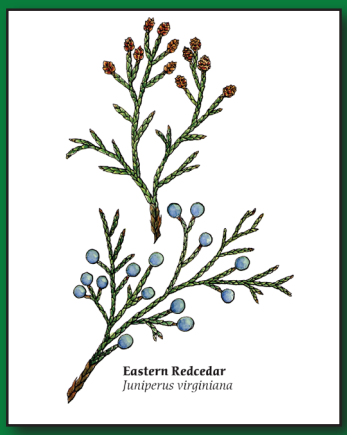
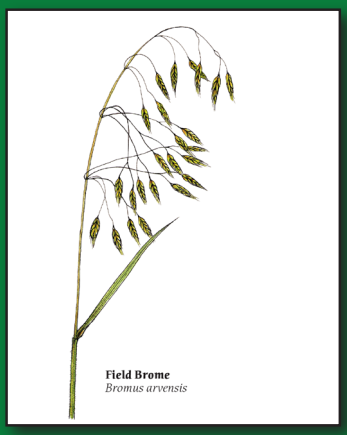
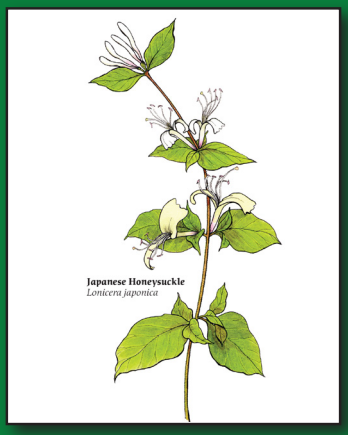
E-1050

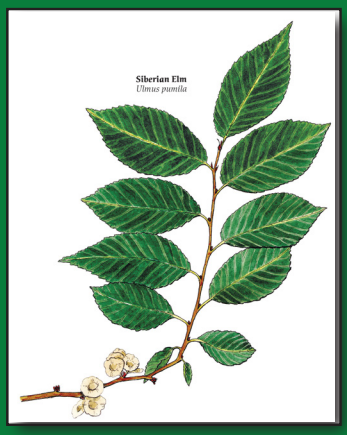
Oklahoma's Dirty Dozen

Unwanted Invasive Plants









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The Oklahoma Invasive Plant Council developed an educational poster to illustrate invasive species that are found throughout the state and cause harm both economically and ecologically. Invasive plants, such as these, have been either intentionally or accidentally introduced into the state. In many instances, knowledge concerning the invasive qualities of these 13 plants was not well understood until the plants were widespread and well established. Most of these species will never be eradicated from these established populations, but early identification of their presence in non-invaded areas could help prevent their spread and successful establishment.

Students in the Ecology of Invasive Species class at Oklahoma State University contributed descriptions of each species, their history of invasion, their community and ecosystem level effects following invasion, as well as a brief overview of potential control methods. This circular is not intended to provide complete instructions on control of these invasive species. Additional information can be obtained by contacting OSU County Extension Educators or the authors

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President for Agricultural Programs and has been prepared and distributed at a cost of $2.00 per copy. 1118 GH.

Lonicera japonica Thunb.

Common Name: Japanese honeysuckle

Origin

Eastern Asia

History of Invasion

Japanese honeysuckle was first introduced to the U.S. in New York in 1806 by William Kerr, a collector for Kew Gardens. The plant was widely used as an ornamental and was also planted for wildlife cover, white-tailed deer and cattle forage and erosion control. Its fragrant flowers provide a tiny drop of honey-flavored nectar enjoyed by children and insects.

Species Description

Japanese honeysuckle is a nonnative perennial vine. The plant grows rapidly and has the ability to re-sprout from cut stems. Stems are typically 0.4 to 2 inches in diameter. At maturity, the vines can reach lengths of 18 feet. It is often evergreen in southeastern parts of North America and becomes increasingly deciduous further north. Japanese honeysuckle is monoecious, meaning both male and female parts are present on the same plant. Leaves are typically 1 to 2.5 inches long, oval and opposite. Flowers of Japanese honeysuckle are fragrant, asymmetric, tubular and 0.6 to 2 inches long. The flowers can be found in white, pink or pale yellow colors. The fruits are berries about 0.16 to 0.24 inches in diameter with two to three seeds per berry.

Population Level Traits Promoting Invasion

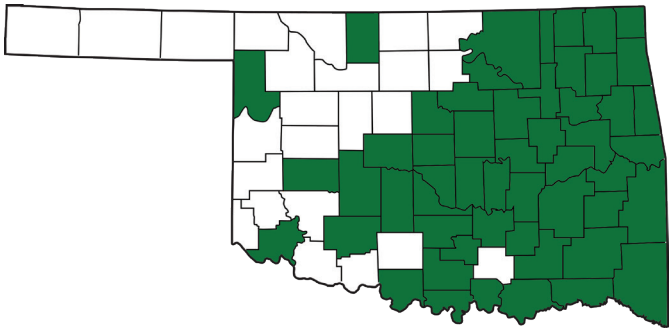
Japanese honeysuckle spreads by both sexual reproduction, by producing flowers and seeds, and vegetative reproduction. Birds and small mammals disperse seeds. Seed longevity and seed bank formation of Japanese honeysuckle are unknown at this time. Vegetatively, the plant produces long runners or stolons that develop roots where stem nodes touch the soil. Their rhizomes help establish and spread the plant underground. Japanese honeysuckle can live in a wide range of sunlight levels. It is commonly found in the understory of pine and oak forests. It is highly competitive primarily due to its ability to shade out native plants and extract soil resources using its deep and widespread root system. Other important traits include rapid growth, early sexual maturity and high seed dispersal.

Community and Ecosystem Level Effects of Invasion

Japanese honeysuckle is detrimental to trees and other plants because it twists tightly around them, restricting the flow of water throughout the plant. It also shades out the host plant due to its large leaves and dense canopy. Japanese honeysuckle is very aggressive and out-competes native grasses and forbs, reducing biodiversity and altering the ecosystem's nutrient and energy cycling. Under some circumstances, Japanese honeysuckle can be a ladder fuel, allowing fires to climb into the overstory tree canopy and may inhibit forest regeneration.

Management

Several management options for Japanese honeysuckle are available, including mechanical and chemical treatments. Mechanical control includes hand-pulling plants, cutting stems near the ground and mowing repeatedly. Hand-pulling is most effective on honeysuckle seedlings (less than two years old), but is difficult



Map of Japanese honeysuckle distribution in Oklahoma (Map produced by OkIPC).

Japanese honeysuckle plant showing dense understory growth. Photo courtesy of J. McQuaig.

Japanese honeysuckle leaves. Photo courtesy of J. McQuaig.

on mature plants because of the plants' extensive root systems. Mowing or brush hogging repeatedly may suppress honeysuckle for up to two years, but is unlikely to eradicate it due to resprouting. Chemical control with herbicides applied to leaves can be done just after the first hard freeze, since most non-target vegetation is dormant and, unlike the semi-evergreen honeysuckle, leaves have fallen off of native deciduous species. Herbicides effective in controlling Japanese honeysuckle are those containing picloram, hexazinone, glyphosate, metsulfuron and triclopyr + 2,4-D. Fire is another option to temporarily suppress Japanese honeysuckle. Densely wooded areas can be difficult to burn because of inadequate understory fuels. Patchy fuels can reduce the effect of prescribed fire on honeysuckle. Integrated approaches, like spot application of herbicide on resprouted honeysuckle following fire, may achieve better control than either approach individually. The most effective fire frequencies, burning methods and timing are still unknown for Japanese honeysuckle.

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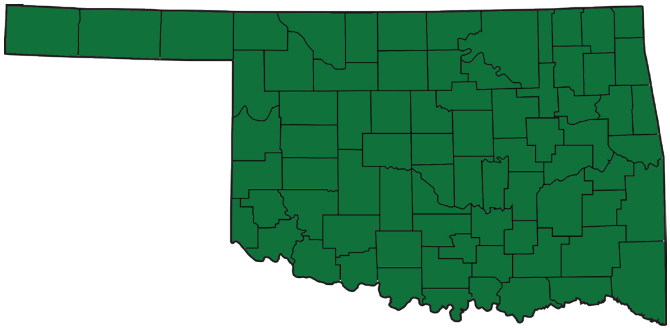
Japanese honeysuckle flowers. Photo courtesy of J. Pruett.

Juniperus virginiana L.

Common Name: Eastern redcedar

Origin

United States



Map of Eastern redcedar distribution in Oklahoma (Map produced by OkIPC).

History of Invasion

In the centuries prior to European settlement, the Great Plains of North America experienced periodic rangeland fires that covered vast areas of land. Because eastern redcedar is unable to resprout after fire, its presence in rangelands was limited to bluffs, stream banks and rocky areas where fuels for fire were limited. As settlers moved west, rangeland fires were suppressed to prevent loss of life and property. Furthermore, eastern redcedar was then planted by settlers and farmers during the Dust Bowl of the 1930s as a way to prevent soil erosion by wind and to shield homes from wind. Extensive planting continued through the 1900s and helped in the spread of eastern redcedar.

Species Description

Growing to a height of 50 feet, eastern redcedar is considered a small- to medium-sized tree. It is an evergreen, therefore does not change color or drop its leaves during the winter. Its aromatic leaves are awl-shaped and are 1/16 to 3/4 of an inch long, with juvenile leaves long, narrow and sharply pointed at the end. Eastern redcedar bark is thin, fibrous, light reddish-brown colored and easily shredded. Resistant to decay, the sapwood is typically whitish, while the heartwood is a purple or red color. Eastern redcedar is able to grow in a wide range of conditions, including a soil pH between 4.7 and 7.8. Individuals can live for centuries.

Example of Juniperus virginiana invasion on rangeland. Note the trees in fencerow that likely grew from seeds deposited by birds. Photo by K. Hickman.

Population Level Traits Promoting Invasion

Eastern redcedar becomes sexually mature at approximately 10 years old. Male trees produce a copious amount of pollen, with peak pollen production in March and April, and are major contributors to allergies in these months. Seeds produced by the female tree mature within two months and have a berry formed around the seeds. These berries are initially green, but change color to white and finally to blue. There are approximately 37,000 berries per pound. Such mass production aids in the dispersal of seeds and may also be an adaption to eastern redcedar's vulnerability to fire. Berries are used as a food source for many birds and mammals, and are subsequently spread in feces.

Community and Ecosystem Level Effects of Invasion

Eastern redcedar provides many birds and mammals with thermal cover along with a food source from the berries. However, while eastern redcedar may provide a few benefits, the native flora that it displaces is often more beneficial to many wildlife species than eastern redcedar alone. Invasion of eastern redcedar often leads to loss of wildlife habitat through changes of the plant community. In fact, most grassland birds respond negatively to eastern redcedar invasion. Along with the reduction in biodiversity, eastern redcedar can reduce water availability by decreasing groundwater recharge and streamflow, subsequently lowering the water table. Because of its physical characteristics, eastern redcedar can also intercept as much as 40 percent of rainfall, leading to low production of plants below the eastern redcedar canopy. Closed canopy redcedar sites in Kansas had a 90 percent reduction in grasses and broadleaf plants, limiting grazing livestock use. Eastern redcedar also poses a threat to human health and safety because of its prolific pollen production and volatility as a fuel in wildfires.

Management

Fire, mechanical and chemical control measures are all effective on eastern redcedar. Fire is perhaps the best method when possible because of its low cost and minimal soil disturbance. When fuel loads are adequate, fire is capable of killing most eastern redcedars under 4 feet tall and is a great approach for preventing invasion into grasslands. Eastern redcedar is not able to resprout following fire, but the burning must be repeated every few years to keep new trees from invading. Fire frequencies of less than five to seven years will keep redcedar from becoming established on most

A mature eastern redcedar female tree bearing numerous berries. Photo courtesy of R.D. Dwayne Elmore.

sites in Oklahoma. Mowing is another low-cost method used to prevent invasion, but is only effective on small trees. Once eastern redcedar reaches heights of 4 feet, mechanical methods such as chainsaws, loppers, tractors or skid steers equipped with shears, mulchers or saws are effective. Mechanical methods tend to be expensive, particularly on large trees or when tree density is high. For chemical control, the size of the tree often dictates how well the herbicide works. There are two liquid chemical options for products applied to the soil: hexazinone (e.g Velpar®) and picloram (e.g. Tordon®), but they are not recommended for trees taller than 15 feet. Hexazinone is also available in a pelleted form (Pronone Power Pellets®) that is applied to the soil. All soil-applied herbicides require about half an inch of rain to dissolve and infiltrate the soil. Non-target trees and shrubs can also be harmed, so it is often best to use chemicals as an individual plant treatment. Picloram can also be applied to foliage. Chemically treating redcedar can be costly. Refer to the E-832, "Extension Agents' Handbook of Insect, Plant Disease, and Weed Control" for the most up-to-date herbicide information.

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Ulmus pumila L.

Common Name: Siberian elm

Origin

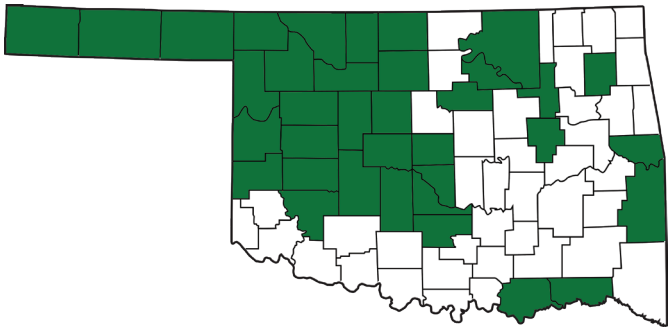
Northern China, eastern Siberia, Manchuria and Korea.

History of Invasion

Siberian elm was first introduced in the 1860s in urban areas for its hardiness, rapid growth and ability to survive in a range of conditions. It was introduced in the early 1900s in the Great Plains to use in windbreaks and shelterbelts for crop fields and pastureland. Siberian elm was commonly planted around homesteads in western Oklahoma because of its resistance to Dutch elm disease, to which many native elms are susceptible.

Species Description

Siberian elm is distinguished by small, toothed, leathery leaves with a pointed tip. The leaf bases are typically symmetrical and form a "V" shape. The leaves are smooth, dark green and alternately arranged along the branches. The branches are hairless with small buds. Flowering occurs in the springtime. The flowers lack petals and occur in drooping clusters of two to five. The fruit is flat and circular (winged for wind dispersal) with a single seed in the center. The bark can be gray or brown, very rough and furrowed at maturity. Siberian elm differs from our desirable native elms, American elm (*Ulmus americana*) and slippery elm (*Ulmus rubra*), in leaf size, leaf margins or leaf edges and the leaf base shape. Siberian elm leaves are typically less than 2 inches long, symmetrical at the leaf base and once-serrate on the leaf edges,



Map of the distribution of Siberian elm in Oklahoma (Map produced by OkIPC).

Photo of the leaves of Siberian elm. Photo courtesy of J. McQuaig.

Mature Siberian elm tree illustrating its use as a landscape tree in western Oklahoma. Photo courtesy of J. McQuaig.

Photo of the bark of a mature Siberian elm tree. Photo courtesy of J. McQuaig.

while the other two species have leaves greater than 2.5 inches long, asymetrical leaf bases and twice-serrated leaf margins.

Population Level Traits Promoting Invasion

The seeds are produced in abundance in the early spring and are spread by wind to new areas easily because of their winged structure. Germination is high and seedlings establish and grow rapidly, allowing them to out-compete native vegetation that begins growth later in the season. Seedling thickets form in bare ground areas near streams and ponds and in disturbed areas in prairies.

Community and Ecosystem Level Effects of Invasion

Effects of invasion include creation of dense thickets or woodlands, which displace native species and reduce forage for wildlife and livestock. Siberian elm reduces native plant biodiversity by actively shading out shade-intolerant species and converting formerly open prairies to closed woodlands. Areas especially vulnerable are moderately moist prairies and stream banks. Some species of wildlife avoid tree cover, and increases in elm can be problematic in formerly open prairies.

Management

Long-term goals can be met by reducing seed sources; however, mechanical, chemical and burning methods are required for established populations. Seedlings can be pulled by hand and larger saplings removed with a hoe. Chemical control methods include applying glyphosphate or triclopyr (ester) on a cut stump, girdled tree with glyphosate or triclopyr or as a basal bark treatment (with crop oil as surfactant). Hack and spray treatments with either triclopyr (amine) or imazapyr are very effective and require minimal effort or herbicide. Fire effectively kills seedlings and needs to be done regularly (one to two times per decade) to prevent invasion.

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Carduus nutans L.

Common Name: Musk thistle

Origin

Europe, western Asia

History of Invasion

Native to Europe and western Asia, musk thistle was introduced into North America as a seed contaminant in the mid 1800s, with the first documented report in 1853. Musk thistle was first confirmed in Oklahoma in 1944 in Payne County, with more plants identified in several eastern counties in the 1950s.

Species Description

During the year of germination, musk thistle appears as a rosette of basal leaves arising from a deep taproot. In the second year, musk thistles range from 2 to 6 feet in height. Leaves are characterized by their spinose (bearing spines) lobes and alternate arrangement on bolted (tall and bearing blooms) plants. Each leaf exhibits a prominent white midvein. Flowers are solitary heads with deep purple coloration that form at the end of the branches. Each flower sits atop large, rigid bracts, which are also purplish in color. The large, showy flowers can often be up to 2 inches in diameter, causing the stem to bend or "nod" under their weight, giving the species its alternative common name, nodding thistle.

Population Level Traits Promoting Invasion

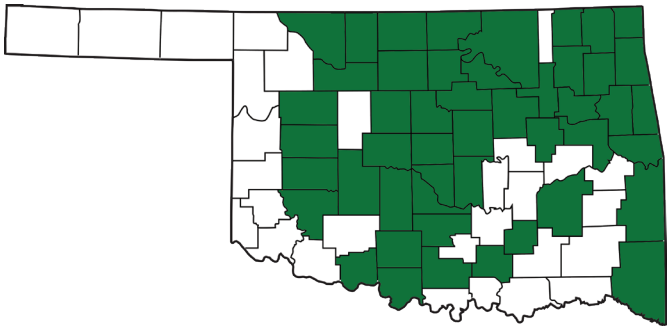
Due to its many invasive characteristics, including abundant seed production, rapid dispersal and lack of natural enemies, the species has rapidly spread westward through much of the U.S. Musk thistle propagates solely by seed. Mature plants often produce between 3,000 and 4,000 seeds, though large plants can produce as many as 10,000 seeds. Attached to each seed is a structure of bristles, known as a pappus, which aids in wind dispersal. Even with this structure, however, most seeds fall within 100 yards of the parent plant. Seeds of this species may stay viable in the soil for up to five years.

Community and Ecosystem Level Effects of Invasion

Musk thistle is a problematic invasive plant in Oklahoma's rangelands, pastures and roadsides. The rapid spread of musk thistle and its ability to form dense, near-monotypic stands allow it to crowd out many desirable native forages and wildflowers. There is some evidence of allelopathy, or the production of chemicals that limit the growth or germination of other plants, allowing it to further out-compete them in crops, hay-fields, pastures and rangelands. Musk thistle can easily be spread through contaminated hay, especially during dry years when hay shipments across the state increase.

Management

Mechanical control of musk thistle can be extremely effective when monitored continually. Because musk thistle reproduces exclusively via seed production, preventing flowering is critical for population control, regardless of method. Some methods of mechanical control include hand-weeding, hoeing, mowing and tilling. If mowing or cutting for control, note that musk thistle will often bolt again and still produce seed. Therefore, multiple mowings or cuttings will be needed. If hoeing, the majority of the



Map of musk thistle distribution in Oklahoma (map produced by OkIPC).

Pasture invaded by musk thistle. Photo courtesy of T. Royer.

Flower of mature musk thistle in year 2 of growth. Photo courtesy of T. Royer.

Basal rosette of musk thistle in first year of growth. Photo courtesy of B. Haggard.

tap root must be removed or the plant will resprout. Much like any control method, chemical control can be very effective, but to receive maximum control, application must be properly timed. Most often, the best control is a result of treating rosettes in the fall or early spring, before the plants have the opportunity to bolt.

Herbicides with 2,4-D amine are inexpensive and effective options when used on the fall or spring rosettes although spraying large areas will eliminate desirable plants as well. Other herbicides that effectively control musk thistle include those that contain picloram, dicamba or methsulfuron methyl such as Grazon P+D®, Weedmaster® and Cimarron Max®. Tolerance to herbicides increases dramatically after the plant has bolted. Sheep and goats may eat musk thistle in its rosette stage, but it is not a preferred forage, and cattle will not typically graze it. Therefore, grazing is not a highly recommended control option. *Trichosirocaulis horridis*, or rosette weevil, tends to be an effective biological control agent. Imported from Italy in the 1970s, this insect targets the rosettes and crowns of musk thistles, killing the plant before it bolts. Adult females lay eggs in the midrib of the basal rosette leaves. Upon hatching, larva begin feeding within the midrib, moving to the center of the rosette as they feed. Plant death often occurs as a result, but occasionally shorter, multi-stemmed plants arise the next spring. This particular species is being distributed throughout Oklahoma, Colorado and other states to combat musk thistle invasions. Oklahoma Extension educators host "weevil roundups" in select areas to promote collection of the weevil and re-distribution to help control infestations. However, this weevil species has also been reported to target native *Cirsium* species, which are not invasive.

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Ligustrum sinense Lour.

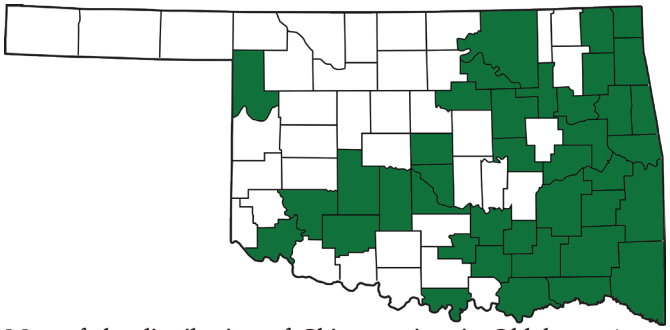
Common Name: Chinese privet

Origin

China

History of Invasion

Chinese privet was first introduced into the southern U.S. in 1852 as an ornamental shrub. Since its introduction, Chinese privet has been planted along fences, streambanks, hedges, forests and used for mass plantings. With an abundance of small, white flowers and its dense evergreen growth form, it is considered attractive as a horticultural ornamental, and is widely sold in nurseries. Having escaped from cultivation, Chinese privet is now established throughout the southeastern U.S., including Oklahoma. It is particularly problematic along shaded streams.



Map of the distribution of Chinese privet in Oklahoma (map produced by OkIPC).

Species Description

Chinese privet is a shrub or small tree that may grow as tall as 30 feet. However, its average height ranges from 5 to 12 feet. It is typically a multi-stemmed clone, but can also occur as an individual plant. It produces many small, white flowers that are very aromatic and once pollinated, develops a fleshy blue-black berry. Chinese privet leaves are evergreen to semi-deciduous and have two leaves per node along the stem, with nodes occurring about every 2 inches. Chinese privet can be distinguished by the fine hairs on its twigs and leaves.

Opposite leaf pattern of Chinese privet. Photo courtesy of J. McQuaig.

Population Level Traits Promoting Invasion

Chinese privet can reproduce both vegetatively and sexually, making the plant difficult to control and eradicate. Chinese privet grows rapidly, has a high reproduction rate and produces many small seeds. A square meter of canopy can produce up to 1,300 fruits. Because of fleshy berries and small seed size, birds eat large quantities of the fruits and act as major dispersal agents for this species. The plants used in landscaping provide a source of seeds for invasion in other areas. Chinese privet also has a very high tolerance to environmental stress. This species has the ability to grow in a wide variety of conditions and can tolerate different soil types and light conditions. The fruits' persistence in winter aids in its success. Chinese privet also benefits from soil disturbance, which provides it with new opportunities for colonization.

Community and Ecosystem Level Effects of Invasion

Chinese privet forms very dense stands at forest edges where it out-competes other species and displaces native vegetation. This causes large-scale ecosystem modification. In addition to being harmful to native species, this plant is also toxic to humans, dogs, cats and horses. The fruit of the Chinese privet is toxic when consumed by humans, causing symptoms such as nausea, abdominal pain, diarrhea, low body temperature and low blood pressure. The dense stands it forms does benefit some bird species and is used as cover by mammals.

Immature Chinese privet fruit. Photo courtesy of J. McQuaig

Management

For small areas with a low abundance of plants, hand removal may be an option. Root fragments must be removed in order to prevent re-sprouting. Mowing and cutting is effective for temporarily controlling Chinese privet, but will not eradicate

Chinese privet showing the characteristic shrubby undergrowth in invaded sites. Photo courtesy of J. McQuaig.

Uncontrolled growth of Chinese privet volunteers. Photo courtesy of A. Goodwin.

it. Prescribed fire also will temporarily suppress privet and kill young seedlings. Various herbicide treatment methods also can be used to effectively control this species and are the preferred control on established plants. Foliage treatment using glyphosate is a successful method when trees are less than 6 feet tall and treatment is done between November and January. For larger stems, consider cut stump treatment with triclopyr ester except in the spring when the sap is rising in the stems. Basal bark with triclopyr and crop oil is another option for larger stems and can be applied anytime. Once the majority of privet is removed with chemical control, periodic prescribed fire (every two to three years) can be used to eliminate seedlings. Currently, there are no known biological controls for the Chinese privet in the U.S. A known pest of this plant is a foliage-feeding insect native to Europe, *Macropha punctumalbum*. Chinese privet is also susceptible to root crown bacteria, *Agrobacterium tume-faciens* and fungal leaf spot, *Pseudocercospora ligustri*.

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Salsola tragus L.

Common Name: Russian thistle

Origin

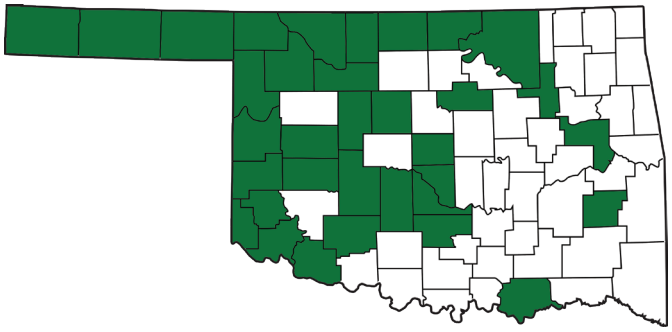
Eurasia

History of Invasion

Russian thistle was first reported in North Dakota in the 1870s, and is thought to have been accidentally introduced as a contaminant in flax seed from Europe. Russian thistle is invasive across the western half of North America and along the Gulf and Atlantic coasts. In Oklahoma, Russian thistle is most common in the western half of the state, with isolated reports in the eastern part of the state, mainly occurring in disturbed areas.

Species Description

Russian thistle is an annual, erect forb with many thin branches and can reach 6 feet in height and up to 5 feet in diameter. The plant can be readily recognized by the spine-tipped leaves and dark purple or red striations running lengthwise along the stem. The plant is notorious for its habit of breaking off at ground level and rolling across the ground, sometimes for many miles, resulting in it being commonly known as tumbleweed. Seeds have small wings that allow for effective dispersal. Russian thistle is most often found in dry, disturbed sites.



Map showing the distribution of Russian thistle in Oklahoma (map produced by the OkIPC.

Russian thistle plants produce multiple branches, which at the end of season produce the characteristic tumbleweed shape. Photo courtesy of B. Haggard.

Russian thistle plants (tumbleweeds) piled up in a tree grove in the panhandle of Oklahoma following high winds. Photo by K. Hickman.

Population Level Traits Promoting Invasion

Mature, dormant plants break off from the stem at ground level and are blown across the landscape, sometimes for many miles. As the plant rolls across the ground, it disperses its seeds along the way, which results in seedling establishment long distances from where the parent plant was found. The seeds bear small wings, allowing for further dispersal once they have dropped off of the plant. Although a single plant can produce up to 250,000 seeds, viability is thought to be relatively short (less than one year). Because of the sheer number of seeds produced, Russian thistle is able to effectively spread across disturbed areas where there is little competition.

Community and Ecosystem Level Effects of Invasion

Russian thistle has the tendency to form monocultures in dry, disturbed areas in the western U.S. These monocultures reduce habitat suitability for many species. In areas where large numbers of Russian thistle are found, the dry aboveground material can accumulate, creating a fire hazard. They also can pile up along fences, creating barriers to movement of animals. In dry areas where native plant regrowth is limited by low soil moisture, areas of bare ground are often colonized by Russian thistle and other weedy species.

Management

Russian thistle can be controlled with the use of metsulfuron-methyl, however reference E-832, "Oklahoma State University Extension Agents' Handbook of Insect, Plant Disease, and Weed Control" for the most current information. In addition, integrated management using both herbicide and grazing can be effective.

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Lespedeza cuneata (Dum. Cours.) G. Don.

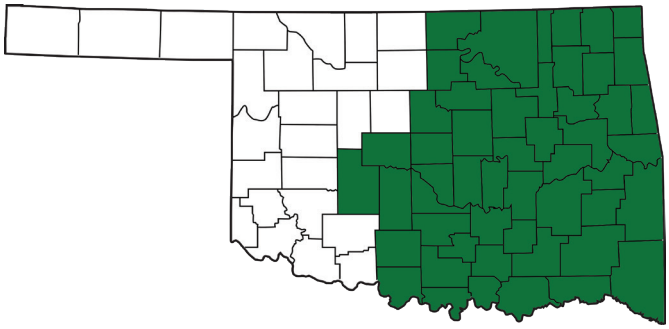
Common Name: Sericea lespedeza

Origin

Eastern Asia

History of Invasion

Sericea lespedeza was introduced into the U.S. in the late 1890s and early 1900s by the USDA for erosion control. It was vigorously planted in strip-mined areas in Oklahoma, Kansas and Missouri and later planted on federal lands in an effort to provide food and cover for wildlife species, such as northern bobwhite and wild turkey. It was also intended to be used for both forage and hay. Sericea lespedeza can be found in every southeastern state and as far north as Wisconsin and Michigan.



A map showing the distribution of sericea lespedeza across Oklahoma (map produced by OkIPC).

Species Description

Sericea lespedeza is a perennial legume. Leaves are compound with three leaflets. On average, a mature sericea lespedeza plant will reach 1 foot to 4 feet tall. The root system of sericea lespedeza is widely branched and can penetrate the soil to a depth of more than 3 feet. Its small white flowers often have purple throats and are found at the base of the leaves along the branches. It is similar to the native and desirable slender lespedeza, which can be distinguished by the net-like leaf veins when held up to light rather than the feather-like leaf veins of sericea.

An image showing a small plant of sericea lespedeza and its multi-stemmed growth form. Photo courtesy R.D. Elmore.

Population Level Characteristics Promoting Invasion

Sericea lespedeza has a wide range of environmental tolerance, including the ability to thrive in very acidic to alkaline soils. It lacks any natural insect predators and is also extremely disease resistant. Sericea lespedeza produces anti-herbivory chemicals known as tannins. As the plant matures, the levels of tannins increase. Drought and elevated air temperatures also raise the tannin levels in sericea lespedeza. A pure stand of sericea lespedeza can produce anywhere from 450 to 850 pounds of seeds per acre per year. A single pound of seeds contains around 350,000 seeds. The seedlings have a relatively low germination rate in any given year; however, this is counteracted by the number of seeds being produced and the seed longevity, which is likely 15 to 20 years.

Community and Ecosystem Level Effects of Invasion

Sericea lespedeza is extremely competitive with native species. It out-competes native species by shading them out with its multiple branches and dense foliage. Sericea lespedeza can also have a major impact on the germination and growth of other plants by its production of allelopathic compounds. Its efficient water use reduces the amount of water available for other plants, especially in times of drought. While it provides cover for species of wildlife and its seeds often are not digestible because of the hard seedcoat. It is generally considered undesirable for wildlife because it out competes so many other important plant species.

Management

Sericea lespedeza has no easy or quick method of control once it has become established. The conventional use of dormant season prescribed fire and grazing with moderate stocking rates on rangelands has not been proven to be an effective method of controlling of sericea lespedeza in Oklahoma. To the contrary, winter prescribed fire increases sericea lespedeza in areas where it has already established. Goats or hair sheep can suppress sericea lespedeza, because they will select it over most other plants. To increase cattle grazing of sericea, plants must be kept young. As the plant matures, tannin levels increase and cattle will not graze it. Prescribed fire and mowing are two additional management options. Summer and early fall prescribed fires are effective at reducing the plant's vigor and the number of seeds it produces, since burning allows the plants only a short amount of time to recover and flower before the fall freeze. In general, fire stimulates sericea seed germination but, if done late, can kill seedlings that have already germinated. For prescribed fire to be an effective method of management, a very high fuel load is needed so the fire can burn at a higher temperature to kill seedlings and reduce seed production in mature plants. If the temperature of the fire is not hot enough, then the fire will merely scarify seeds and increase germination. Mowing sericea lespedeza can also keep plants small and palatable and reduce the vigor of the plant; however, it must be done several times a year with the plant being cut very close to

An image showing a close-up of sericea lespedeza flowers and compound leaves with three leaflets. Photo courtesy J.N. Craun.

the ground. This can be very costly and it does not actually kill the plants. Foliar chemical application of triclopyr and metsulfuron methyl provides adequate control of sericea lespedeza, but new seedling recruitment is always possible because the seed is viable for many years. Triclopyr should be applied prior to flowering in early summer while metsulfuron methyl should be applied once sericea has flowered. After killing mature plants with herbicide immediately before or during flowering, fire can be used to stimulate germination of seeds in the soil, followed by an additional herbicide application to effectively diminish the amount of seeds. Due to the large amount of seeds produced by the plant, multiple treatments will likely be necessary. It should be noted that the application of any herbicides may possibly result in the killing of non-target species and disturbance of the native plant community, opening the door for the establishment of new individuals of sericea lespedeza. Targeting sericea late in the growing season (August and September) before sericea flowers can be a good strategy to minimize nontarget damage as many native forbs will have gone dormant by this time and will not be susceptible to herbicide damage.

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Hydrilla verticillata (L. f.) Royle

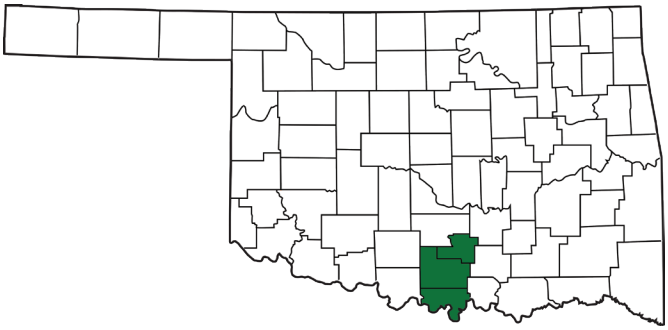
Common Name: Hydrilla

Origin

Asia, Australia and Africa

History of Invasion

Hydrilla is thought to be native to parts of Asia, Australia and Africa, but it has been introduced nearly world-wide. One form of hydrilla, which has separate male and female parts on the same plant, is believed to originate from Sri Lanka, while another form characterized by separate male and female plants is believed to originate from Korea. Hydrilla has been found in numerous states throughout the U.S., and was originally introduced through the aquarium trade. Hydrilla can be spread between bodies of water by fragments on boats and trailers and by floating into streams, rivers and canals to take root.



Map showing the distribution of hydrilla in Oklahoma (map produced by OkIPC).

Species Description

Hydrilla, commonly called water thyme, is a submersed perennial herb. The plant roots in hydric soils and has stems up to 25 feet in length that branch at the surface where growth becomes horizontal and forms dense mats. Small, pointed, often serrated leaves are arranged around the stem in whorls of three to 10. Populations in the southern U.S. (including Oklahoma) produce male and female flowers on the same plant and overwinter as perennials. Populations in the northern U.S. are characterized by separate male and female plants, and depend on tubers for overwintering. Hydrilla produce female flowers with three translucent petals and male flowers with three white to red petals.

Hydrilla next to boating dock. Photo courtesy of Priscilla Crawford.

Population Level Traits Promoting Invasion

One of the world's worst aquatic invasive plants, hydrilla grows aggressively. Stems can grow up to one inch per day. As the stems grow into shallow water, they form thick mats and block sunlight from plants below.

Community and Ecosystem Level Effects of Invasion

Native fish that feed on hydrilla do not obtain adequate nutrients and energy as they would feeding on native species. Thus, native fish using hydrilla as their primary food source will be smaller in size and have reduced population size due to altered food sources. Water becomes stagnant and warmer, and decreased dissolved oxygen causes death of aquatic organisms, namely fish. Fish spawning and waterfowl feeding sites also disappear. Heavy infestations of hydrilla can clog intake pipes that help cool power plants, water treatment facilities and commercial facilities. Waterfront residential property values can also be significantly decreased and drainage canals can suffer reduced volume potential, leading to flooding and bank erosion. Hydrilla also can alter oxygen levels and water chemistry.

Close-up photo of hydrilla. Photo courtesy of Priscilla Crawford.

Management

Mechanical, chemical and biological control methods have been used in effort to reduce or eliminate populations of hydrilla. These methods are expensive and often only moderately effective. Mechanical removal should be limited in use of controlling hydrilla, since the plants can fragment and readily reproduce. Fluridone is the most widely used herbicide and can be effective

in small bodies of water with no inflow or outflow. However, this product is non-selective, meaning it will also kill native aquatic vegetation that provides important habitat structure for fish and other aquatic organisms. Additionally, fluridone is ineffective in moving water. Biological control agents such as sterile grass carp, leaf-boring flies and weevils have been used with moderate levels of success. As with many invasive plants, the best control of hydrilla invasion is preventing new invasions. For all types of watercrafts, avoid passing through dense beds of aquatic vegetation, inspect and clean watercraft and equipment after each use and remove any plant matter, sediment and other material away from where it might get washed back into the lake.

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Bothriochloa ischaemum (L.) Keng

Common Name: Yellow bluestem

Origin

European and Asian countries

History of Invasion

Yellow bluestem was purposefully introduced to the southern U.S. in the early 20th Century for its characteristic ability to quickly establish, to provide livestock forage and to stabilize potentially erodible soils. In the 1980s, the Natural Resources Conservation Service's Conservation Reserve Program promoted the planting of yellow bluestem in Oklahoma as a forage crop in retired crop fields. Such widespread promotion and planting allowed yellow bluestem to establish large populations that are present in at least 18 states from Florida to California.

Species Description

Yellow bluestem is a medium-tall bunch grass that gets its common name from the yellow-green leaves it produces. Its leaves rarely get wider than half an inch in width and are typically 8 to 12 inches in length. The flowering stems can reach 4 feet in height and are very thin. The reddish-purple inflorescence bears multiple branches and appears in early June and July, preceding the seed production of many native grasses.

Population level Traits Promoting Invasion

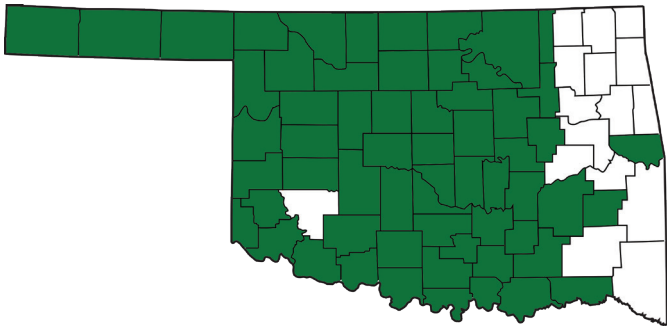
Many of the characteristics that made yellow bluestem an attractive choice for planting also aid its invasion into native grasslands. For example, yellow bluestem has a high nutrient content and is tolerant to drought and grazing. These qualities led to its selection as a forage species, as well as increased its invasiveness. Yellow bluestem is capable of producing more biomass than common native tallgrass species. Such characteristics provide yellow bluestem with a competitive advantage. A recent study discovered an allelopathic toxin produced by yellow bluestem can reduce the reproduction, growth and survival of big (*Andropogon gerardii*) and little bluestem (*Schizachyrium scoparium*). Yellow bluestem also is more tolerant of disturbance than many of our native species, allowing it to invade roadside ditches.

Community and Ecosystem Level Effects of Invasion

Where established, yellow bluestem can form monocultures. Monocultures fail to provide the variety in structure, seasonality of growth and food plant availability required by diverse wildlife species. Pastures invaded by yellow bluestem attract fewer insects, a vital part of the food chain, compared to native pastures because they lack forbs. Forbs attract more insects than wind-pollinated grasses. This ultimately leads to lower songbird diversity due to the lack of available food. This reduction in forbs can also affect native pollinators like bees and butterflies.

Management

Unfortunately, there are limited control measures available for yellow bluestem, however there are some practices that decrease productivity and seed production of yellow bluestem. Imazapyr and glyphosate are the most effective herbicides to control yellow bluestem. Burning or mowing yellow bluestem prior to the application of glyphosate has been shown to be more effective at controlling yellow bluestem as opposed to applying glyphosate alone. Fire alone is not recommended as a control measure because yellow bluestem has a similar fire-tolerance as native warm-season species found in the Great Plains.



Map showing the distribution of yellow bluestem in Oklahoma (map produced by OkIPC).

***Bothriochloa ischaemum* reproductive seed head in July in Central Oklahoma. Note the characteristic yellow-green color, as well as thin leaves yet dense cover. Photo courtesy of R.D. Elmore.**

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Bromus arvensis L.

Common Name: Field brome

Origin

Southern Asia

History of Invasion

Field brome was introduced into North America in the 1950s for erosion control and is still used in the northeast as a winter cover crop on vegetable fields.

Species Description

Field brome is a winter annual cool-season grass. Stems reach up to 36 inches in height. Upper leaf sheaths are covered in short, dense hairs, while lower leaf sheaths are covered by long hairs. Leaf surfaces are rough to the touch (scabrous) and covered by long, soft hairs. Awns are up to 0.4 inch in length and are straight or slightly curved, helping to distinguish field brome from other similar species. The seed head is open with spreading and usually drooping branches.

Population Level Traits Promoting Invasion

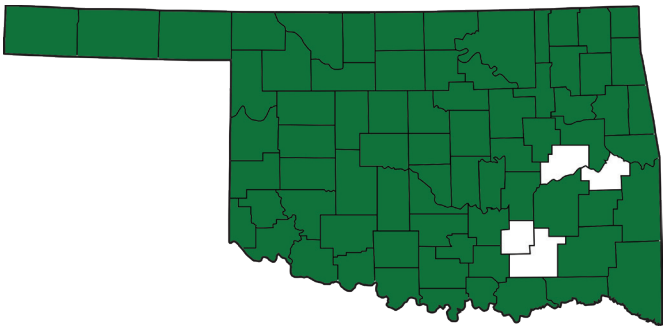
As an annual, field brome reproduces solely by seed, producing as many as 250,000 seeds per pound. Because of this reproductive capability, field brome is able to maintain its population through annual reseeding.

Community and Ecosystem Level Effects of Invasion

Like other brome species, field brome has the ability to invade pastures and prairies, forming dense monocultures in the process, especially in high-fertility soils where it often out-competes native grasses. Field brome thrives on fine-textured soils. Due to the production of large quantities of seed and early emergence, field brome is able to out-compete most other cool-season species, inevitably suppressing native biodiversity.

Management

The best method of preventing or minimizing invasion by field brome is to reduce soil disturbances. In established populations, it is important to prevent or reduce seed production. Seeds may be viable in the soil for several years, so areas of invasion must be monitored to prevent reinvasion from the seed bank. Mechanical removal, such is mowing, is often ill-advised because the associated disturbance may facilitate further invasion. Once established, herbicides offer relatively effective control, with dicamba, picloram and glyphosate being the most commonly used. However, if established over large areas, it is difficult to control without damaging nontarget desirable plants. Clethodim is also very effective at controlling annual bromes while not harming perennial native grasses.



Map showing the distribution of field brome in Oklahoma (map produced by OkIPC).

Close-up of field brome inflorescence at the beginning of seeding-out. Photo courtesy of M. Manucheri.

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Tamarix spp. L.

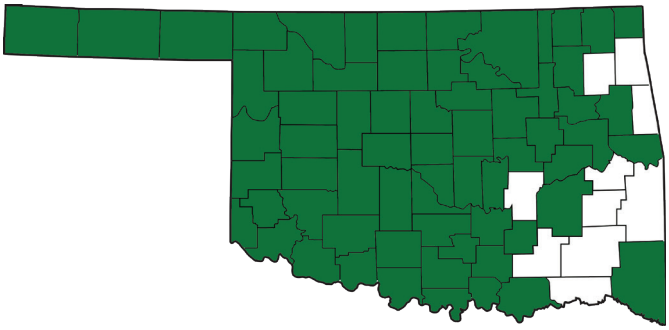
Common Name: Saltcedar

Origin

China and the Middle-East

History of Invasion

Saltcedar was brought into the U.S. in the early 1800s from Eurasia as an ornamental plant. After its introduction, it soon spread into areas of sandy soil with high moisture content. Saltcedar was quickly recognized as being extremely drought tolerant and was widely distributed by government agencies as a means of erosion control. Salt cedar is currently found in about 35 states and Puerto Rico in the U.S. Many states, including Colorado, Montana, Nevada, Nebraska, North Dakota, New Mexico, Oregon, Texas, Washington, South Dakota and Wyoming currently have it listed on their noxious weed list. It has been documented in 67 counties of Oklahoma.



Map showing the distribution of saltcedar in Oklahoma (map produced by OkIPC).

Species Description

Saltcedar is a small tree or shrub that can grow from 5 to 20 feet in height. It has small scale-like leaves and distinct sepals and petals that occur in fours or fives. Fruits are capsules and the roots of the plant can grow deeply, enabling it to survive extended drought periods.

Saltcedar exhibits a shrubby, multiple stemmed growth form, which resembles an evergreen "cedar", but is actually a deciduous woody plant. Photo courtesy of R.D. Elmore.

Population Level Traits Promoting Invasion

Saltcedar has a significant impact because of the high rate at which it spreads. A single tree can produce more than 500,000 seeds in a single year. Since it generally develops along waterways, the water provides a mechanism to spread the seeds to new locations. Once deposited, the seeds will germinate to create a new stand. Studies show saltcedar can germinate in a large temperature range—from 40 F to 95 F. This allows it to grow in a wide variety of climates. Another characteristic of saltcedar is it's ability to sprout from its roots after above ground vegetation has been cut or burned.

Community and Ecosystem Level Effects of Invasion

Saltcedar out-competes native vegetation, which decreases biodiversity of native plants and animals. Monocultures are common in areas invaded by saltcedar. This can decrease food resources and habitat availability for native wildlife. However, it provides habitat for some species, especially birds that require shrubs for nesting along riparian corridors. In areas lacking willow or other native woody vegetation, saltcedar has become an important component of nesting cover. One of the biggest impacts of saltcedar is that it changes water quality and availability. Increased soil salinity is caused by the shedding of leaves containing extremely high salt concentrations. The production of salt degrades the soil quality and reduces native plant populations, since many native species cannot survive in high salinity soils.

Management

Saltcedar can be removed using chemical, mechanical and biological control methods. Chemical control can be done with basal bark treatments (triclopyr ester with crop oil) or cut-stump treatments of triclopyr ester. With saltcedar less than 5 feet tall, foliar herbicides can be sprayed using a backpack sprayer, tractor, fixed-wing airplane or helicopter. Imazapyr or an imazapyr-glyphosate mixture is recommended. If mature saltcedar is first chemically controlled, burning can be a viable method of control for seedlings. Studies have shown that when sprayed with herbicide, then the area control-burned after three years, saltcedar mortality rate could be as high as 93 percent. Mechanical control of saltcedar includes the use of heavy equipment to remove the aboveground growth as well as the underground growth. Grubbing, mulching or excavating, followed by root raking or plowing to remove any below-ground root fragments causes large amounts of disturbance and decreases soil stability. It is also very expensive and time consuming, but it does provide a viable method for control of saltcedar. Goats may be used in conjunction with other control methods to suppress resprouts and decrease seed dispersal. The

Close-up of saltcedar leaves showing the similarity with "cedar" leaves. Photo courtesy of J. McQuaig

Saltcedar in flower. Photo courtesy of J. McQuaig.

most effective and cost-efficient biological control of saltcedar is the use of the northern saltcedar beetle. This beetle feeds on the aboveground foliage of salt cedar. Repeated defoliation over several years can kill saltcedar and is a self-sustaining method. Saltcedar beetle release is not allowed in some states because of the unknown consequences the saltcedar dieback may have on the southwest willow flycatcher, a federally endangered bird of the American Southwest that nests in low-growing woody cover such as saltcedar.

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Bromus tectorum L.

Common Name: Cheatgrass

Origin

Europe, northern rim of Africa and southwest Asia

History of Invasion

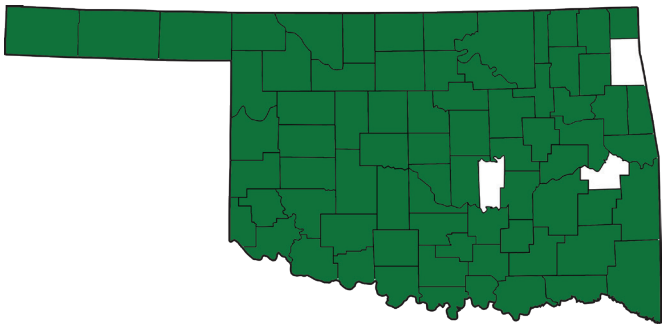
Cheatgrass was introduced in the 17th and 18th centuries. Some cheatgrass was likely purposefully introduced as a forage, while some was transported unintentionally via ship ballast, contaminated crop seed, packing materials and animals. It then began establishing along railroad right-of-ways, in fallow fields and on abandoned farms. It was further spread by vehicles, livestock, wildlife and in contaminated hay.

Species Description

Cheatgrass is a cool-season annual grass. It has a finely divided, fibrous root system that grows rapidly. It has tangled, drooping branches; narrow, hairy spikelets with straight awns; and hairy sheaths. It has an open seed head and typically germinates in the fall or spring.

Population Level Traits Promoting Invasion

Cheatgrass is a fast-growing, prolific seed producer that frequently establishes in disturbed areas. It can thrive in a wide range of climates, growing in areas that receive anywhere from 6 to more than 20 inches of rain annually. It is not restricted by temperature in North America and occurs from Canada to Florida. Seeds can stay dormant in the soil for up to three years. When optimal conditions occur for germination, up to 95 percent of seeds can germinate. Cheatgrass' ample production of fine fuels shortens fire return intervals, allowing it to be competitive where native plants are not well adapted to fire.



Map showing cheatgrass distribution in Oklahoma (map produced by OkIPC).

Community and Ecosystem Level Effects of Invasion

Cheatgrass decreases in palatability quickly as it matures and it is rare for cattle to select it once it has produced seed. Forage production of perennial grasses can be reduced, especially production of native cool-season grasses. Cheatgrass monocultures can inhibit small mammal and ground-nesting bird movement and suppress important native forage plant growth. Cheatgrass-dominated sites also are more likely to be invaded by other non-native invasive species.

Management

Because cheatgrass is very persistent once it is established, eradication of large infestations is typically not possible. Man-

Cheatgrass plants at the beginning of reproduction. Photo courtesy of B. Haggard.

Cheatgrass seedheads showing their drooping nature. Photo courtesy of R.D. Elmore.

aging cheatgrass requires eliminating live plants, preventing seed formation and controlling seed germination. Proper early intensive grazing management with cattle or sheep can prevent seeding establishment and may kill seedlings. Cheatgrass can tolerate repeated heavy trampling and grazing episodes as long as it is allowed to seed before going dormant, so "grazing out" cheatgrass may also be detrimental to other native plant species. Prescribed burning also can be used to reduce the litter layer that helps with seeding germination and establishment. Burning from April through late spring, followed by grazing can prevent cheatgrass from producing seed and may reduce the population over several years. Mechanical methods, such as hand pulling, mowing and tilling are effective control methods when combined with other methods like prescribed fire or herbicide, but not practical except in isolated colonies. Glyphosate has effectively controlled cheatgrass when applied prior to seed maturation, but is only practical when desirable plants are not present. Regardless of the method, the seed banks must be depleted to successfully eradicate cheatgrass. Clethodim is also very effective in controlling cheatgrass while not harming perennial native grasses.

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Sorghum halepense (L.) Pers.

Common Name: Johnsongrass

Origin

Mediterranean region

History of Invasion

Johnsongrass was brought to Alabama in 1830 as a forage crop for livestock and to prevent soil erosion. It can easily be spread by seeds in contaminated hay and equipment, leading to invasion of crop fields, pastures, abandoned fields and streambanks. Johnsongrass is very common in the southern U.S., and occurs in all warm regions of the world. However, Johnsongrass has also been able to adapt to cooler climates.

Species Description

Johnsongrass is a tall, coarse, warm-season perennial grasses. It grows in dense clumps that can reach up to 9 feet tall. Johnsongrass reproduces from rhizomes, which are subsurface stems that put out lateral shoots. It has a fibrous root system and large, pink stems that arise from the rhizomes. Its leaf blades are smooth, large and flat, ranging between 1 and 2 feet long and ½ to 1 inch wide. A white midvein is present on the leaves when Johnsongrass reaches maturity and is a diagnostic characteristic. Its seed head are large, pyramidal and purple to golden brown.

Population Level Traits Promoting Invasion

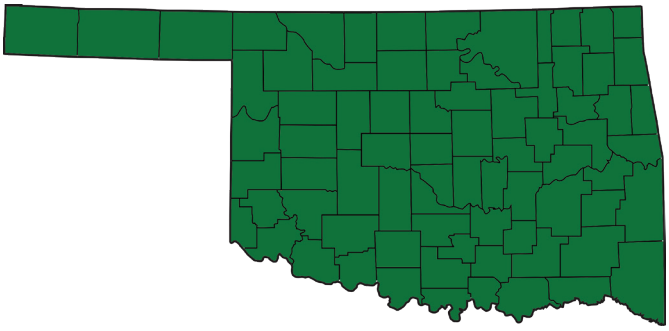
Johnsongrass is an invasive and tenacious grass that thrives in disturbed areas like crop fields and ditches. It quickly invades, with seedlings growing four times as large as native tallgrasses within the first month and producing rhizomes as early as the five-leaf stage. Its extensive root system and rhizomes that serve as carbohydrate reserves also help it survive drought or when the top growth is removed. Johnsongrass is adapted to many different soil types and environments and thrives in open bottomland. One acre of Johnsongrass is able to produce ten bushels of seed in one growing season, with seeds surviving up to five years in the soil.

Community and Ecosystem Level Effects of Invasion

Johnsongrass is able to shade out native plants from sunlight because it grows faster and taller than most native grasses. It drastically decreases nutrients and availability of moisture to other neighboring plants due to its deeper and more extensive root system. Monocultures of dense Johnsongrass patches out-compete native plants, decreasing biodiversity. Johnsongrass not only poses a threat to native grass species, but also can be toxic for livestock to consume. It produces cyanogenic glycosides which ruminants like cattle, sheep and goats convert to cyanide or prussic acid in the rumen. This typically occurs during periods of rapid growth when the plant is a seedling or in secondary growth after heavy grazing or mowing. Johnsongrass can also accumulate nitrates, which can cause sickness or even death in cattle. High nitrate levels are associated with nitrogen fertilization and drought.

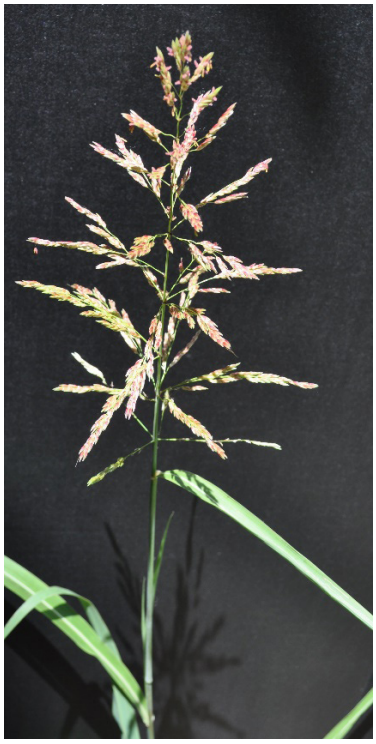
Management

There are numerous methods to control Johnsongrass including burning, pulling, spraying and mowing. The effectiveness of burning depends greatly on timing. In most cases, a single burn in late winter will result in a drastic spread of Johnsongrass. The best time to burn is in mid-spring when new seedlings are beginning to appear, but this will not effectively control established plants. Mowing is another method that is only effective when done properly. When Johnsongrass is mowed on a monthly basis for several seasons, it weakens and reduces rhizome growth. Similarly, continuous grazing can reduce Johnongrass dominance and this plant is typically not common in grazed areas. Pulling can be used for young plants that lack an extensive rhizome system. Tillage is sometimes recommended to bring rhizomes to the surface where they may be killed. This is not recommended because many rhizomes will remain in the soil and will quickly reestablish. Effective herbicides include glyphosate with foliar spot application or a ropewick to apply herbicide to only the tall Johnsongrass. However, it can take multiple applications and years of spraying to completely eradicate the plant. Herbicide should be applied when the Johnsongrass is actively growing, such as early summer. Imazapic or sulfosulfuron are also effective without harming many native warm-season grasses and desirable forbs.



Map showing the distribution of Johnsongrass in Oklahoma (map produced by OkIPC).

Johnsongrass stand. Photo courtesy of R.D. Elmore.



Johnsongrass inflorescence. Photo courtesy of J.N. Craun.

Johnsongrass leaf showing the characteristic prominent, white midvein. Photo courtesy of J.N. Craun.

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EXTENSION