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# Field Guide for Managing Annual and Biennial Invasive Thistles in the Southwest

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## Cover Photos

*Top left: Bull thistle — Steve Dewey, Utah State University, Bugwood.org*

*Top right: Plumeless thistle flowers — Todd Pfeiffer, Klamath Country Weed Control, Bugwood.org*

*Bottom left: Musk thistle flowers — Ricky Layson, Ricky Layson Photography, Bugwood.org*

*Bottom right: Scotch thistle — Steve Dewey, Utah State University, Bugwood.org*



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# **Bull thistle** (*Cirsium vulgare* (Savi) Tenore)
# **Musk thistle** (*Carduus nutans* L.)
# **Plumeless thistle** (*Carduus acanthoides* L.)
# **Scotch thistle** (*Onopordum acanthium* L.)

Sunflower family (Asteraceae)

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Bull, musk, plumeless, and Scotch thistles are annual and biennial nonnative plants in the sunflower family that are considered invasive. Plumeless and Scotch thistles are listed as noxious weeds in both Arizona and New Mexico. Musk thistle and bull thistle have been listed as noxious weeds only in New Mexico.

This field guide serves as the U.S. Forest Service's recommendations for management of annual and biennial invasive thistles in forests, woodlands, and rangelands associated with its Southwestern Region. The Southwestern Region covers Arizona and New Mexico, which together have 11 national forests. The Region also administers 4 national grasslands located in northeastern New Mexico, western Oklahoma, and the Texas panhandle.

# Description

All thistles addressed in this guide are annual to biennial in growth form. They reproduce solely by seed and are prolific seed producers. The seed remains viable in the soil for many years. At maturity, these spiny weeds have basal rosettes, purplish disk flowers, and flowering stems that are highly branched. Distinguishing features by which individual species can be identified include plant size, appearance of phyllaries (involucral bracts), and the hairiness and shape of the leaves. Growth characteristics useful for identifying these thistles are given in table 1.

## Ecology

### *Impacts/Threats*

Thistles are highly competitive and persistent plants. Given suitable conditions, these weeds rapidly invade rangeland, pastures, abandoned fields, roadsides, and disturbed sites. A high density of thistles reduces availability of quality forage and the diversity of flora and fauna species. Additionally, most thistles have taproots that do not stabilize the soil as well as fibrous roots of native grass species; therefore, high densities of thistles can contribute to soil erosion and stream sedimentation.

### *Site/Distribution*

Thistles readily establish on disturbed or neglected sites, especially along roadsides, railways, ditch banks, and waste areas. Bull thistle grows best in nitrogen-rich soil with moderate moisture but do not grow as well in sandy soil, pure clay, or soils with high organic matter content. Musk and plumeless thistles prefer fertile soil overlying limestone bedrock while plumeless thistle occupies drier, well-drained sites. Scotch thistle prefers sites in dry climates with fertile soils and high moisture content.

### *Spread*

Thistle seed is easily dispersed by wind, water, birds, and other animals. Seed can be dispersed by adhering to surfaces and undercarriages of road vehicles and road maintenance equipment. Thistles may also be introduced via seed in hay that is not certified to be weed free.

### *Invasive Features*

Excessive grazing favors thistle over grasses since livestock do not prefer to graze these weeds. In spring, thistles develop a large rosette base that shades the soil and reduces competition from other emerging plants. Moreover, some thistles have allelopathic properties that slow or prevent growth of desirable plant species, thereby allowing these thistles to thrive.

# Management

Since all thistle species addressed in this guide are prolific seed producers, the best approach for controlling these species is prevention and proactive management. The following actions should be considered when planning a management approach:

## Table 1. Growth characteristics

| Species | Life Span | Growth and Root Habit | Vegetative Appearance | Flower and Phyllary[1] | Seed |
|---|---|---|---|---|---|
| Bull thistle | Biennial or annual | Rosette up to 3 feet in diameter.<br>Several primary roots each with many laterals. | Bushy appearance.<br>Leathery, deeply lobed, green leaves; prickly hairs on upper side; underside wooly; yellowish pointed spines.<br>Hairy stems with dark purple veins; broad, prickly wings line stem. | Purple disk flower.<br>Phyllary urn-shaped; spiny. | Glossy light brown to pale yellow or white seed with narrow, dark brown stripes; 0.1 to 0.15-inch long. |
| Musk thistle | Biennial or winter annual | Rosette up to 2 feet or more in diameter.<br>Single, fleshy taproot 15 to 16 inches long. | Waxy, pale green silver-margined leaves with yellow spine tips.<br>Multi-branched stems; stem wings do not extend completely up stem. | Showy purplish-red disk flowers that "nod" at a 90 degree angle.<br>Phyllary with broad, overlapping, brown bracts; resembles a pine cone. | Straw-colored glossy seed with stripes, plume-like bristles, and a light apical rim; 0.15 to 0.2-inch long. |
| Plumeless thistle | Biennial or winter annual | Rosettes up to 2 feet or more in diameter.<br>Stout, fleshy taproot. | Plant looks like a candelabrum.<br>Deeply lobed leaves with white margins and 1 to 3 very stiff spines; hairy underside.<br>Flower stems branched with spiny wings. | Red to purple disk flowers (smaller than musk thistle).<br>Very narrow phyllary bracts with short, sharp spines. | Small, grey to light brown seed with slight curvature and distinct light apical collar; 0.07 to 0.11-inch long. |
| Scotch thistle | Biennial or short-lived perennial | Rosette up to 6 feet in diameter.<br>Stout, fleshy taproot up to 12 inches or more. | Large, grey-green, coarsely lobed, spiny-edged leaves with wooly hairs.<br>Stems have prominent spiny wings. | Purple disk flowers on globe-shaped heads with many spiny phyllaries in overlapping rows. | Mottled brown to blackish seed with wavy ridges and pinkish to red pappus bristles that fuse into a ring at the base; 0.16 to 0.2-inch long. |

[1] A phyllary is an involucral bract subtending (located below) the flower head of a composite plant.

- Maintain healthy plant communities to prevent or limit thistle infestations. This may involve improving grazing management practices to prevent overgrazing.
- Limit disturbance and/or promptly revegetate disturbed areas with desirable perennial forage species, especially perennial grasses.
- Check hay and straw for weed seed before using in thistle-free areas. Certified weed-free and pellets should be fed to horses used in backcountry areas.
- Detect, report, record, and eradicate new populations of thistle as early as possible.
- Combine mechanical, cultural, biological, and chemical methods for most effective thistle control.
- Implement monitoring and a follow-up treatment plan for missed plants and seedlings.
- Map extensive infestations. Keep annual records of reported infestations.

Table 2 summarizes some management options for controlling thistles under various situations. Further details on these options are explained below. Choice of individual method(s) for thistle control depends on the extent and density of infestation, current land use, and site conditions (accessibility, terrain, microclimate, other flora and fauna

present, etc.). Other important considerations include treatment effectiveness, overall cost, and the period of time needed to achieve control. More than one control method may be needed for a particular site.

## Special Considerations

There are at least 20 species of native thistles in the genus *Cirsium* in Arizona and New Mexico. These native, non-invasive thistles are important components of their ecological communities and should not be treated. Since native thistles can be confused with invasive thistles, accurate identification of thistle species is an important first step in thistle management.

The Sacramento Mountain range in southern New Mexico serves as habitat for the endangered Sacramento Mountains thistle (*Cirsium vinaceum*), which is protected under the Endangered Species Act of 1973. Parts of the Sacramento Mountain range within Otero County are also inhabited by local populations of Wright's marsh thistle (*C. wrightii*), which is a New Mexico-listed endangered species and a Federal candidate for listing. Wright's marsh thistle is also found in Eddy, Chaves, Guadalupe, and Socorro Counties in New Mexico. Both thistle species occur in wetland habitats such as spring, seeps, and marshy edges of streams and ponds. To avoid harming these species, information should be obtained from the U.S. Fish and Wildlife Service at (505) 346-2525 before treating thistles in these habitat types within the Sacramento Mountains and aforementioned counties.

## Physical Control

Physical methods can be used to control thistles by reducing seed production and preventing germination through the destruction of individual thistle plants and any maturing seed heads. Methods that sever or eliminate the entire top of a thistle or its root system usually have to be repeated and must be timed properly to be effective.

### *Manual Methods*

Hand pulling, hoeing, grubbing, or cutting may be done any time of year; but these methods are most effective if done before flower head development occurs. Thistle plants should be severed 2 to 4 inches below the soil surface to prevent re-sprouting from the root crown. For isolated thistles or small infestations, seed heads of individual plants may be clipped and placed in bags for disposal. This method can prevent further seed dispersal or seedling establishment while also allowing treated plants to be more easily relocated next year.

Proper disposal of debris is essential in preventing spread. If flowers or seed are not present, plants may be pulled and left onsite. If flowers or seed are present, debris should be bagged and removed from the site for safe disposal or else piled and burned onsite.

### *Mechanical Methods*

*If using machinery to manage thistles, the equipment should be cleaned after use to prevent movement of seed into un-infested areas.*

**Tillage** – Properly timed and repeated tillage with a plow or disc can provide effective control; however, ill-timed or nonrecurring tillage may encourage further invasion. In areas with high densities of viable thistle seed, tillage may actually increase establishment of thistle seedlings in succeeding seasons through disturbance of the soil surface. If tillage is used, thistle plants should be cultivated shortly after they emerge but before they reach a height of 3 inches. Shallow cultivation in hot, dry weather greatly stresses plants. Tillage will not eradicate seeds; therefore, tillage may be more effective when combined with other control methods.

**Mowing** – Mowing reduces plant height of thistles but may not entirely eliminate flowering and seed production. Some vegetation management experts do not recommend mowing at all since plants often produce side branches that have more flowers, even with repeated mowing and proper timing. However, mowing may be useful when combined with other control methods (see "Management Strategies" at the end of this field guide for more information). If mowing is used, cut soon after plants begin to bolt but before flowering; repeat mowing about every 21days during

## Table 2. Management options*

| Site | Physical Control | Cultural Control | Biological Control | Chemical Control |
|---|---|---|---|---|
| Roadsides | Repeat mowing very close to surface throughout the growth season (preferably in the bolt to early bud growth stage before seed matures and disperses). Consider mowing as part of a combined approach. | Use seed, mulch, and fill materials certified to be weed-free.<br><br>Educate road crews to identify and report infestations along roads; implement requirements for vehicle operations in infested areas. | Use biocontrol agents (flies and beetle) if release does not threaten rare or endangered native thistles (see table 3). Agents for thistle control may be used only if thistle infestations are large enough to sustain control agent populations. Effectiveness of agents may be limited due to possible disturbances in agent life cycles from roadside operations. | Apply herbicides in spring or fall at rosette stage. When using truck or tractor spraying equipment, wash thoroughly afterward to prevent seed spread. |
| Rangelands | For smaller infestations, hand pull; otherwise, cut plants 2 to 4 inches below the surface with a hoe, grubbing tool, or spade. Cut prior to flowering.<br><br>For larger infestations, use well-timed mowing to reduce seed production (bolt to flower bud stage).<br><br>Although prescribed burning is not recommended, individual plant treatment with a blow torch or similar device may be an option in localized situations. | Use seed and forage hay certified to be weed-free; use pellets for horses in backcountry areas.<br><br>After passing through infested areas, inspect and remove any seed from animals, clothing, and vehicles before entering treated or un-infested areas. | Use prescribed grazing to target young thistles. Closely manage grazing to prevent overuse.<br><br>Use biocontrol agents (flies and beetle) if release does not threaten rare or endangered native thistles. Agents for thistle control may be used only if thistle infestations are large enough to sustain control agent populations. | Use individual plant treatment with a backpack sprayer on sparse populations. For extensive and dense infestations, use ground or aerial broadcast spraying. |
| Wilderness and other natural areas | Same as above | Use seed and forage hay certified to be weed-free; use pellets for horses in backcountry areas.<br><br>After passing through infested areas, inspect and remove any seed from animals and clothing before entering treated or un-infested areas.<br><br>Post signs warning visitors to inspect for seeds and remove them from animals, clothing, and vehicles when leaving an infested area. | Same as above | Same as above |

* Choice of a particular management option must be in compliance with existing regulations for the land resource

active growth. For sites where plants have begun to flower, consider walking through the infested area before mowing and either pull plants or cut stems that have open flowers. Flower heads should be bagged and disposed offsite to prevent seed dispersal.

### *Prescribed Fire*

Broadcast burning can eliminate existing plants, but this activity is likely to favor invasive thistles in future years. Thus, prescribed burning is not ordinarily recommended for thistle management. However, individual plant treatment (IPT) with a blowtorch or flamethrower has been used with some success on thistles in California.

## Cultural Control

Early detection and plant removal are critical for preventing establishment of thistle. Introduction of thistles should be prevented in areas where they are not currently present. Land managers, the local public, and road crews should be educated on how to identify invasive thistle species so they can help report suspected infestations. Seed and materials used for mulch, forage, or fill should be certified to be weed-free; pellets may be used for horses in backcountry areas.

## Biological Control

### *Grazing*

Livestock generally avoid entering dense stands of mature thistle; but they will graze young, immature thistles. Prescribed grazing, therefore, can be effective if intensive, short-term grazing is used. Cattle, sheep, and goats can be used to graze bull thistle rosettes. Musk thistle is readily grazed by sheep and goats from rosette to bolting stage and by cattle before the bud stage is reached. Goats and cattle graze Scotch thistle in the seedling to vegetative stages. Use of grazing in combination with herbicide can increase effectiveness of both control methods.

### *Classical Biological Control*

There are several approved biocontrol agents (flies and a beetle) that attack bull, plumeless, and musk thistles (see table 3); however, there is no biocontrol agent for Scotch thistle. Biocontrol agents are most suitable for sites where other control methods are impractical. Biocontrol agents for thistles should be used only if infestations are large enough to sustain populations of these agents. Some biocontrol agents are less effective when their life cycle is disturbed, either by the presence of livestock or by management actions involving the thistle. Treatments such as cutting or spraying may not allow the biocontrol agent to complete its life cycle. As a result, the needs of the biocontrol agent (if present) should be considered before other weed treatments are implemented. For further information on biocontrol of annual and biennial thistles, see Winston et al. (2008) in the "References and Further Information" section of this field guide.

Although biocontrol agents have been released over the years for thistle control, many were released before testing for host specificity was as advanced as it is now. The seed head weevil (*Rhinocyllus conicus*) has been found attacking the endangered Sacramento Mountains thistle in southern New Mexico. The rosette weevil (*Trichosirocalus horridus*) has also recently been found in the Sacramento Mountains, and its presence could impact the Sacramento Mountains thistle along with local populations of the Wright's marsh thistle, which is an endangered species listed by New Mexico and a Federal candidate for listing.

Concerns about impacts to non-target species have caused APHIS to cancel interstate permits for some older thistle biocontrol agents like *R. conicus* and *T. horridus*. Although these older biocontrol agents may be present in thistle populations, they should not be re-distributed into new areas. Land managers should contact the New Mexico Ecological Services Field Office of the U.S. Fish & Wildlife Service at (505) 346-2525 before releasing any thistle biocontrol agents within the Sacramento Mountains or in the counties of

**Table 3. Biocontrol agents approved for annual and biennial invasive thistles**

| Species | Type of Agent | Plant Impacted/Site of Attack | Impact on Host | Use/Considerations for Release |
|---|---|---|---|---|
| *Cheilosia corydon* | Shoot, stem, and root-boring fly | Bull, musk, and plumeless thistles: shoots, stems and roots | Larval mining interferes with plant function and ultimately results in a decrease of seed production and sometimes death. | This insect survives in a wide array of climatic conditions throughout the range of host thistles. It tends to do better in areas where host plants flower early. It is available for re-distribution in western States, but it is not widespread. |
| *Urophora solstitialis* | Seed head fly | Musk and plumeless thistles: seed heads | Larval feeding reduces seed production in musk and plumeless thistles. Galls from larval feeding act as metabolic sinks that divert resources away from normal plant development. | This insect's establishment within the United States has not been confirmed, so it is unavailable for collection. |
| *Urophora stylata* | Gall-forming fly | Bull thistle: seed | Adult lays eggs in the closed flower buds. Each larva forms its own gall tissue and the gall forms around the immature seed. Mature larvae reside in the flower head through winter. Pupation is in May, and adults emerge in June. | Species is well established in the western U.S. with 60 to 90 percent of bull thistle seed heads infested in some areas. |
| *Psylliodes chalcomera* | Leaf beetle | Musk and plumeless thistles: leaves, buds, and flowers | Larval feeding stunts growth and reduces seed production of musk and plumeless thistles thereby decreasing their rate of spread. | Little is known about habitat preferences of *P. chalcomera* beyond the observation that it survives both cold and hot temperatures. This species is currently not established in North America despite repeated introductions. |

Eddy, Chaves, Guadalupe, and Socorro in New Mexico that can impact these endangered thistles. Organisms (insects, pathogens, etc.) used as biocontrol agents in southwestern States should be adaptable to arid environments and local conditions. Public, tribal, and private land managers may obtain biocontrol agents for release directly from local offices of the USDA Animal and Plant Health Inspection Service (APHIS) when these agents are available. Other sources for biocontrol agents include locally developed insectaries or private companies.

A permit must be obtained from APHIS before biocontrol agents can be transported across State lines. Regulations and permit applications (PPQ 526 permit forms) pertaining to interstate shipment of biocontrol agents can be found at *https://www.aphis.usda.gov/aphis/ourfocus/planthealth/import-information/permits/regulated-organism-and-soil-permits/sa_apply/ct_plantpest_howtoapply*. Although biocontrol agents may be collected and released internally in a given State without an APHIS permit, the State's department of agriculture or agricultural extension service should be consulted for any regulations relating to movement of these agents within the State.

## Chemical Control

Thistles are best controlled with a post-emergent broadleaf herbicide that is foliar applied. The most commonly used herbicides include dicamba, clopyralid, or picloram either alone or in combination with 2,4-D. Two relatively new herbicides, aminopyralid and aminocylopyrachlor, are labeled for thistle control and are also effective. Cost, availability, and effectiveness are important in the choice of product to use.

## Table 4. Herbicide recommendations

| Common Chemical Name (active ingredient) | Product Example[1] | Broadcast Treatment (rate per acre) | Spot Treatment (spray solution)[2] | Time of Application | Remarks |
|---|---|---|---|---|---|
| Aminopyralid | Milestone | bull, musk, and plumeless thistles: 3–5 fluid ounces<br>Scotch thistle: 5 to 7 fluid ounces | 3–5% | Lower rate for rosette; higher rate at bolting. Fall or spring. | Labeled for use on wildlife management areas and other natural areas. May be applied up to water's edge. No grazing restrictions. |
| Aminopyralid + 2,4-D[3] | GrazonNext | bull, musk, and plumeless thistles: 1.5–2 pints<br>Scotch thistle: 2–2.6 pints | 3–5% | Full leaf through flowering. If using in combination, wait 9 to 12 months to spray after last mowing. | Most perennial grasses are tolerant of this herbicide, as long as they are established. |
| Aminocyclopyrachlor + chlorsulfuron | Perspective | 3–8 ounces | Consult label for spot applications. | Apply to actively growing plants. Lower rate for rosette in fall; higher rate at bolting in spring. | Selective herbicide used on non-crop sites; may cause temporary injury to some grass species. |
| Aminocyclopyrachlor + metsulfuron methyl | Streamline | 4.75–9.5 ounces | Same as above. | Same as above. | Same as above. |
| Clopyralid | Stinger<br>Reclaim | 0.33–1.3 pints | 1–3% | During active growth at rosette stage. | Established perennial grasses are tolerant. |
| Clopyralid + 2,4-D[3] | Curtail | 1–2 quarts | 1–3% | Rosette in spring or fall. | Same as above. |
| Clopyralid + triclopyr | Redeem | 1.5–2 pints | 1–3% | Same as above. | Same as above. |
| Imazapic | Plateau | 8–12 ounces | 3–5% | Same as above. | May cause slight damage to cool season grasses. |
| Metsulfuron + 2,4-D[3] + dicamba | Cimarron Max | Rate II to III | Consult label | Same as above. | Established perennial grasses are tolerant. |
| Picloram[4] | Tordon 22K | 0.5–2 pints | 1–3% | Any growth stage; however, application is most effective in the fall when plants are in rosette stage. | May pose a risk to groundwater in permeable soils or in areas where the water table is near the surface. |
| Picloram[4] + 2,4-D[3] | Grazon P+D | bull thistle: 1–2 pints<br>other thistles: 2–4 pints | 1–2% | Lower rate for rosette stage in spring or fall; higher rate for bolt to bud growth stage. | Established perennial grasses are tolerant. |

**Table 4. Herbicide recommendations (cont.)**

| Common Chemical Name (active ingredient) | Product Example[1] | Broadcast Treatment (rate per acre) | Spot Treatment (spray solution)[2] | Time of Application | Remarks |
|---|---|---|---|---|---|
| Dicamba + diflufenzopyr | Overdrive | 4–6 ounces | 1–3% | Rosette in spring or fall. | Use higher rate for older or denser stands. |
| Dicamba + 2,4-D[3] | Weedmaster (pre-mixed) | 1.5–2 pints | 1–2% | During active growth; lower rate for rosette in fall; higher rate in spring (not advisable to spray during bolt). | Same as above. |

[1] Trade names for products are provided for example purposes only, and other products with the same active ingredient(s) may be available. Individual product labels should be examined for specific information and appropriate use with thistles.

[2] Spray solution is the herbicide/water ratio in a spray mix that may be used for spot treatment with backpack or hand-held sprayers. The amount of product applied during an annual growing season must not exceed the maximum application rate per acre as specified by the product label – refer to the product label for the site type and application.

[3] 2,4-D is a restricted-use pesticide in New Mexico only. A certified applicator's license is required for purchase and use.

Herbicides listed in table 4 are effective in reducing invasive thistles while allowing perennial native grasses to compete. Label instructions and guidelines for mixing, application, and grazing restrictions following treatment should always be followed. Aquatically approved herbicide formulations and surfactants must be used in or near water.

### *Herbicide Application*

For thistles covered in this guide (bull, musk, plumeless, and Scotch), the best time for application is usually during the fall when new plants have emerged and are actively growing during the seedling to rosette stage. Spraying in spring through the summer is also effective, but higher rates of application may be necessary. Consult label directions carefully.

Herbicides may be applied by backpack or hand-held sprayers, ATV or UTV sprayers, or a conventional boom sprayer that is pulled or attached to a tractor or truck. Any equipment used to apply herbicide should be calibrated. For individual plant treatment (IPT), wet the foliage and stem thoroughly by using a backpack or hand-held sprayer with a single nozzle. These herbicides can impact broadleaf and woody species; therefore, precautionary measures should be taken if desirable non-target species need protection.

## Management Strategies

High priority for thistle management should be directed toward preventing establishment and eliminating new plants. Small infestations occurring within otherwise healthy sites should be given special priority for control treatments. Individual plants in small infestations may be controlled by various methods including hand pulling, grubbing, hoeing, cutting (stems or seed heads), or spot spraying. Destroy debris via fire or mulching (or bag and remove plants and/or seed heads). If the treated site is disturbed, reseed with desirable perennial grasses. Periodically monitor for emerged plants and spot treat or hand remove.

Satellite populations and perimeter edges of large infestations should be treated first with the entire infestation scheduled to be reduced and/or eradicated in a series of steps over a period of several years. Initial treatment of well-established infestations should attempt to eliminate live thistle plants and disrupt seed production as much as possible by using an integrated management strategy that involves several control methods.

Since annual and biennial thistles germinate nearly year-round, a range of plant sizes may be present at any

one site. Consider applying herbicide as the initial treatment if thistle seedlings and young rosettes are mostly present in fall or early spring. Mowing or using an intensive grazing approach on a short-term basis may be a better option if treatment is started in late spring or summer. When mowing, cut weeds very close to surface during the early bud stage before flowers begin to color or mature. Mowing will need to be repeated during the summer growing season. Herbicide spraying in the fall should be considered as a follow-up treatment after mowing. Monitor for return of perennial native vegetation and reseed with desirable perennial forage species if necessary, especially perennial grasses. Repeat over multiple years.

Regardless of the treatment approach, thistles typically will not be controlled in a single year or by using only one control method. Since it is ordinarily useless to treat an area only one time without retreatment, sufficient resources must be allocated for the area where control is attempted. After initial treatment, it is especially important that resources are also available to respray or retreat the treated area as necessary. Previously treated areas should always be continuously monitored and retreated when necessary. Failure to perform follow-up management may result in a return of the thistle infestation.

### Adaptive Management

Invasive thistles are common throughout the western United States and controlling these species across broad areas is often impractical. Therefore, realistic goals and objectives should be established to manage thistle infestations occurring extensively throughout a given landscape. To improve long-term success, consider using an adaptive management approach with the overall goal of restoring desirable plant communities. The stepwise process for adaptive management involves:

1. Assessment of the overall weed problem,
2. Establishing management goals and objectives,
3. Implementation of control strategies and measures,
4. Monitoring the effectiveness of management actions,
5. Evaluating actual outcomes in relation to expected results, and
6. Adjusting practices as necessary.

Steps of this process should be repeated in sequence as part of a continuous learning cycle that improves management planning and strategy by learning from the outcomes of previous management actions. In general, an adaptive management strategy is considered to be successful if:

1. Stakeholders are actively involved and remain committed to the process,
2. Monitoring and assessment are used to adjust and improve management decisions, and
3. Management goals and/or objectives for the resource are being achieved.

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## For more information or other field guides, contact:

USDA Forest Service
Southwestern Region
Forest Health
333 Broadway Blvd., SE
Albuquerque, NM 87102

## Or visit the Southwestern Region's website for invasive species:

*http://www.fs.usda.gov/goto/r3/invasivespecies*



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