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Hydrilla (*Hydrilla verticillata*) and **Brazilian elodea** (*Egeria densa*) are invasive aquatic plants that occupy freshwater habitats. While hydrilla is native to Asia, Africa, and eastern Australia, and Brazilian elodea is native to South America, both plants are invasive to North America. Because these plants are related and both have pointed green leaves that whorl up the length of the stem, they may be difficult to distinguish at first glance. Looking

closer, Brazilian elodea leaves have smooth edges and no spines on the midrib of the leaf and whorls of four to six leaves, whereas hydrilla has serrations on the leaf edge and spines on the midrib of the leaf and whorls of five leaves. Native elodea has whorls with three leaves. Hydrilla produce small tight axillary reproductive buds called “turions” at stem nodes and potato-like “tubers” with its underground stems. Both turions and tubers enable Hydrilla to overwinter and persist through harsh environments.

Both of these plants were initially sold for use in aquariums and aquatic gardening, but they became established in water bodies through their intentional release. Both plants can quickly infest underwater habitats, with twisting, submersed vegetation that can produce a dense, impenetrable canopy at the water’s surface. This interferes with native plant growth and impedes recreational activities such as boating or swimming. Hydrilla and Brazilian elodea outcompete native species by growing rapidly in lakes, ponds, marshes, and streams.

Species in the news

Costly eradication of hydrilla from water bodies in Ithaca, New York, <http://ithacajr.nl/x7k7Ed>

Learning extension

Measure how fast Brazilian elodea can grow in classroom experiments

Resources

State of Washington Department of Ecology: www.ecy.wa.gov/programs/wq/plants/weeds/

Why you should care

Invasive aquatic plants compete with native plants for resources. They form thick tangles of vegetation that cover public and private waterways, shade out native plants, and eliminate habitat for fish and other wildlife, sully recreational areas as a result. People and animals can get disoriented and entangled in dense mats of hydrilla and Brazilian elodea. These submersed plants can spread to new areas from small plant fragments, making it particularly easy to expand their range. Both species are difficult to eradicate once established, since leaving only a small fragment of them can result in continued plant growth and reinfestation.

How it got here and spread

Hydrilla is native to the old world (Asia, Africa, parts of Europe) and Brazilian elodea is native to South America. They were typically introduced through the aquarium trade and shipment. If the plants are improperly discarded, they can end up in

water bodies where they rapidly grow and become invasive. Hydrilla reproduces through fragments containing a leaf node or whorl and by underground tubers. Brazilian elodea can reproduce through the spread of plant fragments, with specialized “double nodes” on the stem that can become a new plant.

What you can do

Never release nonnative plants of any kind into a waterbody. Clean boats and trailers of all aquatic plants and mud when exiting a waterway. Learn how to recognize native elodea and be able to distinguish it from Brazilian elodea and hydrilla. In Oregon, report invasive plants by calling 1-866-INVADER or visiting www.oregoninvasiveshotline.org/

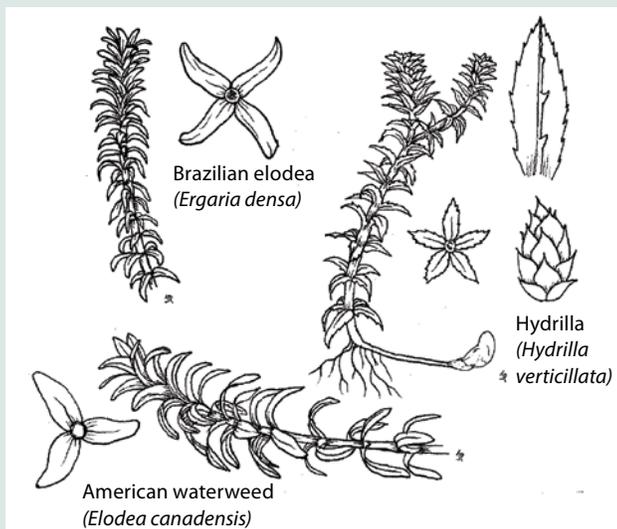
COOL FACT

Hydrilla stands can become so thick that ducks and other birds can walk on top of them at the water’s surface.

Hydrilla (*Hydrilla verticillata*)**Brazilian Elodea** (*Egeria densa*)**INTRODUCTION**

Hydrilla (*Hydrilla verticillata*) and Brazilian elodea (*Egeria densa*) are both submerged, rooted, freshwater aquatic plants that survive well in up to six meters of water. They are perennial and tolerate a variety of climatic conditions in lakes, rivers, and streams. Hydrilla stems can reach more than nine meters in length and Brazilian elodea stems can grow to more than five meters. Brazilian elodea leaves usually grow in dense whorls of four leaves, while hydrilla has three to eight, averaging five leaves per whorl. The leaves of Brazilian elodea have smooth edges and no spines on the midrib of the leaf, whereas hydrilla has serrations on the leaf edge and spines or small conical bumps on the midrib of the leaf.

Hydrilla possesses unique growth and reproductive characteristics and occurs in two forms that are generally found in separate populations. The first kind, called monoecious, can develop both male and female flowers on the same plant, while the other kind, called dioecious, forms male or female flowers on different plants. In both forms, flowers are small, with three translucent petals 10 to 50 millimeters in length. Brazilian elodea is solely dioecious, with small, solitary flowers. In both species, plant fragments have the ability to take root and grow into new plants, allowing them to spread quickly. When established, both species can form intertwined or single-species stands that fill the entire water column.



Line drawings comparing hydrilla, Brazilian elodea, and native elodea.

ECOLOGY**Life cycles and migration patterns**

Hydrilla reproduces and spreads in the following ways:

- The plant forms overwintering structures called turions and tubers. Turions—fattened leaf buds at stem nodes—break off and float away to form new plants. Hydrilla also produces thousands of subterranean tubers, which are small underground buds that can develop into plants.
- Hydrilla spreads and develops from small pieces of root or stem that detach and drift, taking root in new areas.
- Viable plants can sprout from seed.

While Brazilian elodea does not produce tubers or turions, it reproduces through

- stem fragments breaking off and forming a new plant
- ovules developing into viable seeds; but this is rare in North America because females of the species are not known in places other than South America.

Habitat modification and food webs

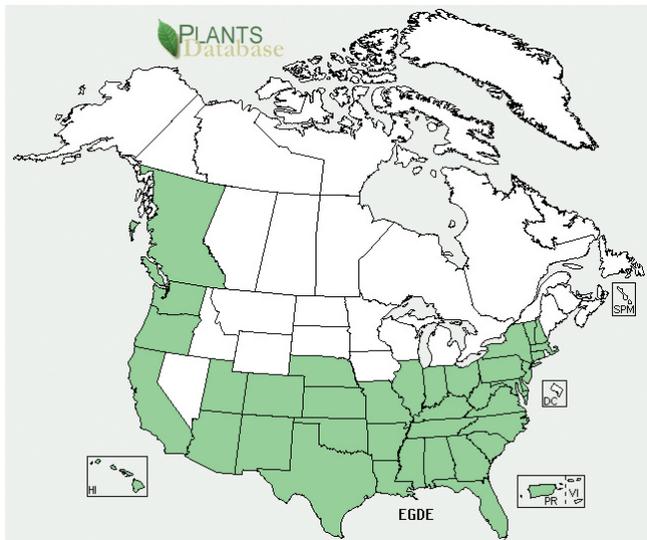
Hydrilla and Brazilian elodea flourish in warm, aquatic environments. Most often, they are rooted in the underwater sediment and clustered near the surface of the water, blocking off sunlight to native plants growing below them. Hydrilla devotes almost 95 percent of its biomass to photosynthetic tissues such as leaves and other structures, making it bulky and overbearing.

Like most plants, hydrilla and Brazilian elodea perform photosynthesis and take up nutrients through their roots. These nutrients, such as nitrogen, phosphorus, and potassium, are essential to plant growth. As aquatic plants, hydrilla and Brazilian elodea stems do not survive out of water.

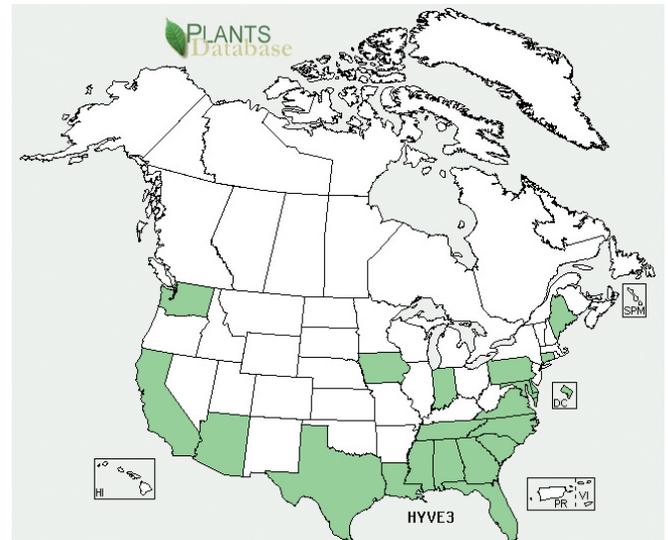
NATIVE AND INVASIVE RANGE

- Brazilian elodea is native to southeastern Brazil, Uruguay, and Argentina. As a nonnative, its invasive range includes Africa, Asia, Australia, New Zealand, Europe, and North America.

Hydrilla and Brazilian Elodea



Brazilian elodea distribution



Hydrilla distribution

- Hydrilla is native to the old world including, tropical Asia, Africa and parts of Europe. Hydrilla is now a widespread invasive plant, existing on nearly every continent. Since its introduction, hydrilla has become the dominant submersed nonnative aquatic plant in Florida.

West Coast Distribution

- Brazilian elodea is found in the more temperate climates of California, Washington, and Oregon.
- Hydrilla can be found in several areas of California and in Idaho where the waters are influence by hot springs. As of 2013, hydrilla has not been discovered in Oregon and is considered eradicated from Pipe and Lucerne Lakes in Washington.

HOW IT GOT HERE

- In the early 1950s, hydrilla was introduced as an aquarium plant in Florida and was deliberately planted in many waterways as a harvestable source for aquarium plant farmers. By 1967, hydrilla was well established and continued to expand its range north into other states.
- Brazilian elodea was sold as an aquarium plant as early as 1915. It continues to be a popular oxygenator for aquariums and is often sold in pet shops, despite the fact that it is recognized as an invasive aquatic plant. Much like hydrilla, it is spread when thrown into natural habitats after use in aquariums.

HOW IT SPREADS

Both hydrilla and Brazilian elodea have the ability to reproduce by plant fragments that can develop into new plants. These fragments, depending on the location of the plant, can be carried by currents to new locations. Secondary vectors, such as boating, fishing, shipping bait, irrigating, ingestion by birds, and aqua-



Brazilian elodea leaves usually grow in dense whorls of four leaves.

Tania Siemens, Oregon Sea Grant

Hydrilla and Brazilian Elodea

culture, also spread hydrilla and Brazilian elodea from primary hubs of introduction.

ECOLOGICAL IMPACTS

- Hydrilla and Brazilian elodea reproduce amazingly fast, shading, outcompeting native aquatic plants and other invasive aquatic weeds, such as Eurasian watermilfoil. Both invasive plants form dense stands that often fill the entire water column in depths of up to six meters of water. These dense plant infestations can alter the structure and function of an aquatic ecosystem.
- Hydrilla and Brazilian elodea can cause severe reductions in dissolved oxygen concentrations, especially during the warmest months. This results from dense, thick plant canopies that seal off the air-water interface. Additionally, bacteria use oxygen to decompose plants under the canopy. These changes in physical and chemical characteristics of a water body can degrade fish and wildlife habitat and impact food-web interactions.
- In the presence of dense hydrilla and Brazilian elodea, fish habitats are often diminished in terms of reduced growth rate and density.
- While invasive plants have a number of negative impacts, a few species benefit from their presence. Hydrilla tubers and turions are used as a food source by migratory birds, while the disruption of human

COOL FACTS

- Because invasive Brazilian elodea usually reproduces through fragmentation, the vast majority of these plants in North America are genetic clones of each other.
- Brazilian elodea is commonly sold as an “oxygenator” plant and used in school classrooms where its large rectangular cells, organelles and cytoplasm are readily visible through microscopy.
- Hydrilla has a bland taste but is high in calcium, iron, and vitamin B-12. Because of this, it can be dried, powdered, and used as a vitamin supplement.
- Hydrilla can grow more than two meters a week.
- Almost 50 percent of hydrilla fragments with just one whorl of leaves can form a new plant.



Tania Siemens, Oregon Sea Grant

Brazilian elodea is a popular aquarium plant. It is also valued in the classroom to teach about photosynthesis and observe cell walls.

activity in waterways because of the dense plant canopies often creates habitat for birds and other animals.

ECONOMIC IMPACTS

The economic damages rendered by hydrilla have been severe. Dense plant stands and surface canopies impede navigation, dramatically reduce recreational opportunities and tourism, increase flooding, and often block irrigation canals by slowing the flow of water. Hydrilla can also interfere with the generation of hydroelectricity by clogging intake pipes and filters, causing millions of dollars in damage at individual hydroelectric facilities. Removal cost, particularly eradication, is very expensive.

Even in its native range, Brazilian elodea is known to be problematic in waterbodies where it wasn't previously present. It has caused extensive monetary losses to hydroelectric companies in southeast Brazil. Its unrestricted growth interfered with the companies' grids and equipment, which decreased electrical output. Invasive Brazilian elodea is also damaging to recreational water industries because it infiltrates areas that would otherwise be used for activities such as swimming or water skiing.



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Elodea canadensis is native to the Pacific Northwest and can easily be confused with hydrilla and Brazilian elodea.

AMERICAN WATERWEED (*Elodea canadensis*)—native Elodea

While superficially resembling its invasive relatives, American waterweed is native to the west coast of North America. Just like Brazilian elodea and hydrilla, American waterweed is a submerged aquatic plant with leaves arranged in whorls along the stem. Unlike Brazilian elodea or hydrilla, American waterweed has leaves growing in clusters of three, which distinguishes its invasive relatives. Brazilian elodea frequently reproduces by fragmentation, although it can also reproduce through pollination as it is a dioecious plant.

American waterweed is a sensible replacement for Brazilian elodea as an aquarium plant. Although American waterweed is native to North America, it is invasive to Australia and causes similar ecological problems there.

CULTURAL SIGNIFICANCE

- Historically, hydrilla and Brazilian elodea have been popular and hardy aquarium plants. Both hydrilla and Brazilian elodea are now banned in much of the United States.
- Recreational and commercial opportunities are reduced when hydrilla or Brazilian elodea fill the water column and impede navigation.
- Due to its large rectangular cells, Brazilian elodea have been used in classrooms to study cell anatomy and observe cytoplasm streaming, despite its invasive potential.
- Thick mats of these invasive plants can make water recreation hazardous and impede water flow and cause flooding.

LAWS CURRENTLY IN PLACE

Hydrilla is listed on the federal noxious weed list, and at least 10 states (including Oregon, Washington, and California) list it as a noxious weed. In many states, if eradication of newly infested areas is feasible, it must be attempted. Trading and transporting hydrilla is illegal.

Brazilian elodea is not on the federal noxious weed list but is considered a Class B noxious weed in Oregon and Washington, where a quarantine strategy is implemented.

MANAGEMENT STRATEGIES

Control and eradication measures have improved over time and include herbicides, mechanical and manual removal, biological control, and habitat alteration. In Washington State's Pipe and Lucerne Lakes, hand pulling and application of herbicide on Hydrilla were the preferred eradication methods. However, hydrilla tubers often lay dormant for years and have been found to persist for over 10 years, so intensive monitoring and annual repetition of the process is paramount to successful eradication.

In areas where hydrilla or Brazilian elodea are well established, eradication is not typically an option, and the reduction of ecological impacts is often the goal. Sterile grass carp (*Ctenopharyngodon idella*), another nonindigenous species, has been an effective biocontrol agent against both of these species. However, not all grass carp are sterile, and they consume native and non-native plants indiscriminately. Research that involves biocontrol insects, such as the hydrilla tuber weevil and the hydrilla leaf-mining fly, continues.

WHAT YOU CAN DO!

- Become a volunteer in local eradication efforts whenever possible.
- Learn to spot the difference between native plants and invasive plants.

Hydrilla and Brazilian Elodea

- Never release nonnative plants into the wild.
- Report invasive species at:
Oregon: 1-866-INVADER or OregonInvasives-Hotline.org
Washington: 1-866-INVADER
California: 1-916-651-8797 or email invasives@dfg.ca.gov
Other states: 1-877-STOP-ANS

INFORMATION GAPS

To effectively manage hydrilla and Brazilian elodea, scientists and resource managers need to do more work in these areas:

- Conduct research to discover more biocontrol agents.
- Educate the public to slow the spread of invasive aquatic plants and eliminate their vectors.
- Predict where hydrilla and Brazilian elodea pose the greatest risk for invasion and harm.

REFERENCES

- Balciunas, J. K., et al. 2002. *Ch. Hydrilla. Biological Control of Invasive Plants in the Eastern United States*. USDA Forest Service Publication FHTET-20020-04, 413 p.
- Barreto, R., R. Charudattan, A. Pomella, and R. Hanada. 2000. Biological control of neotropical aquatic weeds with fungi. *Crop Protection* 19:697-703. www.sciencedirect.com/science/article/pii/S0261219400000934 [last accessed 9-11-13]
- Basiouny, F. M., W. T. Haller, and L. A. Garrard. 1978. Survival of Hydrilla (*Hydrilla verticillata*) Plants and Propagules after Removal from the Aquatic Habitat. *Weed Science* 26(5):502-504.
- Chadwell, T. B., and A. M. Engelhardt. 2008. Effects of pre-existing submerged vegetation and propagule pressure on the invasion success of *Hydrilla verticillata*. *Journal of Applied Ecology* 45:515-523.
- Doyle, R., M. Grodowitz, M. Smart, and C. Owens. 2007. Separate and interactive effects of competition and herbivory on the growth, expansion, and tuber formation of *Hydrilla verticillata*. *Biological Control* 41:327-338.
- Global Invasive Species Database. 2006. *Egeria densa* (Aquatic Plant). IUCN Species Survival Commission. www.issg.org/database/species/ecology.asp?si=289&fr=1&sts=sss&lang=EN [last accessed 9-11-13]
- Haynes, R. R. 1988. Reproductive Biology of Selected Aquatic Plants. *Annals of the Missouri Botanical Garden* 75(3):805-810.
- Madeira, P. T., C. C. Jacono, and T. K. Van. 2000. Monitoring hydrilla using two RAPD procedures and the nonindigenous aquatic species database. *Journal of Aquatic Plant Management* 28:33-40.
- Mony, C., T. J. Koschnick, W. T. Haller, and S. Muller. 2007. Competition between two invasive Hydrocharitaceae (*Hydrilla verticillata* [L.f.] [Royle] and *Egeria densa* [Planch]) as influenced by sediment fertility and season. *Aquatic Botany* 86:236-242.
- Van, T. K., G. S. Wheeler, and T. D. Center. 1999. Competition between *Hydrilla verticillata* and *Vallisneria americana* as influenced by soil fertility. *Aquatic Botany* 62:225-233.
- Washington Department of Water Quality. 2005. *Pipe and Lucerne Lakes 2004 Hydrilla Eradication Project*. King County Department of Natural Resources and Parks. Washington State Department of Ecology. Annual Report.

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It is important to clean any plant fragments off your boat before moving it to a new waterway.

NY Department of Environmental Conservation