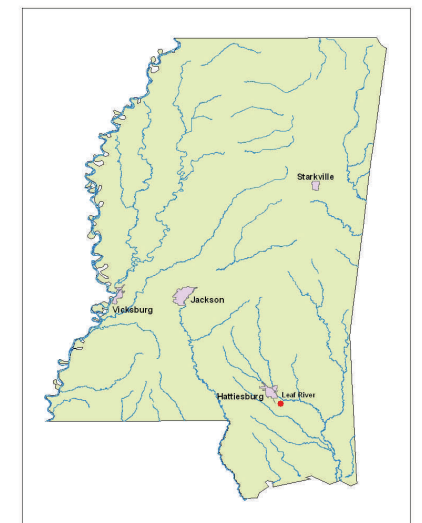


Fig. 8. Location of giant salvinia observations in Mississippi. Data taken from United States Geological Survey and the Mississippi Department of Agriculture and Commerce, Plant Industry Division.

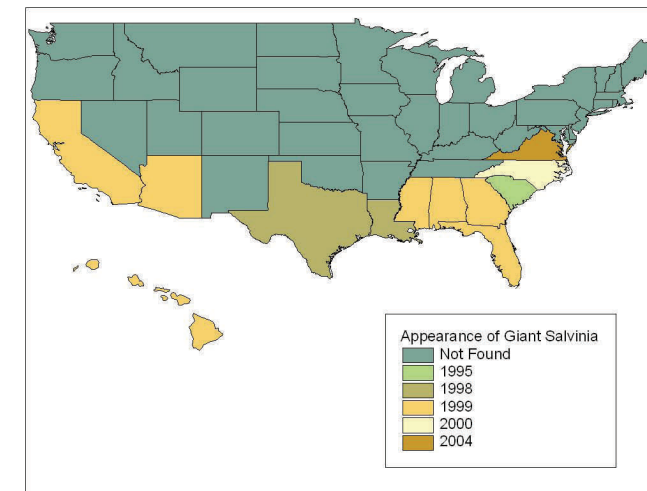


Fig. 7. The distribution and year of appearance of giant salvinia in the United States. Data from United States Geological Survey.

## MORE INFORMATION

Invasive Species Web Links  
<http://www.invasivespecies.gov/profiles/giantsalvinia.shtml>

Mississippi State University, GeoResources Institute, Invasive Species  
[www.gri.msstate.edu/lwa/invspec.php](http://www.gri.msstate.edu/lwa/invspec.php)

United States Department of Agriculture  
<http://www.ars.usda.gov/is/AR/archive/nov01/giant1101.htm>

United States Geological Survey  
<http://salvinia.er.usgs.gov/>

Western Aquatic Plant Management Society  
<http://www.wapms.org/plants/salvinia.html>

## HABITAT

Giant salvinia inhabits calm waters of lakes, ponds, wetlands, and rivers (Figure 6). Plants have been located in ditches, rice fields, and slow-moving rivers and streams. The most common habitats include disturbed sites such as flood canals, rice paddies, artificial lakes, and hydroelectric facilities. Giant salvinia is best adapted and thrives in warm-temperate to tropical areas. Giant salvinia cannot tolerate saline environments and thus will not colonize brackish or marine environments. Likewise, this species can not tolerate dry environments and individual plants can be readily killed by desiccation.