APPENDIX E

INVASIVE SPECIES PROFILES

Fact Sheet: Japanese Knotweed

Japanese Knotweed

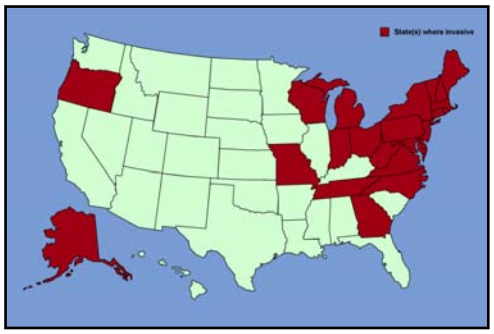
Polygonum cuspidatum Sieb. & Zucc.
Buckwheat family (Polygonaceae)

NATIVE RANGE
Eastern Asia

DESCRIPTION
Japanese knotweed is an upright, shrublike, herbaceous perennial that can grow to over 10 feet in height. As with all members of this family, the base of the stem above each joint is surrounded by a membranous sheath. Stems of Japanese knotweed are smooth, stout and swollen at joints where the leaf meets the stem. Although leaf size may vary, they are normally about 6 inches long by 3 to 4 inches wide, broadly oval to somewhat triangular and pointed at the tip. The minute greenish-white flowers occur in attractive, branched sprays in summer and are followed soon after by small winged fruits. Seeds are triangular, shiny, and very small, about 1/10 inch long.

Japanese knotweed is designated a noxious weed in the State of Washington.

ECOLOGICAL THREAT
Japanese knotweed spreads quickly to form dense thickets that exclude native vegetation and greatly alter natural ecosystems. It poses a significant threat to riparian areas, where it can survive severe floods and is able to rapidly colonize scoured shores and islands. Once established, populations are extremely persistent.



DISTRIBUTION IN THE UNITED STATES
Current distribution of Japanese knotweed includes 36 states in the lower 48 from Maine to Wisconsin south to Louisiana, and scattered midwest and western states. It is not currently known to occur in Hawaii.

HABITAT IN THE UNITED STATES
Japanese knotweed can tolerate a variety of adverse conditions including full shade, high temperatures, high salinity, and drought. It is found near water sources, such as along streams and rivers, in low-lying areas, waste places, utility rights-of-way, and around old homesites. It can quickly become an invasive pest in natural areas after escaping from cultivated gardens.

BACKGROUND
Japanese knotweed was probably introduced to the U.S. in the late 1800's. Also known as crimson beauty, Mexican bamboo, Japanese fleece flower, or Reynoutria, it was first introduced as an ornamental and has also been used for erosion control and for landscape screening. It is now found throughout the eastern U.S., in several western states, and Alaska, which has few exotic invasive plants to date.

BIOLOGY & SPREAD
Japanese knotweed spreads primarily by vegetative means with the help of its long, stout rhizomes. It is often transported to new sites as a contaminant in filldirt seeds, sometimes distributed by water, and carried to a lesser extent by the wind. Escapees from neglected gardens, and discarded cuttings are common routes of dispersal from urban areas.

MANAGEMENT OPTIONS
Grubbing is effective for small initial populations or environmentally sensitive areas where herbicides cannot be used. Using a pulaski or similar digging tool, remove the entire plant including all roots and runners. Juvenile plants can be hand pulled depending on soil conditions and root development. Any portions of the root system not removed will potentially

resprout. All plant parts (including mature fruit) should be bagged and disposed of in a trash dumpster to prevent reestablishment.

Chemical

Cut stem application
Use this method in areas where plants are established within or around non-target plants or where vines have grown into the canopy. This treatment remains effective at low temperatures as long as the ground is not frozen. Cut the stem about 2 inches above ground level. Immediately apply a 25% solution of glyphosate (e.g., Roundup®, or use Rodeo® if applying in or near wetland areas) or triclopyr (e.g., Garlon®) and water to the cross-section of the stem. A subsequent foliar application of glyphosate may be require to control new seedlings and resprouts.

Foliar application
Use this method to control large populations. It may be necessary to precede foliar applications with stump treatments to reduce the risk of damaging non-target species. Apply a 2% solution of glyphosate or triclopyr and water to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. A 0.5% non-ionic surfactant is recommended in order to penetrate the leaf cuticle, and ambient air temperature should be above 65 ºF.

USE PESTICIDES WISELY: Always read the entire pesticide label carefully, follow all mixing and application instructions and wear all recommended personal protective gear and clothing. Contact your state department of agriculture for any additional pesticide use requirements, restrictions or recommendations.

NOTICE: mention of pesticide products on this page does not constitute endorsement of any material.

CONTACT
For more information on the management of Japanese knotweed, please contact:

- Kris Johnson, Great Smoky Mountains National Park, Gatlinburg, TN
- Japanese Knotweed Alliance, http://www.cabi-bioscience.org/html/japanese_knotweed_alliance.htm
- Robert J. Richardson, Aquatic and Noncropland Weed Management, Crop Science Department, Box 7620, North Carolina State University, Raleigh, NC 27695-7620, (919) 515-5653, Rob_Richardson at ncsu.edu

SUGGESTED ALTERNATIVE PLANTS
Many attractive native herbs and shrubs are available that make excellent alternatives to Japanese knotweed. Contact the native plant society in your state for more information.

OTHER LINKS
- http://www.invasive.org/search/action.cfm?q=Polygonum%20cuspidatum
- http://www.lib.uconn.edu/webapps/ipane/browsing.cfm?descriptionid=86

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Canada Thistle

Cirsium arvense (L.) Scop.
Sunflower family (Asteraceae)

NATIVE RANGE

Temperate regions of Eurasia

DESCRIPTION

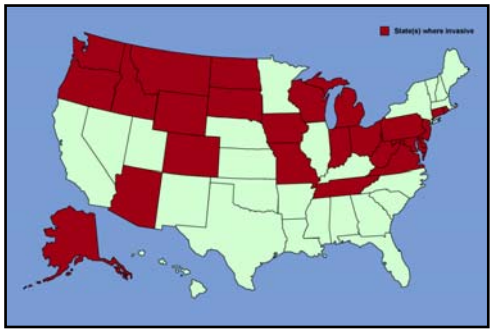
Canada thistle is an herbaceous perennial with erect stems 1½-4 feet tall, prickly leaves and an extensive creeping rootstock. Stems are branched, often slightly hairy, and ridged. Leaves are lance-shaped, irregularly lobed with spiny, toothed margins and are borne singly and alternately along the stem. Rose-purple, lavender, or sometimes white flower heads appear from June through October, generally, and occur in rounded, umbrella-shaped clusters.

The small, dry, single-seeded fruits of Canada thistle, called achenes, are 1-1½ inches long and have a feathery structure attached to the seed base. Many native species of thistle occur in the U.S., some of which are rare. Because of the possibility of confusion with native species, Canada thistle should be accurately identified before any control is attempted.

ECOLOGICAL THREAT

Natural communities that are threatened by Canada thistle include non-forested plant communities such as prairies, barrens, savannas, glades, sand dunes, fields and meadows that have been impacted by disturbance. As it establishes itself in an area, Canada thistle crowds out and replaces native plants, changes the structure and species composition of natural plant communities and reduces plant and animal diversity. This highly invasive thistle prevents the coexistence of other plant species through shading, competition for soil resources and possibly through the release of chemical toxins poisonous to other plants.

Canada thistle is declared a "noxious weed" throughout the U.S. and has long been recognized as a major agricultural pest, costing tens of millions of dollars in direct crop losses annually and additional millions costs for control. Only recently have the harmful impacts of Canada thistle to native species and natural ecosystems received notable attention.



DISTRIBUTION IN THE UNITED STATES

Canada thistle is distributed throughout the northern U.S., from northern California to Maine and southward to Virginia. It is also found in Canada, for which it was named. Canada thistle has been identified as a management problem on many national parks and on preserves of The Nature Conservancy in the upper Midwest, Plains states, and the Pacific northwest.

HABITAT IN THE UNITED STATES

Canada thistle grows in barrens, glades, meadows, prairies, fields, pastures, and waste places. It does best in disturbed upland areas but also invades wet areas with fluctuating water levels such as streambank sedge meadows and wet prairies.

BACKGROUND

Canada thistle was introduced to the United States, probably by accident, in the early 1600s and, by 1954, had been declared a noxious weed in forty three states. In Canada and the U.S., it is considered one of the most tenacious and economically important agricultural weeds, but only in recent years has it been recognized as a problem in natural areas.

BIOLOGY & SPREAD

Canada thistle produces an abundance of bristly-plumed seeds which are easily dispersed by the wind. Most of the seeds germinate within a year, but some may remain viable in the soil for up to twenty years or more. Vegetative reproduction in Canada thistle is aided by a fibrous taproot capable of sending out lateral roots as deep as 3 feet below ground, and from which shoots sprout up at frequent intervals. It also readily regenerates from root fragments less than an inch in length.

MANAGEMENT OPTIONS

Management of Canada thistle can be achieved through hand-cutting, mowing, controlled burning, and chemical means, depending on the level of infestation and the type of area being managed. Due to its perennial nature, entire plants must be killed in order to prevent regrowth from rootstock. Hand-cutting of individual plants or mowing of larger infestations should be conducted prior to seed set and must be repeated until the starch reserves in the roots are exhausted. Because early season burning of Canada thistle can stimulate its growth and flowering, controlled burns should be carried out late in the growing season for best effect.

In natural areas where Canada thistle is interspersed with desirable native plants, targeted application of a systemic herbicide such as glyphosate (e.g., Roundup® or Rodeo®), which carries plant toxins to the roots, may be effective. For extensive infestations in disturbed areas with little desirable vegetation, broad application of this type herbicide may be the most effective method. Repeated applications are usually necessary due to the long life of seeds stored in the soil.

USE PESTICIDES WISELY: Always read the entire pesticide label carefully, follow all mixing and application instructions and wear all recommended personal protective gear and clothing. Contact your state department of agriculture for any additional pesticide use requirements, restrictions or recommendations.

NOTICE: mention of pesticide products on this page does not constitute endorsement of any material.

CONTACTS

For more information on the management of Canada thistle, please contact:

- Daniel Roddy, National Park Service, Wind Cave National Park, SD; dan_roddy at nps.gov
- U.S. Geological Survey, Biological Resources Division, Flagstaff, AZ
  http://www.nbs.nau.edu/FNF/Vegetation/Exotics/Cirsium/cirsiumarvense.html

OTHER LINKS

- http://www.invasive.org/search/action.cfm?q=Cirsium%20arvense
- http://www.lib.uconn.edu/webapps/ipane/browsing.cfm?descriptionid=46

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REFERENCES

Evans, J.E. 1984. Canada thistle (*Cirsium arvense*): a literature review of management practices. Natural Areas Journal 4(2):11-21.

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Garlic Mustard

Alliaria petiolata [Bieb] Cavara & Grande
Mustard family (Brassicaceae)

NATIVE RANGE

Europe

DESCRIPTION

Garlic mustard is a cool season biennial herb with stalked, triangular to heart-shaped, coarsely toothed leaves that give off an odor of garlic when crushed. First-year plants appear as a rosette of green leaves close to the ground. Rosettes remain green through the winter and develop into mature flowering plants the following spring. Flowering plants of garlic mustard reach from 2 to 3½ feet in height and produce buttonlike clusters of small white flowers, each with four petals in the shape of a cross.

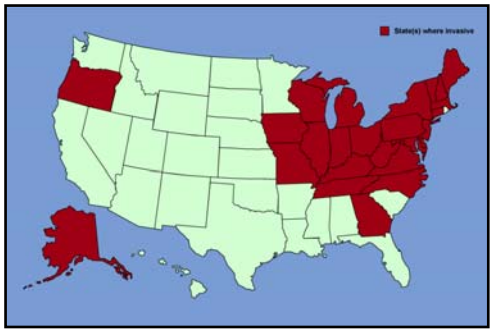
Recognition of garlic mustard is critical. Several white-flowered native plants, including toothworts (*Dentaria* spp.), sweet cicely (*Osmorhiza claytonii*), and early saxifrage (*Saxifraga virginica*), occur alongside garlic mustard and may be mistaken for it.

Beginning in May (in the mid-Atlantic Coast Plain region), seeds are produced in erect, slender pods and become shiny black when mature. By late June, when most garlic mustard plants have died, they can be recognized only by the erect stalks of dry, pale brown seedpods that remain, and may hold viable seed, through the summer.

ECOLOGICAL THREAT

Garlic mustard poses a severe threat to native plants and animals in forest communities in much of the eastern and midwestern U.S. Many native widlflowers that complete their life cycles in the springtime (e.g., spring beauty, wild ginger, bloodroot, Dutchman's breeches, hepatica, toothworts, and trilliums) occur in the same habitat as garlic mustard. Once introduced to an area, garlic mustard outcompetes native plants by aggressively monopolizing light, moisture, nutrients, soil and space. Wildlife species that depend on these early plants for their foliage, pollen, nectar, fruits, seeds and roots, are deprived of these essential food sources when garlic mustard replaces them. Humans are also deprived of the vibrant display of beautiful spring wildflowers.

Garlic mustard also poses a threat to one of our rare native insects, the West Virginia white butterfly (*Pieris virginiensis*). Several species of spring wildflowers known as "toothworts" (*Dentaria* spp.), also in the mustard family, are the primary food source for the caterpillar stage of this butterfly. Invasions of garlic mustard are causing local extirpations of the toothworts, and chemicals in garlic mustard appear to be toxic to the eggs of the butterfly, as evidenced by their failure to hatch when laid on garlic mustard plants.



DISTRIBUTION IN THE UNITED STATES

Garlic mustard ranges from eastern Canada, south to Virginia and as far west as Kansas and Nebraska.

HABITAT IN THE UNITED STATES

Garlic mustard frequently occurs in moist, shaded soil of river floodplains, forests, roadsides, edges of woods and trails edges and forest openings. Disturbed areas are most susceptible to rapid invasion and dominance. Though invasive under a wide range of light and soil conditions, garlic mustard is associated with calcareous soils and does not tolerate high acidity. Growing

season inundation may limit invasion of garlic mustard to some extent.

BACKGROUND
Garlic mustard was first recorded in the United States about 1868, from Long Island, New York. It was likely introduced by settlers for food or medicinal purposes.

BIOLOGY & SPREAD
After spending the first half of its two-year life cycle as a rosette of leaves, garlic mustard plants develop rapidly the following spring into mature plants that flower, produce seed and die by late June. In the mid-Atlantic Coastal Plain region, seeds are produced in erect, slender, four-sided pods, called siliques, beginning in May. Siliques become tan and papery as they mature and contain shiny black seeds in a row. By late June, most of the leaves have faded away and garlic mustard plants can be recognized only by the dead and dying stalks of dry, pale brown seedpods that may remain and hold viable seed throughout the summer.

A single plant can produce thousands of seeds, which scatter as much as several meters from the parent plant. Depending upon conditions, garlic mustard flowers either self-fertilize or are cross-pollinated by a variety of insects. Self-fertilized seed is genetically identical to the parent plant, enhancing its ability to colonize an area. Although water may transport seeds of garlic mustard, they do not float well and are probably not carried far by wind. Long distance dispersal is most likely aided by human activities and wildlife. Additionally, because white-tailed deer prefer native plants to garlic mustard, large deer populations may help to expand it by removing competing native plants and exposing the soil and seedbed through trampling.

MANAGEMENT OPTIONS
Because the seeds of garlic can remain viable in the soil for five years or more, effective management requires a long term commitment. The goal is to prevent seed production until the stored seed is exhausted. Hand removal of plants is possible for light infestations and when desirable native species co-occur. Care must be taken to remove the plant with its entire root system because new plants can sprout from root fragments. This is best achieved when the soil is moist, by grasping low and firmly on the plant and tugging gently until the main root loosens from the soil and the entire plant pulls out. Pulled plants should be removed from site if at all possible, especially if flowers are present.

Mechanical
For larger infestations of garlic mustard, or when hand-pulling is not practical, flowering stems can be cut at ground level or within several inches of the ground, to prevent seed production. If stems are cut too high, the plant may produce additional flowers at leaf axils. Once seedpods are present, but before the seeds have matured or scattered, the stalks can be clipped, bagged and removed from the site to help prevent continued buildup of seed stores. This can be done through much of the summer.

Chemical
For very heavy infestations, where the risk to desirable plant species is minimal, application of the systemic herbicide glyphosate (e.g., Roundup®) is also effective. Herbicide may be applied at any time of year, including winter (to kill overwintering rosettes), as long as the temperature is above 50 degrees F and rain is not expected for about 8 hours. Extreme care must be taken not to get glyphosate on desirable plants as the product is non-selective and will kill almost any plant it contacts. Spray shields may be used to better direct herbicide and limit non-intentional drift.

Fire
Fire has been used to control garlic mustard in some large natural settings but, because burning opens the understory, it can encourage germination of stored seeds and promote growth of emerging garlic mustard seedlings. For this reason,

burns must be conducted for three to five consecutive years. Regardless of the control method employed, annual monitoring is necessary for a period of at least five years to ensure that seed stores of garlic mustard have been exhausted.

Biological
Researchers are investigating potential biological control agents for garlic mustard which may greatly improve the control of this insidious weed.

USE PESTICIDES WISELY: Always read the entire pesticide label carefully, follow all mixing and application instructions and wear all recommended personal protective gear and clothing. Contact your state department of agriculture for any additional pesticide use requirements, restrictions or recommendations.

NOTICE: mention of pesticide products on this page does not constitute endorsement of any material.

CONTACTS
For more information on the management of garlic mustard, please contact:

- Cornell University, Biological Control of Weeds--Garlic Mustard; http://www.invasiveplants.net
- Tennessee Exotic Pest Plant Council; http://www.se-eppc.org/states/tennessee.cfm
- Victoria Nuzzo, Cornell University, Ithaca, NY (vnuzzo @ earthlink.net)
- Virginia Natural Heritage Program Fact Sheet--Garlic Mustard; http://www.state.va.us/~dcr/dnh/invallia.htm

OTHER LINKS
- http://www.invasive.org/search/action.cfm?q=Alliaria%20petiolata
- http://www.lib.uconn.edu/webapps/ipane/browsing.cfm?descriptionid=15

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FACT SHEET: GIANT REED

Giant Reed

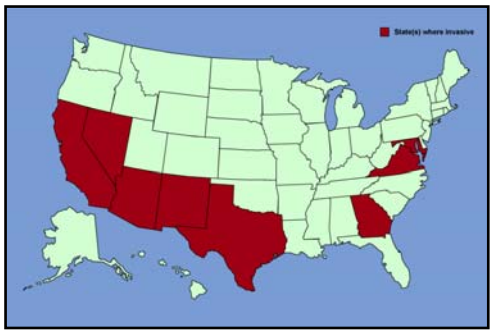
Arundo donax L.
Grass family (Poaceae)

NATIVE RANGE
India

DESCRIPTION
Giant reed, also known as wild cane, is a tall, perennial grass that can grow to over 20 feet in height. Its fleshy, creeping rootstocks form compact masses from which tough, fibrous roots emerge that penetrate deeply into the soil. Leaves are elongate, 1-2 inches wide and a foot long. The flowers are borne in 2-foot long, dense, plume-like panicles during August and September.

ECOLOGICAL THREAT
Giant reed chokes riversides and stream channels, crowds out native plants, interferes with flood control, increases fire potential, and reduces habitat for wildlife, including the Least Bell's vireo, a federally endangered bird. The long, fibrous, interconnecting root mats of giant reed form a framework for debris dams behind bridges, culverts, and other structures that lead to damage. It ignites easily and can create intense fires.

Giant reed can float miles downstream where root and stem fragments may take root and initiate new infestations. Due to its rapid growth rate and vegetative reproduction, it is able to quickly invade new areas and form pure stands at the expense of other species. Once established, giant reed has the ability to outcompete and completely suppress native vegetation.



DISTRIBUTION IN THE UNITED STATES
Giant reed is distributed from Arkansas and Texas to California, where it is found throughout the state, and in the east, from Virginia to Kentucky and Missouri and generally southward.

HABITAT IN THE UNITED STATES
Giant reed becomes established in moist places such as ditches, streams, and riverbanks, growing best in well drained soils where abundant moisture is available. It tolerates a wide variety of conditions, including high salinity, and can flourish in many soil types from heavy clays to loose sands.

BACKGROUND
Giant reed was probably first introduced into the United States at Los Angeles, California in the early 1800's. Since then, it has become widely dispersed into all of the subtropical and warm temperate areas of the world, mostly through intentional human introductions. Today, giant reed is widely planted throughout the warmer areas of the United States as an ornamental and in the Southwest, where it is used along ditches for erosion control.

Giant reed has a variety of uses ranging from music to medicine. Primitive pipe organs were made from it and the reeds for woodwind instruments are still made from its culms, for which no satisfactory substitutes are known. It is also used in basketry, for fishing rods, livestock fodder, medicine, and soil erosion control.

BIOLOGY & SPREAD
Reproduction of giant reed is primarily vegetative, through rhizomes which root and sprout readily. Little is known about the importance of sexual reproduction in giant reed, or about its seed viability, dormancy, and germination, and seedling establishment. Research on these topics may yield some additional improvements in the management of giant reed.

MANAGEMENT OPTIONS

Areas infested with giant reed are best restored through chemical means. Mechanical control (e.g., repeated mowing) may be somewhat effective, but if small fragments of root are left in the soil, they may lead to reestablishment.

Chemical

Systemic herbicides, such as glyphosate (e.g., Rodeo®), may be applied clumps of giant reed, after flowering, either as a cut stump treatment or as a foliar spray. When applying herbicides in or around water or wetlands, be sure to use products labeled for that purpose to avoid harm to aquatic organisms.

Fire

Prescribed burning, either alone or combined with herbicide applications, may be effective if conducted after flowering.

Once giant reed has been reduced sufficiently, native plants may be seeded or transplanted at the treated site.

USE PESTICIDES WISELY: Always read the entire pesticide label carefully, follow all mixing and application instructions and wear all recommended personal protective gear and clothing. Contact your state department of agriculture for any additional pesticide use requirements, restrictions or recommendations.

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CONTACTS

For more information on the management of giant reed, please contact:

- Team Arundo del Norte; http://www.ceres.ca.gov/tadn
- Tom Dudley; tdudley at socrates.berkeley.edu

SUGGESTED ALTERNATIVE PLANTS

Native plant species that are adapted to local conditions should be used in restoration projects and as a substitute for giant reed in landscapes and erosion control practices.

OTHER LINKS

- http://www.invasive.org/search/action.cfm?q=Arundo%20donax
- http://www.hear.org/starr/hiplants/images/thumbnails/html/arundo_donax.htm

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Tidwell, B. 1995. Native Habitat Restoration: Controlling *Arundo donax*. Monsanto Company.

Fact Sheet: Multiflora Rose

Multiflora Rose

Rosa multiflora Thunb.
Rose family (Rosaceae)

NATIVE RANGE

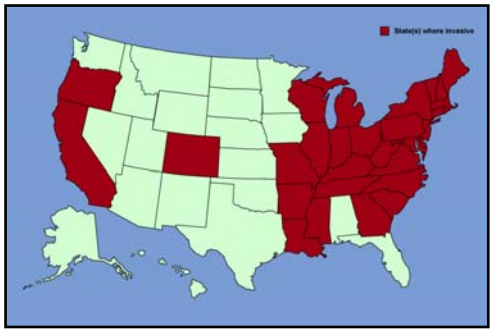
Japan, Korea, and eastern China

DESCRIPTION

Multiflora rose is a thorny, perennial shrub with arching stems (canes), and leaves divided into five to eleven sharply toothed leaflets. The base of each leaf stalk bears a pair of fringed bracts. Beginning in May or June, clusters of showy, fragrant, white to pink flowers appear, each about an inch across. Small bright red fruits, or rose hips, develop during the summer, becoming leathery, and remain on the plant through the winter.

ECOLOGICAL THREAT

Multiflora rose is extremely prolific and can form impenetrable thickets that exclude native plant species. This exotic rose readily invades open woodlands, forest edges, successional fields, savannas and prairies that have been subjected to land disturbance.



DISTRIBUTION IN THE UNITED STATES

Multiflora rose occurs throughout the U.S., with the exception of the Rocky Mountains, the southeastern Coastal Plain and the deserts of California and Nevada.

HABITAT IN THE UNITED STATES

Multiflora rose has a wide tolerance for various soil, moisture, and light conditions. It occurs in dense woods, prairies, along stream banks and roadsides and in open fields and pastures.

BACKGROUND

Multiflora rose was introduced to the East Coast from Japan in 1866 as rootstock for ornamental roses. Beginning in the 1930s, the U.S. Soil Conservation Service promoted it for use in erosion control and as "living fences" to confine livestock. State conservation departments soon discovered value in multiflora rose as wildlife cover for pheasant, bobwhite quail, and cottontail rabbit and as food for songbirds and encouraged its use by distributing rooted cuttings to landowners free of charge. More recently, multiflora rose has been planted in highway median strips to serve as crash barriers and to reduce automobile headlight glare. Its tenacious and unstoppable growth habit was eventually recognized as a problem on pastures and unplowed lands, where it disrupted cattle grazing. For these reasons, multiflora rose is classified as a noxious weed in several states, including Iowa, Ohio, West Virginia, and New Jersey.

BIOLOGY & SPREAD

Multiflora rose reproduces by seed and by forming new plants that root from the tips of arching canes that contact the ground. Fruits are readily sought after by birds which are the primary dispersers of its seed. It has been estimated that an average multiflora rose plant may produce a million seeds per year, which may remain viable in the soil for up to twenty years. Germination of multiflora rose seeds is enhanced by passing through the digestive tract of birds.

Plant Conservation Alliance's Alien Plant Working Group
Weeds Gone Wild: Alien Plant Invaders of Natural Areas
http://www.nps.gov/plants/alien/

MANAGEMENT OPTIONS

Mechanical and chemical methods are currently the most widely used methods for managing multiflora rose. Frequent, repeated cutting or mowing at the rate of three to six times per growing season, for two to four years, has been shown to be effective in achieving high mortality of multiflora rose. In high quality natural communities, cutting of individual plants is preferred to site mowing to minimize habitat disturbance. Various herbicides have been used successfully in controlling multiflora rose but, because of the long-lived stores of seed in the soil, follow-up treatments are likely to be necessary. Application of systemic herbicides (e.g., glyphosate) to freshly cut stumps or to regrowth may be the most effective methods, especially if conducted late in the growing season. Plant growth regulators have been used to control the spread of multiflora rose by preventing fruit set.

Biological

Biological control is not yet available for management of multiflora rose. However, researchers are investigating several options, including a native viral pathogen (rose-rosette disease), which is spread by a tiny native mite, and a seed-infesting wasp, the European rose chalcid. Rose-rosette disease, native to the western U.S., has been spreading easterwardly at a slow pace and is thought to hold the potential for eliminating multiflora rose in areas where it grows in dense patches. An important drawback to both the rose rosette fungus and the European rose chalcid is their potential impact to other rose species and cultivars.

USE PESTICIDES WISELY: Always read the entire pesticide label carefully, follow all mixing and application instructions and wear all recommended personal protective gear and clothing. Contact your state department of agriculture for any additional pesticide use requirements, restrictions or recommendations.

NOTICE: mention of pesticide products on this page does not constitute endorsement of any material.

CONTACTS

For more information on multiflora rose management, please contact:

- Robert J. Richardson, Aquatic and Noncropland Weed Management, Crop Science Department, Box 7620, North Carolina State University, Raleigh, NC 27695-7620, (919) 515-5653, Rob_Richardson at ncsu.edu

SUGGESTED ALTERNATIVE PLANTS

Using native shrubs and trees for land restoration and landscaping purposes is one way to prevent invasions by multiflora rose.

OTHER LINKS

- http://www.invasive.org/search/action.cfm?q=Rosa%20multiflora
- http://www.lib.uconn.edu/webapps/ipane/browsing.cfm?descriptionid=29

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Japanese Stiltgrass

Microstegium vimineum (Trin.) Camus
Grass family (Poaceae)

NATIVE RANGE

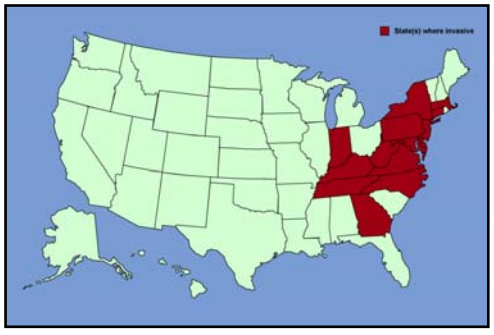
Japan, Korea, China, Malaysia and India

DESCRIPTION

Japanese stiltgrass, or Nepalese browntop, is an annual grass with a sprawling habit. It germinates in spring and grows slowly through the summer months, ultimately reaching heights of 2 to 3½ ft. The leaves are pale green, lance-shaped, asymmetrical, 1 to 3 in. long, and have a distinctive shiny midrib. Slender stalks of tiny flowers are produced in late summer (August through September-early October) and dry fruits called achenes are produced soon afterwards.

ECOLOGICAL THREAT

Japanese stiltgrass is especially well adapted to low light conditions. It threatens native plants and natural habitats in open to shady, and moist to dry locations. Stiltgrass spreads to form extensive patches, displacing native species that are not able to compete with it. Where white-tail deer are over-abundant, they may facilitate its invasion by feeding on native plant species and avoiding stiltgrass. Japanese stiltgrass may impact other plants by changing soil chemistry and shading other plants. The interaction between stiltgrass and the Northern Pearly Eye (*Enodia anthedon*), a member of the brush-footed butterfly family Nymphalidae, is unclear. This butterfly is rare to uncommon along the Potomac River in the Washington, DC area. Its caterpillar eats grasses. Dr. Robert Robbins, a Smithsonian entomologist and butterfly specialist takes weekly walks at Great Falls, Maryland, and made the following observations. The Northern Pearly Eye occurs uncommonly at Great Falls from May to October (maybe 2-15 individuals seen over the entire flight period). Adults were especially common during the summer of 2004. The butterfly became exceedingly common during the summer of 2005 when about 20 adults were seen during a 2 hour walk, especially in the vicinity of stiltgrass, on which a female was observed placing an egg. In May 2006, the butterfly was again common, but the population then crashed, and only 2-3 individuals were seen from June to October 2006. Further investigation is needed to study the potential impacts of stiltgrass on this and possibly other butterflies or other insects that utilize stiltgrass as an alternative host plant.



DISTRIBUTION IN THE UNITED STATES

The current distribution of Japanese stiltgrass includes 25 eastern states and it has been reported to be invasive in natural areas in 15 of these (Connecticut, Delaware, Georgia, Indiana, Kentucky, Maryland, Massachusetts, New Jersey, New York, North Carolina, Pennsylvania, Tennessee, Virginia, West Virginia) and Washington, D.C.

HABITAT IN THE UNITED STATES

Stiltgrass occurs in a wide variety of habitats including moist ground of open woods, floodplain forests, wetlands, uplands, fields, thickets, paths, clearings, roadsides, ditches, utility corridors, and gardens. It readily invades areas subject to regular mowing, tilling, foot traffic, and other soil disturbing activities as well as natural disturbances such as the scouring associated with flooding. Stiltgrass appears to prefer moist, acidic to neutral soils that are high in nitrogen.

BACKGROUND

First documented in Tennessee around 1919, stiltgrass may have accidentally escaped as a result of its use as a packing material for porcelain.

BIOLOGY & SPREAD

Japanese stiltgrass is an annual grass, with all plants dying each fall. It is a colonial species that spreads during the summer and fall by rooting at stem nodes that touch the ground. Individual plants may produce 100 to 1,000 seeds that fall close to the parent plant from both self-fertilizing and cross-fertilizing flowers. Seed may be carried further by water currents during heavy rains or moved in contaminated hay, soil, or potted plants, and on footwear and vehicles. Stiltgrass seed remains viable in the soil for five or more years and germinates readily. Deer and other grazers reportedly do not browse it, though they have been found to spread the seeds. Stiltgrass leaves a thick layer of thatch after dieback each year in heavily invaded areas, and while leaves decompose quickly, stems do not. Like other invasive species, stiltgrass is physiologically adaptive. For example, it is able to withstand low light levels where nutrient levels are sufficient, and able to withstand low nutrient levels where light levels are sufficient. While stiltgrass can photosynthesize in low light conditions and respond quickly to the changing light conditions typically found on the forest floor, the very low light conditions found beneath a multilayered forest canopy will limit its growth.

MANAGEMENT OPTIONS

A variety of control methods are available for stiltgrass, depending on the extent of the infestation, the type of habitat, and the availability of labor and other resources. Preventing the introduction of stiltgrass from infested to non-infested areas should be a priority. Early control of new infestations will also reduce the likelihood of establishment.

Biological

No biological controls are currently available for this plant.

Chemical

For extensive stiltgrass infestations, use of a systemic herbicide such as glyphosate (e.g., Roundup Pro®) is a practical and effective method. Roundup Pro® is surfactant-loaded (no additional surfactant needed) and the surfactant is not lethal to amphibians and aquatic invertebrates like the polyoxyethyleneamine surfactant in Roundup Classic® is. Roundup Pro® carries the 'Caution' signal word while Roundup Classic® carries 'Warning'. Herbicide use avoids disturbance to soil which can result in additional germination of stiltgrass seed. When treating stiltgrass in wetland sites, use Rodeo® or other formulation labeled for wetlands.

Apply a 2% solution of Roundup® or Rodeo® mixed with water (8 oz. per 3 gals. mix) and a surfactant in late summer. Be careful to avoid application to non-target plants. Glyphosate is a non-specific herbicide that will kill or damage almost any herbaceous plant and possibly some woody plants it contacts. Some researchers have also found success using pre-emergent herbicides like imazapyr (e.g., Plateau® for government use only, or Journey® for all other applicators) which is very effective against stiltgrass when applied in March in the Mid-Atlantic states. The best rate for maximum selectivity is 4 oz. per acre, applied as a broadcast application with backpack sprayers. Sprayers should be fitted with an 8003E flat fan nozzle and calibrated at 15 to 20 gpa. Plateau® and Journey® can be applied continually through germination of the stiltgrass and throughout the summer during its peak growth. No surfactant is necessary for pre-emergent applications. As germination nears, begin to add 1/4% non-ionic surfactant to the mixture.

Another option that may be appropriate for certain situations is to apply a pre-emergent (only) treatment with Pendulum® Aquacap™ at 2.4 qts. to 4.8 qts. per acre (15 to 20 gpa). The higher rates have provided season long control.

Note: Calibration of spray equipment will ensure that the correct rate of herbicide mix is actually applied to the plants. Actual rate of application can vary widely based on different skills and techniques of applicators. These differences can lead to under-application or over-application of herbicide mix which can affect the efficacy of the treatment. For this reason, it is important to calibrate spray equipment before conducting herbicide applications.

Manual
Stiltgrass is a shallow-rooted annual that can be pulled by hand throughout the growing season, especially when the soil is moist and entire plants with roots can be removed. Pulling is easier and probably more effective in mid-to-late summer when the plants are much taller and more branched. At this stage, entire plants can be easily removed by grabbing the basal portion of a plant and pulling firmly. In short time, a fair amount of stiltgrass can be pulled and piled up to dehydrate on site. If plants are already in the fruiting stage, they should be bagged and disposed of offsite to prevent dispersal of seed. Also, try to avoid pulling native grasses like Virginia cutgrass (*Leersia virginia*) that often grow intermingled with stiltgrass and may be difficult to distinguish from it. Because hand pulling plants disturbs the soil and may expose stiltgrass seed from previous seasons, late season pulling will avoid the likelihood of seed germination. Hand pulling of plants will need to repeated and continued for many seasons until the seed bank is exhausted.

Mechanical
Stiltgrass can be mowed in late summer (i.e., August through September) when the plants are flowering but preferably before seed is produced. This can be done using a lawn mower or "Weed Whacker" type machine or a scythe. Because stiltgrass is primarily an annual plant, cutting late in the season before the plants would die back naturally avoids the possibility of regrowth. Recent information suggests that stiltgrass plants that are cut early in the summer respond by regrowing and flowering soon after cutting, much earlier than they would normally flower. This is another reason to consider cutting in late summer to fall rather than during the early summer months.

USE PESTICIDES WISELY: Always read the entire pesticide label carefully, follow all mixing and application instructions and wear all recommended personal protective gear and clothing. Contact your state department of agriculture for any additional pesticide use requirements, restrictions or recommendations.

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CONTACT
For more information on the management of Japanese stiltgrass, please contact:

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- Fred Yelverton, Box 7620, NCSU Campus Raleigh, NC; (919) 515-5639; Fred_Yelverton at ncsu.edu

OTHER LINKS
- http://www.invasive.org/search/action.cfm?q=Microstegium%20vimineum
- http://www.lib.uconn.edu/webapps/ipane/browsing.cfm?descriptionid=12

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Purple Loosestrife

Lythrum salicaria L.
Loosestrife family (Lythraceae)

NATIVE RANGE

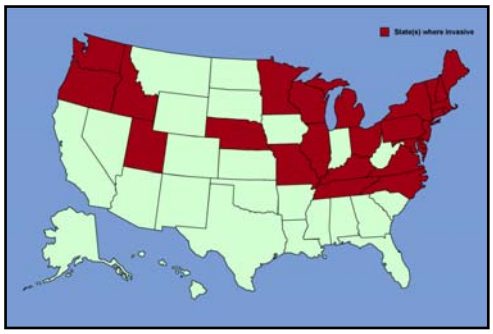
Eurasia; throughout Great Britain, and across central and southern Europe to central Russia, Japan, Manchuria China, southeast Asia and northern India

DESCRIPTION

Purple loosestrife is an erect perennial herb in the loosestrife family, with a square, woody stem and opposite or whorled leaves. Leaves are lance-shaped, stalkless, and heart-shaped or rounded at the base. Plants are usually covered by a downy pubescence. Loosestrife plants grow from four to ten feet high, depending upon conditions, and produce a showy display of magenta-colored flower spikes throughout much of the summer. Flowers have five to seven petals. Mature plants can have from 30 to 50 stems arising from a single rootstock.

ECOLOGICAL THREAT

Purple loosestrife adapts readily to natural and disturbed wetlands. As it establishes and expands, it outcompetes and replaces native grasses, sedges, and other flowering plants that provide a higher quality source of nutrition for wildlife. The highly invasive nature of purple loosestrife allows it to form dense, homogeneous stands that restrict native wetland plant species, including some federally endangered orchids, and reduce habitat for waterfowl.



DISTRIBUTION IN THE UNITED STATES

According to the U.S. Fish and Wildlife Service, purple loosestrife now occurs in every state except Florida.

HABITAT IN THE UNITED STATES

Purple loosestrife is capable of invading many wetland types, including freshwater wet meadows, tidal and non-tidal marshes, river and stream banks, pond edges, reservoirs, and ditches.

BACKGROUND

Purple loosestrife was introduced to the northeastern U.S. and Canada in the 1800s, for ornamental and medicinal uses. It is still widely sold as an ornamental, except in states such as Minnesota, Wisconsin, and Illinois where regulations now prohibit its sale, purchase and distribution.

BIOLOGY & SPREAD

Purple loosestrife enjoys an extended flowering season, generally from June to September, which allows it to produce vast quantities of seed. The flowers require pollination by insects, for which it supplies an abundant source of nectar. A mature plant may have as many as thirty flowering stems capable of producing an estimated two to three million, minute seeds per year.

Purple loosestrife also readily reproduces vegetatively through underground stems at a rate of about one foot per year. Many new stems may emerge vegetatively from a single rootstock of the previous year. "Guaranteed sterile" cultivars of purple loosestrife are actually highly fertile and able to cross freely with purple loosestrife and with other native Lythrum species. Therefore, outside of its native range, purple loosestrife of any form should be avoided.

MANAGEMENT OPTIONS

Small infestations of young purple loosestrife plants may be pulled by hand, preferably before seed set. For older plants, spot treating with a glyphosate type herbicide (e.g., Rodeo® for wetlands, Roundup® for uplands) is recommended. These herbicides may be most effective when applied late in the season when plant are preparing for dormancy. However, it may be best to do a mid-summer and a late season treatment, to reduce the amount of seed produced.

Biological

While herbicides and hand removal may be useful for controlling individual plants or small populations, biological control is seen as the most likely candidate for effective long term control of large infestations of purple loosestrife. As of 1997, three insect species from Europe have been approved by the U.S. Department of Agriculture for use as biological control agents. These plant-eating insects include a root-mining weevil (*Hylobius transversovittatus*), and two leaf-feeding beetles (*Galerucella calmariensis* and *Galerucella pusilla*). Two flower-feeding beetles (*Nanophyes*) that feed on various parts of purple loosestrife plants are still under investigation. Galerucella and Hylobius have been released experimentally in natural areas in 16 northern states, from Oregon to New York. Although these beetles have been observed occasionally feeding on native plant species, their potential impact to non-target species is considered to be low.

USE PESTICIDES WISELY: Always read the entire pesticide label carefully, follow all mixing and application instructions and wear all recommended personal protective gear and clothing. Contact your state department of agriculture for any additional pesticide use requirements, restrictions or recommendations.

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CONTACTS

For more information on the management of purple loosestrife, please contact:

- Cornell University Non-indigenous Plant Species Program, http://www.invasiveplants.net
- Virginia Natural Heritage Program. http://www.dcr.virginia.gov/dnh/invinfo.htm

SUGGESTED ALTERNATIVE PLANTS

Native species of Liatris (blazing star) have showy pink-purple flower spikes and are an important nectar source for many native species of butterflies and other insects.

OTHER LINKS

- http://www.invasive.org/search/action.cfm?q=Lythrum%20salicaria
- http://www.lib.uconn.edu/webapps/ipane/browsing.cfm?descriptionid=72

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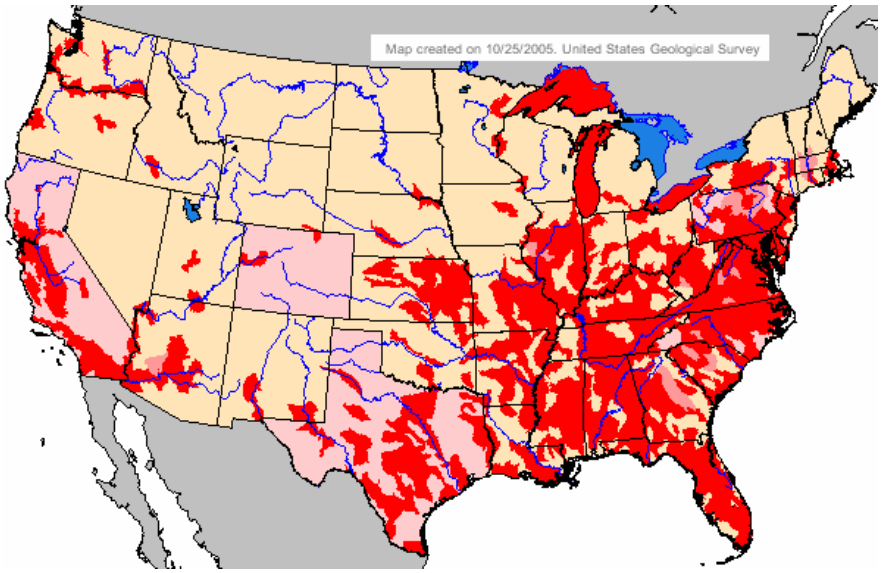
ASIATIC CLAM

COMMON NAME: Asiatic Clam, Asian Clam, or Corbicula

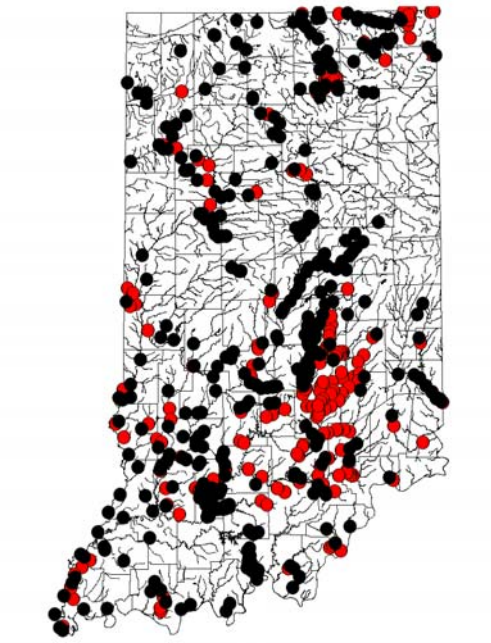
SCIENTIFIC NAME: *Corbicula fluminea*

DISTRIBUTION: The Asian clam is indigenous in temperate to tropical southern Asia and east to the Mediterranean, southeast Asian islands, eastern and central Australia, and Africa, except in the Sahara desert. Since being discovered in the United States in 1924, this species has now spread to 40 U.S. states and the District of Columbia. Asiatic clam is well established in Indiana.



DESCRIPTION: This freshwater bivalve mollusk with distinct concentric rows of elevated ridges on the shells. The shell is rounded to slightly triangular. The exterior is

usually brown in color but can vary to a yellowish-gold. The nacre, or interior of the shell, is usually white to light purple. The average adult size is rarely larger than 1.5 inches.



LIFE CYCLE BIOLOGY: *Corbicula fluminea* prefers sand or gravel substrates in areas with running water. These filter feeders can be found at sediment surface or slightly buried beneath. A tubelike siphon draws water, food, and dissolved oxygen into the body and a second exhalent siphon expels water and wastes. This small clam moves by means of a strong muscular foot. The Asiatic clam has the ability to secrete a mucous thread from within the gills; this thread performs like a dragline, catching the current which pulls the clam off the bottom to allow it to float downstream. Robert S. Prezant of the University of Southern Mississippi reports this to be the first clam to have such a "booster thread."

This species of clam is hermaphroditic, meaning that an individual produces both eggs and sperm, and is capable of self-fertilization. While self-fertilization occurs, they will also release sperm into the water that can be captured by other clams for fertilization of eggs. One small clam can produce as many as 400 larvae per day or up to 70,000 per year! The Asian clam can reach densities of 10,000 to 20,000 clams per square meter in a very short time.

Asiatic clams do not do well in water temperatures below 36^{o} F (2^{o} C). This explains the sparse distribution along the northern tier of the United States. Reproduction generally occurs in water temperatures above 61^{o} F (16^{o} C). This species can live in slightly brackish water (salinity up to 13ppt) but is viewed as a freshwater species.

PATHWAYS/HISTORY: The first record of *Corbicula fluminea* in the United States was documented in 1924 on the west coast, and it was discovered later in the Columbia River in Washington in 1937. This species was thought to enter the U.S. as a food item by Chinese immigrants. By the 1970s, the Asian clam had found its way into most of the Mississippi Basin, the Gulf Coast and on the east coast. By 1990, this species was recorded in New Jersey, Delaware, New York and Connecticut.

DISPERSAL/SPREAD: The primary means of dispersion of the Asiatic clam is through human transport, by way of water transfer through recreational activities, accidental transfer with imported aquaculture, and intentional introduction to provide a food item. Corbicula is occasionally sold for use in aquariums or water gardens. Passive movement via water currents is also a considerable means of distribution.

RISKS/IMPACTS: The most significant impact of the Asian clams' introduction has been biofouling. Biofouling is the impairment or degradation of something as a result of the growth or activity of living organisms. Power plants, drinking water treatment systems, and other industries who withdraw water have suffered in areas where the clams reach high densities resulting in the shells clogging and reducing the volume of water withdrawn from a body of water. The Asian clam also has been shown to cause problems in the pipes and canals of irrigation systems. Like most invasive species, this clam competes with native species for limited resources.

MANAGEMENT/PREVENTION: The use of screens and traps to "filter" out these adult clams from water systems is a means of mechanical control. Hot water can be injected into pipes containing Asian clams to kill the individuals. Chemicals, such as chlorine and bromine, have been proven to effectively kill juveniles and adults, however many environmental agencies have regulations restricting the use of these chemicals. Some states have regulations prohibiting the import, transport or possession of this species in order to attempt to control its numbers and limit the spread. In Indiana, it is illegal to possess a live Asiatic Clam (312 IAC 9-9-3).

By learning about the Asian clam and educating yourself on the ecological and economical impacts is a start to help stop their spread. You can also help by practicing a few good techniques for stopping the spread of any aquatic invasive species.

- ✓ Never empty your bait bucket into a different body of water from where you obtained your bait. Dispose of unused bait in the trash
- ✓ Never transfer live fish from one body of water to another.
- ✓ Remove all plant fragments and rinse any mud or debris from equipment and wading gear before leaving the access area.
- ✓ Drain all water from your boat before leaving the launch site.

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