Invasive Aquatic and Wetland Plants

FIELD GUIDE

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A Field Guide to Invasive Aquatic and Wetland Plants

Plants are an important component of aquatic systems – providing food, shelter and reproductive habitat for fish and wildlife, and enhancing the aesthetic appeal of the environment. Most plants are beneficial native species with sufficient natural controls to limit their growth.

The introduction of highly invasive, exotic plants into aquatic and wetland habitats along our coastlines, across the Great Lakes, and other inland bodies of water is increasing at an alarming rate. This is due in part to great public demand for attractive plants to use in aquascaping, aquaria, and water gardens. The water garden trade is expected to double annually for the next five years. In addition, some species have been carried in the ballast waters of ships arriving from ports around the globe.

A few aggressive exotic species – especially some recent introductions – lack natural controls and may develop large populations that overtake native plants and adversely impact water use. These species require ongoing management efforts to help minimize their environmental and economic impacts. Early identification and control of invasive plants by resource managers and the general public can reduce these impacts.

This field guide was produced by North Carolina Sea Grant and the North Carolina State University Department of Crop Science. It is part of the Aquatic Nuisance Species Research and Outreach Initiative – a comprehensive educational effort by Sea Grant programs and state and federal agencies to halt the inadvertent spread of invasive plant species.

The objective of the initiative is to educate extension agents and regulatory and environmental agency field personnel to recognize the most invasive, noxious aquatic and wetland weeds being sold and distributed; to educate and foster environmental responsibility within the aquatic and wetland plant nursery and water garden industries; to provide a stimulus for developing and cultivating native species; and to educate users about choosing native noninvasive alternatives.

In addition, members of the national steering committee from the University of Florida's Center for Aquatic and Invasive Plants developed a Web site *(http://plants.ifas.ufl.edu)*. Also planned are an identification guide for the general public, a pamphlet for water garden hobbyists and a booklet for developers, commercial landscapers, property associations and other lay audiences.

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Federal Noxious Weed Act of 1974

Congress passed the Federal Noxious Weed Act of 1974 to prevent the introduction of foreign weeds into the United States and to promote the eradication of listed species before they become widespread.

Many states also have adopted laws that prohibit the possession, importation and distribution of specific exotic aquatic plant species known to cause problems.

Preventing the occurrence and spread of aquatic weed infestations in public waters can help curtail both economic and ecological losses.

Listed here are the scientific names and common names of nuisance aquatic and wetland plants on the Federal Noxious Weed list. Some common names may vary according to region. Some species have multiple varieties. (The federal list also names parasitic and terrestrial weeds that are prohibited.)

The U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS) is responsible for implementing and enforcing the Federal Noxious Weed Act.

Azolla pinnata	Mosquito fern
Caulerpa taxifolia	Mediterranean caulerpa
Eichhornia azurea	Rooted water hyacinth
Hydrilla verticillata	Hydrilla
Hygrophila polysperma	Miramar weed
Ipomoea aquatica	Water spinach
Lagarosiphon major	African oxygen weed
Limnophila sessiliflora	Ambulia
Melaleuca quinquenervia	Melaleuca
Monochoria hastata	Arrow-leaved monochoria
Monochoria vaginalis	Monochoria
Ottelia alismoides	Duck lettuce
Sagittaria sagittifolia	Arrowhead
Salvinia auriculata	Giant salvinia
S. biloba	
S. herzogii	
S. molesta	
Solanum tampicense	Wetland nightshade
Sparganium erectum	Exotic bur reed
Stratiotes aloides	Water aloe

For additional information about the Federal Noxious Weed Act, plant information, and individual state noxious weed listings, on the Internet, go to *http://www.aphis.usda.gov/ppg/weeds/* or *http://plants.usa.gov/cgi_bin* and click on invasive and noxious plants.

Glossary

Amphibious plant – a plant which can grow, reproduce and complete its life cycle equally well in aquatic, wetland and terrestrial environments.

Annual – plants that survive the winter as seeds, completing their life cycle in a single year.

Axil – the upper angle that a leaf makes with its associated stem.

Calyx – the outermost whorl of the flower, usually green in color.

Dioecious – possessing imperfect (staminate or pistillate) flowers on separate plants of the same species.

Emergent – rising out of and above the surface of the water; emersed.

Fibrous – having loose, woody fibers, often referring to root systems that are extensively branched in a fibrous network.

Flower – complete flowers are composed of sepals, petals, stamens and pistil; incomplete flowers lack one or more of these components.

Monoecious – having both staminate or pistillate flowers on one plant.

Node – stem region or joint from which a leaf or leaves, branch or branches originate.

Perennial – living more than two years.

Petiole – the narrow, stalk-like base of a leaf.

Pistil – the innermost structure or whorl in a flower, the base of which is the ovary, the site of the seeds.

Rhizome – a horizontal underground stem distinguished from a root by having nodes.

Sepal – one of the individual floral units of the calyx, usually green.

Sessile – lacking a stalk or petiole at a structure's point of attachment.

Stolon – a horizontal runner; a stem with elongated internodes that trails along the surface, often rooting at the nodes.

Submersed – normally growing underwater.

Tuber – a fleshy enlarged rhizome or stolon.

Turion – a scaly, thickened winter bud produced at leaf axils in aquatic plants.

Undulate – a wavy leaf margin.

Vegetative reproduction – a form of reproduction in which neither spore production nor seed production occur.

Whorl – a cyclic arrangement of leaves around a common point like spokes of a wheel.

References

Center for Aquatic and Invasive Plants Web site, Plant Information and Images, University of Florida, http://aquat1.ifas.ufl.edu/welcome.html.

Aulsbach-Smith, Cynthia A., and de Kozlowski, Steven J. *Aquatic & Wetland Plants of South Carolina.* Second Edition. 1996. South Carolina Department of Natural Resources.

Bender, J., updated by J. Rendall. 1987. *Element Stewardship Abstract for Lythrum Salicaria. Purple Loosestrife.* Nature Conservancy, University of California, Davis, http://tncweeds.ucdavis.edu/esadocs/documnts/lythsal.pdf.

Dressler, R. L., D. W. Hall, K D. Perkins, and N H. Williams. 1987. *Identification Manual for Wetland Plant Species of Florida.* Institute of Food and Agricultural Sciences, University of Florida.

Godfrey, R. K. and J. W. Wooten. 1979. *Aquatic and Wetland Plants of Southeastern United States. Monocotyledons.* University of Georgia Press, Athens.

Godfrey, R. K. and J. W. Wooten. 1981. *Aquatic and Wetland Plants of Southeastern United States. Dicotyledons.* University of Georgia Press, Athens.

Jacono, C. 2000. *Nonindigenous Aquatic Species. Myriophyllum spicatum L. Eurasian water-milfoil.* U.S. Dept. of the Interior, Geological Survey, Gaineville, FL, http://nas.er.usgs.gov/dicots/my_spica.html.

Langeland, K. A. and K. C. Burks, eds. 1998. *Identification and Biology of Non-Native Plants in Florida's Natural Areas.* University of Florida.

McCann, J. A., L. N. Arkin, and J. D. Williams. 1996. *Nonindigenous Aquatic and Selected Terrestrial Species of Florida. Status, Pathway and Time of Introduction, Present Distribution, and Significant Ecological and Economic Effects.* University of Florida, Center for Aquatic Plants, http://plants.ifas.ufl.edu/mctitle.html.

Pieterse, A. H. and K. J. Murphy, eds. 1993. *Aquatic Weeds. The Ecology and Management of Nuisance Aquatic Vegetation.* Oxford University Press.

Radford, A. E., Ahles, H. E., and C. R. Bell. 1968. *Manual of the Vascular Flora of the Carolinas.* University of North Carolina Press, Chapel Hill, NC.

Thompson, D. Q., R. L. Stuckey, and E. B. Thompson. 1987. *Spread, Impact, and Control of Purple Loosestrife (Lythrum salicaria) in North American Wetlands.* U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Jamestown, ND, http://www.npwrc.usgs.gov/resource/1999/loosstrf/loosstrf.htm

Alligatorweed • *Alternanthera philoxeroides*

Origin, growth habit and ecological threat:

This herbaceous, emergent freshwater perennial was introduced from South America in the late 1800s into the southeastern states in ships' ballast. It is widespread throughout tropical and subtropical areas of the U.S. as far north as Virginia. It forms dense mats that may be free-floating or rooted in shallow water. Thick mats crowd out native plants and block light penetration, resulting in unsuitable conditions for fish. Thick stands in drainage canals and rivers can cause flooding. The plant grows well in aquatic, wetland and terrestrial environments. It is resistant to herbicides and difficult to control because of its extensive rhizome system, from which it regrows. It is sold for ornamental hanging baskets and water gardens, and has been introduced as food in commercial crawfish production. It should be considered highly invasive due to its rapid growth rate and ability to tolerate a wide range of environmental conditions.

Vegetative characteristics:

LEAVES: Leaf shape varies from elongated, lance-shaped to elliptic. They are green with smooth edges and a dull surface, 0.25 to 0.75 in. wide and 1 to 4 in. long, and arranged opposite, attached to stem without a petiole. Leaf pairs are oriented at a 90-degree angle to those at the nodes immediately above or below.

STEMS: Stems are smooth, hollow (terrestrial stems may be nearly solid), from 0.25 to 1 in. in diameter. They are light green, often with darker green parallel lines between nodes, pinkish or lighter colored at nodes just above the leaf axils. Young or stressed stems, or those formed underground, are reddish or pink. Stems are highly branched, forming densely tangled mats, rooting at nodes. One new shoot bud is present in each leaf axil.

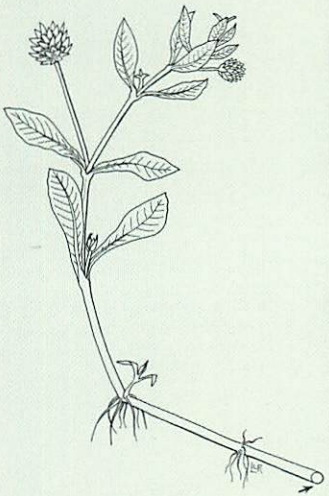
ROOTS: Roots are white to pale yellow, fibrous and highly branched. They form at the stem nodes and occasionally between the nodes of broken stems.

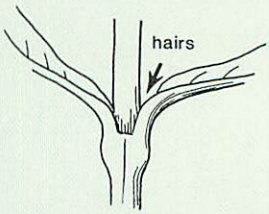
RHIZOMES: Terrestrial alligatorweed forms a whitish, fleshy, vertical, taproot-like rhizome, which may extend several feet into the soil. Even small fragments may produce roots and new shoots within a few days. Rhizomes can survive wherever surface soils do not freeze.

Reproduction:

Reproduction is entirely vegetative in North America. It forms flowers prolifically, but no viable seeds are produced.

FLOWERS: Flowers are white, solitary, and clover-like, up to 0.5 in. in diameter. They grow on light green stalks originating from leaf axils in upper part of erect stems, and are produced all summer.

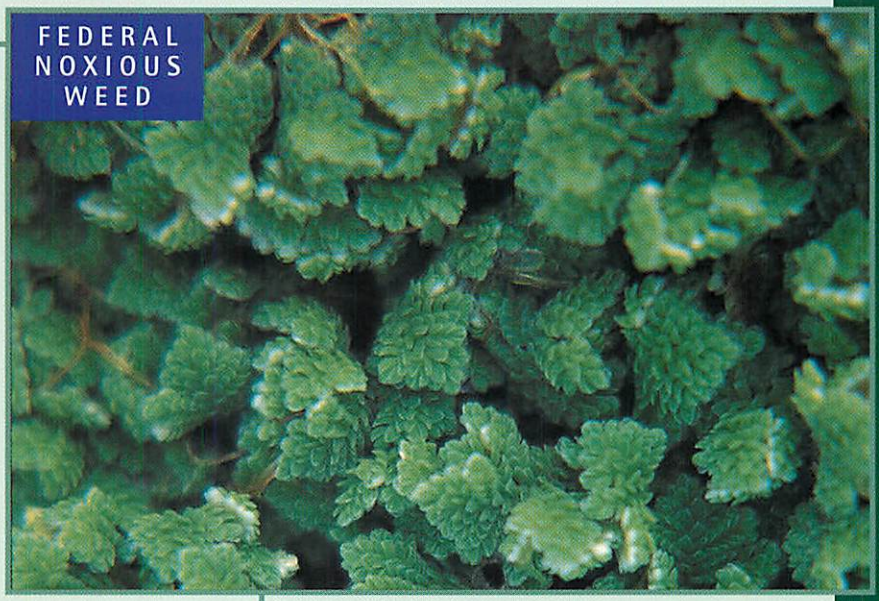




Similarities to other plants:

Resembles several common species of smartweed and water primrose, but is distinguished by its white, clover-like flowers and hollow stems.

Pinnate Mosquito Fern • *Azolla pinnata*



Origin, growth habit and ecological threat:

This aquatic, free-floating, true fern most likely was introduced accidentally in the mid- to late-1990s from Africa or Asia by the water garden plant trade and spread by the wetland plant trade. It has not been found outside of cultivation in the U.S., but is known to have a rapid growth rate, and should be considered as potentially highly invasive. It can be annual where there is severe frost, or perennial where there is no frost. It may form surface mats which crowd out native plants and block light penetration, causing low oxygen conditions unsuitable for most fish. It should be regarded as a potentially serious threat to all freshwater aquatic resources.

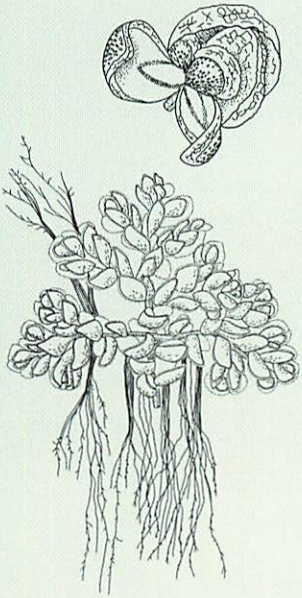
Pinnate Mosquito Fern

Vegetative characteristics:

LEAVES: Leaves are somewhat angular and arranged in triangular patterns, with Christmas tree-shaped fronds from 0.5 to 1 in. long. Their upper sides are bright, grass green and under sides are translucent white.

STEMS: Stems are not conspicuous, hidden among leaves.

ROOTS: Roots are whitish to yellowish brown, 0.5 to 1 in. or more in length



Reproduction:

Reproduction is largely vegetative by fragmentation. Produces spores on the underside of leaves, but their potential importance to the spread of this plant is not known.

FLOWERS: A true fern, it has no flowers.

Similarities to other plants:

It resembles the native mosquito fern, *Azolla caroliniana*, but does not have the spreading leaves and dark green to rust-colored appearance of the latter.

Fanwort • *Cabomba caroliniana*

Origin, growth habit and ecological threat:

This herbaceous, submersed, annual forms shoals, which may extend to the surface in shallow water, occasionally forming surface mats. Fanwort is native to the southeastern states from Virginia to Florida and west to Texas. Localized populations are naturalized north of Massachusetts. Fanwort is a common plant in the aquarium trade. Fanwort has been problematic for about two decades in some areas of New England, where it is considered non-native and invasive because it crowds out native submersed vegetation in sluggish freshwater ponds, lakes and shallow waters.

Vegetative characteristics:

LEAVES: It bears two types of leaves: Opposite, submersed leaves are bright green to reddish-green or purplish, fan-shaped, about 1.5 in. across, flattened, with each filament highly dissected. Small, alternate, diamond-shaped floating leaves, 1 to 1.5 in. long, are attached near the stem tip just below the flower stalk.

STEMS: Stems are lightly flattened, flexible, green to reddish green, branched, and upwards of 6 ft.

ROOTS: Roots are fibrous and silvery and form in soil or at stem nodes.

Reproduction:

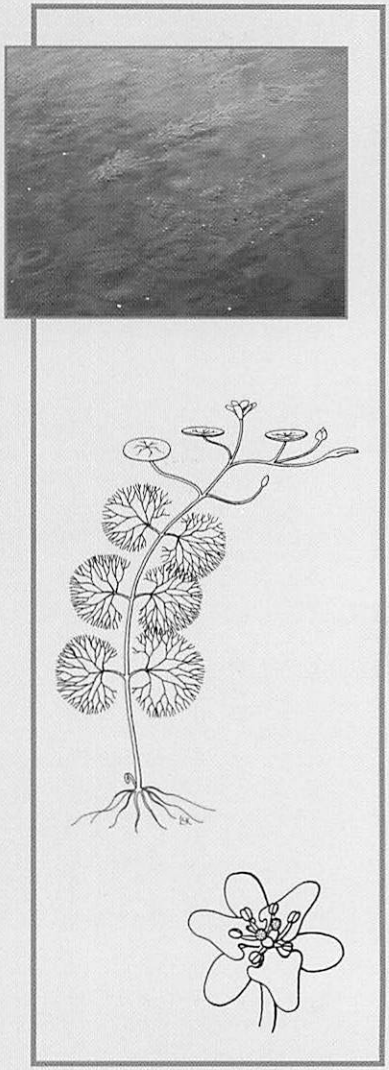
It reproduces through seed production and vegetatively by fragmentation.

FLOWERS: Raised just above water's surface, the flowers are whitish to pinkish, 0.33 in. wide. Each has three petals, spotted with yellow or yellow-orange near bases, and three sepals, giving the appearance of having six petals. They are produced in summer on stalks arising from the axils of the floating leaves.

SEEDS: Three leathery, spindle-shaped seeds are produced in small pods.

Similarities to other plants:

Superficially it resembles several of the submersed species of watermilfoils and the submersed form of *Limnophila*. However, the leaves are opposite and not whorled as in the milfoils or *Limnophila*.



Brazilian Elodea, South American Waterweed • *Egeria densa*

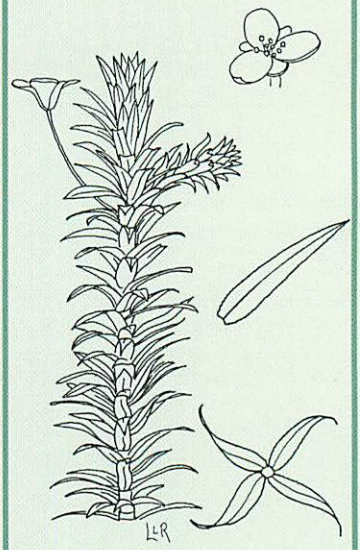
Origin, growth habit and ecological threat: This herbaceous, submersed perennial was introduced from South America in the early 1900s as an aquarium plant. Currently it occurs throughout New England, the Southeast, Mid-South, across the Southwest, and the Pacific Coast. Brazilian elodea forms dense surface mats in freshwater ponds, lakes and sluggish streams. Thick growth can shade out native submersed species, interfere with drainage and recreation, and contribute to anoxic conditions unsuitable for fish.

Vegetative characteristics:

LEAVES: Leaves are dark green, strap-shaped, from 1 to 1.25 in. long, and about 0.2 in. wide. They are usually in whorls of four. Nodes, where branching, occurs usually have 8, occasionally 10 leaves. Their fine marginal teeth require magnification to be seen.

STEMS: Stems are dark green, up to 6 ft. long, about 0.125 in. in diameter, branching occasionally. Branching usually appears where two nodes occur close together.

ROOTS: Roots are white, fibrous and unbranched.



Reproduction:

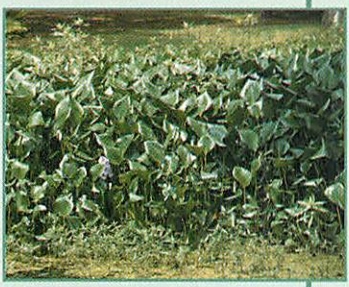
Its reproduction in the U.S. is entirely vegetative by fragmentation. It has separate male and female plants. Only male plants are present in the U.S.

FLOWERS: Male flowers are three-petaled, approximately 0.5 to 0.75 in. in diameter, growing in groups of two to four on individual stalks up to 4 in. long. Originating from leaf axils near shoot tip, they rise just above the water's surface. Flowering occurs in late spring through early summer.

Similarities to other plants:

It may appear very similar to hydrilla or American elodea, but can be distinguished from these plants by its larger flowers and distinctly darker green color. It usually has larger leaves and is more robust than either of the other plants. It does not produce tubers and turions like hydrilla. The plant texture is softer in most cases due to the absence of marl deposits and lack of spines or pronounced marginal teeth.

Water Hyacinth • *Eichhornia crassipes*



Origin, growth habit and ecological threat:

This herbaceous, free-floating plant is native to South America, and was introduced to Florida and Louisiana in the mid-1890s as an ornamental. It is a major pest from coast to coast across the southern tier of states, and tolerates cooler latitudes than previously thought possible. It is the top-selling aquatic plant in the water garden industry. It occasionally will grow on exposed, wet soil, but will break loose and float to the surface when the soil is reflooded. It is an emergent that forms dense floating mats more than 3 ft. high, impeding water flow and navigation and creating conditions unsuitable for native plants, fish and wildlife. It can produce more than 200 tons of biomass per acre, and is considered to be the world's worst aquatic weed by most aquatic botanists. It grows in freshwater rivers, ponds, lakes and drainage canals in tropical, subtropical and warmer areas of the temperate zone.

Vegetative characteristics:

LEAVES: Its leaves are dark green, thick, waxy, rounded, and somewhat circular, up to 8 in. in diameter, attached to a swollen or bulb-shaped petiole. Its veins are fine and parallel, all originating from the same point at the base of the leaf.

STEMS: The true stems of this plant are beneath the water's surface. The apparent stem actually is a swollen leaf petiole, up to 2 ft. long, which provides floatation; leaf petioles are elongated and more slender in dense stands. A brittle, pale green runner, or stolon, branches out from the true (underwater) stem with a new plant attached at its tip. These small plants readily break loose from the parent plant, facilitating spread of this weed.

ROOTS: Roots are purple in young plants to black in older plants. Fibrous and highly branched, they often extend 2 to 3 ft. or more beneath large plants. Roots tend to be short in very nutrient rich waters and longer where fewer nutrients are present.

RHIZOMES: The true stem is a stout, brown, rhizome that grows just beneath the water's surface. The leaves grow from the tip of this stem.

Reproduction:

Reproduction is mostly vegetative.

FLOWERS: A spike of up to 20 lavender to purple flowers is produced at the end of a long stem. The flowers are lightly colored at the edges with a central yellow spot, surrounded by darker purple. Flowering occurs throughout the growing season.

SEEDS: Each flower produces a capsule containing many dark brown seeds. Seeds may germinate readily in the presence of light, particularly when the water level drops and the wet soil is exposed. Seedlings often are found after the soil is reflooded. They are a common source of reinfestation where the vegetative growth has been lost due either to herbicide treatments, or in areas where cold weather has killed the plants.

Similarities to other plants:

Smaller water hyacinths may be confused with frogbit *(Limnobium spongia)* plants growing on wet soils or with large pickerelweed plants, (*Pontederia cordata*). The leaf petiole of frogbit is very slender and not swollen as in water hyacinth, and the flower is very tiny and inconspicuous. Pickerelweed also has a fairly slender leaf petiole, smaller flower spikes and flowers, and does not form free-floating mats.

Hydrilla or Water Thyme • *Hydrilla verticillata*

Origin, growth habit and ecological threat:

Hydrilla is a submersed herbaceous plant native to Asia or Africa. Two biologically distinct forms, dioecious and monoecious, occur in the United States via separate introductions. The dioecious form initially was introduced into Florida in the 1950s or early 1960s by the aquarium trade. It quickly became a serious pest throughout Florida and spread across the southeastern U.S. from southeastern North Carolina to Florida, west through Texas and Arizona and California. This form is a perennial and remains green throughout the year. Only the female plants of the dioecious type are present in the U.S. The monoecious form is an annual plant, which was introduced later, most likely in the mid-1970s near Washington, D.C. Its range currently includes the mid-Atlantic region from North Carolina to Washington, D.C., with small outbreaks in Connecticut, Washington, California and Georgia. Dense surface mats of hydrilla crowd out native vegetation and prevent light penetration, producing anoxic conditions unsuitable for fish. The mats may interfere with water flow, drainage, navigation, and may harbor mosquitoes. It grows in freshwater ponds, rivers and lakes in temperate to tropical areas.

Vegetative characteristics:

LEAVES: Leaves are sessile, strap-like, in whorls of three to eight, serrated margin, often with pronounced spines on under side of midrib; the marginal teeth and spines on the midrib are particularly conspicuous in the dioecious form.

STEMS: Stems are slender, 0.05 to 0.125 in. in diameter. Dioecious stems elongate toward the water's surface as soon as the sprouted tubers or turions reach the soil surface; monoecious plants branch immediately at the soil surface, form runners and sprawl across the soil before elongating toward the surface, and branch again at the surface to form a tangled mat.

ROOTS: Roots are white, unbranched, thread-like, forming at base of shoots and nodes on stems and rhizomes.

RHIZOMES: Rhizomes are white to red-brown, and form in soil.

Reproduction:

Reproduction is mostly vegetative by runners or fragmentation.

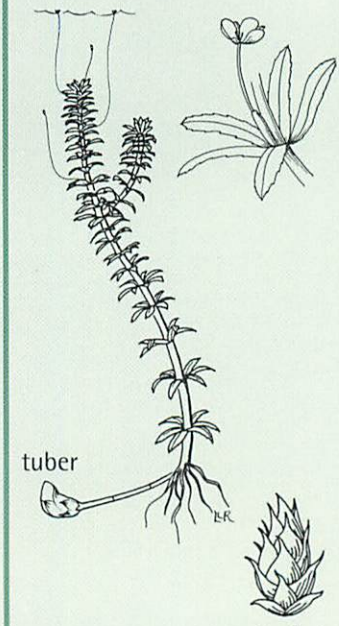
FLOWERS: Female flowers 0.125 in. in diameter, are translucent white, with three to six petals, produced on upper branches during summer and fall. Male flowers produced in leaf axils of monoecious plants detach and become free floating in late summer and fall. Only female plants of the dioecious type are present in the U.S.

TUBERS: Tubers are smooth, comma shaped, pea-sized, yellow to black, forming in soil at ends of white rhizomes.

TURIONS: Turions are scaly green, forming in leaf axils in late fall.

Similarities to other plants:

Hydrilla looks similar and is closely related to Brazilian elodea and two native species of American elodea, *Elodea canadensis* and *E. nuttallii*. *Hydrilla* can be distinguished easily from these plants by its flowers and by the tubers and turions, which neither of the other plants produce. Hydrilla plants usually are rougher to the touch because of the pronounced spines on the leaf midrib and, in alkaline waters, the frequent presence of a deposit of marl on the leaf surfaces.



Origin, growth habit and ecological threat:

This herbaceous, usually submersed perennial was introduced from Asia or the Indian subcontinent into Ohio near the end of World War II as an aquarium plant. It subsequently was introduced into Florida by the aquarium industry. Its present range is primarily Florida and Texas. Serious infestations are found in some parts of both of these states, especially South Florida. It usually grows in slow-moving freshwater streams, rivers and canals, where it produces dense mats that interfere with water flow, drainage, navigation, and other water uses and creates conditions unsuitable for fish. It also grows on canal banks. The plant is very resistant to herbicides and is replacing hydrilla in many herbicide-treated drainage canals in southern Florida.

Hygrophila, Hygro, Miramar Weed, Indian Swampweed

Vegetative characteristics:
LEAVES: Leaves are opposite, 1.5 in. long and 0.5 in. wide, and are slightly elongated and pointed at the tip. They are green to red-green.

STEMS: Stems are square, light green, up to 6 ft. long, and branching.

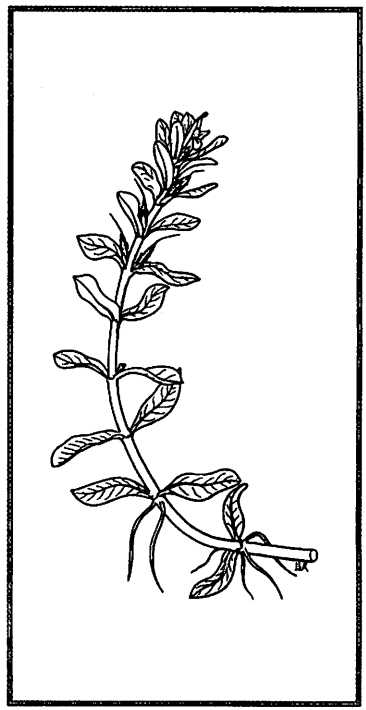
ROOTS: Roots are white to red-brown, fibrous and slightly branched. They grow at the stem nodes as well as at the base of the root crown of the plant.

Reproduction:
It reproduces both by seed production and vegetatively by fragmentation.

FLOWERS: Its flowers are attached directly in leaf axils, and are white or blue-white, with two lips. Flowering occurs from late November through mid-March in South Florida.

SEEDS: No information available.

Similarities to other plants:
It resembles several members of the water primrose family, particularly, *Ludwigia palustris*, which frequently grows submersed. Water primroses, however, have round stems and yellow, five-petaled flowers.



Water Spinach, Chinese Water Spinach • *Ipomoea aquatica*

Origin, growth habit and ecological threat:

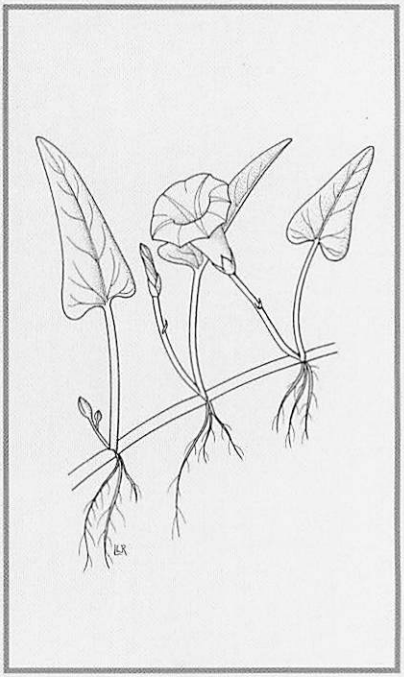
This herbaceous emergent has a trailing vine with milky sap. It was introduced into Florida in the mid-1970s from southeastern Asia. Its use as a vegetable by Oriental communities has led to its continued spread. It should be considered potentially invasive throughout the subtropical U.S. This plant currently is known to occur only in central and southern Florida. It is a highly invasive pest which forms dense, floating mats of intertwined stems, shading out native vegetation in freshwater ponds, lakes, rivers and canals in subtropical to tropical areas. Vines grow rapidly (4 to 6 in. per day) on moist soil or in flowing or still water, and can produce up to 84 tons of biomass per acre in nine months.

Vegetative characteristics:

LEAVES: Leaves are alternate, arrowhead shaped, usually smooth, up to 7 in. long, attached to stems by 1- to 6-inch petioles. Leaf blades are emergent when the stems are floating on the water.

STEMS: Stems are hollow, usually yellow-green, trailing, up to 9 ft. or longer, with milky sap. Distinct nodes form at roots and flower stalks.

ROOTS: Roots are white, branched and are produced at nodes.



Reproduction:

Water spinach reproduces by prolific seed formation and by stem fragmentation.

FLOWERS: Flowers are white or pinkish-lavender, funnel-shaped, from 1 to 2 in. in diameter. They grow either singly or, occasionally in clusters of two to three, on stalks arising from node. Flowers are produced in summer.

SEEDS: Seeds are gray, with short hairs, with one to four seeds produced in a woody, spherical capsule, 0.5 in. in diameter. Mature plant may produce 200 to 250 seeds.

Similarities to other plants:

It resembles many closely related terrestrial morning glories and other vines. It is distinguishable by its hollow stem, milky sap and sprawling growth habit, and by its growth as floating mats.

African Elodea, Oxygen Weed • *Lagarosiphon major*

FEDERAL NOXIOUS WEED

Origin, growth habit and ecological threat:

This herbaceous, submersed, mat-forming freshwater plant is native to subtropical Africa. It has been intercepted among aquarium plant shipments on several occasions at ports of entry in Florida. It is not known to be established in U.S. waters. The plant has caused serious environmental damage in ponds, lakes and rivers in Australia, New Zealand, and South Pacific islands. It forms dense mats on the water's surface, blocking light and creating unsuitable conditions for fish and wildlife and native plants. Dense infestations can interfere with fishing and boat traffic and water flow. It has an extremely rapid growth rate and similar

environmental range as hydrilla and should be considered a potentially serious threat to U.S. inland waters.

Vegetative characteristics:

LEAVES: Leaves are green, 0.5 to 1 in. long, linear, with smooth or very slightly toothed edges. They alternate along the stem in a somewhat spiraling pattern. They usually are strongly curled downward.

STEMS: Stems are green, 3 to 6 ft. long, highly branched, particularly near the water's surface. They are usually rooted on the bottom.

ROOTS: Roots are white, unbranched, thread-like, forming at base of shoots and nodes on stems

Reproduction:

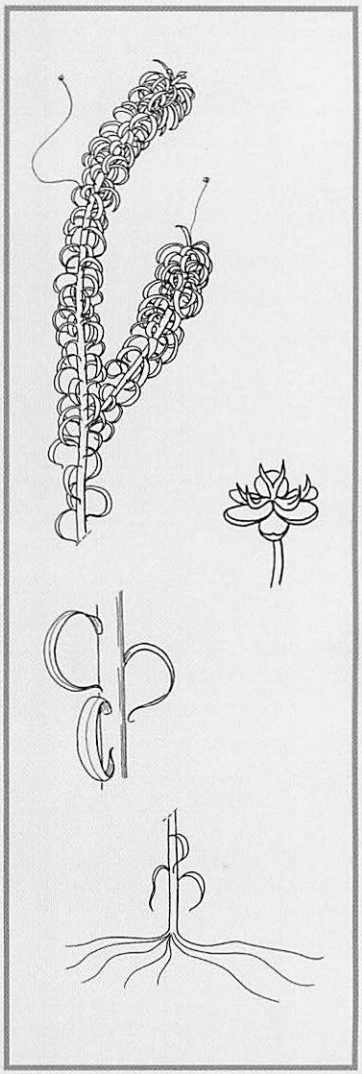
Reproduction is largely vegetative by fragmentation, but also by seed production.

FLOWERS: Male and female flowers occur on separate plants during the summer, are small, and have three curled petals.

SEEDS: Seed production is poorly described, but indications are that sufficient tiny seeds are produced that they can become a problem as contaminants among seeds of desirable plants.

Similarities to other plants:

It is very similar to hydrilla, Brazilian elodea, and both species of American elodea. It can be distinguished from these related plants by its backward curving, alternate and spiraling leaf arrangement.



Ambulia, Limnophila • *Limnophila sessiliflora*

FEDERAL NOXIOUS WEED

Origin, growth habit and ecological threat:

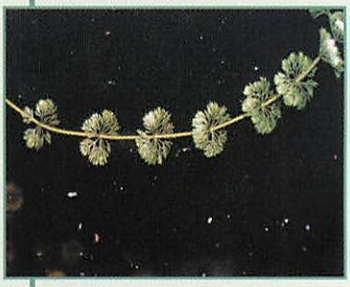
This herbaceous, submersed, mat-forming, perennial plant was introduced from India or Southeast Asia in the 1950s as an aquarium plant. It forms dense growths near the water's surface in slightly acid waters of shallow freshwater lakes, rivers, and marshes. Short sections of stem tips may become emergent. This plant has caused occasional problems in Florida. It is very resistant to herbicides and has begun to replace hydrilla in a number of sites in southern Florida. It interferes with water flow, drainage, navigation and other water uses and creates conditions unsuitable for fish. It presently occurs primarily in central and southern Florida, but also has been found in Lake Seminole on the Georgia-Florida border. It should be considered a highly invasive weed with a potential range well beyond Florida.

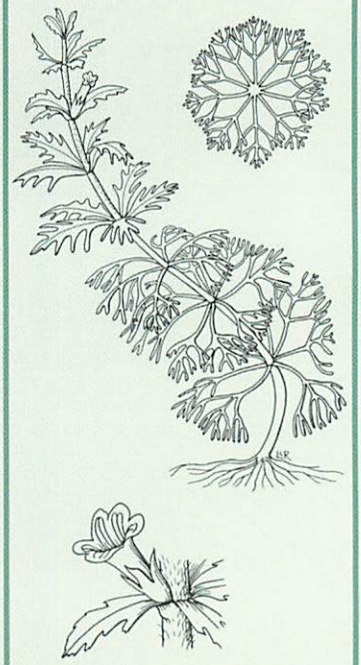
Vegetative characteristics:

LEAVES: Two types of leaves are present: Emergent leaves are whorled, four to five leaves per stem node, elongated or lance-shaped, 1 in. long, with irregularly lobed margins. Submersed leaves are whorled, finely dissected and feather-like, with up to 10 leaves per node. All leaves are smooth and grass green in color.

STEMS: Stems are green, flexible, grow to up to 12 ft. long, becoming highly branched near the water's surface.

ROOTS: Roots are fibrous, white, either unbranched or only slightly branched, forming at bases of stems and at nodes.





Reproduction:

Reproduction is largely vegetative by fragmentation, with very limited seed production.

FLOWERS: Flowers have three petals, lavender to pink, occasionally blue, with darker patches of color. They are produced singly on a short stalk from the axil of emergent leaves. Flowering occurs primarily in the summer in south Florida, but some sources suggest that it may flower year round.

SEEDS: No information available.

Similarities to other plant:

Submersed leaves resemble those of fanwort. However, fanwort has only two opposing leaves at each node, whereas the leaves of *Limnophila* occur in whorls of up to 10 leaves.

Origin, growth habit and ecological threat:

Formerly called *Ludwigia uruguayensis,* this herbaceous, perennial, mat-forming emergent plant, easily roots terrestrially on wet or damp soil. Introduced from South America most likely as an ornamental, it is now problematic from the Mid-Atlantic States south to Florida, west into Texas, and along the West Coast to Washington. It has been misidentified and inadvertently sold by the water garden industry under other names. Creeping water primrose forms dense floating mats up to 3 ft. high in freshwater ponds, lakes and sluggish waters, and may cover many acres. Highly aggressive, it displaces most native and non-native plants, and creates anoxic water conditions unsuitable for fish. It may cause flooding of ditches and streams. It has been spread by seeds, stem fragmentation and intentional plantings. It is fairly tolerant of cold weather. Creeping water primrose should be considered highly invasive.

Vegetative characteristics:

LEAVES: Leaves are grass green to yellow-green, alternate, up to 1.5 in. wide and 6 in. long, attached by a short petiole. They have smooth margins and prominent light green (occasionally tinged with purple) midveins and lateral veins. Plants produce both rounded floating leaves (particularly in early season) and elongated, lance-shaped leaves on emergent or terrestrial stems. Its rounded leaves are smooth, shiny, and closely spaced, giving the appearance of rosettes lying on the water's surface. Emergent leaves are distinctly alternate in arrangement, have a dull upper side, and may be slightly to very hairy along the under side of the midvein.

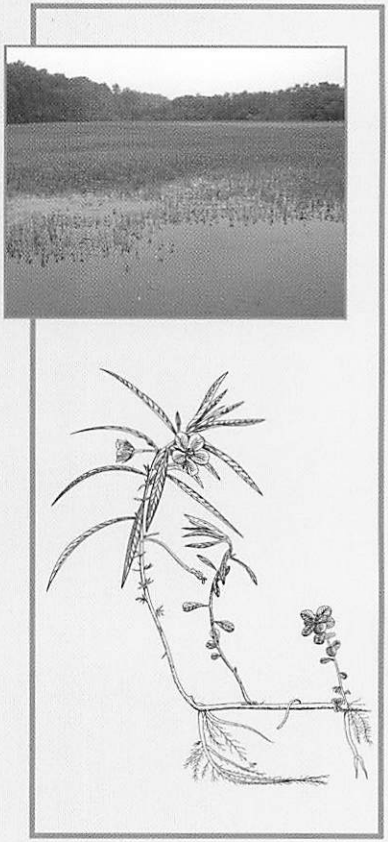
STEMS: Young stems are green and lie just under the water; older stems become hard, woody, up to 1 in. in diameter and may be visibly swollen between nodes. Emergent and terrestrial flowering stems produced in summer turn red and may develop lengthwise splits in the woody outer surface. Surface may be sparsely to densely hairy. Stems are moderately branching, particularly the submersed stems. They may be rooted on the bottom in more than 6 ft. of water.

ROOTS: Two types of roots form: White to yellow-tan, highly branched and feathery, wiry roots are produced at nodes and at shoot crown. Spongy, white, worm-like roots also are produced along the nodes of floating stems and provide air for the submersed stems.

Reproduction:

Reproduction is by prolific seed production and vegetatively by fragmentation.

FLOWERS: Flowers are yellow, about 1 in. in diameter, with five or six petals, produced singly on smooth to hairy green-white stalks, which originate from the leaf axils on the upper part of emergent stems. Flowering occurs in the summer.



SEEDS: Seeds are small, densely hairy, round to angular, numerous, enclosed in a cylindrical, woody capsule.

Similarities to other plants:

It resembles *Ludwigia peploides (Jussiaea repens)*, particularly in spring and early summer before the stems become emergent. It can be distinguished later in the season by hairs on the emergent stems and undersides of the leaves, and by the lance-shaped leaves on the emergent stems.

Purple Loosestrife • *Lythrum salicaria*

Origin, growth habit and ecological threat:

This erect, emergent perennial is a colonizer of freshwater wetland habitats. It was introduced from Europe about 200 years ago both as a medicinal herb and as a contaminant in ship ballast. It now occurs throughout the continental U.S., except Florida. This plant has been sold widely as an ornamental, and has been spread by seed production and intentional plantings. Purple loosestrife is a serious threat to wetlands in the northern tier of states from coast to coast. It grows in dense stands, choking out native vegetation, and rendering wetlands useless for wildlife.

Vegetative characteristics:

LEAVES: Leaves are opposite (sometimes whorled), lance-shaped and somewhat heart-shaped at the base, from 1.5 to 4 in. long, and are attached directly to the stem (no petiole). Leaves at bases of flower spikes are smaller and may be arranged alternately.

STEMS: Stems are erect, woody, growing to heights of 6 to10 ft. The upper parts of the plants tend to be covered with short hairs. As many as 50 stems may arise from a single, mature rootstock.

ROOTS: Roots are highly branched, fibrous, dense, spreading.

RHIZOMES: Woody rhizomes grow slowly at a rate of about 1 ft. per year and may give rise to new shoots or, if fragmented, produce separate plants.

Reproduction:

Reproduction is predominantly by seed, but also vegetatively.

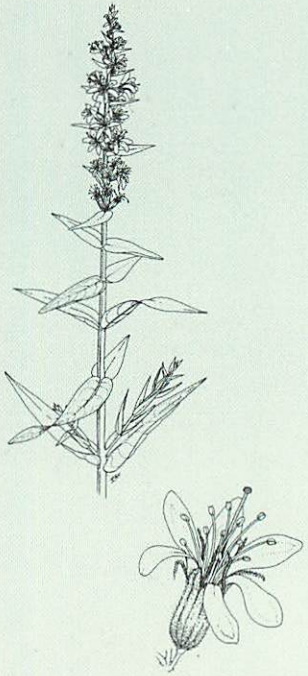
FLOWERS: Clusters of magenta-colored flowers arranged in spikes are produced throughout the summer. Flowers have five to seven petals and are insect pollinated.

SEEDS: More than 2.5 million seeds can be produced on a single, large plant. Seeds may remain dormant for many years and sprout following soil disturbance.

ADVENTITIOUS SHOOTS AND STEMS: New shoots may arise and form new colonies from stems that have been buried or cut.

Similarities to other plants:

Several other species of *Lythrum* occur in the U.S. and may be confused with purple loosestrife. Purple loosestrife generally can be identified by its overall larger size, the leaf arrangement and shape, and its extremely aggressive growth in wetlands. In some cases, a botanical key may be required to distinguish it from other *Lythrum* species.



Melaleuca, Punktree, Australian Paperbark Tree • *Melaleuca quinquenervia*

Origin, growth habit and ecological threat:

This large, rapidly growing, evergreen is a tropical to subtropical freshwater wetland tree native to Australia, New Guinea and New Caledonia. It was introduced into the U.S. from Australia in the early 1900s for landscaping and swamp draining. Melaleuca is confined largely to South Florida, where it has overtaken nearly a half million acres of the Everglades. The tree forms dense, impenetrable thickets, which alter ecosystem function by dewatering wetlands. These thickets also shade out all other vegetation and create an environment unsuitable for wildlife. This tree grows from terrestrial to flooded conditions, but prefers wet soils. It is highly frost tolerant and flowers within two to three years from the seed. A single tree can produce a seedling thicket 600 ft. in diameter within a single growing season. Volatile oils released into the air during blooming can cause respiratory distress, asthma, rashes and headaches. Melaleuca should be considered potentially invasive well outside its tropical range in Florida.

Melaleuca, Punktree, Australian Paperbark Tree

Vegetative characteristics:

LEAVES: Leaves are dull, gray-green, elongated oval, 1 to 5 in. long, arranged alternately along stem, and are attached by short, pinkish petiole. Veins are nearly parallel. They smell of camphor if crushed.

STEMS: Trunks are up to 5 ft. in diameter and 100 ft. tall. Its stems and trunk are covered with white peeling, papery bark.

ROOTS: Extensive, shallow roots readily produce new shoots.

Reproduction:

It reproduces by extensive seed production, with massive seed releases following severe stresses such as fires and herbicide treatments; roots and stumps resprout readily.

FLOWERS: Flowers are creamy white, bottlebrush-shaped spikes, up to 6 in. long. Young trees may flower as early as two years from the seed. Flowering and fruit production occurs year round.

SEEDS: Seeds are miniscule, produced in rounded, woody capsules about 0.33 in. in diameter, that are borne in clusters around young stems. Each capsule has 200 to 300 seeds. A large tree may produce more than 20 million seeds per year. Seeds may be retained in the capsules for more than one growing season only to be released all at one time following a period of severe stress on the parent tree, such as fire, drought or herbicide treatment.

Similarities to other plants:

It is readily distinguished from most other species by the peeling, papery bark, distinct flower, and the camphor-like odor of the leaves.

Origin, growth habit and ecological threat:

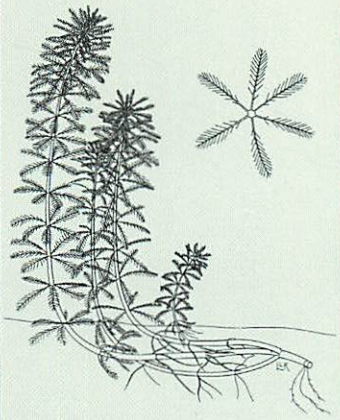
This herbaceous, perennial is a submersed aquatic plant with emergent tips. It occasionally roots on wet or damp soil. Introduced from South America in the late 1800s as an ornamental, it is now naturalized throughout much of the subtropical U.S. It also has become locally problematic in New England. It forms dense mats in shallow freshwater ditches, ponds, lakes, and slow-moving streams, blocking water flow for irrigation and drainage and preventing light penetration. It creates unsuitable conditions for fish and wildlife. Its sale as an ornamental for water gardens may be responsible for infestations nationwide.

Vegetative characteristics:

LEAVES: Leaves are light gray-green, 0.5 to 2 in. long and 0.5 in. wide, occurring in whorls of three to six at each node. They are finely dissected and feathery in appearance with 20 or more stiff segments per leaf. The segments on the submersed leaves are narrower and not as stiff in texture.

STEMS: Emergent stems are light olive-green, while submersed stems are green to red. They are moderately branched, fairly stiff, and up to 6 ft. or more in length.

ROOTS: Roots are white, unbranched, thread-like, formed at the submersed stem nodes.



Reproduction:

Reproduction is entirely vegetative by fragmentation, not by seed production, as only the female plants are present in the U.S.

FLOWERS: Small, inconspicuous, yellow-green flowers form in the spring in the axils of emergent leaves. Flowering occurs in spring and summer, but they rarely are noticed.

Similarities to other plants:

It is unlikely to be confused with other submersed plants, including members of the milfoil group, due to its distinct color and the feathery leaves on the emergent shoots.

Eurasian Watermilfoil • *Myriophyllum spicatum*

Origin, growth habit and ecological threat:

This herbaceous, submersed, mat-forming perennial was introduced from Eurasia in the 1940s as an aquarium plant. Its current distribution is throughout North America, but the most serious problems occur from New England, the Midwest and Great Lakes regions, Pacific Northwest and Canada. Some serious infestations also have occurred in the Tennessee Valley and areas of Florida. Plants remain vegetative during the winter, are tolerant of a wide range of environmental conditions, including pollution, and grow well in brackish and fresh water. It is an aggressive colonizer of reservoirs and disturbed natural water bodies, including rivers and lakes, and freshwater sounds. It forms dense mats which crowd out native vegetation and prevent light penetration.

Vegetative characteristics:

LEAVES: Leaves are gray-green to grass green, finely dissected and resembling small, stiff, feathers; up to 1 in. long. Leaves usually occur in whorls of four at each node and have 12 to 16 pairs of thread-like segments. Leaves commonly are confined to uppermost parts of the stems.

STEMS: Stems are smooth, yellow-green, flexible, usually devoid of leaves except near the tips. Usually 3 to 10 ft. long, they extend to the surface to form dense mats.

ROOTS: Roots are white, fibrous, unbranched, forming at stem nodes.

Reproduction:

Dispersed largely by fragmentation but also produces seeds.

FLOWERS: Flowers occur on small, emergent spikes up to 2 in. in length and are yellow to yellow-brown, sometimes with a pink cast. Flowering occurs mostly in early summer and fall, occasionally all summer. There are no distinct leaves at the nodes of the flower spike where individual flowers form.

SEEDS: Seeds are oblong, round-triangular and obscurely warty on back surface.

Similarities to other plants:

It resembles many other species of water milfoils, as well as the submersed form of *Limnophila sessiliflora*, but usually can be distinguished by the number of leaves at each node, the number of segments on each leaf, and characteristic floral spike. Many other milfoils and limnophila have emergent leaves, with the flowers growing either in the leaf axils or on short stalks originating from the leaf axils. A botanical key may be needed to distinguish this plant from a few of the closely related species of watermilfoils.

Common Reed • *Phragmites australis*

Origin, growth habit and ecological threat:

This herbaceous perennial is an emergent marshland grass. Some consider it to be native, others believe it was introduced, possibly from Europe in the 18th century or earlier. It is a vigorous colonizer of freshwater and brackish marshes and has been reported in the entire continental U.S. except Alaska and Arkansas. It is highly invasive along the mid-Atlantic coast to New England, across the Great Lakes region and Midwest and, to a lesser extent, the West Coast. It is particularly invasive in disturbed areas, such as manmade drainage ditches alongside roadways. Dense growths crowd out wildlife habitat and native vegetation used as forage by wildlife, especially migratory waterfowl. Solid stands of common reed as large as 7,000 acres have been reported. Dead stems and thatch may accumulate for several years and can be a fire hazard during the winter.

Vegetative characteristics:

LEAVES: Leaves are blue-green, alternate, flat, linear, 0.5 to 1 in. wide, and 10 to 18 in. long. Blade surface is smooth with rough margins. Its white, silky hairs are up to 0.25 in. long and are present at the junction of the leaf blade and the sheath, which wraps around the stem.

STEMS: Stems are slender, stiff, erect, green, up to 15 ft. or more in height and 200 to 300 per square meter. Leaves are produced from base of the stem to the flower. Broken stems that fall into the water will form roots at the nodes.

ROOTS: Roots are white, fibrous, highly branched, forming at shoot bases and at nodes along the rhizomes.

RHIZOMES: Rhizomes are coarse, thick, woody, white to yellow-brown, and hollow. They are up to 0.5 in. in diameter, slightly flattened in cross section, with distinct nodes.

Reproduction:

Reproduction is vegatively by fragmentation and rhizomes, also by seed production.

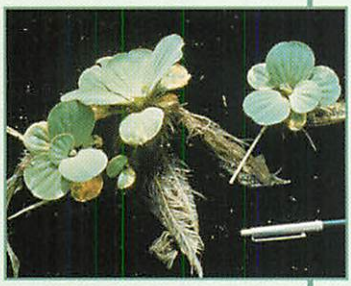
FLOWERS: The flower forms a large, brownish-purple plume often more than 1 ft. long. Mature flowers or spikes have long hairs, which give the plume a silky, silvery appearance. Flowering occurs mid-summer through late September or early October.

SEEDS: Seeds are brown, thin and delicate. A long, narrow bristle is attached to each seed. The seed and bristle together measure approximately 0.33 in. long.

Similarities to other plants:

It closely resembles the introduced giant reed, *Arundo donax*. But, giant reed has a lighter, tawny-colored plume and a large clasping flange of tissue where the leaf blade joins the sheath.

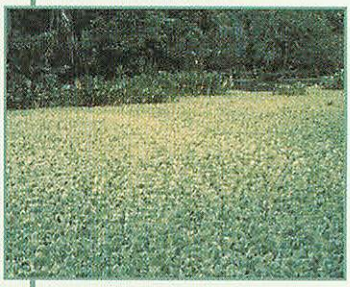
Water Lettuce • *Pistia stratiotes*

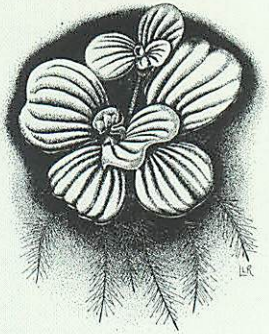


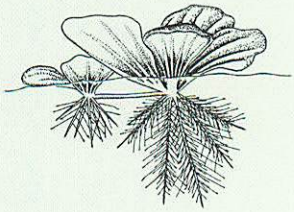
Origin, growth habit and ecological threat:

This herbaceous freshwater plant can be perennial or annual. It forms free-floating mats that resemble lettuce. The origin of this plant is somewhat uncertain. It is considered by most aquatic plant specialists to have been introduced, probably from South America. It first was reported in Florida in 1765, which led some early botanists to consider it to be native. However, the absence in Florida of herbivorous insects that are specific to water lettuce, and their presence on this plant in South America, suggest that it was introduced. Its widespread sale and use as an ornamental in water gardens may be responsible for its spread into colder areas. Water lettuce behaves as a perennial in tropical and subtropical areas, where it remains continuously in the vegetative state. Its extremely rapid growth may form solid stands on the surface of the water, blocking drainage and navigation and producing anoxic conditions unsuitable for fish. The presence of water lettuce increases water loss as much as ten times more rapidly than evaporation from the water's surface. Its root system also increases

silt deposition, changing the quality of the pond or lake bottom, making it unsuitable as habitat for many aquatic invertebrates and as nesting sites for fish. Water lettuce can overtake small ponds, lakes and canals in a single growing season. Its current range in North America appears to be primarily in Florida. However, it has been known to overwinter in New York and has been documented as having naturalized in the cold climate of The Netherlands, where it resprouts from seeds each year. This plant should be considered a serious pest, which potentially could become established throughout the subtropical region and well into the U.S. temperate region.







Vegetative characteristics:

LEAVES: Leaves are dull light green, sometimes with a slight olive cast. They are ridged, very hairy, and somewhat triangular, up to 6 to 8 in. long, with no petiole. Their tips are blunt and slightly undulating.

STEMS: The stems produce light green stolons from the base of the larger plants. Daughter plants occur at the tips of these stolons.

ROOTS: Roots are long, dense, feathery, and light colored, may be 3 ft. or longer.

Reproduction:

Reproduction is largely vegetative, producing new plants at the ends of stolons. Seed production is important in Florida upon reflooding after a drought or drawdown and in colder climates where the plants do not overwinter.

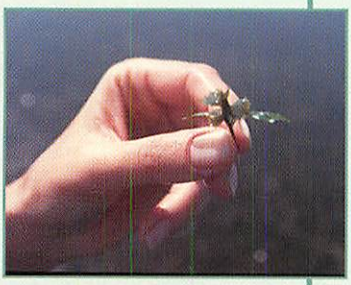
FLOWERS: Flowers are small, hidden on a tiny stalk within the center of the leaf bases, both male and female flowers are present. Flowering occurs throughout the growing season.

SEEDS: Fruits are green and contain many tiny seeds with thick, wrinkled skins, which provide protection for overwintering in cold climates.

Similarities to other plants:

Water lettuce is easily distinguished from all other floating plants present in the U.S by its shape, color, and deeply ridged, hairy leaves.

Curled-leaf Pondweed, Curly Pondweed • *Potamogeton crispus*



Origin, growth habit and ecological threat:

This submersed perennial is native to Eurasia, Africa, and Australia, but apparently was introduced from Europe in the mid-1800s. This plant now is naturalized throughout most of North America. It may grow to depths of 15 ft. in freshwater lakes, ponds and sluggish streams. Dense mats just beneath the surface may shade out native submersed species and impair recreational and other water uses. It currently is sold widely in pet shops and via the Internet as an aquarium plant. Curly pondweed is fairly resistant to herbicides and is considered to be moderately invasive.

Vegetative characteristics:

LEAVES: Leaves are all submersed, alternate, oblong to almost linear, usually 2 to 3 in. long and 0.25 to 0.5 in. wide. They have prominently toothed margins, and somewhat rounded or blunt tips, with conspicuous midvein and two parallel veins near the margins. The leaves are attached directly to the stem, with the bases clasping the stem. They appear curly or undulating, hence, its common name.

STEMS: Stems are flattened, highly branched, pale yellow and brittle.

ROOTS: Roots are fibrous, white and unbranched.

RHIZOMES: Rhizomes are slender, red or light brown in color, rooting at nodes.

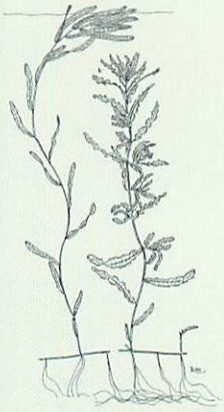
Reproduction:

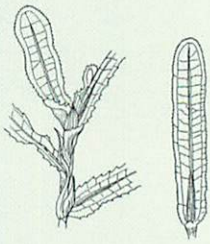
Reproduction is primarily by stem fragmentation and turion production, with some seeds.

FLOWERS: Flowers are very small (individually inconspicuous), whitish. They are produced in spring and summer in loosely flowered spikes 0.4 - 0.8 in. long and raised above the water's surface.

SEEDS: One triangular, beaked seed is produced per fruit. It is questionable whether seeds are viable and are of any importance reproductively.

TURIONS: Turions are hard, dark green-brown, auger-shaped, about 1 in. long and 0.5 inch wide, produced at the tips of lateral branches. Sprouting occurs in fall in northern states, with the new plants overwintering.





Similarities to other plants:

Superficially similar to another submersed pondweed, *P. perfoliatus*, except that the leaves of *P. perfoliatus* are much smaller and more curled, and stems are more rigid.

Giant Salvinia, Kariba Weed • *Salvinia molesta*

Origin, growth habit and ecological threat:

This free-floating freshwater perennial aquatic fern was accidentally introduced from South America in the mid-1990s, and was probably spread in the southeastern and mid-Atlantic states by the water garden industry. It grows in reservoirs, lakes, ponds, rivers, wetlands and drainage canals. Plants may double their growth in about three days in nutrient-rich environments, expanding to cover many acres within one or two years. Plants commonly accumulate in mats 1 ft. or more thick, completely blocking out light penetration, preventing photosynthesis, out-competing native plants, and creating conditions unsuitable for fish and waterfowl.

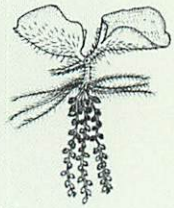
Vegetative characteristics:

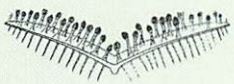
Plants have three stages of growth: a very small, compact overwintering form; a very brittle, prostrate, invasive form; and a larger, compact mature form.

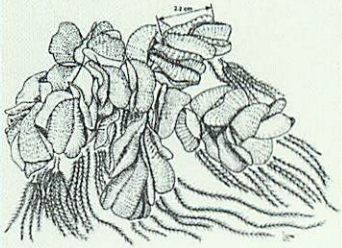
LEAVES: Floating on surface, leaves are usually light yellow-green to medium green, often with brownish edges in mature plants. Three leaves are present at each node, two of which lie on the surface and resemble leaves, and the third of which trails vertically into the underlying water and resembles a highly branched root system. Leaves may be less than 0.125 in. in diameter in small plants. These small plants can become entangled easily among the foliage or roots of other, larger species of aquatic and wetland plants and are very difficult to detect.
The invasive stage has leaves that are bright grass green, up to 0.5 in. in diameter, slightly oval, and with an obvious crease along the centerline. These leaves float on the water's surface. Mature leaves may be 1 in. in diameter and are folded and compacted, the edges tinged with brown. Both the upper and lower surfaces of all leaves are densely covered with leaf hairs. The leaf hairs on the upper surfaces are shaped like tiny eggbeaters and are the distinguishing feature for identification of this plant.

STEMS: Stems are smooth, light yellow-green and very brittle

ROOTS: No true roots are present, but the third leaf resembles a root and has a similar function in nutrient uptake. These third leaves may be very long and highly branched.







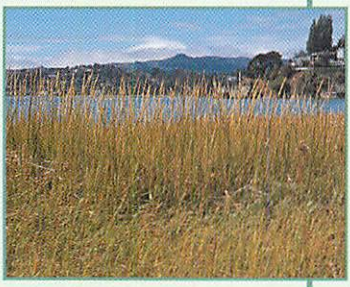
Reproduction:

Reproduction is totally by fragmentation. Although the plants do produce the structures that form spores, the prominent male spore-producing structures do not produce viable spores. Hence the plants are sterile.

Similarities to other plants:

Giant salvinia looks similar to another introduced, but somewhat smaller and less invasive fern, *Salvinia minima*, formerly called *S. rotundifolia*. This smaller fern has leaf hairs that open at the tips, rather than forming "egg beaters" and is thereby easily distinguished from giant salvinia. The leaf hairs on the upper surfaces of both plants can be seen easily with a magnifying glass. Occasionally, very small *Salvinia molesta* plants may be confused with duckweed, particularly giant duckweed, *Spirodela polyrrhiza*. It is easily distinguished from duckweed if examined under a magnifying glass. Duckweed has smooth upper and lower surfaces, while the upper surface of small *S. molesta* is slightly creased along the midline and has hairs on both the upper and lower surfaces. The roots of duckweed also are unbranched, compared with the highly branched third leaf "roots" of *S. molesta*.

Saltmarsh Cordgrass, Smooth Cordgrass *Spartina alterniflora*



Origin, growth habit and ecological threat:

This herbaceous, perennial, emergent is a beneficial saltmarsh grass that is native to the intertidal mudflats of the Atlantic and Gulf Coast states. It is non-native to the Pacific Coast where it is known to form dense stands in brackish tidal marshes. This species of cordgrass was introduced into southern San Francisco Bay from the East Coast around the mid-1970s and subsequently spread northward to the Puget Sound region, where it has no competitors or natural enemies. It is able to colonize the upper part of the intertidal zone, causing severe habitat disruption and displacing native saltmarsh plants by its tendency to collect silt. Dead stems and leaves also persist into the second growing season. Mudflats having dense populations of this cordgrass are unsuitable habitat for shore birds. This plant also crosses readily with California cordgrass, *Spartina foliosa*. Along the West Coast, saltmarsh cordgrass should be considered highly invasive.

Saltmarsh Cordgrass, Smooth Cordgrass

Vegetative characteristics:

LEAVES: Alternate, leaf blades are smooth, flat, 0.625 in. wide and up to 2 ft. long. They are folded at tips, with bases (sheaths) that are smooth and overlapping. Leaf margins are usually smooth, occasionally slightly rough, with a fringe of short hairs where leaf base joins the stem.

STEMS: Stems are erect, stiff, 8 in. to 5 ft. in height.

ROOTS: Roots are fibrous, highly branched, and are produced at bases of stems and at nodes along rhizomes.

RHIZOMES: Rhizomes are tough, creeping, jointed, brownish in color, and usually deeply seated in the marsh soil.

Reproduction:

Reproduction is by seeds and vegetatively by rhizomes. Broken stems may root as well.

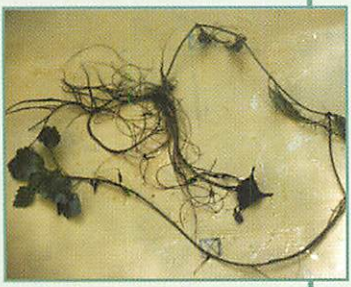
FLOWERS: It produces a flower with from five to 15 white to yellowish spikes, each up to 16 inches long, arranged alternating along the stem tip; spikes have 10 to 40 overlapping spikelets, arranged in two rows. Flowering usually occurs in late summer through early fall.

SEEDS: Seeds are smooth, flattened spikelets from 0.5 to 0.6 in. in length.

Similarities to other plants:

Usually smoother than the other cordgrasses. Seeds are smooth, compared with rough, toothed seeds of the other species. This plant may require a botanical key to distinguish.

Water Chestnut • *Trapa natans*



Origin, growth habit and ecological threat:

This herbaceous, floating-leafed, annual plant was introduced from Eurasia in the 1870s as a potential food and medicinal plant. The first known field infestation was found in 1879 in the Charles River, Massachusetts. Water chestnut currently is found from Virginia to Vermont, with the most serious infestations centered near the Hudson River Valley and the Lake Champlain watersheds. Plants usually grow rooted in soft mud in open, fresh shallow water, but occasionally may grow on exposed mudflats. The plant is aggressive and forms dense, impenetrable surface mats in nutrient-rich waters of ponds, lakes, and slow-moving streams and rivers. Mats obstruct light penetration into the water, eliminating growth of native plants and creating habitat unsuitable for fish and waterfowl. The spiny seed capsules also may inflict painful foot wounds to animals and humans wading in infested areas. This plant does not resemble, and is not related to, the Chinese water chestnut, which is a sedge.

Vegetative characteristics:

LEAVES: Plants have finely-dissected, feather-like, submersed leaves arranged in whorls of three or four at each underwater node. Floating leaves are 0.75 to 1.75 in. long, somewhat triangular to arrowhead shaped with strongly toothed margins and a spongy, inflated base about 6 in. long. Leaves form a rosette at the tip of the stem.

STEMS: Stems are long, cord-like and up to 16 ft. long.

ROOTS: Roots are dense, and fibrous in the soil. Numerous, finely-branched adventitious roots also form along the lower part of the stems.

Reproduction:

It reproduces solely by overwintering seeds.

FLOWERS: White, four-petaled flowers about 0.5 in. across are produced on short stalks in the axils of the floating leaves during mid-summer and are insect-pollinated.

SEEDS: Seeds are contained within a hard, woody, capsule about 1 in. long and armed with four sharp, barbed spines. They can remain dormant for 12 years or longer. They germinate in early spring and can give rise to 10 to 15 floating rosettes. Each rosette may produce up to 20 seeds.

Similarities to other plants:

This invasive plant looks similar to a species of water primrose, *Ludwigia stellata*, or mosaic plant, which is cultivated for ornamental pool use. The water chestnut has feathery, submersed leaves. The floating leaves of *L. stellata*, although similar to those of the water chestnut, have smooth margins. The water primrose also has five-petaled, yellow flowers.