

**Noxious Weed Guide**  
**Las Animas County, Colorado**  
*A Comprehensive Guide to  
Noxious Weed Identification  
and Control*

**By: Shannon Clark**  
*and*  
**Shelly L. Simmons**

*Spotted Knapweed – Gulnare Area*  
*Photo by: SL Simmons ©*



Spanish Peaks-Purgatoire River  
Conservation District



## **Purgatoire Watershed**

WEED MANAGEMENT  
COLLABORATIVE

**3590 E. Main Street**

**Trinidad, CO 81082**

**719.497.3118**

**[www.PurgatoireConservation.org](http://www.PurgatoireConservation.org)**

*Musk thistle – Hoehne Area  
Photo by: SL Simmons ©*

## **Noxious Weeds: A major threat to the economy and environment of Las Animas County and the Purgatoire River Watershed**

The Purgatoire River Watershed is one of the most ecologically intact watersheds in the State of Colorado. It boasts amazingly intact native vegetation and extraordinary biological diversity, all while supporting vibrant communities, robust agricultural production and highly sought after recreational and hunting opportunities.

Counties within the Purgatoire River Watershed depend on their natural resources for economic well-being and quality of life. Agriculture, recreation, hunting, tourism, drinking water supply; each of these depends upon quality natural resources and informed resource management as the basis to a sustainable economy.

Noxious weeds pose one of the biggest threats to these resources and the long-term health of the Purgatoire River Watershed. Whether through declining agricultural productivity and recreational opportunities, degraded wildlife habitat and hunting opportunities, or simply the ongoing costs associated with noxious weed control, the economic and environmental costs are staggering. **By working together, landowners, businesses and communities can more efficiently and effectively invest in protection of our natural resources!**

**To learn more about noxious weeds and land conservation in Las Animas County, contact:  
Spanish Peaks-Purgatoire River Conservation District or  
Branson-Trinchera Conservation District  
719.497.3118 or [www.PurgatoireConservation.org](http://www.PurgatoireConservation.org)**

## Noxious Weed Snapshots

**133,000,000**

The number of acres nation-wide that are infested with noxious weeds <sup>3</sup>



**Over 100**

The number of noxious weeds known in the State of Colorado <sup>2</sup>

**\$14 Million**  
Estimated annual economic impact to the State of Colorado from only ten noxious weed species <sup>1</sup>



**\$32 Billion**

Estimated annual value of lost crop production to US Agriculture (2007) <sup>3</sup>

**1,700,000 acres**  
New land overcome by noxious weeds each year in the United States <sup>3</sup>

<sup>1</sup> Colorado State University Department of Agricultural and Resource Economics, 2014;

<sup>2</sup> Colorado Department of Agriculture;

<sup>3</sup> *Invasive Plants: Their Role in Species Extinctions and Economic Losses*



# Table of Contents

## Introduction

About the Guide .....	1
Noxious Weed Laws and Resources.....	1-2
Types of Weed Control .....	3
Glossary of Terms.....	4-5

## **Weeds** (*Alphabetically by Family then by Common Name*)

Poison hemlock.....	6-9
Common burdock.....	10-13
Bull thistle.....	14-16
Canada thistle .....	17-19
Musk thistle .....	20-22
Scotch thistle.....	23-25
Thistle chemical control.....	26
Diffuse knapweed.....	27-29
Russian knapweed .....	30-32
Spotted knapweed.....	33-35
Knapweed chemical control .....	36
Oxeye daisy .....	37-40
Houndstongue.....	41-44
Dames rocket.....	45-48
Hoary cress .....	49-51
Perennial pepperweed .....	52-54
Hoary cress and pepperweed chemical control.....	55
Russian-olive.....	56-59

## Table of Contents *(continued)*

### **Weeds** *(continued)*

Leafy spurge .....	60-63
White horehound .....	64-67
Downy brome .....	68-70
Japanese brome .....	71-73
Brome chemical control .....	74
Jointed goatgrass .....	75-78
Common mullein .....	79-81
Moth mullein .....	82-84
Mullein chemical control .....	85
Dalmatian toadflax .....	86-88
Yellow toadflax .....	89-91
Toadflax chemical control .....	92
Tamarisk .....	93-96
African rue .....	97-100

### **Appendices**

A: Photo Citations .....	101-106
B: Source Citations .....	107
C: Sponsors .....	108-112

# Introduction

## About this Guide

This guide addresses **noxious** or **invasive** weeds that are problematic in Las Animas County. Merriam-Webster defines a *weed* as “a plant that is not valued where it is growing and is usually of vigorous growth; especially one that tends to overgrow or choke out more desirable plants”. The Colorado Department of Agriculture defines **noxious** weeds as “the non-native aggressive invaders that replace native vegetation, reduce agricultural productivity, cause wind and water erosion, pose an increased threat to communities from wildfire and are also **the subject of regulations by the state of Colorado**”.

**Invasive** weeds have a similar definition of impacts, but have **not** been designated for regulation by the state of Colorado. This guide will provide identification information, photos and management recommendations for many of the noxious and invasive weeds present in Las Animas County. The focus will be on weeds found in range, pasture and natural areas, although many of these species are also problematic in cultivated lands.

## Colorado’s Classification of Noxious Weeds

Each state has the ability to designate problematic weeds to be listed as a noxious weed. In Colorado, the State designates noxious weeds into three categories: List A, List B, and List C. There is also a Watch List in which the species have not been designated as noxious, but pose potential threats that could cause it to be listed in the future.

The **Colorado Noxious Weed Act** states that noxious weed management is the responsibility of local governing agencies: incorporated municipalities, counties, and lands owned by state and federal agencies. The Act states that the board of county commissioners of each county in the State shall adopt a noxious weed management plan for all the unincorporated lands within each county.

## Introduction (*continued*)

**List A** species require mandatory eradication by local governing agencies.

**List B** species are mandated for eradication in some parts of the State, and recommended for suppression or containment in other areas, depending on distribution and densities around the State. Each county chooses whether to require eradication or management based on their goals.

**List C** species are widespread and well established. Individual county governments or jurisdictions can choose whether or not to require management of these species.

**Watch List** species are provided to educate and encourage identification and reporting. They are determined by: 1) Not known to occur in the State, but their noxious characteristics are found in the region; 2) They have been found to display noxious characteristics in plant communities similar to those in Colorado; 3) They have noxious characteristics as determined by the plant assessment process used by the State, yet their distribution and effect on lands in the State is still unknown.

## Weed Management Resources

- Purgatoire Watershed Weed Management Collaborative/ Spanish Peaks-Purgatoire River Conservation District/Branson-Trinchera Conservation District [www.PurgatoireConservation.org](http://www.PurgatoireConservation.org)
- Colorado Department of Agriculture's Noxious Weed Program [www.colorado.gov/ag/weeds](http://www.colorado.gov/ag/weeds)
- Colorado Weed Management Association [www.cwma.org](http://www.cwma.org)
- Crop Data Management Systems *Label database that includes herbicide and MSDS (Material Safety Data Sheet) information* [www.cdms.net/](http://www.cdms.net/)
- Colorado State University Weed Science <http://bspm.agsci.colostate.edu/outreach-button/weed-science-information/>



## Introduction (*continued*)

### Types of Noxious Weed Control

#### ***Mechanical Control***

Mechanical control consists of methods that kill or suppress weeds through physical disruption. Such methods include pulling, digging, tilling and mowing. Success of various mechanical control methods is dependent on the life cycle for the targeted weed species. Biennials usually respond better to these methods.

#### ***Cultural***

Cultural control methods include practices that suppress weeds or provide competition against invasion. These practices can include livestock grazing, fire and revegetation, or a combination of these.

#### ***Biological Control***

In this guide, biological control is considered the use of living agents (insects, bacteria and fungi) to suppress vigor and spread of weeds. Insect use is the most common form of biological control, typically requiring 3-5 years for establishment. Eradication of a weed cannot be attained through insect control.

#### ***Chemical Control***

The use of herbicides to control weeds. Herbicides can provide a cost and time efficient method to manage weeds. This guide provides herbicide recommendations for non-crop sites, based on input from noxious weed experts – this is not an exhaustive list of all herbicides that can be used. Herbicide application requires user responsibility and compliance with all product label requirements for herbicide handling, use and cleanup. When using herbicides, always read the label: **The label is the LAW.** Follow all manufacturer's instructions for appropriate use. Always be mindful of proximity to water, trees and desirable vegetation based on herbicide label instructions. This guide does not cover adjuvants, although an adjuvant is generally recommended for post-emergence applications. Follow label guidelines for adjuvant type and rate depending on targeted weed species.

## Introduction (*continued*)

### Glossary of Terms

**Adventitious roots:** Roots that arise from somewhere other than the existing roots, usually a stem, but sometimes a leaf.

**Annual:** Plants that live, reproduce, and die in one growing season.

**Biennial:** Plants that need two growing seasons to complete their life cycle; normally completing vegetative growth the first year and flowering the second year.

**Bolt/Bolting:** When a plant begins to quickly grow, shooting up (or producing) a flowering stem.

**Bract:** The leaf or scale-like appendages that are located just below a flower and are sometimes showy or brightly colored.

**Branching:** Dividing into multiple smaller segments.

**Broadleaves** (Dicotyledons): Usually have wider leaf blades than grasses. Each leaf typically has a main vein that divides the leaf in half with a network of smaller veins forming a netlike pattern.

**Creeping:** Growing along the ground and producing roots and intervals along the surface.

**Erect:** Having an essentially upright vertical habit or position.

**Forb:** An herbaceous flowering plant other than a grass.

**Fruit:** Structure containing all the seeds produced by a single flower.

**Grasses** (Monocotyledons): Have long, narrow leaves with veins running parallel to each other.

**Herbaceous:** Non-woody plants with shoot systems that die back to the ground each year.

**Lobed:** When the blade of a leaf curves in towards the middle of the leaf (or vein) and then curves back out.

**Perennial:** Plants that live for more than two years, with the shoot system dying back to soil level each year, or with shoot systems that remain alive above the soil level from one year to the next.

## Introduction (*continued*)

### Glossary of Terms (*continued*)

**Rhizome:** A continuously growing horizontal underground stem that puts out lateral shoots and adventitious roots at intervals.

**Rosette:** Leaves that form in a circular pattern from a central growing point, located at or beneath the soil surface.

**Taproot:** A primary root that grows downward into the soil.

### Chemical Control Terms and Abbreviations

**Ac. :** acre

**A.e. :** acid equivalent

**A.i. :** active ingredient

**Lb(s) :** pound(s)

**Non-selective:** Herbicide that damages or kills all plants (i.e. glyphosate). NOTE: some plants can be resistant to non-selective herbicides.

**Oz. :** Ounces

**Post-emergence:** Herbicide application made *after* the plant has germinated and emerged through the soil surface. Kills only existing plants. Some herbicides have pre-emergence and post-emergence activity.

**Pre-emergence:** Herbicide application made *before* the plant has germinated and emerged through the soil surface. Kills weeds as they germinate.

**Pt(s) :** Pint(s)

**Qt(s) :** Quart(s)

**Selective:** Herbicide formulated to kill certain weeds or categories of weeds, but not others (i.e. 2,4-D kills broadleaf plants, but generally not grasses).

## Poison hemlock

## *Conium maculatum*

### List C Species

**Family:** Apiaceae

**Range:** Throughout the US and Canada, including all western states.

**Habitat:** Commonly found in moist sites including streams, rivers, irrigation and roadside ditches, meadows, woodlands, crop and pasturelands, as well as disturbed sites. Adaptable to a wide range of climates as long as there is adequate moisture.

**Origin:** Native to Europe.

**History:** Introduced as a garden plant sometime in the 1800's.

**Impacts:** Poison hemlock produces alkaloids that are highly toxic to both humans and livestock. Animals generally do not eat the plants unless food is scarce. Ingestion of only 0.25-0.30% of an animal's body weight can be lethal. Poisoning in humans has occurred, and the plant is sometimes confused for other edible plants such as wild carrots. Plants can grow in dense patches and replace desirable vegetation.



*Second-year mature plant.*



*Mature plant in the field.*



## Poison hemlock

## *Conium maculatum*

**Life Cycle:** A biennial plant that reproduces solely by seed. First year plants form rosettes with hairless, shiny green leaves and pale yellow taproots. During the second year of growth, plants bolt, producing stems that flower.

**Stem:** Can grow up 4 to 8 ft. tall with an erect, branching stem. The stem is hollow, smooth, bright green with distinct purple spots.

**Flowers:** Flowering can occur June to July. Flowers are white with five petals and less than 1/16 in. long. The ends of the branches have umbrella-like clusters of 12 to 16 small branches (rays) with numerous flowers at the end.

**Leaves:** Leaves are hairless, bright green and divided into smaller leaves called leaflets. Leaves are lacy, resembling parsley and have a musty odor when crushed.

**Fruit:** Each flower produces two flat, grayish-green seeds which are the most poisonous part of the plant. Seeds germinate almost immediately if conditions are favorable, but can remain dormant. Seeds can remain viable in the soil for up to three years.



*Poison hemlock flowers demonstrating umbrella-like cluster.*



*Stem showing characteristic purple spots or splotches.*

## Poison hemlock

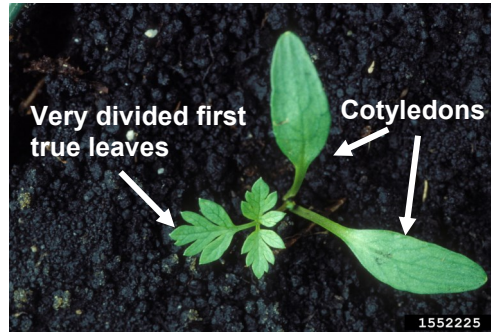
## *Conium maculatum*



*This is one leaf divided into smaller leaves called leaflets.*



*Close-up of the five-petaled flowers.*



*Poison hemlock seedling with pointed oval shaped first leaves (cotyledons) and very divided first true leaves.*

### Non-chemical Control:

Mechanical	Hand-pulling is effective for small infestations. Must dig to remove entire taproot or plant can grow back from root. Always wear gloves and wash hands immediately after working with plants. Mowing is ineffective. Plowing can prevent populations from becoming established.
Cultural	Grazing is not an option due to the plant's toxicity. Burning can release toxins into the air so it cannot be used as a control option.
Biological	The hemlock moth ( <i>agonopterix alstroemeriana</i> ) larvae feed on leaves, young stem tissue, flowers and seeds causing severe defoliation and death of the plant. For more information contact the Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.

## Poison hemlock

---

### Chemical Control:

2,4-D (Several trade names exist)	Rate: 2 to 4 pt./acre, 1 to 2 lb. ai/acre	Timing: Post-emergence from rosette to early bolting stage.  Remarks: 2,4-D is broadleaf-selective. Efficacy can be increased by tank-mixing with dicamba (Banvel, Clarity), or using a premixed formulation such as 2,4-D + picloram (Graslan) or 2,4-D + aminopyralid (GrazonNext).
Aminocyclopyrachlor (Method)	Rate: 12 to 18 oz./acre	Timing: Post-emergence from seedling to rosette stage.  Remarks: Do not apply in the root zone of trees and shrubs. Not yet labeled for use in grazed sites. These higher rates will injure cool season grasses. Tank mixing with 1 oz/acre of chlorsulfuron (Telar) can increase control.
Chlorsulfuron (Telar)	Rate: 1 to 2.6 oz./acre	Timing: Post-emergence from rosette to early bolting.  Remarks: Can be applied to water's edge. Generally safe on established grasses.
Glyphosate (Roundup, Accord XRT II, and several others)	Rate: 1.5 to 3 lb a.e./acre	Timing: Post-emergence in seedling to rosette stage.  Remarks: Non-selective herbicide with no soil activity. Must spot-treat if desirable vegetation is present at site. Aquatic formulations are available.
Metsulfuron (Escort)	Rate: 1 oz/ acre	Timing: Post-emergence from rosette to early bolting stage.  Remarks: Other premix formulations can be used: Opensight (aminopyralid + metsulfuron) and Cimarron Xtra (metsulfuron + chlorsulfuron).

## Common burdock

*Arctium minus*

### List C Species

**Family:** Asteraceae

**Range:** Almost all US states and Canada

**Alternate Names:** lesser burdock, beggar's button

**Habitat:** Commonly found in areas with high disturbance including roadsides, waste sites, hay fields, crop fields, rangeland/pasture, and along fences. Often found in full or partial sun, slightly moist conditions, and loamy fertile soil.

**Origin:** Native to Europe.

**History:** Accidental introduction to the US during the 1600's from European settlers.

**Impacts:** Common burdock can form dense patches over time, especially in hay meadows and pastures. Serves as a host for pathogens, including powdery mildew and root rot, which can affect nearby desirable plants and crops. Reduces the quality of sheep's wool due to the seed heads that easily become entangled. Most animals avoid grazing common burdock due to the spines and burs, but if grazed in large quantities it can taint milk flavor.



*Second-year mature plant.*



*Common burdock flowers.*



## Common burdock

## *Arctium minus*

**Life Cycle:** A biennial forb that reproduces solely by seed. First year plants form rosettes with large, hairy leaves. During the second year of growth, plants bolt, producing a stem that flowers.

**Stem:** Can grow up 3 to 10 ft. tall with an erect, coarse, multi-branched stem.

**Flowers:** Flowering can occur July to October. Flowers are pink to purple in color and enclosed by several spines, usually with a hook at the end of each spine. Numerous, clustered flowers develop at the end each branch.

**Leaves:** The large lower leaves are dark green, heart shaped and up to 1 ft. long with toothed or wavy edges. The leaves on the stem are smaller than the lower leaves but still very large, heart-shaped with hairy undersides.

**Fruit:** As the flowers and spines dry out they become an easily dispersible bur that contains the seed. Plants produce an average of 15,000 seeds each. The hooks on the ends of the burs readily attach to fur making distribution easy over large areas.



*Heart-shaped leaf of common burdock with wavy, toothed edges.*



*Common burdock flowers surrounded by spines.*

## Common burdock

*Arctium minus*



*Common burdock rosette; rosette leaves can be up to one foot long.*



*Burs that are easily dispersed on animal fur and clothing.*



*Common burdock seedling.*

### Non-chemical Control:

Mechanical	Tillage or hand-pulling before flowering to prevent seed production can be effective. This must be repeated as new seedlings germinate. Mowing can be effective if done before seed production to prevent seed dispersal. Tilling plants before seed production is also provides very effective control but must be repeated.
Cultural	Fire is likely not effective and creates conditions that can stimulate recruitment. Livestock will not readily graze common burdock the first year due to the hairy leaves and the second year due to the spines and burs.
Biological	No known biocontrol agents are available for use on common burdock.

## Common burdock

---

### Chemical Control:

<p>2,4-D (Several trade names exist)</p>	<p>Rate: 1 to 4 pt./acre, 0.48 to 1.9 lb a.e./acre</p>	<p>Timing: Post-emergence to young, rapidly growing plants or in the fall to new rosettes.</p> <p>Remarks: 2,4-D is selective to broadleaves and has no soil activity. Do not apply when temperatures are above 80°F. Efficacy can be increased by tank-mixing with another broadleaf herbicide such as picloram (Tordon), dicamba (Banvel, Clarity), or aminopyralid (GrazonNext).</p>
<p>Aminopyralid (Milestone)</p>	<p>Rate: 4 to 7 oz./acre</p>	<p>Timing: Post-emergence at the rosette stage in the spring or early fall.</p> <p>Remarks: Can injure some desirable broadleaf species and trees. Other premix formulations can be used: aminopyralid + 2,4-D (GrazonNext).</p>
<p>Clopyralid (Transline)</p>	<p>Rate: 0.67 to 1.33 pt./acre</p>	<p>Timing: Post-emergence to young actively growing plants in the spring.</p> <p>Remarks: Best applied to rapidly growing weeds. Can injure some Asteraceae or Fabaceae species but is safe around trees.</p>
<p>Dicamba (Banvel, Clarity)</p>	<p>Rate: 1 to 2 pt./acre, 0.5 to 1 lb a.e./acre</p>	<p>Timing: Post-emergence to young, rapidly growing plants before flowering in the spring.</p> <p>Remarks: Higher rates can increase control, although higher rates can cause some injury to grasses. Can be tank-mixed with 2,4-D.</p>

## Bull thistle

*Cirsium vulgare*

### List B Species

**Family:** Asteraceae

**Range:** All US states and Canada

**Habitat:** Commonly found in areas with high disturbance including forest clearcuts, riparian areas, roadsides and rangeland/pasture. Prefers nitrogen-rich and gravelly to clay-textured soils.

**Origin:** Native to Eurasia

**History:** Thought to be introduced to eastern North America during colonial times as a seed contaminant, and to the western US during the late 1800's and early 1900's.

**Impacts:** Populations can spread rapidly and form dense stands in disturbed areas, displacing desirable vegetation. Unpalatable to wildlife and livestock due to its spiny foliage. Reduces the forage quality in pastures, and if present in cut hay, can significantly reduce the market value. Can also cause hay fever in some individuals. Common, but not considered as problematic as musk or Scotch thistle.



*Second-year mature plant.*



*Bolting bull thistle.*

*Photo Credit: Shelly L. Simmons*



## **Bull thistle**

*Cirsium vulgare*

**Life Cycle:** Almost always a biennial plant but can sometimes be an annual or short-lived perennial. Produces a large, spiny rosette up to 3 ft. in diameter the first year, bolting and flowering the second year.

**Stem:** Can grow up to 7 ft. tall; erect, usually with many branches; slightly hairy.

**Flowers:** Flowering can occur June to September. Flowers are magenta to dark purple in color, 1-2 in. in diameter with large spiny bracts surrounding the seed heads. Flowers develop at the end of each stem and the plant dies after flowering.

**Leaves:** The leaves are alternate, 3 to 12 in. long, deeply lobed with prickly hairs on the top and woolly hairs underneath. Sharp spines are found down the middle, on the lobes and on the tip of the leaf.

**Fruit:** Plants can produce 100 to 300 seeds per flowerhead, with 1 to 400 flowerheads per plant. Seeds are feathery and hairy, and detach at maturity easily spreading.



*Bull thistle can have one or several stems. Notice spines on the stem.*



*Light and feathery seeds at maturity.*

## Bull thistle

## *Cirsium vulgare*

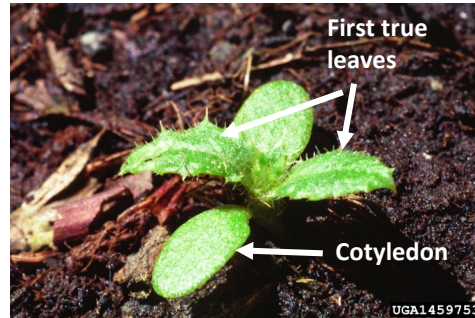


First-year bull thistle rosette. In year two this plant will bolt, seed and die.



Spines on middle and lobes of leaves.

Deeply lobed leaves.



Bull thistle seedling; first leaves (cotyledons) to appear are round with first true leaves oval-shaped and spiny.

### Non-chemical Control:

Mechanical	Tillage or hand-pulling before flowering to prevent seed production can be effective. The plant must be removed below the soil surface to prevent regrowth. Mowing must be done immediately before flowering and usually needs to be repeated through growing season.
Cultural	Fire is likely not effective and creates conditions that can stimulate recruitment. Sheep and goats will eat young plants which can reduce infestations, and goats will eat flowerheads which can prevent seed dispersal.
Biological	The bull thistle gall fly, <i>Urophora stylata</i> , has proven to be ineffective in Colorado so no biological control option is available in the state at this time.

## Canada thistle

*Cirsium arvense*

### List B Species

**Family:** Asteraceae

**Range:** Most of the US states and Canada. More problematic in the western states.

**Habitat:** Commonly found in areas with high disturbance including roadsides, pasture/rangeland, streambanks and riparian areas, forest clearings, and cropland. Prefers moist soils but can grow in a variety of soil types.

**Origin:** Native to southeastern Europe and eastern Mediterranean.

**History:** Introduced to the US in the 1600's. By the 1700's it was recognized as a weed and efforts were made to reduce its spread.

**Impacts:** Canada thistle is one of the most problematic weeds in the U.S. It is an aggressive competitor against native species competing for water and nutrients. Large infestations significantly reduce crop and cattle forage production. It is also a host plant for several agricultural pests and diseases.



*Mature flowering Canada thistle plant.*



*Close up of the small cluster of flowers occurring on each stem.*



## Canada thistle

## *Cirsium arvense*

**Life Cycle:** A deep-rooted perennial that spreads by seeds and aggressive creeping, horizontal roots called rhizomes. Stems die in the winter and grow back in the spring from stem bases, root buds or seed.

**Stem:** Plants can grow 1 to 4 ft. tall and form patches or clumps. The stem is branched and mostly smooth.

**Flowers:** Flowers range from magenta to white, blooming from June to August. There are both male and female flowers, ~0.5 in. in diameter with one to five flowerheads per branch. Female flowers are fragrant and male flowers are not.

**Leaves:** The leaves are spiny and lobed, 6 to 8 in. long and 1 to 1.5 in. wide. Leaves are oblong shaped, dark green and smooth on top with short white hairs on the underside.

**Fruit:** The small seeds are white to light brown, light weight being easily dispersed by the wind. Each stem can produce 1,000 to 5,000 seeds per stem and remain viable for up to 20 years especially when buried deep in the soil.



*Canada thistle leaves and stems.*



*Flask-shaped magenta-colored flowerhead.*

## Canada thistle

## *Cirsium arvense*



Canada thistle rosette.



Canada thistle seeds at maturity.



Canada thistle seedling; first leaves (cotyledons) are oblong shaped with first true leaves oval-shaped and spiny.

### Non-chemical Control:

Mechanical	Mowing can suppress flower formation but must be repeated often through the growing season. Tillage can actually stimulate new plant development through stimulating new root shoots.
Cultural	Both grazing and fire have been shown to be ineffective for Canada thistle management. Maintaining healthy pastures and avoiding overgrazing can prevent new stand establishments.
Biological	Currently insects are available for release but have not had a significant impact to Canada thistle. A Canada thistle rust ( <i>Puccinia punctiformis</i> ) is currently being collected and researched for distribution. For more information contact the Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.

## Musk thistle

*Carduus nutans*

### List B Species

**Family:** Asteraceae

**Range:** Almost all US states and Canada

**Alternate Names:** Nodding plumeless thistle, nodding thistle

**Habitat:** Commonly found in areas with high disturbance including forest clearcuts, fire areas, roadsides and rangeland/pasture. Prefers fertile, well-drained soils but can tolerate many soil types.

**Origin:** Native to Europe and Mediterranean region.

**History:** Accidentally introduced to North America in the mid-1800's.

**Impacts:** Musk thistle can form dense stands in disturbed areas, displacing desirable vegetation. Unpalatable to most wildlife and cattle due to its spiny foliage. Dense infestations can discourage livestock from using effected pastures. Once established, it can spread rapidly due to high seed production.



*Second-year mature plant with several branching stems.*



*Musk thistle flowerheads.*



## Musk thistle

## *Carduus nutans*

**Life Cycle:** A biennial plant or occasionally a winter annual that reproduces solely by seed. Produces a large, spiny rosette in the spring or fall the first year, bolting and flowering in spring the second year.

**Stem:** Can grow up to 6 ft. tall with winged spines along stem. After bolting, stems branch near top.

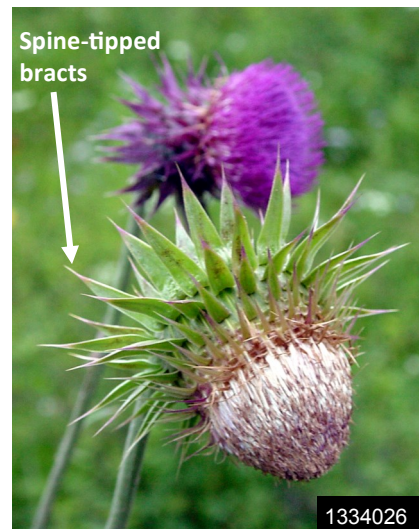
**Flowers:** Flowering can occur June to September. Flowers are pink to purple in color, 1.5-3 in. in diameter surrounded by numerous, wide spine-tipped bracts resembling an open pineapple. One flower develops at the end of each stem and bends over as if nodding. Robust plants can have up to 100 flowerheads.

**Leaves:** The leaves are waxy and dark green in color with a prominent light green-to-white down the middle. Bottom leaves are 4 to 16 in. long, lobed with sharp spines along the edge of the leaf.

**Fruit:** Seeds can be 1.5 in. long but are less than 1/8 in. in diameter. Several hundred feathery seeds develop from each flower bud and can remain viable in the soil for over a decade.



*Musk thistle can have several stems. Notice the winged spines on the stem.*



*Flower head surrounded by spine-tipped bracts. Notice the nodding.*

## Musk thistle

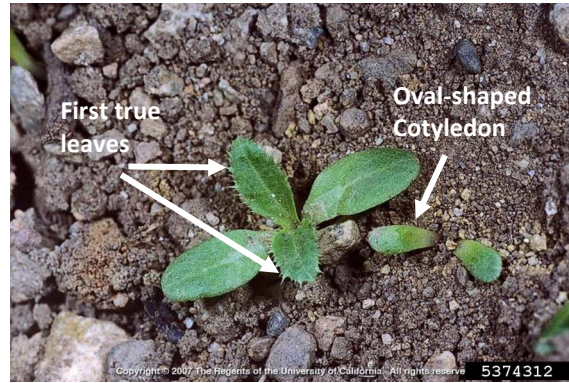
## *Carduus nutans*



*Musk thistle rosette. Notice the light green-to-white down the center of the leaves (mid-rib), and the white-colored leaf edges.*



*Musk thistle seeds at maturity.*



*Musk thistle seedling; first leaves (cotyledons) to appear are oval with first true leaves spiny and narrow, oval-shaped coming to a point.*

### Non-chemical Control:

Mechanical	Hand-pulling before flowering to prevent seed production can be effective; remove plant below the soil surface to prevent regrowth. Mowing or chopping can be done before flowering although it stimulates new growth and needs to be repeated through the growing season.
Cultural	Fire is likely not effective and creates conditions that can stimulate recruitment. Sheep and goats may eat flowerheads which can prevent seed dispersal, but the spiny stalks and leaves usually deter livestock grazing.
Biological	<i>Trichosiocalus horridus</i> is a biological control agent available for musk thistle in Colorado. For more information contact Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.

## Scotch thistle

## *Onopordum acanthium*

### List B Species

**Family:** Asteraceae

**Range:** Most US states and Canada. More problematic in the western states.

**Alternate Names:** Cotton thistle

**Habitat:** Commonly found in areas with high disturbance including forest clearings, stream corridors, areas with high rodent activity, abandoned cropland, roadsides and rangeland/pasture. Prefers areas with high soil moisture for germination.

**Origin:** Native to Eurasia

**History:** Introduced to the US in the 1800's as an ornamental plant from the Mediterranean region.

**Impacts:** Scotch thistle can form dense stands in disturbed areas, displacing desirable vegetation and making it impassable to livestock and wildlife. With enough moisture, it can re-sprout from roots cut up during cultivation. Prolific seed producer spreading easily as seeds are dispersed through wind, by water or by being caught in the fur of animals. Spreads heavily during wet years as seeds need moisture to break dormancy.



*Second-year mature plant with several branching stems.*



*A mature Scotch thistle plant can be 4 to 6 ft. tall.*



## Scotch thistle

## *Onopordum acanthium*

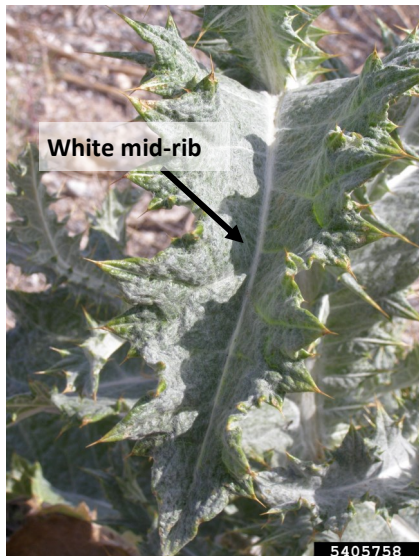
**Life Cycle:** A biennial that reproduces solely by seed. Produces a large, spiny, hairy rosette 1-2 ft. in diameter the first year. The second year the plant bolts, flowers and sets seed before dying.

**Stem:** Mature plants are generally 4 to 6 ft. tall, but can grow as tall as 10 ft. with numerous branched, spiny, winged stems.

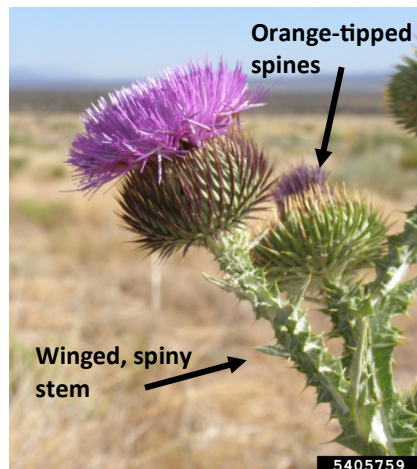
**Flowers:** Flowering can occur July to October. Flowers are violet to reddish in color, spherical shaped, 1-2 in. in diameter surrounded by numerous, orange-colored, flat spine-tipped bracts. One to as many as seven flowerheads develop at the end of each stem.

**Leaves:** The leaves are oblong, prickly and slightly toothed with a white strip running down the middle. Leaves are green with pale gray hairs giving a bluish– or grayish-green appearance to the foliage. The lower leaves can grow up to 1 ft. long.

**Fruit:** The small, gray seeds are attached to bristles in the flowerhead and released at maturity. Seeds can remain viable for up to 30 years but most will germinate in the spring or fall with adequate moisture. Seeds need moisture to germinate.



Scotch thistle leaf showing white mid-rib and grayish appearance.

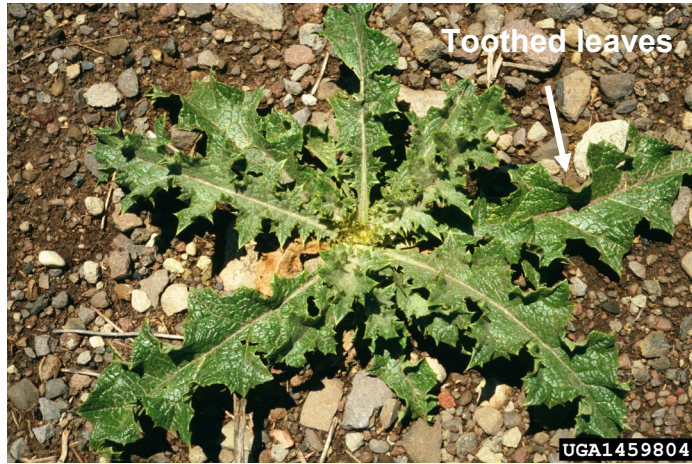


Flowerhead surrounded by spine-tipped bracts.



## Scotch thistle

## *Onopordum acanthium*



Scotch thistle rosette.



Scotch thistle seeds at maturity.



Close-up of leaf and flowerhead.

### Non-chemical Control:

Mechanical	Hand-pulling before flowering to prevent seed production can be effective; dig and remove plant below the soil surface to prevent regrowth. Mowing or chopping can be done just before flowering but often needs to be repeated through the growing season.
Cultural	Fire is not effective and creates conditions that can stimulate recruitment. Sheep and goats may eat flowerheads which can prevent seed dispersal, but the spiny stalks and leaves usually deter cattle grazing. Overgrazing promotes Scotch thistle establishment.
Biological	<i>Trichosirocalus horridus</i> is a biological control agent available for musk thistle in Colorado. For more information contact Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.

## Biennial/Perennial Thistles

### Chemical Control:

Aminopyralid (Milestone)	Rate: 5 to 7 oz./ acre	<p>Timing: Post-emergence from rosette to early budding stage. Can also be applied to fall rosettes or regrowth.</p> <p>Remarks: Aminopyralid provides excellent control of thistles with soil residual control. Can be injurious to some broadleaf species and to certain tree species. Other premix formulations can be used: Opensight (aminopyralid + metsulfuron) and GrazonNext (aminopyralid + 2,4-D).</p>
Chlorsulfuron (Telar)	Rate: 1 to 2.6 oz./acre	<p>Timing: Post-emergence from rosette to flower bud stage. Can also be applied in the fall.</p> <p>Remarks: One of the better control options for larger plants. Can be applied with 2,4-D for a quicker burndown.</p>
Clopyralid (Transline)	Rate: 0.67 to 1.33 pt./acre	<p>Timing: Post-emergence from rosette through early bolting stage. Can also be applied in the fall to new rosettes or regrowth.</p> <p>Remarks: More effective on younger, rapidly growing plants. Shorter soil residual than aminopyralid. Can injure some Asteraceae or Fabaceae species but is safe around trees.</p>
Picloram (Tordon 22k)	Rate: 1 qt./acre	<p>Timing: Post-emergence from rosette to early bolting.</p> <p>Remarks: Restricted use product. Broad spectrum herbicide with long soil residual activity. Most broadleaf plants are susceptible to picloram. Good option when there are additional weeds species that are being targeted. Do not apply near trees or water.</p>

## Diffuse knapweed

*Centaurea diffusa*

### List B Species

**Family:** Asteraceae

**Range:** All western states and western Canada.

**Habitat:** Commonly found in areas with high disturbance including roadsides, pasture/rangeland, gravel pits, industrial sites, and rugged terrain. Prefers dry, well-drained soils and is very drought tolerant. Cannot tolerate excessive moisture or shade.

**Origin:** Native to southeastern Eurasia.

**History:** Diffuse knapweed was accidentally introduced into the USA and Canada in the early 1900's in shipments of contaminated alfalfa seed.

**Impacts:** Diffuse knapweed can outcompete and reduce the quantity of desirable native species, especially perennial grasses. This decreases biodiversity and increases soil erosion in areas with heavy infestations. Diffuse knapweed also has tumbleweed like features and dense populations of dry plants can be caught along fences, increasing fire risks.



*Mature diffuse knapweed plant just before flowering.*



*Diffuse knapweed rosettes.*



## Diffuse knapweed

## *Centaurea diffusa*

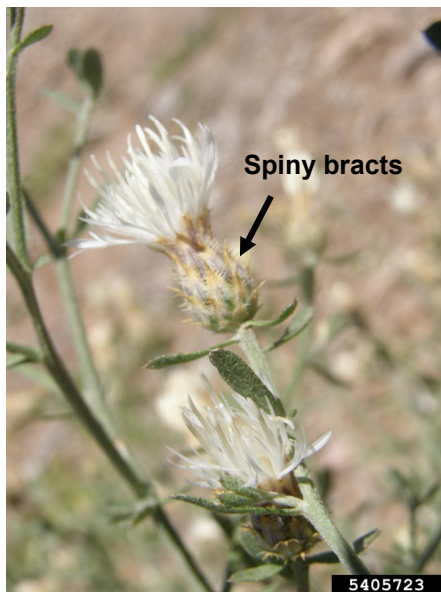
**Life Cycle:** A biennial or short-lived perennial with a deep taproot that spreads solely by seed. Seeds can germinate in the spring or fall and complete the first year as a rosette. In year two the plant bolts, flowers, sets seed, and dies.

**Stem:** Plants can grow up to 3 ft. tall. At maturity, the stem breaks off near the ground and the plant tumbles along the ground in the wind.

**Flowers:** Flowering occurs from July to September. The urn-shaped flowerheads produce flowers that are usually white but can be pink. Flowers are surrounded by straw-colored, spiny scales.

**Leaves:** Leaves are covered with short grayish hairs. Lower leaves are 4 to 8 in. long and deeply lobed. Leaves become smaller and less lobed as they move up the stem.

**Fruit:** Seeds are small, 0.08 to 0.12 in. long with bristle-like hairs. When the plant tumbles across the ground, the flowerheads break off, dispersing seeds. Seeds can remain viable for approximately 2 to 5 years in the soil.



*Diffuse knapweed flowers surrounded by straw colored bracts.*



*Second-year diffuse knapweed rosette starting to bolt.*

## Diffuse knapweed

## *Centaurea diffusa*



Diffuse knapweed plant starting to set seed.



Up-close of diffuse knapweed foliage.



Diffuse knapweed seedling; first leaves (cotyledons) are oval-shaped with first true leaves oblong shaped.

### Non-chemical Control:

Mechanical	Hand-pulling or digging can be effective if done before seed set. The entire taproot needs to be removed or the plant can grow back. Mowing can reduce seed production but if done too early the plant will recover and set seed and mowing too late can disperse seed.
Cultural	Grazing is not an effective strategy as diffuse knapweed is not generally palatable to livestock. Fire has been shown to decrease infestations while stimulating grass regrowth.
Biological	No one biocontrol method provides good control of diffuse knapweed. However, the seedhead weevil ( <i>Larinus minutus</i> ) and the root weevil fly ( <i>Cyphocleonus achates</i> ) when used in combination can provide fair to good control. Expect 3 to 5 years for results. For more information contact the Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.

## Russian knapweed

## *Acroptilon repens*

### List B Species

**Family:** Asteraceae

**Range:** Most of the US states and Canada. More problematic in the western states.

**Habitat:** Found in pasture/rangeland, cultivated fields, roadsides, ditchbanks, waste sites, river bottoms and riparian areas. Prefers areas that have moist soils and full sun but is extremely drought tolerant once established.

**Origin:** Native to southern Ukraine, southeast Russia, Iran, Kazakhstan and Mongolia.

**History:** It was accidentally introduced in the United States during the late 1800s via alfalfa seed.

**Impacts:** Russian knapweed competes with and displaces native species creating dense stands and reducing forage values on rangeland. It is allelopathic, which means it contains a toxic substance that inhibits the growth of competing plants. This weed is toxic to horses when consumed in large amounts over a period of weeks, causing chewing disease or other neurological conditions, possibly resulting in death.



*Mature flowering Russian knapweed plant.*



*Close-up of the solitary flowerhead at the end of a branch.*



## Russian knapweed

## *Acroptilon repens*

**Life Cycle:** A deep-rooted perennial that spreads by seeds and aggressive creeping, horizontal roots called rhizomes. Roots grow several feet deep, branching to form an extensive root system. The plants die back in the winter and begin growing again in the early spring when temperatures stay just above freezing.

**Stem:** Plants can grow up to 3 ft. tall. Stems are erect and branched covered with gray hairs.

**Flowers:** Flower heads are urn-shaped, approximately 0.5 in. in diameter with pink to purple flowers. Flowers turn a straw color as they mature. There is one flower head at the end of each branch and smooth, papery scales surround the flowers.

**Leaves:** The lower leaves are oblong and 2 to 5 in. long, while the upper leaves are narrow, oval-shaped, 0.5 to 1.5 in. long.

**Fruit:** Fruits are ivory colored and hairy, dispersing at maturity. Plants produce a small number of viable seeds but germination of new seedlings is uncommon. Seeds are short-lived in the soil, surviving at most for 3 years.



*Russian knapweed foliage.*



*Russian knapweed urn-shaped flowerheads surrounded by papery scales.*

## Russian knapweed

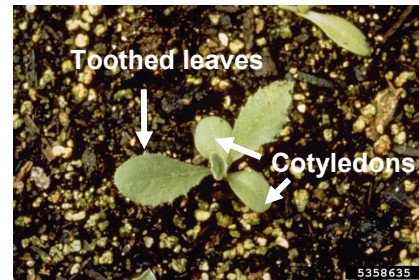
## *Acroptilon repens*



*Russian knapweed rosette.*



*Close-up of the stem and leaves, showing characteristic woolly hairs on the stem.*



*Russian knapweed seedling; first leaves (cotyledons) are round with first true leaves oblong and toothed.*

### Non-chemical Control:

Mechanical	Hand-pulling stimulates the stands to send out new root shoots. Mowing multiple times through a growing season can suppress stands, but can also stimulate new growth from root system.
Cultural	Livestock usually avoid grazing Russian knapweed because of its bitter taste. Burning is not an effective control method but can remove dead plant material buildup on the soil surface. Crops with dense canopies that shade out the weed can suppress it.
Biological	The gall midge, <i>Jaapiella ivannikovi</i> , lays eggs in the shoot tips of Russian knapweed, forming galls that reduce flowering and seed production. This will stress the stand of Russian knapweed but will not eliminate it. It is not yet available to the public in Colorado.

## Spotted knapweed

*Centaurea stoebe*

### List B Species

**Family:** Asteraceae

**Range:** Most of the US except for parts of the southeast US and central Canada.

**Habitat:** Commonly found in areas with high disturbance including roadsides, pasture/rangeland, sandy soils, and logged areas. Prefers light, well-drained soils but can tolerate moist areas, making it a very versatile invader.

**Origin:** Native to Europe and Asia Minor.

**History:** Diffuse knapweed was accidentally introduced into the USA in the late 1800's through seed or ballast from a ship.

**Impacts:** Spotted knapweed is highly competitive with native vegetation. It can reduce livestock and wildlife forage by outcompeting and excluding desirable species. Spotted knapweed has been shown to occasionally hybridize with diffuse knapweed.



*Mature flowering spotted knapweed plant (both pictures).*





## Spotted knapweed

*Centaurea stoebe*

**Life Cycle:** A bushy biennial or short-lived perennial with a deep taproot that spreads by seed or vegetatively by lateral roots. Newly germinated plants form rosettes in the winter or early spring and can persist as rosettes for several years. Once the growing conditions are favorable, the plant bolts, flowers, sets seed and dies.

**Stem:** Plants can grow up to 3 ft. tall and develop erect, highly branched stems.

**Flowers:** Flowering occurs from June to October. The urn-shaped flowerheads produce flowers that are pink to purple, or rarely white. A distinguishing characteristic of spotted knapweed are the black-tipped, spiny scales (bracts) at the base of the flowers.

**Leaves:** Leaves are covered with short grayish hairs. Rosette leaves are deeply lobed and up to 6 in. long. Leaves on the stem are larger and deeply lobed near the bottom becoming smaller and less lobed up the stem.

**Fruit:** As the flowerheads mature and dry out, they pop open, ejecting the fruits which have short bristles on top. Seeds can remain viable for 8 years in the soil and different germination patterns occur— germination with or without dormancy and germination with or without light.



*Spotted knapweed seedling.*



*Close-up of deeply lobed leaves.*

## Spotted knapweed

## *Centaurea stoebe*



Spotted knapweed rosette.



Flowers surrounded by the characteristic black-tipped bracts.



Close-up of spotted knapweed leaves and stem.

### Non-chemical Control:

Mechanical	Hand-pulling or digging can be effective if done before seed set. The entire taproot needs to be removed or the plant can grow back. Mowing can reduce seed production but if done too early the plant will recover and set seed and mowing too late can disperse seed.
Cultural	Grazing is not an effective strategy as diffuse knapweed is not generally palatable to livestock. Fire has been shown to decrease infestations while stimulating grass regrowth.
Biological	Root and seedhead weevils ( <i>Cyphocleonus Achates</i> and <i>Larinus minutus</i> ) used for diffuse knapweed control have also shown to be effective on spotted knapweed. Expect 3 to 5 years for results. For more information contact the Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.

# Knapweeds

## Chemical Control:

Aminocyclopyrachlor (Method)	4 to 8 oz/acre	<p>Timing: Preemergence or Post-emergence from seedling to mid-rosette.</p> <p>Remarks: Do not apply in the root zone of trees and shrubs. Not yet labeled for use in grazed sites. Higher rates can injure cool season grasses.</p>
Aminopyralid (Milestone)	Rate: 5 to 7 oz./acre	<p>Timing: Preemergence to Post-emergence from rosette to bolting stage or fall rosette application.</p> <p>Remarks: Aminopyralid is one of the most effective herbicides for knapweeds. Can injure some desirable broadleaf species. Other premix formulations can be used: Opensight (aminopyralid + metsulfuron) and GrazonNext (aminopyralid + 2,4-D).</p>
Chlorsulfuron (Telar)	Rate: 1 to 2.6 oz./acre	<p>Timing: Post-emergence at flower bud to flowering stage, or to fall rosettes.</p> <p>Remarks: *Only known to be effective for Russian knapweed control. Can be applied to waters edge. Can be applied with aminocyclopyrachlor (Method).</p>
Clopyralid (Transline)	<p>Rate: 0.67 to 1.33 pt./acre</p> <p>*1 to 1.33 pt./acre for Russian knapweed</p>	<p>Timing: Post-emergence spring or fall rosettes or up to bud stage.</p> <p>Remarks: Best applied to rapidly growing weeds. Can injure some Asteraceae or Fabaceae species but is safe around trees.</p>
Picloram (Tordon 22k)	Rate: 1 to 2 pt./acre	<p>Timing: Preemergence to Post-emergence from rosette to mid-bolting or fall rosettes.</p> <p>Remarks: Restricted use product. Broad spectrum herbicide with long soil residual activity. Most broadleaf plants are susceptible to picloram. Do not apply near trees or water.</p>



## Oxeye daisy

## *Leucanthemum vulgare*

### List B Species

**Family:** Asteraceae

**Range:** Throughout North America including all western states.

**Habitat:** Found in disturbed sites, mountain meadows, pastures, gardens, streambanks, and grasslands. Can spread from disturbed areas to healthy rangeland. Often grows on poor soil, but can thrive in a wide-variety of soil types including moist clay soils. Can grow in sun to partial shade. Typically found in high elevation sites, up to 11,000 feet, in Colorado.

**Origin:** Native to Europe.

**History:** Introduced as a seed contaminant and as an ornamental. Has been widely cultivated for ornamental use, but escaped cultivation and spread.

**Impacts:** Oxeye daisy forms dense clumps which crowd out desirable vegetation. Heavy infestations can reduce nutrient cycling and create areas of bare soil. Livestock generally do not graze the plants and milk from dairy cows who have consumed the plant can taste tainted. Plants can carry several crop diseases including the yellow dwarf potato virus.



*Mature oxeye daisy plant.*  
Photo Credit: Shelly L. Simmons



*Close up of oxeye daisy flowers with one flower occurring on each stem.*

## **Oxeye daisy**

## ***Leucanthemum vulgare***

**Life Cycle:** A short-lived, clumping perennial that can spread by seed but mainly spreads through creeping, shallow roots or root fragments that can regenerate into new plants. Plants die back to their roots in the winter and new growth occurs in early spring.

**Stem:** Plants grow 10 in. to 2 ft. tall with erect, hairless stems.

**Flowers:** Flowering occurs from June to September. The daisy-like flowers are 1 to 3 in. in diameter with white petals and a yellow center. The flowers are solitary, with only one flower occurring on the end of each stalk.

**Leaves:** The lower leaves are spoon or oval-shaped, toothed with a long leaf stem (the stalk that joins the leaf to the stem). The upper leaves are narrow, toothed and clasp around the stem. The leaf blades have coarse, rounded teeth. Upper leaves are also shorter and do not have a leaf stem.

**Fruit:** One flowerhead can produce up to 200 small (0.08 in. long) seeds. Seeds can be dispersed in water, soil and through animal movement. Many seeds are distributed in commercial “wildflower” mixes—always read the label prior to planting.



*Oxeye daisy leaves and stems.*



*Close-up of oxeye daisy leaf.*

## Oxeye daisy

## *Leucanthemum vulgare*



Oxeye daisy rosette.



Oxeye daisy flowerhead.



Oxeye daisies have an extensive root system.

### Non-chemical Control:

Mechanical	Small patches can be removed through hand-pulling repeatedly for several years. Mowing can reduce seed set but will not control the plant so it must be combined with another control method. Repeated, deep cultivation can help reduce populations although shallow cultivation can spread root fragments.
Cultural	Cattle tend to avoid grazing oxeye daisy although other livestock will graze plants. Grazing alone will not control populations. Burning is not effective.
Biological	No known biocontrol agents are available for control of oxeye daisy, especially due to its similarity to cultivated flowers such as chrysanthemums.

## Oxeye daisy

---

### Chemical Control:

Aminopyralid (Milestone)	Rate: 4 to 7 oz./acre	<p>Timing: Preemergence and seedling control in winter to early spring; Post-emergence up to flower bud stage.</p> <p>Remarks: Can injure some desirable broadleaf species but is more selective than picloram. Do not apply in tree root zone. Other premix formulations can be used: Opensight (aminopyralid + metsulfuron) and GrazonNext (aminopyralid + 2,4-D).</p>
Clopyralid (Transline)	Rate: 0.67 to 1.33 pt./acre	<p>Timing: In spring up to the flower bud stage.</p> <p>Remarks: Shorter soil residual than aminopyralid. Can injure some Asteraceae or Fabaceae species but is safe around trees.</p>
Metsulfuron (Escort)	Rate: 0.5 to 1 oz/acre	<p>Timing: Post-emergence to young, rapidly growing plants in the spring before flowering, or fall to new rosettes.</p> <p>Remarks: Metsulfuron is a selective herbicide and has some soil residual. Other premix formulations can be used: Opensight (aminopyralid + metsulfuron) and Cimarron Xtra (metsulfuron + chlorsulfuron).</p>
Picloram (Tordon, Picloram 22k)	Rate: 1 to 2 pt./acre	<p>Timing: Post-emergence when plants are actively growing before flowering, or to fall rosettes.</p> <p>Remarks: Restricted use product. Broad spectrum herbicide with long soil residual activity. Most broadleaf plants are susceptible to picloram, especially at the higher rate. Do not apply near trees or water. Can be tank mixed with dicamba (Banvel) or 2,4-D.</p>



## Houndstongue

*Cynoglossum officinale*

### List B Species

**Family:** Boraginaceae

**Range:** Most of the US and Canada, except for parts of the south and southeastern US. Occurs in all western states.

**Alternate Names:** Houndstongue hawkweed, gypsy flower, sticktight.

**Habitat:** Inhabits disturbed sites, roadsides, ditchbanks, pasture/rangeland, sand dunes, abandoned crop fields, and forest edges. Often found on moist, shady sites in sandy or gravelly alkaline soil. Areas with over 10% bareground are much more vulnerable to invasion.

**Origin:** Native to Eurasia.

**History:** Houndstongue was introduced to the US in the late 1800's as a seed contaminant in cereal grains.

**Impacts:** Houndstongue has greater impacts in rangeland and forested areas where it can form dense stands, crowding out desirable vegetation. The leaves and fruits contain pyrrolizidine alkaloids which are liver toxins in livestock, especially horses. Livestock generally do not graze houndstongue, but poisoning can occur when ingested from infested hay.



*Second-year flowering houndstongue plant.*



*Houndstongue mature plants.*

## Houndstongue

## *Cynoglossum officinale*

**Life Cycle:** A biennial or short-lived perennial with erect stems that reproduces solely by seed. The first year's growth is vegetative and the plant stores carbohydrates in the deep taproot which becomes black and woody. In the second year, the plant produces flowers and sets seed.

**Stem:** Plants can grow up to 4 ft. tall with erect, unbranched stems that are coarse and hairy.

**Flowers:** Flowering occurs from May to July. Plants produce reddish-purplish flowers that are about 0.25 in. wide and slightly drooping. Flowers have five rounded petals and several occur on the upper portion of the stems.

**Leaves:** The leaves can be 4 to 12 in. long and 1 to 3 in. wide and are oblong shaped with narrower leaves occurring towards the top of the plants. Leaf edges are smooth with sharply pointed tips. Leaves are covered in long, soft white hairs appearing dusty.

**Fruit:** Plants produce seed pods known as nutlets that occur in groups of four. Nutlets are 0.5 in. long and brown with short, hooked prickles which are similar to Velcro and cling to fur and clothing. Seeds mostly stay attached to the plant, even for several years after the plant dies. Plants can produce up to 2,000 seeds.



*Close-up of nutlets in groups of four.*



*Reddish-purple flowers with five rounded petals.*

# Houndstongue

# *Cynoglossum officinale*



*Houndstongue rosettes.*



*Houndstongue flowers occurring up the top portion of the stems.*



*Houndstongue seedling.*

## Non-chemical Control:

Mechanical	Hand-pulling or digging is effective, but digging below the ground and taking part of the root is necessary to prevent regrowth. Mowing second year plants during flowering can greatly reduce seed production. Tillage can reduce populations, but must be done frequently as many first year plants can withstand tillage.
Cultural	Grazing is not an option due to the plant toxins. Seeding with competitive grasses can provide competition against houndstongue and reduce populations. Fire has not been shown to be effective.
Biological	A root-mining weevil, <i>Mogulones cruciger</i> , has been successful in Canada and introduced in Montana, but has not yet been approved for release in Colorado. For more information contact the Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.

# Houndstongue

## Chemical Control:

2,4-D (Several trade names)	Rate: 4 pt./acre	<p>Timing: Post-emergence when plants are actively growing. Spring applications provide the best control.</p> <p>Remarks: Selective to broadleaf species so can be safely used in areas with desirable grass. Can be tank mixed at 1 qt. of 2,4-D with 1 oz. of metsulfuron (Escort) or chlorsulfuron (Telar) for increased control.</p>
Aminocyclopyrachlor (Method)	4 to 8 oz/acre	<p>Timing: Preemergence or Post-emergence.</p> <p>Remarks: Do not apply in the root zone of trees and shrubs. Not yet labeled for use in grazed sites. Higher rates can injure cool season grasses.</p>
Chlorsulfuron (Telar)	Rate: 1 to 1.5 oz./acre	<p>Timing: Preemergence or Post-emergence. Spring applications are more effective.</p> <p>Remarks: Can be applied to waters edge. Pre-mixed formulations can be used for increased control: Cimarron Plus (metsulfuron + chlorsulfuron) at 2 oz/acre, Landmark (sulfometuron + chlorsulfuron) at 0.75to 2.25 oz/acre.</p>
Metsulfuron (Escort)	Rate: 1 oz./acre	<p>Timing: Early Post-emergence. Spring applications are more effective.</p> <p>Remarks: Pre-mix formulations that include metsulfuron can provide increased control: Opensight (metsulfuron + aminopyralid) at 2.5 to 3.3 oz/acre, Cimarron Plus (metsulfuron + chlorsulfuron) at 2 oz/acre.</p>



## Dame's rocket

*Hesperis matronalis*

### List B Species

**Family:** Brassicaceae

**Range:** Most of US and Canada, except for parts of the south and southeastern US.

**Habitat:** Commonly found in semi-dry, partially shaded areas including gardens, pasture/rangeland, roadsides, woodlands, forests, and disturbed sites. Prefers fertile, loamy soil.

**Origin:** Native to Eurasia.

**History:** Introduced to North America in the 1600's as an ornamental plant.

**Impacts:** Damesrocket quickly escapes cultivation in gardens due to its prolific seed production. Many people think damesrocket is a native wildflower and seeds can be found in wildflower mixes. Be sure to check the contents of wildflower seed mixes before planting. It can outcompete native species and form dense monocultures. Plants also serve as a host to many viruses that are harmful to plants in the cruciferous family, including cauliflower, cabbage and broccoli.



*Mature flowering Dame's rocket plant.*



*Close-up of dame's rocket flowers.*

## Dame's rocket

## *Hesperis matronalis*

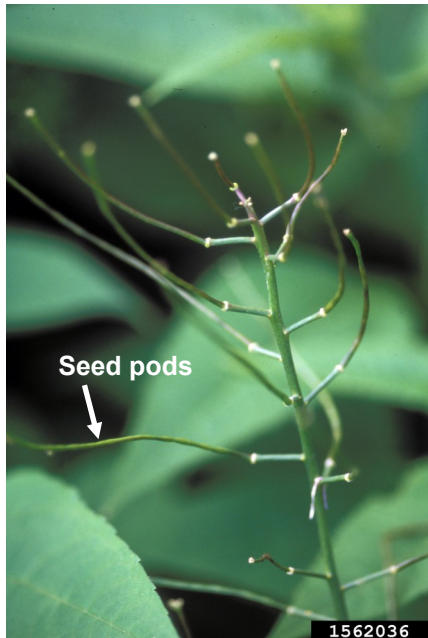
**Life Cycle:** An herbaceous biennial or short-lived perennial that reproduces solely by seed. Plants grow as rosettes in the first year, bolting and producing flowers in the second year. The root system is shallow.

**Stem:** Plants can grow up to 4 ft. tall with erect, hairy stems that branch at the top.

**Flowers:** Flowering occurs from May to August. Plants produce showy, fragrant white-to-purple flowers with four petals. Flowers develop in clusters at the ends of plant stalks.

**Leaves:** Leaves are slightly hairy and 2 to 4 in. long. Leaves are oval to oblong shaped with pointed ends and toothed edges.

**Fruit:** Plants produce long, narrow and cylindrically shaped seed pods that contain the seeds. The seeds are small and dark reddish brown. The seed pods are about 1.5 in. long and very narrow.



*Dame's rocket fruit.*



*Dame's rocket stem.*

## Dame's rocket

*Hesperis matronalis*



*Dame's rocket rosette.*



*Dame's rocket foliage showing lance (oblong with point) shaped leaves.*



*Mature seed pods.*

### Non-chemical Control:

Mechanical	Hand-pulling or digging is effective for small populations; need to remove root. Plants can regrow after mowing. Mowing can reduce seed production but needs to be done for 2-5 years. Tillage can reduce populations but plants are likely to re-sprout after. Needs to be repeated throughout growing season.
Cultural	No information is available on grazing although it is most likely ineffective as livestock generally do not seek out plants. Fire can provide control of dame's rocket seedlings, but established plants will usually re-sprout.
Biological	No known biological control agent is available.

## Dame's rocket

---

### Chemical Control:

Chlorsulfuron (Telar)	Rate: 1 to 2.6 oz./acre	Timing: Post-emergence from rosette to bolting stage.  Remarks: Can be applied to waters edge but not to water. Has long soil residual activity. Can be applied with 2,4-D for quicker burndown.
Imazapic (Plateau, Panoramic)	Rate: 9 to 10 oz./acre	Timing: Post-emergence in the late flower growth stage (late spring to fall).  Remarks: Some soil residual activity. Higher rates may injure some grass and broadleaf species. Premix formulations can be used for increased control: Journey (imazapic + glyphosate).
Metsulfuron (Escort)	Rate: 1 to 2 oz./ acre	Timing: Post-emergence from rosette to bolting stage.  Remarks: Has some soil residual activity. Can be applied with 2,4-D for quicker burndown. Other premix formulations can be used: Cimarron Max (metsulfuron + dicamba + 2,4-D) and Cimarron Xtra (metsulfuron + chlorsulfuron).
Triclopyr (Remedy Ultra, Garlon 3A, Garlon 4A Ultra)	Rate: 1.25 lb a.e./acre (be sure to read label as many formulations exist)	Timing: Post-emergence from rosette to bolting stage.  Remarks: More effective on smaller plants. Use with caution in warm temperatures as herbicide can volatilize and cause off-target damage.



## Hoary cress

*Cardaria draba*

### List B Species

**Family:** Brassicaceae

**Range:** Most of US and Canada, except for parts of the southeastern US. Primarily problematic in the western US.

**Alternate Names:** whitetop, heart-podded hoarycress

\*Hoary cress is very difficult to distinguish from lenspod whitetop (*Cardaria chalepensis*) so characteristics presented here apply to both species.

**Habitat:** Inhabits disturbed sites, roadsides, ditchbanks, pasture/rangeland, streambanks, riparian areas, and agricultural fields. Often on moist, alkaline to saline soils, but can tolerate a range of soil types and moisture conditions.

**Origin:** Native to central Europe and western Asia.

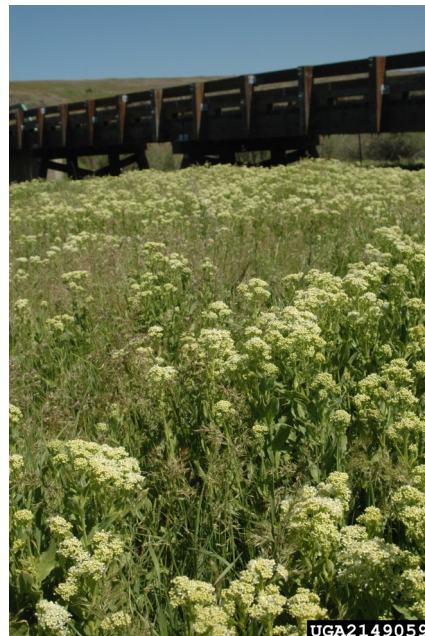
**History:** Hoary cress was introduced to the US in the 1800's possibly as an ornamental.

**Impacts:** Hoary cress can form dense monocultures that displace desirable vegetation and greatly reduce grazing quality. Once established, it can be very difficult to control.



*Flowering hoary cress plant.*

*Photo Credit: CDA*



*Dense hoary cress infestation.*

## Hoary cress

## *Cardaria draba*

**Life Cycle:** An erect perennial can spread by seed, but primarily spreads vegetatively through an extensive system of horizontal and vertical roots. Roots can reach depths of over 10 ft. and form clonal colonies. Foliage dies back in the winter but roots survive.

**Stem:** Plants can grow up to 2 ft. tall with erect, branching stems that are covered with short hairs.

**Flowers:** Flowering occurs from May to June. Plants contain numerous small, white, fragrant flowers with four petals approximately 1/8 in. long.

**Leaves:** The leaves are gray-green and variable in shape but some may appear heart-shaped or arrowhead shaped. Leaves alternate on the stem and are 0.5 to 4 in. long by 0.1 to 1.5 inches wide.

**Fruit:** Plants produce tiny seed pods that are heart-shaped with two small, reddish-brown seeds. One plant can produce 1,200 to 4,800 seeds which are set by mid-summer.



Close-up of stem and leaves.



Hoary cress plant showing extensive root system.

## Hoary cress

## *Cardaria draba*



*Hoary cress four-petaled flowers with heart-shaped seed pod below.*



*Hoary cress rosette.*



*Hoary cress seedling.*

### Non-chemical Control:

Mechanical	Due to its extensive root system, hand-pulling or digging is ineffective. Mowing with competitive cropping can reduce infestations, along with decreasing irrigation and grazing pressure. Mowing combined with herbicides can increase efficacy.
Cultural	Sheep and goats will eat hoary cress, although grazing is not an effective strategy due to the extensive root system. Glucosinolates in plants can form toxic compounds in cattle. Fire is not effective and can promote regrowth. Flooding with 6 to 10 in. of water for >2 months can be highly effective.
Biological	Biological control agents are not available for any of the <i>Cardaria</i> species.



## Perennial pepperweed

*Lepidium latifolium*

### List B Species

**Family:** Brassicaceae

**Range:** Primarily the western US and Canada, except North and South Dakota.

**Alternate Names:** tall whitetop, broadleaved pepperweed

**Habitat:** Invades many different areas and habitats, including wetlands, riparian areas, meadows, salt marches, flood plains, roadsides, irrigation ditches, and crop fields. Typically found on moist or seasonally wet sites.

**Origin:** Native to Eurasia.

**History:** Introduced in the early 1900's as a contaminate in sugar beet seed.

**Impacts:** Perennial pepperweed is very problematic in wetlands. It can form dense monocultures that increase over time, crowding out native vegetation and wildlife. Roots do not hold soil together well and can cause erosion on river and ditch banks. Plants can extract salt from deep in the soil bringing it to the surface, inhibiting germination and growth of salt sensitive species.



*Mature flowering perennial pepperweed plant.*



*Large, dense perennial pepperweed infestation.*



## **Perennial pepperweed**

*Lepidium latifolium*

**Life Cycle:** An erect perennial that can spread by seed but primarily spreads vegetatively through an extensive system or root fragments. Plants die back in late fall to early winter and rosettes develop in early spring from thick branched roots or above-ground parts of the plant. Stems elongate in the spring and produce flowers.

**Stem:** Plants can grow up to 6 ft. tall and have numerous semi-woody stems.

**Flowers:** Flowering occurs from late spring to summer. Flowers have four spoon-shaped petals in dense, rounded clusters existing on the branch tips of erect stems.

**Leaves:** The leaves are hairless, green to gray-green often dusted with powdery white from a rust fungus. Leaves are oblong shaped with serrated edges that are slightly wavy, with lower leaves up to 1 ft. long and 4 in. wide.

**Fruit:** Plants produce a round to oval, hairy capsule 0.06 in. in diameter containing one tiny reddish-brown seed. Perennial pepperweed is a prolific seed producer although seeds do not remain viable in the soil for extended periods of time.



*Close-up of stem and leaves.*



*Perennial pepperweed plant and root system.*

## Perennial pepperweed

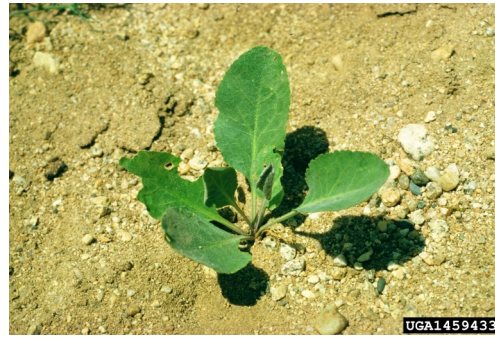
*Lepidium latifolium*



*Perennial pepperweed rosette.*



*Perennial pepperweed flowers.*



*Perennial pepperweed seedling.*

### Non-chemical Control:

Mechanical	Due to its extensive root system, hand-pulling or digging is ineffective. Tillage can increase infestations by dispersing root fragments. Mowing causes plants to re-sprout and produce new growth, although it removes thatch and breaks down stems. Mowing combined with herbicides is an effective control strategy.
Cultural	Livestock will readily graze rosettes in the spring and can suppress infestations when kept on a pasture throughout the growing season. Burning is ineffective. Flooding for long time periods (around 6 months) can significantly reduce populations.
Biological	Biological control agents are being evaluated for use on perennial pepperweed, but none are currently available.

## Hoary cress and perennial pepperweed

---

### Chemical Control:

Chlorsulfuron (Telar)	Rate: 1 to 2.6 oz./acre	Timing: Post-emergence from seedling to flowering stage. Most effective at flower-bud or flowering stage.  Remarks: Can be applied to waters edge but not to water. Has long soil residual activity. Can be applied with 2,4-D for quicker burndown.
Imazapic (Plateau, Panoramic)	Rate: 8 to 12 oz./acre	Timing: Post-emergence from seedling to flowering stage. Most effective at flower-bud or flowering stage.  Remarks: Some soil residual activity. Higher rates may injure some grass and broadleaf species. Premix formulations can be used for increased control: Journey (imazapic + glyphosate).
Imazapyr (Arsenal, Habitat, Stalker, Chopper, Polaris)	Rate: 1 to 2 qt./ acre	Timing: Post-emergence from seedling to flowering stage. Most effective at flower-bud or flowering stage.  Remarks: Non-selective herbicide; in areas with desirable vegetation use spot treatment. Has long soil residual activity. Habitat is registered for aquatic use and can be applied both near and to water.
Metsulfuron (Escort)	Rate: 1 to 2 oz./ acre	Timing: Post-emergence from seedling to flowering stage. Most effective at flower-bud to flowering stage.  Remarks: Has some soil residual activity. Can be applied with 2,4-D for quicker burndown. Other premix formulations can be used: Cimarron Max (metsulfuron + dicamba + 2,4-D) and Cimarron Xtra (metsulfuron + chlorsulfuron).

## Russian-olive

## *Elaeagnus angustifolia*

### List B Species

**Family:** Eaeagnaceae

**Range:** Throughout most of the US except for the southeast.

**Habitat:** Found in riparian areas, floodplains, grasslands, roadsides, seasonally moist pastures, irrigation ditches and disturbed sites. Grows under a wide range of environmental conditions including clay, sandy, alkaline and saline soils. Tolerates a wide variety of conditions including drought, high water tables, hot and cold temperatures.

**Origin:** Native to temperate regions of Asia.

**History:** Introduced to the US as a landscape ornamental and a windbreak tree.

**Impacts:** Russian-olive trees can easily invade seasonally wet riparian areas and may eventually replace stands of native willows and cottonwoods. Trees can outcompete native plants by taxing the water table and disrupting nutrient cycling. Russian-olives have the ability to fix nitrogen in their roots so it can grow in a variety of conditions, overtaking riparian areas. Although birds do eat the fruits, most wildlife do not use the trees for habitat.



*Mature Russian-olive tree.*



*Russian-olive trunk.*



## Russian-olive

## *Elaeagnus angustifolia*

**Life Cycle:** A perennial, deciduous tree that reproduces primarily by seed, but can also reproduce by root suckers. The plant's extensive root system sprouts root suckers frequently.

**Stem:** Trees can grow up to 30 ft. tall and has twigs and branches with thorns 1 to 2 in. long. The twigs attached to the branches are flexible, reddish in color and can be smooth or coated in gray hairs.

**Flowers:** Flowering usually from May to June. The very fragrant flowers are four-petaled, light yellow and are 0.25 to 0.5 in. long and wide. Flowers are clustered on the end of branches.

**Leaves:** Leaves are elliptical-shaped and 2 to 4 in. long. The tops of the leaves are gray-green in color and covered in silvery hairs and scales. The leaf undersides are silvery gray and densely covered in silvery scales.

**Fruit:** Fruits are 0.5 to 1 in. long and have a fleshy outer layer containing one seed inside. Fruits usually stay on the trees until dispersed by animals. Seeds require a 2 to 3 months of a cool, moist period before they can germinate.



*Russian-olive foliage.*



*Mature Russian-olive fruit.*

## Russian-olive

## *Elaeagnus angustifolia*



*Russian-olive flowers.*



*Russian-olive fruits.*



*Russian-olive branch showing thorns.*

### Non-chemical Control:

Mechanical	Hand-pulling new seedlings can help prevent the spread of new trees. Cutting or bulldozing usually does not provide effective control as trees can easily re-sprout. Mechanical methods combined with herbicide are the most effective control efforts.
Cultural	Burning alone is not effective. Burning combined with herbicide application can increase control. Burning cut stumps can also provide effective control.
Biological	There are no approved biocontrol options available for Russian-olive in Colorado.

## Russian-olive

---

### Chemical Control:

<p>Glyphosate (Roundup; Rodeo or Aquamaster for aquatic use)</p>	<p>Rate: Undiluted 100% solution or 50% solution in basal bark oil.</p>	<p>Timing: Summer to fall. Fall treatments have shown less regrowth.</p> <p>Remarks: Cut-stump treatment– apply to the living part of the tree just inside the bark (cambial layer) immediately after the cut-stump treatment and to roots above the soil surface. Diluted solutions require regular agitation.</p>
<p>Imazapyr (Arsenal, Habitat)</p> <p>NOTE: Kochia is resistant to imazapyr</p>	<p>Rate: Broadcast foliar treatment: 0.5 to 1 lb a.e./acre. Spot foliar treatment: 1 to 4% v/v solution.</p>	<p>Timing: Summer to early fall.</p> <p>Remarks: Non-selective herbicide with long soil residual activity. Use spot treatments where desirable vegetation is present. Imazapyr has only been shown to give about 75% control of Russian-olive.</p>
<p>Triclopyr (Remedy Ultra, Garlon 3A, Garlon 4A Ultra)</p>	<p>Rate: 20-30% solution in basal bark oil.</p>	<p>Timing: Summer to fall. Fall treatments have shown less regrowth.</p> <p>Remarks: Cut-stump treatment– apply to the living part of the tree just inside the bark (cambial layer) immediately after the cut-stump treatment. Basal bark treatment– spray until wet but not dripping; target the root above the soil surface and up the trunk 12 to 15 in.</p>

## Leafy spurge

*Euphorbia esula*

### List B Species

**Family:** Euphorbiaceae

**Range:** Throughout most of North America except for the southeast.

**Habitat:** Found in disturbed sites, prairies, pastures, riparian areas, and roadsides. Can tolerate semi-arid to mesic conditions and can even tolerate flooding for 4 to 5 months. More commonly found in wetter sites.

**Origin:** Native to southern Europe.

**History:** Introduced to the US as a seed contaminant in the early 1800's.

**Impacts:** Leafy spurge is a major pest in places such as natural areas, nature preserves and national parks. Is adapted to a wide variety of habitats in the state. Infestations can completely overtake large areas of land and displace native vegetation. Plants produce a white, milky sap that can irritate eyes or sensitive skin. Leafy spurge can be toxic to cattle and horses, although they do not generally graze plants.



*Flowering leafy spurge plant.*



*Dense leafy spurge infestation.*



## Leafy spurge

## *Euphorbia esula*

**Life Cycle:** An erect, herbaceous perennial which forms an extensive system of creeping roots that form adventitious buds. New infestations are generally started by seed, but current infestations can expand vegetatively by budding from roots or by root fragments that regenerate into new plants.

**Stem:** Plants grow 2 to 3 ft. tall with a smooth, pale-green stem that produces milky sap when broken.

**Flowers:** Flowering usually occurs in June. The clustered flowers are very small and yellowish-green. They are enclosed by very visible, yellowish-green heart shaped bracts (or scales).

**Leaves:** Leaves are smooth, narrow and oblong to elliptical shaped, about 1 to 4 in. long. Leaves become shorter and more oval-shaped towards the top of the stem.

**Fruit:** One plant can produce up to 130,000 seeds. The three-sided seed capsules explode when mature, projecting seeds up to 15 ft. away from the parent plant. Seeds can be dispersed through human and animal movement, in water or as hay or seed contaminants. Seeds can remain viable in the soil for 8 years.



*Leafy spurge flowers surrounded by heart shaped bracts.*



*Leafy spurge foliage.*

## Leafy spurge

## *Euphorbia esula*



Leafy spurge flowers.



Leafy spurge stem showing milky sap.



Leafy spurge seedling and extensive roots.

### Non-chemical Control:

Mechanical	Small patches can be removed through repeatedly hand-pulling before seed production throughout the growing season for several years. Mowing is not an effective option.
Cultural	Goats and sheep grazed in the spring have been successfully used to reduce leafy spurge populations. Must take care not to overgraze area. Grazing combined with herbicide can be extremely effective. Burning is not an effective control strategy.
Biological	Three flea beetles <i>Aphthona nigriscutis</i> , <i>A. lacertosa</i> , <i>A. cyparissiae</i> are available for release in Colorado. These species have been very effective at reducing stem densities over large areas. For information contact the Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.

## Leafy spurge

### Chemical Control:

Aminocyclopyrachlor (Method) + chlorsulfuron (Telar)	Rate: 8 to 12 oz. of method/acre + 1 to 1.75 oz. of Telar/acre	Timing: In spring up to the flower bud stage or in fall rosette stage. Remarks: Do not apply in the root zone of trees and shrubs. Not yet labeled for use in grazed sites. Higher rates will suppress or injure some cool season grasses. For increased control, this combination can also be tank mixed with diflufenzopyr + dicamba (Overdrive) at 4 oz./acre.
Dicamba (Banvel, Clarity)	Rate: 1 to 2 qt./acre	Timing: Post-emergence in spring to early summer. Remarks: Dicamba is a broadleaf herbicide and will control many broadleaf species. May require yearly applications for up to three years. Can be tank mixed with 2,4-D at 1 qt/acre for increased control.
Quinclorac (Quinstar, several generics)	Rate: 12 to 24 oz./acre	Timing: Post-emergence at flowering or at fall when combined with other herbicides. Remarks: Very selective herbicide and very safe on most desirable species. For increased control, quinclorac can be tank mixed with diflufenzopyr + dicamba (Overdrive) at 4 oz./acre.
Picloram (Tordon, Picloram 22k)	Rate: 1 to 2 qt./acre	Timing: Post-emergence at true flower stage or in the fall. Remarks: Restricted use product. Broad spectrum herbicide with long soil residual activity. Most broadleaf plants are susceptible to picloram, especially at the higher rate. Do not apply near trees or water. Higher rate extends control significantly.

## White horehound

*Marrubium vulgare*

**Family:** Lamiaceae

**Range:** Most states, including all western states except possibly North Dakota.

**Alternate Names:** Common horehound, horehound, hairhound

**Habitat:** Found in disturbed sites, pastures, rangeland, open fields, roadsides, waste places and ditches. Generally found in dry areas. Very common in overgrazed pastures/ rangeland.

**Origin:** Native to southern Eurasia.

**History:** Originally introduced for cultivation. Historically horehound has been used for medicinal purposes, especially for respiratory ailments and used in hard candies as lozenges for sore throats.

**Impacts:** Horehound can significantly increase population sizes during periods of drought or in overgrazing situations. Infestations can outcompete desirable vegetation, forming dense stands. Livestock avoid grazing horehound due to its bitter taste. In disturbed sites void of other vegetation, plants can thrive and quickly form dense patches.



*White horehound foliage.*



*Close-up of white horehound foliage and flowers.*



## White horehound

## *Marrubium vulgare*

**Life Cycle:** A cool-season, herbaceous perennial which looks like a low shrub and forms a branched, woody taproot with numerous lateral roots. Plants reproduce only by seed.

**Stem:** Plants grow up to 2 ft. tall and have hairy, white-woolly stems that are thick and square. Stems are branched near the base.

**Flowers:** Flowering occurs during the summer months. Plants produce clusters of small, tubular white flowers along the upper part of the main stem.

**Leaves:** Leaves are oval to nearly round in shape, 0.5 to 2.5 in. long and toothed. The aromatic leaves are hairy and have a puckered appearance.

**Fruit:** Fruits are egg-shaped with a slightly rough texture and disperse usually in the late fall when the plant dies back. Seeds mainly fall to the ground near the parent plant but can be dispersed long distances by clinging to the fur or feathers of animals, or on clothing of people. It is suggested that seeds can remain viable in the soil for 7 to 10 years.



*Flower clusters that occur on the upper portion of the stem.*



*Close-up of the hairy, puckered leaves.*

## White horehound

## *Marrubium vulgare*



*White horehound plant.*



*White horehound young plant.*



*Close-up of white horehound flowers.*

### Non-chemical Control:

Mechanical	Small patches can be removed through repeatedly hand-pulling. Mowing before seed production can help restrict growth. Deep cultivation can provide good horehound control.
Cultural	Grazing alone will not reduce populations and overgrazing can cause the plant to spread. Grazing with herbicide applications can increase control. Burning alone is not an effective control option, although burning followed by herbicide can be very effective.
Biological	No biocontrol options are available in North America. Several moth species have been released in Australia, although further research is needed in the US on the safety and effectiveness of these species.

## White horehound

---

### Chemical Control:

2,4-D (Several trade names exist)	Rate: 1 to 4 pt./acre, 0.48 to 1.9 lb a.e./acre	Timing: Post-emergence to young, rapidly growing plants or in the fall to new rosettes.  Remarks: 2,4-D is selective to broadleaves and has no soil activity. Do not apply when temperatures are above 80°F. 2,4-D alone can have variable results. Efficacy can be increased by tank-mixing with another broadleaf herbicide such as picloram (Tordon), dicamba (Banvel, Clarity), or metsulfuron (Escort).
Dicamba (Banvel, Clarity)	Rate: 1 to 4 pt./acre, 0.5 to 2 lb a.e./acre	Timing: Post-emergence to young, rapidly growing plants or in the fall to new rosettes.  Remarks: Higher rates are needed for more mature plants, although higher rates can cause some injury to grasses. Can be tank-mixed with 2,4-D or metsulfuron (Escort).
Metsulfuron (Escort)	Rate: 0.2 to 1 oz./acre	Timing: Post-emergence to young, rapidly growing plants before flowering or in the fall to new rosettes.  Remarks: Has some residual and is relatively safe on grasses. Can be tank-mixed with 2,4-D or dicamba.
Picloram + 2,4-D (Graslan)	Rate: 2 to 4 pt./acre	Timing: Post-emergence when plants are actively growing or to fall rosettes.  Remarks: Restricted use pesticide. Do not apply near trees or water. Long soil residual.
Triclopyr (Remedy Ultra, Garlon 3A, Garlon 4A Ultra)	Rate: 1.25 lb a.e./acre (be sure to read label as many formulations exist)	Timing: Post-emergence when plants are actively growing.  Remarks: More effective on smaller plants. Use with caution in warm temperatures as herbicide can volatilize and cause off-target damage.

## Downy brome

## *Bromus tectorum*

### List C Species

**Family:** Poaceae

**Range:** Throughout the US and Canada, although most problematic in the western states.

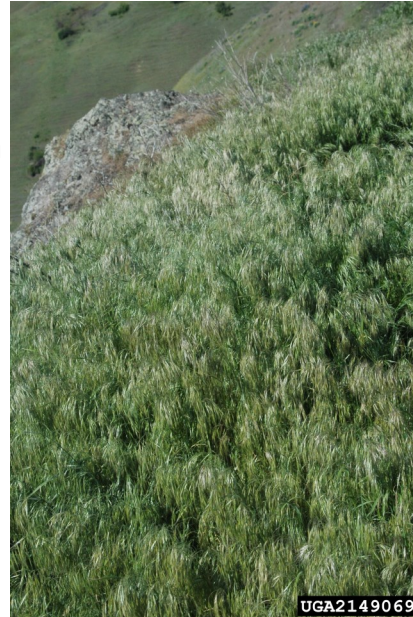
**Alternate Names:** cheatgrass

**Habitat:** Invades a wide variety of sites including rangeland/pasture, roadsides, disturbed sites, natural areas, forestry sites, orchards, sagebrush communities, desert shrub grasslands and crop fields. Favors sites with well-drained coarse soils where there is less competition with other vegetation, but can grow in a variety of soil types and moisture conditions.

**Origin:** Native to Eurasia.

**History:** Multiple accidental introductions to the US in the mid-1800's as shipping contaminants.

**Impacts:** Downy brome easily invades perennial systems in the west due to its different life cycle. Plants begin growing in the spring before native species break dormancy, depleting available moisture and nutrients. Large monocultures are easily formed and increase fire frequency in fire sensitive communities, decrease wildlife habitat, and impact desirable species abundance and forage availability.



UGA2149069  
*Flowering downy brome invasion in late spring.*



UGA2149074  
*Plants producing seed heads.*



## **Downy brome**

## ***Bromus tectorum***

**Life Cycle:** A winter annual grass which reproduces solely by seed. Seedlings germinate in late summer through late fall and overwinter as seedlings before growing and setting seed in late spring. Seedlings can also germinate in spring.

**Stem:** Plants can grow 0.3 to 2 ft. tall and stems are covered in short hairs. Stems are solitary or occur in a few stemmed tuft.

**Flowers:** Flowering occurs in late spring. Inflorescences (flowers) become reddish to purplish as they mature and then a tan-buff color when they fully mature. Flowers grow in clusters that can be 2.5 to 9 in. long at the end of the stem, drooping to one side.

**Leaves:** Leaf blades are flat, narrow and up to 8 in. long and 1/8 to 3/16 in. wide. Leaves are covered in short, fine hairs and have a membrane where the leaf attaches to the stem.

**Fruit:** At maturity the inflorescence (flowers) releases seeds that are contained in florets (small part of the flower). The florets are a buff-tan color, light and fluffy with sharp, pointed ends. These sharp points readily attach to fur and clothing to be dispersed. Seeds can remain viable in the soil for 2 to 5 years.



*Reddish-purple maturing seedheads.*



*Close-up of ligule on stem.*

## Downy brome

## *Bromus tectorum*



*Monoculture of mature, senescing (dying) downy brome.*



*Immature flowers (inflorescence).*



*Downy brome seedlings.*

### Non-chemical Control:

Mechanical	Hand-pulling small infestations can be effective before seeds mature. Mowing can reduce seed production and should be done after flowering, but before seeds are mature. Will need to be repeated as plants regrow. Deep tillage can reduce infestations but must be repeated as new seedlings emerge.
Cultural	Considered by some to be good livestock forage if perennial grass has been depleted. Intensive grazing in the early spring can reduce the number of plants that set seed. Burning is usually ineffective as it generally does not burn hot enough to kill seeds on the soil. Burning or grazing followed by herbicide application can increase control.
Biological	Several soil fungi ( <i>Pseudomonas</i> ) have been tested that may inhibit downy brome growth and germination, although none have proven effective.

## Japanese brome

## *Bromus japonicus*

**Family:** Poaceae

**Range:** Throughout the US and Canada, although most problematic in the western states.

**Alternate Names:** Japanese chess

**Habitat:** Invades a wide variety of sites including rangeland/pasture, roadsides, disturbed sites, natural areas, desert shrub-grasslands, sagebrush communities, pinyon-juniper communities, and cropland. Favors disturbed sites with dry, well-drained soil.

**Origin:** Native to Europe.

**History:** Introduced to the US as a forage species.

**Impacts:** Japanese brome easily invades disturbed, perennial systems in the west due to its winter annual life cycle. Plants begin growing in the spring before native species break dormancy, depleting available moisture and nutrients. Large monocultures are easily formed and increase fire frequency in fire sensitive communities, decrease wildlife habitat, and impact desirable species abundance and forage availability.



*Mature Japanese brome invasion in early summer.*

*Photo Credit: Shannon Clark, CSU*



*Japanese brome in late spring, just starting to produce seeds.*

*Photo Credit: Shannon Clark, CSU*



## Japanese brome

## *Bromus japonicus*

**Life Cycle:** A winter annual grass which reproduces solely by seed. Seedlings germinate in late summer through late fall and overwinter as seedlings before growing and setting seed in late spring. Seedlings can also germinate in spring.

**Stem:** Plants generally grow 1 to 2 ft. tall and stems are covered in dense, soft hairs. Stems occur in a few stemmed tuft.

**Flowers:** Flowering occurs in late spring. Inflorescences (flowers) become a tan-buff color when they fully mature. Flowers grow in clusters of 4 to 10 florets (small part of the flower) that can be 3 to 8 in. long at the end of the stem and nodding.

**Leaves:** Leaf blades are flat, 3 to 8 in. long and approximately 0.5 in. wide. Leaves are covered in soft hairs and have a 1/8 in. long membrane where the leaf attaches to the stem (see photo).

**Fruit:** At maturity the inflorescence (flowers) releases seeds that are contained in florets (small part of the flower). The florets are a buff-tan color, light and fluffy with straight to bent/twisted ends (awns). These sharp awns readily attach to fur and clothing to be dispersed. Seeds can remain viable in the soil for 2 to 5 years.

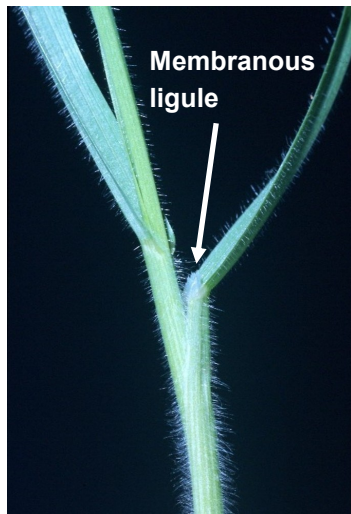


Photo Credit: Mark Renz. Robert W. Freckmann Herbarium. U. of Wisconsin-Stevens Point



Photo Credit: Mark Renz. Robert W. Freckmann Herbarium. U. of Wisconsin-Stevens Point



## Japanese brome

## *Bromus japonicus*



*Immature inflorescence (flowers) in late spring. Inflorescence will later mature and set seed.*

*Photo Credit: Nicole Kimmel, Alberta Agriculture & Forestry*



*Maturing seedheads.*

*Photo Credit: Václav Dvořák on BioLib.cz*



*Base of Japanese brome plant.*

*Photo Credit: Russ Kleinman, Bill Norris & Richard Felger*

### Non-chemical Control:

Mechanical	Hand-pulling small infestations can be effective before seeds mature. Mowing can reduce seed production and should be done after flowering but before seeds are mature. Will need to be repeated as plants regrow. Deep tillage can reduce infestations but must be repeated as new seedlings emerge.
Cultural	Considered by some to be good livestock forage if perennial grass has been depleted. Intensive grazing in the early spring can reduce the number of plants that set seed. Burning is usually ineffective as it generally does not burn hot enough to kill seeds on the soil. Burning or grazing followed by herbicide application can increase control.
Biological	No known biocontrol agents are available.

## Downy brome and Japanese brome

### Chemical Control:

<p>Imazapic (Plateau, Panoramic)</p>	<p>Rate: 4 to 10 oz./acre</p>	<p>Timing: Preemergence in late summer or fall, or early Post-emergence in late winter before tiller.</p> <p>Remarks: Higher rates can cause injury to grasses. Use low rate in dry climates and low litter sites and high rate in wetter areas or high litter.</p>
<p>Indaziflam (Esplanade)</p>	<p>Rate: 5 to 7 oz./ acre</p>	<p>Timing: Preemergence in early to mid summer (1 to 2 months before germination), or Post-emergence with glyphosate in fall to early spring.</p> <p>Remarks: Very safe on perennial grasses, forbs and shrubs. Long soil residual. Not yet labeled for grazed sites. Use higher rate in areas with high litter. For increased control the first year apply Post-emergence in a tank-mix with glyphosate or rimsulfuron (Matrix). Can provide control for up to three years.</p>
<p>Glyphosate (Roundup, Accord XRT II, and several others)</p>	<p>Rate: 0.5 to 1 lb a.e./acre</p>	<p>Timing: Post-emergence in late winter to early spring before flowering.</p> <p>Remarks: Non-selective herbicide so must be applied during winter dormancy of desirable species or by spot treatment. No soil activity; good option if reseeding is planned for site. Can be tank-mixed with imazapic (Plateau), indaziflam (Esplanade) for increased control.</p>
<p>Rimsulfuron (Matrix)</p>	<p>Rate: 2 to 4 oz./ acre</p>	<p>Timing: Preemergence in late summer or Post-emergence in early spring.</p> <p>Remarks: Provides soil residual control. Can cause injury when applied to actively growing grasses. Can be tank-mixed with indaziflam (Esplanade) or imazapic (Plateau) for increased control.</p>

## **Jointed goatgrass**

*Aegilops cylindrica*

### **List B Species**

**Family:** Poaceae

**Range:** Many parts of the US including all western states.

**Habitat:** Invades a wide variety of sites including grasslands, wheat fields, fence rows, roadsides, waste sites, alfalfa fields, and pasture/rangeland. Favors areas with long growing season, precipitation and cool weather.

**Origin:** Native to Mediterranean Europe and western Asia.

**History:** First introduced into the US in the 1800's as a contaminant in winter wheat seed, although multiple introductions occurred over time.

**Impacts:** Jointed goatgrass can quickly form monocultures, overtaking desirable vegetation by depleting available moisture and nutrients. High silica content in dead tissue (thatch) can persist on the soil surface suppressing other species. Very problematic in winter wheat fields and can cause long-term economic losses.



*Mature plants starting to dry out and die in the field.*



*Plants producing seed heads.*

## **Jointed goatgrass**

*Aegilops cylindrica*

**Life Cycle:** A winter annual grass which reproduces solely by seed. Seedlings germinate in late summer through late fall and overwinter as seedlings before growing and setting seed in late spring to early summer.

**Stem:** Plants grow up to 2.5 ft. tall and can have single or multiple stems (tillers) and fine hairs where the leaf blades attach to the stem.

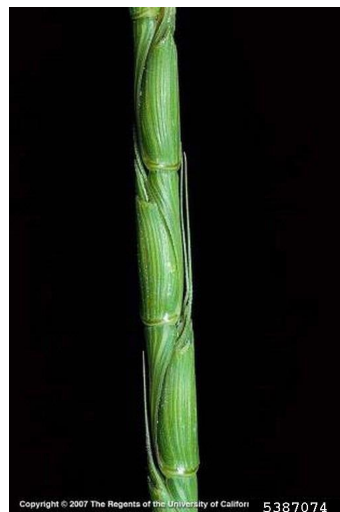
**Flowers:** Flowering occurs in late spring to early summer (May-June) when the plants produce red or straw-colored spikes. Spikes are cylindrical and contain 2 to 12 spikelets per spike.

**Leaves:** The foliage looks similar to winter wheat but leaf blades have evenly-spaced, fine, short hairs that are perpendicular to the blade. Leaf blades are 1/8 to 1/4 in. long.

**Fruit:** Spikelets are 1 to 5 in. long and large, hard and cylindrical with long awns. At maturity the seedheads turn reddish and then straw-colored and break into individual segments. Seeds can remain viable in the soil for 3 to 5 years. Can hybridize with winter wheat, although the seeds of the hybrid are almost always sterile.



*Close-up of stem showing fine hairs.*



*Close-up of joints on seedhead (spike).*



## Jointed goatgrass

*Aegilops cylindrica*



Comparison of winter wheat seedheads (left) to jointed goatgrass seedheads (right).



Seedheads at maturity.



Jointed goatgrass seedlings.

### Non-chemical Control:

Mechanical	Hand-pulling small infestations can be effective if the roots are completely pulled. Mowing can reduce seed production and should be done after flowering but before seeds are mature. Will need to be repeated as plants regrow. Tillage can reduce infestations but must be repeated as new seedlings emerge.
Cultural	Intensive grazing in the early spring can reduce the number of plants that set seed. Burning is usually ineffective as it generally does not burn hot enough to kill seeds on the soil. Burning followed by herbicide can increase control.
Biological	There are no known biological control agents effective against jointed goatgrass authorized in Colorado.

## Jointed goatgrass

---

### Chemical Control:

Imazamox (Imox)	Rate: 4 to 6 oz/ acre	<p>Timing: Post-emergence in fall or early spring.</p> <p>Remarks: Fairly better control with fall applications. Safe on most desirable grasses and forbs. Has a short soil residual. Can be tank-mixed with indaziflam (Esplanade) to provide long-term residual control or glyphosate for increased Post-emergence control.</p>
Imazapic (Plateau, Panoramic)	Rate: 4 to 7 oz./ acre	<p>Timing: Pre-emergence in late summer or fall, or early Post-emergence in late winter before tiller.</p> <p>Remarks: Safe on most grasses and has long soil residual. Use low rate in dry climates and low litter sites and high rate in wetter areas or high litter.</p>
Indaziflam (Esplanade)	Rate: 5 to 7 oz./ acre	<p>Timing: Pre-emergence in early to mid summer (1 to 2 months before germination), or Post-emergence with glyphosate in fall to early spring.</p> <p>Remarks: Very safe on perennial grasses, forbs and shrubs. Long soil residual. Not yet labeled for grazed sites. Use higher rate in areas with high litter. For increased control the first year apply Post-emergence with glyphosate.</p>
Glyphosate (Roundup, Accord XRT II, and several others)	Rate: 0.5 to 1 lb a.e./acre	<p>Timing: Post-emergence in late winter to early spring before flowering.</p> <p>Remarks: Non-selective herbicide so must be applied during winter dormancy of desirable species or by spot treatment. No soil activity; good option if reseeding is planned for site.</p>

## **Common mullein**

*Verbascum thapsus*

### **List C Species**

**Family:** Scrophulariaceae

**Range:** All western states.

**Habitat:** Commonly found in areas with high disturbance including roadsides, industrial areas, railroad right-of-ways, fire impacted sites, forest clearings, and rangeland/pasture. Prefers disturbed sites with well-drained and dry sandy soils but it is not limited to these areas.

**Origin:** Native to Eurasia.

**History:** Introduced to the US in the 1700's as a medicinal plant.

Europeans used the flowers for tea and leaves to treat burns and rashes. Native Americans smoked the dried eaves to treat bronchitis.

**Impacts:** Populations can spread rapidly and form dense stands in disturbed areas, overtaking native species. Following fires or other disturbances, it can prevent reestablishment of native forbs and grasses. Unpalatable to livestock due to its woolly leaves. Established stands are extremely difficult to control due to their abundant, long-lived seed bank.



*Second-year mature plant.*



*Flowerheads.*

## **Common mullein**

*Verbascum thapsus*

**Life Cycle:** Most commonly a biennial but can be a short-lived perennial or annual. Produces a large, thick rosette of fuzzy leaves the first year and a single, stout, erect stem the second year.

**Stem:** Can range from 2-6 ft. tall; erect, stout.

**Flowers:** Flowering occurs June to August. Flowers are yellow in color, five-petaled and more than an inch in diameter. Flowering occurs at the end of the stalk and the plant dies afterwards.

**Leaves:** The leaves are alternate, overlapping one another, light green, densely woolly. Basal leaves are 4-12 in. long and 1-5 in. wide. Cauline (stem) leaves are alternate and decrease in size towards the top of the stem.

**Fruit:** Fruits have two chambers with numerous, small, angular, brownish seeds, 1/32 inch long. A single plant can produce 100,000 to 180,000 seeds which may remain viable up to 100 years in the soil.



*Common mullein fruits producing seeds.*



*Common mullein flower and flowerhead.*



## Common mullein

## *Verbascum thapsus*



*First-year common mullein rosette. In year two this plant will bolt, seed and die.*



*Wooliness characteristic of common mullein foliage.*



*Common mullein seedling has oval-shaped first true leaves.*

### Non-chemical Control:

Mechanical	Hand-pulling before seed set can be effective. Mowing in the bolting to early-flowering stage can reduce seed set. Tillage can control growing plants. Any soil disturbance can stimulate recruitment.
Cultural	Low-palatability to livestock makes grazing an unfeasible control method. Fire is not effective and stimulates recruitment. Promoting competitive vegetation and minimizing soil disturbance can enhance control.
Biological	The seed weevil ( <i>Gymnetron tetrum</i> ) has been found to reduce seed production. For more information contact Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.

## Moth mullein

## *Verbascum blattaria*

### List B Species

**Family:** Scrophulariaceae

**Range:** Most common in western states but occurs across most of the US and Canada.

**Habitat:** Commonly found in areas with high disturbance including roadsides, industrial areas, vacant lots, open sites in forests, and rangeland/pasture. Prefers disturbed sites with richer soils but is tolerant to dry sandy soils.

**Origin:** Native to Eurasia

**History:** Most likely introduced accidentally as a contaminant it was first recorded in Pennsylvania in 1818. Considered naturalized in most of the US.

**Impacts:** Populations can spread rapidly and form dense stands in disturbed areas, overtaking native species. This can impact forage quality and quantity for wildlife and grazing livestock. Following fires or other disturbances, it can prevent re-establishment of native forbs and grasses. Established stands are extremely difficult to control due to their abundant, long-lived seed bank.



*Second-year mature plant.*



*Flower and flowerheads.*

## Moth mullein

## *Verbascum blattaria*

**Life Cycle:** A biennial that is usually unbranched. Develops as a basal rosette the first year and produces a single tall flowering stem the second year at maturity.

**Stem:** Can range from 2-4 ft. tall; erect, stout.

**Flowers:** Flowering occurs in second-year plants, typically from June to August. Flowers are 5-petaled, white or pale yellow in color, ~1 in. long, with purple hairs close to the center. Each flower is attached individually to the flowering stem.

**Leaves:** The stem leaves are alternate, up to 6 in. long and bright green. They are deeply toothed and sparsely hairy to no hair. Basal leaves are 8-12 in. long. Upper leaves near the flowering stem are smaller and more shallow-toothed.

**Fruit:** Fruits are small, spherical, hairy, 0.3 in. long with a greenish capsule containing many small dark brown seeds with wavy ridges. Only second-year plants fruit and set seed. A single plant can produce 100,000 seeds which may remain viable up to 100 years in the soil.



*Flowers can be white or yellow.*



*Spherical seeds of moth mullein.*



## Moth mullein

## *Verbascum blattaria*

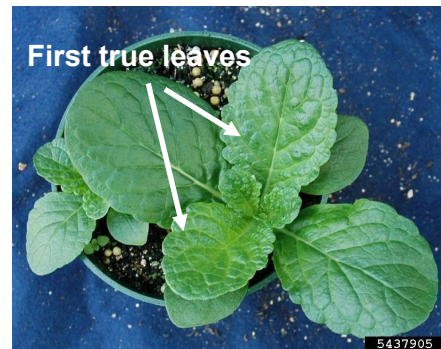


First-year moth mullein rosette. In year two this plant will bolt, seed and die.

Deeply lobed leaves.



Purple hairs covering stamen.



Moth mullein seedling has oval-shaped first true leaves and void of hairs.

### Non-chemical Control:

Mechanical	Hand-pulling or removing flowers before the plant sets seed can be effective. Mowing in the bolting to early-flowering stage can reduce seed set. Tillage can control growing plants, but any soil disturbance can stimulate recruitment.
Cultural	Fire is not effective and stimulates recruitment. Planting desirable vegetation and minimizing soil disturbance and bare spots can reduce establishment and spread. Maintain healthy pastures and avoid overgrazing.
Biological	The seed weevil ( <i>Gymnetron tetrum</i> ) has been found to reduce seed production. For more information contact Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.



## Common mullein and moth mullein

### Chemical Control:

Aminocyclopyrachlor (Method)	Rate: 4 to 8 oz./acre	Timing: Pre-emergence or Post-emergence from rosette to early bolt stage.  Remarks: Do not apply in the root zone of trees and shrubs. Not yet labeled for use in grazed sites. Higher rates can injure cool season grasses.
Aminopyralid (Milestone)	Rate: 7 oz./acre	Timing: Post-emergence from rosette to early bolting.  Remarks: Other premix formulations with aminopyralid can enhance control; i.e. Opensight (aminopyralid + metsulfuron).
Chlorsulfuron (Telar)	Rate: 1 to 2.6 oz/acre	Timing: Post-emergence from seedling to bolting.  Remarks: Can be added with aminocyclopyrachlor for enhanced control.
Glyphosate (Roundup, Accord XRT II, and others)	Rate: 2 qt./acre (Roundup ProMax), 2.25 lb a.e./acre.	Timing: Post-emergence  Remarks: Non-selective herbicide; in areas with desirable vegetation use spot treatment. No soil activity. Good control option when seeding is planned for shortly after application.
Metsulfuron (Escort)	Rate: 1 to 2 oz/acre	Timing: Post-emergence from seedling to bolting.  Remarks: Some soil residual activity. Can use premix formulations such as Cimarron X-tra (metsulfuron + chlorsulfuron)
Picloram (Tordon 22k)	Rate: 1 qt./acre	Timing: Pre-emergence or Post-emergence from rosette to early bolting.  Remarks: Restricted use herbicide. Picloram has long soil residual activity and can kill desirable broadleaves. Do not apply near trees or water.

## Dalmatian toadflax

*Linaria dalmatica*

### List B Species

**Family:** Scrophulariaceae

**Range:** Most of North America except for the southeastern US.

**Habitat:** Invades open fields, pasture/rangeland, riparian areas and disturbed sites including forest clearings, roadsides and crop fields. Prefers cool, semiarid climates and dry, neutral to slightly alkaline soils. Usually in disturbed areas, although infestations can move into undisturbed prairies and riparian areas.

**Origin:** Native to the Mediterranean region.

**History:** Introduced in the late 1800's or early 1900's to be cultivated as an ornamental, for use in fabric dye, and for medicinal purposes.

**Impacts:** Dalmatian toadflax is a very aggressive invader, forming dense colonies through its extensive, creeping root system. Infestations can crowd out desirable grass and broadleaf species. Decreases forage for livestock and wildlife. One of the few species to invade the short-grass steppe in eastern Colorado. Yellow toadflax and Dalmatian toadflax readily cross to produce a vigorous hybrid.



*Mature flowering Dalmatian toadflax plant.*



*Stems of yellow toadflax (left), hybrid toadflax (middle), Dalmatian toadflax (right).*

## Dalmatian toadflax

## *Linaria dalmatica*

**Life Cycle:** An herbaceous perennial that can spread by seed but mainly spreads through creeping, lateral roots with adventitious buds that form new plants. Plants die back in the winter and regenerate from root buds in the early spring.

**Stem:** Plants can grow over 3 ft. tall and produce as many as 25 stems during the first year. Stems are rough and woody at the base, becoming smooth and waxy higher up the plant.

**Flowers:** Flowering occurs from late spring to summer. Plants produce bright yellow snapdragon-like flowers which have an orange, bearded throat and long spur. They mature from the lower part of the stem upwards, with various stages of flowering occurring on the stem at one time.

**Leaves:** The leaves, 0.5 to 2.3 in. long, are bluish-green in color and heart-shaped to oval, usually pointed. The leaves wrap or clasp around the upper portion of the stem.

**Fruit:** Plants produce as many as 500,000 tiny black seeds contained in irregularly shaped, angular capsules. Seed viability is highly dependent on out-crossing from pollination. Seeds can germinate in spring or fall if conditions are favorable.



*Flowers showing orange bearded throat and spur.*



*Heart-shaped claspings leaves.*

## Dalmatian toadflax

## *Linaria dalmatica*



*Dalmatian toadflax rosette.*



*Close-up of flowers.*



*Dalmatian toadflax seedlings.*

### Non-chemical Control:

Mechanical	Due to its extensive root system, hand-pulling or digging is ineffective. Tillage can be effective but needs to be repeated several times through the growing season and for multiple years. Mowing stimulates reproduction through the roots.
Cultural	Livestock will usually not graze Dalmatian toadflax, although some studies have shown intensive goat grazing to reduce populations. Fire is not effective, as the root system will survive and re-sprout.
Biological	Three biocontrol agents are available in Colorado. <i>Calophasia lunula</i> , a predatory moth; <i>Eteobalea intermediella</i> , a root boring moth; and <i>Mecinus janthiniformis</i> , a stem boring weevil, which has had dramatic results in reducing populations in Colorado. For information contact the Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.



## Yellow toadflax

*Linaria vulgaris*

### List B Species

**Family:** Scrophulariaceae

**Range:** Throughout North America

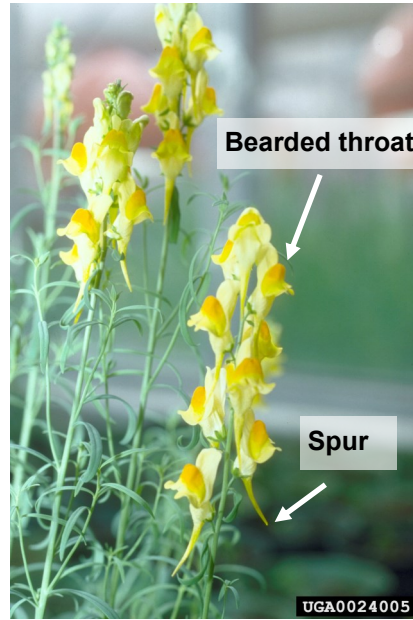
**Alternate Names:** Wild snapdragon, butter-and-eggs

**Habitat:** Invades pasture/rangeland, roadsides, riparian areas, and forest clearings. Prefers moist, coarse soils, particularly sandy or gravelly soils. Usually in disturbed areas, although infestations can move into undisturbed prairies and riparian areas. Tolerates sub-arctic conditions.

**Origin:** Native to Europe and the Mediterranean region.

**History:** Introduced in the late 1600's as a garden ornamental and medicinal plant.

**Impacts:** Yellow toadflax is very competitive with annuals and shallow-rooted perennials for soil moisture. Large infestations displace desirable vegetation reducing diversity and decreasing forage for livestock and wildlife.



*Flowering yellow toadflax plant (both pictures).*



## **Yellow toadflax**

*Linaria vulgaris*

**Life Cycle:** An herbaceous perennial that can spread by seed but mainly spreads through creeping, lateral roots that spread to form new plants. Plants die back in the winter and regenerate from roots in the early spring.

**Stem:** Plants grow 1 to 3 ft. tall and produce erect stems that emerge in clumps and are hairless on the upper stems and have a woody base.

**Flowers:** Flowering occurs from May to September. The snapdragon-like flowers are about 1 in. long and yellow to pale yellow with a deep orange bearded throat and yellow spur. The upper portion of each stem can contain 15 to 20 flowers. Flowers of hybrid species are larger than yellow toadflax and more widely spread on stem.

**Leaves:** Leaves are pale green, 1 to 2 in. long, narrow and linear. On hybrid toadflax the leaves are broader than yellow toadflax but not heart-shaped or clasping like Dalmatian toadflax.

**Fruit:** The fruits are brown, oval capsules 0.25 to 0.5 in. long and contain several small, flat dark brown seeds. It is unknown how long the seeds can remain viable in the soil, but due to their small size it is likely they only survive for a few years.



*Yellow toadflax foliage.*

## Yellow toadflax

*Linaria vulgaris*



*Dense yellow toadflax stand.*



*Close-up of yellow toadflax flowers.*



*Yellow toadflax narrow and linear leaves.*

### Non-chemical Control:

Mechanical	Due to its extensive root system, hand-pulling or digging is ineffective. Tillage can be effective but needs to be repeated several times through the growing season and for multiple years. Mowing stimulates reproduction through the roots.
Cultural	Livestock will usually not graze yellow toadflax and the plants contain alkaloids that can be toxic. Grazing is not considered a viable control option. Fire is not effective as the root system will survive and re-sprout.
Biological	<i>Calophasia lunula</i> , a moth, is available for both toadflax species. <i>Mecinus janthinus</i> , a stem boring weevil, is also available for release. At this point effectiveness has not been determined and populations will take several years to establish. For information contact the Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.

## Toadflax (Dalmatian and Yellow)

---

### Chemical Control:

Aminocyclopyrachlor (Method)	Rate: 4 to 8 oz./acre	<p>Timing: Post-emergence during rosette stage or in mid-fall when plants are dormant.</p> <p>Remarks: Do not apply in the root zone of trees and shrubs. Not yet labeled for use in grazed sites. Higher rates can injure cool season grasses. Tank mixing with 1 oz./acre of chlorsulfuron (Telar) is one of the best toadflax control options.</p>
Chlorsulfuron (Telar)	Rate: 1.5 to 2.6 oz./acre	<p>Timing: Post-emergence when plants are growing rapidly in the bud to bloom stage or dormant applications in mid-fall.</p> <p>Remarks: May only suppress yellow toadflax. Can be applied to waters edge but not to water. Has long soil residual activity. Mixed with 1 qt./acre picloram (Tordon) or 8 oz./acre aminocyclopyrachlor (Method) provides superior control, especially on yellow toadflax stands.</p>
Picloram (Tordon, Picloram 22k)	Rate: 1 to 2 qt./acre	<p>Timing: Post-emergence when plants are growing rapidly before full bloom, or in late summer to early fall.</p> <p>Remarks: Restricted use product. Late summer to early fall treatments are generally more effective. May require repeated applications. Broad spectrum herbicide with long soil residual activity. Most broadleaf plants are susceptible to picloram, especially at the higher rate. Do not apply near trees or water. Tank mixing with 1 oz./acre chlorsulfuron (Telar) or 6 oz./acre of dicamba + diflufenzopyr (Overdrive) provides superior control.</p>



## Tamarisk

*Tamarix spp.*

### List B Species

**Family:** Tamaricaceae

**Range:** All western and southwestern states.

**Alternate Names:** Saltcedar, tamarack

**Habitat:** Found along floodplains, riverbanks, streambanks, marshes, roadsides, and irrigation ditches. Prefers alkaline soils but tolerates salinity and acidity. Mature plants can tolerate high temperatures, freezing, flooding, drought and burning.

**Origin:** Native to eastern Asia, northern Africa, the Middle East, India, and southern Europe.

**History:** Introduced to the US for ornamental purposes and streambank stabilization.

**Impacts:** Several species of tamarisk exist in Colorado and are difficult to distinguish between. Trees use large amounts of surface and groundwater reducing underground water tables and surface water availability. This can cause wetlands to dry up. Roots extract salt from deep in the soil and excrete it from their leaves. This increases the salinity of the soil surface as leaves are dropped as litter. This inhibits the growth and survival of native species.



*Mature tamarisk tree.*  
Photo Credit: RiversEdge West



*Flowering tamarisk tree.*

## Tamarisk

*Tamarix spp.*

**Life Cycle:** A deciduous shrub or small tree that form dense thickets in wetlands. Trees can reproduce by seed or vegetatively. Trees form deep root systems (>15 ft.) that allows them to use available ground water.

**Stem:** Trees can grow 5 to 20 2 ft. tall with slender branches. The bark of young branches is reddish brown and smooth, while older branches become more bluish-purple to brown with ridged bark.

**Flowers:** Buds form from February to March with flowering typically occurring during June/July in SE CO. Flowers are tiny, pink to white, and have five petals. Flowers occur in clusters on the end of branch tips.

**Leaves:** Leaves are small, scale-like and bluish-green in color.

**Fruit:** The fruit is a small capsule, less than 0.25 in. long which contains numerous seeds. A mature plant can produce up to 600,000 seed per year, although seeds are only viable for up to 45 days with most germinating in 24 hours after contacting water. Trees can live for 75 to 100 years.



*Tamarisk leaves.*



*Mature tamarisk tree.*

# Tamarisk

# *Tamarix spp.*



Close-up of tamarisk flowers.



Close-up of leaves and reddish-brown stem.



Tamarisk seedling.

## Non-chemical Control:

Mechanical	Mechanical control methods only suppress tamarisk temporarily as plants easily re-sprout from roots. Cutting can reduce the amount of groundwater used by trees and is very effective when combined with herbicide. Hydro-axing or root plowing can reduce stand sizes although plants usually re-sprout.
Cultural	Livestock will graze young tamarisk seedlings and goats will eat regrowth, although this is not an effective control option alone. Burning has not been successful.
Biological	The saltcedar leaf beetle ( <i>Diorhabda elongata</i> ) larvae and adults feed on foliage. This causes stem dieback and potential death of the plant if defoliation is consistent. For information contact the Palisade Insectary of the Colorado Department of Agriculture at 970-464-7916.

# Tamarisk

## Chemical Control:

<p>Glyphosate (Roundup; Rodeo or Aquamaster for aquatic use)</p>	<p>Rate: 1.7 to 3.7 lb a.e./acre for broadcast treatment. 100% of concentrated product to wet cut stumps.</p>	<p>Timing: Late summer to early fall. Cut stump treatments can be made year-round.</p> <p>Remarks: Provides only partial control of tamarisk. Non-selective herbicide with no soil activity. Must spot-treat if desirable vegetation is present at site. Aquatic formulations are available.</p>
<p>Imazapyr (Arsenal, Habitat)</p> <p>NOTE: Kochia is resistant to imazapyr</p>	<p>Rate: 1 lb a.i./acre for broadcast foliar treatment. Spot treatment 1% v/v. Cut-stump 10% v/v.</p>	<p>Timing: Late summer or early fall.</p> <p>Remarks: One of the best options for tamarisk control. <u>Non-selective</u> herbicide; in areas with desirable vegetation use spot treatment. Has long soil residual activity. Habitat is registered for aquatic use and can be applied both near and to water. Can be tank-mixed with 1 to 2 pt. glyphosate/acre.</p>
<p>Triclopyr (Remedy Ultra, Garlon 3A, Garlon 4A Ultra)</p>	<p>Rate: Cut stump: 50% of undiluted Garlon 3A (in water) or 25 to 100% Garlon 4 (in oil). Basal bark treatment: 20 to 30% Garlon 4 in oil.</p>	<p>Timing: Best results with summer or fall applications.</p> <p>Remarks: Cut stump treatments can be very effective. Safe on grasses. Cut stumps near ground level and immediately apply herbicide solution. Basal bark applications should be made to younger trees— spray the lower trunk.</p>



## African rue

## *Peganum harmala*

### List A Species

**Family:** Zygophyllaceae

**Range:** Throughout North America, but prevalent in the Southwest and semi-arid climates.

**Alternate Names:** Wild rue, Harmal

**Habitat:** Found in disturbed sites, pasture/rangeland, roadsides, cropland, and semi-arid deserts. Can spread from disturbed areas to healthy rangeland. Can grow in sandy or clay soils and is tolerant of saline and alkaline conditions. Considered a drought evader making plants extremely drought tolerant.

**Origin:** Native to northern Africa and the Middle East.

**History:** First discovered in the US in the early 1900's. Possibly introduced for medical purposes.

**Impacts:** African rue is extremely drought tolerant due to its deep-rooted system and easily out-competes native rangeland shrubs and grasses. Contains toxic alkaloids that are extremely toxic to livestock, although livestock will rarely graze the plant due to its bitter taste and smell. The only known infestation in Colorado is in Las Animas County, so early detection of new infestations is critical.



*African rue infestation in Las Animas County.*

*Photo Credit: Shelly L Simmons*



*African rue plant showing large taproot.*

## African rue

## *Peganum harmala*

**Life Cycle:** A succulent, shrubby perennial herb that can spread by seed but mainly spreads through lateral roots with adventitious root buds that can extend 20' or more into the soil. Plants die back to their roots in the winter and new growth occurs in late winter or early spring. Plants can have some vegetative regrowth in the fall.

**Stem:** Plants grow 1 to 2 ft. tall and are low-growing and bushy in shape. Stems are multi-branched, stiff, erect and hairless.

**Flowers:** Flowering may occur from April to September; but typically during June in Las Animas County. The white, five-petal flowers have a green underside or sepals that support the flowers and a yellow center (stamen).

**Leaves:** Leaves are dark green, 0.8 to 2 in. long, succulent and smooth. They alternate up the stem and are deeply lobed (see photo). Leaves produce a strong odor when crushed.

**Fruit:** The plant produces a green to orangish-brown capsule that contains 45-60 seeds which dries and bursts open at maturity.



*African rue leaves and fruit.*



*Leaves and mature fruit.*

## African rue

## *Peganum harmala*



*Flowering African rue plant.*

*All Photo Credits:  
Shelly L. Simmons*



*Five-petaled flower with yellow center.*



*African rue fall rosettes.*

### **Non-chemical Control:**

Mechanical	Hand-pulling newly established plants can help reduce infestations, but mechanical methods on established plants are ineffective. Multiple years of hand-pulling is required. Not an effective or advised management strategy as eradication of List A species is mandated.
Cultural	Grazing is not a control option as African rue is highly toxic to livestock. Fire is not effective as the root system will survive and re-sprout.
Biological	Biocontrol agents are not included in prescribed management plans for List A species in Colorado, as eradication is the main objective. No biocontrol agent for African rue is available.

## African rue

### Chemical Control:

<p>Imazapyr (Arsenal, Habitat)</p> <p>NOTE: Kochia is resistant to imazapyr</p>	<p>Rate: 3 pt./acre; 0.75 lb. a.e./ acre</p>	<p>Timing: Post-emergence when plants are actively growing and to fall regrowth. Better control has been noted for fall treatments.</p> <p>Remarks: One of the best options for African rue control. <u>Non-selective</u> herbicide; in areas with desirable vegetation use spot treatment. Has long soil residual activity. Habitat is registered for aquatic use and can be applied both near and to water.</p>
<p>Hexazinone (Velpar)</p>	<p>Rate: Individual plant treatment recommended—mix 50/50 with water and apply 4 ml/foot of canopy.</p>	<p>Timing: Can be applied anytime. Post-emergence when plants are actively growing and to fall regrowth is potentially more effective.</p> <p>Remarks: Non-selective herbicide that will damage and kill most vegetation. In areas with desirable vegetation use spot treatment.</p>
<p>Metsulfuron (Escort)</p>	<p>Rate: 3.2 to 6.4 oz/acre</p>	<p>Timing: Post-emergence when plants are actively growing and to fall regrowth.</p> <p>Remarks: Metsulfuron is a selective herbicide and provides seasonal foliage suppression, but low African rue plant mortality. Great option in areas where injury to desirable species needs to be avoided. May need multiple years of treatment.</p>
<p>Tebuthiuron (Spike)</p>	<p>Rate: 10 lbs./acre</p>	<p>Timing: Can be applied anytime. Post-emergence when plants are actively growing and to fall regrowth is potentially more effective.</p> <p>Remarks: Apply only on sandy or coarse soils. Will likely damage nearby vegetation. Increased herbicide efficacy if applied just before a rain event.</p>



## Appendix A - Photo Citations

Photo ID#	Citation
0024005	Bob Nowierski, Montana State University, Bugwood.org
0024005	Bob Nowierski, Montana State University, Bugwood.org
0024042	Norman E. Rees, USDA Agricultural Research Service - Retired,
24090	Sara Rosenthal, USDA Agricultural Research Service, Bug-
0025049	Norman E. Rees, USDA Agricultural Research Service - Retired,
0025062	Norman E. Rees, USDA Agricultural Research Service - Retired,
0580013	Loke T. Kok, Virginia Polytechnic Institute and State University, Bugwood.org
1149026	USDA APHIS PPQ - Oxford, North Carolina , USDA APHIS PPQ,
1149027	USDA APHIS PPQ - Oxford, North Carolina , USDA APHIS PPQ,
1196054	Michael Shephard, USDA Forest Service, Bugwood.org
1196176	Michael Shephard, USDA Forest Service, Bugwood.org
1196177	Michael Shephard, USDA Forest Service, Bugwood.org
1196178	Elizabeth Bella, AECOM, Bugwood.org
1211064	Dave Powell, USDA Forest Service (retired), Bugwood.org
1237112	Dan Tenaglia, MissouriPlants.com, Bugwood.org
1322086	Keith Weller, USDA Agricultural Research Service, Bugwood.org
1334026	Wendy VanDyk Evans, Bugwood.org
1354011	Mary Ellen (Mel) Harte, Bugwood.org
1354014	Mary Ellen (Mel) Harte, Bugwood.org
1358052	Mary Ellen (Mel) Harte, Bugwood.org
1358055	Mary Ellen (Mel) Harte, Bugwood.org
1358057	Mary Ellen (Mel) Harte, Bugwood.org
1358332	Mary Ellen (Mel) Harte, Bugwood.org
1358352	Mary Ellen (Mel) Harte, Bugwood.org
1382012	Ricky Layson, Ricky Layson Photography, Bugwood.org
1383005	Tom Heutte, USDA Forest Service, Bugwood.org
1383019	Tom Heutte, USDA Forest Service, Bugwood.org
1383069	Tom Heutte, USDA Forest Service, Bugwood.org
1416003	Elizabeth Goulet, Cornell University, Bugwood.org
1416010	Bob Nowierski, Montana State University, Bugwood.org
1459114	Steve Dewey, Utah State University, Bugwood.org

## Appendix A - Photo Citations

Photo ID#	Citation
1459118	Steve Dewey, Utah State University, Bugwood.org
1459134	Steve Dewey, Utah State University, Bugwood.org
1459136	Steve Dewey, Utah State University, Bugwood.org
1459137	Steve Dewey, Utah State University, Bugwood.org
1459183	Steve Dewey, Utah State University, Bugwood.org
1459184	Steve Dewey, Utah State University, Bugwood.org
1459185	Steve Dewey, Utah State University, Bugwood.org
1459207	Steve Dewey, Utah State University, Bugwood.org
1459226	Steve Dewey, Utah State University, Bugwood.org
1459258	Steve Dewey, Utah State University, Bugwood.org
1459265	Steve Dewey, Utah State University, Bugwood.org
1459432	Steve Dewey, Utah State University, Bugwood.org
1459433	Steve Dewey, Utah State University, Bugwood.org
1459434	Steve Dewey, Utah State University, Bugwood.org
1459437	Steve Dewey, Utah State University, Bugwood.org
1459538	Steve Dewey, Utah State University, Bugwood.org
1459541	Steve Dewey, Utah State University, Bugwood.org
1459545	Steve Dewey, Utah State University, Bugwood.org
1459622	Steve Dewey, Utah State University, Bugwood.org
1459624	Steve Dewey, Utah State University, Bugwood.org
1459722	Steve Dewey, Utah State University, Bugwood.org
1459753	Steve Dewey, Utah State University, Bugwood.org
1459773	Steve Dewey, Utah State University, Bugwood.org
1459777	Steve Dewey, Utah State University, Bugwood.org
1459793	Steve Dewey, Utah State University, Bugwood.org
1459798	Steve Dewey, Utah State University, Bugwood.org
1459803	Steve Dewey, Utah State University, Bugwood.org
1459804	Steve Dewey, Utah State University, Bugwood.org
1459808	Steve Dewey, Utah State University, Bugwood.org
1459924	Steve Dewey, Utah State University, Bugwood.org
1459928	Steve Dewey, Utah State University, Bugwood.org
1551117	John Cardina, The Ohio State University, Bugwood.org
1552225	Ohio State Weed Lab , The Ohio State University, Bugwood.org
1553025	Ohio State Weed Lab , The Ohio State University, Bugwood.org
1553029	John Cardina, The Ohio State University, Bugwood.org

## Appendix A - Photo Citations

Photo ID#	Citation
1553030	John Cardina, The Ohio State University, Bugwood.org
1553031	Ohio State Weed Lab , The Ohio State University, Bugwood.org
1553138	Theodore Webster, USDA Agricultural Research Service,
1553139	Catherine Herms, The Ohio State University, Bugwood.org
1553142	Ohio State Weed Lab , The Ohio State University, Bugwood.org
1553166	Ohio State Weed Lab , The Ohio State University, Bugwood.org
1553168	Ohio State Weed Lab , The Ohio State University, Bugwood.org
1557461	Theodore Webster, USDA Agricultural Research Service,
1560052	Ohio State Weed Lab , The Ohio State University, Bugwood.org
1560089	John Cardina, The Ohio State University, Bugwood.org
1562026	Mark Frey, The Presidio Trust , Bugwood.org
1562030	Mark Frey, The Presidio Trust , Bugwood.org
1562036	Mark Frey, The Presidio Trust , Bugwood.org
1595109	Mark Schwarzlander, University of Idaho, Bugwood.org
2149050	Chris Evans, University of Illinois, Bugwood.org
2149059	Chris Evans, University of Illinois, Bugwood.org
2149069	Chris Evans, University of Illinois, Bugwood.org
2149074	Chris Evans, University of Illinois, Bugwood.org
2151065	Chris Evans, University of Illinois, Bugwood.org
2153080	Montana Statewide Noxious Weed Awareness and Education Program, Montana State University, Bugwood.org
2155019	John D. Byrd, Mississippi State University, Bugwood.org
2189081	Chris Evans, University of Illinois, Bugwood.org
2189088	Chris Evans, University of Illinois, Bugwood.org
2307049	Patrick Breen, Oregon State University, Bugwood.org
2307050	Patrick Breen, Oregon State University, Bugwood.org
3943076	William M. Ciesla, Forest Health Management International, Bugwood.org
5004042	Mary Ellen (Mel) Harte, Bugwood.org
5004048	Mary Ellen (Mel) Harte, Bugwood.org
5078008	Douglas Barbe, California Department of Food and Agriculture, Bugwood.org
5160013	Forest and Kim Starr, Starr Environmental, Bugwood.org
5161005	Forest and Kim Starr, Starr Environmental, Bugwood.org

## Appendix A - Photo Citations

Photo ID#	Citation
5163053	Forest and Kim Starr, Starr Environmental, Bugwood.org
5203096	Pedro Tenorio-Lezama, Bugwood.org
5203100	Pedro Tenorio-Lezama, Bugwood.org
5204001	Pedro Tenorio-Lezama, Bugwood.org
5204002	Pedro Tenorio-Lezama, Bugwood.org
5204003	Pedro Tenorio-Lezama, Bugwood.org
5204035	Pedro Tenorio-Lezama, Bugwood.org
5204041	Pedro Tenorio-Lezama, Bugwood.org
5270071	Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
5270072	Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
5358629	L.L. Berry, Bugwood.org
5358632	L.L. Berry, Bugwood.org
5358635	L.L. Berry, Bugwood.org
5358636	L.L. Berry, Bugwood.org
5358637	L.L. Berry, Bugwood.org
5358641	L.L. Berry, Bugwood.org
5366140	K. George Beck and James Sebastian, Colorado State University,
5366141	K. George Beck and James Sebastian, Colorado State University,
5366144	K. George Beck and James Sebastian, Colorado State University,
5366146	K. George Beck and James Sebastian, Colorado State University,
5366154	K. George Beck and James Sebastian, Colorado State University,
5366166	K. George Beck and James Sebastian, Colorado State University,
5366167	K. George Beck and James Sebastian, Colorado State University,
5366171	K. George Beck and James Sebastian, Colorado State University,
5366179	K. George Beck and James Sebastian, Colorado State University,
5366193	K. George Beck and James Sebastian, Colorado State University,
5370199	Bonnie Million, Bureau of Land Management, Bugwood.org
5371319	Jan Samanek, Phytosanitary Administration, Bugwood.org
5374312	Joseph M. DiTomaso, University of California - Davis, Bugwood.org



## Appendix A - Photo Citations

Photo ID#	Citation
5374333	Joseph M. DiTomaso, University of California - Davis, Bugwood.org
5374607	Joseph M. DiTomaso, University of California - Davis, Bugwood.org
5374609	Joseph M. DiTomaso, University of California - Davis, Bugwood.org
5385909	Joseph M. DiTomaso, University of California - Davis, Bugwood.org
5386545	Joseph M. DiTomaso, University of California - Davis, Bugwood.org
5386733	Joseph M. DiTomaso, University of California - Davis, Bugwood.org
5386735	Joseph M. DiTomaso, University of California - Davis, Bugwood.org
5386832	Joseph M. DiTomaso, University of California - Davis, Bugwood.org
5387074	Joseph M. DiTomaso, University of California - Davis, Bugwood.org
5387075	Joseph M. DiTomaso, University of California - Davis, Bugwood.org
5387653	Joseph M. DiTomaso, University of California - Davis, Bugwood.org
5389078	Norbert Frank, University of West Hungary, Bugwood.org
5391684	Barry Rice, sarracenia.com, Bugwood.org
5391801	John M. Randall, The Nature Conservancy, Bugwood.org
5391962	John M. Randall, The Nature Conservancy, Bugwood.org
5392048	John M. Randall, The Nature Conservancy, Bugwood.org
5392343	John M. Randall, The Nature Conservancy, Bugwood.org
5395928	Robert Vidéki, Doronicum Kft., Bugwood.org
5399605	Robert Vidéki, Doronicum Kft., Bugwood.org
5402611	David Cappaert, Bugwood.org
5405632	Bonnie Million, Bureau of Land Management, Bugwood.org
5405674	Bonnie Million, Bureau of Land Management, Bugwood.org
5405676	Bonnie Million, Bureau of Land Management, Bugwood.org
5405689	Bonnie Million, Bureau of Land Management, Bugwood.org
5405692	Bonnie Million, Bureau of Land Management, Bugwood.org
5405723	Bonnie Million, Bureau of Land Management, Bugwood.org
5405751	Bonnie Million, Bureau of Land Management, Bugwood.org
5405752	Bonnie Million, Bureau of Land Management, Bugwood.org
5405758	Bonnie Million, Bureau of Land Management, Bugwood.org

## Appendix A - Photo Citations

Photo ID#	Citation
5405759	Bonnie Million, Bureau of Land Management, Bugwood.org
5417155	Bonsak Hammeraas, NIBIO - The Norwegian Institute of Bioeconomy Research, Bugwood.org
5422863	Caleb Slemmons, National Ecological Observatory Network, Bugwood.org
5424206	David Cappaert, Bugwood.org
5436161	Eric Coombs, Oregon Department of Agriculture, Bugwood.org
5437905	Bruce Ackley, The Ohio State University, Bugwood.org
5438451	Bruce Ackley, The Ohio State University, Bugwood.org
5448080	Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
5450155	Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
5450185	Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
5450189	Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
5474275	Rob Routledge, Sault College, Bugwood.org
5474276	Rob Routledge, Sault College, Bugwood.org
5496035	Rob Routledge, Sault College, Bugwood.org
5497929	Rob Routledge, Sault College, Bugwood.org
9005085	Barry Rice, sarracenia.com, Bugwood.org

## **Appendix B - Source Citations**

Colorado Department of Agriculture Noxious Weeds. (2018).  
<https://www.colorado.gov/pacific/agconservation/noxiousweeds>

DiTomaso, J. M., Kyser, G. B., Oneto, S. R., Wilson, R. G., Orloff, S. B., Anderson, L. W., ... & Ransom, C. (2013). Weed control in natural areas in the western United States.

A Center for Invasive Species and Ecosystem Health. (2018).  
[www.invasive.org](http://www.invasive.org).

Nissen, S. J., Kessler, K., Ortiz, M., Warnick, K., Hansen, K. (2016). Native & non-native seedlings of the west: A guide to identifying over 100 weed & restoration species.

**This Guide was made Possible by  
Financial Contributions from the  
Following Organizations**



**COLORADO**

**Colorado Water  
Conservation Board**

Department of Natural Resources



**COLORADO**

**Department of Agriculture**

Conservation Services Division