



Chapter Three

Control and Identification of Invasive Species

A Management Guide for Missouri

Introduction

Throughout the United States, invasive plants are destroying native ecosystems and landscapes as they out-compete native plants for light, nutrients and moisture. Most of these invaders purposely were brought to the United States from other parts of the world for reasons that include ornamental value, livestock forage, erosion control, and food for wildlife. Some arrived accidentally as part of ship cargo, embedded on animals, clinging to clothing and other means. Whatever the means of entry, when these plants entered the U.S, their spread was unimpeded by natural enemies such as grazing animals, insects, and diseases, that kept them in check in their homeland.

Unregulated, they spread rapidly and wreak havoc on biodiversity as they overtake landscapes that once provided shelter and food for native wildlife. Among the worst offenders are bush honeysuckle, wintercreeper, autumn olive, sweet clover, Japanese honeysuckle, purple loosestrife, garlic mustard, sericea lespeeza, Japanese hops, and Johnsongrass.

The severity of infestation ranges from a few plants in a backyard to acres filled with dense populations of undesirable species. This guide includes control measures that can be used by homeowners and professional land managers. Homeowners likely will be able to use simple, mechanical methods, while professional land managers likely will resort to methods that call for herbicide application and use of large equipment. Herbicides suggested in this manual are low risk and are not apt to contaminate groundwater. They break down rapidly in the environment and have low toxicity to animals.



Top: Crown vetch planted along interstate.
Middle: Herbicide application. Herbicides should be used in conjunction with other methods, such as hand pulling, mowing, controlled burning, reseeding and/or planting native alternatives.

Introduction

Points to Remember When Controlling Invasive Species

It is easier to control invasive species before they get out of control, so control early. When dealing with a large population of an invasive species, begin removal at the edges and work inward. This reduces the rate of spread.

Personnel should be trained on herbicide and equipment use and should be able to identify target and non-target species.

Prevent contamination of streams, ponds, and lakes by selecting herbicides that degrade rapidly in the soil and by using the right amount of herbicide for the job. Use approved herbicides when applying near water and prevent spills, drips, and non-target drift.

Do not buy invasive plants. Many nurseries sell invasive plants such as wintercreeper, periwinkle, burning bush, autumn olive, purple loosestrife and crown vetch.

Replace invasive species with appropriate



Purple loosestrife taking over pond edge at Shaw Nature Reserve.

native plants (see Chapter 1, Reconstructing a Tallgrass Prairie). There are native alternatives available for each of the invasive plants mentioned in this guide.

Effective control may take several years. Scout annually for sprouts of invasive plants and remove immediately.

This Guide Will:

- help identify and effectively control invasive species.

- describe how to remove mechanically invasive species in small landscapes.

- describe how and when to apply herbicides for large landscapes.

- suggest native plant alternatives for invasive species.

- demonstrate how to manage land to prevent the invasion or re-invasion of invasive species.

Terms to Know

Invasive Species

A plant or other organism, usually non-native that reproduces unchecked. It readily colonizes and thrives in habitats where it did not historically occur, causing changes in bio-

diversity and ecological functioning of those habitats.

Non-native/Exotic Species

An organism that occurs in an area because it was brought there, intentionally or accidentally, by humans. Most exotic species do not become invasive, and some may occur in an area for many years before becoming invasive.

Native Species

A plant or other living organism that occurs in a geographic area without human influence.

Herbicide

Chemicals formulated to kill plants, with low or insignificant toxicity to other organisms. Broad-spectrum herbicides such as Roundup are toxic to virtually all plants, while broadleaf herbicides kill only or most effectively broadleaf plants, leaving grasses and related plants unharmed. There also are grass-specific herbicides.

Seed Bank

Some seeds live in the top layer of soil for decades, creating a seed bank. When parent plants are removed, a new crop of seedlings sprout quickly from the seed bank and

reclaim the area. To prevent reinfestation of invasive species, plant desirable native species or sow an appropriate native seed mix in these areas. After the initial removal, diligently remove resprouting invasive seedlings as they appear. The smaller the seedling, the easier it is to remove by hand. See section on revegetation to prevent secondary invasion of weeds.

Surfactants

Also called adjuvants, nonionic surfactants, or spreader stickers. A barrier to herbicide absorption into plants is the cuticle, a waxy layer that covers leaves and stems. Its purpose is to prevent water loss during dry periods. Surfactants added to herbicides improve absorption through the cuticle and help herbicides adhere to leaves. You may need to add a surfactant to your herbicide. Read labels to determine if a product already contains surfactants.

Mechanical Control Methods of Invasive Species

Shrubs

Bush honeysuckle, Privet, Autumn olive,



Pulling medium-size Bush honeysuckle with a weed wrench.

Burning bush, Buckthorn, Multiflora rose, Japanese knotweed.

Trees

Amur maple, Tree of heaven, Golden raintree, Lacebark elm, Eastern red cedar.

Newly emerged seedlings of woody plants are easily hand-pulled when soil is moist (a day or two after rainfall).

Stems less than one inch in diameter can be cut with sharp hand pruners or loppers*. Then use a weed wrench, winch, or come-along to yank the roots out of the ground. If this is not an option, dig out roots with hand tools or rent a stump grinder.

to the opposite hand when using hand pruners. Practice appropriate safety measures at all times.

Stems more than an inch in diameter typically require a handsaw, chain saw, or a string trimmer outfitted with a circular saw blade. Chain-saw and circular-saw use require training and proper safety gear (helmet, ear and eye protection, leg and ankle protection, and sturdy leather boots).

For large shrubs and trees, remove trunks and stems first. Then roots are more easily removed. Leave 1-3 feet of stem attached



Hand pruners, hand saw, and loppers.

Top: Hand-pulling Bush honeysuckle after a soaking rain. Use the roots to use as a handle or lever and use a weed wrench, winch, or come-along to yank out the roots. If this is not an option, dig out the roots with hand tools

*The most common injury among horticulturists and volunteers at Shaw Nature Reserve is a cut

or rent a stump grinder.

Large-scale removal (more than an acre) requires a skid-steer and front-mounted grapple or bull hog to remove mature shrubs – roots and all. Some grapples grab the stems and pull up, others grab the roots and pry out. Skid-steer removal should be done only when the ground is dry to keep soil disturbance to

a minimum. Disturbed ground quickly grows with weeds, so have a native plant seed mix ready to sow in these areas.

(See section on revegetation to prevent secondary invasion of weeds.)

Woody Vines
Japanese honeysuckle, Wintercreeper, Periwinkle, English ivy, Asiatic bittersweet

Newly emerged seedlings of woody plants are easily hand-pulled when soil is moist (a day or two after rainfall).



A circular saw or chain saw are used in larger areas and require protective equipment and training.

Top: Root grapple on a skid-steer pries large plants out of the ground.
Bottom: Bull hog on a skid-steer shreds plants from top to bottom.

It is difficult to control small areas of woody vines by mechanical methods. When carpets of these vines occur, smother them with black plastic, tin, rubber mats, or a 12-inch layer of wood chips. Because these materials can be expensive or hard to come by, they are useful only on small areas and should remain in place for a year to be effective.

A second method for small areas is to cut out the plants with a sharp garden spade. Cut and peel back the carpet of vines in small sections. Because they are shallow-rooted, they come up easily. Large sections of carpet, however, can be heavy and difficult to handle. Stem and root segments will be missed and need to be removed at a later date.

In large areas a skid-steer can be used to uproot large sections of invasive vines. This equipment causes disturbance and compaction to topsoil, so use only when ground is dry. Again, stem and root segments may be missed and should be removed when they are found.

Herbaceous Vines

Japanese hops, Kudzu, Bindweed

These plants are a problem because they spread rapidly by underground runners. Plants and the top 6-8 inches of topsoil should be dug and removed from the site

to effectively control dense patches and their seed bank when herbicide is not used.

Perennial Legumes

Sericea lespedeza, Bird's foot trefoil, Crown vetch, Red clover, White clover

Non-herbicide methods to control these difficult species generally are not effective. Plants and the top 3 inches of topsoil should be dug and removed from the site to effectively control dense patches of the listed species and their seed banks* when herbicide is not used. Watch for missed root segments and remove immediately.

*Sericea lespedeza, Bird's foot trefoil, Red clover, and Crown vetch have seed banks in the top few inches of topsoil that are viable for as many as 20 years.

Perennials

Curly dock, Purple loosestrife, Teasel

When carpets of these perennials occur in small areas, they can be smothered with black plastic, tin, rubber mats, or a 12 inch layer of wood chips, which should remain

in place for a year to be effective.

In large areas, dig up the top 3 inches of topsoil (including the roots) and remove it from the site.

Biennials

Garlic mustard, Sweet clover, Hedge parsley, Musk thistle, Bull thistle, Canada thistle, Spotted knapweed

Mechanical removal of biennial weeds in small areas is reliable. Mow, string trim, or hand cut plants close to ground-level just as the first blooms open or when plants begin to bolt. May need to repeat treatment if resprouting occurs. In small areas, biennials can be pulled by the roots. Seeding or flowering plants must be bagged and removed from the site.

Annual Weeds

(Not necessarily invasive)

Ragweed, Smartweed, Yellow rocket, Mares tail, Chickory, Queen Anne's lace, Henbit, Foxtail

These mostly sun-loving native annuals can

be weedy in newly seeded/planted areas but are not considered invasive. Control them with regular mowing during the first growing season after seeding.

Perennial Grasses

Johnsongrass, Tall fescue, Orchard, Smooth brome, Reed canary, Maiden grass, Yellow nutsedge.

When carpets of these grasses occur in small areas, they can be smothered with black plastic, tin, rubber mats, or a 12 inch layer of wood chips, which should remain in place for a year to be effective. Wood chips may not be effective on Miscanthus or Johnsongrass.

In large areas dig up the top 3 inches of topsoil (including the roots) and remove it from the site. Watch for and remove missed root segments.

Guidelines for Herbicide Use

When to Apply Herbicides

Seasons to apply

Late spring/early summer when leaves are

fully developed is an ideal time for foliar applications. Fall foliar applications also are effective, especially on woody vines.

Winter is a good time to control invasive trees, shrubs, or vines. Cut stump and basal treatments are mixed at higher concentrations than spring and fall foliar mixes.

Seasons to avoid

During dry summer months leaf cuticles are thicker and more difficult to penetrate with herbicides.

In early spring when plants begin budding and leafing out, they are transferring water from the roots to the buds and developing leaves. This inhibits effective herbicide absorption.

Apply herbicides when weather conditions permit

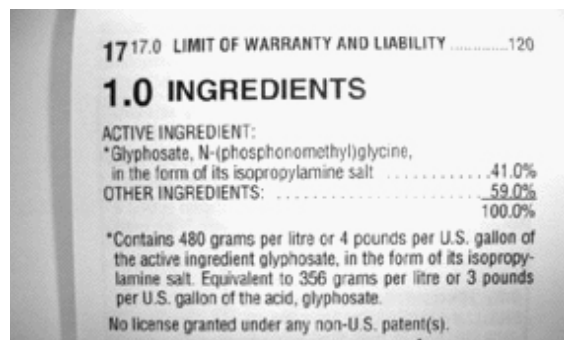
- Do not spray if rain is expected within four

hours of application.

- Do not spray when windy. Mornings tend to have less wind.
- Do not spray when temperatures exceed 90 degrees Fahrenheit. Herbicides can volatilize.

Safety Requirements

- Follow all label recommendations.
- Protective gear should always be worn. Be sure to use rubber gloves, safety goggles or glasses, Tyvec suits or dedicated overalls.



How to Read an Herbicide Label

If you read an herbicide label, you will see that it lists a percentage of active ingredient. For example, if herbicide A contains 50% active ingredient, then it is a 50% concentration of that herbicide A. If the recommended concentration of herbicide A is...

50%	apply it full-strength directly from the container.
25%	dilute it at a ratio of 1 part water to 1 part herbicide.
12.5%	dilute it at a ratio of 3 parts water to 1 part herbicide.
10%	is a ratio of 4 parts water to 1 part herbicide.
6.25%	is a ratio of 6 parts water to 1 part herbicide.
3.125%	is a ratio of 12 parts water to 1 part herbicide and so on.

When mixing herbicides avoid spills and exposure to skin. Small amounts of concentrated herbicide spilled on skin is the equivalent to exposure received after a full day of applying herbicides in the field.

- When herbicides are used in public areas (near buildings, trails, meeting areas), post warning signs.
- Mix colored dyes with herbicides to increase spraying accuracy and to locate spills and personal exposure to herbicides. Inexpensive clothing dye can be used with water-soluble herbicides such as glyphosate and triclopyr.
- Rinse empty containers at least three times



Top: Protective gear includes safety glasses, rubber gloves, and Tyvec suit.

with clean water. If possible, store rinse water for future use in mixing.

- Store herbicides in a ventilated, dry area between 50-80°F. Floor should be concrete or lined with plastic to prevent leaks from reaching the soil. The area should not be accessible to the public and should be locked when not in use. Containers should be labeled with contents and date mixed.

Herbicide Application Methods for the Removal of Invasive Plants

Foliar Treatment

Spot spraying

Used to control most invasive species in this guide. It is recommended for annuals,



Top: Avoid spills and use care when pouring concentrated herbicides.
Bottom: Always label unused herbicides.

biennials, perennials and small woody plants (less than 3-4 ft. tall or 1/2 inch stem diameter). It is recommended when native plants already exist in the treatment area.

- Glyphosate and triclopyr are typically used for this application applied at a rate of 2-4% concentration.
- Adjust hand-held or backpack sprayer for low-pressure/low volume applications by pumping minimally. This reduces drift caused by light wind.
- Use flat or cone-shaped nozzles to direct spray to cover entire plant and adjust nozzle for a coarse spray pattern.
- Nonionic surfactants added to the mixture help ensure complete leaf coverage and increase the rate of absorption.
- Cover leaf surface thoroughly, but keep herbicide from dripping off the leaves.

Crown spraying

Crown spraying or spraying over the top is used on shrubs and vines (more than 4-5 ft. tall or 1/2 inch stem diameter and less than 10 ft. tall).

- Glyphosate and triclopyr are typically used for this application and applied at a rate of 5-10% concentration.



- Adjust hand-held or backpack sprayer for low-pressure/low volume applications by pumping minimally. This reduces drift caused by light wind.
- Adjust nozzle to apply a coarse spray pattern over the plant.
- Requires 50-75% of total foliage area to be covered by herbicide spray.

Foliar Treatment (cont'd)

Broadcast spraying

Broadcast spraying is used to kill vegetation in old fields, on roadsides and in lawns.

- Glyphosate is typically used for this application.
- Hand-held and backpack sprayers are effective on small-scale home applications.



Crown spraying requires a coarse spray pattern to reach the top of shrubs.

Wide-reaching boom-sprayers are needed on large-scale sites (one half acre and more).

Cut-surface Treatment

This treatment includes two methods for controlling invasive trees, shrubs, and vines. It often is recommended when native plants exist in the treatment area. The treatment is inexpensive and reduces non-target damage. Glyphosate and triclopyr are typically applied at high concentrations using nozzles that have a straight or fan-shaped spray tip to minimize non-target damage. Sub-freezing applications are made possible by substituting window-washing fluid for water (mix with water-soluble herbicides only) or by using oil-based herbicides like Garlon 4 or Pathfinder II.

Cut stump method Cut stems off close to ground level with loppers or a hand saw and immediately apply concentrated herbicide to the cambial area of the stump (outer edge). For stems smaller than 3 inches in diameter, treat the entire stump surface. For larger stems, apply herbicide to the outer 20% of the stump. The chemical moves to the roots and kills the root system. Delays in application after cutting results in reduced control. Applications are most effective during active growth and full leaf expansion. Winter applications are effective, but herbicide must be applied at a 20% concentration.

The hatchet and spray method is generally used for stems larger than 3 inches in diameter using an axe or hatchet. Make uniformly spaced cuts around the base of the stem less than 1 inch apart. Angle cuts downward, going through the bark and into the sapwood. Spray herbicide into each cut. The chemical moves to the roots and kills the root system. Large trees may be left standing after they die.



Top: Broadcast spraying with a 50-gallon tank.



The cut stump method
Above: Stems are cut, stumps are immediately sprayed. Brush piles provide cover for wildlife.

Basal bark treatment is used for controlling large trees, shrubs, and vines when cut surface treatment is not feasible. For a large acreage it may be cost-prohibitive to cut and spray thousands of plants. Spraying the bark without cutting stems saves time. Great care must be taken to prevent non-target damage.

Garlon 4 mixed with basal oil or Pathfinder II typically are used for basal bark treatments any time of year except when snow or water prevents spraying the base of the stem.

A 20% concentration is needed for effective control. Use a sprayer at low pressure (20-40 psi) that has a straight stream or fan-shaped tip. Low pressure helps prevent non-target damage. Stems should be sprayed on all sides to a height of 1-2 feet from the ground. It may require several months for a single application to kill the target species, but by spring the tree or shrub either doesn't leaf out or dies later in the season. Eventually the roots die, and the plant topples to the ground. Basal treatment is not effective on older trees with thick bark. For larger trees with thick bark, use the hatchet and spray method.



Top: The hatchet and spray method.

Middle: Correct container pressure with no splashing.

Bottom: High pressure results in splashing.

2,4-D is active against broadleaf plants (perennials, biennials, and annuals) only; grasses are unaffected. This herbicide is

Herbicides and What They Control

Herbicide & Concentration	Trade Name	General Description	Control Method	Species Affected	Notes	Target Species
2,4-D	Weedone® Dynamec® Weed Pro®		Foliar applications	Broadleaf herbaceous plants	Will not kill most grasses	Annuals, Thistle, Hedge parsley, Teasel
Glyphosate (premixed with surfactant)	Roundup® Roundup Pro® Buccaneer® Kill Zall® Glyphos® Kleenup®	Water-soluble, no additional surfactant needed	Foliar applications (use 2-10% concentration) Cut stump application on woody plants (use 20% concentration)	Nonselective	Not safe to use near water. Not effective on waxy-leaved species like Wintercreeper, Periwinkle, and English ivy.	Crown vetch, Red clover, Curly dock, Sweet clover, annuals
Glyphosate (no surfactant)	Rodeo® Accord® Pondmaster®		Foliar spot spray applications (use 2-3% concentration)	Nonselective	Can be used safely near water with a nonionic surfactant such as Sidekick®	Purple loostrife
Triclopyr 41%	Garlon 3-A® Turflon® Brush-B-Gon®		Cut stump application on woody plants (use 8-20% concentration)	Woody plants and broadleaf herbaceous plants	Will not kill grasses	Japanese hops, Sericea lespedeza, Bird's foot trefoil
Triclopyr 61%	Garlon 4® (should be mixed with colorfast purple dyes only)	Mix with basal oil, diesel or kerosene	Basal bark application on woody plants (use 20% concentration)	Woody plants	Hackberry is highly sensitive to Garlon. Will not kill grasses	Wintercreeper, Asian elms, Amur maple, Tree of heaven, Golden raintree
Triclopyr (premixed with basal oil, surfactant and dye)	Pathfinder II®	Comes premixed with basal oil	Basal bark application on woody plants (no dilution necessary)	Woody plants		Honeysuckles, Autumn olive, Burning bush, Privet, Buckthorn, English ivy, Periwinkle
Sulfosulfuron	Outrider®	Highly concentrated material needs to be diluted carefully	Foliar applications	Johnsongrass	Herbicide that controls only Johnsongrass	Johnsongrass

used widely for weed control in lawns. It can be applied over native grasses to control many invasive species.

Glyphosate is a broad-spectrum herbicide that kills most plants within days after spraying (yellowing may take a month when spraying in winter). It is used for foliar and cut stump applications.

Triclopyr is used widely for the control of woody plants, but also controls broadleaf perennials (does not affect grasses). It is often used in cut-stem and basal-bark applications. Garlon 4 is the oil-based form used in basal bark treatments. Hackberry is highly sensitive to Triclopyr.

Sulfosulfuron at low doses is specific for Johnsongrass. Follow label mixing rates carefully because it is highly concentrated. Do not mix with Roundup or other herbicides because it is slower acting. Spray foliage before flowering or plants may go to seed.

Revegetation and Maintenance After Removal of Invasive Species

In spot-treated areas that are minimally to moderately infested, plant container or bare root native alternatives in spring or fall following treatment (see table on page 16). If sowing seeds for revegetation, sow in

December or January following treatment (See Chapter 1: Reconstructing a Tallgrass Prairie: A Seeding Guide for Missouri for complete seeding directions). Choose native species appropriate to your light, moisture and soil conditions.

In moderately to highly infested treatment areas, sow an annual cover crop immediately after treatment to prevent or reduce erosion and reinfestation of invasive species. A second or third herbicide treatment may be necessary for quality control. You may need to reseed an annual cover crop after each herbicide application. When control is achieved, plant container or bare root native alternatives (see table on page 17) in spring or fall immediately following treatment. If sowing seeds for revegetation, sow in December or January following treatment (See Chapter 1: Reconstructing a Tallgrass Prairie: A Seeding Guide for Missouri for complete seeding directions). Choose native species appropriate to your light, moisture and soil conditions.

Long-term Maintenance

Scout treated areas for re-sprout and/or new seedlings. Young seedlings are easily pulled by hand soon after rain or watering. Bush honeysuckle and Privet are easily visible in October and November because their leaves are yellow and most other shrub leaves have already fallen.

Native alternatives to invasive non-native landscape plants

Invasive Species		Native Alternatives	
Common Name	Scientific Name	Common Name	Scientific Name
Shrubs and Small Trees			
Amur maple	<i>Acer ginnala</i>	American hornbeam Pagoda dogwood Indian cherry	<i>Carpinus caroliniana</i> <i>Cornus alternifolia</i> <i>Rhamnus caroliniana</i>
Autumn olive	<i>Elaeagnus umbellata</i>	Serviceberry Winged sumac Black chokeberry	<i>Amelanchier arborea</i> <i>Rhus copallina</i> <i>Aronia melanocarpa</i>
Bush honeysuckle	<i>Lonicera maackii</i>	Rusty blackhaw Roughleaf dogwood American beautyberry	<i>Viburnum rufidulum</i> <i>Cornus drummondii</i> <i>Callicarpa americana</i>
Golden raintree	<i>Koelreuteria paniculata</i>	Fringe tree Redbud Green hawthorn	<i>Chionanthus virginicus</i> <i>Cercis canadensis</i> <i>Crataegus viridis</i>
California privet	<i>Ligustrum obtusifolium</i>	Arrow wood Wafer ash Prairie willow	<i>Viburnum dentatum</i> <i>Ptelea trifoliata</i> <i>Salix humilis</i>
Burning bush	<i>Euonymus alatus</i>	Wahoo Strawberry bush Red buckeye	<i>Euonymus atropurpureus</i> <i>Euonymus americanus</i> <i>Aesculus pavia</i>
Multiflora rose	<i>Rosa multiflora</i>	Prairie rose Alabama snow wreath Deciduous holly	<i>Rosa setigera</i> <i>Neviusia alabamensis</i> <i>Ilex decidua</i>
Japanese knotweed	<i>Polygonum cuspidatum</i>	Hazelnut Bladdernut Wild hydrangea	<i>Corylus americana</i> <i>Staphylea trifoliata</i> <i>Hydrangea arborescens</i>
European buckthorn	<i>Rhamnus cathartica</i>	Green hawthorn Gum bumelia Wahoo	<i>Crataegus viridis</i> <i>Bumelia lanuginosum</i> <i>Euonymus atropurpureus</i>

Invasive Species		Native Alternatives	
Common Name	Scientific Name	Common Name	Scientific Name
Vines			
Chinese bittersweet	<i>Celastrus orbiculatus</i>	American bittersweet Supplejack Passion flower	<i>Celastrus scandens</i> <i>Berchemia scandens</i> <i>Passiflora incarnata</i>
English ivy	<i>Hedera helix</i>	Virginia creeper Sensitive fern Golden ragwort	<i>Parthenocissus quinquefolia</i> <i>Onoclea sensibilis</i> <i>Senecio aureus</i>
Japanese honeysuckle	<i>Lonicera japonica</i>	Carolina moonseed Pale leather flower	<i>Lonicera flava</i> <i>Cocculus carolinus</i> <i>Clematis versicolor</i>
Japanese hops	<i>Humulus japonicus</i>	Pale leather flower Ladies eardrops Climbing milkweed	<i>Clematis versicolor</i> <i>Brunnichia ovata</i> <i>Matelea decipiens</i>
Periwinkle	<i>Vinca minor</i>	Wild ginger Buxbaum's sedge Roundleaf ragwort	<i>Asarum canadense</i> <i>Carex buxbaumii</i> <i>Senecio obovatus</i>
Wintercreeper	<i>Euonymus fortunei</i>	Virginia creeper Bog sedge Golden ragwort	<i>Parthenocissus quinquefolia</i> <i>Carex buxbaumii</i> <i>Senecio aureus</i>
Herbaceous Perennials and Grasses			
Crown vetch Bird's foot trefoil	<i>Coronilla varia</i> <i>Lotus corniculatus</i>	Little bluestem Lanceleaf coreopsis Short's sedge	<i>Schizachyrium scoparium</i> <i>Coreopsis lanceolata</i> <i>Carex shortiana</i>
Red clover White clover	<i>Trifolium pratense</i> <i>Trifolium repens</i>	Switch grass Eastern gama grass Indian grass	<i>Panicum virgatum</i> <i>Tripsacum dactyloides</i> <i>Sorghastrum nutans</i>
Sericea lespedeza	<i>Lythrum salicaria</i>	Little bluestem Broom sedge Switch grass	<i>Schizachyrium scoparium</i> <i>Andropogon virginicus</i> <i>Panicum virgatum</i>
Purple loosestrife	<i>Lythrum salicaria</i>	Queen of the prairie Winged loosestrife	<i>Juncus effusus</i> <i>Filipendula rubra</i> <i>Lythrum alatum</i>

Major Invasive Species
of Concern

Invasive Species		Native Alternatives	
Common Name	Scientific Name	Common Name	Scientific Name
Maiden grass Fountain grass	Miscanthus sinensis Pennisetum stp.	Prairie dropseed Little bluestem Big bluestem	Sporobolus heterolepis Schizachyrium scoparium Andropogon gerardi
Tall fescue	Festuca arundinacea	Prairie dropseed Sideoats grama Fringed sedge	Sporobolus heterolepis Bouteloua curtipendula Carex crinita
Biennials			
Garlic mustard	Alliaria petiolata	Golden ragwort Wild geranium American beakgrass	Senecio aureus Geranium maculatum Diarrhena obovata
Yellow sweet clover White sweet clover	Melilotus officinalis Melilotus alba	Purple coneflower River oats Greyhead coneflower	Echinacea purpurea Chasmanthium latifolium Ratibida pinnata
Hedge parsley	Torilis arvensis	Wild ageratum Palm sedge Blue flag	Eupatorium coelestinum Carex muskingumensis Iris virginica
Musk thistle Bull thistle Canada thistle	Carduus nutans Cirsium vulgare Cirsium arvense	Ashy sunflower Indian grass Rosin weed	Helianthus mollis Sorghastrum nutans Silphium terebinthinaceum
Spotted knapweed	Centaurea biebersteinii	Slender mountain mint Broom sedge Pale purple coneflower	Pycnanthemum tenuifolium Andropogon virginicus Echinacea pallida

sometimes confused with privet. The flowers of Amur honeysuckle are faintly fragrant. This shrub was improved by breeding for greater fruit production by the USDA in Missouri, and has been planted for landscaping and attracting wildlife across the eastern US. In fact, bush honeysuckle provides poor quality food and habitat for birds. It thrives from Maryland and Virginia to Missouri and eastern Kansas. Plantings are known to rapidly spread to nearby forests where they can occupy several square miles of wooded areas within 5 years. Similar stories could be repeated all over the St. Louis and Kansas City regions in Missouri.

Small infestations can be killed with most wide-spectrum and broadleaf-specific herbicides (RoundUp or Garlon) applied to the foliage at 1.5-4% concentration. Timing is important, with late growing season (September-October) applications often reported to be more lethal than those in earlier or later months. Homeowners should be aware that brush from bush honeysuckle containing berries contains seeds and should not

be put into municipal mulch piles to avoid spreading the seed further. Larger individuals are best controlled in fall or winter with either basal or cut stump treatments of Garlon or related herbicides at 20% concentration.

In cold weather, diluting herbicides with windshield-washer fluid rather than water prevents freezing and may improve penetration into plant tissues. Prescribed burning will only top-kill plants. Plants will re-sprout from the roots but flowering and seed production are set back two seasons. Unless burning is frequent, mechanical or chemical removal are the only effective means of control.

Japanese honeysuckle

Lonicera japonica

Japanese honeysuckle (an “evergreen” woody vine) historically was much-loved in gardens for the delicious fragrance of its flowers. In nature however, it is a plague throughout the Eastern United States. The flowers open white and turn creamy yellow, emitting the fragrance for which they are famed. The fruit is



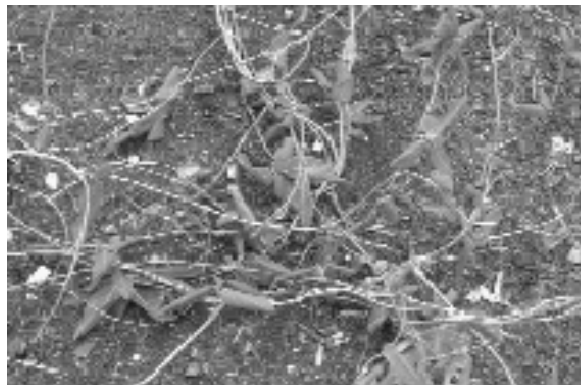
The berries of Amur honeysuckle (above) are attractive to the human eye and are eaten eagerly by migrating and resident birds, which disperse the seeds in their droppings.

Amur or Bush honeysuckle
Lonicera maackii

Bush honeysuckle (a woody shrub) is often mistakenly referred to as Japanese honeysuckle, and

a shiny, black berry that is eaten by robins and other birds that gobble them up and disperse the seeds “down the flyway a piece”.

The evergreen foliage can be sprayed in fall and winter when many other plants are dormant. Though death is slow (typically well into the following spring), fall spraying with 1.5-2% Roundup or other common foliar herbicides is highly effective. Japanese honeysuckle resprouts after prescribed burning, but frequent burning reduces their abundance. More importantly, it limits flowering and fruiting. This reduces the establishment of new populations through seeds dispersed by birds and mammals.



dark-green, elliptical leaves are also paired, and

California privet *Ligustrum obtusifolium*

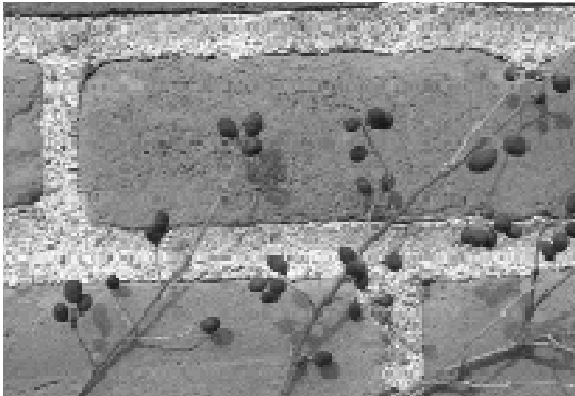
California privet (a woody shrub) is a species of shiny-leaved, sweet-flowered privets from Asia. Various species of this exotic privet are planted in different parts of North America. All of them have become invasive. California privet has smooth gray bark. Its stems have paired, thorn-like twigs along their lengths. The shiny,



Top: Japanese honeysuckle in flower. The corollas fall away to leave a tiny green fruit that ripens to a plump, black berry in fall (bottom).

missing photo

only a little over an inch long. Small, white



flowers appear in June and are fragrant. They are eagerly visited by pollinators ranging from tiny sweat bees to large swallowtail butterflies. As autumn arrives all the early-summer pollinator activity pays off in the form of a large crop of blue-black berries that birds love. This privet species traditionally has been maintained by heavy pruning into a hedge that does not set fruit and presents little danger of spreading. Unfortunately, once such a shrub is abandoned to grow freely, abundant seed production spread by birds starts an invasion. At Shaw Nature Reserve, the population of this plant, negligible in numbers before 1990, has exploded in the last 15 years.

(For control methods, see comments on Amur honeysuckle on page 19.)

Autumn olive

Eleagnus umbellata

This woody shrub was widely planted for its presumed value to wildlife, especially migratory birds who eat the plentiful berries. The fruits and younger twigs are covered with characteristic tan or whitish scales. The upper side of the leaves has a grayish cast and the underside is nearly white. The fine hairs, which cause this gray or whiteness, reduce moisture loss through the leaf surface during hot and/or dry weather. The

flowers of autumn olive are produced in profusion in early May and exude a powerful and alluring fragrance. Autumn olive shrubs buzz with pollinating insect life when in bloom.

Autumn olive is killed easily with Roundup or Garlon applied to the foliage of small plants at 1.5-4%. Timing is important, with late growing-season applications generally more lethal. Larger plants are best controlled in fall or winter with either basal or cut stump treatments of Garlon at 20% in paraffin oil or diesel. Freshly cut stumps also may be painted with 20% Roundup with a good kill rate. In cold weather, diluting Roundup with automobile window-washing fluid prevents freezing and may improve penetration into plant tissues.

Wintercreeper *Euonymus fortunei*

Wintercreeper (an evergreen woody vine) is a native of Asia, and Missouri's most worrisome member of the bittersweet family. The plant forms a handsome, solid evergreen ground cover attractive to gardeners and the bright red berries are irresistible to birds. When creeping on the ground, wintercreeper rarely flowers, but when it grows to the top of a tree or post, it produces plentiful fruits. The first line of defense against wintercreeper is to sever



climbing vines to stop them from producing fruit. Be sure to remove a one-inch stem segment.

Wintercreeper is difficult to control because its thick, waxy foliage resists penetration by herbicides. Recent experimentation at the Green Center in St. Louis provides some hope. The waxy cuticle of wintercreeper's leaf wears thin in late summer and this, plus a high level of physiological activity in the plant, are factors that may lead to higher susceptibility to Roundup in September than at other times of year. A single spraying of 1.5% Roundup Pro plus surfactant showed initial efficacy and a small amount of mortality. The experiments indicate that spraying with 1.5% Roundup Pro two September days in a row increases the mortality rate and spraying four days in sequence kills it completely. By comparison, spraying once with 6% Roundup Pro yielded slightly less than 100% mortality.

Weedwhipping or mowing wintercreeper to the ground and then spraying immediately with 2% Roundup in July-August has been found effective at the Litzsinger Road Ecology Center.

Tall fescue

Festuca arundinacea

Tall fescue (a perennial grass) was first used in the United States in the late 1800's for pasture improvement. Today it is the most commonly used grass in lawns, pasture, and roadsides in Missouri because it is aggressive and resistant to heavy foot traffic, grazing, drought, and short-term flooding. Throughout Missouri thousands of acres have been converted from prairie to tall fescue pasture. In the Missouri Ozarks, it was promoted as a way to increase pasture productivity and



farming income. It also spreads into natural habitats on its own and out-competes native plants. Quail and other ground nesting birds avoid tall fescue fields because they lack sufficient food and are too dense to nest, feed, and take cover in.

The seed is dispersed readily by small rodents, transported on the hooves of large animals and the tires of heavy equipment. More than half of the 100-million-plus pounds of fescue seed sold in the U.S. annually is produced in Missouri, and is a testament to the value of fescue as a lawn grass, roadside vegetation and forage for cattle.

Because it is virtually evergreen, tall fescue is susceptible to Roundup applied any time of the year. Grass-specific herbicides are used when desirable broad-leaved plants (e.g. coneflowers or blazing star) are comingled with fescue.

Sericea lespedeza
(a.k.a. Sericea,
Chinese bush clover)
Lespedeza cuneata

Sericea lespedeza (a perennial herb) is a member of the bean/clover family that has become a pest as a result of an aggressive marketing program. Originally, sericea was promoted widely as food for quail and other small game birds. It turns out these birds avoid sericea. Also, it was promoted as protein-rich forage for livestock though cows will only eat the tender young stems. Lastly, it



was promoted as a superior erosion control along highways but it turns out to have a coarse root system. Dense-rooted native grasses are a far better choice. The saying "beware of anything that sounds too good to be true" applies here. This tough and prolific weed has diminished the quality of more acres of pasture and corrupted the ecological integrity of more acres of native prairie than any other broadleaved herb in Missouri.

While sericea lespedeza is susceptible to many herbicides, it is difficult to control. Seed can live in the ground for over twenty years, which makes reinfestation likely.

In addition, it often grows nearby desirable plants that may be damaged by herbicide. By spot-spraying individual plants with Roundup using low pressure, these problems can be avoided. For treatment of larger populations that are mixed with native grasses, September spraying with Garlon works well (Garlon will not kill native grasses).

There are two mechanical methods to deal with

sericea lespedeza. First involves mowing with sharp blades shortly after plants bloom in September. This will not kill the plants but will prevent seed development. The only way to control a serious infestation of sericea mechanically is to remove the top 3-6 inches of topsoil. This involves use of heavy machinery such as a skid steer or high lift. This may well be the only effective method of removal for this incredibly difficult invasive species.

Johnsongrass

Sorghum halepense

Johnsongrass (a suckering perennial grass) is increasingly noticeable along Missouri highways and is a concern because of its ability to invade gravel bars, prairie plantings and open floodplain habitats. Its seeds are spread by mowing equipment and in natural areas by flood waters and in mud on the feet of animals. Johnsongrass was imported as a prolific livestock forage, though the food value of Johnsongrass is questionable. It is a perennial grass, with stout underground stems (rhizomes) that spread rapidly.



The only herbicide that effectively controls Johnsongrass is Outrider. A tiny dose of this chemical kills Johnsongrass and is non-toxic to most other plants (please read label instructions carefully). The herbicide, however, must be applied by licensed applicators. Non-restricted grass herbicides such as Poast and Select are less effective on Johnsongrass, but are more readily available. The only mechanical controls for Johnsongrass include frequent mowing, which only prevents seed production, and removal of the top 6 inches of soil.



The Sweet clovers

Melilotus alba, *M. officinalis*

Sweet clover (a biennial) was originally introduced in the Midwest as a forage crop and soil nitrogen-builder. Though it has become a serious invasive species, it is still promoted for large animal forage. Sweet clover contains a high amount of coumarins that give them a sweet, pea-like smell.

Sweet clover aggressively invades native prairie and open woodland habitats and out-competes native plants by shading them out. It is a common plant along roadsides, fields, and can be a problem plant in prairie reconstruction. Unfortunately, use of fire increases seed



germination and its ability to spread.

Eradication of a serious sweet clover infestation is very difficult, and control must be ongoing. Treat thick patches of seedlings with Garlon herbicide as the clover is greening up in February/March. The leaf surface of sweet clovers is waxy so use surfactants to prevent water from rolling off the leaves.

Individual seedlings scattered between native plants may be difficult to treat and so herbicide is not recommended. Instead, annual hand-pulling is recommended following a soaking rain when the plants begin to flower (June or July). This method gradually diminishes the soil seed bank of this persistent biennial weed.

Burning bush

Euonymus alatus

Burning bush is a woody landscaping shrub that is commonly used in foundation and parking lot plantings and has the ability to spread by seed into nearby woodlands. It is a popular nursery plant because it produces brilliant fall color and handsome winged branches in winter. Unfortunately, the berries are loved by birds who carry seeds into nearby natural forests where plants often sucker to form dense thickets. This species became invasive in the St. Louis area only recently and it has proven difficult to control because it does not respond well to herbicides and is difficult to pull from the ground (seedlings under two feet tall can be pulled after a soaking rain. Suckering sprouts



Yellow sweet clover

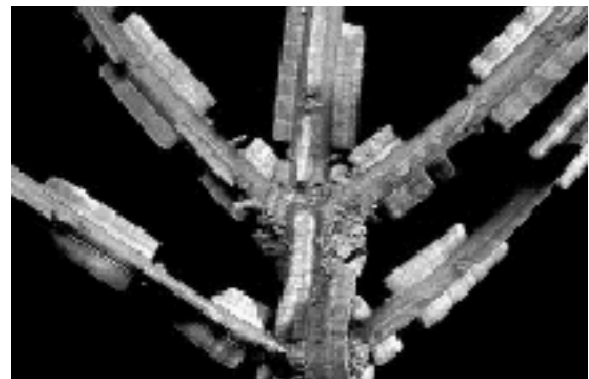
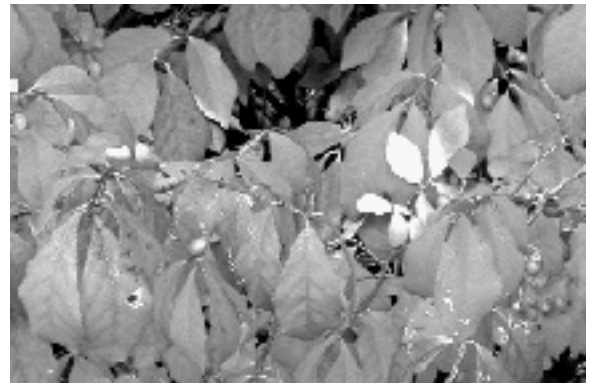


White sweet clover

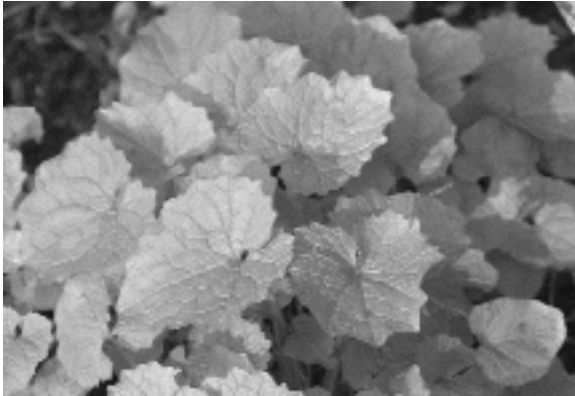


resemble small seedlings and are impossible to hand pull). Larger plants can be dug out with a shovel or mattock but suckers are easily left behind and re-sprout.

Herbicide treatments include cut stump or basal bark methods using Roundup Pro or Garlon. Please note that cut stump herbicide treatments alone do not completely kill the roots of the plant, so repeat herbicide applications may be necessary. Where populations are so dense that cutting is impractical, foliar applications may be used.



Garlic mustard
Alliaria petiolata



Top: First year plant.
Middle: Second year plant.
Bottom: Flower.

Garlic mustard (a biennial) is an invasive plant from Europe that invades natural woodlands.

In a forest habitat it often dominates the ground layer over wide areas and has the potential to produce solid stands. It is believed that garlic mustard infestations displace several species of native plants, salamanders, mollusks, and possibly woodland butterflies, ground foraging birds and reptiles. It is considered to be one of the most potentially harmful and difficult to control invasive plants because it spreads so rapidly, produces thousands of seeds and has no natural predators. It tolerates shade and can invade undisturbed natural woodlands or disturbed areas such as trails, roadsides and forests where trees have been logged.

Garlic mustard is a member of the mustard family (Brassicaceae). Young leaves smell like garlic when crushed, although the odor decreases as plants grow older. It is a biennial; a plant with a two-year life cycle. The first year it grows in a dark purple to green rosette stage (stemless and low to the ground) and the second year it flowers on a 3-4 foot stalk. Plants bloom March through May with white flowers. The flower is typical of other plants in the mustard family with six stamens: two long and four short.

It reproduces only by seed and seeds can remain viable in the soil for up to five years. Seeds are produced in slender, one to two inch long pods. People disperse seeds inadvertently on boots, clothes, mowers, or cars, however birds, small mammals and whitetail deer may also disperse seed. Seeds only germinate in spring after exposure to winter cold.

Garlic mustard (cont'd)

Hand Pulling

Once large colonies of garlic mustard exist, control may be difficult. The easiest way to

control it is to catch the invasion in the early stages, before it has a chance to become widespread. If you know that garlic mustard is in your community, it is important to scout your property or neighborhood for early invasions. Small patches can be easily controlled by pulling plants by hand. The best time to pull seedlings is just after a soaking rainfall. If pulling first-year seedlings, you may need a dandelion digger. If pulling second-year plants, pull before plants are in their final bloom stage. Do not leave any large roots in the ground because they may resprout. Also, do not put plants in compost piles or leave lying on the ground because they may continue to set seed or root into the soil. Place all plants in bags and send them to a landfill where they will be buried.

Mowing or String Trimming

When dense stands of garlic mustard occur, cutting plants in their second growing season at ground level may be an effective control method. Plants should be cut prior to the full bloom stage to avoid seed ripening.

This method needs to be repeated annually until colonies are under control.

Herbicide Control

When large colonies of garlic mustard exist the best control is with glyphosate (Roundup) sprayed in late fall and winter (late November thru mid-March) when garlic mustard is

still green and most native wildflowers are dormant. A 1-2% concentration applied with a backpack sprayer works well when applied above 50 degrees. Avoid spraying non-target plants because some native plants remain green well into early winter.

Because garlic mustard has a 5-year seed bank you will need to monitor for seedlings and resprouting. Repeat control methods for several years until the area is under control and always be on the lookout for new infestations.

When control is achieved, plant container or bare root native alternatives in spring or fall immediately following treatment. If sowing seeds, sow in December or January following treatment (See Chapter 1: Reconstructing a Tallgrass Prairie: A Seeding Guide for Missouri for complete seeding directions). Choose native species appropriate to your light, moisture and soil conditions.

Oriental or Asian bittersweet

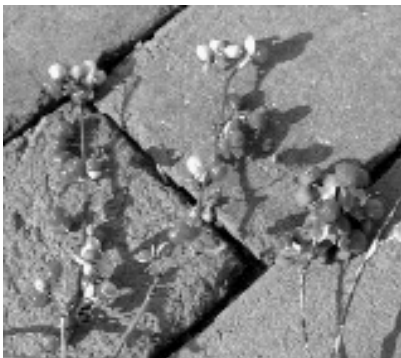
Celastrus orbiculatus

Oriental bittersweet is a climbing woody vine that can grow 60 feet into tree canopies

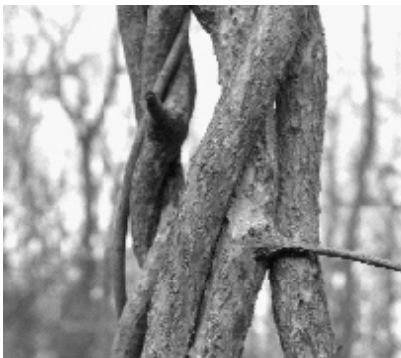
smothering native trees. It grows at forest edges and openings, and will occasionally become established in fields. It colonizes rapidly and produces prolific amounts of seed that are dispersed by birds, animals and especially humans who collect the showy vines for home decoration in autumn and winter. Drooping clusters of fruits are green in summer turning yellow-orange by late summer and fall, and then tan in winter. Invasive Oriental bittersweet resembles the native American bittersweet, *Celastrus scandens*. Native American bittersweet leaves are usually twice as large. Fruits of the native American bittersweet have orange seed pods and red berries while invasive Oriental bittersweet has yellow-orange seed pods with orange-red berries (see photos). Plants bloom in May with flowers in clusters. Each cluster has three to seven small yellowish flowers; each flower with five petals.

Oriental bittersweet is easily killed with Roundup or Garlon applied to the foliage with late growing-season applications generally more lethal. Large vines are best controlled in fall or winter with either basal or cut stump treatments of Garlon at 15-25% in paraffin oil or diesel. Freshly cut stumps also may be painted with 15-25% Roundup with a good kill rate. In cold weather, diluting Roundup with automobile window-washing fluid prevents freezing and may improve penetration into plant tissues.

Other Invasive Species of Concern



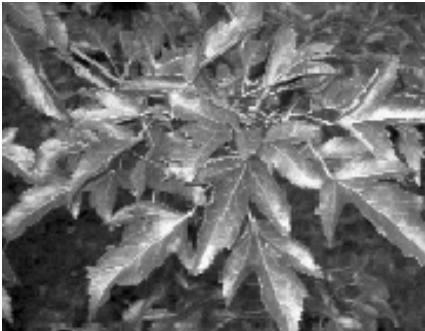
Asian bittersweet (left) and American bittersweet (middle and right).



Asian bittersweet (left) and American bittersweet (middle and right).



Lacebark elm



Amur maple



Buckthorn



Multiflora rose



Tree of heaven



Golden rain tree



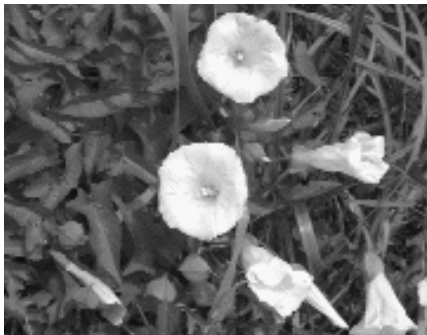
Japanese knotweed
English ivy



Kudzu



Other Invasive Species of Concern (continued)



Bindweed



Japanese hops



Periwinkle

Crown vetch

Bird's foot trefoil

Red clover



White clover



Spotted knapweed



Hedge parsley



Purple loosestrife



Curly dock



Canada thistle

Bull thistle

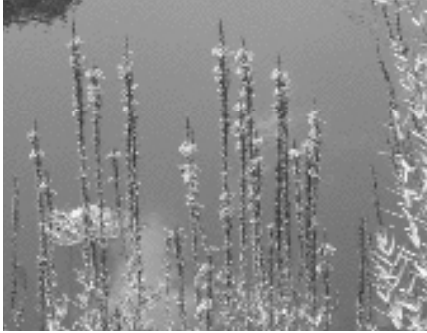
Musk thistle

Teasel

Internet Resources

These internet sites offer additional information about invasive species, the problems they create and potential solutions.

Missouri Department of Conservation



Yellow nutsedge



Maiden grass



Reed canary grass



Annual Weeds

These mostly sun-loving native annuals can be weedy in newly seeded/planted areas



but are not considered invasive. Control them with regular mowing during the first

growing season after seeding.

Yellow rocket

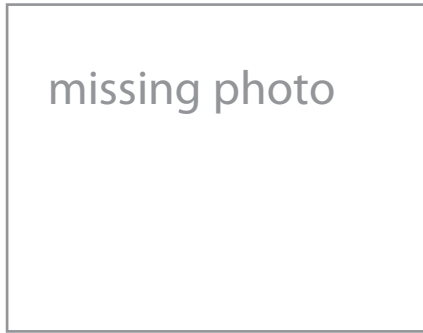
Smartweed

Henbit

Giant ragweed

Common ragweed

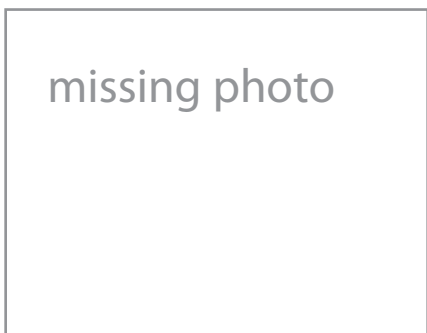
Mares tail



Queen Anne's lace

Chickory

Foxtail



Vegetation Management Manual <http://mdc.mo.gov/nathis/exotic/vegman/index.htm>

The Nature Conservancy Global Invasive Species Initiative
<http://tncweeds.ucdavis.edu/>

TNC Guidelines for Herbicide Use
<http://tncweeds.ucdavis.edu/products/handbook/07.HerbicideGuidelines.pdf>

TNC Weed Control Methods Handbook
<http://tncweeds.ucdavis.edu/handbook.html>

TNC Tool Review Page
<http://tncweeds.ucdavis.edu/tools.html>

Invasive Plants of the Eastern U.S.
<http://www.invasive.org/eastern>

Invasive Plants Association of Wisconsin
<http://www.ipaw.org/>

National Park Service
Weeds Gone Wild <http://www.nps.gov/plants/alien/moreinfo.htm>

Ecological Society of America
Biological Invasions: Recommendations for U.S. Policy and Management. <http://www.esajournals.org/perlserv/?request=get-abstract&issn=1051-0761&volume=016&issue=06&page=2035>

Additional Resources

The Missouri Department of Conservation through its Private Lands Sources and its regional biologists provide technical information about invasive species. Companies that produce herbicides offer reliable information and assistance through their technical representatives.

Sources for Safety Equipment and Herbicides

(c) John M. Randall/The Nature Conservancy
 (c) Barry A. Rice/The Nature Conservancy
 (c) Mandy Tu/The Nature Conservancy

A.M. Leonard, Inc.
 241 Fox Drive
 Piqua, Ohio 45356-0816
 Phone: 1-800-543-8955
 Web Address: <http://amleo.com>

Ben Meadows Company
 190 Etowah Industrial Court
 Canton, GA 30114
 Phone: 1-800-241-6401
 Web Address: <http://www.benmeadows.com>

Hummert International
 4500 Earth City Expressway
 Earth City, MO 63045
 800-325-3055
 314-506-4500
 Fax: 314-506-4510
 Web Address: <http://www.hummert.com>

Forestry Suppliers, Inc.
 P.O. Box 8397
 Jackson, MS 39284-8397
 Phone: 1-800-647-5368
 Web Address: <http://www.forestry-suppliers.com>

Vegetation Management Supply
 Mexico, MO 65265
 800-295-5791
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This Management Guide is a collaborative effort between Shaw Nature Reserve and the Missouri Department of Conservation's Grow Native! Program.

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