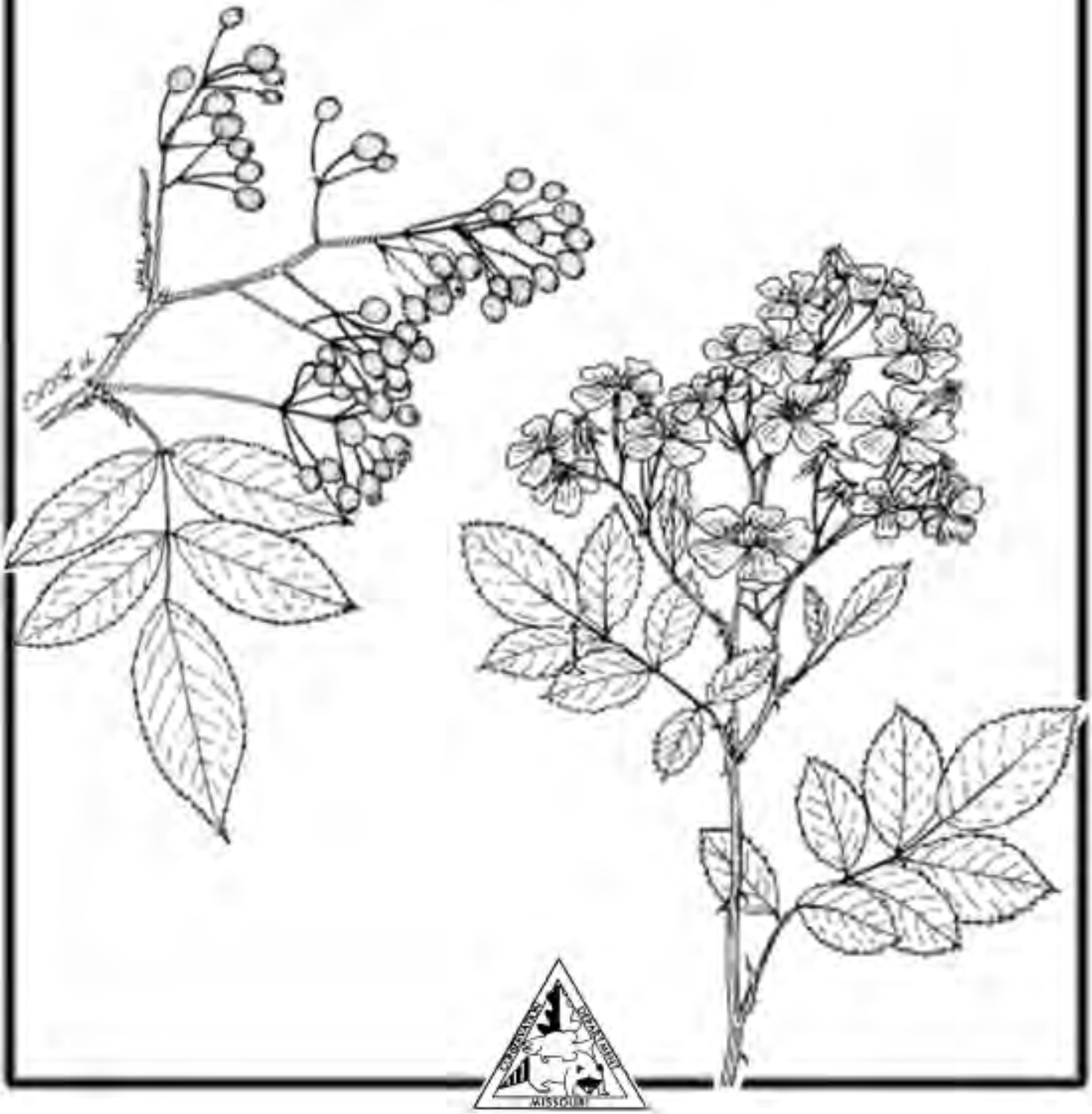
Missouri

VEGETATION MANAGEMENT MANUAL



MISSOURI

VEGETATION MANAGEMENT MANUAL

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Cover Illustrations: Multiflora rose (*Rosa multiflora* Thunb. ex Murray) by Phyllis Bick

ACKNOWLEDGEMENTS

This document was compiled from numerous publications and personal communications with land managers who are engaged in combating unwanted plant species. The primary source of information for many of the guidelines included in this manual is the Illinois Nature Preserves Commission's Vegetation Management Manual. The format for the Illinois manual also served as a model for this manual. The consent of the Illinois Nature Preserves Commission to use their guidelines as a basis for this work is greatly appreciated.

Additional references that were very helpful in preparing this document were the Element Stewardship Abstracts (ESAs) for a number of species which were prepared by The Nature Conservancy. The ESAs provide a wealth of information that is drawn from references across the range of each species. The ESA authors' efforts in compiling comprehensive information which could be incorporated into this manual is gratefully acknowledged.

The participants in the October 1992 workshop "Managing Problem Exotic Plant Species in Missouri and the Midwest" deserve special thanks for contributing their individual expertise and experiences in vegetation management. The interest and enthusiasm of the participants of that workshop spawned the effort to compile management experience into this document. The Natural Areas Association's Compendium on Exotic Species, which was first available at the October 1992 workshop, provides a collection of published articles from the Natural Areas Journal dealing with the management of exotic plants and animals.

Several people in the Missouri Department of Conservation deserve thanks for their part in this project. Rick Thom helped generate initial interest in hosting the exotics workshop and saw the value in providing this management information as a result of the workshop. Don Kurz provided guidance in the selection of species to be included and reviewed the entire document. Kriste Ericsson helped in the early stages of compiling the species guidelines. George Yatskievych and George Hartman facilitated contractual arrangements with Phyllis Bick, who illustrated the plants described in this manual with the exception of kudzu. Martha Daniels and Amy Wieberg guided the layout of illustrations and Barb Singleton provided expert clerical support throughout the project.

The treatment of kudzu was added with the October 1997 revision. For kudzu, Dr. James H. Miller, USDA Forest Service, Southern Research Station, Auburn University, AL, provided his research and expertise. Becky Erickson and Chris Dietrich reviewed literature and compiled a rough draft. Dr. Ellen Lissant provided the illustration of kudzu. Carol Davit assisted in layout of the revision.

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INTRODUCTION

In October of 1992, the Missouri Department of Conservation and the Natural Areas Association hosted a workshop for land managers entitled "Managing Problem Exotic Plant Species in Missouri and the Midwest." At that workshop a number of problem plant species were addressed with a focus on effective control measures on public lands. Speakers from throughout the Midwest contributed their experiences and expertise on mechanical, chemical, and biological methods for controlling exotic or native plant species that can cause problems on public or private lands.

The purpose of this manual is to provide land managers a compilation of control recommendations from workshop participants as well as from available published and unpublished material on plant species of concern. The scope of this effort was broadened to include guidelines not only for those species addressed at the workshop, but also for some additional Missouri problem plants for which control methods are documented. The twenty-four guidelines that follow are intended to alert managers to aggressive exotic plants that may require control as well as to give specific recommendations for treatment. Results cannot be guaranteed using the methods given here because of the variability between sites where these plants may occur. We are in the early stages of learning the best treatment methods for many problem species. Nevertheless, managers can save years of experimentation by learning from the successes and failures of others. A list of references is included with each guideline to allow for further study of pertinent literature or to contact other management personnel with experience in controlling particular species.

Although an attempt was made to include most problem plant species currently requiring control in Missouri, there are certainly additional species that will join the ranks of Missouri's problem exotics in the future. These may be aggressive exotics that should be controlled wherever they are found, or they may be native species which are only problems in specific settings where their spread is at the expense of a natural community that should be protected. The following list consists of species not included in this manual that have presented management problems in other states and may create problems in Missouri now or in the future.

Moneywort (*Lysimachia nummularia*)
Quaking aspen (*Populus tremuloides*)
Round-leaved bittersweet (*Celastrus orbiculatus*)
Siberian elm (*Ulmus pumila*)
Silver poplar (*Populus alba*)
Wild parsnip (*Pastinaca sativa*)
Caucasian bluestem (*Andropogon bladhii*)

Burning bush (*Euonymus alatus*)
Common privet (*Ligustrum sinense*)

Managers should be aware of the potential aggressive spread of these species on public lands, so that, if control becomes necessary, it can begin before the species becomes well-established.

Recommendations given for the use of herbicides in this manual are subject to label restrictions. **By law, herbicides may only be applied according to label directions.** The herbicides recommended in this manual are general use herbicides with the exceptions of Tordon 101 Mixture and Tordon K for kudzu treatment. Pesticide application certification is governed by state laws and therefore varies by state. For safety reasons, it is a good idea for persons who will be dealing with even general use herbicides to get pesticide certification, whether required by law or not. In Missouri, certification and recertification classes are taught by the Missouri Department of Agriculture.

This manual is provided as a three-hole-punched manuscript that can be kept in a looseleaf binder and added to as further material is gathered on the species included or as additional species' recommendations become available. It is hoped that this document will be a useful resource for land managers in controlling aggressive exotic and native plant species. Comments are welcome on the recommendations presented here. As managers gain experience with controlling unwanted vegetation, that experience can be incorporated into future revisions. A form is provided at the end of this manual that may be used to submit additional management experience.

HERBICIDE NAMES AND USES

Brand Name/ Manufacturer	**Generic Name**	**Application**
_____ Numerous brands & manufs.	2,4-D Amine	Dicot-specific. Foliar.
Accord Monsanto	Glyphosate	Non-selective. Foliar. Approved for forestry applications.
Ally DuPont	Metsulfuron	Non-selective. Foliar.
Ammate X-NI DuPont	AMS-Ammonium sulfamate	Non-specific. Foliar, cut surfaces.
Banvel Sandoz	Dicamba	Dicot-specific. Foliar, basal-bark, granular.
Basagran BASF	Bentazon	Non-selective. Foliar.
Crossbow Dow	2,4-D + triclopyr	Dicot-specific. Foliar, cut surfaces, thin line basal-bark on woody stems.
Escort DuPont	Metsulfuron	Non-selective. Foliar.
Fusilade 2000 ICI Americas	Fluazifop-P-Butyl	Monocot-specific. Foliar.
Garlon 3A DowElanco	Triclopyr (triethanolamine salt)	Dicot-specific. Foliar, basal-bark, cut surface,injection.

Garlon 4 DowElanco	Triclopyr (butoxyethyl ester)	Dicot-specific. Foliar, basal, injection.

Brand Name/ Manufacturer	**Generic Name**	**Application**
Krenite DuPont	Fosamine	Non-specific. Foliar.
Mec Amine-D Platte Chemical	2,4-D + mecoprop + dicamba	Dicot-specific Foliar.
Remedy	[Same as Garlon 4 but labeled for Dow range/pasture applications]	
Rodeo Monsanto	Glyphosate	Non-selective. Foliar, cut surfaces. Can be used over water.
Roundup Monsanto	Glyphosate	Non-selective. Foliar, cut surfaces. Cannot be used over water because it contains a surfactant which is not approved for aquatic use.
Spike 20P (pellets) DowElanco	Tebuthiuron	Non-selective. Spread dry on soil surface for root absorption.
Spike 80W (wettable powder) DowElanco	Tebuthiuron	Non-selective. Sprayed on soil surface for root absorption.
Tordon 101 Mixture DowElanco	2,4-D + picloram	Dicot-specific. Foliar.
Tordon K DowElanco	picloram	Dicot-specific. Foliar.
Tordon RTU	Picloram	Dicot-specific.

DowElanco		Foliar, injection, pellets.

Brand Name/ Manufacturer	**Generic Name**	**Application**
Transline DowElanco	Clopyralid	Dicot-specific (esp. composites, legumes, and smartweeds). Foliar.
Trimec Rhone-Poulenc Agro-chimie/May & Baker	Dicamba + 2,4-D + mecoprop	Dicot-specific. Foliar, basal-bark, or granular.
Veteran 720(formerly Banvel 720) Riverdale Chem. Co.	Dicamba	Dicot-specific. Foliar.

References:

Herbicide Handbook Committee. 1989. Herbicide handbook of the weed science society of America, 6th ed. WSSA. 301 pp.

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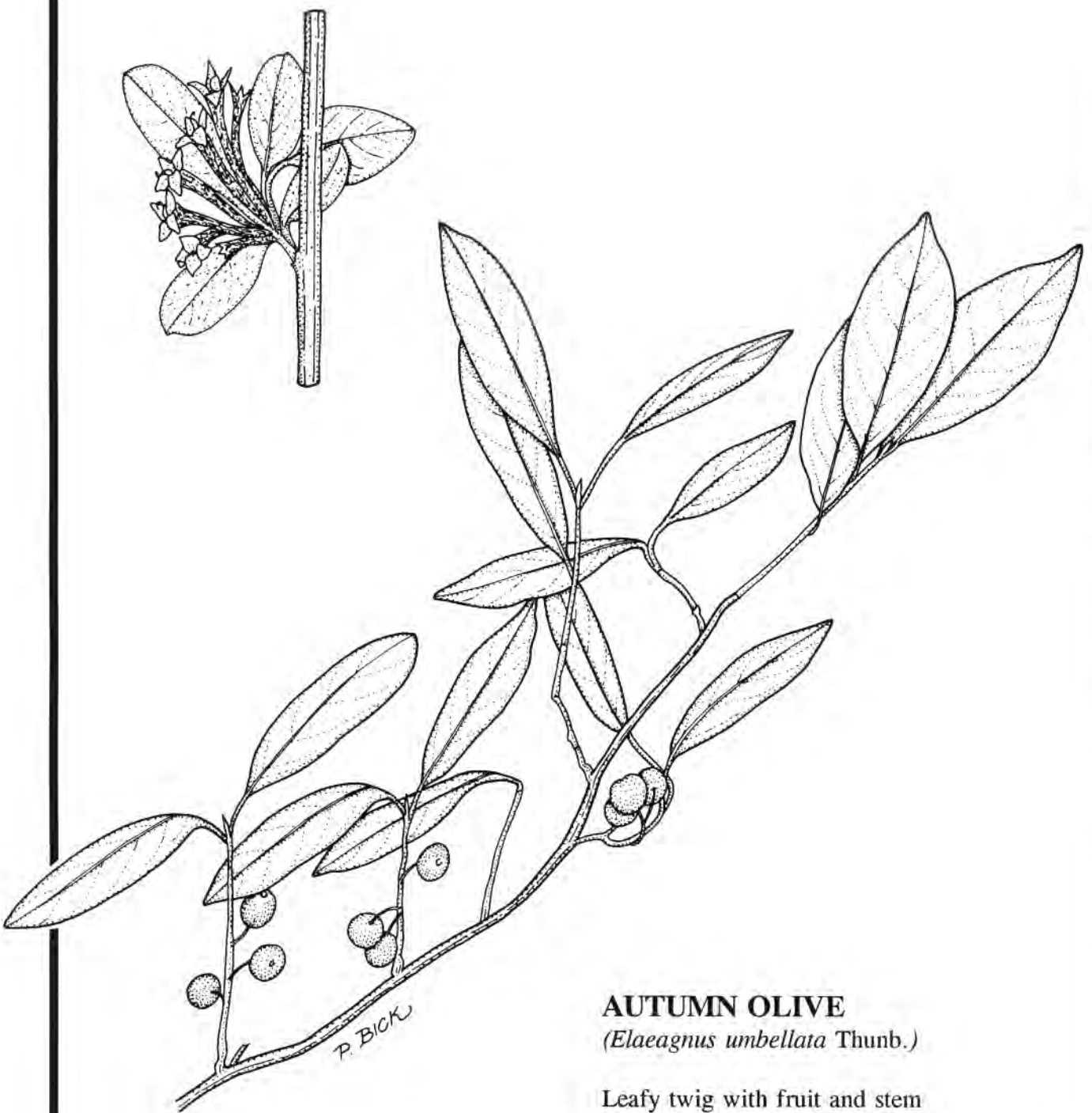
Illustration (Autumn Olive)



AUTUMN OLIVE
(Elaeagnus umbellata Thunb.*)*

Leafy twig with fruit and stem section with leaves and flowers.

VEGETATION MANAGEMENT GUIDELINE

Autumn Olive (*Elaeagnus umbellata* Thunb.)

SPECIES CHARACTER

DESCRIPTION

Autumn olive is a medium to large shrub, often reaching heights of 20 feet. The leaves, borne alternately on the stems, are generally oval in shape, approximately 1-3 inches (2.5 - 7.5 cm.) long, and lack teeth. The upper surface of leaves is dark green to grayish-green in color, while the lower surface is covered with silvery white scales, a conspicuous charac-teristic that can be seen from a distance. The small light yellow flowers, borne along twigs, bloom in late April and May. The small (less than ¼ inch) fleshy fruits range in color from pink to red, are finely dotted with pale scales, and are produced in abundance each year.

SIMILAR SPECIES

Autumn olive is distinguished from other shrubs by the silvery white scales covering the lower leaf surface and by its elliptical or ovate leaves that often have a slightly wavy margin. Autumn olive resembles Russian olive (*Elaeagnus angustifolia*), another exotic shrub to small tree, in that leaves of both species appear silvery on the lower surface. However, Russian olive has narrower leaves that are lance-shaped. *Elaeagnus commutata* Bernh. & *E. multiflora* Thunb. are other cultivated species that may escape cultivation to become established in more natural settings. Autumn olive should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Autumn olive was introduced into U.S. cultivation in 1830 from its native range in China, Japan, and Korea. In Japan, this species is common and variable, occurring in thickets and thin woods in both lowlands and uplands. In the U.S., autumn olive has long been promoted by state and federal agencies. The species was studied in the 1940s by the Soil Conservation Service and the strain 'Cardinal' was released in 1963 for commercial propagation. In the eastern and central United States, autumn olive has been planted primarily to provide food and cover for wildlife but also as screens, windbreaks, and barriers along highways, to stabilize and revegetate road banks, and to reclaim mine spoil. The first documented collections from non-cultivated material in Missouri were made in Shannon and Warren counties in 1989 and 1988 respectively. However, due to extensive planting in the state, the species is probably now naturalized in most Missouri counties.

HABITAT

Autumn olive occurs in disturbed areas, successional fields, pastures, and roadsides, where it has been widely planted. It has been noted from prairies, open woodlands, and forest edges. Autumn olive rarely is encountered in dense forests or in very wet sites.

LIFE HISTORY

Autumn olive is a non-leguminous, nitrogen-fixing woody shrub. Plants flower and develop fruits annually after reaching 3 years of age, although 2 year old plants have been known to flower. An individual plant can produce up to 8 pounds of fruit. Seed dispersal appears to be mainly by falling fruit and birds. Birds seem to be the primary vector for dispersal, although raccoons, skunks, and opossums are known to feed on the fruit. Once established, this species is highly invasive and difficult to control. Burned, mowed, or cut plants will resprout vigorously.

CURRENT STATUS

Autumn olive is no longer grown for distribution by the George O. White State Forest Nursery, but it is available from private nurseries where its sale is not restricted. It is sometimes planted in black walnut plantations because of its nitrogen-fixing capability and because its brushy growth form reduces predation on walnut saplings.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Treatment approach can be either a selective or non-selective method depending upon site quality. Young seedlings and sprouts can be hand pulled in early spring when adequate ground moisture is present to allow removal of the root system along with above-ground growth. Autumn olive is easily seen in early spring because its leaves appear while most native vegetation is still dormant.

A combination of mechanical and chemical treatment appears to be the most successful. Cutting the plant off at the main stem and applying herbicide to the stump has been effective in killing root systems and preventing resprouting. Herbicides recommended include glyphosate, triclopyr and picloram. Roundup herbicide (a formulation of glyphosate) has been effective in controlling autumn olive when used as a 10-20% solution and applied directly to the cut stump. Although the Roundup label specifies a higher concentration for cut-stump application (50-

100%), this lower concentration has proven effective. Roundup can be applied either by spraying individual stumps with a low pressure hand-held sprayer or else by wiping each stump using a sponge applicator (sponge-type paint applicators can be used). With cut-stump treatment, herbicide is applied specifically to the target plant, reducing the possibilities of damaging nearby, desirable vegetation. Cut-stump treatment is particularly effective late in the growing season (July-September), but is also effective during the dormant season. Treatment of cut stumps should be done as soon as possible after cutting, i.e. within a few minutes. Glyphosate is a nonselective herbicide, so care should be taken to avoid contacting nontarget species. Time of treatment should be planned so that glyphosate is not applied when rain is forecast within 6 to 8 hours. By law, herbicides only may be applied according to label directions.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Same as above for high-quality natural communities. In addition, the following treatments are effective.

Thin-line basal bark treatments with triclopyr herbicide (tradename: Garlon) have demonstrated 95% kill. Undiluted Garlon 4 (or Garlon 4 diluted 50:50 with diesel fuel) should be applied in a thin, pencil-point line around the base of the plant 6-12 inches (15-30 cm.) above the ground. Application can be made with a hand-held plant sprayer and should be performed during the dormant season to minimize risk to nontarget species. A narrow band of Garlon 4 encircling the stem is needed to be effective.

Great care should be exercised to avoid getting any of the mixtures on the ground near the target plant since some nontarget species may be harmed. **This method should not be used in high quality natural areas because the diesel fuel may kill vegetation around the tree.** Avoid using Triclopyr if rain is forecast for the following 1-4 days; otherwise runoff can harm nontarget species. Foliar application of dicamba herbicides (available under the tradename Banvel) and 2,4-D herbicides (available under a variety of brand names, including Crossbow) can provide total kill with little or no regrowth the following year. Banvel is mixed at the rate of 1 oz. per gallon of water plus 1/2 oz. of surfactant. The 2,4-D herbicide should be mixed according to label instructions. One hundred percent coverage of foliage should be achieved during the growing season (April-September). Therefore, this control application can be done any time during the growing season: summer application (July-August) is especially effective. Banvel and 2,4-D are selective against broadleaf plants, so care must be taken to avoid contacting desirable, broadleaf vegetation. **Do not spray so heavily that herbicide drips off the target species. Foliar spray of herbicides should only be used in less sensitive areas because of problems with contacting nontarget species.** The herbicide should be applied while backing away from treated areas to avoid walking through the wet herbicide.

Although glyphosate (Roundup) is an effective foliar spray when applied during the growing season, it is not recommended because it is nonselective. Use of this herbicide as a foliar spray can result in unnecessary damage to nontarget species.

FAILED OR INEFFECTIVE PRACTICES

Repeated pruning of established plants to ground level without subsequent herbicide application is not effective for autumn olive control. Each regrowth results in a thicker stem base and denser branches.

Prescribed burning has not proven effective in controlling established autumn olive.

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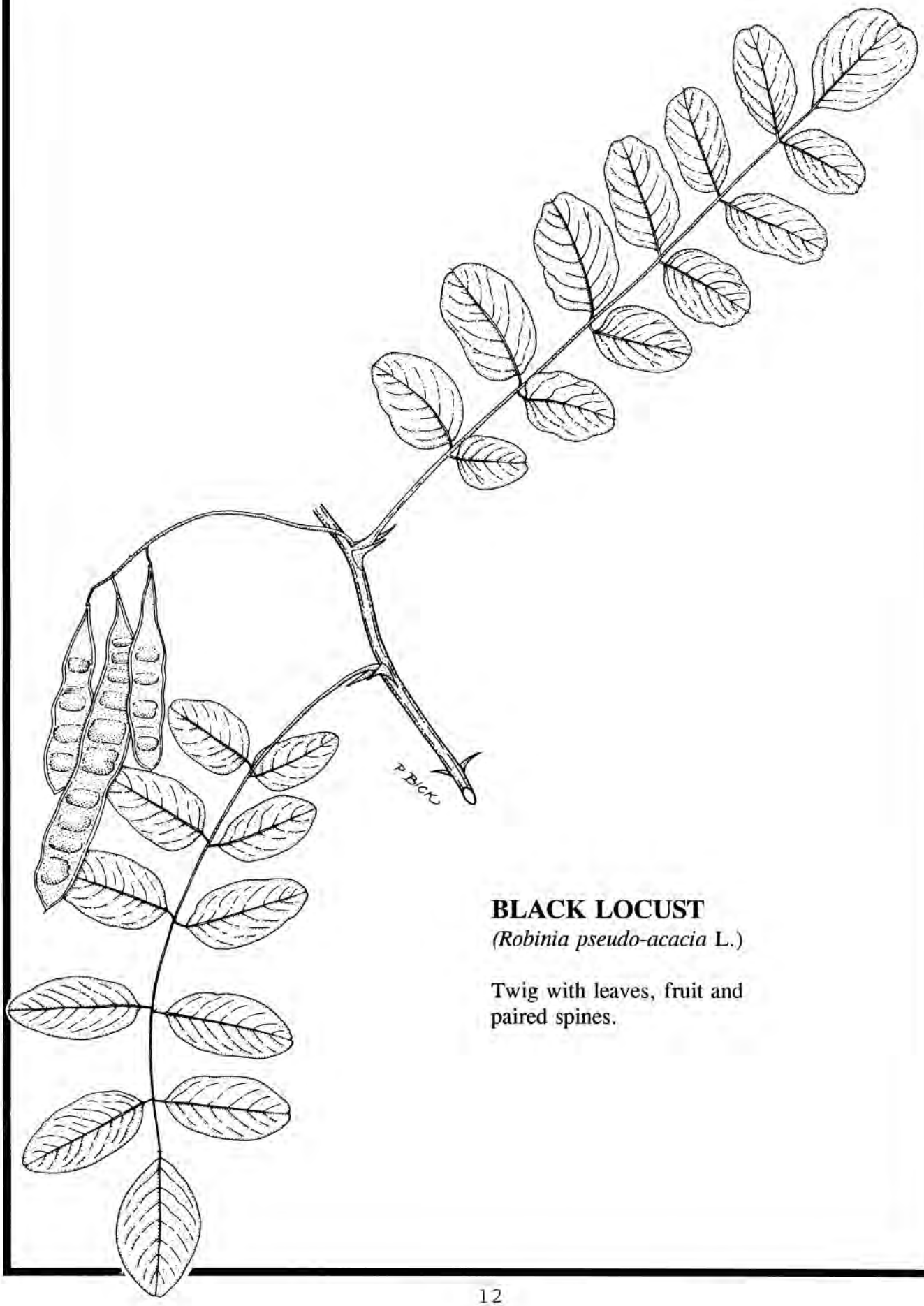

BLACK LOCUST
(Robinia pseudo-acacia L.)

Twig with leaves, fruit and paired spines.

VEGETATION MANAGEMENT GUIDELINE

Black Locust (*Robinia pseudo-acacia* L.)

NOTE: Although the following guideline is written for black locust, the control methods will also be effective for honey locust (*Gleditsia triacanthos* L.). Honey locust can be controlled more easily than black locust using the methods outlined below because it does not readily form root sprouts.

SPECIES CHARACTER

DESCRIPTION

Black locust has pinnately compound leaves that have an odd number of leaflets, with 1 leaflet at the tip. A pair of short, sharp spines occur where the leaf is attached to the strong, zigzag stem. The alternate branches lack a terminal bud. The fragrant, drooping, white, pea-like flowers each have a yellow blotch on the uppermost petal (standard), and occur in clusters that appear in May and June and develop into smooth fruit pods (legumes) up to 4 inches (10.2 cm) long, containing 4-8 seeds. In the fall its foliage turns a greenish-yellow. Black locust is a fast growing tree that attains heights over 100 feet. It puts out underground root suckers which may extend a long way, and which is a good method of propagation. Seedlings and sprouts exhibit rapid growth and heavy spines that occur in pairs. The seeds are toxic and children have been reportedly poisoned from chewing the licorice-like roots and inner bark. This is considered the most durable wood of any species in N. America. It is used in making fence posts, tree nails, rungs of ladders and policeman's clubs. It has high fuel value) 1 cord nearly equals 1 ton of anthracite coal.

SIMILAR SPECIES

This member of the legume family (Fabaceae) is distinguished by its pinnately compound leaves with up to 21 oval, smooth-edged leaflets, together with the pairs of spines where the leaf is attached to the stem. Black locust should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and /or by consulting appropriate books.

DISTRIBUTION

The natural distribution of black locust originally centered on the lower Appalachian Mountain slopes of the southeastern United States with outliers north along the slopes and forest margins of southern Illinois, Indiana, and Missouri. Planted extensively for its nitrogen-fixing

capability and hardwood qualities, black locust has been reported to be the most widely planted North American tree. Also, it is planted extensively to provide nectar for honeybees and to provide wooden fence posts. Due to its successful reproduction by root suckering, black locust (including many cultivated forms) has become naturalized throughout much of the New and Old Worlds.

HABITAT

This tree occurs in a variety of disturbed habitats including pastures, degraded woods, thickets, old fields, roadsides and other rights-of-way. It has become naturalized in upland forests, prairies, and savannas.

LIFE HISTORY

Black locust grows best in humid climates, although it has been introduced in many parts of the world where the climate is much drier. Black locust is a prolific seed-producer but seedlings are not common; few seeds germinate because of the impermeable seed coat. Most natural reproduction is vegetative by means of root suckering and stump sprouting. Root suckers arise spontaneously from the extensive root system of trees as young as 4-5 years old. Productivity of root suckers increases in full sun, in open areas, and in sandy loamy soils. They are interconnected by fibrous roots to form groves of trees with oldest plants in the center and youngest on the periphery.

EFFECTS UPON NATURAL AREAS

Black locust invades dry or moist open woodlands, stream valleys, pastures, thickets and roadsides. It can be found in upland forest natural areas where it becomes established along ridgetop logging roads, at old homesites, or in openings following natural tree fall. Eroded areas along streams also provide potential habitat for seedling establishment.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Black locust is difficult to control due to its rapid growth and clonal spread. Mowing and burning largely have proven only temporarily effective due to the tree's ability to spread vegetatively. As a result, management has concentrated on chemical control with variable success. Whatever control measure is adopted, a follow-up treatment is usually necessary.

Cutting

Spread of black locust can be hindered by repeated cutting during the growing season. All stems should be cut, and new stems that appear subsequently should also be removed in the same growing season. This treatment will probably need to be repeated for several years to achieve adequate control. Annual haying may be adequate to control first year seedlings and prevent spreading in prairie communities.

Herbicides

Best success with herbicides has resulted from basal bark application of herbicides to live standing trees. This should be done when trees are small and thin-barked (6 inches or less DBH). It is not as effective on larger trees. This method minimizes resprouting from roots and stumps when applied between mid-July and the end of December. Remedy (a formulation of triclopyr) is recommended at a 2% solution in diesel fuel. Spray basal part of brush or trees to a height of 15 to 20 inches above the ground. Thoroughly wet all basal bark areas, including crown buds and ground sprouts. A thorough spraying that includes spraying until run-off at the ground line is noticed is necessary to hinder resprouting. Applications in periods of dry weather will aid in root control.

Basal bark treatment with Garlon 4 (triclopyr) can also be effective, although resprouting has occurred in at least one instance with this treatment. Two to 2 1/2 oz. of Garlon 4 is added to one gallon of diesel fuel. Follow same directions as with Remedy. Great care should be exercised to avoid getting any of the mixtures on the ground near the target plant since some nontarget species may be harmed. Diesel fuel may kill vegetation around the target tree. Avoid using triclopyr if rain is forecast for the following 1-4 days; otherwise runoff will harm nontarget species.

Pelleted herbicides are discouraged because leaching could occur, affecting native woody plants. A variety of sprays are available for foliage or cut stump treatment, but these methods will probably require more follow-up treatments than the basal bark applications.

Krenite (a formulation of forsamine ammonium) is a non-volatile, contact, brush herbicide, applied as a spray to leaves usually during the 2-month period before fall coloration. Krenite should be applied only in July-September. Thorough coverage with a soft water carrier is required and a nonionic surfactant will improve results. A 1% solution applied as a foliar spray is effective. Krenite inhibits bud expansion in the spring, and control effects are not seen until the following spring. Slight regrowth may occur the following season but saplings will die during summer. Follow label recommendations to obtain best results; minimize drift. Care should be taken to avoid contacting non-target species.

Garlon 3A (a formulation of triclopyr) is a selective translocated herbicide that can be applied as a foliar or cut-surface treatment. Cut-surface treatment provides a high level of control of tree root systems, especially for suckering species such as black locust. Cut-surface application can be made during any season of the year, but application during the dormant season reduces the potential for drift injury. Undiluted or diluted Garlon 3A at a rate of 50% water can either be sprayed on the cut surface using a hand sprayer or else wiped on the cut surface using a sponge applicator (sponge-type paint applicators can be used). Either a stump or a girdle can be used for the cut surface. Girdles around the stem can be made quickly, using a chainsaw. Application should be within a few hours of cutting, adhering closely to label precautions and directions.

Crossbow may be sprayed on cut stumps at a 1% or 1.5% rate in the early fall, well before freezing. This kills small saplings, however suckering, partial greenup of treated trees and germination of seed may continue for a couple of years.

Glyphosate (trade name Roundup) can be foliar-sprayed on black locust leaves as a control when trees are actively growing. For good control, all leaves on all shoots should be treated. Roundup should be applied by hand sprayer at a 1/2 to 1 1/2 % solution (0.6 to 2 oz. of Roundup/gallon of clean water). Spray coverage should be uniform and complete. **Do not spray so heavily that herbicide drips off the target species.**

Black locust stems can be cut at the base with brush-cutters, chainsaws or hand tools, followed by treating the stump with a 20% solution of Roundup. While the Roundup label recommends a 50-100% concentration of herbicide for stump treatment, a 20% concentration has proven effective. The herbicide should be applied either by spraying individual stumps using a hand held sprayer or by wiping each stump with a sponge applicator. Treatment should occur immediately after cutting for best results. Application in late summer, early fall, or the dormant season has proven effective.

Glyphosate is a nonselective herbicide, so care should be taken to not let it come in contact with nontarget species. **Foliar spray of glyphosate should not be used in high quality areas because of problems with spraying nontarget species.**

In general, foliar spray application of herbicides should not be used in high quality areas because of potential damage to nontarget plants. Herbicide application to cut stumps or cut surfaces is preferred in high-quality natural areas because this minimizes damage to nontarget plants.

Any herbicide should be applied while backing away from the treated area to avoid walking through the wet herbicide. By law, herbicides only may be applied according to label directions. As mentioned earlier, follow-up treatments are usually necessary because of black locust's prolific sprouting and rapid growth.

Biological Control

The locust borer, *Megacylline robinine*, can cause serious injury and disfigurement to black locust. No information is available, however, on the use of the borer as a control method.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Dozing

Dozing may be practical consideration on some sites. A black locust planting of 300 plants was established in 1963 at the Elsberry Plant Materials Center near Elsberry, Missouri. Removal of the mature stand occurred in about 1987. Bulldozing, piling, and burning of trees followed by cultivation and planting to soybeans effectively eliminated root sprouts and seed germination. Monitor dozed sites for sprouting from roots or seed germination and follow-up with mechanical or chemical treatment. Roundup, Krenite, or Garlon may be used to treat any sprouts that appear.

Aerial application

Aerial spraying with Krenite works well on degraded sites having dense, tall infestations.

FAILED OR INEFFECTIVE PRACTICES

Tordon RTU (picloram) is a premixed general use herbicide labeled for cut-surface applications only. This herbicide kills treated black locust stems, but vigorous sprouts develop from roots. Stump treatments that do not effectively control the tree's root system may necessitate several additional years of foliar treatment of root sprouts. Tordon RTU has high soil mobility and persistence, and is no longer labelled for use on sandy soils.

Girdling kills the black locust stem that is girdled, but it does not prevent the formation of suckers.

Mowing areas around mature trees where seed pods have dropped seems to promote seed germination.

Fire kills the main stems but prolific sprouting results.

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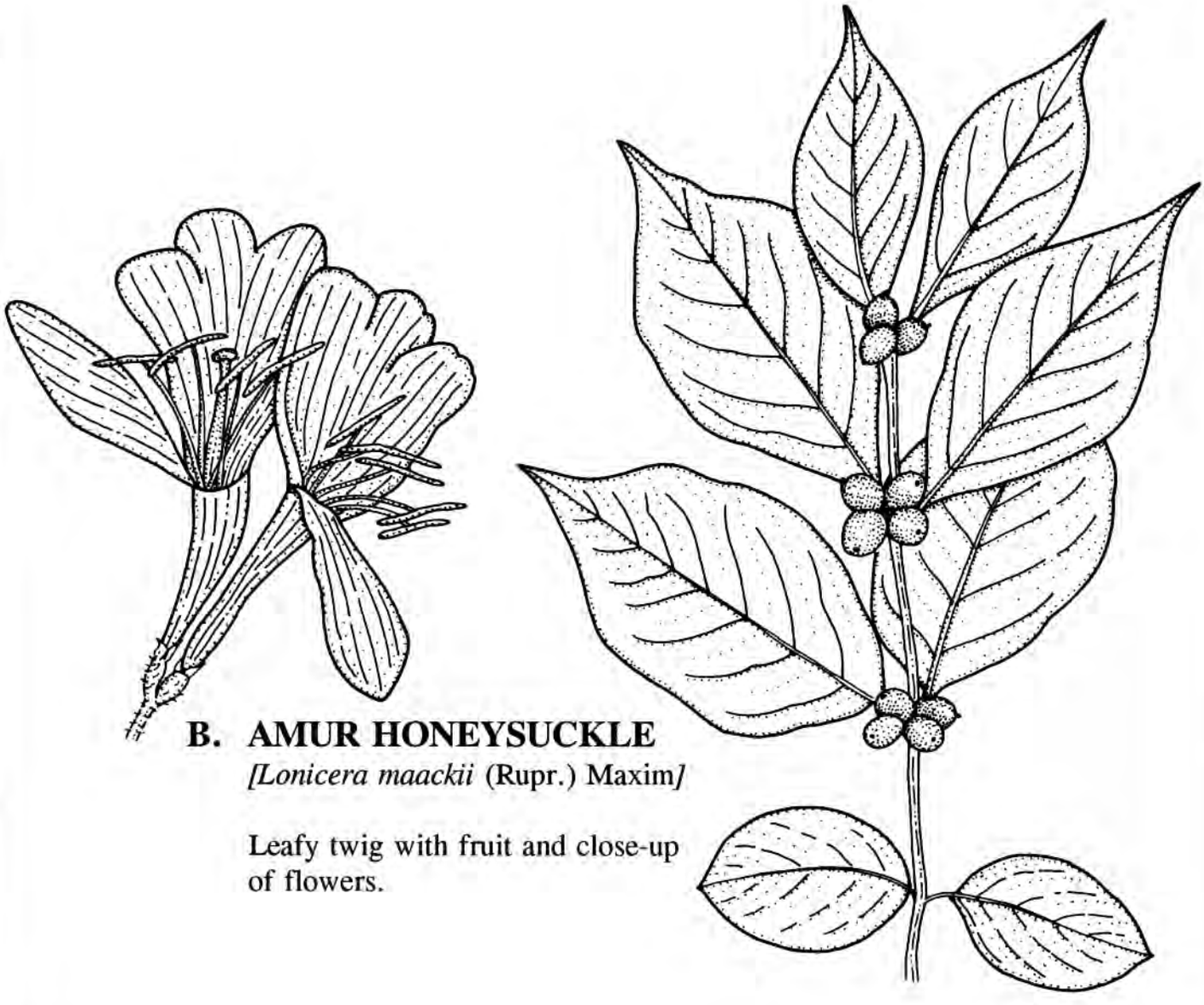
A. MORROW'S HONEYSUCKLE

(Lonicera morrowii Gray*)*

Leafy twig with fruit.



B. AMUR HONEYSUCKLE

[Lonicera maackii (Rupr.) Maxim*]*

Leafy twig with fruit and close-up of flowers.

Illustration (Shrub honeyscukles)

VEGETATION MANAGEMENT GUIDELINE

Bush Honeysuckles: Morrow's and Amur Honeysuckle [*Lonicera morrowii* Gray and *L. maackii* (Rupr.) Maxim.]

SPECIES CHARACTER

DESCRIPTION

The two species of honeysuckle shrubs planted (Morrow's and Amur) that cause the more frequently observed invasive problems will be referred to collectively as bush honeysuckles. Bush honeysuckles grow to heights of 6-20 feet (1.8-6 meters). They are deciduous, with opposite, entire leaves, and often the older branches are hollow. Differences between individual species of non-native honeysuckles are dependent on the presence of pubescence on leaves and flowers and the length of flowers and their stems. Bush honeysuckles flower during May and June. Amur and Morrow's honeysuckle flowers are both white, fading to yellow as they age. Fruits are red and are found in pairs in the axils of the leaves.

SIMILAR SPECIES

Bush honeysuckles are easily separated from native honeysuckle species by their stout, erect shrub growth. All native species are "woody twiners" that are vine-like in nature. Japanese honeysuckle, an exotic, is also a twiner. See page 63 for its description. Native honeysuckle species are grape honeysuckle (*Lonicera reticulata*), yellow honeysuckle (*Lonicera flava*), and limber honeysuckle (*Lonicera dioica*). However, a shrub should be accurately identified as a bush honeysuckle before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Bush honeysuckles are native to Asia. These species were introduced to North America in the late 1800s and 1900s. Morrow's honeysuckle and Amur honeysuckle are now known from northern and central Missouri. Although the distribution of these plants is predominately near larger urban areas, where they are used as ornamentals, rural infestations are common when the species are used to improve wildlife habitat.

HABITAT

Bush honeysuckles have a broad tolerance to a variety of moisture regimes and habitats. Most natural communities are susceptible to invasion by one or both of the species. Often the source of the invasion comes from a planting or from a highly disturbed successional community in which the honeysuckle has flourished. Both Morrow's and Amur honeysuckle frequently escape into woodlands, and Morrow's honeysuckle is sometimes found along roadsides as well. Wetlands, prairie, and forested communities are all affected. Habitat disturbance appears to facilitate introduction of these species, but native habitats without previous disturbance are also subject to invasion.

LIFE HISTORY

The spread of bush honeysuckle is generally accomplished by birds. Fruits are consumed readily upon ripening during summer. Bush honeysuckle plants commonly are found growing under tall shrubs or trees that act as perch areas for birds. Seeds appear to need a cold stratification period in order for the seed to break dormancy. Seedlings establish in areas of sparse herbaceous vegetation and can tolerate moderate shade. It is suspected that bush honeysuckles may produce allelopathic chemicals that enter the soil and inhibit the growth of other plants, preventing native plants from competing with the shrub. Shading by bush honeysuckle may also limit the growth of native species. Bush honeysuckles leaf out before many native species and hold their foliage until November.

EFFECTS UPON NATURAL AREAS

Bush honeysuckles will invade a wide variety of native habitats with or without previous disturbances. Affected natural communities in Illinois include: lake and stream banks, marsh, fens, sedge meadow, wet and dry prairies, savannas, floodplain and upland forest. Mesic upland and bottomland forests in Missouri are known to contain invasive stands.

CONTROL RECOMMENDATIONS

Control measures may enlist one or more of the following techniques: prescribed burning, hand pulling of seedlings, cutting, and herbicide treatments.

A recently introduced pest, the European Honeysuckle aphid, somewhat controls flower and fruit production in some of the bush honeysuckles. Heavy infestations cause tips of branches to form "witches brooms' or deformed twigs. This often greatly reduces fruit production. Native ladybug beetles, however, have been noted to control this aphid.

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

In fire-adapted communities, spring prescribed burning will kill seedlings and kill the tops of mature plants. Bush honeysuckles readily resprout and repeated fires are necessary for adequate control. It may be necessary to burn annually or biennially for five years or more for effective control.

Seedlings may be hand-pulled when soils are moist. All of the root should be removed or resprouting will occur. Physical removal by hand-pulling smaller plants or grubbing out large plants should not be used in sensitive habitats. Open soil and remaining root stocks will result in rapid reinvasion or resprouting of honeysuckles and other exotics.

Bush honeysuckle stems can be cut at the base with brush-cutters, chainsaws or hand tools. After cutting, a 20% solution of glyphosate should be applied to the cut stump either by spraying the stump with a low pressure hand-held sprayer or wiping the herbicide on the stump with a sponge applicator to prevent resprouting. Glyphosate is available under the tradenames Roundup and Rodeo, products manufactured by Monsanto. While the Roundup and Rodeo labels recommend a 50-100% concentration of herbicide for stump treatment, a 20% concentration of Roundup has proven effective. It is not known if this lesser concentration is effective for Rodeo also. Rodeo can be used in wetlands and over open water, but Roundup is only labelled for use in non-wetlands. Herbicides should be applied to the cut stump immediately after cutting for best results. Application in late summer, early fall, or the dormant season has proven effective. Some resprouting may occur with a follow up treatment being necessary. Glyphosate is non-selective so care should be taken to avoid contacting non-target plants. The wood of bush honeysuckles is very tough and easily dulls powertool blades.

Underplanting of native species following honeysuckle removal may be necessary to reestablish a desirable composition of groundcover, shrubs, and understory trees. This may also minimize the risk of reinvasion by shrub honeysuckles and other exotics.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Methods given above for high-quality natural communities are also effective and preferred on buffer and disturbed sites. When an area with bush honeysuckle lacks sufficient fuel to carry a fire, herbicides may be necessary to obtain control.

In dry, upland areas, a foliar spray of 1% Roundup (glyphosate) will control seedlings. A 1-1/2% foliar spray of Roundup just after plant blooming in June will control mature shrubs. Application should occur from late June to just prior to leaf color changes in fall. The herbicide should be applied while backing away from treated areas so as not to walk through

the wet herbicide.

In areas near water, a foliar spray of 1% Rodeo (glyphosate) with Ortho-X27 spreader, will control seedlings. Application should occur from late June to just prior to changes in leaf color in the fall. Foliar application of a 1-1/2% solution of Rodeo (2 oz. Rodeo/gallon clean water) will kill mature plants if all foliage is sprayed. This control method usually requires less labor but more herbicide.

In addition, Krenite controls bush honeysuckle when applied according to label instructions.

Any treatment should be rechecked in following years for reinvasion. Glyphosate is a nonselective herbicide and care should be taken to avoid contacting nontarget plants with herbicide. Do not spray so heavily that herbicide drips off the target species. By law, herbicides only may be applied according to label instructions.

FAILED OR INEFFECTIVE PRACTICES

The herbicide Garlon does not control bush honeysuckle.

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Illustration (Canada thistle)

CANADA THISTLE

[Cirsium arvense (L.) Scop.*]*

Upper stem with leaves, spines and flower heads.

VEGETATION MANAGEMENT GUIDELINE

Canada Thistle [*Cirsium arvense* (L.) Scop.]

SPECIES CHARACTER

DESCRIPTION

Canada thistle is a 2 to 5 foot (0.6 to 1.5 meters) tall forb with deep, wide spreading, horizontal roots. The grooved, slender stems branch only at the top and are slightly hairy when young, becoming covered with hair as the plant grows. The oblong, tapering, sessile leaves are deeply divided, with prickly margins. Leaves are green on both sides with a smooth or slightly downy lower surface. Numerous small, compact (3/4 inch or 1.9 cm diameter), rose-purple or white flowers appear on upper stems from June to September. Seeds are small (3/16 inch or 0.5 cm long), light brown, smooth and slightly tapered, with a tuft of tan hair loosely attached to the tip.

SIMILAR SPECIES

Canada thistle is distinguished from other thistles (*Cirsium* spp.) by its deep-running perennial rootstocks, more slender stems, and small compact heads. Canada thistle should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Canada thistle, which is naturalized from Europe, occurs throughout the northern U.S. east of the Rocky Mountains. It is scattered throughout the northern two-thirds of Missouri. Missouri distribution is poorly documented due to a lack of collecting of weedy thistles by botanists.

HABITAT

Canada thistle does best in disturbed areas (overgrazed pastures, old fields, waste places, fence rows, along roadsides). It sometimes occurs in wet areas where water levels fluctuate (along stream banks and ditches). It can invade sedge meadows and wet prairies from adjacent disturbed sites. This thistle does not do well in undisturbed prairies, good to excellent pastures, or in woodland. Plants are tall and lax, with few flowers, on sites that are shaded most of the day.

LIFE HISTORY

This dioecious, weedy perennial occurs in patches, commonly in disturbed areas. Introduction to new areas occurs mostly by windborn seed or sometimes by run-off in ditches. It spreads rapidly by rhizomes or root segments. Lateral roots 3 or more feet deep spread from a fibrous taproot. Aerial shoots are sent up at 2 to 6 inch intervals. Basal leaves are produced the first year, flowering stems the next. Pollination is mostly by honeybees, and wind pollination is limited. Most seeds germinate within one year. Some seeds immediately produce rosettes before winter and emerge to flower the next spring. Seeds remain viable in soil up to 20 years in some cases. Emergence occurs in early May, with bolting in mid-to-late June. As frequency of Canada thistle increases at a site, species diversity decreases, possibly due to allelopathic substances.

EFFECTS UPON NATURAL AREAS

Canada thistle is an alien species capable of crowding out and replacing native grasses and forbs. It is detrimental to natural areas where it occurs, particularly non-forested communities, and it can change the natural structure and species composition where it becomes well-established. Prairies, barrens, savannas, and glades are susceptible, particularly those sites that have been disturbed and are reverting naturally to native species, as well as those undergoing manipulative restoration management.

CURRENT STATUS

Canada thistle is a noxious weed under Missouri law. As such, all landowners are required to control the plant if it is growing on their property. Control is considered to be prevention of seed production. County prosecuting attorneys are required to notify offending landowners in a prescribed manner before leveeing penalties.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Prescribed fire can be effective in controlling this species and is a preferred treatment. Late spring burns, between May and June, are most detrimental to this noxious weed and should be used when possible. Prescribed burns to control this plant should not be conducted early in the spring, as early spring burns can increase sprouting and reproduction of this species. During the first 3 years of control efforts, burns should be conducted annually.

Management practices that maintain and encourage the development of healthy stands of native species will help prevent establishment of Canada thistle or help shade and weaken plants on sites already infested.

Repeated and frequent pulling or hand-cutting of individual plants will eventually starve underground stems. Cutting or pulling should be at least 3 times each season, in June, August, and September. This treatment is feasible for light and moderate infestations, but may be relatively time consuming in heavy infestations.

Spot application of the amine formulation of 2,4-D according to label instructions can control this plant. Individual plants of Canada thistle should be treated with a wick applicator or hand sprayer. The herbicide 2,4-D amine is selective for broadleaf plants. To reduce vapor drift, use an amine formulation of 2,4-D rather than an ester formulation. Precautions should be taken to avoid contacting nontarget plants with the solution. Do not spray so heavily that herbicide drips off the target species. The herbicide should be applied while backing away from the areas to avoid walking through the wet herbicide. By law, herbicides may only be applied as per label instructions.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Control procedures recommended above for high quality natural communities are also applicable to buffer and severely disturbed sites. Additional control measures are as follows. On large sites (old fields, ditch banks, roadsides) with heavy infestations, thistles should be mowed when in full bloom, and as close to the ground as possible. Cut flower-heads should be removed to prevent scattering seeds on site. Repeated mowing may be needed for several years to obtain adequate control.

A foliar application of a 1-2% solution of Roundup (a formulation of glyphosate) applied in spring when plants are 6-10 inches (15.2 -25.4 cm) tall is an effective herbicide treatment. Individual plants should be spot-treated with a wick applicator. Roundup normally kills the entire plant, including the roots, when applied in this manner. Roundup is a nonselective herbicide and precautions should be taken to avoid contacting nontarget plants with the solution. **Do not spray so heavily that herbicide drips off the target species.** As with 2,4-D amine, Roundup should be applied while backing away from the areas to avoid walking through the wet herbicide. Roundup should not be used in high-quality natural areas during the growing season because of the possibility of harming nontarget plants.

On severely disturbed sites with heavy infestations, such as cropland or abandoned cropland, the site could be plowed and sowed to a cover crop (wheat, alfalfa, rye), if practical and desirable. The following May, the cover crop should be plowed under and desired native species should be seeded.

FAILED OR INEFFECTIVE PRACTICES

Fire early in the growing season can increase sprouting and reproduction. Prescribed burns in late spring are effective, as discussed previously.

Tillage disturbance of soil may provide ideal conditions for reinvasion and for introduction of other exotics.

Grazing is not an effective control measure as the prickles prevent livestock from grazing near Canada thistle.

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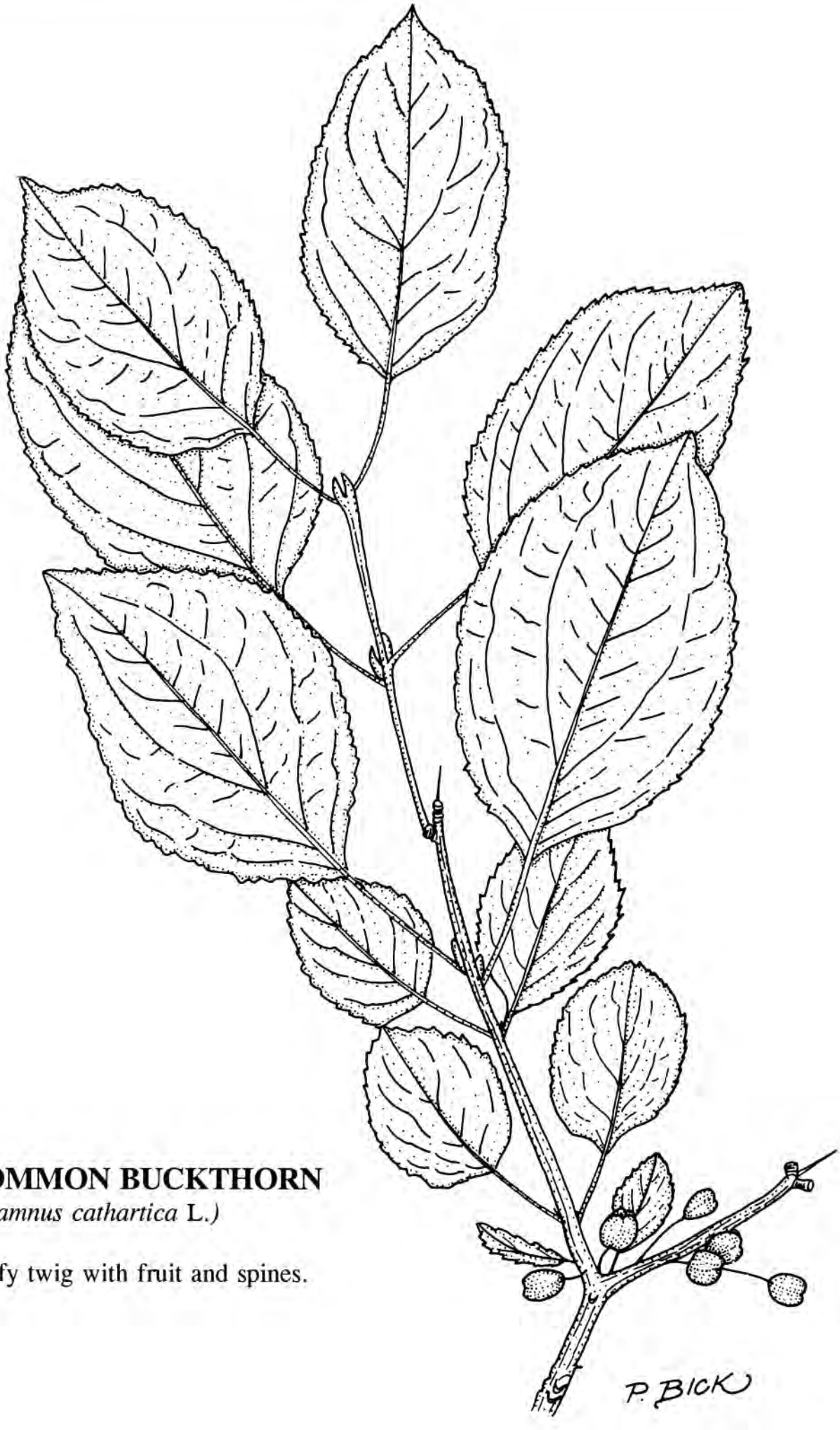
Illustration (Common buckthorn)



COMMON BUCKTHORN
(Rhamnus cathartica L.*)*

Leafy twig with fruit and spines.

VEGETATION MANAGEMENT GUIDELINE

Common Buckthorn (*Rhamnus cathartica* L.)
Other names: European buckthorn, Hart's thorn, waythorn, rhineberry

SPECIES CHARACTER

DESCRIPTION

Common buckthorn ia a shrub or small tree reaches heights of 25 feet (7.6 meters); trunk diameter is up to 10 inches (25 cm); crown is spreading and irregular. The bark is gray to brown, showing a rough texture when mature. Twigs are often tipped with a spine. Leaves and bud scars are nearly opposite to opposite. Small black fruits up to 1/4 inch (0.6 cm) diameter and containing 3-4 seeds are typical. Leaves are broadly elliptic, rounded to pointed at the tip, and toothed. Both upper and lower leaf surfaces are smooth. Leaves stay green late into fall.

SIMILAR SPECIES

Two native species of buckthorn are found in Missouri. These are Carolina buckthorn (*Rhamnus caroliniana*) and lance-leaved buckthorn (*Rhamnus lanceolata*). Carolina buckthorn is essentially restricted to the Ozark region in Missouri, whereas lance-leaved buckthorn is found throughout the state with the exception of the Mississippi Lowlands of southeast Missouri. Both species grow in soils derived from limestone or dolomite. Common buckthorn can be distinguished from both native species by its opposite or near opposite leaf arrangement and by the presence of spiny tips on its twigs. Its leaves are abruptly pointed to rounded at the tip, whereas the two native species both have leaves that are more gradually tapered to a point at the tip.

Common buckthorn should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

This exotic buckthorn is an endemic of Eurasia that was introduced to North America as an ornamental shrub. It has become naturalized from Nova Scotia to Saskatchewan, south to Missouri and east to Virginia. Distribution records from Missouri are scattered, but the species probably has the potential for establishment throughout the state.

HABITAT

Common buckthorn inhabits woodlands and savanna. It is quite sun tolerant, as it is also found in prairies and abandoned fields. It is cultivated for hedges and wildlife habitat and is used in shelterbelt plantings. It has become naturalized in pastures, fencerows, roadsides, and slopes of ravines.

LIFE HISTORY

Common buckthorn produces fruit that is readily eaten by birds. The severe laxative effect of the fruits readily distributes seeds. The shrub readily resprouts from cut or damaged stems.

EFFECTS UPON NATURAL AREAS

Common buckthorn readily invades natural communities. Once established, it crowds or shades out native shrubs and herbs. It can invade woodlands, savannas, and prairies.

CURRENT STATUS

Exotic buckthorns are sold as ornamentals by several nurseries, and are used as hedges in many urban areas. There are no current legal restrictions on the sale or propagation of these plants.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

As with all management, control efforts must balance improvement of the biotic community with damage caused by the management. It is always best to take the least damaging approach that will affect the desired control of an exotic. The following are effective control measures for common buckthorn.

Fire is sometime effective in controlling buckthorn. Regular prescribed fire will kill seedlings and stems of this species in fire-adapted upland sites, although resprouting may occur. Some control usually will be evident after the first burn. However, for complete control in established stands of buckthorn, burning yearly or every other year may be required for 5-6 years or more. Early spring burns, late April to early May, capitalize on the fact that buckthorn leafs out earlier than most native shrubs. Burning shortly after leaf out may reduce resprouting, since root reserves will be low at that time. Fire should not be used to control this species if the community will be affected adversely. Burns should be conducted by

persons trained or experienced in conducting prescribed burns, and proper safety precautions should be followed.

When burning is not feasible, larger trees can be cut or girdled and resprouts clipped as they occur. When using chainsaws and other power equipment, proper safety equipment and precautions need to be used. For safety recommendations refer to your chainsaw owner's manual. For girdling to be effective, use an ax or saw to make 2 parallel cuts 4-5 inches apart, cutting through the bark slightly deeper than the cambium. The bark is then either knocked off, using a blunt object like an ax head, or peeled away, using a blunt ax blade. Phloem should be removed without damaging the xylem. Girdles should be checked after a few weeks to make sure that bark does not develop over the cut area. Girdled trees take time to die and the results may not be seen until a year later. Basically, the tree is slowly starving to death. All suckers should be cut. Since girdling will probably produce abundant sprouting below the girdle, the cut-stump treatment described below will provide a more efficient means of control by eliminating sprouting.

In upland areas where burning is not feasible, cut stumps can be treated with Trimec (a formulation of 2,4-D, MCCP and Dicamba) or Roundup (formulation of glyphosate) to prevent resprouting. Trimec, an herbicide specific for broadleaf plants, should be diluted with an equal portion of water and applied according to label instructions. Roundup is non-specific and kills all photosynthetically active vegetation. Although the Roundup label recommends a rate of 50-100% for cut-stump treatment, a 50% solution has proven effective. Autumn is the preferred time to cut and stump-treat buckthorn, because 1) buckthorns retain green leaves late into the fall, making it easy to find all plants and 2) most native vegetation is dormant, minimizing the potential harm to non-target plants.

To be effective, the herbicides mentioned above must be applied immediately after cutting. Consult appropriate herbicide label(s) for specific application directions. These chemicals can be applied either by spraying individual cut stumps with a low pressure hand sprayer or else by wiping the herbicide on each cut stump with a sponge applicator (sponge-type paint applicators can be used). Care should be taken to avoid herbicide contact with nontarget plants. Native nontarget plants will be important in recolonizing the site after buckthorn is eliminated. By law, herbicides may only be applied according to label directions.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Same as given above for high-quality areas, with the following additions:

In addition to the cut-stump treatments recommended above, Garlon 3A (a formulation of triclopyr) is a selective, translocated herbicide that can also be applied on cut stumps. A 50% Garlon solution diluted with water can be sprayed, using a hand sprayer, to the cut stump. Application should be within minutes of cutting. Cut-surface application can be made during

any season of the year, but application during the dormant season reduces the potential for drift injury.

Dormant season basal-bark treatment using Garlon 4 herbicide is effective on trees and resprouts less than 6 inches in diameter, however, this treatment is not labelled for use in wetlands. Two to 2 1/2 oz. of Garlon 4 is added to one gallon of diesel fuel. Spray this mixture, using a hand sprayer, to the basal portion of the trunk. Spray to a height of 12-15 inches (30.5-38.1 cm.). A thorough spraying is necessary. **This treatment should not be used in high quality natural areas because the diesel fuel may kill vegetation around the tree.**

Another formulation using Garlon 4 has been used successfully in the spring and fall at Cuivre River State Park in Lincoln County, Missouri. Managers there used a mixture of Garlon 4 (25%), Cide-kick (10%), and diesel fuel (65%) as a thinline treatment for common buckthorn. Cide-kick is a spreading agent that improves the ability of a spray to encircle a stem when sprayed from one side. If the treatment is done during the dormant season, the percentage of Garlon 4 may be increased to 30%. Stems under two inches in diameter were sprayed on only one side. Larger stems were sprayed all the way around. All but the larger trees were killed completely using this method. Fall treatment was preferred because of the ease of spotting buckthorn after most other vegetation had lost its leaves.

Use of Garlon 4 is best done in the dormant season to lessen damage to nontarget species. Great care should be exercised to avoid getting any of the mixtures on the ground near the target plant since some nontarget species may be harmed. Avoid using Garlon 4 if rain is forecast for the following 1-4 days; otherwise runoff will harm nontarget species.

In areas of heavy infestation, a large seedbank of common buckthorn in the soil will probably necessitate repeated control measures for a period of years, as new seedlings emerge.

Seedlings or small plants may be hand pulled or removed with a grubbing hoe or larger plants may be pulled out with heavy equipment. Excavation often disturbs roots of adjacent plants, or creates open soil that may be readily colonized by new seedlings. This technique may be most useful to control invasion at low densities, or along trails, roads, and woodland edges.

FAILED OR INEFFECTIVE PRACTICES

No effective biological controls that are feasible in natural areas are known.

Girdling or cutting without chemically treating the stumps will cause sprouting that will require retreatment by cutting or using foliar sprays.

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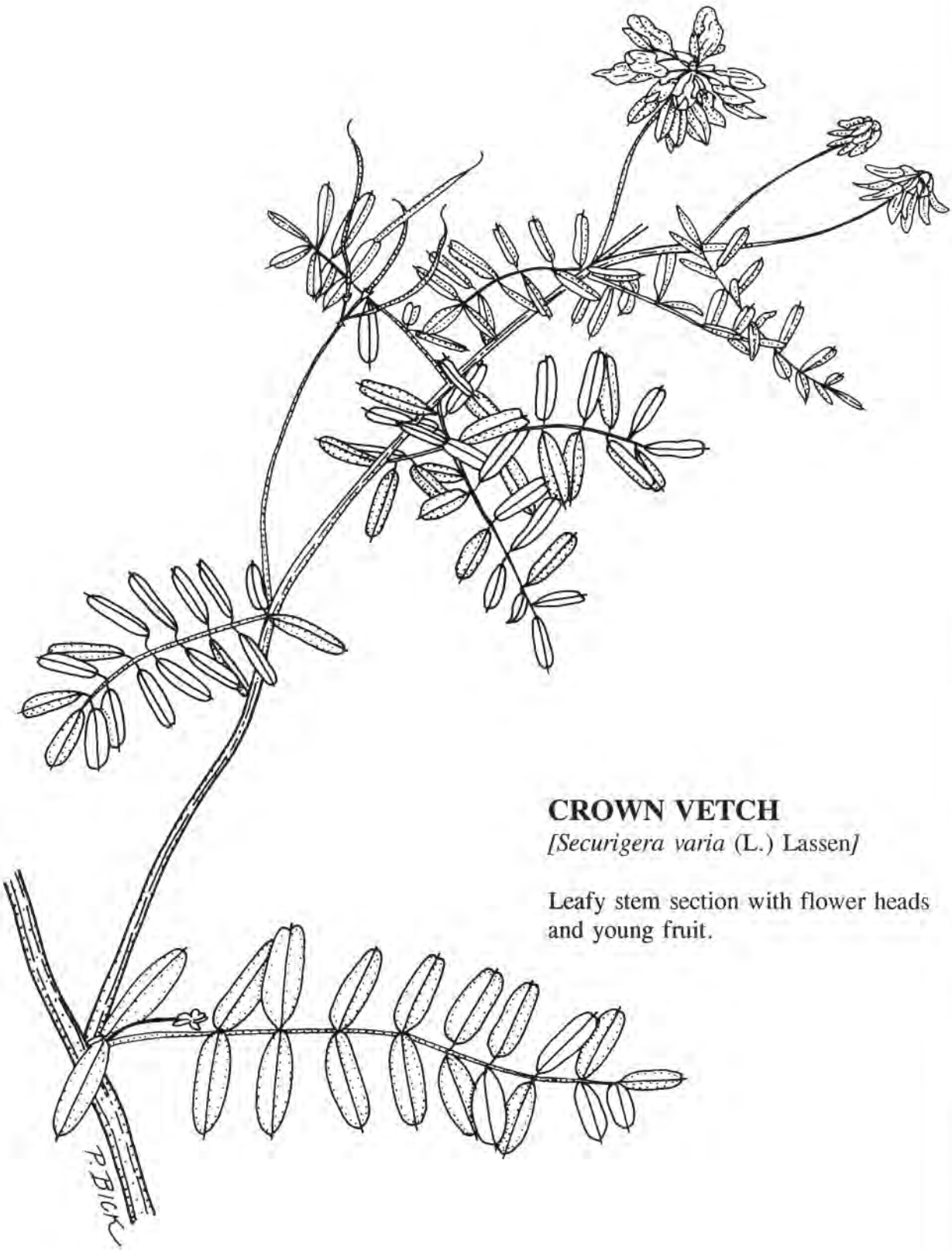
Illustration (Crown vetch)



CROWN VETCH
[Securigera varia (L.) Lassen*]*

Leafy stem section with flower heads and young fruit.

VEGETATION MANAGEMENT GUIDELINE

Crown Vetch [*Securigera varia* (L.) Lassen]
Synonym: *Coronilla varia* L.

SPECIES CHARACTER

DESCRIPTION

Crown vetch is a perennial legume that reproduces by seeds and spreads vegetatively. It can form large clumps from creeping stems. The stems can be up to 6 feet (1.8 meters) long. Crown vetch has rhizomes up to 10 feet (3.04 meters) long which allow the plant to spread rapidly. The vegetative growth habit can rapidly cover and shade out native vegetation. A single plant may fully cover 70 to 100 square feet within a four year period (Anonymous, 1963). The compound leaves consist of 15-25 pairs of oblong leaflets. The flowers are pinkish and are clustered in umbels on long stalks. The flowers develop into narrow, flattened pods. The agent of dispersal is not known, however animals may play a role in dispersal since some populations have turned up miles from a nearby seed source. The seeds are reported to be poisonous (Steyermark, 1963). Crown vetch blooms from May through August. It is found most easily during blooming, when its profuse pinkish blossoms are conspicuous.

SIMILAR SPECIES

Crown vetch is distinguished from other plants in the legume family by the following characteristics: 1) compound leaves with an odd number of leaflets ranging between 15-25, 2) the presence of leaves and flower stalks arising from the main stem, and 3) the occurrence of flowers in an umbel. Crown vetch should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

The natural distribution of crown vetch is Europe, southwest Asia and northern Africa. It is introduced or naturalized in the United States from Maine to South Dakota, south to Virginia, West Virginia, Kentucky, Illinois, and Missouri. It is widespread in Missouri, having been extensively planted on rights-of-way along the interstate highway system.

HABITAT

Crown vetch has been grown extensively in the northern two-thirds of the United States for temporary ground cover, erosion control, and as a green fertilizer crop. It is also used as a

bank stabilizer along roads and waterways. This plant prefers open, sunny areas. It occurs along roadsides and other rights-of-way, in open fields and on gravel bars along streams.

LIFE HISTORY

Flowers appear from May to August. Crown vetch is a perennial, herbaceous plant that can spread rapidly by seed and by its multi-branched, creeping rhizomes.

EFFECTS UPON NATURAL AREAS

Crown vetch is a serious management threat to natural areas due to its seeding ability and rapid vegetative spreading by rhizomes. This aggressive exotic is now widespread along roadsides, from where it may become a serious invader of Missouri's natural areas.

CONTROL RECOMMENDATIONS

Repeated late spring mowing has shown some success (Heim, 1990). Probably the best method would be to perform several mowings per year over several years. If not completely controlling crown vetch, mowing offers a method of stopping its spread. Mowing around the periphery of a natural area threatened by crown vetch may keep the vetch from spreading into the natural area vegetatively but will not control the spread of seeds.

Herbicides, at the present time, appear to be the most effective means of control. Three different herbicides (2,4-D amine, Triclopyr, and Glyphosate) have been used with varying success. Another herbicide that shows some promise, but has not been tested sufficiently yet is Clopyralid.

2,4-D amine is sold under a number of trade names. The amine, low volatility formation should probably be used over the high volatility ester formulation. Drift can become a problem with the ester formulation. 2,4-D amine applied during the growing season will kill back the above ground portions, although there has been some survival of crown vetch in treated areas. This ineffectiveness of the herbicide could be the result of incomplete treatment, or re-establishment through seeds. There are some formulations of 2,4-D amine made just for controlling legumes. These formulations have not been tried, but may do a better job of controlling crown vetch. 2,4-D amine has the advantage of being dicot specific, so grasses will not be harmed.

Glyphosate, sold under the trade name Roundup has also been successful, but not 100%. A 1-1.5% solution of Glyphosate has been used and has killed back crown vetch with results similar to 2,4-D amine. It is believed that incomplete herbicide coverage was the reason for survival of crown vetch in some treated areas. Many crown vetch infestations may be a single

plant or only a few plants, and it may be necessary to get uniform coverage over all the above ground stems. Small populations of single plants have been successfully controlled using Glyphosate. Glyphosate is a nonselective herbicide, so any other plants covered with the herbicide will be affected. Rodeo should be used, rather than Roundup, for infestations along streams or near any other aquatic community.

Triclopyr, under the trade name Garlon 3A has shown the most promise to date. A 2% solution has been successful in killing 99% of the crown vetch in large infestations. The 1% survival rate may be due to incomplete coverage or re-establishment by seeds. It is thought that incomplete coverage may be the reason for less than total control. Triclopyr has the advantage that it is dicot specific. Some brown out of grasses may occur but is usually only temporary.

Another herbicide that may be successful is Clopyralid under the trade name Transline. Transline is more specific than Triclopyr, it is quite effective on the plant families: Compositae, Leguminosae, and Polygonaceae, with very little effect on most grasses and most other plant families (Colby, et al., 1989). Because of the very specific nature of Clopyralid, fewer non-target species will be affected. Clopyralid has been successful in controlling crown vetch along roadsides (Mike Stafford, pers. com.). There is no research on the relative success of Clopyralid. Clopyralid shows promise, but more research is needed.

These herbicides can be used as spot treatment with backpack sprayers, or can be used with high volume equipment (e.g. booms). Whichever herbicide is used it appears that complete coverage of all crown vetch stems is necessary. The spray on the leaves should be thorough to the point of runoff. Prior prescribed burning will be helpful to remove accumulated plant litter to insure complete herbicide coverage of the foliage. It is necessary to perform a follow-up treatment to get any stems missed or new seedlings. By law, herbicides may only be applied according to label directions.

ADDITIONAL SUGGESTIONS ON CONTROL OF CROWN VETCH

Crown vetch spreads rapidly and appears to be difficult to control. Several years of treatment may be necessary to totally eradicate crown vetch from a natural community. It is important to prevent any seed production as well as to control the vegetative spread. It is useful to map locations of infestations so that they can be readily located in future years. When crown vetch is blooming its many pink blossoms make it quite noticeable and easy to locate. New populations can be located and treated during blooming. Previously located populations should be treated earlier and retreated later.

Crown vetch has many characteristics that make it a tough exotic to control. It is necessary to locate it early and start treatment early. Watch for it along highway rights-of-way and eradicate it before it invades a natural area.

Seedlings and resprouts can be difficult to locate in native vegetation. Thick native vegetation can make detection of small plants difficult. Prescribed burning may be useful in removing litter for detection, but later in the season some plants may go unnoticed.

FAILED OR INEFFECTIVE PRACTICES

Prescribed burning alone has not been successful. Prescribed burning may be effective against seedlings or in slowing the spread of crown vetch, but it will not control large populations. Large populations of crown vetch will shade out all other vegetation and there is not enough fuel in crown vetch vegetation to carry a fire. The periphery of the crown vetch where there is some grass fuel may be set back, but the center of the population will not be affected.

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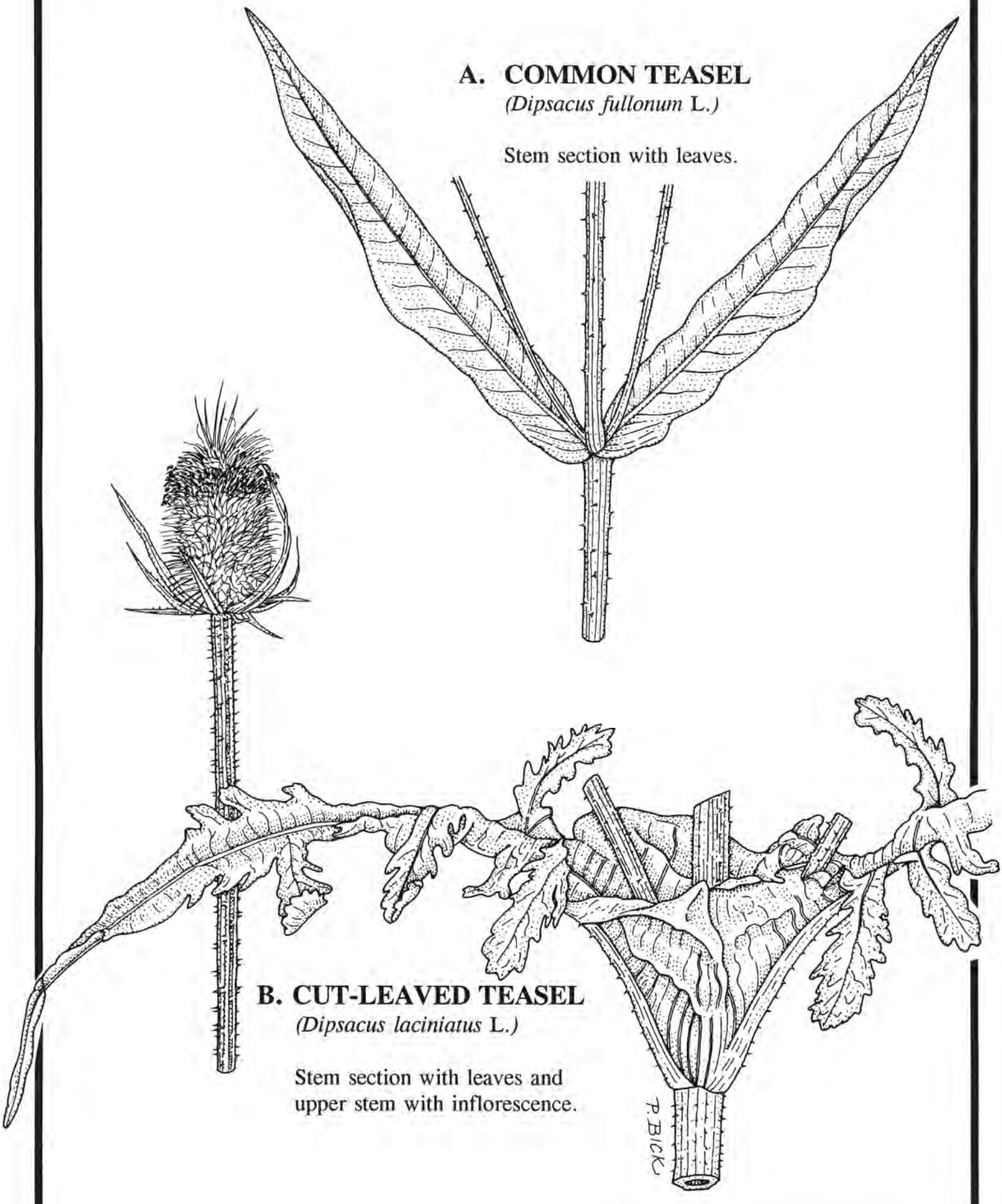
Illustration (Common Teasel)



A. COMMON TEASEL

(Dipsacus fullonum L.*)*

Stem section with leaves.

B. CUT-LEAVED TEASEL

(Dipsacus laciniatus L.*)*

Stem section with leaves and upper stem with inflorescence.

VEGETATION MANAGEMENT GUIDELINE

Cut-leaved Teasel (*Dipsacus laciniatus* L.)
Common Teasel (*Dipsacus fullonum* L.)

SPECIES CHARACTER

DESCRIPTION

Although usually called a biennial, teasel is better described as a monocarpic perennial. The plant grows as a basal rosette for a minimum of one year (this rosette period frequently is longer) then sends up a tall flowering stalk and dies after flowering. The period of time in the rosette stage apparently varies depending on the amount of time needed to acquire enough resources for flowering to occur.

During the rosette stage leaves vary from somewhat ovoid in young plants to large and oblong leaves that are quite hairy in older rosettes. During the rosette stage teasel develops a large tap root. The tap root may be over 2 feet (0.6 meter) in length and 1 inch (2.5 cm.) in diameter at the crown.

Cut-leaved teasel blooms from July through September, and common teasel blooms from June through October. Flowering plants have large, oblong, opposite, sessile leaves that form cups (the cups may hold water) and are prickly, especially on the lower midrib. Stems also are prickly. Teasel's unique inflorescence makes the plant readily identifiable when blooming. Flowers are small and packed into dense oval-shaped heads. The heads (inflorescences) are subtended by upcurved bracts and are located terminally on the flowering stems. Cut-leaved teasel usually has white flowers, while common teasel usually has purple flowers. Cut-leaved teasel can also be distinguished from common teasel by its irregularly pinnately-lobed upper stem leaves. Upper stem leaves of common teasel have smooth margins. Flowering stems may reach 6-7 feet (1.8-2.1 meters) in height.

Cut-leaved and common teasel should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Teasel is endemic to Europe. It was introduced to North America possibly as early as the 1700's. Common teasel was introduced for use in raising the nap of cloth. Possibly, cut-leaved teasel was introduced with common teasel or introduced accidentally with other plant material from Europe. Teasel has spread rapidly in the last 20-30 years, spreading from Quebec and Maine to Ontario and Michigan, then south to North Carolina, Tennessee and Missouri. This rapid range expansion probably was aided by construction of the interstate highway system.

Teasel has colonized many areas along interstates. Common teasel sometimes is used as a horticultural plant, which has aided in expansion of its North American range. In particular, the use of teasel in flower arrangements has aided its dispersal, especially to cemeteries.

HABITAT

Teasel grows in open sunny habitats, ranging from wet to dry conditions. Optimal conditions seem to be mesic habitats. In Illinois, teasel sometimes occurs in high quality prairies, savannas, seeps, and sedge meadows, though roadsides, railroads, dumps and other heavily disturbed areas are the most common habitats of teasel. Missouri locations are predominately highway rights-of-way at present, but the potential is great for eventual spread into a variety of other natural and disturbed sites.

LIFE HISTORY

A single teasel plant can produce over 2,000 seeds. Depending on conditions, up to 30-80% of the seeds will germinate, so each plant can produce many offspring. Seeds also can remain viable for at least 2 years. Seeds typically don't disperse far; most seedlings will be located around the parent plant. Parent plants often provide an optimal nursery site for new teasel plants after the adult dies. Dead adult plants leave a relatively large area of bare ground, formerly occupied by their own basal leaves, that new plants readily occupy. Seeds may have the capacity to be water-dispersed, which may allow seeds to be dispersed over longer distances. Immature seed heads of cut-leaved teasel are capable of producing viable seed. Common teasel may also have this capability.

EFFECTS UPON NATURAL AREAS

Teasels are aggressive exotic species that have the capacity to take over prairies and savannas if allowed to become established. Lack of natural enemies allows teasel to proliferate. If left unchecked, teasel quickly can form large monocultures excluding all native vegetation. Cut-leaved teasel is more aggressive than common teasel and has severely threatened several northern and central Illinois natural areas.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

For small populations or if large cheap labor pools (volunteers) are available mechanical methods work quite well. Young rosettes can be dug up using a dandelion digger. Just as in

digging up dandelions, as much of the teasel root needs to be dug up as possible. Once the rosettes get large, it is difficult to dig the roots up without doing damage to the natural area around the plant. Very small seedlings can be pulled up by hand when the soil is moist.

Flowering plants can be cut before seed set. At the initiation of flowering, the flowering heads should be cut off and removed from the natural area. Removed immature seed heads left in place can still develop some viable seeds. Once the flowering heads have been removed, the flowering stalk should be cut off at or slightly below ground level. A machete is useful in cutting off the flowering stalks. Cutting off the flowering stalks just at flowering time will usually prevent resprouting from the root crown. Cutting flowering stalks prior to flowering should be avoided since the plants will resprout and flower again. A later inspection should be performed to catch any root crowns that do resprout.

Probably the most cost effective method of control is the use of foliar applied herbicides. Any of the herbicides recommended below for buffer or disturbed sites can be used, but with greater care to prevent damaging native plants. Spot treatment with backpack sprayers is probably the preferred method in high quality areas as opposed to high volume units. Triclopyr is a good choice during the growing season since it usually does not harm the monocots. Some grass species will be burned back by Triclopyr, but will usually come back. During the dormant season Glyphosate has worked in controlling teasel in some situations. Triclopyr may also work during the dormant season, but has yet to be tested.

Prescribed burning as suggested below in conjunction with herbicide treatment is probably the best strategy to insure complete coverage.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

The most cost effective control method for heavily infested sites is the use of foliar applied herbicides. Glyphosate (under trade name Roundup), 2,4-D amine (under various trade names), and Triclopyr (under trade name of Garlon 3A) have all been used successfully.

Triclopyr and 2,4-D amine are dicot specific and should not harm monocots. Both herbicides should be applied during the growing season, preferably before the plant has bolted (sent up a flowering stalk). Triclopyr appears to be slightly better at controlling teasel than 2,4-D amine. Application can be made after bolting, but there is a risk of the seeds still developing, depending upon the date of application. Neither of these herbicides have been tried during the dormant season, but they may be effective. The rosettes of teasel stay green late into fall or even into winter when most other plants have died back. Application at this time would allow treatment without harming other dicots.

Glyphosate will kill any green plant. To avoid killing monocots, Glyphosate should be used sparingly during the growing season. If harming other plants in the immediate vicinity is not a

problem, Glyphosate is quite effective. Glyphosate should be applied before the plant bolts. Glyphosate can also be applied after bolting, but again there is a risk of the seeds still maturing. Glyphosate can also be applied during the dormant season. The results of dormant season treatment are mixed, some individuals have reported success and others failures. The condition of the rosettes and daytime temperature are probably important factors. Rosettes in good condition on warm days are probably photosynthesizing and Glyphosate would be effective. Stressed plants and plants on very cold days may not be photosynthesizing and Glyphosate may not be effective under these conditions. More research is needed on the use of Glyphosate during the dormant season.

These herbicides can be used as a spot treatment method with a backpack sprayer. A 1.5 - 2% solution of Glyphosate is effective. A 2% solution of Triclopyr has proven successful. Triclopyr needs the addition of an agricultural non-ionic surfactant. Herbicide coverage should be thorough to wet all the leaves and stems. Use of high volume equipment (booms, etc) may be possible in highly disturbed areas where there is little likelihood of damaging wanted vegetation. By law, herbicides may only be applied according to label directions.

Prescribed burns may make detection of teasel rosettes easier. Small rosettes can be hidden in the litter, while dried grass and forb stems can make complete spray coverage with a herbicide difficult. Either fall or spring burns would open up the area for detection. Fall burns would allow detection of rosettes during the dormant season. There is some evidence that singed rosettes may not be as active during the dormant season, and not as susceptible to herbicides. Fires will not carry well through dense stands of rosettes, so singed rosettes may only be a problem around the periphery of an infestation, or with isolated plants.

ADDITIONAL SUGGESTION ON CONTROL OF TEASEL

Several years treatment may be necessary to totally eradicate teasel from a natural community. It is important to prevent all seed production so that there is no addition to the seed bank in the soil. It may take several years (even up to 5 or 6 years) of repeated treatment before the seed bank is depleted. It is useful to map locations of infestations and treatment so that they can be readily located in future years.

If treated in the early stages of infestation it is possible to cheaply and quickly control teasel. If teasel is noticed outside, but near a natural community, get control of the teasel before it gets into the natural community. As with all exotics, start control before they become a serious problem.

FAILED OR INEFFECTIVE PRACTICES

Mowing is ineffective because the root crown will resprout and flower after being cut. Even repeated mowing is ineffective. Repeated mowing will stop some plants from flowering, but

others will produce short flowering stems that may be short enough to be below the height of the mower. Plants that have been knocked over by a mower and not cut off will lie horizontally and produce short flowering stalks below the height of the mower.

Cutting off the flower stalks at flowering time and leaving the flowering heads has been shown to be ineffective. Viable seeds can still develop from the cut stems. The flowering heads should be removed.

Prescribed burning alone is ineffective. Prescribed burning may kill some of the isolated small seedlings, but is ineffective against dense seedlings or large rosettes. Many seedlings germinate around the parent plant where shade from the parent plant has created a bare soil area. Fire will not carry through these bare soil, low fuel areas. Teasel remains green late in the fall and into winter, and also greens up early in the spring. The green teasel plants in areas of large infestations stop the fire from carrying into the interior of the population.

No biological controls are known that are feasible in natural areas.

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Illustration (Garlic mustard)

GARLIC MUSTARD

[Alliaria petiolata (Bieb.) Cavara & Grande*]*

Leafy upper stem and close-up of fruit.

VEGETATION MANAGEMENT GUIDELINE

Garlic Mustard [*Alliaria petiolata* (Bieb.) Cavara & Grande]

SPECIES CHARACTER

DESCRIPTION

Garlic mustard produces a characteristic fragrance of garlic from all parts of the plant. Adult flowering or fruiting plants grow 24-48 inches (61-125 cm) high. Basal rosettes have dark green, kidney-shaped leaves that differ somewhat in shape from the sharply-toothed, triangular, alternate, petioled leaves on the stems. Garlic mustard usually blooms in May. Numerous small white flowers, 0.25 inches (6-7 mm) across, are borne in a terminal raceme at the apex of the stem, and also at some leaf axils. Plants usually produce 1 flowering stem, but may have as many as 10 stems from a single root. Each flower is composed of 4 white petals that narrow abruptly at the base. Black seeds are produced in 1-4.7 inch (3-12 cm) long, narrow, linear capsules called siliques.

SIMILAR SPECIES

Garlic mustard is easily distinguished from all other woodland mustard plants by its characteristic odor of garlic and the 2-4 foot (0.6-1.2 m) tall flower stalks covered with numerous small, four-petalled, white flowers in May. The alternate, coarsely toothed, broadly triangular stem leaves with a distinct petiole are also characteristic. The garlic odor gradually dissipates by autumn, and garlic mustard rosettes may then be mistaken for violets (*Viola* spp.) or immature white avens (*Geum canadense*). Garlic mustard can be distinguished from these species by examining the roots. Garlic mustard has a white slender taproot, with a characteristic crook or "s" shape at the top of the root, just below the base of the stem. Garlic mustard should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Garlic mustard is native to Europe, and also occurs in northern Africa, Sri Lanka, and India. In North America, garlic mustard is now distributed from Quebec and Ontario, south to North Carolina and Kentucky, and west to Kansas and North Dakota. It is scattered in mesic woodlands in Missouri, and will probably become more widespread in the near future. It occurs in at least 41 counties in Illinois, mostly in the northern half of the state.

HABITAT

This species occurs most frequently in upland and floodplain forests, savannas, and along roadsides. It invades shaded areas, especially disturbed sites, and open woodland. It is capable of growing in dense shade and occasionally occurs in areas receiving full sun.

LIFE HISTORY

Garlic mustard is a biennial herb. Seeds germinate in early spring, young plants overwinter as basal rosettes, and adults bloom from May-June the following year. Each plant dies after producing seed. Seeds disperse when the siliques burst at maturity in August. Seeds have a 20-month dormancy period and do not germinate until the second spring after ripening. The species reproduces readily from the numerous seeds produced.

EFFECTS UPON NATURAL AREAS

Garlic mustard aggressively has invaded numerous forested natural areas and is capable of dominating the ground layer in many areas. It is a severe threat to many natural areas where it occurs because of its ability to grow to the exclusion of other herbaceous species.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Initial effort in areas of heavy infestation

Fall or early spring burning is an effective control treatment in oak woods. Repeated burns over several years may be necessary to achieve adequate control and to eliminate plants produced from the seed bank. Removal of leaf litter by burning will increase the survival of seedlings the following spring, therefore, burning in consecutive years may be necessary to deplete the seedbank. Prescribed fires should be of sufficient intensity to burn the affected site thoroughly. A clean fire that burns down to the root crown when the spring rosettes are up is recommended. Low intensity fires that leave unburned areas will not control garlic mustard effectively. Any isolated plants that are not burned should be removed by hand prior to flower production.

Research by Victoria Nuzzo indicates that cutting flowering stems at ground level results in 99% mortality, while cutting at 4 inches (10 cm) above ground level produces 71% mortality and reduces total seed production by 98%. Plants cut near ground level when in full flower usually do not resprout. Viable seed may be produced after stems are cut: pending further research, cut stems should be removed from the site when possible.

The control method used over the last three years at The Nature Conservancy's Trice-Dedman Woods nature preserve in northwest Missouri has been a combination of hand pulling and prescribed fire. The Nature Conservancy has successfully controlled or eliminated this plant from several such sites by a combination of spring burning, hand-pulling, and cutting flowering stems with a scythe. When garlic mustard occurs in nearly pure populations with few other plants, scything is advantageous in that large areas can be covered quickly and the soil is not disturbed.

Spot application of 1% Roundup (a formulation of glyphosate) to the foliage of individual plants is effective during spring and fall when most native vegetation is dormant but garlic mustard remains green. Herbicide should be applied when air temperatures are above 32 deg. F (0 deg. C). Managers should exercise caution when applying herbicide to garlic mustard to avoid contacting nontarget plants. Roundup is a nonselective herbicide (kills all vegetation) and should not be used during the growing season in high-quality areas because of the possibility of harming nontarget plants. **Do not spray so heavily that herbicide drips off the target species.** The herbicide should be applied while backing away from the treated areas to avoid contacting the wet herbicide. Basagran (generic name Bentazon) has also been used effectively as a foliar spray and may have less impact on semi-evergreen forbs which may be active in late fall or early spring. By law, herbicides only may be applied as per label instructions.

Initial effort in areas of light infestation

Removal of plants by hand-pulling is effective if the root is removed. If the stem snaps off from the root crown of a non-flowering plant, the plant may resprout. When hand-pulling, disturb the soil as little as possible, and tamp the soil firmly after removing the plant. Soil disturbance can bring garlic mustard seed to the surface and create a favorable environment for garlic mustard germination and growth.

Maintenance control

Vigilant monitoring and hand removal of first- and second-year plants prior to flower production can be effective.

A regular burning regime in oak woods can control garlic mustard.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Fall or early spring burning in oak woods can control this species. Repeated burns may be necessary over several years. Spot application of 2% Roundup to individual plants as described above can be used in severely disturbed woods. Cutting or scything flowering stems, as described above, is effective. Maintenance control is the same as given above.

In addition, hand spraying individual plants with an amine formulation of 2,4-D is an effective control when applied according to label instructions. To reduce vapor drift, use an amine formulation of 2,4-D rather than an ester formulation. A 1% solution of Mec Amine-D (2,4-D plus Dicamba) applied to the foliage of young plants is also effective. Either herbicide should be applied only during spring or fall when most native vegetation is dormant but garlic mustard remains green. The herbicide 2,4-D amine is selective for broadleaf plants. As with Roundup, managers should exercise caution when applying these herbicides to garlic mustard to avoid contacting nontarget plants. Do not spray so heavily that herbicide drips off the target species.

FAILED OR INEFFECTIVE PRACTICES

Low intensity fires that do not burn through the leaf litter have no effect on garlic mustard.

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Illustration (Gray dogwood)

GRAY DOGWOOD
[Cornus foemina ssp. *racemosa* (Lam.) J. Wilson*]*

Leafy twig with flowers and fruit.

VEGETATION MANAGEMENT GUIDELINE

Gray dogwood [*Cornus foemina* ssp. *racemosa* (Lam.) J. Wilson]
In Flora of Missouri as *Cornus racemosa Lam.*

SPECIES CHARACTER

DESCRIPTION

Gray dogwood is a deciduous, thicket-forming shrub that can grow to a height of 15 feet (5 m). It has entire, oppositely-arranged leaves born on twigs that are at first green but become gray or gray-brown with age. The lanceolate to elliptical leaves are 2 - 4" (5-10 cm) in length, a third to half as wide as long, and taper to a broadly-pointed tip. The lower leaf surface is whitish. Flowering occurs from May through July, and fruiting dates are July through October. The small, creamy-white flowers occur in branched clusters. White fruits are supported on red stalks, an attractive characteristic in ornamental uses.

SIMILAR SPECIES

Gray dogwood resembles three other Missouri native dogwood species: Rough-leaved dogwood (*Cornus drummondii*), swamp dogwood (*Cornus amomum* ssp. *obliqua*), and stiff dogwood (*Cornus foemina* ssp. *foemina*). It can usually be distinguished from these other species by its leaves with whitish lower surface and without a wooly covering of hairs and by its white rather than bluish fruit. Swamp dogwood and stiff dogwood are generally restricted to wet sites with stiff dogwood being confined to Missouri's Bootheel and adjacent counties. Rough-leaved dogwood typically has young twigs and leaves that are rough to the touch, whereas gray dogwood is smooth. However, the two species do hybridize in the Midwest making identification difficult at times.

DISTRIBUTION

Gray dogwood is a native species to North America and occurs from Canada and Maine south to southern Illinois and southern Missouri. In Missouri it can be found in most counties.

HABITAT

Habitat for gray dogwood includes moist or rocky ground along streams and ponds, wet meadows and borders of prairies, thickets along fence rows and roadsides, upland rocky thickets bordering glades, and along bluffs. In the tallgrass prairies of western Missouri, gray dogwood tends to be restricted to the dry, rocky exposures within prairies and to edges along fencerows and wooded draws. In the loess hill prairies of northwest Missouri, this shrub can

encroach on open prairies and, through competition and shading, reduce the area available for herbaceous prairie vegetation.

LIFE HISTORY

Gray dogwood is a woody perennial that forms thickets from rhizomes. Sexual reproduction begins at about three to four years. One viable seed is produced in each fruit. Hybridization occurs between gray dogwood and the similar species listed above.

A variety of bird species eat the fruits and disperse the seeds below perching sites. At least one report suggests that gray dogwood seeds have a low rate of germination. Dormancy may not be broken during the first winter following deposition. Its ability to effectively spread vegetatively may compensate for a lower reproduction by seeds. Groundcover vegetation diminishes beneath thickets of gray dogwood although annual weeds can persist.

EFFECTS UPON NATURAL AREAS

Gray dogwood is a native shrub that is a natural component of many woodland and prairie communities. Eradication of this plant is not practical nor desirable. Managers who are concerned by the abundance of gray dogwood on a particular managed area should determine the desired abundance of the shrub on the site before setting goals for control. A sequence of historical aerial photos can be helpful in confirming or refuting the belief that this shrub is increasing coverage at the expense of prairie groundcover on a given site. A knowledge of appropriate levels of shrub cover will allow informed decisions regarding the need for control.

By crowding out native prairie grasses and forbs, gray dogwood can reduce the habitat available for a prairie groundcover. In Missouri, gray dogwood is considered a problem in remnant loess hill prairies of the northwest because it reduces the size of these already diminished communities. In the western U.S., this shrub has invaded former river channels, thus reducing the channel area following water diversions.

CONTROL RECOMMENDATIONS

Control measures may enlist one or more of the following techniques: prescribed burning, cutting, or herbicide treatments. No biological controls are known. Although grazing is used in management of some Missouri prairies, it is not felt to significantly affect the growth of gray dogwood.

-Prescribed burning: No consensus of opinion was found for optimum time to burn for gray dogwood control. Resprouting is likely following fire; and if sufficient fuel is not available for annual burning, then root reserves may soon be replenished to pre-burning levels.

Fire is probably more effective when combined with cutting and/or herbicide treatments.

-Cutting: Cutting twice within a growing season combined with prescribed burning after resprouting will significantly weaken this shrub. Summer cutting and herbicide application followed by burning the following spring (after budbreak) is reported to give control. After a stand has been reduced to an acceptable level, cutting and burning alone should maintain the desired level of abundance.

-Chemical control: As cut stem treatments, both glyphosate (Roundup) and triclopyr have proven effective. A 10 - 20% solution in water of either chemical can be painted on stems immediately following cutting during the summer. The higher concentration may be necessary for the larger stems. Mowing of shrubs with a later foliar application of a 1 1/2% solution of glyphosate resulted in 100% control of the related rough-leaved dogwood.

Ammonium sulfamate (AMS), tradename Ammate X-NI Weed and Brush Killer, has also produced 100% control when painted on cut stems in an Illinois study. As concentrate a solution as possible in water was painted on gray dogwood stems immediately after cutting in February.

At a Missouri loess hill prairie in Atchison County, gray dogwoods were cut and cut stems treated with Tordon RTU in April. The area was burned the following spring. This combination of cutting, chemical stem treatment, and burning was effective in areas where prairie vegetation carried the fire. Dogwoods that were not surrounded by prairie vegetation were not impacted by the fire and were resprouting vigorously two years later. A thin-line basal bark application of Garlon 4 in March has been used at this same site, but results are not yet available. The thin-line bark treatment allows treatment of a larger number of stems in a shorter time period than the cut stem treatment.

The recommended method of chemical control is the use of glyphosate or AMS because of their relatively low toxicities, lack of persistence in soils, and effectiveness in gray dogwood control. By law, herbicides may only be applied according to label directions.

FAILED OR INEFFECTIVE PRACTICES

Gray dogwood is topkilled by fire but resprouts readily. Prescribed burning will probably be ineffective in well-established stands unless repeated frequently or accompanied by cutting and herbicide application.

Cutting and treating stems with Tordon RTU in April was ineffective in northwest Missouri, except when followed by a prescribed burn the following spring. Thickets with too little fire-carrying fuel resprouted vigorously.

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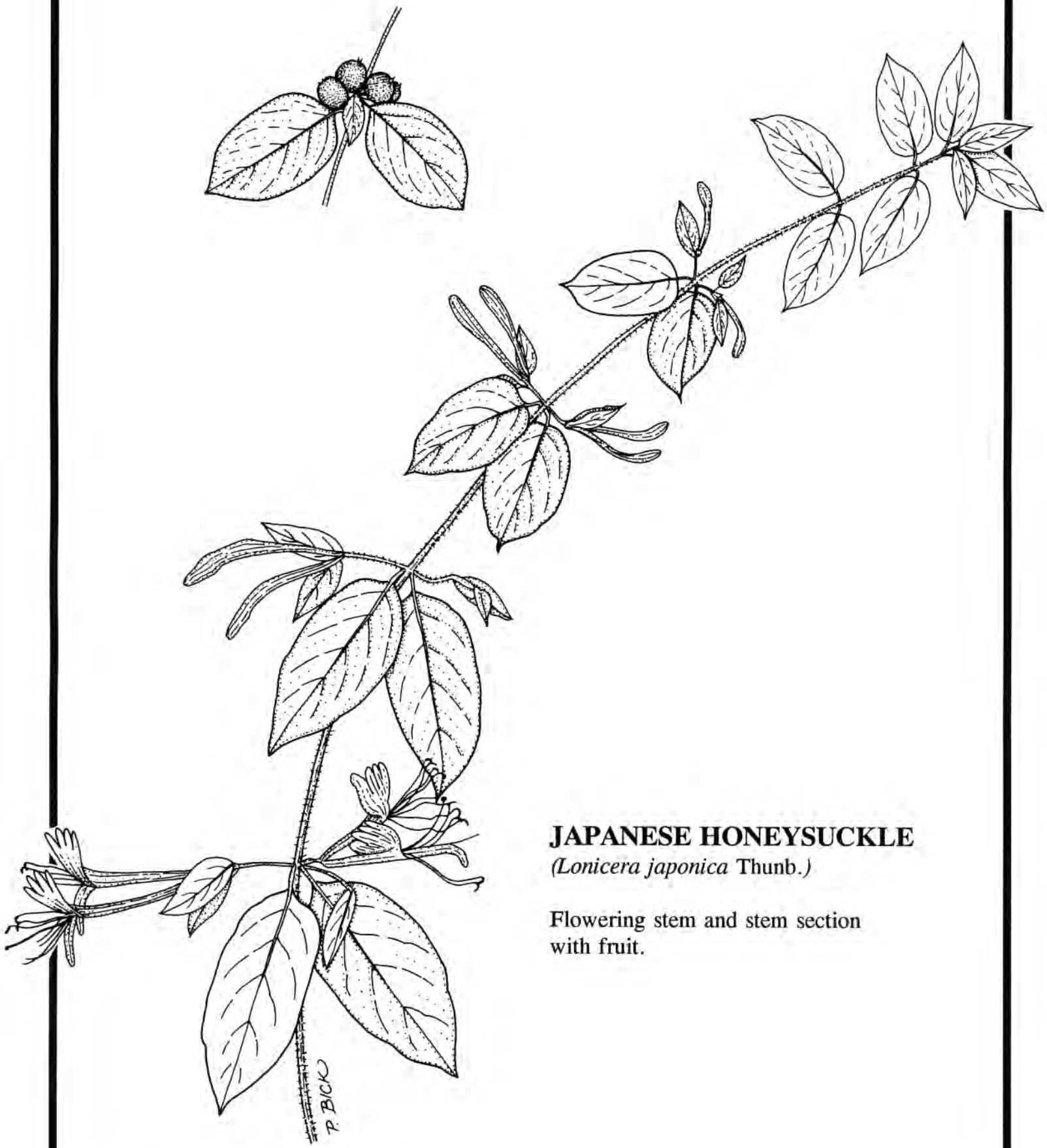
Illustration (Japanese honeysuckle)



JAPANESE HONEYSUCKLE
(Lonicera japonica Thunb.*)*

Flowering stem and stem section with fruit.

VEGETATION MANAGEMENT GUIDELINE

Japanese Honeysuckle (*Lonicera japonica* Thunb.)

SPECIES CHARACTER

DESCRIPTION

Japanese honeysuckle is a semi-evergreen vine in Missouri, often holding its leaves late into winter. Leaves are ovate and 1.5-3.2 inches (4-8 cm) long. White to yellow tubular flowers form in pairs in the leaf axils from May-June. The 2-3 seeded fruits are small (5-6 mm long) and black.

SIMILAR SPECIES

Japanese honeysuckle is separated easily from the native honeysuckle vines by its leaves. Leaves near tips of the vines of Japanese honeysuckle are opposite and not united, while leaves of native honeysuckles (3 species) are united at the base, forming a single leaf surrounding the stem. Trumpet or coral honeysuckle is another non-native vine that occasionally escapes from cultivation in the Midwest, but it is not an aggressive species. The leaves near the tips of the vine of trumpet honeysuckle are united at the base as in our native species. It may be distinguished from the native vines as well as from Japanese honeysuckle by its red flowers. Japanese honeysuckle should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Japanese honeysuckle is native to Japan, introduced to the U.S. in 1806 for horticultural ground-cover purposes. It was slow to escape and did not become widely established over the eastern U.S. until the early 1900's. It presently occurs as far north as Illinois and Michigan, from Texas to Florida, and north to Massachusetts, New York and Ohio. In Missouri, the species is most abundant in the southeastern counties, but it occurs sporadically throughout most of the rest of the state. Bitter winter temperatures appear to limit its establishment.

HABITAT

Japanese honeysuckle readily invades open natural communities, often by seed spread by birds. An aggressive colonizer of successional fields, this vine also will invade mature forest and open woodlands such as post oak flatwoods and pin oak flatwoods. Forests with either natural or unnatural openings are often invaded by Japanese honeysuckle when birds drop seeds into

these light gap areas. Old homesites frequently harbor Japanese honeysuckle and provide a seed source for spread into the surrounding landscape. Deep shading reduces the amount of invasion.

LIFE HISTORY

Japanese honeysuckle climbs and drapes over native vegetation, shading it out. It is capable of completely covering herbaceous and understory plants, and climbing trees to the canopy. The semi-evergreen condition of this honeysuckle allows for growth both prior to and after dormancy of other deciduous plants. The prolific growth covers and smothers vegetation present including understory shrubs and trees in forested communities. Although this prolonged growth period is beneficial to the plant, it is also beneficial in controlling the plant. Vegetative runners are most prolific in the open sun and will resprout where touching the soil, forming mats of new plants. This honeysuckle will display little growth under moderate shade. In deep shade, runners develop but often die back. Flowering and seed development are heaviest in open-sun areas. Seedling establishment and growth is slow in the first 2 years of development of a new honeysuckle colony.

EFFECT UPON NATURAL AREAS

This aggressive vine seriously alters or destroys the understory and herbaceous layers of the communities it invades, including prairies, barrens, glades, flatwoods, savannas, floodplain and upland forests. It may become established in forested natural areas when openings are created from treefalls or when natural features allow a greater light intensity in the understory. Japanese honeysuckle also may alter understory bird populations in forest communities.

CURRENT STATUS

Missouri natural areas in the Crowley's Ridge area have suffered from Japanese honeysuckle invasion. The species is well-established at numerous other Missouri sites and will surely be a continuing problem for land managers.

CONTROL RECOMMENDATIONS

Initial effort in areas of heavy and light infestation

Efforts to control Japanese honeysuckle infestations have included the following methods: mowing, grazing, prescribed burning and herbicides. While grazing and mowing reduce the

spread of vegetative stems, prescribed burns or a combination of prescribed burns and herbicide spraying appears to be the best way to eradicate this vine.

In fire-adapted communities, spring prescribed burns greatly reduced Japanese honeysuckle coverage and crown volume. Repeated fires reduced honeysuckle by as much as 50% over a single burn. A previously burned population of honeysuckle will recover after several years if fire is excluded during this time. By reducing honeysuckle coverage with fire, refined herbicide treatments may be applied, if considered necessary, using less chemical.

Because Japanese honeysuckle is semi-evergreen, it will continue to photosynthesize after surrounding deciduous vegetation is dormant. This condition allows managers to detect the amount of infestation, and allows for treatment of the infestation with herbicides without damage to the dormant vegetation.

Glyphosate herbicide (tradename Roundup) is the recommended treatment for this honeysuckle. A 1.5-2% solution (2-2.6 oz of Roundup/gallon water) applied as a spray to the foliage will effectively eradicate Japanese honeysuckle. The herbicide should be applied after surrounding vegetation has become dormant in autumn but before a hard freeze (25 deg. F). Roundup should be applied carefully by hand sprayer, and spray coverage should be uniform and complete. **Do not spray so heavily that the herbicide drips off the target species.** Retreatment may be necessary for plants that are missed because of dense growth. Although glyphosate is effective when used during the growing season, use at this time is not recommended in natural areas because of the potential harm to nontarget plants. Foliar application of herbicides will be less effective prior to early summer (July 4) because early season shoot elongation will limit the transfer of chemical to the root system. Glyphosate is non-selective, so care should be taken to avoid contacting nontarget species. Nontarget plants will be important in recolonizing the site after Japanese honeysuckle is controlled.

Crossbow, a formulation of triclopyr and 2,4-D, is also a very effective herbicide that controls Japanese honeysuckle. Crossbow should be mixed according to label instructions for foliar application and applied as a foliar spray. It may be applied at dormant periods, like glyphosate, and precautions given above for glyphosate should be followed when using Crossbow. Either herbicide should be applied while backing away from the treated area to avoid walking through the wet herbicide. Garlon 3A and Garlon 4 (triclopyr) are also effective in foliar applications. By law, herbicides only may be applied according to label instructions and by licensed herbicide applicators or operators when working on public properties.

Mechanical cutting of aerial vines, followed by cut-surface herbicide treatment can be effective and minimizes the risk of spray drift. Undiluted Garlon 4 or a 20% solution of Roundup should be applied to cut stems immediately following cutting.

Maintenance control

In fire-adapted communities, periodic spring burning should control this species.

FAILED OR INEFFECTIVE PRACTICES

Mowing limits the length of Japanese honeysuckle vines, but will increase the number of stems produced.

Grazing may have the same effects as mowing, but is less predictable due to uneven treatment given by browsing animals.

Herbicides that have given poor control results or that are more persistent in the environment than other types are picloram, annitrole, aminotriazole, atrazine, dicamba, dicamba & 2,4-D, 2,4-D, DPX 5648, fenac, fenuron, simazine & triclopyr.

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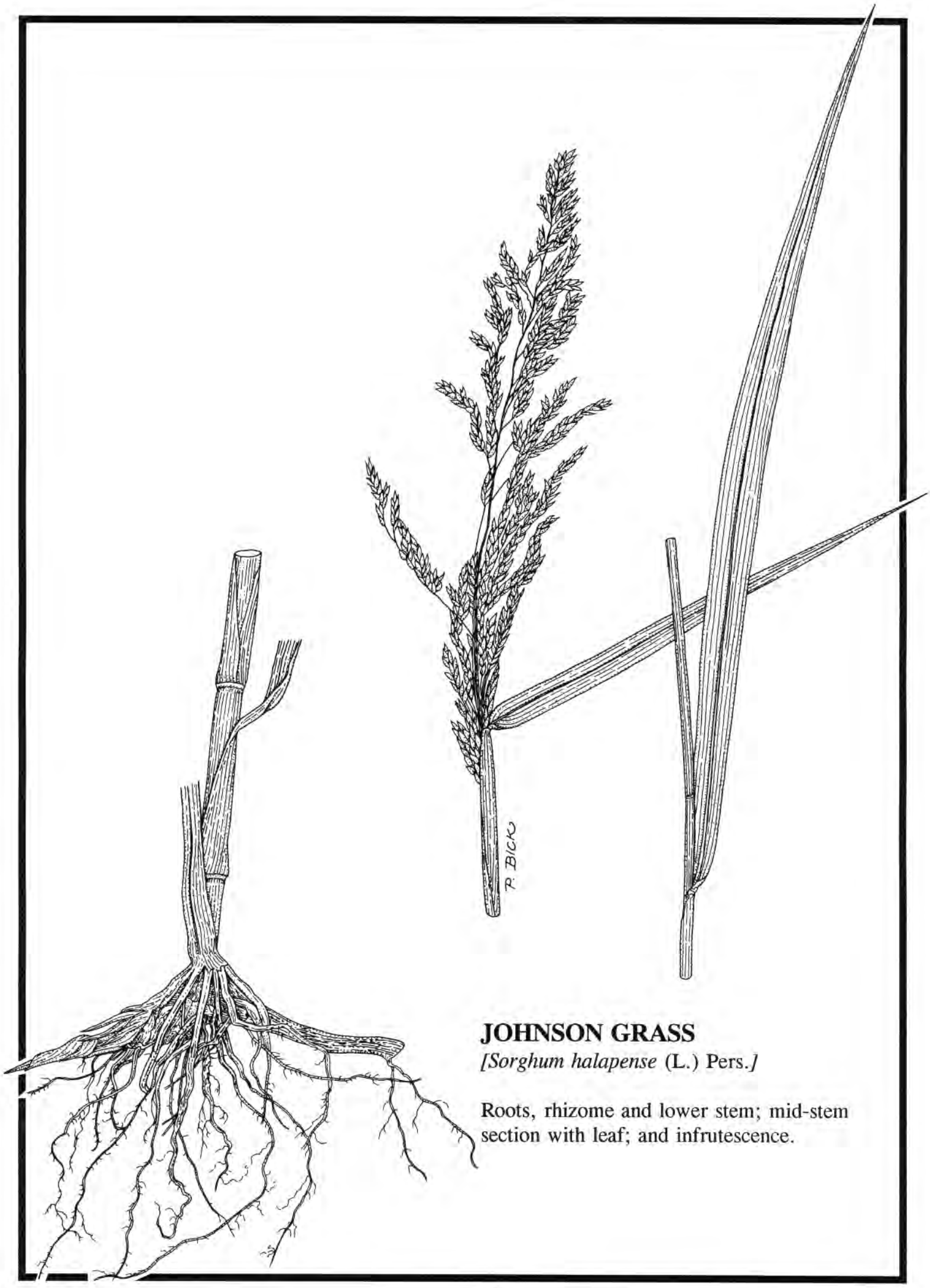
Illustration (Johnson grass)



JOHNSON GRASS

[Sorghum halapense (L.) Pers.*]*

Roots, rhizome and lower stem; mid-stem section with leaf; and infrutescence.

VEGETATION MANAGEMENT GUIDELINE

Johnson Grass [*Sorghum halepense* (L.) Pers.]

SPECIES CHARACTER

DESCRIPTION

Johnson grass is a tall, coarse, perennial grass with stout (up to 3/4" in diameter) rhizomes. It grows in dense clumps or nearly solid stands and can reach 8 feet (2.4 meters) in height. Leaves are smooth, 6-20 inches (15.2-50.8 cm.) long, and have a white or light green midvein. Stems are pink to rusty red near the base. Panicles are large, loosely branched, purplish, and hairy. Spikelets occur in pairs or threes and each has a conspicuous awn. Seeds are reddish-brown and nearly 1/8 inch (0.3 cm.) long. Johnson grass should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

SIMILAR SPECIES

Sorghum halepense with its white leaf vein, wide leaves, and reddish seedhead is distinguished from (1) eastern gamagrass (*Tripsacum dactyloides*), which has flowers in a spike rather than a loose panicle; (2) switchgrass (*Panicum virgatum*), which has no white vein and a greenish-yellow seedhead; (3) big bluestem (*Andropogon gerardii*) and Indian grass (*Sorghastrum nutans*) which both have narrower leaves and usually lack a prominent vein. Johnson grass can be distinguished from Sudan grass (*Sorgham halapense*) by the fact that Sudan grass is an annual and therefore has no rhizomes.

DISTRIBUTION

Originally native to the Mediterranean, this grass now occurs in all warm-temperate regions of the world. It is widely distributed in tropical America, and is common in the southern U.S. Heavy infestations are found in all the major river bottoms of Missouri, with more than 300,000 acres infested in the Missouri Bootheel alone.

HABITAT

This species occurs in crop fields, pastures, abandoned fields, rights-of-way, forest edges, and along streambanks. It thrives in open, disturbed, rich, bottom ground, particularly in cultivated fields. Heavy river-bottom infestations can reduce corn or soybean yields in Missouri to a few bushels per acre.

LIFE HISTORY

Johnson grass is a very aggressive, perennial grass. It occurs in dense clumps that spread by seed and rhizomes to form nearly pure stands. The thick rhizomes live over winter and in the spring send out new, white, spur-like shoots. In clay soils 80% of the rhizomes are in the top four inches of soil. In sandy loam soil, 80% occur in the top six inches. However, rhizomes may grow downward through cracks to a depth of 10 to 20 inches. The grass leaves emerge late in spring and the plant forms seed by July 1. A single plant may produce over 80,000 seeds per year. Stems and leaves die back after the first frost, but the dead litter often covers the ground all winter. Rhizome cuttings commonly form new plants, making it very difficult to eradicate. It spreads rapidly and is not affected by many of the agricultural herbicides.

EFFECTS UPON NATURAL AREAS

Johnson grass invades riverbank communities and disturbed sites, particularly fallow fields and forest edges, where it crowds out native species and slows succession. It quickly dominates the herbaceous flora, reduces plant diversity, and is unsightly to observers. This grass is a serious potential threat in many old fields where succession to forest communities is desired.

CONTROL RECOMMENDATIONS

Control Practices

To eradicate Johnsongrass, control measures must be thorough. Various cultural practices and chemical herbicides will effectively control germinating seed, seedlings, and established plants.

Objectives of a Good Control Program:

1. Prevent production and spread of seed.
2. Destroy seedlings before rhizomes are formed.
3. Weaken and kill existing rhizomes.
4. Control new infestations as they appear.

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Initial effort in areas of heavy infestation

Johnson grass does not infest areas of high natural quality heavily except for the naturally disturbed environment such as along river banks where it is difficult to control selectively. Seed panicles should be cut and removed from the area where practical. Dense patches can be controlled by spraying the foliage with 2% Roundup (a formulation of glyphosate). Best results

are obtained when glyphosate is applied to plants that are 18" tall to early flowering stage. During this period the herbicide will be most effectively translocated to the roots and rhizomes. Care should be taken to avoid contacting nontarget plants, since Roundup is a nonselective herbicide. **Do not spray so heavily that herbicide drips off the target species**. The herbicide should be applied while backing away from the area to avoid walking through wet herbicide. By law, herbicides may only be applied as per label instructions.

Effort in areas of light infestation

Clumps and individual plants may be hand pulled during June, just after a rain when the ground is soft. All plant parts should be removed from the area. Broken stems and roots left in the ground should be dug up if only a small area is involved. It is more effective to spot-treat the individual plants with herbicide than to pull them, and large clumps can be sprayed with 2% Roundup using a hand sprayer or backpack sprayer. Herbicide treatment may need to be repeated for several years to ensure good control.

Maintenance control

Preferred treatment is hand pulling of individual plants immediately upon discovery. All plant parts, including rhizomes, must be removed. It may be necessary to hand pull a population several times to obtain control. Surrounding seed sources should be eliminated where possible to prevent continual reinvasion.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Initial effort in areas of heavy infestation

Repeated and close mowing kills Johnson grass seedlings, prevents seed production, and reduces rhizome growth and regrowth of shoots. Sites may be tilled where it is practical (e.g. abandoned cropland) and the exposed roots left to winter kill. Repeated tillage (e.g. 6 times at 2-week intervals during the growing season) prevents rhizome development and reduces Johnson grass populations. Limited early season tillage, however, encourages rhizome growth by spreading pieces of the rhizomes. In a monoculture, livestock may be used to eliminate the Johnson grass by grazing. Spraying 2% Roundup on foliage using a tractor and power sprayer provides effective control.

Effort in areas of light infestation

Cutting and removal of seed heads during early July and then spot application of 2% Roundup to the foliage usually will be effective if continued for 3-4 years.

Maintenance control

Preferred treatment is the same as given above for high-quality areas. Another treatment is spot application of 2% Roundup to eliminate invading individuals the first year and to eliminate all surrounding seed sources.

FAILED OR INEFFECTIVE PRACTICES

The following practices should be avoided:

- hand control: too slow and not practical in large areas where infestations are heavy. Rhizomes break easily and are often left in the ground. Large mature plants are almost impossible to pull by hand.
- mowing: usually does not kill or eliminate established plants.
- fire: more research needed. Spring burns may encourage regrowth.
- herbicides: single applications seldom eliminate the species from an area.
- tillage: not practical in many places because of terrain and erosion hazard. It seldom is effective by itself and allows other weedy species to invade. It may also destroy native species present.
- grazing: Grazing increases the potential for introducing other exotic plants. Livestock trample the soil and damage other species.
- manipulation of water levels: Johnson grass does not typically occur in areas where water level manipulation is practical.
- biological controls: livestock grazing may reduce plant vigor, but has negative impacts (e.g., excessive trampling, damage to other species, soil compaction) associated with it. No other biological controls are known that are feasible in natural areas.

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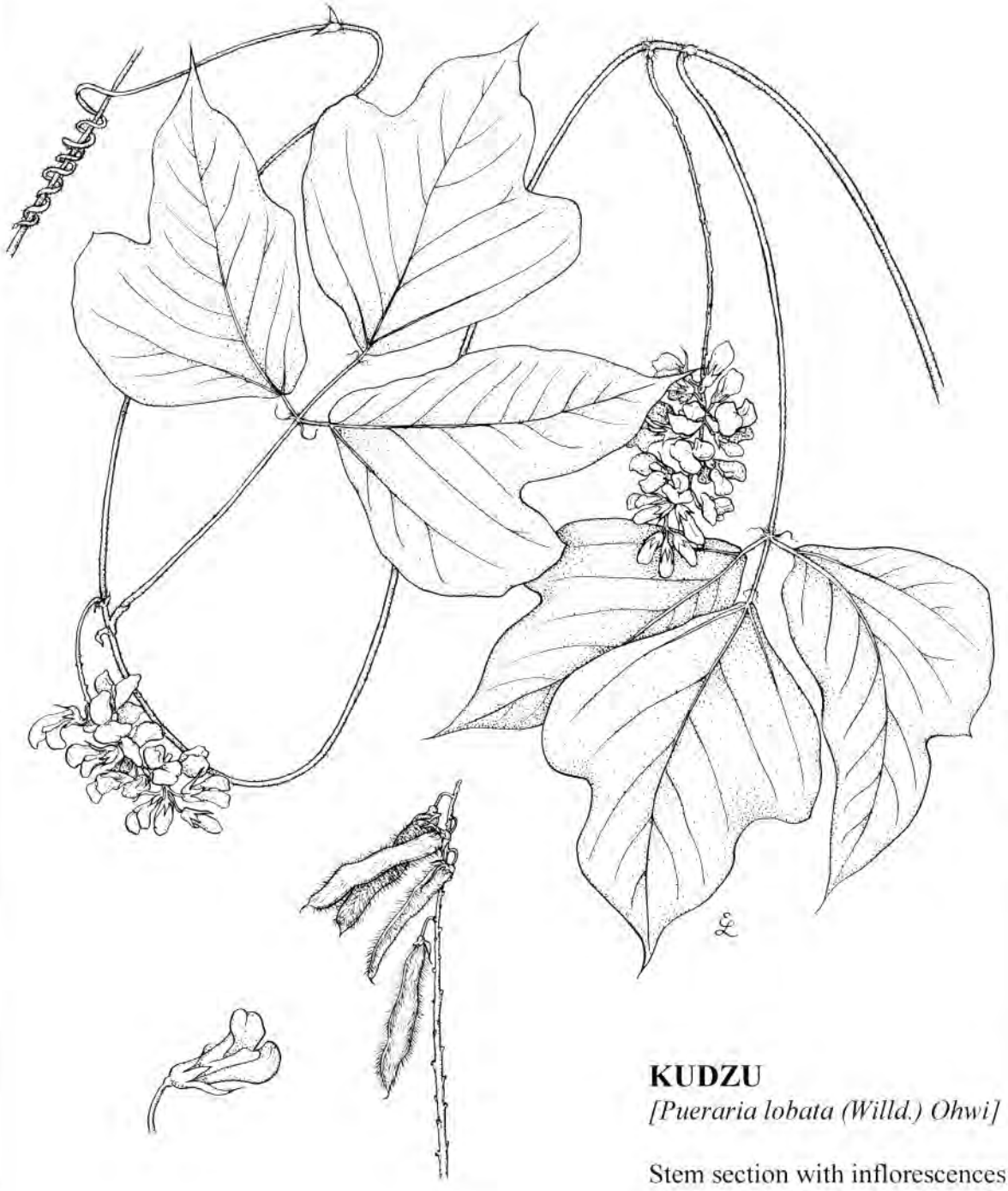
Illustration (Kudzu)



KUDZU
[Pueraria lobata (Willd.) Ohwi]

Stem section with inflorescences; close-up of flower and fruits.

VEGETATION MANAGEMENT GUIDELINE

Kudzu [*Pueraria lobata* (Willd.) Ohwi]
Note: Some authors accept the following name:
Pueraria montana (Lour.) Merr. var. *lobata* (Willd.) Maesen & S. Almeida

SPECIES CHARACTER

DESCRIPTION

Kudzu is a perennial vine of the legume family (Fabaceae). Each leaf has three dark green leaflets, 7 to 25 cm (2.75 to 9.84 in) long, with or without irregular, shallow lobes, otherwise entire, hairy beneath. Many rampantly growing, hairy vines trail, sprawl and loosely twine from a large, central root crown. Rhizomes are also present and contribute to the plant's rapid spread. In late July to September plants in full sun sometimes produce, pea-like, grape scented, purple flowers [up to 2 cm (0.79 in)] in elongated clusters. Following flowering, clusters of elongated, bean-like, hairy pods appear, but produce few viable seeds. Vines can have a diameter up to 2.5 to 3.0 cm. (1.0 to 1.18 in) in southern states. New growth is soft hairy. Sugars produced in the leaves are transferred to the roots as starch which the roots store in swollen taproots as impressive as the above-ground structure. Roots can descend 4 meters into sandy loam soils.

SIMILAR SPECIES

This legume is easily identified by its habit of many trailing, sprawling and climbing vines from a central root crown with each trailing vine sending down new roots from stem nodes. In areas of heavy infestation, a dense, uniform stand of dark green leaves blanketing everything is a key field characteristic. At a quick glance, leaves may look like large poison ivy (*Toxicodendron radicans*) leaves, but unlike the toxic plant, kudzu stems and leaves are much more conspicuously hairy. Crown vetch (*Securigera varia*) has a similar uniform growth pattern, but the crown vetch's compound leaves are finer, with about 15 to 25 leaflets per leaf. Its prolific pink flowers in tight clusters in contrast to the uncommon purple-flowered inflorescences of kudzu. The round-leafed beggar's tick (*Desmodium rotundifolium*) might be confused with a very young plant of kudzu, but this trailing *Desmodium* rarely grows to lengths of more than 1.5 m (5 ft), and leaflets are seldom over 7 cm (2.75 in) long.

DISTRIBUTION

Kudzu was originally imported from Japan in 1876 to landscape a garden at the Japanese Pavilion at the Philadelphia Centennial Exposition. In the early 1900's, this vine was discovered to be excellent forage for cows, pigs, and goats in the South in acidic soils and during droughty seasons. It was also promoted as cover for erosion control in gullies. The distribution of kudzu in

the United States today extends from Connecticut to Missouri and Oklahoma, south to Texas and Florida. Before 1970, kudzu was planted along Missouri highways to control erosion and some farmers experimented with kudzu for livestock fodder.

In Missouri, kudzu has been found locally in Jackson, St. Louis, Howard, Christian, Wayne, Reynolds, Douglas, Newton, Lawrence, Ralls, and Taney counties. Patches have also been sighted along the route of Old U. S. Highway 66 in Phelps Co. and along U. S. Highway 67 in Madison and St. Francois counties. Fruit production appears to be rare in Missouri, if it occurs at all. Kudzu is not yet listed as a noxious weed in Missouri, but local populations can spread aggressively if not controlled.

HABITAT

Kudzu grows best in rough, well-drained eroded land or in disturbed, sandy, deep-loam soils in full sun. It will, however, invade well drained, acid-soil forests. It does not grow well or at all in wet bottomlands or in thin hard-pan soils. It will not establish in healthy grass cover, but may spread into such areas by running vines. (U. S. Dept. Ag., Coop Extent. Serv., MS)

LIFE HISTORY

This vine grows up to one foot per day in early summer and can cover everything in its path. In the South, it has become destructive to the point of pulling down power poles, breaking power lines, collapsing buildings and killing trees. A cold winter will kill young vegetative growth back to the root crowns, but the vine resumes growth again in spring (Kloepfer and Hinkle 1991). Freeze and frost does not kill vines that are 1 cm. in diameter and larger (J. H. Miller, personal communication). Kudzu thrives through drought and hot temperatures, however continuous removal of all vegetative parts during extreme weather will kill kudzu over time. Only vines one meter or more above the ground in full sun will flower in August and September, but few fruiting pods develop viable seeds. Those few viable seeds produced may be responsible for most long distance migration, possibly from pods falling into watercourses (J.H. Miller, personal communication). Vegetative reproduction occurs as trailing vines root at the nodes. These new root crowns mature and send out more vines. Reproduction also occurs from rhizomes which sprout new vines. From early August until frost, sugars produced in leaves are transported to roots and are stored as starch. Under good growing conditions, kudzu can grow an impassable mass of vines.

CONTROL RECOMMENDATIONS

It can not be over emphasized that **total eradication of kudzu is necessary to prevent re-growth**. As with most aggressive exotic species, eradication requires persistence in monitoring and thoroughness in treating patches during a multi-year program. Revegetation of sites following treatment is an important last step to ensure that any residual kudzu does not

reestablish. All land owners in an infestation area must cooperate in a unified program.

TREATMENT IN AREAS OF LIGHT INFESTATION

Treatments timed to the plant's life cycle seem to be an important factor in control or eradication strategy. Efforts to control kudzu infestations have included the following methods: cutting, grazing, digging, disking, prescribed burning and application of herbicides. Roots of mature plants grow too deeply to be affected by freezing. Burning will kill only the very young plants. Young colonies can be eradicated in three to four years if roots are dug, or if plants are overgrazed or persistently cut back repeatedly during the hottest temperatures of summer. Plants that persist after four years of overgrazing and disking can be spot treated with a recommended herbicide.

Grazing can be an economical alternative to mechanical or chemical treatments in some control situations. It can be effective in combating younger infestations if used persistently during the growing season. Kudzu is readily eaten by most livestock, but cattle grazing has shown the most success in eradication (Miller, 1996). Close grazing for three to four years can totally eliminate kudzu when at least 80% of the vegetative growth is continuously removed by livestock. It is especially effective if heavy grazing occurs late in the growing season (July - September) when the kudzu is actively sending nutrients to the roots for winter. For maximum effect, it may be necessary to fence livestock within the area being treated and to provide water and supplemental feed as needed for animal nutrition. Additionally, kudzu vines which are out of reach should be cut and fed to livestock. Any plants that remain after four years of grazing can be spot treated with a recommended herbicide (Miller, 1996).

If the only feasible treatment is herbicides, then systemic chemicals provide the best success. (See the Chemical Control Section for details of herbicide treatments.) After kudzu has wilted from herbicide treatment, a controlled burn can stimulate alternative vegetation to grow. Grasses can be planted in the fall after the first treatment and after every successive treatment to control erosion and to discourage weeds. Healthy stands of grasses will discourage the reestablishment of seedlings and resprouting. Pines, hardwoods, and forbs can be planted following eradication of kudzu, allowing an appropriate interval for any residual effects of herbicides to subside.

TREATMENT OF INFESTATIONS MORE THAN TEN YEARS OLD

Old kudzu infestations may have overgrown an acre or more with older roots growing too deeply for manual removal. Patches more than 10 years old will typically have root crowns (woody knots at the soil surface where stems originate) over 5 cm (2.0 in) in diameter (Miller, 1996). Surface disturbances such as mowing, disking, grazing or burning are unlikely to have much effect. Therefore, few options remain except the application of herbicides. A prescribed burn in March before herbicide treatment will kill the smallest plants and sever draping vines leaving roots and new growth a better chance for exposure to chemicals. This is an opportune time to mark the largest roots as well as any hazards in the area slated for treatment. Old roots need

heavier herbicide application than young ones. Best results from chemical treatment occurs if application is done in late summer when flowers appear and nutrients are being actively transported to roots (VA Dept. of Conservation & Recreation).

RECOMMENDED CONTROL IN NATURAL AND HIGH QUALITY AREAS

If preservation of a natural area limits the use of grazing or large-scale herbicide application, a combination of trimming, disking, and digging as outlined above will set the plants back and perhaps eradicate a new infestation in three to four years. Foliar application of herbicide using a backpack sprayer will provide more rapid eradication. The expense of restoration of a small area following herbicide use compared to the effects of kudzu spreading over additional acres may weigh in favor of a concentrated herbicide treatment prior to spread. Plant native grasses in the fall after treatment to control erosion and spread of kudzu and invasion of other weedy plants which may colonize the site after kudzu dies.

CHEMICAL CONTROL

Although many herbicides will kill back the stems and leaves of kudzu, most will not provide eradication by killing of the root systems. Testing of 25 herbicides over an eight-year period by Miller (1996) led to the following recommendations:

Open Patches on Level Ground

Tordon 101 Mixture (2,4-D + picloram) and **Tordon K** (picloram liquid) proved to be the most cost-effective herbicides over the testing period. Both products are applied as foliar sprays which then should be washed from the leaves to the ground by rainfall or spray irrigation of less than one inch within two to five days after application. This allows additional uptake by root systems. Treatment should be done no earlier than late June or July to assure that all stems are actively growing. Tordon 101 Mixture is recommended at a rate of one gallon per acre for younger kudzu infestations and two gallons per acre for patches older than ten years. Tordon K is recommended at a rate of 0.5 gal. per acre in younger patches and 1.0 gallon per acre in old infestations. A mixture of Tordon 101 Mixture at 0.5 gallons per acre plus Tordon K at 1.0 quart per acre is also effective on young patches. The rates are again doubled for this mixture on older infestations. Successful eradication has been achieved by applying the Tordon sprays at a volume of 40 to 80 gallons of spray mixture per acre.

Thorough coverage of herbicide is essential to successful treatment. Open patches should be sprayed in a cross-hatch pattern because of the density of foliage. Half of the total solution should be sprayed in one direction and the other half sprayed perpendicular to the first application. Spot treatment with a backpack sprayer can be used on small patches or as a second treatment. The best solutions for spot spraying are either 1 pint Tordon 101 in 4 to 5 gallons of water, or ½ pint Tordon K in 4 to 5 gallons of water, or 1 pint Veteran 720 in 4 to 5 gallons of water. These mixtures will be 99% effective when vines immediately around root crowns are sprayed to medium wetness.

Retreatment with the Tordon products is recommended following a successful initial treatment. Many large kudzu roots will not sprout for two years following the first treatment, so retreatment should occur starting in the third year following the initial treatment. Thus, one year is skipped between the initial treatment and the first retreatment. Retreatment application rates are half those of the initial treatment.

Both Tordon products are **restricted use herbicides** and management agencies may only apply by certified applicators or persons under their direct supervision. Private landowners may purchase and apply for agricultural purposes after training from University Extension Service personnel. Picloram will harm non-target organisms, including crops and other non-target plants. It is very water soluble and may move into groundwater or waterways; therefore, it should not be used near streams, ponds, or other sensitive areas. Picloram is particularly damaging to legumes and is relatively persistent in the environment. It can kill new plants introduced into the treated area too soon after application, although many grasses are not affected.

Near Streams, Ponds, Wetlands, or Ditches

Veteran 720 (dicamba) (formerly **Banvel 720**), a product of Riverdale Chemical Company, is recommended for sites near water, although it should not be sprayed directly onto water. Veteran 720 is a dicot-specific herbicide used as a foliar spray. Application rate is two gallons per acre for younger patches and three gallons per acre for infestations over ten years old. August or September are recommended months for application, but moderate rainfall is required for proper soil activation.

Non-crop Areas Such As Fencerows and Rights-of-Way

Spike 20P (pellets) and **Spike 80W** (wettable powder), both DowElanco formulations of tebuthiuron, are slow-acting, residual herbicides that cause vegetation to yellow the first year and die the second year. The Spike herbicides can cause residual effects in the soil for three years. Effective application rate for Spike 80W is six to eight pounds per acre and for Spike 20P, twenty to thirty pounds per acre. Early spring application is recommended. Spike herbicides are non-selective and will kill any desirable plants in the treated area as well as the kudzu, so these products should not be used in natural areas.

Residential and Environmentally Sensitive Areas

Roundup and **Rodeo**, both Monsanto formulations of glyphosate, are still the safest herbicides for use in residential and environmentally sensitive areas. Both are non-selective, foliar-applied herbicides, with Rodeo being licensed for use over water. **Accord**, also from Monsanto, is the glyphosate formulation that is labeled for forestry applications. Glyphosate is not as effective on kudzu as the herbicides discussed above, and many years of persistent treatment will be necessary to achieve eradication (Miller 1996).

Transline (clopyralid), from DowElanco, is readily absorbed by foliage and roots and is translocated throughout the plant. This herbicide is targeted to three plant families: legumes, smartweeds and composites. At 21 ounces per acre, Transline has the benefit that it may be used near trees, grasses and dicots, other than the three target families, without damaging them. Transline has not proven effective in eradicating older infestations of kudzu, but may be helpful in treating young patches and in controlling the spread of older plants.

CAUTION

If not handled properly, herbicides can be injurious to non-target plants as well as to humans and other animals. Use all herbicides and pesticides conservatively, selectively and carefully. Research the proper use thoroughly, follow directions carefully and follow recommended practices for disposal of surplus chemicals and their containers. Consult the Herbicide Handbook of the Weed Science Society of America (Humberg *et al*. 1989) when considering your special situation.

FAILED OR INEFFECTIVE PRACTICES

Pre-burning, cutting, hand digging and disking are only measures to weaken the roots. They are ineffective alone, but helpful when used in conjunction with systemic herbicides.

Although the Virginia Department of Conservation and Recreation recommends the use of biodegradable glyphosate (Roundup and Rodeo), tests show these products provided only 64% control after annual treatment for two years (Miller 1986). Other trade name products which were tested and were found to have less than 95% control of kudzu are Amitrol (87%), Krenite (71%), Garlon 4 (66%), Garlon 3A (65%), Oust (63%), Esteron 245 (51%), 2,4-D (36%), Super Brush Killer (36%), Maintain CF125 (17%), Weedone 2, 4-DP (8%). All were sprayed at least twice over two years (Miller 1986).

BIOLOGICAL CONTROL

Although no biological agents are currently available for kudzu control, efforts are underway to organize funding to screen insects that feed on kudzu in China (J. H. Miller, personal communication). The possibility of future releases of biological control agents probably represents the best hope for long-term control of kudzu.

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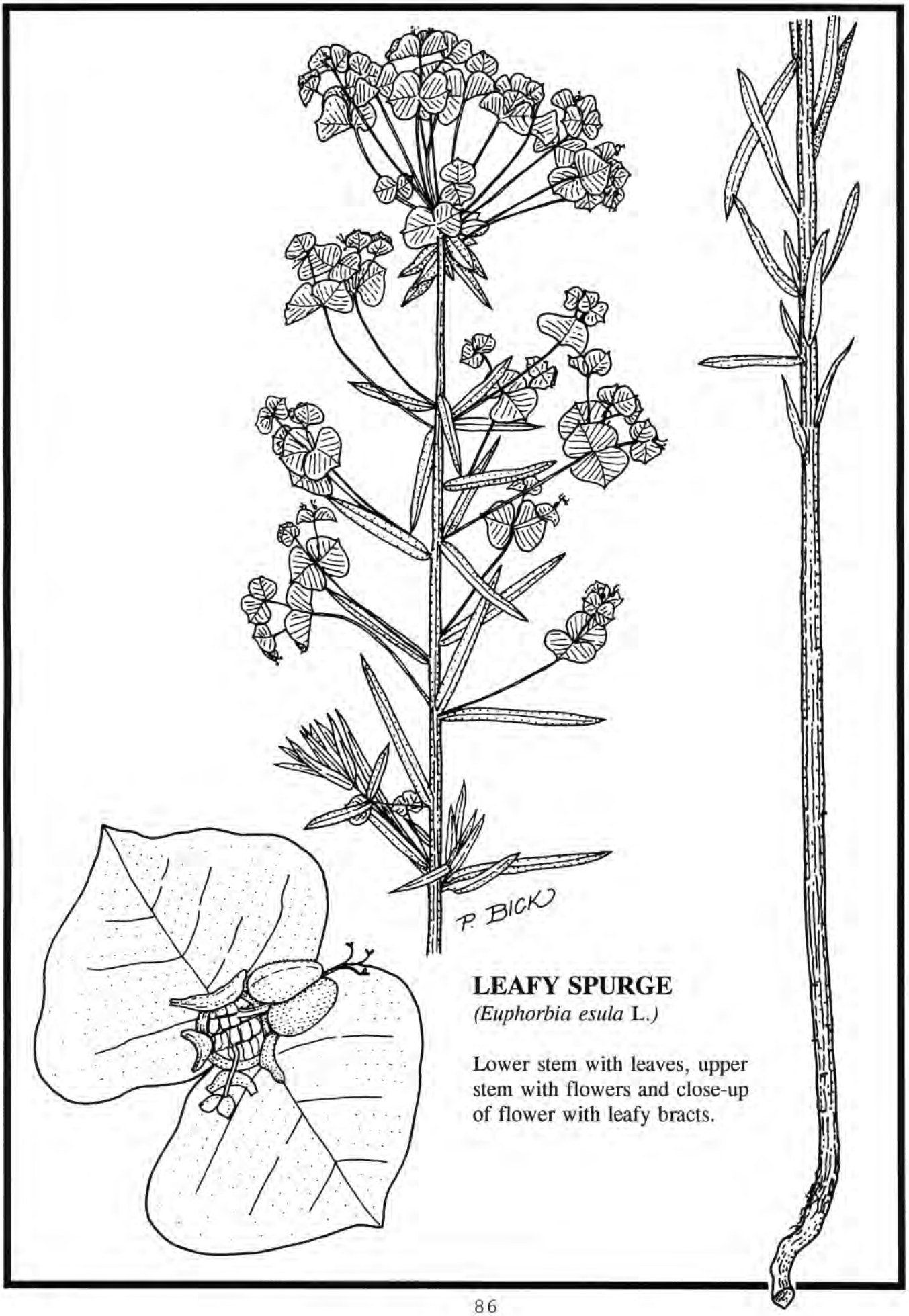
Illustration (Leafy Spruge)



LEAFY SPURGE

(Euphorbia esula L.*)*

Lower stem with leaves, upper stem with flowers and close-up of flower with leafy bracts.

VEGETATION MANAGEMENT GUIDELINE

Leafy Spurge (*Euphorbia esula* L.)

SPECIES CHARACTER

DESCRIPTION

Leafy spurge is a deep-rooted perennial that ranges in height from 6" to 36" (15-91 cm). Its greenish-yellow inflorescences are borne in an umbel pattern, and it typically blooms from May-October. Each umbel supports 7-10 groups of tiny, inconspicuous, flowers, subtended by 4 crescent-shaped glands and two conspicuous greenish-yellow bracts.

The bluish-green leaves of leafy spurge are usually alternate except for those located immediately under the inflorescence. These are in a whorled arrangement. Another characteristic is the two kinds of leaves present on the stem: leaves located on the lower half of the stem are scale-like, while those on the upper portion are linear to oblong. Leafy spurge has milky white sap that will flow from any part of the plant following injury. This sap may cause severe irritation to human skin and is reported to cause blistering and hair loss on the legs of horses in heavily infested pastures.

SIMILAR SPECIES

The most conspicuous features to look for when distinguishing leafy spurge from other plants are its greenish-yellow inflorescences; alternate, linear to slightly oblong or scaly leaves; and milky-white sap that flows readily upon injury to the plant. Leafy spurge should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Native to Europe and temperate Asia, leafy spurge currently is found throughout the world with the exception of Australia. It was probably introduced into the United States as a contaminant in imported grain. Since its introduction, the plant has become a serious management problem, particularly for the north and central plains states. States with the greatest infestations include Colorado, Idaho, Minnesota, Montana, Nebraska, North Dakota, Oregon, South Dakota, Wisconsin and Wyoming. The plant has been documented in Missouri from Grundy and Chariton counties, but it is probably more widespread in northern Missouri than records indicate.

HABITAT

Leafy spurge is adapted to a wide range of soil moisture conditions from moist to dry. However, it is especially aggressive in very dry situations where competition from native species is less intense. Areas most sensitive to leafy spurge infestation include pastures, roadsides, abandoned fields, railroad ballasts, disturbed and undisturbed mesic to dry prairies, and possibly open natural communities such as savannas.
It is not a common invader of tilled cropland sites.

LIFE HISTORY

Leafy spurge emerges in the early spring when temperatures still fluctuate around freezing. Seedlings at this time may be deep red or purplish in color. As the temperature rises, the stems grow rapidly and, if the plant is over a year old, flowers may appear as early as May. After 4-6 weeks, each stalk may produce and disperse over 200 seeds with a germination rate of 60-80%. However, in spite of this impressive germination rate, the key reproductive capabilities of leafy spurge remain underground. The root system of the plant is very extensive. Some roots may penetrate to a depth of 12 feet. Vegetative reproduction from both crown buds and root buds explain not only the persistence of this weed, but the difficulties encountered in eradicating it as well. Even if the foliage of the plant is removed or destroyed, the living root tissue will regenerate new shoots, and the new shoots can emerge from buds located anywhere along the length of the root.

EFFECTS UPON NATURAL AREAS

If leafy spurge becomes well established in Missouri, it will probably threaten mesic to dry prairies. Forbs and native grasses can be completely displaced by leafy spurge in a few years if the infestation is left unchecked.

CURRENT STATUS

Leafy spurge is not a widespread species in Missouri at present. It does occur in at least two counties of northern Missouri. Great Plains states northwest of Missouri report expanding populations of this weed, and there is every reason to believe that it will continue to spread in our area.

CONTROL RECOMMENDATIONS

Leafy spurge is well established in the central plains states where much time and effort is spent

trying to find a control. Most agree that the key to stopping this pest revolves around the ability to destroy its root system. The best way to inhibit this nuisance plant from becoming as destructive as purple loosestrife and multiflora rose is to recognize it as a pest now; treat the initial invading populations and prevent it from spreading any further. The sooner you attack leafy spurge--in its first year if possible--the better the chances of controlling it. All methods below may need to be repeated for 5-10 years.

Chemical control

Whatever the treatment, it is important to remember that leafy spurge cannot be controlled with a single herbicide application. At Devil's Tower National Monument in Wyoming, managers have been spraying on an annual basis for about 20 years and have significantly reduced but not eradicated leafy spurge populations.

Several chemicals have been used for leafy spurge control. These include picloram, 2,4-D, dicamba and glyphosate. Picloram is thought to be the most effective; but, due to its expense, it is often mixed with 2,4-D to treat large infestations. Picloram's residual activity in the soil may harm non-target species in natural communities. Biannual application of 2,4-D alone will probably prevent seed production and limit the spread of leafy spurge. It is unlikely to reduce the size of the original infestation, however.

For top growth control, the herbicide 2,4-D amine can be sprayed on the foliage in a 25% solution (1 part 2,4-D in 4 parts water) twice a year. The most effective time to apply the herbicide is mid- to late June when the true flowers (not the bracts) begin to appear. The second spray application should be made early to mid-September when fall regrowth has begun but before a killing frost occurs.

The nonselective herbicide Roundup (a formulation of glyphosate), sprayed on leafy spurge foliage as a 33% solution (1 part Roundup in 3 parts water), will provide 80-90% top control if applied between mid-August and mid-September. A follow-up treatment with a 25% solution of 2,4-D amine between mid-June and mid-July of the following year is necessary to control seedlings.

Apply the herbicide with a hand-sprayer until the spray coverage is uniform and complete. **Do not spray so heavily that herbicide drips off the target species.** Roundup is a nonselective herbicide that kills grasses and broadleaf plants. 2,4-D is a selective herbicide that kills broadleaf plants, but not grasses. Try to spray leafy spurge only, and carefully avoid contacting nontarget species. Native nontarget plants will be important in recolonizing the site after leafy spurge is controlled. The herbicide should be applied while backing away from the areas to avoid walking through the wet herbicide. By law, herbicides only may be applied according to label instructions.

Prescribed burning and herbiciding

Fire in conjunction with herbicides may be more effective than either method alone. Burning stimulates vegetative growth, making the plant more vulnerable to herbicides. Plants can be sprayed with 2,4-D in autumn (September) and burned the following spring (April). This should be followed by another 2,4-D treatment in June and a fall burn in October. The process may have to be repeated many times.

Biological control

Biological control is being actively researched at many locations and since the 1960's several insects have been released in certain location, most notably the spurge hawkmoth, *Hyles euphorbiae*. Biocontrol agents alone have not so far been effective in controlling spurge populations, but may become valuable if several different insects can be successfully used together or in conjunction with other control methods.

Grazing by goats has been used to control the spread of leafy spurge in pastureland, but the plant will probably resume its spread as soon as the grazers are removed. Cattle avoid grazing this plant.

FAILED OR INEFFECTIVE PRACTICES

Mowing or hand cutting is not completely effective because the root system remains undamaged and new sprouts will reappear rapidly. Also, mowing would have to be done continuously because it stimulates development of inflorescences on the lateral branches.

Hand-pulling, digging, or tilling is not completely effective because the entire root system must be excavated for complete control of leafy spurge. Pulling and digging can rip or cut the root into smaller pieces, leaving portions to resprout. This method could actually increase the number of plants.

Prescribed burning will not be likely to provide adequate control if used alone because its effect would be only on top growth and seeds. Established plants would quickly resprout.

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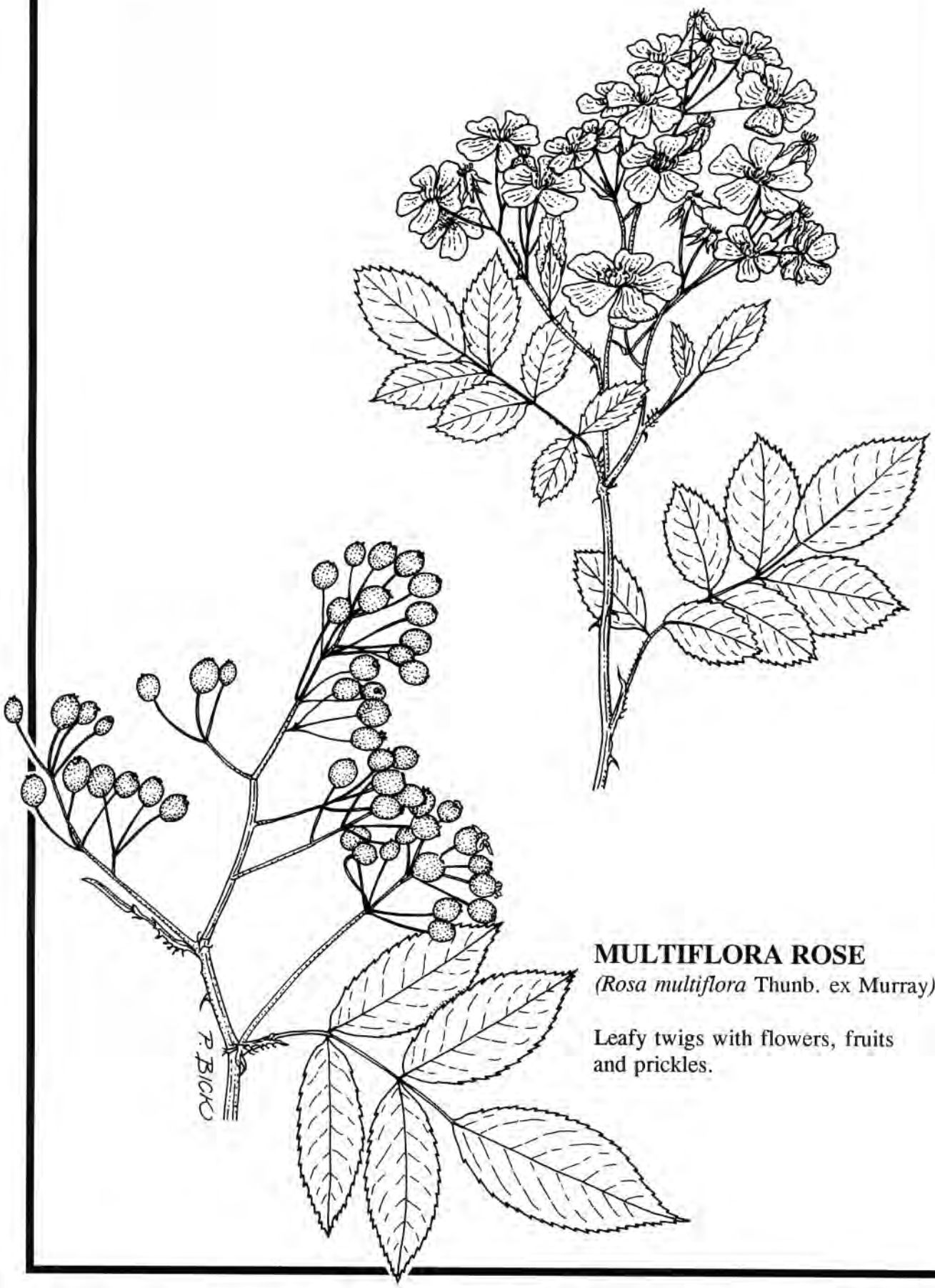
Illustration (Multiflora rose)



MULTIFLORA ROSE
(Rosa multiflora Thunb. ex Murray*)*

Leafy twigs with flowers, fruits and prickles.

VEGETATION MANAGEMENT GUIDELINE
Multiflora Rose (*Rosa multiflora* Thunb. ex Murray)

SPECIES CHARACTER

DESCRIPTION

Multiflora rose is a medium height, thorny, bushy shrub with a more spreading than erect growth form. Leaves are born alternately on the stems and divided into 5-11 leaflets (usually 7-9). Each leaflet is broadly oval and toothed along its margin. Clusters of numerous, white flowers, 3/4 - 1-1/2 inches (1.9-3.8 cm) across, bloom in late spring. The fruits are small, firm, red hips that may remain on the plant well into winter. Older rose shrubs may obtain a height of 15 feet (4.6 meters) or more with a root crown diameter of 8 inches (20 cm).

SIMILAR SPECIES

Multiflora rose can be distinguished from Missouri's native roses by the presence of a feathery or comb-like margin on the narrow stipules (a green, leaf like structure found at the base of each leaf stalk). Missouri's native rose species all have stipules at the base of the leaf stalk, but their stipules do not have feathery margins. Multiflora rose can also be distinguished from most native roses by the fact that its styles are fused together into a column. The native roses, except prairie rose (*Rosa setigera*) have separate styles. Multiflora rose should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Multiflora rose was originally introduced to the East Coast from Japan in 1886 as rootstock for cultivated roses. In the 1930's the U.S. Soil Conservation Service advocated use of multiflora rose in soil erosion control. Experimental plantings were conducted in Missouri and Illinois, and as recently as the late 1960's, many state conservation departments were distributing rooted cuttings to landowners. It was planted in the Midwest for living fences and soil conservation. Managers recognized that plantings of this thorny, bushy shrub provided excellent escape cover and a source of winter food for wildlife. The species soon spread and became a serious invader of agricultural lands, pastures, and natural communities from the Midwest to the East Coast.

HABITAT

Multiflora rose occurs in successional fields, pastures, and roadsides. It also may occur in

dense forests, particularly near natural disturbances such as treefall gaps and along streambanks. It has a wide tolerance for soil, moisture, and light conditions; but it does not grow well in standing water.

LIFE HISTORY

Multiflora rose is named for the clusters of many white flowers born on this perennial bramble during May or June. The flowers develop into small, hard fruits called hips that remain on the plant throughout winter. The great majority of plants develop from seeds remaining in the soil relatively close to plants from which they were produced. Birds and mammals also consume the hips and can disperse them greater distances. Rose seeds may remain viable in the soil for 10-20 years. Multiflora rose also spreads by layering, i.e., where tips of canes touch the ground and form roots, and by plants that arise from shallow roots.

EFFECTS UPON NATURAL AREAS

Multiflora rose readily invades prairies, savannas, open woodland, and forest edges. It is a thorny, bushy shrub that can form impenetrable thickets or "living fences" and smother out other vegetation. It is a serious pest species throughout the eastern United States.

CURRENT STATUS

There are probably no counties in Missouri where multiflora rose cannot be found today. The species was designated a noxious weed by Missouri state law in 1983. As such, Missouri counties may adopt a law that requires mandatory control of multiflora rose.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Pulling, grubbing, or removing individual plants from the soil can only be effective when all roots are removed or when plants that develop subsequently from severed roots are destroyed. These approaches are most practical for light, scattered infestations.

In fire-adapted communities, a routine prescribed burn program will hinder invasion and establishment of multiflora rose.

Research indicates that 3-6 cuttings or mowings per growing season for more than one year can achieve high plant mortality. Such treatment may need to be repeated for 2-4 years. Increased mowing rates (+6/season) did not increase plant mortality. In high quality

communities, repeated cutting is preferred over mowing, because repeated mowing will damage native vegetation as well as multiflora rose.

Cutting stems and either painting herbicide on the stump with a sponge applicator (sponge-type paint applicators can be used) or spraying herbicide on the stump with a low pressure hand-held sprayer kills root systems and prevents resprouting. Roundup herbicide (a formulation of glyphosate) has been effective in controlling multiflora rose when used as a 10-20% solution and applied directly to the cut stump. Although the Roundup label recommends a higher concentration for cut-stump treatment (50-100%), this lower concentration has proven effective. With this technique, herbicide is applied specifically to the target plant, reducing the possibilities of damaging nearby, desirable vegetation. Cut-stump treatment is effective late in the growing season (July-September), and also during the dormant season. Dormant season application is preferred because it will minimize potential harm to nontarget species. Glyphosate is a nonselective herbicide, so care should be taken to avoid contacting nontarget species. Both glyphosate and piclorum (Tordon RTU) are recommended for controlling established plants.

In addition, Triclopyr (tradename Garlon 3A) can be applied to cut stems or canes for selective control of multiflora rose. Garlon 3A diluted in water at a rate of 50% can be sprayed, using a hand sprayer, to the cut surface. Application should be within minutes of cutting. Use of Garlon 3A is best done in the dormant season to lessen damage to nontarget species. Great care should be exercised to avoid getting any of the herbicide on the ground near the target plant since some nontarget species may be harmed. Avoid using Triclopyr if rain is forecast for the following 1-4 days; otherwise runoff will harm nontarget species. By law, herbicides may only be applied according to label directions.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Repeated cutting, as discussed above, is effective. For large populations on severely disturbed areas, mowing can be substituted for cutting individual plants. However, mowing multiflora rose can result quickly in flat tires. On mowers, filling tires with foam is recommended.

Fosamine (tradename Krenite) can be applied as a foliar spray in a 2% solution plus 0.25% surfactant (2-1/2 ounces of Krenite plus one-half ounce surfactant per gallon of water). The Krenite S formulation contains the appropriate amount of surfactant. Coverage of foliage should be complete. Krenite should be applied only in July-September. No effects will be observed during the autumn season following application. Slight regrowth may occur the following season but canes will die during the summer. Fosamine kills only woody species and is non-volatile, therefore it is the preferred foliar spray treatment.

Dicamba (tradename Banvel) is an effective foliar spray that is less preferred than Krenite. Banvel is selective against broadleaf plants, so care must be taken to avoid contacting

desirable, broadleaf vegetation. It can be applied as a foliar spray in a 1% solution (1 ounce of Banvel per gallon of water). Though this solution can be applied any time during the growing season, best results are obtained during May and June when plants are actively growing and flowering, following full leaf-out. One-half ounce of a surfactant should be added when treating dense foliage and, to enhance control in late season applications, complete coverage of all green leaves should be achieved. **Do not spray Krenite or Dicamba so heavily that herbicide drips off the target species. Foliar spray of herbicides should only be used in less sensitive areas because of problems with contacting nontarget species.**

Glyphosate (tradename Roundup) is an effective foliar spray when applied as a 1% solution to multiflora rose plants that are flowering or in bud. Roundup is not a preferred chemical treatment, however, because it is nonselective and the selective herbicides mentioned above are effective. Nevertheless, Roundup can be used as a foliar spray during the growing season on severely disturbed sites if care is taken to avoid contacting nontarget plants. Roundup should not be used as a foliar spray during the growing season in high-quality natural areas because it can be result in damage to nontarget species. Roundup is useful as a foliar spray for alien plants that remain green and retain their leaves after native vegetation is dormant or senescent. Multiflora rose does not fit this description adequately and is controlled most effectively when treating during the growing season.

PROPOSED BIOLOGICAL CONTROLS

No effective biological controls that are currently considered feasible in natural communities are known. Rose rosette disease (RRD) is a fatal disease of multiflora rose and some cultivated roses, first described in the 1940s. The disease is caused by a virus-like particle transmitted by an eriophyid mite (*Phyllocoptes fructiphilus* K.). During past drought years, mite populations built up and RRD spread through much of the Midwest. The disease kills infected roses within two to three years and has already reduced weed populations in some areas. Pruning of multiflora rose will encourage succulent growth, which is more susceptible to mite infestation. Pruning may be practical in areas where RRD is present to encourage the spread of the disease. However, RRD may also infect native roses and plums, as well as commercially important plants in the rose family such as apples, some types of berries, and ornamental roses.

The rose seed chalid (*Megastigmus aculeastus* var. *nigroflavus*), a small wasp-like insect also imported from Japan, attacks developing seed of several rose species. By destroying large amounts of seed, the chalid limits new infestations. Research on the impact on cultivated roses along with studies on environmental limitations are currently being conducted. Both RRD and the rose seed chalid have been documented in Missouri, but not in all counties. Once more is known about the biology of these two control agents, RRD and the rose seed chalid could provide effective control of multiflora rose in areas where other methods are not feasible or are undesirable.

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Illustration (Musk Thistle)

MUSK THISTLE
(Carduus nutans L.*)*

Stem section with leaf and flower head.

VEGETATION MANAGEMENT GUIDELINE

Musk Thistle (*Carduus nutans* L.)

SPECIES CHARACTER

DESCRIPTION

Musk thistle is a large biennial, growing to 6 feet (1.8 m.) tall. Its flowerheads are rose-purple, up to 2 1/2 inches (7 cm.) wide and are mostly solitary and nodding at the tips of the branches. At the base of each flowerhead are numerous, spine-tipped involucral bracts, 1/8" - 3/8" (2 - 8 mm) broad, that are curved away from the heads. The leaves are of two types. One type forms basal rosettes during the first year, which overwinter, staying green, and killing any plants underneath. These are deeply-lobed leaves, growing up to 10 inches (25 cm) long and 4 inches (10 cm.) wide, and possessing a prominent, nearly white midrib. The upright flowering stalk grows during the second year, producing smaller, very spiny leaves. Stems are commonly winged with spiny leaf tissue.

SIMILAR SPECIES

Musk thistle resembles several other thistles that are found in Missouri. Curly thistle or welted thistle (*Carduus crispus*), the most closely related Missouri thistle, can be distinguished by its smaller flowerheads 0.5 - 1.0 in. (1.5 - 2.5 cm broad), narrower involucral bracts 1/8 inch (2mm, or less broad), and by its clustered flowerheads that are ascending rather than nodding.

Other Missouri thistles, including bull thistle (*Cirsium vulgare*), field thistle (*Cirsium discolor*), tall thistle (*Cirsium altissimum*), and Canada thistle (*Cirsium arvense*), can be distinguished from musk thistle by the fine bristles that are attached to the seeds. Musk thistle has unbranched bristles whereas the thistles in the genus *Cirsium* have feathery or plume-like bristles. The thistles in the genus *Cirsium* also tend to have smaller flower heads than does musk thistle. Canada thistle (see page 27), also a noxious weed in Missouri, occurs in thick colonies because it is a perennial with creeping rootstocks. Biennial species like musk thistle die after flowering and therefore do not usually occur in dense colonies.

Musk thistle should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Musk thistle is a native of Europe that was introduced into the U.S. as early as the 1850's. It has become widely naturalized in the U.S. and Canada. In this country, it occurs in at least 40

of the mainland states from the East to the West Coast. Kansas and Nebraska are reported to have the most serious infestations. In Missouri, musk thistle is widespread and probably occurs in most counties today.

HABITAT

Musk thistle is found in waste ground, old fields, pasture, and along roads and railroads. It has become a major weed in range and pasture land, a nuisance pest along rights-of-way, and a potential weed in land placed in conservation reserve programs. It can invade native grasslands, even where existing dense prairie vegetation exists. Glade communities are also likely areas for establishment of musk thistle, especially those with grazing histories and with inadequate buffers of natural land.

LIFE HISTORY

Musk thistle is variable in its flowering strategy, acting as a biennial, a winter annual, or an annual. Plants typically overwinter as rosettes and send up flowering stalks the following spring. Flowering can occur from early June through October. Seeds mature and can begin dispersing within 7 to 10 days of flowering. As many as 11,000 seeds per plant may be produced. Most seeds fall near the parent plant and can remain viable for as long as ten years.

Musk thistle infestations are economically important in agricultural systems because they compete with crops for light, space, nutrients, and water. The plants spiny tissue renders it unsuitable for livestock.

CURRENT STATUS

Musk thistle has been formally designated a noxious weed by Missouri law. As such, all landowners are required to control the plant if it is growing on their property. Control is considered to be prevention of seed production. County prosecuting attorneys are required to notify offending landowners in a prescribed manner before leveeing penalties.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Cultural, mechanical, biological and chemical control methods have all been used on musk thistles with varying degrees of success in different parts of the country.

-Cultural and Mechanical Methods: Musk thistle favors abandoned fields and overgrazed pastures. Rotationally grazed or deferred pasture is less susceptible to infestation than heavily grazed pastures. Although some investigators report thistle populations declined rapidly as natural succession proceeded, others report populations that persisted for twelve years in an unmanaged area.

Hand-cutting or mowing can provide control if repeated over a period of years. Hand-cutting with a sharpened shovel should insure that lateral as well as the terminal bud on the root crown are destroyed. A labor-intensive hand chopping at ground level just before flowering eliminated musk thistle at Konza Prairie, Kansas from a 350-acre pasture. The plants are apparently less likely to regrow if allowed to bolt before hand chopping the root crown. Mowing should also be timed to occur just prior to flowering.

-Biological Controls: Two exotic weevils, the flower head weevil, (*Rhinocyllus conicus*), and the rosette weevil, (*Trichosirocalus horridus*) were purposely introduced from Europe and have become established in Missouri and at least ten other states. These biological control agents aid in reducing populations of the thistle. In areas of Missouri where the weevils have been present for the longest period of time (1976-1992), an 80-90% reduction in thistle population has occurred. These weevils are increasing and dispersing naturally. They have also been collected for recolonization throughout the state. As of 1992, flower head weevils were established and widely distributed in 65 counties, whereas the rosette weevil is presently known from 25 counties. Recent recolonizations of the rosette weevil (1990-1992) have been made in 13 additional counties. An integrated pest management system has been developed utilizing knowledge of thistle and weevil life cycles. This program encourages survival of the weevils through a harmonious use of herbicides and mechanical control methods.

Biological control methods are intended to establish a balance between predator and target species. As a population of thistle is diminished by the weevils, weevil numbers decline. This allows the thistle to rebound and the weevil numbers to again increase. This scenario of fluctuating thistle and weevil populations does not totally eliminate musk thistle. If the thistle is eradicated from a site by herbicide application or other means, then the predator weevils will also be lost. Then future colonization of the site by musk thistle will require reintroduction of weevils or other means of treatment.

Two studies have addressed the effect of herbicides on biological control agents. In Montana, the effect of 2,4-D on *Rhinocyllus conicus* varied with weevil density. As larval populations increase, survival decreased. A Virginia study found that treatment with 2,4-D did not adversely affect either *Rhinocyllus conicus* or *Trichosirocalus horridus*.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

-Chemical Controls: The effectiveness of chemical control is influenced by the weather and the stage of growth of the thistle at the time of application. Chemical control of all types is most effective in the rosette stage and least effective when musk thistle is in flower. By law, herbicides may only be applied according to label directions.

Due to its low cost, 2,4-D ester at 2-4 lb/a (4.48 kg/ha) is the most commonly used herbicide. Application can be made aerially, with a tractor-mounted sprayer, with a backpack sprayer, or in granular form. Effectiveness depends on application when temperatures are not too cool and when it is not too dry. This may limit its use in early spring applications or in fall applications in some areas. 2,4-D is most effective when applied 10-14 days before bolting in the spring. 2,4-D is less effective than picloram or dicamba after plants have bolted.

Dicamba can be used to allow treatment earlier in the spring than 2,4-D. Dicamba at the rate of 1 lb/a provided the same control as 2 lb/a of 2,4-D in one study. Dicamba at 0.5 lb/a (0.6 kg/ha) provided between 90 and 100 percent control in the year of treatment for three successive years, but residual control in the second and third years fell to 36% or less. Spring applications of dicamba (.25 lb/a) in combination with 2,4-D ester (0.5 lb/a) gave 97% control by the fall of the same year.

Picloram alone or in combination with either 2,4-D or dicamba gives the best late-season control but is more expensive and carries more restrictions. These include restrictions on use near groundwater and on the season of use. Reports of effective use of picloram vary in recommended rates from .27 lb/a (0.3 kg/ha) to 0.5 lb/a (.56 kg/ha). The greatest attraction of picloram is that it provides excellent control during the cool, dry autumn season when neither 2,4-D nor dicamba is as effective, and when non-targeted vegetation is less susceptible. Although picloram overcomes the effects of weather, it does not fully overcome the effect of growth stage. Control of dense, even height, bolted plants using picloram in a ropewick applicator was effective, but control was poor when plants were of varying heights. Concomitant with its greater effectiveness, picloram presents a greater risk of damaging non-target species. Damage to cool-season grasses was reported in a study using higher concentrations of picloram (1 lb/a).

FAILED OR INEFFECTIVE PRACTICES

Mowing, brushhogging, and spraying when thistles are in full bloom is ineffective. Cutting the stems does not kill the plant at this stage. Stems will regrow and still flower and seed. Similarly, if herbicide application does not kill the plant, which is not too uncommon, regrowth and seeding will occur.

Fire has not been effective as a method for directly controlling musk thistle. It is difficult to generate enough heat to kill the thistle's root crown and fire-scarred plants can bolt, flower, and fruit.

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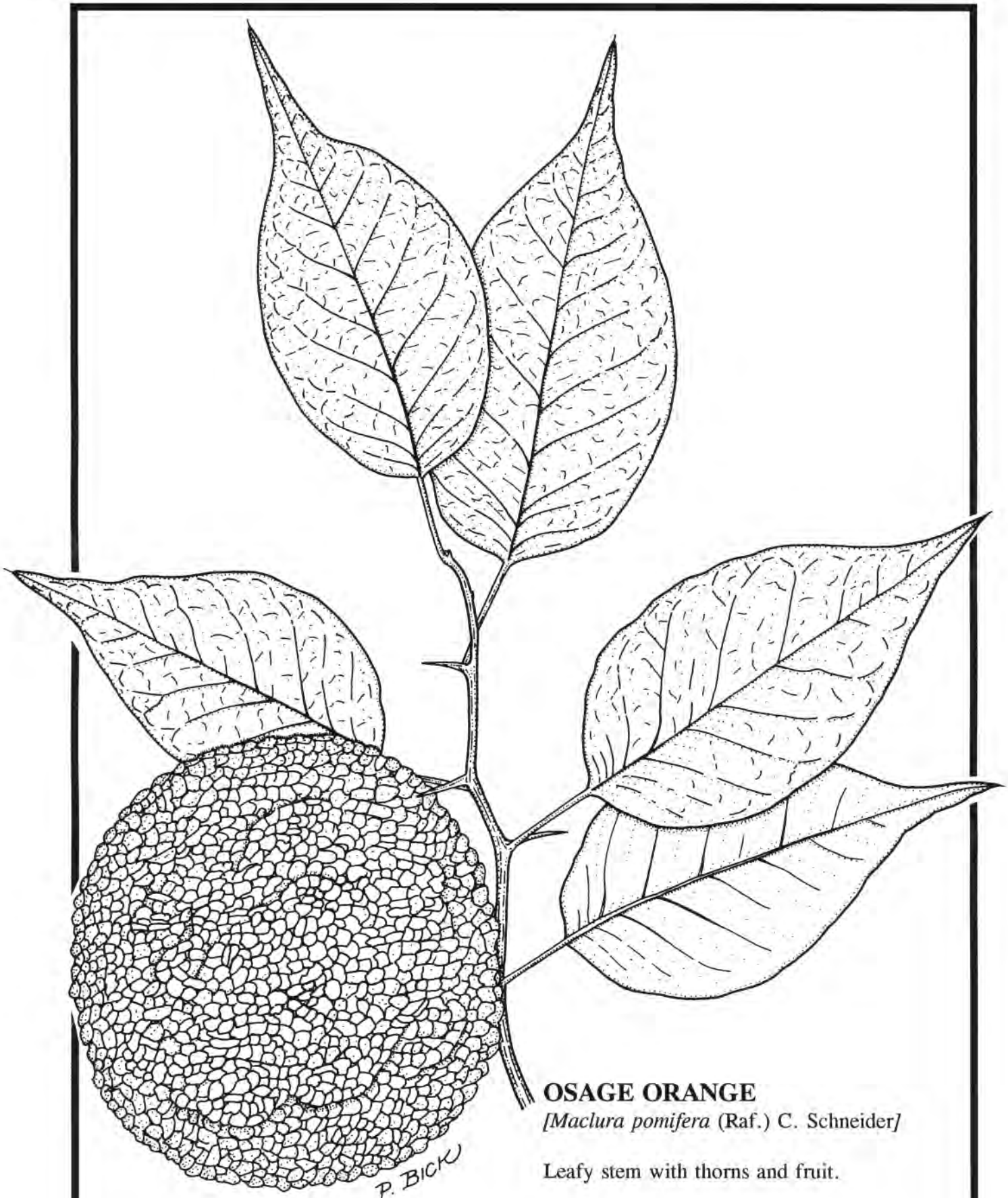
Illustration (Osage orange)



OSAGE ORANGE
[Maclura pomifera (Raf.) C. Schneider*]*

Leafy stem with thorns and fruit.

VEGETATION MANAGEMENT GUIDELINE

Osage Orange [*Maclura pomifera* (Raf.) C. Schneider]
Also known as Bois-d'arc or Hedge Apple

SPECIES CHARACTER

DESCRIPTION

Osage orange is a medium-sized tree with milky sap that will grow to 40 feet (12.2 meters) tall. Bark is light gray-brown tinged with orange. Bark on large trees separates into shaggy strips. Twigs are orange-brown with a zigzag shape and have sharp axillary spines on vigorous juvenile growth. These spines may be infrequent or absent on mature, slow-growing trees, but will return on sprouts from such trees. Leaves are alternate, entire, shiny, ovate or ovate-lanceolate, and long pointed at the tip.

Staminate and pistillate flowers are born on separate plants. Flowers are tiny. Staminate flowers form short clusters and pistillate flowers are crowded into spherical heads. The multiple fruit is large, spherical, and fleshy. The green-yellow fruit can be up to 6 inches (15.2 cm.) in diameter and contains many seeds. These fruits are hazardous during abscission in late September to early November, and workers should wear hardhats around female trees. Osage orange should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Osage orange is native to the south-central United States where it occurs naturally in Arkansas, Texas, Oklahoma, and perhaps Louisiana. It was introduced early into Missouri to be used for windbreaks, railroad ties, and for fencing cattle pastures. When planted close together in a row, the thorns make a barrier to cattle, hence Osage orange is described as a "living" fence. Osage orange frequently escapes from hedgerows. It has become naturalized and widespread in the Central States and undoubtedly occurs in all Missouri counties today.

HABITAT

Osage orange typically occurs in open sunny areas and can grow in a variety of soils. It is most frequently found growing in hedgerows or in pastures, but also occurs in disturbed forests and on river banks. Osage orange dominates large areas of abandoned pastureland in the Glaciated Plains, the Osage Plains and the Springfield Plateau regions of Missouri.

LIFE HISTORY

A single female Osage orange tree can produce many fruits, each containing many seeds. Although fruits are quite large, the seeds do get dispersed over long distances by animals that eat them. Osage orange can reproduce from root sprouts.

EFFECTS UPON NATURAL AREAS

Osage orange is an exotic species that frequently invades prairies and savannas. It also invades forest communities, usually as a result of past disturbance such as grazing.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Initial effort in areas of heavy infestation

Cutting and/or burning offer the best solutions for control. Cutting during summer months (June-August) should provide the best results, and two cuttings in one year are more effective than one. Summer cutting affects the plant when its root reserves are low and the possibility of adverse weather during the fall and winter may further harm the plants. Repeated cutting may be necessary to control Osage orange completely because it resprouts from the stump and by root suckers, and may cover large areas vegetatively. Cutting is most feasible with smaller plants.

Although girdling has not been tried as yet on Osage orange, it may prove successful on smaller trees that do not have thick bark. Older trees have quite thick bark, making girdling difficult. For girdling, the phloem should be removed without damaging the xylem. The xylem should be left to continue to conduct root reserves into the crown, thereby diminishing the capacity of the tree to resprout. The girdles should be checked every several weeks at first to make sure that bark does not develop over the cut area. Girdling can be done with an ax, saw, or chainsaw. Two parallel cuts 3-4 inches apart, cutting through the bark slightly deeper than the cambium, are needed. The bark is knocked off using a blunt object like the head of an ax.

Periodic prescribed burning will help keep young Osage orange plants from becoming established. Burning in conjunction with cutting works well on small plants. Large Osage orange trees are resistant to fire and will need another control method such as girdling or cutting.

All cutting or girdling practices, without herbicide treatment, will result initially in the development of masses of vigorous sprouts which are extremely difficult and hazardous to handle due to their axillary spines. The tips of these spines are brittle and may remain embedded when the spines are extracted from puncture wounds. Workers should take extra precautions to protect their eyes, hands, arms, knees, and feet when handling these sprouts. A cut-surface treatment with herbicide, as described below, is recommended to minimize sprouting.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Initial efforts in areas of light infestation

Same as given above for heavily infested areas.

Maintenance control

Periodic prescribed burning will hinder establishment of young Osage orange plants. Burning or chipping also will be required to reduce the thorny debris following cutting, since the spines as well as the heartwood are very decay resistant.

Initial effort in areas of heavy infestation

Same as given above for heavily infested areas except that labor-saving herbicides discussed below may be used when manpower is limited.

Triclopyr herbicide (trade name Garlon 4 or 3A) is effective as a bark treatment or cut-surface treatment. Undiluted Garlon 4 can be applied in a thin stream to all sides of the stem, 6 inches above the base of the plant. This only works on trees with stems less than 6 inches in diameter. A narrow band of Garlon 4 encircling the stem is needed for control. **This method should not be used in high-quality natural areas because the diesel fuel may kill vegetation around the tree.**

Cut-surface treatment with Garlon 3A, a selective translocated herbicide, effectively controls Osage orange. A diluted solution of Garlon 3A (50% solution in water) can be sprayed on cut surfaces or else wiped on the cut surface using a sponge applicator. Either a stump or girdle can be used for the cut surface. Girdles can be made rapidly using a chain saw. Application should be as soon as possible, and no later than 2-3 hours after cutting. Cut-surface application can be made during any season of the year, but application during the dormant season reduces the potential for injury to other plants due to drift.

Basal bark treatment with Garlon 4 also is effective. Two or 2 1/2 oz. of Garlon 4 is added to 1 gallon of diesel fuel. This mixture is sprayed, using a hand sprayer, to the basal portion of

the tree trunk. Spray to a height of 12-15 inches (30.5-38.1 cm.). Thorough spraying is necessary. **This method should only be used in less sensitive areas because runoff of diesel fuel and herbicide may harm nearby plants.**

Use of Triclopyr is best done in the dormant season to lessen damage to non-target plants. Great care should be exercised to avoid getting any of the mixtures on the ground near the target plant since some non-target species may be harmed. Avoid using Triclopyr if rain is forecast for the following 1-4 days, otherwise run off will harm non-target species. By law, herbicides only may be applied as per label directions. Osage orange seems to be very sensitive to Triclopyr, therefore very small amounts can be used, lessening the possible harm to non-target plants.

Initial efforts in areas of light infestation

Same as given above for heavily infested areas. Periodic prescribed burning controls seedlings and saplings.

Maintenance control

Periodic prescribed burning will hinder establishment of young Osage orange plants.

FAILED OR INEFFECTIVE PRACTICES

No biological controls are known that are feasible in natural areas.

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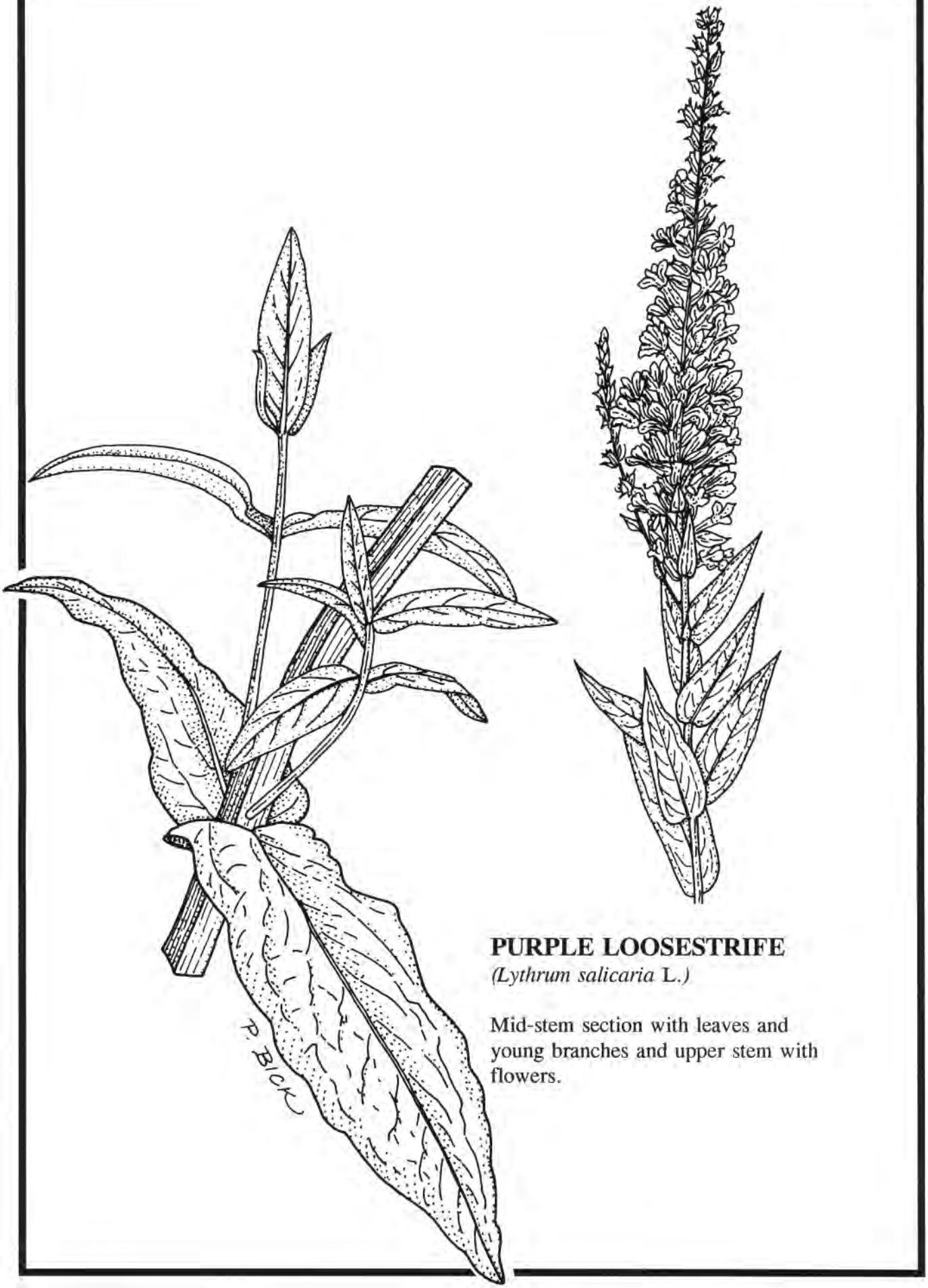
Illustration (Purple loosestrife)



PURPLE LOOSESTRIFE
(Lythrum salicaria L.*)*

Mid-stem section with leaves and young branches and upper stem with flowers.

VEGETATION MANAGEMENT GUIDELINE

Purple Loosestrife (*Lythrum salicaria* L.)

SPECIES CHARACTER

DESCRIPTION

Purple loosestrife is a stout, erect perennial herb with a strongly developed taproot. It may grow from 3 to 10 feet tall, with an average height of 5 feet. Its most notable characteristic is its showy spike of rose-purple flowers that are present in mid-to-late summer (early June thru early September). There are , however, several native species that also produce purple spikes of flowers that superficially resemble those of purple loosestrife. Purple loosestrife can be differentiated from these species by a combination of other characteristics. Purple loose-strife has flowers with 5 to 7 purple petals (petals are occasionally pink or white also); the leaves are opposite or in whorls of 3, all lacking teeth; and it has a stiff 4-sided stem that may appear woody at the base of large plants.

SIMILAR SPECIES

Purple loosestrife may be distinguished from the native winged loosestrife (*Lythrum alatum*), which it most closely resembles, by its generally larger size (native loosestrife has an average height of only 2 feet) and its opposite leaves (native loosestrife's upper leaves are usually alternate). The flowers of native loosestrife are also more widely spaced than those of purple loosestrife. Purple loosestrife should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Purple loosestrife is a perennial herb native to Europe and Asia. It was introduced to North America in the 1800's for use as an ornamental and by beekeepers. For nearly a century it occurred as a pioneering species on the northeastern seaboard, then, about 60 years ago the range of purple loosestrife began rapidly expanding, reaching the upper-Midwest in the 1930's. The species appears to go through a period of acclimation after each range expansion during which the invasive character of the species is not expressed. Heaviest U.S. concentrations are in the glaciated wetlands of the Northeast, but it occurs in nearly all sections of the country. Botanists have been aware of purple loosestrife populations in Missouri since the early 1950's.

HABITAT

Purple loosestrife occurs widely in wet habitats, such as freshwater marshes, fens, sedge meadows, and wet prairies, but it also occurs in roadside ditches, on river and streambanks, and at the edges of lakes and reservoirs. It thrives best in moist soil conditions in full sun, but it can survive in as much as 50% shade.

LIFE HISTORY

The reproductive capacity of purple loosestrife is one of the most significant and relevant life history characteristics of this herbaceous perennial plant. A single stalk can produce 300,000 seeds, and densities as high as 80,000 stalks/acre have been recorded, with the potential of producing as many as 24 billion seeds/acre. The seeds can remain viable even after 20 months of submergence in water. Seed set begins in mid-to-late July and continues through late summer. Seeds may be dispersed by water, wind and in mud attached to animals. Purple loosestrife also spreads vegetatively. Root or stem segments can form new flowering stems. Muskrat cuttings and mechanical clipping can also contribute to rapid spread by floating in riverine and lacustrine systems. Purple loosestrife lacks natural enemies in the United States.

EFFECTS UPON NATURAL AREAS

Purple loosestrife quickly crowds out most native vegetation in marsh, fen, sedge meadow, and wet prairie communities, creating a monoculture that provides little food or shelter for native wildlife. Once established, it can destroy marshes and wet prairies and choke waterways.

CURRENT STATUS

Purple loosestrife was declared a noxious weed by the Missouri Legislature in 1989. As such, the sale in Missouri of purple loosestrife or any of its hybrids is prohibited. It is also unlawful to distribute or plant seeds, plants or plant parts in the state.

CONTROL RECOMMENDATIONS

Current mechanical and chemical control methods have only limited success. Smaller infestations are more likely to be controllable, therefore early diagnosis is critical.

Biological control of purple loosestrife is being studied by Dr. Richard Malecki of the New York Cooperative Wildlife Research Unit at Cornell University. Three beetles, two

leaf-eaters and a root miner, that are natural predators of purple loosestrife in Europe have been approved for release in the U.S. after extensive testing. Initial releases will probably take place in Minnesota and Washington. These insects were selected for their specificity to purple loosestrife as a host plant. In Missouri, other species that may be affected are *Lythrum alatum* (winged loosestrife) and *Decodon verticillatus* (swamp loosestrife).

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES WITH NO KNOWN INVASION

Potential loosestrife habitat should be searched annually during late July and August for the plant. Early detection is the best approach!

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES WITH INVASIONS

Effort in areas with individual plants and clusters of up to 100 plants

Younger plants (1-2 years old) can be hand-pulled. Do not pull after flowering because this will scatter seed. Older plants, especially those in fens or in deep organic soils, can be dug out. Roots of older plants can be "teased" loose with a hand cultivator. Bag and remove the plants from the site. Failure to place the removed plants in a bag could result in spreading the plant along your exit route because fragments may be dropped. Dispose of the plant by burning (preferable) or in an approved landfill. Follow-up treatments are recommended for three years after the plants are removed. Clothing, equipment and personnel should be cleaned to insure no seeds are spread on them, if seeds were present on plants.

If the above control method is not feasible in areas with relatively small infestations, spot application of glyphosate herbicides can be used as described below.

Effort in areas with clusters in excess of 100 plants (up to 4 acres in size)

Spot application of a glyphosate herbicide to individual purple loosestrife plants is the recommended treatment where hand pulling is not feasible. Glyphosate is available under the trade names Roundup and Rodeo, products manufactured by Monsanto. Only Rodeo is registered for use over open water. By law herbicides may only be applied according to label directions.

Glyphosate is non-selective so care should be taken not to let it come in contact with non-target species. Glyphosate application is most effective when plants have just begun flowering. Timing is crucial, because seed set can occur if plants are in mid-late flower. Where feasible, the flower heads should be cut, bagged, and removed from the site before application to prevent seed set. Roundup should be applied by hand sprayer as a 1-1/2% solution (2 oz. Roundup/gallon of clean water). Rodeo should also be applied as a 1-1/2% solution (2 oz.

Rodeo/gallon clean water) with the addition of a wetting agent, as specified on the Rodeo label.

Another option is to apply glyphosate twice during the growing season. Foliage should be sprayed as described above, once when flowering has just started and a second time 2-3 weeks later. With this procedure control is likely more effective, because plants are not allowed to set seed and those missed because they were not flowering the first time are treated the second time.

Excessive application of herbicide (causing dripping from the plant) can kill desirable plants under the loosestrife. These plants, left unharmed, will be important in recolonizing the site after the loosestrife has been controlled. If the desirable plants are killed, the vigorously resprouting and growing purple loosestrife seeds present in the soil will fill the void. Since purple loosestrife is usually taller than the surrounding vegetation, application to the tops of plants alone can be very effective and limit exposure of non-target species. Complete coverage is not required to affect control.

The herbicide should be applied while backing away from treated areas to avoid walking through the wet herbicide. Equipment, clothing and personnel should be cleaned completely before entering other uninfested sensitive areas, if seeds were present in the treated area. It will be necessary to treat the same area again annually until missed plants and plants originating from the seed bank are eliminated. Relatively young populations seem to be almost eliminated in 2-3 years of consecutive treatment while older stands will require more treatment.

Cutting purple loosestrife and subsequently flooding the area so that cut plant stalks are completely immersed has controlled purple loosestrife in at least one case. However, flooding may encourage the spread of purple loosestrife if seed are present in the soil. Artificial flooding should not be used in high-quality natural communities with an intact natural flooding regime.

Effort in areas with large monocultures (greater than 4 acres in size)

For large purple loosestrife populations, an assessment should be made to determine if the loosestrife can be eradicated with available resources. If it can not be controlled, then efforts should be placed on keeping the loosestrife out of the highest quality areas.

Applying glyphosate from a vehicle mounted sprayer is usually necessary in areas with extensive stands of purple loosestrife. The most effective control can be achieved by beginning treatment at the periphery of large patches and working towards the center in successive years. This allows peripheral native vegetation to reinvade the treated area as the loosestrife is eliminated.

FAILED OR INEFFECTIVE PRACTICES

Mowing, burning, and flooding have proven largely ineffective. A single known exception is cutting followed by flooding as described above. Mowing and flooding can actually contribute to further spread of the species by disseminating seed and cut plant stems. Do not mow because cut parts may re-root.

EFFORTS TO ELIMINATE PURPLE LOOSESTRIFE IN MISSOURI

Botanists have been aware of purple loosestrife populations in parts of Missouri since the early 1950s. An active eradication program began in 1990 when herbicide was distributed, free of charge, to landowners with purple loosestrife populations. Successful control was limited, probably due to poor application techniques or poor timing of treatment.

Since 1991, a more aggressive approach has been used in which the Missouri Department of Conservation (MDC) personnel conduct the chemical treatment. MDC treatment crews use Rodeo at a 1% solution with a surfactant. The age of purple loosestrife infestations seems to be a major factor in determining the effectiveness of control. Early treatment, excellent landowner cooperation and dedicated treatment crews are in large part responsible for good progress toward control of purple loosestrife in Missouri.

Landowners or managers who know of sites of purple loosestrife infestations in Missouri should contact the Missouri Department of Conservation so that treatment can be initiated.

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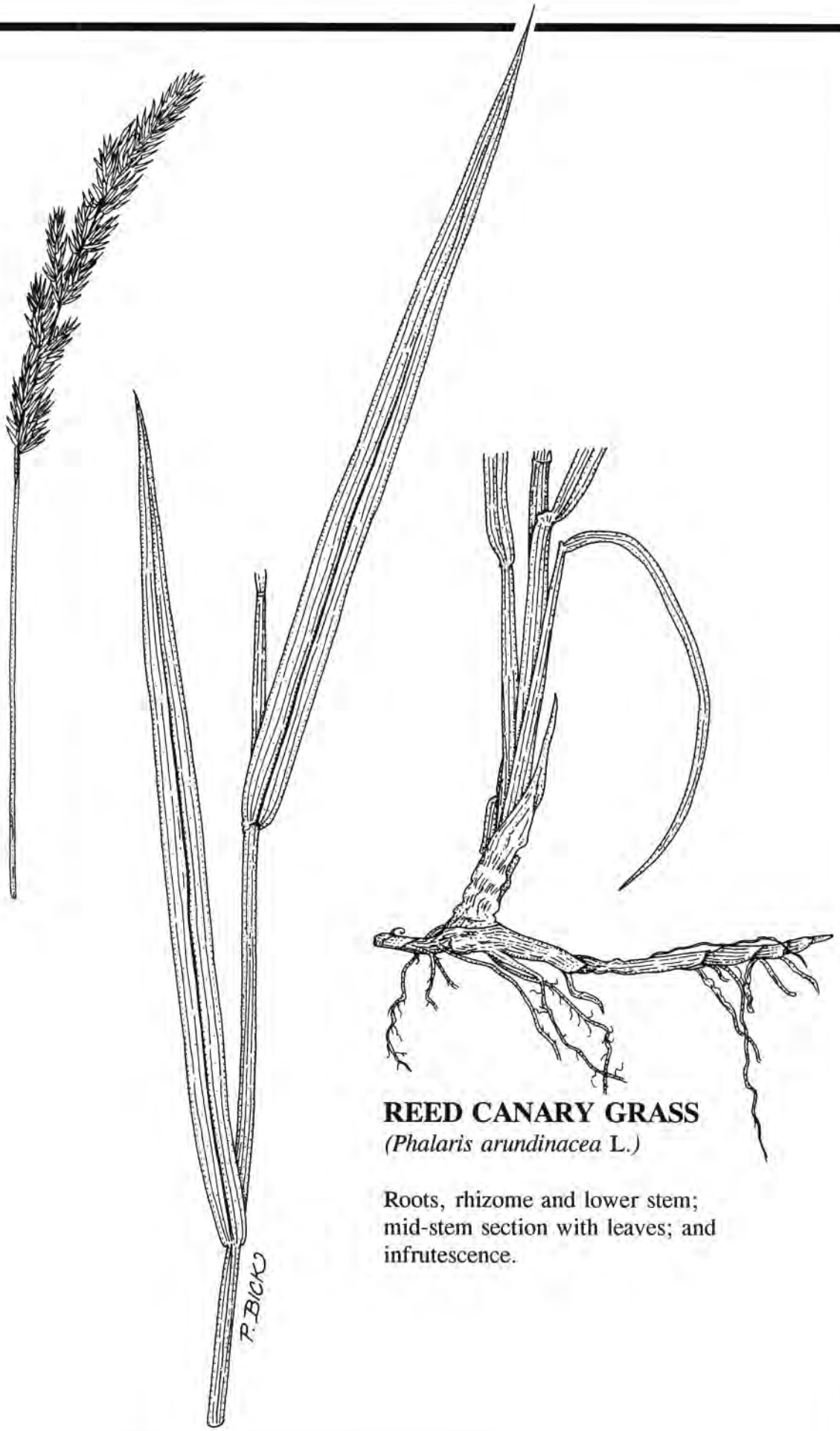
Illustration (Reed canary grass)



REED CANARY GRASS
(Phalaris arundinacea L.*)*

Roots, rhizome and lower stem; mid-stem section with leaves; and infrutescence.

VEGETATION MANAGEMENT GUIDELINE

Reed Canary Grass (*Phalaris arundinacea* L.)

SPECIES CHARACTER

DESCRIPTION

This large, coarse grass has erect, hairless stems, usually from 2 to 6 feet (0.6-1.8 meters) tall. The ligule is prominent and membranous, 1/4 inch (0.6 cm) long and rounded at the apex. The gradually tapering leaf blades are 3 1/2-10 inches (8.9-25.4 cm) long, 1/4-3/4 inch (0.6-1.9 cm) wide, flat, and often rough on both surfaces. The compact panicles are erect or sometimes slightly spreading and range from 3-16 inches (7.6-40.6 cm) long with branches 1/2-1 1/2 inches (1.2-3.8 cm) long. Single flowers occur in dense clusters in May to mid-June or August. Inflorescences are green or slightly purple at first, then become tan. Seeds are shiny brown.

The species growth form is highly variable, sometimes reclining at the base and rooting at the nodes. The amount of shading may also affect growth form. A Eurasian ecotype that is difficult, if not impossible, to distinguish from the native ecotype has also been introduced widely for forage and hay.

SIMILAR SPECIES

Reed canary grass closely resembles orchard grass (*Dactylis glomerata*). It differs from orchard grass in that reed canary grass's leaves are much wider, the inflorescence is more narrow and pointed, and the individual flowers have a different shape. The glumes and lemmas (scales that are part of the spikelet) of orchard grass are hairy, while those of reed canary grass lack hairs. Reed canary grass should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

This grass is found throughout the world except Antarctica and Greenland. The Mediterranean region is the center of diversity of the genus. It is native to lowland areas of northwestern Missouri and has escaped from cultivation in other regions.

HABITAT

This species occurs in wetlands, including marshes, wet prairies, wet meadows, fens, stream banks, and swales. It has been planted widely for forage and for erosion control.

LIFE HISTORY

Reed canary grass is a coarse, sod-forming, cool-season, perennial grass. It is native to temperate regions of Europe, Asia, and N. America, and is adapted to much of the northern half of U.S. It occurs from wet to dry habitats with best growth on fertile and moist or wet soils (shores, swales, meadows). Reproduction is from seed and vegetatively by stout, creeping rhizomes. It begins growth in early spring, growing vertically 5-7 weeks after germination, and then expands laterally. Growth peaks in mid-June and declines in mid-August. Vegetative vigor is related to maximum root and shoot production. Seeds ripen in late June and shatter when ripe. The native reed canary grass is not thought to be as aggressive as is the Eurasian ecotype.

EFFECTS UPON NATURAL AREAS

It is a major threat to marshes and natural wetlands because of its hardiness, aggressive nature, and rapid growth. Native wetland and wet prairie species are replaced after several years of reed canary grass presence. It is of particular concern because of the difficulty of selective control.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Fire can help control the spread of reed canary grass and keep it out of high quality wetlands. Repeated late autumn or late spring burning for several years can control this species. Annual burning may be needed for 5-6 years before good control is apparent. Burning is most effective where other species are present or in the seed bank, since fire allows native, fire-adapted species to compete successfully. Fire is not very effective in dense monocultures of this grass where seeds or plants of native species are absent.

The native reed canary grass should not be totally eliminated, but no reliable method for telling the difference between the forms is known. Control measures should be implemented when reed canary grass degrades the natural quality or diversity of a community.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Prescribed fire as described above should be used in areas that will burn. Hand removal for control may be feasible in small stands. There is evidence that hand chopping the culms at flowering time may kill small clones.

Certain herbicides are effective where there is no real concern for damage to surrounding native species. Rodeo, a formulation of glyphosate designed for use in wetlands, will kill reed canary grass, especially young plants, when applied to foliage according to label recommendations. Rodeo should be applied in early spring when reed canary grass is green and most native wetland species are still dormant. The area should be checked after spraying, and any surviving reed canary grass should be sprayed the following spring. Dalapon and Amitrol also reportedly kill canary grass, although no treatment recommendations other than label recommendations are available. All 3 herbicides are licensed for use in aquatic areas. **Rodeo and Amitrol are nonselective herbicides that will kill all vegetation contacted.** Dalapon selectively kills grasses and monocots, but not broadleaf plants. Spraying foliage with Roundup (a formulation of glyphosate) mixed according to label instructions and subsequent burning of dead residue has been moderately effective in northern Illinois. However, Roundup is not licensed for use in aquatic areas and should only be used in areas without standing water. When using any herbicide, precautions should be taken to avoid contacting non-target species. **Do not spray so heavily that herbicide drips off the target species.** The herbicide should be applied while backing away from the treated area to avoid contacting wet herbicide. By law, herbicides only may be applied as per label instructions.

Where practical, it can be useful to sow in seed of nearby native grasses and forbs after reed canary grass has died (due to control efforts) or gone dormant. Seed of nearby native grasses and forbs should be collected when ripe and then raked into the sod as soon as the reed canary grass has died.

FAILED OR INEFFECTIVE PRACTICES

The following practices should be avoided:

- hand control: very slow and too labor-intensive for large stands.
- mowing: probably not effective as a control measure.
- herbicides: probably none that are selective enough to be useful in high quality areas.
- grazing: probably not a practical method of control in wetland areas where canary grass usually is a problem.
- tillage: not usually practical in wetlands and not appropriate for high quality sites.
- restoring water levels: many wetlands are drier now than historically, and restoring water levels needs more research.
- biological controls: none known that are feasible in natural areas.

- introduction of competitive species: probably few native species can compete with reed canary grass in wetlands if burning is not used also. It reportedly will even crowd out cattails. Prescribed burning allows native species that are present or seeded-in to compete successfully.
- heavy equipment: removal with construction equipment is ineffective, as reed canary grass responds quickly by growing back from rhizomes and seeds remaining in the soil. Use of heavy equipment is not appropriate in good quality natural communities.

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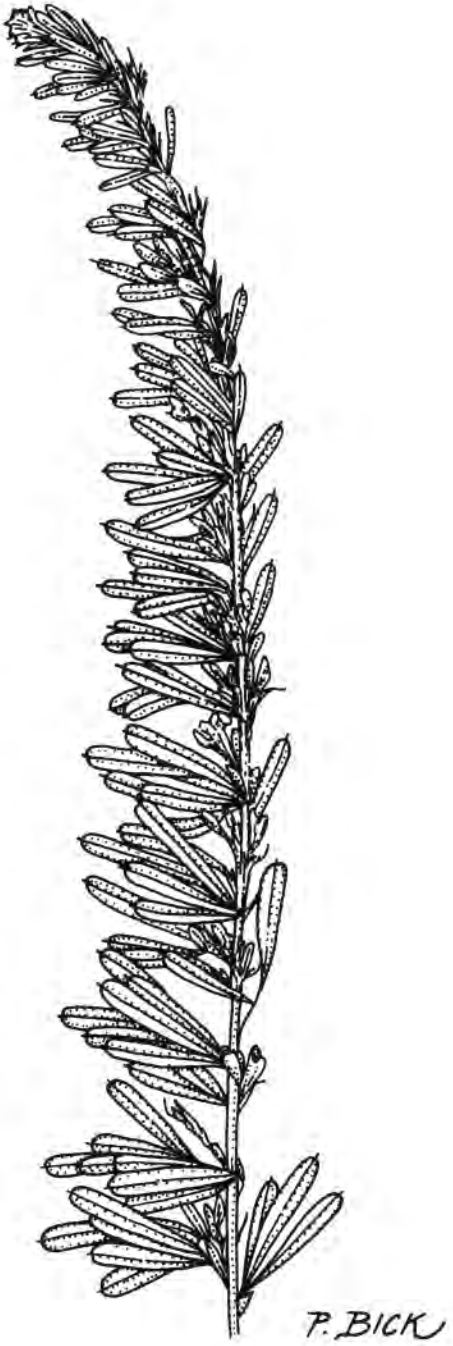
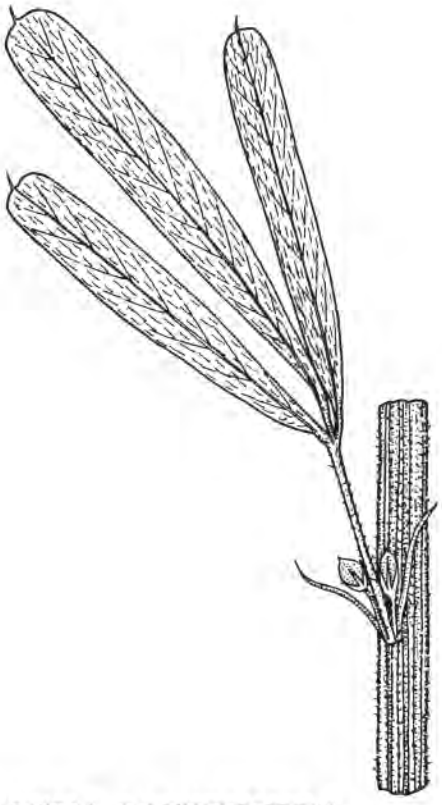
Illustration (Sericea lespedeza)





SERICEA LESPEDEZA

[Lespedeza cuneata (Dum.-Cours.) Don*]*

Mid-stem section with leaves and fruit.
Upper stem with leaves and flowers.

VEGETATION MANAGEMENT GUIDELINE

Sericea Lespedeza [*Lespedeza cuneata* (Dum.-Cours.) Don]

SPECIES CHARACTER

DESCRIPTION

Sericea lespedeza is an introduced perennial legume. It has erect, herbaceous to somewhat woody stems, standing 3 to 6 feet (0.8-2 m.) high, with many erect, leafy branches which are green to ashy in color. The compound leaves are composed of three leaflets, with leaflets varying in length from 1/4" to 1" (0.8 - 2.5 cm). The lower leaves have petioles, but the upper leaves are nearly sessile. The leaflets are much longer than wide, tapering to the base, and wider above the middle, narrowing abruptly to a small sharp point. Flowers are in clusters of mostly 2-3 in upper leaf axils. The corollas measure from 1/4 to 3/8 inches (7-9 mm.) long and are a pale creamy-yellow with conspicuous purple or pink markings. Its myriads of fruits are oval, and up to 1/8 inch (3 mm.) wide.

SIMILAR SPECIES

The pale creamy-yellow flowers are smaller than those of the native species, *L. capitata* and *L. hirta*, which also have cream-colored or yellowish flowers. The base of the standard (the upper petal of the flower) of sericea lespedeza has two broad purplish-rose-colored streaks on the inside of the center portion. The flowers of *L. capitata* and *L. hirta* occur in clusters of three to many (20-25), and the stem hairs of these two native species are spreading rather than being appressed to the stem as in sericea lespedeza.

DISTRIBUTION

Sericea lespedeza is a native of eastern Asia. It was first introduced in southern United States, and has now become naturalized from Maryland, Virginia, Tennessee, Missouri, and Texas, north to Pennsylvania, Ohio, Michigan, Illinois and Oklahoma. The first recorded collection of sericea lespedeza in Missouri was made in 1938. It has been introduced into various areas as a soil cover for erosion control, for soil improvement, as food and cover for bob-white, wild turkey, and other wildlife, and to a lesser extent, for forage and hay.

HABITAT

Sericea lespedeza grows in woodlands, thickets, fields, prairies, disturbed open ground, borders of ponds and swamps, meadows, and especially along roadsides. It shows great resistance to summer drought and an ability to form a dense stand on sterile, steep, or eroded

slopes. Where it has invaded grasslands, sericea lespedeza is unpalatable compared to native species because of tannins present in its tissues.

LIFE HISTORY

Sericea lespedeza produces growth in the spring (mid to late April) from root crown buds at the base of last year's stems. Flowering begins in late July and can continue through October. As flowering progresses, root reserves are increased; a fact that has implications for use of translocated herbicides. Seeds are dispersed in the fall and are reported to remain viable for twenty or more years. Birds may play a role in seed dispersal, and certainly the species is spread by haying of infested fields.

CURRENT STATUS

Since its introduction into Missouri this century, sericea lespedeza has been widely planted and has become naturalized in most if not all Missouri counties. Numerous stands that are well-established along roadways will continue to provide a source for spreading into surrounding, more natural habitats. Sericea lespedeza is designated a noxious weed in several Kansas counties.

CONTROL RECOMMENDATIONS

Options available for control of sericea lespedeza include management, mechanical, and chemical methods. There are no biological controls approved for sericea lespedeza at this time other than grazing.

Management: Rangelands can be managed to control sericea lespedeza by burning, grazing, and fertilization. Prescribed burning of native grass in the late spring followed by intensive grazing with mature cattle will increase utilization on sericea lespedeza. Grazing infested sites with sheep and goats will provide effective control. Pastures should be properly fertilized and grazed during April and May to reduce the occurrence of sericea lespedeza.

Fire has been used on non-rangeland infestations with some success. Late spring burns (May 15 to the end of June) may be effective if a fire will carry through the area at that time. Seed dormancy of sericea lespedeza can be broken by prescribed burning but resulting seedlings may be less viable. Breaking seed dormancy by burning may be preferable to allowing natural processes to accomplish this, since a persistent, long-lived seed bank may add new plants to the site for years to come. By forcing more seeds to germinate, following up with a mechanical or chemical treatment may have more long-term effects.

Mechanical: Root reserves of sericea lespedeza increase during flowering with a low point in the cycle at the flower bud stage. This low point provides a vulnerable stage at which to use mechanical control. Mowing in the flower bud stage for 2 to 3 consecutive years should reduce the vigor of sericea lespedeza.

Chemical:

-Rangeland control: Treatments containing triclopyr (e.g. Garlon 3A, Garlon 4) or metsulfuron (e.g. Ally, Escort) have been shown to be the most effective herbicides for sericea lespedeza control. Triclopyr at 0.5 lbs. acid equivalent/acre or metsulfuron at 0.3 oz. product/acre can provide effective control of sericea lespedeza treated during the vegetative stage prior to branching or during flowering. Ground application of herbicides should be in 10 to 20 gallons of solution per acre to insure adequate coverage.

-Spot applications: Application of herbicides using backpack sprayers has been effective for small or scattered infestations. Foliar applications of 2,4-D amine or glyphosate (tradename Roundup) have been effective at normal concentrations for foliar treatments. See herbicide label directions for appropriate concentrations. Glyphosate is effective from mid-June until seed set. 2,4-D amine should be applied from late June until seed set. When using any herbicide, precautions should be taken to avoid contacting non-target species. **Do not spray so heavily that herbicide drips off the target species.** The herbicide should be applied while backing away from the treated area to avoid contacting wet herbicide. By law, herbicides only may be applied as per label instructions.

FAILED OR INEFFECTIVE PRACTICES

Prescribed burning alone may not be effective in controlling sericea lespedeza. Fire may actually enhance germinating of sericea lespedeza seed.

In rangeland situations, intensive, early stocking (doubling the normal stocking rate from May 1 to July 15 and then removing the livestock) with steers has not provided consistent utilization of sericea lespedeza.

2,4-D was not found to provide effective control for sericea lespedeza in rangeland applications.

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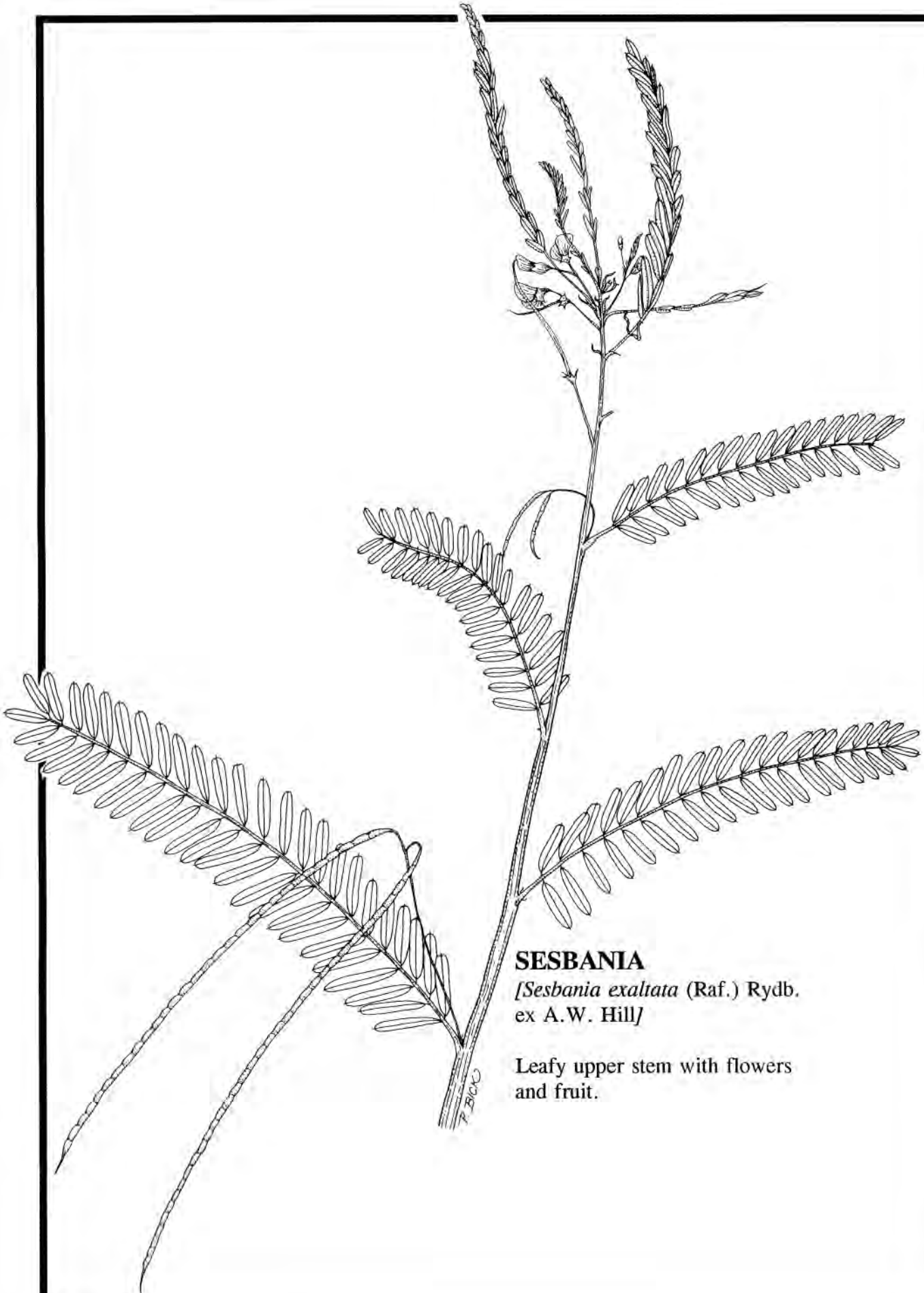
Illustration (Sesbania)



SESBANIA
[Sesbania exaltata (Raf.) Rydb. ex A.W. Hill*]*

Leafy upper stem with flowers and fruit.

VEGETATION MANAGEMENT GUIDELINE

Sesbania [*Sesbania exaltata* (Raf.) Rydb. ex A.W. Hill]
Additional common names: Coffeeweed, Indigoweed, Bequilla

SPECIES CHARACTER

DESCRIPTION

Sesbania is an erect annual herb of the legume family which typically grows to a height of 3-10 feet (1-3 meters). Its rather large leaves are 4-12 inches (1-3 dm) long with 20-70 leaflets per leaf. Flowers are 1/2-3/4 inches (15-20 mm) long, are yellowish in color, and strongly speckled with purplish brown.

It has slender, quadrangular pods, about 6-8 inches (15-20 cm) long and 2/16-3/16 inches (3-4mm) wide. The seeds are small and numerous, about 2/16-3/16 inches (3-4 mm) long and 1/16 inch (2mm) wide. The seeds are more or less orange on their attachment side, with the other surface possessing a more or less olive-green background, speckled or blotched with black.

DISTRIBUTION

This plant of the southeastern U.S. and adjacent Mexico ranges from South Carolina to the southern tip of Florida, and westward to the eastern third of Texas. From there its range extends northward to Oklahoma, Illinois, and Missouri. It has also been reported as an introduced species in the northeastern U. S.

HABITAT

Sesbania prefers wet, highly disturbed habitats and sandy sites. It occurs in low sandy fields, sand bars of streams, alluvial ground along sloughs and borders of oxbow lakes, and along roadsides, railroads, in disturbed urban sites and agricultural areas. It may become a troublesome exotic species in wetland communities that are managed for waterfowl.

LIFE HISTORY

Optimum germination occurs late in the growing season when mudflats are exposed during periods of elevated temperatures. Although germination is late (best following late spring or summer drawdowns), sesbania sometimes forms dense stands that preclude germination and growth of desirable moist-soil species. Longevity of seeds is great and sporadic occurrences are common, particularly following disturbance.

CURRENT STATUS

In Missouri, sesbania is most common in the Mississippi Lowlands counties of southeastern Missouri, but it also occurs in other scattered counties of southern and central Missouri.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Sesbania is not likely to colonize high-quality natural communities in Missouri as it typically grows in disturbed areas. Isolated occurrences may be found on sand bars along streams or along margins of oxbows or marshes. Spot treatment may best be accomplished by mechanical removal of the stems prior to the production of fruits. Follow-up will probably be necessary for several additional growing seasons if a seed bank is present or if reinfestation occurs.

Another option would be to treat local occurrences with a foliar application of Rodeo (glyphosate) herbicide prior to fruit production. Follow-up will again be necessary if a seed bank exists at the site or if reinfestation occurs.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Control of sesbania is best accomplished by creating conditions favorable for the germination of beneficial plants early in the growing season. Once established, beneficial plants can outcompete newly germinated sesbania. Therefore, control strategies should be performed early in the growing season. If early control is not possible, late disk-flood often prevents reestablishment of sesbania and creates conditions favorable for fall migrating shorebirds. This can be followed by an early drawdown during the subsequent growing season.

Chemical methods of control include spraying with 2,4-D at the rate of 3/4 pint per acre, applying it with a boom sprayer. One can also wick the plants with Roundup or Rodeo.

A mechanical method, such as mowing, should be accomplished prior to seed set if at all possible. One should mow as high as possible to preserve and promote growth of desirable plants in the understory.

FAILED OR INEFFECTIVE PRACTICES

Burning appears to stimulate germination. Soil disturbance by disking also stimulates germination when done in early to mid-summer. A late drawdown during elevated temperatures and dry weather conditions stimulates germination as well.

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PERSONAL COMMUNICATIONS

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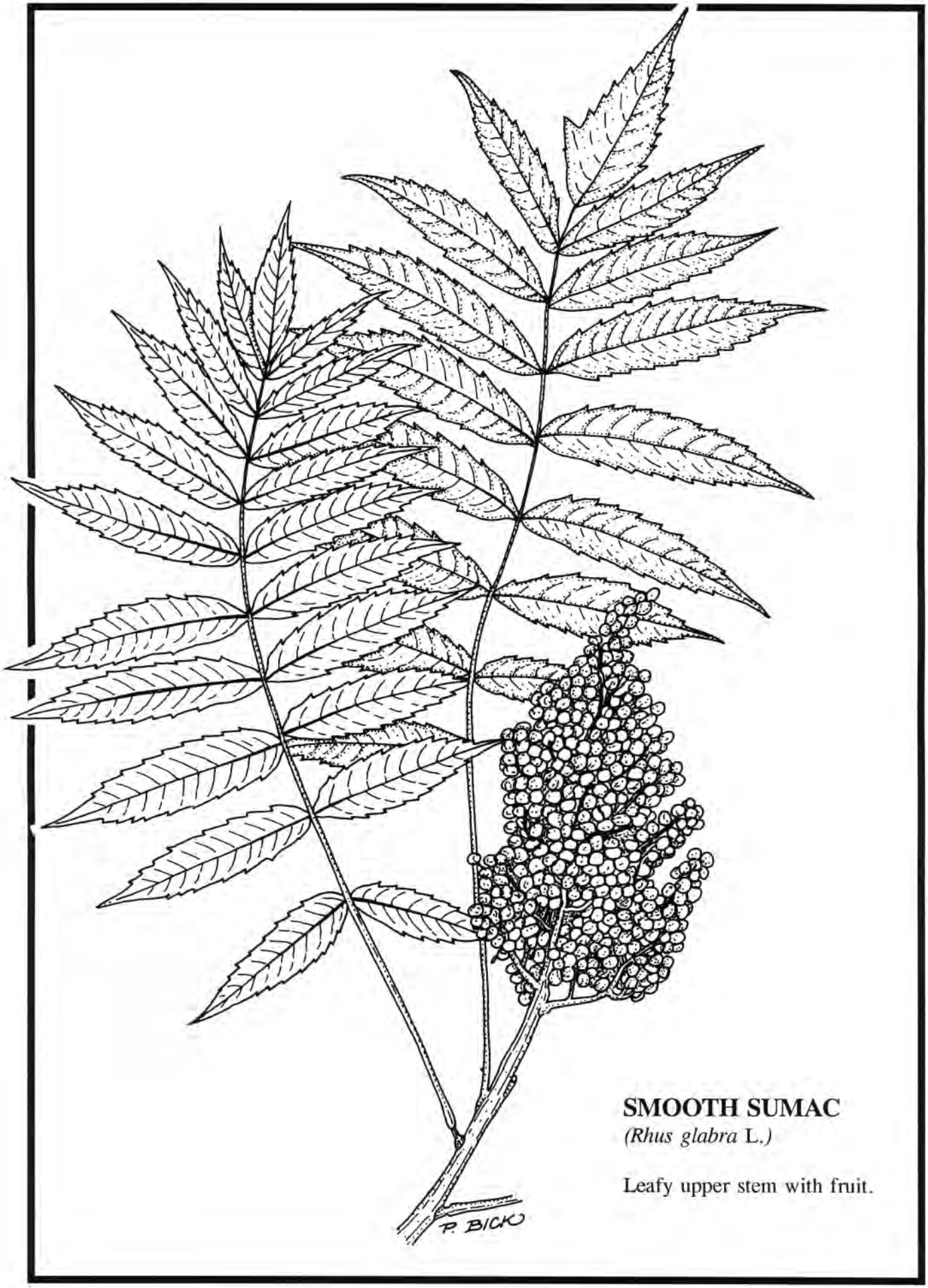
Illustration (Smooth sumac)



SMOOTH SUMAC
(Rhus glabra L.*)*

Leafy upper stem with fruit.

VEGETATION MANAGEMENT GUIDELINE

Smooth Sumac (*Rhus glabra* L.)

SPECIES CHARACTER

DESCRIPTION

This shrub or small tree reaches up to 20 feet (6.1 meters) tall and has a spreading crown. It grows in colonies that result from stems sprouting from roots. The bark is light brown and smooth on young plants. Twigs are stout, angular, smooth, and covered with a whitish coat that can be wiped off. Leaves are pinnately compound with 7-31 leaflets that are green on upper surface and nearly white on lower surface. Leaves turn red in autumn. The small, numerous flowers occur in much branched clusters. The fruit is a cluster of red drupes. Each drupe (a fleshy fruit with a hard or stony center) is round, has short hairs and contains a single seed.

SIMILAR SPECIES

Black walnut is a tree that, when young, might be confused with smooth sumac. Black walnut can be identified by slicing a stem to reveal a dark brown pith with air chambers. The pith of sumac is a lighter color and is homogenous, i.e. it lacks the air chambers. Winged sumac has wing-like tissue connecting the leaflets along the rachis of its compound leaf. Staghorn sumac is a non-native species in Missouri that has velvet covered twigs. Smooth sumac should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Smooth sumac is native to and occurs throughout the U.S. and into southern Canada, but is most common in the eastern U.S. It occurs throughout Missouri.

HABITAT

This species is usually found on disturbed sites, abandoned fields, railroad edges, fence rows, rights-of-way, upland prairies and borders and openings in forest.

LIFE HISTORY

This native but sometimes aggressive shrub occurs in clumps or colonies and spreads by seeds and rootstocks. It flowers from late May until mid-August. Seeds are formed by September. It sprouts easily, grows rapidly, and aboveground stems are relatively short-lived while roots persist and form new stems.

EFFECTS UPON NATURAL AREAS

Smooth sumac is known to shade and replace prairie plants and endangered species. It is one of the primary woody invaders that moves into prairies and loess hill prairies in Missouri, where its dense colonies eliminate other native species.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Managers first must decide what part of the population should be removed. In general, sumac should be left in ravines and draws within prairie communities. It should not be eliminated totally from communities where it is a natural component, but should be controlled where it has invaded or spread to the detriment of other native vegetation.

Stems should be cut with an axe, lopper, or harp blade in July or shortly after flowering. Sprouts then should be cut in August. Spot-treating cut stumps with Roundup (a formulation of glyphosate) will minimize resprouting. While the Roundup label recommends a 50-100% concentration of Roundup for stump treatment, a 10-20% concentration has proven effective. Roundup can be applied to cut stumps either with a low pressure hand-held sprayer or else by wiping it on the stump with a sponge applicator (similar to paint applicators). The herbicide applicator must be extremely careful not to contact non-target species with Roundup since this herbicide is nonselective and will kill most photosynthetically active plants when applied in July or August. By law, herbicides only may be applied as per label instructions.

If sumac is intermingled with other non-target plants, mechanical removal may be preferred to chemical control. Sumac should be cut twice, once in July and once in August. Cutting at the appropriate time is crucial for effective control. Double-cutting (once in July and once in August) may need to be repeated for several consecutive years to achieve effective control in dense populations.

Where fire will carry through a stand, burning in August will often kill mature plants, but sprouts must be cut. In glades and prairies, an occasional August burn should be sufficient.

For maintenance control, edge individuals that provide the source of young plants invading high-quality prairie or glade communities should be cut and the stumps spot-treated with Roundup, as described above. An occasional August fire should be sufficient to keep the sumac population in check. Midsummer (July or August) mowing or cutting of sumac can reduce its vigor.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

The control procedures recommended above for high quality natural areas are also applicable to buffer and severely disturbed sites. In addition, foliar applications of Garlon 3A (a selective translocated herbicide that is a formulation of triclopyr) or 1-2% Roundup applied according to label instructions also are effective. If herbicides are used, great care should be taken to avoid contacting nontarget plants with the herbicide. In addition, **do not spray so heavily that herbicide drips off the target species.** The herbicide should be applied while backing away from the treated area to avoid walking through the wet herbicide. Large smooth sumac colonies should not be allowed to develop next to naturally open communities.

INEFFECTIVE OR FAILED PRACTICES

The following practices should be avoided:

- hand control: fall or winter cutting has little effect.
- mowing: early- or late-season mowing has little effect and is not practical on all sites, particularly steep glades and hill prairies. As mentioned above, midsummer mowing or cutting is an effective control.
- fire: early spring fires can actually increase sprouting and encourage the spread of smooth sumac. Dormant season (late fall, winter) fires do not control sumac.
- herbicides: are not as effective during the dormant season.
- grazing: encourages sumac growth and spread.
- biological controls: none are known that are feasible in natural areas.

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Illustration (White sweet clover)

WHITE SWEET CLOVER
(Melilotus alba Medic.*)*

Leafy upper stem with flowers.

VEGETATION MANAGEMENT GUIDELINE

White and Yellow Sweet Clover [*Melilotus alba* Medic. and *Melilotus officinalis* (L.) Pallas]

SPECIES CHARACTER

DESCRIPTION

White and yellow sweet clover are biennial herbs that are somewhat easy to identify, especially when in flower. Flowers are crowded densely on the top 4 inches (10 cm) of an elongated stem, with younger flowers emerging nearest the tip, or apex. Each tiny flower is attached to the stem by a minute stalk. The small pea-like flowers are white or yellow and each produces one or two seeds during the second growing season.

The compound leaves of sweet clover are alternate and have three leaflets per leaf. Leaflets are finely-toothed and longer than broad. Mature plants (second-year) may appear bushy. These aromatic plants are members of the pea (legume) family, but they are not true clovers.

SIMILAR SPECIES

White and yellow sweet clover are distinguished from other members of the pea family by the following combination of characteristics. The leaves of yellow and white sweet clover are divided into three leaflets that are finely toothed, the middle leaflet occurs on a distinct stalk, and the flowers occur in a long, narrow inflorescence. No other member of the pea family has this combination of characteristics. Sweet clover seedlings closely resemble those of alfalfa. Sweet clover can be distinguished from alfalfa by its lack of hair on the lower leaflet surfaces and by its bitter taste. Mature sweet clover has a more erect growth habit than does alfalfa. Sweet clover should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Sweet clover is native to Europe and Asia. It can be found in all 50 states. The earliest records of its occurrence in North America date to 1664. More recently, around the turn of the century, sweet clover was cultivated as a forage crop and soil builder. It has been used most extensively in the north-central and Great Plains states of North Dakota, Minnesota, Montana, Iowa and Wisconsin. Today it is also used as a wildlife cover crop and in production of honey. Both species of sweet clover have been recorded from throughout Missouri, most commonly in disturbed habitats. Because this exotic is considered economically important and thus will

continue to be planted it will remain a problem for land managers well into the future.

HABITAT

Sweet clover has adapted to a variety of conditions, withstanding both hot and cold climates. It grows well in direct sunlight and in partial shade. Sweet clover, however, cannot tolerate dense shade. Even the thick growth of a second-year sweet clover produces enough shade to cause its own lower leaves to fall. Sweet clover seems to prefer calcareous or loamy soils with a pH level of 6.5 or greater. Areas most likely to contain sweet clover include roadsides, abandoned fields, railroad ballasts, pastures and any unflooded, open natural community such as a prairie.

LIFE HISTORY

Sweet clover is an obligate biennial, which means that the plant always puts its energy into developing a healthy root system during the first season, and during the second season, it flowers, sets seed and dies. In the first growing season, sweet clover is entirely vegetative. A small, branched stem with clover-like leaves is visible. In late summer, the root continues to develop. By the second year sweet clover has a strong taproot and root crown from which new shoots emerge. The plants flower from May through September, producing hardy little seeds that may remain viable in the soil for years (up to 30 years or more). Seeds are dispersed by rainwater runoff and stream flow and, for shorter distances, by wind. After setting seed the plant dies. Because sweet clover dies after the second year, seed production is critical for its continued existence, and is the key to controlling it. If the flowering stage of sweet clover is halted, so is the spreading of the plant--as long as management procedures continue long enough to deplete viable seeds remaining in the soil.

EFFECTS UPON NATURAL AREAS

These clovers readily invade open habitats and already have successfully exploited many Midwestern native prairies and open, unflooded communities.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Hand-pulling is effective if done when the ground is moist and most of the root can be removed. The best times to hand-pull sweet clover are in the late fall, after the first-year plant root-crown buds have developed, or anytime early in spring, before second year plants develop

flower buds. Fall weeding is recommended because: 1) the bright green sweet clover is easily spotted within the yellowing prairie, 2) moist fall conditions and an immature first year root may make pulling easier, and 3) fall weeding is less stressful to native vegetation. However, sweet clover is easily located in the spring also, because it becomes green before native prairie vegetation. Hand-pulling in summer can be effective if done when the ground is moist. Hand-pulling is labor-intensive and must be done consistently. This treatment is feasible for light and moderate infestations, but may be too time consuming in heavy infestation.

In large, dense colonies of sweet clover, cutting first and second year stems close to the ground with a hand-held scythe is effective if done after leaves on the lower stems have died (before flowering occurs) and up to early stages of flowering (before seeds form). Sweet clover usually does not resprout when the stems are cut close to the ground during this time.

Prescribed burning can control sweet clover. A combination of an April burn in the first year, followed by a May burn the following year is most successful in eradicating an even-aged stand of sweet clover. A hot, complete, first-year April burn scarifies sweet clover seeds, stimulating them to grow (a late fall burn will also have this effect). A hot, complete, second-year May burn kills the emerging shoots before they can go to seed. Heavily infested stands are best controlled with the above sequence twice, separated by 2 years without burning. Problems with this method may arise if the burn is patchy, leaving viable seeds or second-year shoots unscathed.

In an uneven-aged stand of sweet clover, second-year clover may escape the harmful effects of the early first-year burn because their shoots were not fully emerged. These plants would live to set seed. In this case, a combination of other procedures can be used: 1) spring burns could be later (after shoots emerge, but before second-year plants set seed) in a sequence of 3-5 years, or 2) follow up the early burn with hand-pulling, if practical.

In an even-aged stand of sweet clover, fall mowing can speed up the 2-year burn program. In this situation, one should burn in April; mow first-year plants in August, leaving the stems behind to dry; and burn again in mid-late September.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Same as given above for high quality areas, with the following addition. Herbicide can be useful in controlling large sweet clover populations in degraded areas. Following a fall burn, hand spray individual seedlings with an amine formulation of 2,4-D according to label instructions in spring, before native prairie vegetation emerges. This treatment also is effective when plants are in the cotyledon stage (i.e., when the first leaves appear in the development of the seedling). To reduce vapor drift, use an amine formulation of 2,4-D rather than an ester formulation. A 1% solution of Mecamine (2,4-D plus Dicamba) applied

to the foliage as a spray is very effective. The herbicide 2,4-D amine is selective for broadleaf plants.

When applying either herbicide described above, spot application should be done such that coverage is uniform with the entire leaf being wet. Precautions should be taken to avoid contacting non-target plants with the solution. **Do not spray so heavily that herbicide drips off the target species.** By law, herbicides may only be applied according to label instructions.

Little information is available on grazing effects on sweet clover, but observations in South Dakota suggest that bison tend to avoid it while cattle consume it quite readily. A May burn followed by grazing in September through October is effective, but a high stocking rate is required.

FAILED OR INEFFECTIVE PRACTICES

No effective biological controls that are currently feasible in natural areas are known.

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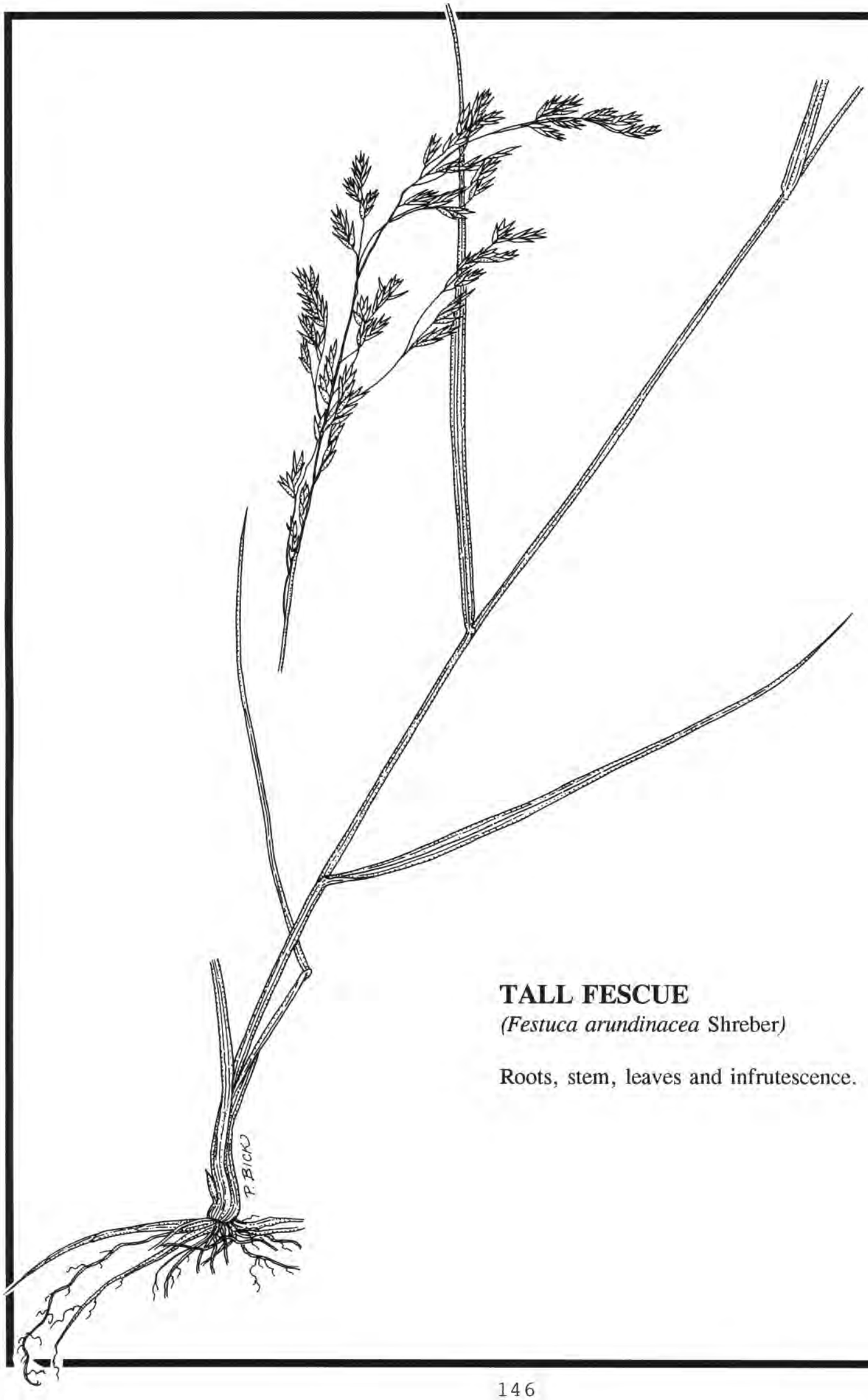
Illustration (Tall fescue)



TALL FESCUE
(Festuca arundinacea Shreber*)*

Roots, stem, leaves and infrutescence.

VEGETATION MANAGEMENT GUIDELINE

Tall Fescue (*Festuca arundinacea* Shreber) and Meadow Fescue (*Festuca pratensis* Ruds.)

SPECIES CHARACTER

DESCRIPTION

Both tall fescue and meadow fescue are common cool-season pasture grasses in Missouri. They will be referred to here collectively as fescue. These tall, coarse grasses have short creeping rootstocks and grow in heavy clumps with erect stems 2-5 feet (0.6-1.5 meters) tall. They often forms dense solid stands. Leaves are 4-5 inches (10.1-12.7 cm.) long, smooth on the undersurface and usually rough above. The erect panicles are usually 2-10 inches (5-25 cm.) long and often nodding at top. The panicles are somewhat narrow and contracted to slightly spreading. Flowers occur in flat, oval spikelets that are 0.3-0.5 inches (6-12 mm.) long. Usually, 6-12 individual flowers occur in each spikelet of meadow fescue and 4-5 flowers are in each spikelet of tall fescue. Grasses, in general, are fairly difficult to identify, and fescue should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Fescue has been spread widely by cultivation throughout most of the U.S. and southern Canada. It now occurs throughout Missouri, with tall fescue being the more common of these two pasture grasses in Missouri.

HABITAT

Fescue occurs in a variety of disturbed habitats including pastures, abandoned fields, roadsides, grazed woods, and along railroad tracks. It can tolerate a wide range of moisture conditions and is common along some levees where it is often planted, and stream banks. Where it occurs in natural communities, it has often been spread by horses and cattle through manure.

LIFE HISTORY

These hardy perennials were introduced from Europe and are commonly sown for pasture and hay. They do well on poor acid soils and often are found where there is little competition from other species. Fescue grows best in open sunlight and spreads primarily by seed to form dense

solid stands. The heavy clumps have thick mats of roots that make it almost impossible to pull them out of the ground. Fescue emerges early in spring and often forms new growth in the fall after the seed matures in July and August. In southern Missouri, the leaves usually stay green all winter. These grasses are slow to become established, but once the heavy clumps are formed, they are difficult to eradicate. As the density of fescue increases at a site, species diversity decreases, partly due to allelopathic substances. It can withstand trampling and heavy grazing by livestock.

EFFECTS UPON NATURAL AREAS

Fescue occasionally invades open natural communities, such as prairies and glades. In a few places, it is changing the species composition and possibly is crowding out native species. This alien plant has the potential to become a significant problem because of its adaptability to poor sites, allelopathic character, and difficulty of eradication.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Effort in areas of heavy infestation

On native prairies with a major invasion of fescue a late fall application of Roundup (10 gallons of spray containing 1 quart of Roundup and 6 ounces of surfactant) can be used to begin control of the fescue. Hand held sprayers or wick/wiper applicators may be used. Application should take place after several killing frosts and a subsequent warmup period.

Residual vegetation should be removed the year prior to the application by a mid to late July haying or by some other method. This will prevent an excessive buildup of residual vegetation by the fall of the following year that would limit the exposure of chemical to the fescue.

Rest the prairie the year of application allowing the native vegetation to complete its normal cycle so it will be dormant prior to the application date.

Scout the prairie just prior to the application date to make sure prairie species are dormant and fescue is active due to a warm up period following killing frosts. If some prairie species appear to be photosynthesizing consider delaying the application or expect some damage to those species. By law, herbicides may only be applied as per label directions.

Consider a prescribed burn the spring following the herbicide application to further damage remaining fescue and reduce competition for native vegetation. This burn should probably take place between April 1, and April 20, when fescue is actively growing and native grasses have

just begun to show new leaf material. Native vegetation should put on a lot of growth and provide further competition for fescue trying to rebound during the summer and fall period.

Effort in areas of light infestation

Late spring prescribed burning should help eliminate young plants. Repeated burning for 2-4 years may be needed to achieve good control. Spot applications of 1-2% Roundup applied with a hand-held sprayer or wick applicator in early spring or late fall may help if prescribed burning is insufficient. Spot applications of Fusilade 2000 (according to label instructions) may be effective following a burn. Fusilade 2000 selectively kills grasses and does not kill broadleaf plants. **Do not spray so heavily that herbicide drips off the target species.** A few isolated clumps may be dug up by hand.

Maintenance control

Surrounding seed sources must be eliminated where it is possible to prevent seed from continually moving into the natural area. Livestock should be kept out of the area, because seeds are spread in manure. Seedlings and young plants that invade should be eliminated by hand digging or spot applications of either 1-2% Roundup or Fusilade 2000, according to label instructions the first year.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Initial effort in areas of heavy infestation

The site should be burned in late spring and can then be sprayed with 1-2% Roundup the following autumn. It may be necessary to burn and spray 2 or 3 years in succession.

Effort in areas of light infestation

Late spring prescribed burning helps eliminate young plants and is a preferred treatment. A few isolated clumps may be dug up by hand. Spot applications of 1-2% Roundup in early spring or late fall are effective. Spot applications of Fusilade 2000 may work best following a burn.

Maintenance control

Same control practices recommended as for high quality natural communities.

FAILED OR INEFFECTIVE PRACTICES

The following practices should be avoided:

- Pulling by hand is almost impossible because of the tough root system. Digging up clumps is slow and sometimes undesirable in a high-quality natural area.
- Mowing does not reduce existing populations and may encourage spreading by root stocks.
- Fire usually is ineffective when fescue is dormant.
- Most herbicides are ineffective if applied while fescue is dormant or after mowing.
- Tillage usually is not an effective way to control any species in a natural area, but may be used in severely disturbed buffer areas.
- Grazing is ineffective since it usually eliminates other species first and encourages the spread of fescue.
- Manipulating water levels usually is not practical on natural areas where fescue occurs.
- No biological controls are known that are feasible in natural areas.

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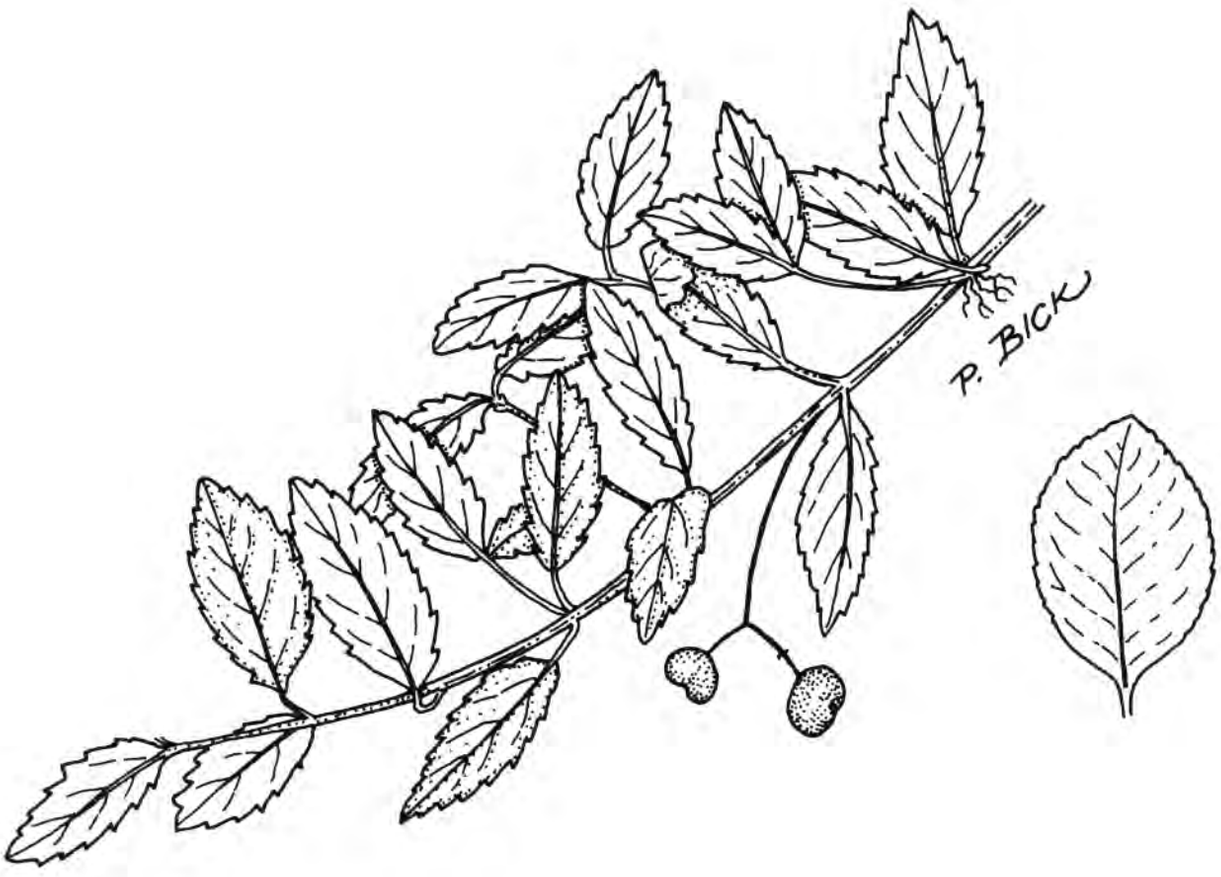
Illustration (Wintercreeper)



WINTERCREEPER
[Euonymus fortunei (Turcz.) Hand.-Mazz.*]*

Leafy stem with fruit and leaf variation.

VEGETATION MANAGEMENT GUIDELINE

Wintercreeper [*Euonymus fortunei* (Turcz.) Hand.-Mazz.]
Also called Climbing Euonymus

SPECIES CHARACTER

DESCRIPTION

Wintercreeper is an evergreen vine forming a dense ground cover or climbing or trailing to 20 feet (6.1 m) or more high. It has aerial rootlets and leathery opposite elliptic leaves that are veiny beneath. Numerous cultivars exist that exhibit a range of leaf sizes and colors. Branches are densely covered with minute warts. The small greenish flowers occur in clusters, with a long flower stalk. Fruits are globose and smooth in an orange capsule, maturing in June and July.

SIMILAR SPECIES

This vine differs from bittersweet (*Celastrus* spp.) because bittersweet has alternate leaves. It can be distinguished from other *Euonymus* spp. in that it is a vine rather than an erect shrub or tree. Wintercreeper should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate books.

DISTRIBUTION

Wintercreeper occurs infrequently in the eastern U.S. It was introduced from Asia as a groundcover. In Missouri, it is frequently found near urban centers, with heavy infestations in woodlands in the St. Louis and Kansas City vicinities. It is commonly sold by nurseries today as an ornamental groundcover and may spread from plantings in any part of the state.

HABITAT

This species occurs as a cultivated plant at home sites. It has spread into several types of forest, including floodplain, mesic and dry-mesic forest. It invades natural openings and relatively undisturbed forests.

LIFE HISTORY

Wintercreeper is a very aggressive perennial woody vine that climbs on rocks and trees as well as spreading over the ground. It tolerates full sun, heavy shade, and most soil moisture conditions, except extremely wet conditions. It appears to be spread by birds that eat its seeds.

EFFECTS UPON NATURAL AREAS

Wintercreeper can cover the ground and vegetation and eliminate native groundcover species in mesic and dry-mesic forests. It is a serious potential threat because it spreads so rapidly and replaces spring ephemerals. The Shirling Sanctuary in Kansas City's Swope Park provides an example of a mesic forest that has been seriously degraded by the aggressive spread of wintercreeper.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Initial effort in areas of heavy infestation

Vines should be cut by hand and each cut stem sprayed with Roundup (a formulation of glyphosate) just after the last killing frost. While the Roundup label recommends a 50-100% concentration of Roundup for stump treatment, a 20% concentration has proven effective. A squirt bottle may be used for spot treatment or individual stumps can be painted by hand using a sponge applicator. Treatment should be in late winter when most native vegetation is dormant and prior to the emergence of spring wildflowers. Care should be taken to avoid contacting non-target species with the herbicide. By law, herbicides may only be applied as per label instructions.

Effort in areas of light infestation

In small areas, where practical, individual vines should be pulled up by the roots and removed from the area.

Maintenance control

The most effective control is to totally eradicate the species from the surrounding area where possible. Invading individuals should be pulled and removed as soon as possible after recognition.

RECOMMENDED PRACTICES ON LANDS OTHER THAN HIGH-QUALITY NATURAL AREAS

Initial effort in areas of heavy infestation

Same as above in areas where hand labor is available and where area affected is relatively small. In large areas, foliar spraying with Crossbow (mixture of 2,4-D and triclopyr) in autumn after the first frost can reduce the population. Crossbow should be mixed according to label instructions for foliar application and applied as a foliar spray. Spraying should be completed prior to emergence of spring wildflowers. Care should be used to avoid contacting non-target plants with herbicide. The herbicide should be applied while backing away from the treated area to avoid walking through the wet herbicide.

Effort in areas of light infestation

Same as described for high-quality natural areas.

Maintenance control

Same as described for high-quality natural areas.

FAILED OR INEFFECTIVE PRACTICES

The following practices should be avoided:

- hand control: slow and labor intensive, making it impractical for large infestations.
- mowing: ineffective without chemical treatment and not practical in woodland.
- fire: often not desirable in mesic woodland.
- herbicides: should not be used during growing season when spring wildflowers and other native species are likely to be affected.
- manipulating water levels: not practical on sites where it occurs.
- biological control: no effective biological controls are known that are feasible in natural areas.
- introduction of competitive species: no native species known that can compete.

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SUBMISSION FORM FOR:

MISSOURI VEGETATION MANAGEMENT MANUAL

Name of species (common and scientific name):

Control recommendations (including biological, chemical, mechanical, or other means with which you have experience or knowledge):
This section may be divided into methods appropriate for natural landscapes and methods appropriate for highly-disturbed or low-quality sites.

Failed or ineffective practices:

References cited:

List of contact persons (including affiliation, address, and phone number): This list should include persons, besides yourself, with experience or knowledge about control of the species.

Your name, affiliation, address, and phone number: