Impacts of Invasive Aquatic Plants

Water lettuce clogs a water supply canal in the Rio Grande Valley in Texas.

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Many people are aware of the threats of invasive species due to media attention to "killer bees," fire ants, and zebra mussels, to name a few. However, most do not recognize the significant problems associated with invasive aquatic plants. Non-native or exotic species like hydrilla (*Hydrilla verticillata*), Eurasian watermilfoil (*Myriophyllum spicatum*), giant salvinia (*Salvinia molesta*), water lettuce (*Pistia stratiotes*), and water hyacinth (*Eichhornia crassipes*) are among the most problematic aquatic plants. They form dense mats on the water surface that change nutrient cycling, increase siltation rates, shade out native vegetation, alter the native ecology and water quality, choke waterways, and reduce recreational uses and waterfront residence values.

Removed from their native environments, these plants are freed from the presence of the indigenous herbivores, diseases, and pests that kept their populations under control or at least in ecological balance. An analogy would be the rabbit, whose population is not a problem in its native environment because of its many predators and diseases, but when released in Australia, rapidly overpopulated and wreaked ecological havoc. Without natural checks, non-native species can explode into massive populations.

Interconnected waterways contribute to the spread of invasive plant species, as do human activities like boating, fishing, and water gardening. In the Southwest, hydrilla, water hyacinth, water lettuce, and giant salvinia pose problems in public and private waters and water transport systems.

Hydrilla is a submerged or underwater plant native to Southeast Asia. The plant grows up from the bottom of a water body to form dense mats across the surface. Seventy percent of its total biomass resides in these surface mats. The first documented incidence of hydrilla in the United States was in St. Louis, Missouri, via the aquarium trade in 1947. Today it continues to expand its range and is found in many states.

> *The growth rate for water hyacinth exceeds all other known vascular plants.*

Photo: Michael Masser

Giant salvinia is a floating fern.

Water hyacinth, **water lettuce**, and **giant salvinia** are all of South American origin. Water hyacinth was introduced into Florida's St. John River in the 1880s and water lettuce was brought to Florida by early Spanish settlers of St. Augustine in the 1500s. Giant salvinia is a fern (not a flowering plant like the others) first documented in South Carolina in 1995, probably introduced from tropical water lilies imported by water gardeners. Today, all three species continue to expand throughout much of the United States. They are free-floating plants with roots suspended in the water, and like hydrilla form dense floating rafts or mats.

Expansive Growth Rates

Water hyacinth, water lettuce, and salvinia propagate vegetatively by producing new plants as offshoots; water hyacinth and water lettuce also produce seeds. Through vegetative growth, water hyacinth can double in biomass in 6 to 18 days depending on water temperature (50°F or above) and nutrient availability. In fact, the growth rate for water hyacinth exceeds all other known vascular plants (terrestrial or aquatic) on a dry biomass basis.

Growth rates for water lettuce and giant salvinia are similar to water hyacinth but they are smaller plants with less total biomass. Giant salvinia has been documented to double in biomass in 4 to 10 days and form mats up to 2 to 3 feet thick. Hydrilla can grow 3 to 4 inches per day and propagates from fragments, subterranean tubers, and turions (auxillary buds). Turions break off, disperse, sink to the bottom, and germinate when conditions are good, but can stay dormant for several years. Tubers are produced in large numbers (5,000 per square yard) at the tips of the root system and germinate when conditions are favorable.

The ecological impacts of these invasive aquatic plants are primarily due to their rapid growth and formation of a dense floating canopy that outcompetes native submerged and planktonic vegetation for nutrients and light. The shading and nutrient sequestering alter biogeochemical cycles and water quality. Dissolved carbon dioxide increases, while dissolved oxygen can drop to critical levels under these mats, particularly in small impoundments or coves with limited circulation, killing fish and invertebrates, such as mollusks, insects, crustaceans, and worms. The consequences of this anoxia are reduction of native population densities and species diversity or richness, and potentially of the birds and mammals using this food source. Temperature, pH, turbidity, conductivity, and bicarbonate alkalinity values also decrease. Where water hyacinth, water lettuce, and giant salvinia totally cover the water surface, particularly in backwaters and small impoundments, migrating waterfowl do not appear to recognize it as aquatic habitat and don't land or utilize it.

Photo: Michael Masser

Water Loss from ET

One of the hydrological consequences of some of these non-native aquatic plants is increased evapotranspiration (ET) rates. Normal surface water evaporation rates vary greatly with environmental factors, and in Texas typically range from 20 to 60 inches per year. Water hyacinth ET rates are estimated to be three to six times those of normal evaporation rates, and water lettuce ET rates are two to ten times greater. Salvinia seems to have little net ET loss and no studies have been documented for hydrilla. Thus, when considering water storage or open water transport systems inhabited by water hyacinth or water lettuce, ET rates must be taken into account.

It has been hypothesized that both water hyacinth and hydrilla impede water flow in irrigation canals, but no investigations have yet documented the amount of restriction. A study currently underway at Texas A&M University is trying to fill this information void. The results should provide important information for water managers trying to efficiently move water.

Governmental and private spending to manage invasive aquatic plants exceeds $100 million per year in the United States. Mechanical, biological, and chemical methods all have been utilized. The plants can be mechanically harvested, but their rapid growth and propagation capacity limit the success of this approach. In fact, fragmentation from mechanical harvesting often promotes their expansion. Furthermore, in all but isolated cases, mechanical harvesting has proven to be uneconomical in terms of initial cost plus maintenance.

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Biological management of hydrilla and giant salvinia has been successful in some cases. Hydrilla is very susceptible to grass carp (*Ctenopharyngodon idella*, another non-native species from Asia), but the fish can eliminate *all* submerged vegetation if stocked at too high a rate. Other biological agents attempted for hydrilla have included a non-native but species-specific fly (adults are introduced, lay eggs, and the larvae bore into the plants), a weevil, and a fungus that feeds on the plant. Similarly, a species-specific weevil has been used on giant salvinia and a few types of weevils on water hyacinth. These have not proved especially successful in most U.S. habitats and rarely achieve the densities needed to elicit control.

Chemical methods such as herbicides registered for aquatic use have been used successfully on all these plants. The problems inherent with herbicides are cost, public perception, and water use restrictions, primarily related to human and livestock consumption and irrigation. Civic resistance to using herbicides to control aquatic plants in public waters is usually due to misconceptions of their toxicity to non-target species, ecological fate, or persistence in the environment. When properly selected and correctly applied, these registered herbicides are environmentally safe and effective.


Photo: Michael Masser

Dissolved oxygen levels under giant salvinia mats often do not support aquatic organisms.


Photo: Michael Masser

Hydrilla is a submerged plant that forms dense surface mats.

Regardless of the methods used, these non-native aquatic plants must be managed to mitigate their impacts on our aquatic environments. Based on past history, we will never eradicate any of them, but with integrated management using a combination of chemical, biological, mechanical, and nutrient manipulation, we can lessen their impacts and maintain an ecological balance with native species. However, much more research is needed to refine these means of controlling the pests.

For help in identifying and managing these and other aquatic plants, visit aquaplant.tamu.edu. Contact Michael Masser at m-masser@tamu.edu.

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species. Endangered nesting birds are not approached closer than 100 meters; their territories are revisited for Arundo removal after nesting is completed.

On the Santa Ana River, Arundo control starts with biomass reduction and removal. Where possible, the canes are chipped in place to pieces smaller than six inches. The roots are left in place to avoid the major excavation required to remove them. New growth is allowed to reach four to six feet tall and then sprayed with the systemic herbicide "Rodeo" (glycol is the active ingredient), which is taken in through the herbage to the roots. Over sufficient years of retreatment, the huge root masses eventually dry out and become unable to support new plant growth. Any unabsorbed herbicide degrades to water and other harmless ingredients within 48 hours. As resprouting diminishes and Arundo eradication approaches in an area, the need for riparian revegetation is assessed, but the forest usually reclaims treated areas naturally over time. Achieving total eradication of Arundo in some parts of the Santa Ana River Watershed will take decades.

As of July 2007, SAWA has raised nearly $30 million and has more than 3,000 acres of Arundo treated and under management (see map, page 25). Native riparian forests once again dominate most of those acres and at least 11,250 acre-feet of water is back in the river annually. The alien invasion was once so expansive that the most widely held belief was that Arundo eradication on the Santa Ana was not possible. We are in the process of disproving that belief.

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Photo: Richard Zembal

Floods stacked broken Arundo stalks against the River Road Bridge, giving flood waters the purchase to push the bridge off its foundation in 2004.