Aquatic Invasive Species Quick Guide

Asian Clam (*Corbicula fluminea* O.F. Müller)

Golden Sands Resource Conservation & Development Council, Inc.

Description: The shell of the Asian clam is yellowish brown or black, with a polished white or light blue interior. The size of the shell averages about one inch across, but may be over two inches. Ridges on the shell are very pronounced and evenly spaced. Inside each half (valve) of the shell is a serrated lateral tooth and three large teeth at the hinge (see lower photo). Asian clams prefer sandy habitats of lakes and streams, and may be burrowed several inches into the sediment. They require well-oxygenated water with minimal pollution, and consume plankton through filter-feeding.

North American Distribution: Found in at least 43 U.S. states and the District of Columbia. Occurs in Lake Superior and Lake Michigan.

Asian clams are usually less than 1 inch across, but can be up to 2.5 inches.

Asian clams have a yellowish-brown to black shell, with well-defined ridges.

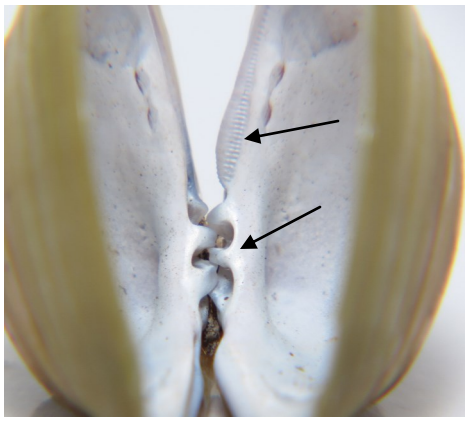
Dispersal Vectors: Native to China, Korea, and southeastern Russia, Asian clams probably arrived in the United States as juveniles in ballast water discharge, or as adults through importation as a food item. They could potentially be spread by anything that has sediment attached, such as boat anchors. Asian clams have also been sold through the aquarium trade. Densities of up to 20,000 per square meter have been observed. Asian clams can self-fertilize, and each individual can release up to 70,000 juveniles in one year.

Ecological Impacts: Asian clams are very successful at outcompeting native mollusks. In areas with very dense populations of Asian clams, fish spawning habitat and aquatic insect populations can also decrease. Costs of repairing Asian clam damage to water intake systems in the United States is estimated at nearly $1 billion per year.

Control Options: In small systems like power plant water intake systems, Asian clams can be controlled by chlorine injection, screening, or a temporary increase in temperature beyond 37 degrees Celsius.

In natural systems, an effective method of control is not yet known. Manual removal of Asian clams is possible, but labor-intensive. Prevention of spread is crucial to minimizing the impact of Asian clams on our native ecosystems. Asian clams and other aquarium pets should never be released into natural waters.

Note: Native fingernail clams look similar, but they are smaller, and lack the well-defined shell ridges and serrated lateral teeth.



Each side of the shell has a serrated lateral tooth (upper arrow), and three large hinge teeth (lower arrow).

Additional Information:

Global Invasive Species Database. *Corbicula fluminea*. http://www.issg.org/database/species/ecology.asp?si=537&fr=1&sts=sss&lang=EN

Foster, A.M., P. Fuller, A. Benson, S. Constant, D. Raikow, J. Larson, and A. Fusaro. 2013. *Corbicula fluminea*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=92

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources.

Aquatic Invasive Species Quick Guide

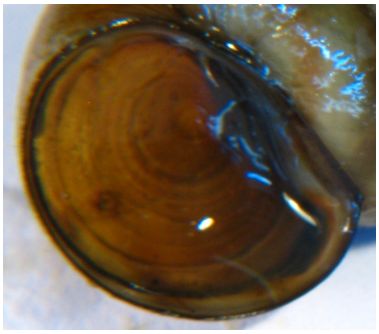
Banded Mystery Snail (*Viviparus georgianus* Lea)

Golden Sands Resource Conservation & Development Council, Inc.

Description: The banded mystery snail is a member of the family Viviparidae. Snails in this family give birth to live young, complete with shells. The shell is up to 1.5 inches tall, and 1-1.5 inches wide. Horizontal brown bands on the shell are visible from outside or inside the shell. A sturdy operculum is able to seal off the shell when the snail feels threatened. A typical life span is 3 years for males and 4 years for females. Mass die-offs of mature banded mystery snails are common in early spring after reproduction. Banded mystery snails occupy silt, marl, muck, and sand substrates.

North American Distribution: Southeastern U.S., lower Mississippi River, the Great Lakes states, northeastern U.S., and Quebec.

The banded mystery snail is usually about an inch tall and has distinct horizontal bands.



Banded mystery snails have a tough plate called an operculum covering the shell opening.

Dispersal Vectors: Banded mystery snails are native to the southeastern U.S. They were first documented in the Great Lakes basin in 1867 when 200 banded mystery snails were intentionally released by a civilian into the Hudson River drainage. Introductions have probably also occurred via the aquarium trade.

Ecological Impacts: Primarily grazes on diatoms, green algae, and fish eggs, but it is also capable of filter-feeding. First- and second-year individuals may be consumed by turtles, fish, and crayfish. Banded mystery snails have been documented at densities as high as 864 individuals per square meter. This species probably competes for food and resources with native snail species, but no serious negative impacts have been documented in its introduced range. It has been identified as an intermediate host to multiple trematode parasites, which have been involved in waterfowl die-offs in the Upper Mississippi River area.

Control Options: Manual removal of banded mystery snails is possible, but probably impractical in most situations.

Several chemical pesticides have been used to control snails in aquaculture ponds, but the banded mystery snail's thick operculum makes it less susceptible to these chemicals. Since most native snails do not have an operculum to seal off their shell, these native species are much more susceptible to pesticides.

An effective biological control agent is not known at this time.

A mass die-off of mature banded mystery snails.

Additional Information:

Eckblad, J.W. and M.H. Shealy, Jr. 1972. Predation on largemouth bass embryos by the pond snail *Viviparus georgianus*. Transactions of the American Fisheries Society. 101 (4): 734-738.

Kipp, R.M., A.J. Benson, J. Larson, and A. Fusaro. 2013. *Viviparus georgianus*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=1047 Revision Date: 3/12/2013

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources.

BMS-1-14

Aquatic Invasive Species Quick Guide

Big-eared Radix (*Radix auricularia* L.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: The big-eared Radix (also called European ear snail) has a yellow-tan, conical shell with 4-5 whorls and deep grooves between them. The lowest whorl is several times wider than the other whorls—it holds about 90% of the shell's total volume. The large, ear-shaped shell opening (aperture) is on the right side. The big-eared Radix does not have an operculum. This species can tolerate large fluctuations in water temperature and water level, and can also tolerate periods without oxygen. It prefers shallow, silty habitats, but has been observed in deep, rocky areas. In Great Britain, the species appears to be restricted to hard-water systems.

The big-eared Radix averages between 1/2 and 1 inch long, and the shell opening is greater than 50% of the shell's height.

North American Distribution: Widely scattered in at least 15 U.S. states, and all of the Great Lakes.

Young big-eared Radix are harder to discern from natives, but as they age, their lowest whorl becomes disproportionately larger than the upper whorls.

Dispersal Vectors: This European species is capable of self-fertilization (hermaphroditic) and breeds twice per year. Each snail can produce about 1300 eggs per year, laid in clumps of 50-150 eggs each. Eggs of the big-eared Radix can be transported along with plants, so it may have been introduced to new locations throughout the United States via the aquarium trade. Boats and other equipment moving plant material or mud between water bodies could also transport attached snails.

Ecological Impacts: The big-eared Radix feeds mostly on decaying organic material and algae of the genus *Cladophora*. It is an important host of many trematode parasites, especially the liver flukes *Fasciola gigantica* and *F. hepatica*. Some fishes and turtles feed on the big-eared Radix. Its impacts to native aquatic organism communities are largely unknown.

Control Options: Prevention of spread is crucial. Aquarium plants and animals should never be released into natural waterways.

Manual removal of snails is possible, but probably impractical in most cases. This snail's preference for soft substrates makes it difficult to access them by wading, and snails burrowed into the substrate may be difficult to find.

Niclosamide pesticides are used to control snails, but are not species-selective. They may be effective on the big-eared Radix, but other snails would also likely be harmed by the pesticide.

No effective biological control agent is known at this time.

Additional Information:

Mills, E. L., J. H. Leach, J. T. Carlton and C. L. Secor. 1993. *Exotic species in the Great Lakes: a history of biotic crises and anthropogenic Introductions*. Journal of Great Lakes Research 19(1):1-54.

Kipp, R.M., A.J. Benson, J. Larson, and A. Fusaro. 2013. *Radix auricularia*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=1012 Revision Date: 6/11/2012

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources.

RAD-1-14

Aquatic Invasive Species Quick Guide

Brittle Naiad (*Najas minor* All.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Brittle naiad is a small, highly branched, submersed annual in the Najadaceae family. It has opposite leaves with tiny teeth on the edges, and are usually curved (especially later in the year). Brittle naiad gets its name from its weak, brittle stems, which fragment easily and serve to disperse fruits that are located in the leaf axils. Under magnification, these fruits have many rows of tiny, rectangular pits in a ladder-like arrangement.

Brittle naiad has been observed growing as deep as 5 meters, and prefers calm, alkaline environments.

North American Distribution: Ontario and the eastern and southeastern United States. One population has been reported from California.

Brittle naiad is highly branched, and leaves are often curved.

Long, elliptical fruits form in the leaf axils.

Dispersal Vectors: Brittle naiad is native to Europe and Asia, and was intentionally introduced to many lakes to increase food for waterfowl, which readily consume its seeds. It may have also been introduced by aquarium dumping into local waterways. Waterfowl can excrete the viable seeds in new areas. Fragments of brittle naiad can cling to boat trailers or equipment such as waders, duck hunting decoys, or even dogs.

Ecological Impacts: Brittle naiad can grow in very dense patches, and can outcompete native vegetation. This species is so aggressive that it has even been known to outcompete two very invasive aquatic plants—Eurasian watermilfoil and Hydrilla. Brittle naiad fruits are a food source for waterfowl.

Control Options: Brittle naiad is difficult to control once it is established. Manual removal of this plant can be difficult, because it easily fragments. Any leftover fragments could potentially produce new plants, especially if they contain fruits.

Mechanical harvesters have been used to remove brittle naiad biomass, but will likely spread the plant further via fragmentation.

Successful chemical control has been achieved with diquat, endothall, and fluridone herbicides. These herbicides can have negative impacts on many native aquatic plant species, so proper timing and dosage is crucial. Most states require chemical use permits for any herbicide treatments in standing water or wetland situations.

A successful biological control agent is not known at this time.

Brittle naiad readily breaks into small pieces, which help disperse its seeds.

Additional Information:
Global Invasive Species Database. *Najas minor.* http://www.issg.org/database/species/ecology.asp?si=1560&fr=1&sts=tss&lang=EN

Photo Credit: Paul Skawinski

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BN-1-14

Aquatic Invasive Species Quick Guide

Chinese Mystery Snail (*Cipangopaludina chinensis* Reeve)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Chinese mystery snails are often large, up to nearly 3 inches tall. Shells are typically dark brown, and may have some dark vertical ridges near the opening. The lowermost whorl of the shell is usually much wider than the rest of the shell. At the opening of the shell, a thick, hardened plate called an operculum is able to seal the shell against predators or harmful chemicals in the water. Chinese mystery snails are capable of grazing algae from surfaces and filter-feeding on suspended algae particles.

North American Distribution: Scattered across North America, but they are most abundant in the eastern and central United States.

The Chinese mystery snail can be nearly 3 inches tall.

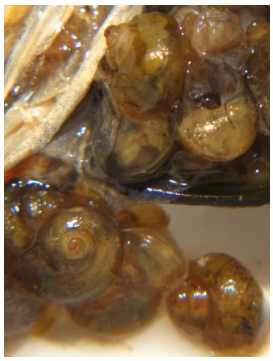
Chinese mystery snails have a tough plate called an operculum covering the shell opening.

Dispersal Vectors: Native to eastern Asia, Chinese mystery snails were first imported to the U.S. in the late 1800s as a food item in oriental markets. It is believed that some people may have "seeded" these snails into local waterways for later harvest. Chinese mystery snails are also introduced to water gardens for the purpose of clarifying the water and grazing algae from hard surfaces. At any time during summer and fall, each female may contain dozens of small snails at different stages of development. She occasionally gives birth to small batches of live young, complete with shells.

Ecological Impacts: Chinese mystery snails likely compete for food and resources with native snails and other grazers or filter-feeders. Some research studies suggest that impacts to native species may be insignificant. Chinese mystery snails serve as a secondary host for a trematode parasite that has been killing large numbers of waterfowl in the Midwestern U.S. Some larger animals like turtles or muskrats may occasionally feed on Chinese mystery snails.

Control Options: Manual removal of Chinese mystery snails remains the only effective method of control. Of course, the effect on the population depends on the number removed and the total population size. These snails prefer mucky, organic sediments, so manual removal is likely to be a difficult option in many areas.

Chemical control efforts tend to be unsuccessful and have unintended consequences to native snails and/or other animals. Chinese mystery snails can seal up their shells with their operculum, protecting them from unfavorable conditions like chemical pesticides. Most North American snails do not have this ability and would be harmed.



Juvenile Chinese mystery snails, just minutes old.

Additional Information:

Dillon, R. T. Jr., M. Ashton, M. Kohl, W. Reeves, T. Smith, T. Stewart & B. Watson 2013. *The freshwater gastropods of North America*. http://www.fwgna.org.

Global Invasive Species Database. *Bellamya chinensis*. http://www.issg.org/database/species/ecology.asp?si=1812&fr=1&sts=sss&lang=EN

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources. CMS-1-14

Aquatic Invasive Species Quick Guide

Curly-leaf Pondweed (*Potamogeton crispus* L.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Curly-leaf pondweed is a non-native, perennial aquatic plant in the Potamogetonaceae family, can grow in very shallow water or down to at least 15 feet deep. Its leaves are alternate with serrated margins, a blunt tip, and 3-5 veins running from the base to the tip. Late in its seasonal life cycle, the leaves become very wavy, but young plants have flat leaves. Curly-leaf pondweed typically dies back in June/July, but may grow year-round if a source of cool water exists nearby. Small, cloning buds (turions) are produced at the tip of the plant and in the leaf axils, which lie dormant through the summer and sprout by the following spring.

Curly-leaf pondweed has alternate, wavy leaves with blunt tips.

North American Distribution: Curly-leaf pondweed has been found across at least 47 U.S. states and most of southern Canada.

Leaves have small teeth on the edges and 3-5 veins running the length of the leaf.

Dispersal Vectors: Curly-leaf pondweed was introduced to North America from Europe in the late 1800s as an aquarium plant. It may also have been introduced during common carp stocking programs. Local spread is by rhizomes and turions. Seed viability in natural systems is typically very low (~0.001%) (Catling and Dobson, 1985). Boats have the potential to move curly-leaf pondweed between water bodies by transporting plants fragments with developed turions attached.

Ecological Impacts: Curly-leaf pondweed can form large, dense beds that sprawl across the surface, often seen in shallow lakes with soft sediments. These beds inhibit recreational activities and can reduce water flow. Die-off of curly-leaf pondweed in summer often leads to algae blooms. Seeds of curly-leaf pondweed are readily consumed by many species of ducks.

Control Options: Manual removal of curly-leaf pondweed is difficult; it involves pulling the plant and rhizome in as few pieces as possible. Rhizome fragments will sprout new plants. Turions also must be removed, so removal before turions are produced is recommended.

Mechanical removal can be done with aquatic plant harvesters, and should be done just before turion development. Removal of the top several feet of the plant at this time will reduce the number of seeds and turions produced that year. This type of removal could possibly stimulate rhizome development.

Chemical control typically uses contact herbicides like endothall. It can be effective on curly-leaf pondweed when applied at the proper dose and time of year, but multiple years of treatments are necessary to deplete the reserve of turions in the sediment. Unintended damage to the native aquatic plant community is likely with these herbicides. Most states require chemical use permits for any herbicide treatments in standing water or wetland situations.

Turion of curly-leaf pondweed.

No effective biological control agents are currently known.

Additional Information:

Catling, P. M. and Dobson, I. 1985. The biology of Canadian weeds. 69. *Potamogeton crispus* L. Can. J. Plant Sci. 65: 655-668.

Photo Credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources. CLP-1-14

Aquatic Invasive Species Quick Guide

Eurasian Watermilfoil (*Myriophyllum spicatum* L.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Eurasian watermilfoil is a non-native, perennial, submersed aquatic plant in the family Haloragaceae. Feather-shaped leaves are divided into 12 or more pairs of slender leaflets. Leaves are arranged in whorls of 4-6 around the stem. Stems and leaves tend to be limp, often with some pinkish color. 2-4" flower spikes are pink and yellow, held above the water, with many whorls of pink flowers (female) on the lower half, and whorls of yellow flowers (male) on the upper half. Eurasian watermilfoil can survive on wet shorelines during the growing season if water levels recede.

Eurasian watermilfoil has whorls of feather-shaped leaves with 12 or more pairs of leaflets.

North American Distribution: Eurasian watermilfoil occurs in British Columbia, Ontario, Quebec, and at least 47 U.S. states.

Fragments of Eurasian watermilfoil can produce roots and continue growing.

Dispersal Vectors: Eurasian watermilfoil was introduced from Europe and Asia in ballast water of trans-oceanic ships, and probably also as a result of aquarium dumping. Stem fragments disperse the plant short distances, but they can easily catch on boat trailers and other equipment and be moved between water bodies. Seeds are thought to have very low viability.

Ecological Impacts: Populations can spread quickly by fragmentation, and can create dense stands that exclude native vegetation. These stands also create floating mats of tangled vegetation, which increase water temperatures, reduce water movement, and impede recreational activities.

Control Options: Small patches of Eurasian watermilfoil can be removed manually. The base of the plant and roots must be removed, and all parts of the plant should be disposed of away from any water body. Use of large rakes is not recommended because of the risk of fragmentation. A free, helpful tutorial on manual removal of Eurasian watermilfoil is available on YouTube at http://www.youtube.com/watch?v=CfsEDyAwQP4

Chemical herbicides can be used to control large stands of Eurasian watermilfoil. These herbicides must be applied by a licensed applicator, and when water temperatures are 50-60°F. These herbicides may have negative impacts on native aquatic plant species, so proper timing and dosage is crucial. Most states require chemical use permits for any herbicide treatments in standing water or wetland situations.

An aquatic insect native to much of North America, *Euhrychiopsis lecontei*, has been associated with declines of Eurasian watermilfoil. The weevil damages Eurasian watermilfoil through its feeding activity. In order to be effective, these weevils require abundant natural shoreline vegetation for overwintering.

Eurasian watermilfoil (left) has 12+ pairs of leaflets per leaf, while native watermilfoils (right) tend to have <12 pairs.

Additional Information:

Aiken, S. G., Newroth, P. R. and I. Wile. 1979. The biology of Canadian weeds. 34. *Myriophyllum spicatum* L. Can. J. Plant Sci. 59: 201-215.

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources. EWM-1-14

Aquatic Invasive Species Quick Guide

Faucet Snail (*Bithynia tentaculata* L.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: A member of the Bithyniidae family, faucet snails grow up to 12-15mm tall (about 1/2"), and have a light brown to black shell with 5-6 whorls. The shell opening (aperture) is on the right side, and is less than half the height of the shell. A tough plate called an operculum tightly covers the aperture. It is teardrop-shaped, and displays several concentric rings on adults. Faucet snails can filter-feed on suspended algae, or graze algae off of rocks and other surfaces, whichever is more favorable at the time.

North American Distribution: Great Lakes region from New York and Quebec east to Minnesota. Also known from Montana and Chesapeake Bay.

Faucet snails have light brown to black shells, with the opening on the right side.

Faucet snail shells have 5-6 whorls, and a teardrop-shaped opening.

Dispersal Vectors: Faucet snails are native to Europe, and arrived in the Great Lakes through ballast water transport in the 1870s. They can be transported locally by boats, trailers, anchors, duck decoys, and other equipment that is moved between water bodies. Faucet snails can live for up to a month in dry mud, so proper cleaning of equipment is essential before moving to a new water body. Eggs are deposited on firm substrates in masses of up to 77.

Ecological Impacts: Faucet snails are intermediate hosts for three trematode parasites that can kill waterfowl. Several massive waterfowl die-offs have occurred in the Upper Midwestern U.S., and have been attributed to the birds' consumption of faucet snails. These parasites do not pose a risk to humans consuming cooked fish or waterfowl. Faucet snails also compete with native snails for food and other resources, and can clog water intake screens and pipes in municipal water systems.

Control Options: The best control measure for faucet snails is preventing their spread to new water bodies. Boats, trailers, decoys, and other recreational equipment should always be thoroughly checked before leaving a water body, to prevent faucet snails and other aquatic invasive species from being transported.

No effective chemical or biological control measures are known for faucet snails.

The adult faucet snail's operculum has many concentric rings.

Additional Information:

Brendelberger, H. and Jürgens, S. 1994. Suspension feeding in *Bithynia tentaculata* (Prosobranchia, Bithyniidae), as affected by body size, food, and temperature. Oecologia. 94:1 36-42.

Kipp, R.M., A.J. Benson, J. Larson, and A. Fusaro. 2013. *Bithynia tentaculata*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=987 Revision Date: 6/4/2012

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources. FS-1-14

Aquatic Invasive Species Quick Guide

Flowering Rush (*Butomus umbellatus* L.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Flowering rush is a non-native, perennial aquatic plant in the family Butomaceae which grows from dark rhizomes that may be lumpy or hairy. Large, narrow leaves are dark green, usually twisted, triangular in cross-section, and originate from a basal cluster. Leaves are often slightly cupped at the base where they partially sheath each other. Plants are typically emergent and 3-5 feet tall, but can grow submerged to over 10 feet deep. A large umbel inflorescence is held on a round stalk and contains many pink flowers with 3 sepals, 3 petals, and red anthers.

Flowering rush has a large, showy inflorescence on a round stalk.

North American Distribution: Flowering rush has been reported across most of the northern United States and Canada.

Creamy white bulbils are produced on the rhizomes and resemble small onions.

Dispersal Vectors: Flowering rush was introduced from Eurasia as an ornamental plant for water gardens and other wet sites. It spreads locally by rhizomes, and produces asexual reproductive structures called bulbils (also called bulblets), which can dislodge from the parent plant and sprout new plants elsewhere. Fragments of the rhizome can also produce new plants. Muskrats may transport flowering rush short distances when building their huts, and waterfowl hunters may contribute to spread by using it in construction of hunting blinds.

Ecological Impacts: Populations can spread quickly by rhizomes and bulbils, crowding out valuable native species and decreasing plant and animal diversity. Its ability to grow on wet shores, as an emergent, or as a submergent allow it to create large, dense colonies. Colonies can be dense enough to prevent passage of boats.

Control Options: Small patches of flowering rush can be manually removed by gently digging up the rhizomes and removing all plant material from the site. Care should be taken to remove all bulbils and rhizome fragments. This is more easily done by reaching under the rhizome with bare hands rather than using a shovel. Removing the plants in as few pieces as possible will result in less risk of rhizome fragmentation and dislodged bulbils.

Chemical control of flowering rush is difficult due to the narrow, waxy leaves. Research is ongoing to find an herbicide that effectively controls flowering rush without serious negative effects on beneficial native vegetation. Most states require chemical use permits for any herbicide treatments in standing water or wetland situations.

This emergent stand of flowering rush in 2 feet of water is preventing passage of a kayak.

No effective biological control agent is known at this time.

Additional Information:

Madsen, J.D., B. Sartain, G. Turnage, and M. Marko. 2013. Herbicide trails for management of flowering rush in Detroit Lakes, Minnesota for 2012. Geosystems Research Institute Report 5059, Geosystems Research Institute, Mississippi State University, Mississippi State, MS. April 2013.

Minnesota Sea Grant. Flowering Rush. www.seagrant.umn.edu/ais/floweringrush

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources.

FR-1-14

Aquatic Invasive Species Quick Guide

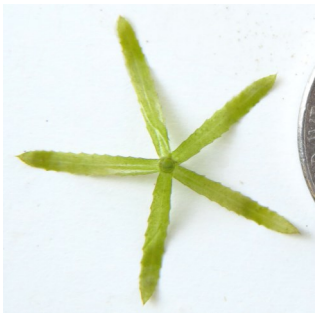
Hydrilla (*Hydrilla verticillata* (L. f.) Royle)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Hydrilla, sometimes called water thyme, is a submersed, non-native, perennial aquatic plant in the Hydrocharitaceae family. Long stems contain many whorls of 4-8 short leaves, and tend to be bushy near the top. Leaves are serrated on both sides, and contain several spines on the underside of the midvein. Scaly tubers are produced in the sediments. Dense, overwintering turions can also form in the leaf axils. Small, white, female flowers are produced on long, slender stalks that rise to the surface. Green, male flowers release from the plant and float freely on the surface. Hydrilla prefers soft sediments in nutrient-rich waters.

Hydrilla has long, branching stems with whorls of 4-8 leaves.

North American Distribution: Along the west, south, and east coasts of the U.S.. Also documented in TN, IN, IA, and WI.



Leaves have whorls of 4-8 leaves that are serrated on the margins and have teeth under the midvein.

Dispersal Vectors: Native to Asia and Africa, Hydrilla was introduced to North America through the aquarium trade. Fragments of the plant are readily dispersed by water currents, boat trailers, anchors, motors, and other recreational equipment. Tubers are eaten by waterfowl and remain viable. Hydrilla has been sold through the aquarium trade, and was likely spread to local waters via illegal aquarium dumping. Hydrilla has been found attached to water lilies ordered over the Internet.

Ecological Impacts: Hydrilla forms dense monocultures and can shade out native vegetation. These dense colonies also restrict fish passage, and can cause stunting of fish populations as predator fish have trouble hunting for food. Dense mats can create areas of stagnant water, perfect for mosquito breeding habitat. Hydrilla mats can prevent boat passage, fishing, and swimming.

Control Options: Manual removal of Hydrilla is possible, but usually impractical if large mats are present. Plants must be removed carefully so that turions, tubers, or fragments are not left behind. Mechanical harvesting is widely used and effective at removing vegetation near the surface. Harvesting is not species-selective and can cause further spread through fragmentation.

Fluridone was the most heavily used herbicide for many years, but Hydrilla developed a resistance to this chemical. Endothall-based herbicides are now more common in many areas where fluridone-resistant Hydrilla is prevalent, but plants appear to be developing a resistance to this chemical as well. Use of these herbicides can destroy the stems and leaves, but tubers, turions, and seeds are not destroyed and may re-sprout. Most states require chemical use permits for any herbicide treatments in standing water or wetland situations.

Several biological control agents have been used to control Hydrilla. Grass carp (*Ctenopharyngodon idella*) effectively suppress Hydrilla by feeding on stems and leaves, but they are not species-selective and often destroy much of the aquatic plant community. Grass carp are illegal to possess or transfer in many states. An aquatic weevil (*Bagous affinis*) feeds on the tubers, but only when they are exposed to the atmosphere. Larvae of a fly (*Hydrellia pakistanae*) feed on the leaves, but cause insignificant damage to the plant.

Hydrilla produces small, scaly tubers in the sediments.

Additional Information:
Hetrick, S.A. and K.A. Langeland. 2012. Hydrilla management in Florida lakes. University of Florida IFAS Extension Publication #SS-AGR-361. http://edis.ifas.ufl.edu/ag370
Global Invasive Species Database. 2006. *Hydrilla verticillata*. http://www.issg.org/database/species/ecology.asp?si=272&fr=1&sts=sss&lang=EN
Photo Credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources.

Aquatic Invasive Species Quick Guide

Japanese Knotweed (*Fallopia japonica* Houtt. Ronse Decr.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Japanese knotweed is a large, non-native shrub that grows up to 12 feet tall. It has hollow, woody stems (canes). Leaves are alternate, and widely lance-shaped to heart-shaped. Tiny, white flowers are produced in short, erect spikes that originate from the leaf axils. This species prefers full sun exposure, and grows aggressively in riparian areas, but can also grow in upland habitats. Rhizomes are dark brown and knotty, with an orange core. This plant has been nominated to be included in the list of 100 "World's Worst" invasive species. It has been known to damage foundations and sprout through asphalt.

North American Distribution: Documented in at least 41 U.S. states and 5 Canadian provinces.

Japanese knotweed has large, heart-shaped leaves and spikes of white flowers that originate from the leaf axils.

Stems are hollow, but solid at the nodes.

Dispersal Vectors: Japanese knotweed is native to Japan, and was introduced to North America as an ornamental plant, usually planted as "living fences" to generate privacy. It has occasionally been planted by beekeepers for its abundant flowers. Japanese knotweed primarily spreads by rhizomes. Fragments of rhizomes or stems can sprout new plants. Many populations along streams are started by fragments drifting in from upstream. Seeds have fairly high viability, but seedlings often die soon after germinating.

Ecological Impacts: This species forms dense stands that exclude native vegetation. This loss of diversity results in a loss of usable habitat for wildlife. A study found up to ten times as many plant species outside of Japanese knotweed patches, compared to within the patches. It also noted a 50% decrease in invertebrate diversity within a Japanese knotweed patch. Patches on streambanks can increase erosion as the plant dies back in fall and exposes large amounts of soil.

Control Options: Manual removal of Japanese knotweed is very difficult, due to its large network of rhizomes. These rhizomes can be several meters deep, making removal by digging nearly impossible. Repeated mowing or pulling of shoots can eventually exhaust the plant's underground energy supply, but this may take two years or more.

Systemic herbicides like glyphosate can control this species. It can be sprayed on the foliage, but take care to minimize chemical overspray, which will kill native vegetation. Cut stems once in early summer so plants re-grow shorter for fall treatment with less overspray. Stems can also be cut near the ground in fall, and a small volume of herbicide can be poured into the cut stem. A combination of manual removal and herbicide application tends to be the most effective control strategy. Always follow label directions. A WDNR permit is required when near water.

An effective biological control agent is not known at this time.

Dense patches of Japanese knotweed can exclude all other vegetation.

Additional Information:

Wisconsin Department of Natural Resources and University of Wisconsin Extension. Japanese knotweed. Informational brochure.
http://clean-water.uwex.edu/pubs/pdf/knotweed.pdf

Global Invasive Species Database. *Polygonum cuspidatum*.
http://www.issg.org/database/species/ecology.asp?si=91&fr=1&sts=sss&lang=EN

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an AIS education program, supported by a grant from the Wisconsin Department of Natural Resources.

JK-1-14

Aquatic Invasive Species Quick Guide

New Zealand Mudsnail (*Potamopyrgus antipodarum* Gray)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Mature New Zealand mudsnails have a cone-shaped, 4-6mm long, gray-brown shell with 7-8 whorls, separated by deep grooves. The opening (aperture) of the shell is on the right side, and can be sealed with a firm plate called an operculum. These snails can live out of water for up to 26 days; this adaptation combined with their small size make them very easily transferrable. Nearly all New Zealand mudsnails in North America appear to be female clones. Despite its name, these snails inhabit a variety of substrates, including silt, sand, cobble, and vegetation.

The tiny New Zealand mudsnail is only a few millimeters long.

North American Distribution: Widely scattered in the western U.S.; Lakes Ontario, Superior, and Michigan; St. Louis River; south-central WI; PA.


New Zealand mudsnail shells are brown, black, or gray, and may have tiny bumps.

Dispersal Vectors: New Zealand mudsnails are native to New Zealand and its nearby islands, and have been introduced to North America, Europe and Australia. In 1987, they were first discovered in the U.S. in Idaho's Snake River. These snails can reproduce asexually, so only one snail is needed to start a new population. Newly born, asexual females already contain developing embryos. Once established, they can be spread quickly by boots, waders, and other equipment. They may also be spread by fish that consume them—New Zealand mudsnails can pass through a fish's digestive system unharmed.

Ecological Impacts: New Zealand mudsnails have been observed at incredible densities of up to 800,000 per square meter. They consume large amounts of phytoplankton, which comprise the base of the aquatic food web. They also displace native snails and invertebrates that are more beneficial as food for wildlife—many birds and fish cannot digest New Zealand mudsnails. Industries drawing water from infested lakes or rivers often have problems with snails blocking their screens and clogging pipes.

Control Options: The most effective method of controlling New Zealand mudsnails is through prevention of their spread to new water bodies. Thorough cleaning/scrubbing or freezing of gear for 8 hours before moving to a new water body is crucial.

Long-term water level fluctuation can kill New Zealand mudsnails through dessication (drying out) or freezing, but these snails can live out of water in a damp environment for at least 26 days.

Several chemicals have shown to be lethal to New Zealand mudsnails in laboratory studies, but their safety and effectiveness in natural systems may differ. Bayluscide (active ingredient: niclosamide) was successfully used in a small stream in Montana at a concentration of 1ppm for 1 hour and achieved 100% mortality of New Zealand mudsnails. However, this chemical is also harmful to native snails and aquatic life, and is heavily regulated.

Some positive research exists regarding biological control using a trematode parasite from its native range, especially *Microphallus* sp., but this research is in early stages and has not been approved for use in North America.

Additional Information:

Benson, A.J., R.M. Kipp, J. Larson, and A. Fusaro. 2013. *Potamopyrgus antipodarum*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=1008 Revision Date: 6/11/2012

Global Invasive Species Database. *Potamopyrgus antipodarum*. http://www.issg.org/database/species/management_info.aspsi=449&fr=1&sts=sss&lang=EN

Photo Credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources.

NZMS-1-14

Aquatic Invasive Species Quick Guide

Common Reed (*Phragmites australis* (Cav.) Trin. ex Steud.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Common reed, also called *Phragmites*, is a perennial, non-native grass that can grow up to 16 feet tall. Leaves are wide, dark green to blue-green, and up to 30 inches long. The base of the leaf narrows to a long sheath that tightly wraps around the stem. The leaf base has a short ligule (0.1 - 0.4mm). Leaves are dropped in winter but the sheaths remain attached to the stems. Stems are very strong, with distinct ridges. Large rhizomes quickly spread the plant locally, and may be seen creeping above ground as stolons. Seedheads are fluffy, often 8-12 inches tall, and are tan to purple.
A native subspecies also occurs in the U.S. and Canada. It has smooth, reddish stems, bright green leaves, and ligules 0.4—1.0mm long (see back side).

Common reed grows in dense patches and can tower over a person.

North American Distribution: Occurs throughout the continental United States and southern Canada.

Large, fluffy seedheads are present by late summer and persist into winter.

Dispersal Vectors: Stem and rhizome fragments can float to new locations and create new populations. Muskrats may transport stems for their shelters. Waterfowl hunters could move viable fragments for construction of hunting blinds. Seeds are dispersed by wind and water, but have low viability.

Ecological Impacts: Common reed can form very dense populations along streams and lakes, which often prevent access for humans and wildlife. They also shade out native vegetation, which leads to decreased diversity of plants and animals. *Phragmites* has displaced many large stands of coastal cordgrass (*Spartina*) populations, which are valuable for waterfowl. Abundant dead stems of *Phragmites* also increase the risk of marsh fires.

Control Options: Manual removal is difficult due to its extensive rhizome network. Combining bundling and cutting stems with painting herbicide on the cut stumps in fall can be effective on small sites. For large sites, cut stems in early summer and spray shorter re-growth stems in fall. Multiple applications will likely be needed. Herbicides must be labeled for aquatic use. Large stands of *Phragmites* along the Great Lakes shorelines and North American coastlines have been targeted with aerial herbicide applications.

Flooding can be used if the rhizomes are covered with several feet of water for at least four months. Draining can also be effective to reduce stand vigor.

No successful biological control agents are known at this time.

Phragmites has distinct ridges on its stems. The leaf sheath (shown at left) is tightly held.

Additional Information:
Global Invasive Species Database. *Phragmites australis.* http://www.issg.org/database/species/ecology.asp?fr=1&si=301
Great Lakes Phragmites Collaborative. http://greatlakesphragmites.net

Photo Credit: Paul Skawinski

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Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources. PHR-2-15

How can I tell the non-native *Phragmites* from the native *Phragmites*?

Golden Sands
Resource Conservation
& Development Council, Inc.

Non-native *Phragmites*

(*Phragmites australis* subsp. *australis*)

Leaf sheath tightly wrapped around stem

- Stem has distinct ridges and is tan-brown. Ridges can easily be felt with a fingernail.
- Dark green leaves
- May have some irregular spots caused by mildew.
- Leaf sheaths stay attached to stems year-round.

Stems are often 12-15ft tall, with large, dense seedheads

Native *Phragmites*

(*Phragmites australis* subsp. *americanus*)

- Stem is smooth (or with faint ridges), shiny, often reddish.
- Yellow-green leaves
- Stem often has distinctly round, black spots.
- Leaf sheaths fall off stem during winter.

Stems usually less than 10ft tall, with sparse seedheads

Photo credit: Paul Skawinski

Aquatic Invasive Species Quick Guide

Purple Loosestrife (*Lythrum salicaria* L.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Purple loosestrife is a perennial wetland plant in the Lythraceae family, growing to about 8 feet tall. Stems are woody, and 4-sided (rarely 6-sided in very large plants). Leaves are opposite or occasionally in whorls of 3, with smooth margins and no leaf stalk. Each flower has six petals, and many whorls of these flowers bloom at the same time. Large plants may have many pink-purple flower spikes. Fruit capsules contain thousands of seeds each.

North American Distribution: Nearly all U.S. states and the southern Canadian provinces. Reported as far north as 65°N latitude.

Purple loosestrife flowers have six wrinkled, pink-purple petals.

Purple loosestrife produces tall flower spikes and stands up to 8 feet tall.

Dispersal Vectors: Purple loosestrife seeds probably arrived in North America from Europe, in heaps of soil used for ship ballast. It also may have been intentionally imported for ornamental use, medicinal use, or use by beekeepers. Large purple loosestrife plants can produce over two million wind-dispersed seeds per year.

Ecological Impacts: Purple loosestrife can rapidly colonize new areas, displacing native vegetative communities. In many wetlands, purple loosestrife has become the dominant species. Nesting habitat quality can decrease as the result of purple loosestrife introduction, reducing the waterfowl and shorebird communities. Some cultivars of purple loosestrife can also hybridize with our native winged loosestrife (*Lythrum alatum*), reducing the native's genetic integrity.

Control Options: Manual removal of small stands of purple loosestrife can be very effective. Plants in moist, soft substrate can often be pulled out by hand, including the roots. Very large plants may require some digging to remove the entire plant. Cutting flowerheads or seedheads can prevent seed dispersal in the short term, but plants will re-sprout from the roots and may produce new flower spikes.

Glyphosate or 2,4-D-based herbicides can be used; they should be approved for aquatic use to avoid unnecessary harm to the ecosystem. For scattered plants, herbicide is best applied with a small bottle and a wicking tip that can be used to "paint" herbicide onto the plants.
Cutting the stem near the base and "painting" the cut stem is often effective. Most states require chemical use permits for any herbicide treatments in standing water or wetland situations.

Purple loosestrife stems are woody and nearly square.

Biological control of purple loosestrife is a widely used, effective method of control. *Galerucella* beetles feed on purple loosestrife without negatively affecting native wetland plants. Many states and organizations offer free assistance to volunteers looking to raise *Galerucella* beetles for local release into infested wetlands.

Additional Information:

Mai, T.K., Lovett-Doust, J., Lovett-Doust, L., and Mulligan, G. A. 1992. The biology of Canadian weeds. 100. *Lythrum salicaria*. Can. J. Plant Sci. 72: 1305-1330

Wisconsin Department of Natural Resources. Purple loosestrife biocontrol. http://dnr.wi.gov/topic/invasives/loosestrife.html

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources. PL-1-14

Aquatic Invasive Species Quick Guide

Rusty Crayfish (*Orconectes rusticus* Girard)

Golden Sands Resource Conservation & Development Council, Inc.

Description: The rusty crayfish is a large crayfish of the family Cambaridae. Adults can reach six inches in length, including the claws. Most of the body is tan to light brown, but each side of the carapace has a rusty brown spot. Claws are large and typically have brightly colored tips above dark bands. Rusty crayfish are omnivores, feeding primarily on aquatic plants, snails, and other small invertebrates. They can commonly be found hiding under rocks, logs, and other debris. Rusty crayfish typically live 3-4 years.

North American Distribution: Rusty crayfish are most abundant in the western Great Lakes states, but have been documented from Minnesota and Iowa eastward to Maine, and in northern New Mexico.

Rusty crayfish are mostly light brown, with bright claw tips.

Each side of the carapace has a rusty brown spot.

Dispersal Vectors: Rusty crayfish are native to the Ohio River Basin, and were likely transported to the Midwest United States as bait by fishermen. Rusty crayfish quickly colonize lakes and streams by producing several hundred eggs per female each season. Eggs are protected under the female's tail until they hatch.

Ecological Impacts: Rusty crayfish are larger and more aggressive than most native crayfish, and are able to outcompete native species for food and habitat. Rusty crayfish consume large amounts of aquatic invertebrates, small fish, fish eggs, tadpoles, native crayfish, plants, and other aquatic life. They can hasten spread of Eurasian watermilfoil and other aggressive plants by cutting the stems, which then take root elsewhere.

Control Options: Manual trapping is effective for rusty crayfish. Always follow local trapping regulations. Modification of size limits of predator fish species can be effective. Walleye, smallmouth bass, largemouth bass, and yellow perch will consume young rusties. This strategy combined with trapping of large adults can reduce rusty crayfish populations.

An effective, safe pesticide for rusty crayfish has not been found. Although crayfish-selective pesticides exist, they are also harmful to native crayfish species.

An effective biological control agent has not been found. A parasite called *Microphallus* infects rusty crayfish (and other crayfish species), and is currently being researched. Lakes with abundant rusty crayfish are often found to have no *Microphallus* present.

Eggs and newly hatched young are held under the female's tail for protection.

Additional Information:

Hein, C.L., Roth, B.M., Ives, A.R., and M. Jake Vander Zanden. 2006. Fish predation and trapping for rusty crayfish (*Orconectes rusticus*) control: a whole-lake experiment. Can. J. Fish. Aquat. Sci. 63: 383-393.

Wisconsin Department of Natural Resources. Potential impacts to rusty crayfish (*Orconectes rusticus*) populations from a parasite, *Microphallus* sp.

Photo Credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources. RC-1-14

Aquatic Invasive Species Quick Guide

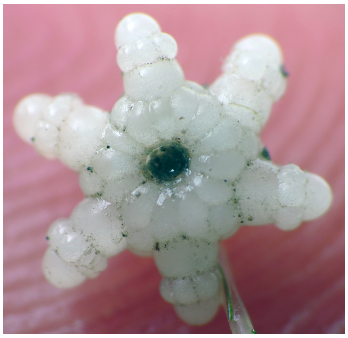
Starry Stonewort (*Nitellopsis obtusa* L.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Starry stonewort is a non-native species of large algae in the Characeae family. It has whorls of 4-6 long branchlets. It is more robust than most members of its family, and can grow to over two meters tall. Anchored by colorless filaments (rhizoids) that contain up to several dozen 4-5mm, star-shaped bulbils, starry stonewort typically grows in marl sediments of alkaline lakes, up to 9 meters deep. Orange reproductive structures are located in the axils of the upper branchlets. Starry stonewort is typically an annual, but can behave as a perennial during mild winters. Interestingly, starry stonewort is listed as an endangered species in the United Kingdom.

Starry stonewort has many whorls of long branchlets. Some branchlets may appear forked due to short bracts where reproductive structures are forming.

North American Distribution: Michigan, northern Indiana, and the northeastern United States. Recently found in southeastern Wisconsin.



Star-shaped bulbils are produced in the sediments, and give starry stonewort its name.

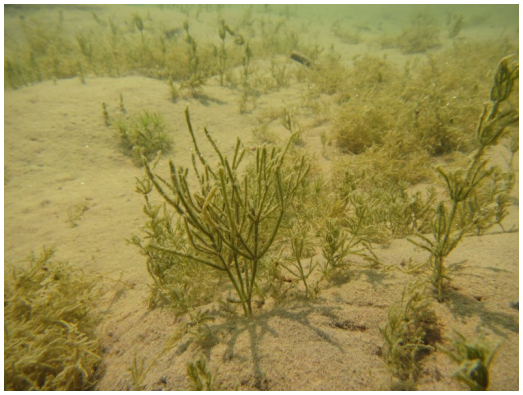
Dispersal Vectors: Starry stonewort is native to Europe and western Asia. It was probably introduced to the Great Lakes via ballast water carried in trans-oceanic ships. Fragments of starry stonewort can easily be spread between lakes by boats, trailers, and anchors holding sediments. Local dispersal occurs by bulbils or fragments being transported by water currents or boats within the lake. Since only male starry stonewort exists in the U.S., no viable "seeds" are produced.

Ecological Impacts: By forming dense mats of vegetation, starry stonewort can greatly reduce the diversity of aquatic plants in a lake. It can also impede movement of fish and other animals, and can decrease successful spawning activity. Mats growing to the surface can reduce water flow and make recreational activities difficult.

Control Options: Manual removal of starry stonewort is difficult and may be impractical on a large scale. Abundant bulbils on the rhizoids can dislodge if disturbed, and will sprout new individuals. Manual removal efforts must emphasize careful removal of these bulbils.

Some chemical herbicides and algaecides have been effective at suppressing starry stonewort. Herbicide applications may be less effective on tall stands of starry stonewort, as the chemical is quickly absorbed into the upper parts of the algae, leaving the lower parts unharmed. Most states require chemical use permits for any herbicide/algaecide treatments in standing water or wetland situations.

An effective biological control agent is not known at this time.



Starry stonewort (front, center), much more robust than the surrounding native muskgrasses (*Chara* spp.).

Additional Information:

Pullman, G. Douglas and Gary Crawford. 2010. A decade of starry stonewort in Michigan. Lakeline. 36-42.

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development Council, Inc. as part of an aquatic invasive species education program, supported by a grant from the Wisconsin Department of Natural Resources. Maintained by the Wisconsin Citizen Lake Monitoring Network.

SS-3-15

Aquatic Invasive Species Quick Guide

Water Chestnut (*Trapa natans* L.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Water chestnut is a non-native, annual aquatic plant in the Trapaceae family. It produces a floating rosette of very waxy, triangular leaves which are heavily serrated on the edges. The leaf stalk is swollen at the base to provide buoyancy. Submersed leaves are opposite and highly divided into delicate leaflets. Roots can form at any of the submersed nodes, and the plant may be found rooted to the bottom in shallow water. Flowers are 4-parted and occur at the base of the floating leaves. Fruits are hard, about one inch across, with four stiff spines. Water chestnut prefers slow, nutrient-rich waters.

North American Distribution: Along the east coast, from Virginia to Quebec.

Water chestnut forms large, floating rosettes with dozens of triangular leaves.

Submersed leaves are opposite and highly divided into many thin leaflets.

Dispersal Vectors: Native to Europe and Asia, it was introduced intentionally to several water bodies in Massachusetts. Fragments of water chestnut can be transported by boat trailers and equipment, and rosettes can float to new areas (especially in riverine systems). Water chestnut has been used in water gardens, and may escape through improper disposal of unwanted plants. Seeds remain viable for 12 years, and are probably too heavy to cling to animal fur or feathers.

Ecological Impacts: Water chestnut can rapidly cover entire bays of lakes and rivers, shading out native plants underneath, and reducing dissolved oxygen levels. The reduction in plant diversity and dissolved oxygen has serious consequences to the aquatic animal community. Large, barbed fruits are extremely sharp and can puncture feet and even shoe soles.

Control Options: Manual removal of water chestnut is highly effective. Plants are easily seen, and floating rosettes can be easily removed from the water. Care must be taken to remove all fragments of the plant, and rooted portions must be carefully removed to avoid breakage. Seeds may also fall off easily if removal is done late in the growing season. Mechanical harvesting has been effective at clearing large areas of water chestnut, but fragmentation is likely to spread water chestnut. Rooted plants will re-sprout if only the top portion is removed.

Chemical control can be successful at reducing water chestnut, and typically utilize 2,4-D or triclopyr herbicides. Several years of treatments are necessary to kill seedlings as they re-populate the area. Most states require chemical use permits for any herbicide treatments in standing water or wetland situations.

Several possible biological control agents have been studied, but none has been considered a feasible strategy for large-scale control.

Note: The water chestnut common in Asian cooking is *Eleocharis dulcis*, not *Trapa natans*.

The stalks of floating leaves are swollen with large air cells.

Additional Information:

Naylor, Mike. 2003. Water chestnut (*Trapa natans*) in the Chesapeake Bay watershed: a regional management plan. Maryland Department of Natural Resources. http://www.dnr.state.md.us/irc/docs/00016247.pdf

Poovey, A.G. and Kurt D. Getsinger. 2007. Subsurface applications of triclopyr and 2,4-D amine for control of water chestnut (Trapa natans L.). J. Aquat. Plant Manage. 45: 63-66. http://www.apms.org/japm/vol45/v45p63.pdf

Photo Credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources.

WC-1-14

Aquatic Invasive Species Quick Guide

Yellow Floating Heart (*Nymphoides peltata* (S.G. Gmel.) Kuntze)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Yellow floating heart is a perennial, rhizomatous aquatic plant in the Menyanthaceae family. It has small, heart-shaped, floating leaves. Each leaf usually has a wavy edge (margin). The flowers are held on stalks several inches above the water, with one flower per stalk. Each flower is yellow with 5 petals, and each petal has a very thin fringe surrounding it (see photo below). Fruits are green, flattened, and about 1 inch long. Seeds are flattened, gray-black, with dozens of tiny, transparent hairs.

North American Distribution: Eastern Canada, eastern U.S., Midwestern U.S., southern U.S. from Texas to California.

Yellow floating heart has small, floating leaves and yellow flowers held on long stalks.

Flowers are yellow with 5 fringed petals.

Fruits are flattened, pointed at one end, and about 1 inch long.

Dispersal Vectors: Native to Europe and Asia, yellow floating heart was introduced to North America as an ornamental plant for water gardens. Water gardeners probably released excess plants into local waterways, or the seeds may have been carried to local waters by animals. Yellow floating heart can spread by fragments of the rhizomes or stolons, and by seed. Seeds have a fringe of tiny hairs that allow the seeds to float and cling to animal fur. Nursery shipments of yellow floating heart have been found to contain seeds and fragments of additional invasive species, including Hydrilla.

Ecological Impacts: Yellow floating heart can completely cover the water's surface in shallow areas. It can choke out native vegetation and reduce a waterbody's value to wildlife. Dissolved oxygen concentrations are often reduced by thick cover of yellow floating heart, which reduces diversity of aquatic animals. Stagnant areas produced by the dense vegetation can provide ideal breeding conditions for mosquitoes.

Control Options: Many states have prohibited sale or possession of yellow floating heart due to its incredibly invasive nature. Plants or animals should never be released from aquaria or water gardens.

Manual removal is difficult, but effective. All fragments and roots of the plants must be removed. Rhizomes are incredibly strong, and lifting plants from underneath the rhizome is most effective. Manual removal of yellow floating needs to occur multiple times to remove seedlings or new sprouts. Continued monitoring of the site is essential.

Chemical control of yellow floating heart is also difficult. Even at maximum label rates, many aquatic herbicides are ineffective against this species. Its thick, waxy leaves are effective at repelling liquid herbicides. Most states require chemical use permits for any herbicide treatments in standing water or wetland situations.

A successful biological control agent is not known at this time.

Seeds are oblong, 3mm long, and surrounded by tiny, transparent hairs

Additional Information:
Global Invasive Species Database. *Nymphoides peltata*. http://plants.usda.gov/core/profile?symbol=NYPE

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources.

YFH-1-14

Aquatic Invasive Species Quick Guide

Yellow Iris (*Iris pseudacorus* L.)

Golden Sands Resource Conservation & Development Council, Inc.

Description: Yellow Iris is a non-native, perennial aquatic plant in the family Iridaceae that grows from rhizomes. Large, sword-like leaves are light-dark green, and sheath each other at the base. Several large, yellow flowers are held on a round or slightly flattened stalk. Each flower has three large, drooping sepals and three shorter petals. Plants grow in wet soil or emerge from shallow water, and reach 2-6 feet tall.

North American Distribution: Yellow Iris has been reported across most of the northern United States and Canada.

Yellow Iris produces many large, yellow flowers on a rigid stalk.

Long fruit capsules produce dozens of tan-brown, circular seeds.

Dispersal Vectors: Yellow Iris was introduced from Eurasia as an ornamental plant for water gardens and other wet sites. It spreads locally by rhizomes and by large, round seeds. Dislodged fragments of the rhizome can also produce new plants. Muskrats may transport yellow Iris short distances to build their huts, and waterfowl hunters may contribute to spread by using it in construction of hunting blinds. Yellow Iris is still sold in some nurseries and internet stores.

Ecological Impacts: Populations can spread quickly by rhizomes and seeds, crowding out valuable native plant species and decreasing plant and animal diversity. A study by Raven and Thomas in 1990 noted a large population of yellow Iris that had excluded all other vegetation, even cattails. Yellow Iris is unpalatable to wildlife and livestock due to high levels of glycosides.

Control Options: Manual removal of yellow Iris is difficult, because of its strong rhizome network. Removal of small clumps is easier in areas of soft, water-logged substrates, and these clumps should be grasped as far down the stem as possible and pulled straight up to have the best chance of removing the entire rhizome. Digging is also an option—care should be taken to get underneath the entire rhizome without breaking it, and removal of native species must be minimized. All plant material must be removed from the site and disposed of away from water bodies. Yellow Iris can cause skin irritation, so gloves should be worn when working with this species.

Yellow Iris can be controlled by glyphosate-based herbicides. Plants growing near standing water should be treated with an herbicide approved for aquatic use to minimize harm to amphibians.

Large stands of yellow Iris in shallow water of a lake.

No effective biological control agent is known at this time.

Additional Information:

Jacobs, J. et al. 2010. Ecology and management of yellowflag Iris (*Iris pseudacorus* L.). Invasive Species Technical Note No. MT-28. United States Department of Agriculture, Natural Resources Conservation Service. 6pp.

Raven, P.H. and J.H. Thomas.. 1970. *Iris pseudacorus* in western North America. Madrono. 20:390-391

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources.

YI-1-14

Aquatic Invasive Species Quick Guide

Zebra Mussel (*Dreissena polymorpha* Pallas)

Golden Sands Resource Conservation & Development Council, Inc.

Description: The zebra mussel is a small mollusk in the family Dreissenidae. It grows up to about 1.25 inches long. The shells are flat on the hinged side (D-shaped). Zebra mussels have tiny threads that anchor themselves to various firm surfaces like rocks, logs, plants, trash—even other animals. Shells are typically light brown to white, with brown-black stripes. These colors may be faint if the shells have been exposed to prolonged direct sunlight.
The related quagga mussel looks similar, but their shells are not flat on the hinged side.

Zebra mussels have D-shaped shells with brown-black stripes. 4X typical size.

North American Distribution: Zebra mussels are abundant in the Great Lakes, and are scattered in inland waters in the eastern and central United States. They have recently been introduced to the western U.S.

Zebra mussels will colonize any firm surface, even this old tennis ball.

Dispersal Vectors: Zebra mussels were first documented in Michigan's Lake St. Clair in 1988, probably arriving from the Black or Caspian Sea via ballast water of ocean-going ships. Each female can produce up to a million eggs each year, which hatch into free-floating larvae. These microscopic larvae can be transported between water bodies in live wells, bait buckets, or motors. Adult zebra mussels can also attach to plants, and can be transported by boats that aren't cleaned properly after use. Female zebra mussels can reproduce at two years old.

Ecological Impacts: Zebra mussels are filter-feeders, consuming tiny food particles that are the base of the aquatic food web. This removal of food particles results in less food available for other animals like zooplankton, native mussels, and fishes. In many cases, the clearer water caused by the zebra mussels has resulted in severe blooms of filamentous algae. These blooms washing up on shore provide ideal conditions for Clostridium botulinum, the bacteria responsible for killing birds through avian botulism. The sharp shells can cut the feet of people enjoying beaches, and can result in various infections.

Control options: Manual removal of zebra mussels is easy, but impractical due to their sheer abundance. Zebra mussels are occasionally removed from inside water intake pipes with chisels or high-pressure water jets.

No chemical control agent is known to kill zebra mussels without seriously harming other aquatic life or water quality. A 2% chlorine bleach solution is effective at killing zebra mussels when cleaning boating equipment or other gear away from waterbodies.

A bacterial formulation is currently being researched, which uses a native soil bacterium to kill zebra mussels without causing other damage to the ecosystem. This formulation is not approved for widespread use at this time.

These zebra mussels are attached to a fragment of Eurasian watermilfoil.

Additional information:
United States Geological Survey. *Dreissena polymorpha*. http://nas.er.usgs.gov//queries/FactSheet.aspx?speciesID=5

Photo credit: Paul Skawinski

Developed by Golden Sands Resource Conservation & Development (RC&D) Council, Inc. as part of an aquatic invasive species (AIS) education program, supported by an AIS grant from the Wisconsin Department of Natural Resources.

ZM-1-14