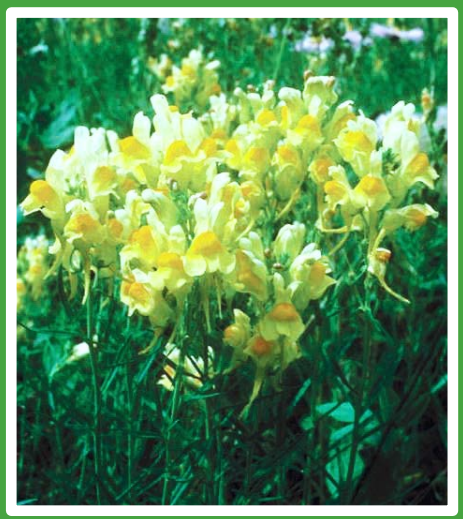
USDA
United States Department of Agriculture

Field Guide for Managing Dalmatian and Yellow Toadflaxes in the Southwest



Forest Service
Southwestern Region
TP-R3-16-06
Revised July 2017

Cover Photos

Top left: Dalmatian toadflax; Utah State University Archive, Utah State University, Bugwood.org

Top right: Dalmatian toadflax flower; Bob Nowierski, Montana State University, Bugwood.org

Bottom left: Yellow toadflax, David Powell, U.S. Forest Service, Bugwood.org

Bottom right: Yellow toadflax flower; Wendy Van Dyk Evans, Bugwood.org

Printed on recycled paper

Dalmatian toadflax (*Linaria dalmatica* (L.) Mill. ssp. *dalmatica*)
Yellow toadflax (*Linaria vulgaris* Mill.)

Figwort family (Scrophulariaceae)

Dalmatian toadflax and yellow toadflax are invasive plants that have been introduced into the southwestern U.S. Both species are listed in New Mexico as noxious weeds; however, Dalmatian toadflax is listed only in Arizona.

This field guide serves as the U.S. Forest Service's recommendations for management of Dalmatian and yellow toadflaxes 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

Dalmatian toadflax (synonyms: broad-leaved toadflax, wild snapdragon) and yellow toadflax (synonyms: butter-and-eggs, common toadflax, toadflax, Jacob's ladder, common linaria, wild snapdragon) were brought from the Mediterranean region to the western U.S. as ornamentals and have since escaped to become widely growing invasive plants. These short-lived perennials produce new plants from adventitious buds on a re-sprouting root system that is both extensive and deep. Flowers of both plants are snapdragon-like. While similar in appearance, Dalmatian toadflax grows taller and produces new plants mainly from seed whereas yellow toadflax spreads mostly from root buds. Table 1 lists growth characteristics of both toadflax species.

Ecology

Impacts/Threats

These aggressive weeds are highly adaptable and can out-compete winter annuals or shallow-rooted perennials for soil moisture. A high density of toadflax reduces the availability of quality forage and diversity of flora and fauna species. Dalmatian and yellow toadflaxes contain glucoside compounds that are poisonous, especially to cattle; however, these plants typically are not grazed by animals.

Table 1. Growth characteristics

Species	Life Span	Growth and Root Habit	Vegetative Appearance	Flower Appearance	Reproductive Method and Seed Appearance
Dalmatian toadflax	Short-lived perennial (generally < 5 years)	Averages 3 feet tall; up to 25 stems per crown during first year of growth; taproot and creeping lateral roots.	Waxy, blue-green oval to heart-shaped; leaves clasp upper stem; rough, woody stem at base that becomes smooth, waxy and herbaceous near the top.	0.75 to 1.5 inches long yellow, two-lipped flowers with an orange bearded throat and a long spur; flowers in leaf axils. Fruit 2 celled and irregular shaped.	Reproduces mainly by seed and partly by adventitious root buds. Black, sharply angled seeds that are slightly winged. Produces 500,000 seeds per plant.
Yellow toadflax	Same as above.	1.5 to 3 feet tall; has taproot and extensive system of vertical roots with creeping laterals. Grows in tight clumps.	Pale green, soft linear lanceolate leaves that are sessile and do not clasp stem; Upright, unbranched stem that is woody at the base and smooth at the tip.	1-inch long yellow flowers with 5 fused petals (2 upper lobes and 3 lower), an orange bearded throat, and a yellow spur; flowers in leaf axils. Fruit 2 celled and globe shaped.	Reproduces primarily by adventitious buds on lateral roots. Seeds are dark brown to black, long, flattened, and winged. Produces 30,000 seeds per plant.

Site/Distribution

Disturbance favors toadflax establishment. Both species thrive in degraded areas such as roadsides, cleared lots and fields, gravel pits, heavily grazed rangeland, and riparian zones. These weeds often establish in naturally occurring openings within sagebrush, ponderosa pine, and other woodland or parkland plant communities at higher elevations. Dalmatian toadflax favors cool, semiarid climates and coarse, dry soils with a neutral pH. Yellow toadflax favors moist soils and can tolerate subarctic conditions.

Currently, large infestations of toadflax occur in all western States. In New Mexico, Dalmatian toadflax is typically found at elevations between 5,000 and 6,000 feet, whereas yellow toadflax occurs at higher elevations between 6,000 and 9,500 feet. Infestations of both species are expanding in Arizona and New Mexico.

Spread

Yellow toadflax produces shoots from underground stems as early as March from which new, independent plants can form later during the growing season. Seed viability in yellow toadflax is quite low; therefore, the spread and persistence of plants in the field are mainly due to vegetative reproduction. Unlike yellow toadflax, Dalmatian toadflax spreads vegetatively and by seed with shoots emerging from these two sources in early April through May. Seed viability for Dalmatian toadflax is high with germination rates near 75 percent.

Invasive Features

Yellow toadflax can grow new shoots on lateral roots up to 10 feet away from parent plants. A single Dalmatian toadflax plant produces about 500,000 seeds from July through October depending on location, aspect, and availability of water. Seeds remain viable in the soil for up to 10 years, and roots are easily spread by machinery.

Management

Once the root system is established, Dalmatian and yellow toadflaxes are extremely competitive for water and resources; thus, they are difficult to eradicate or control. Early detection and prevention of population expansion should be the first priorities for managing these plants. The following actions should be considered when planning a management approach:

- Maintain healthy plant communities to reduce or limit toadflax infestations. This may involve improving grazing management practices to prevent overgrazing.
- Check hay and straw for presence of toadflax seed. Only certified weed-free hay and pellets should be fed to horses used in backcountry areas.
- Detect, report, and eradicate new populations of toadflax as early as possible.
- Combine mechanical, cultural, biological, and chemical methods for most effective toadflax control.
- Implement monitoring and a follow-up treatment plan for missed plants and seedlings.
- Map large infestations. Keep annual records of reported infestations.

Table 2 summarizes some management options for controlling Dalmatian or yellow toadflax under various situations. Further details on these management options are explained below. Choice of individual control method(s) for these toadflaxes 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 number of years needed to achieve control. More than one control method may be needed for a particular site.

Physical Control

Physical methods to control toadflax should focus on destroying the root system. Surface treatments (such as mowing) used to reduce flowering and seed production can suppress infestations but will not kill the plants.

Manual Methods

Hand pulling, digging, or hoeing can be effective for seedlings or small infestations of toadflax. These

Table 2. Management options*

Site	Physical Control	Cultural Control	Biological Control	Chemical Control
Roadsides and non-crop areas	In level terrain, use repeated cultivation with disk or sweep-type cultivators about 8 to 10 times the first year followed by 4 to 5 times the second year. Follow up with chemical control.	Use seed, mulch, and fill materials certified to be weed-free. Educate road crews to identify and report infestations along roads; implement requirements for vehicle operations.	Use beetles, moths, or weevils as classical biocontrol agents (see table 3). Effectiveness of biocontrol agents may be limited when disturbance from road operations interrupts an agent's life cycle.	Apply in fall during late flowering stages. Use truck or ATV-mounted spraying equipment. Wash under vehicle after application to prevent spread.
Rangeland	In level terrain, use repeated cultivation with disk or sweep-type cultivators about 8 to 10 times the first year followed by 4 to 5 times the second year. Follow up with chemical control.	Use seed and forage hay certified to be weed-free; use pellets for horses in backcountry areas. Check animals, clothing, and vehicles for seeds. Corral sheep for 11 days before moving to un-infested areas. Reseed treated areas if necessary to make desirable plants more competitive. Fertilization and/or irrigation may help establishment of desirable plants.	Use beetles, moths, or weevils as classical biocontrol agents (see table 3). Closely manage grazing to prevent overuse.	For extensive and dense infestations, use ground or aerial broadcast spraying. For less dense infestations, consider individual plant treatment with crews using backpack sprayers.
Wilderness and other natural areas	Repeated hand-pulling, digging, or hoeing for seedlings and regrowth. Anticipate need to repeat treatments and monitor for ~10 years.	Use seed and forage hay certified to be weed-free; use pellets for horses in backcountry areas. Check animals, clothing, and vehicles for seeds. Corral sheep for 11 days before moving to un-infested areas. Post signs warning visitors to inspect and remove seed from clothing, animals, and vehicles. Reseed treated areas if necessary to make desirable plants more competitive. Fertilization and/or irrigation may help establishment of desirable plants.	Same as above	Use backpack or hand-held sprayers. Broadcast spraying by aerial or ground methods may be used on thicker stands if allowed.

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

methods are easier if done in sandy or moist soils. Although removal of the root is very difficult, it is necessary for maximum effectiveness. Treatments should be repeated several times per growing season, and the site should be revisited for many years to assure that new plants have not grown from dormant seed. Proper disposal of debris is important to reduce further spread. If flowers or seed are present, they will continue to mature. Therefore, debris should be destroyed by burning or else bagged and removed from the site. If flowers or seed are not present, plants may be pulled and left onsite.

Mechanical Methods

Mowing, chopping, or cutting plants can suppress toadflax; but these practices are generally not

recommended since new shoots can re-sprout rapidly from adventitious root buds in response. Repeated cultivation with a disk or a sweep-type cultivator can be effective if done for 2 or more consecutive years. However, mechanical control with these two implements is typically limited to agronomic settings since the terrain must be suitable for their use. Starting in May or June, cultivation should be done through the growing season as often as required to eliminate green growth. Do not allow new growth to be visible for longer than 7 to 10 days before repeating cultivation. Generally, 8 to 10 cultivations are required during the first season and at least 4 to 5 times in the second year. Consider reseeding the next spring or fall with desirable perennial forage species of varying root depths and growth habits. It will probably be necessary to use a follow-up chemical treatment to control new toadflax seedlings and re-sprouting of roots. Plan to periodically monitor the treated site for as many as 10 years, and then spot treat or hand pull plants as they emerge.

If machinery is used to manage toadflax, the equipment should be cleaned after use to prevent movement of seed or root fragments into un-infested areas.

Prescribed Fire

Wildfire or controlled burns can destroy toadflax canopies, but plants taller than 2 inches tend to have well-developed roots and usually are not killed by heat from fire. Typically, there is prolific sprouting from Dalmatian and yellow toadflaxes after fire; therefore, burning is not recommended. However, burning Dalmatian toadflax seedlings less than 2 inches high with a propane torch has been used with some success in Oregon and Washington.

Cultural Control

Early detection and plant removal are critical in preventing establishment of toadflax species. 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. Land managers, the local public, and road crews should be educated in identifying these species (especially in the seedling stage) so they can help report all suspected infestations. Farm, rangeland, and outdoor recreation equipment can transport seeds; care should be taken to clean the equipment thoroughly before moving from infested areas to un-infested areas. If possible, weed screens should be used on irrigation water intakes in infested areas to prevent seed transportation in ditches or canals. Reseeding of treated areas may help establish desirable plants if native plants are not already present. However, native grasses generally increase rapidly in the season following herbicide treatment.

Biological Control

Grazing

Toadflaxes contain glucosides that are poisonous to livestock when consumed in high quantity, but animals typically avoid eating these species. Care should be taken not to overgraze infested areas since overgrazing allows toadflax plants to become more competitive and abundant than desirable grazed species. Short-term, intensive grazing by sheep during spring and late season can suppress Dalmatian toadflax and limit seed production, as shown by field trials in Montana. However, follow-up herbicide treatment was still needed to control the toadflax.

Classical Biological Control

Under certain conditions, insect biocontrol agents can be used to help control toadflax species, but these agents will not completely eradicate them. Biocontrol agents for toadflax should be used only if infestations are large enough to sustain populations of these species. 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.

Several insect species are permitted for release in the United States as biocontrol agents for both Dalmatian and yellow toadflaxes. Table 3 lists biocontrol agents approved for release in the U.S.; however, the long-term success of these agents in the Southwest is largely unknown. For further information on biocontrol of Dalmatian and yellow toadflaxes, see Sing et al. (2016) in the “References and Further Information” section of this field guide.

Table 3. Biocontrol agents approved for Dalmatian and yellow toadflaxes

Species	Type of Agent	Site of Attack	Impact	Use/Considerations for Release
Brachypterolus pulicarius	beetle	Dalmatian and yellow toadflax: shoots and flowers	Adults feed on shoot tips and axillary buds; lays eggs in buds; larvae feed on immature seeds. Can reduce seed set by 74 percent.	An accidental introduction in the USA, it is approved for redistribution within North America. Because the beetle is already widespread and its overall impact is low, it is not a high priority for redistribution.
Eteobalea intermediella and *E. serratella*	moth	Both toadflaxes: roots	Adults lay eggs in lower leaf axils at base of yellow toadflax and on non-flowering Dalmatian toadflax stems. Larvae bore into stem or root.	Impacts both toadflaxes.
Mecinus janthinus	weevil	Yellow toadflax: stem mining	Repeated, yearly attack by both adults and larvae can lead to striking reductions in toadflax plant density. Adult weevils consume/chew on the growing tips of toadflax shoots, stems, and leaves, producing a distinctive shot hole injury pattern. This damage weakens the plant, suppresses flowering and seed production, and severely stunts shoots. Larval mining causes desiccation and likely depletes nutrient reserves in the roots.	While currently not widely distributed, *M. janthinus* densities and impact on yellow toadflax can be high locally; this species appears to establish well in new areas.
Mecinus janthiniformis	weevil	Dalmatian toadflax: stem mined	Repeated, yearly attack by both adults and larvae can lead to striking reductions in toadflax plant density. Adult weevils consume/chew on the growing tips of toadflax shoots, stems, and leaves, producing a distinctive shot hole injury pattern. This damage weakens the plant, suppresses flowering and seed production, and severely stunts shoots. Larval mining causes desiccation and likely depletes nutrient reserves in the roots. Large aggregations of *M. janthiniformis* adults feeding on new shoot growth can result in significant injury to shoot tips and leaves; heavily attacked shoot tips may turn brown and shrivel.	*M. janthiniformis* is currently established in northwestern US where it has dramatically reduced Dalmatian toadflax populations in some locations.
Rhinusa antirrhini (formerly *Gymnaetron*)	weevil	Dalmatian and yellow toadflax: seed capsule	Adults eat leaf buds, young leaves, and young shoot tips. After bloom, adults eat floral tissue and lay eggs in floral ovaries; larvae eat seeds.	This beetle (yellow toadflax biotype) was unintentionally introduced. It has spread throughout North America on both toadflaxes.
Rhinusa neta (formerly *Gymnaetron*)	weevil	Dalmatian and yellow toadflax: seed capsule	Similar to *R. antirrhini*. Both species impact seed production and may reduce toadflax by 85 to 90 percent.	This beetle was unintentionally introduced and is now established in North America, but only in scattered populations.
Rhinusa linariae (formerly *Gymnaetron*)	weevil	Yellow toadflax: root	Adult foliage feeding and larval galling are known to reduce plant nutrient reserves; however, current populations are too low to have a significant impact on yellow toadflax populations.	To date, *R. linariae* is established only on yellow toadflax in British Columbia. Since populations are slow to build, redistributions are made whenever possible.

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

Herbicides recommended in table 4 will control or suppress Dalmatian or yellow toadflax s when properly applied, although these herbicides may also impact non-target species such as forbs, shrubs, or trees. Control results will vary due to weather variables and the plant's growth stage, so special care should be taken to follow label directions closely. Each herbicide product will have different and unique requirements and restrictions according to the herbicide label. Read and understand the label prior to any application. Consult the registrant if you have questions or need further details.

The best performing herbicides for toadflax control are chlorsulfuron (e.g., Telar® XP) and picloram (e.g., Tordon® 22K) either alone or in combination. Other herbicides in table 4 will control toadflax, but plants often recover from a single treatment so anticipate that spraying may need to be repeated. Research of herbicide effects on Dalmatian toadflax in Colorado and Wyoming showed that Telar® XP applied at 2 oz/acre gave excellent control over 5 years while Tordon® 22K at 2 pt./acre gave good control. Treatments made on yellow toadflax were somewhat site dependent and required higher rates of Telar® XP (2.5 to 3 oz/a) or Tordon® 22K (2 to 4 pt/acre) to be effective. When mixing Telar® XP, use a quality nonionic surfactant (NIS) or silicone-based adjuvant at the labeled rate. Control of yellow toadflax with Telar® XP may be improved by using methylated seed oil at 1 percent v/v instead of a NIS, but injury to native forbs and shrubs may increase.

Herbicide Application

Most herbicide treatments are recommended for application during the flowering or post-flowering stage in fall. Yellow toadflax is usually more difficult to control with herbicide than Dalmatian toadflax; however, repeated treatments over several years are often needed to control either species.

Herbicides shown in table 4 may be applied by backpack or hand-held sprayers, ATV or UTV sprayers, or conventional boom sprayers that are pulled or attached to a tractor or truck. Any equipment used to spray herbicide should be calibrated. For individual plant treatment (IPT), use a single nozzle on a backpack or hand-held sprayer to wet the foliage and stems thoroughly. Consult the herbicide label for mixing directions. Herbicides listed in table 4 will impact desirable species; therefore, precautionary measures should be taken if non-target species need protection.

Management Strategies

The seedling is the most vulnerable stage for toadflaxes, and seedlings should be removed upon discovery. Control of established toadflax populations should focus first on smaller infestations in otherwise healthy sites. Initial toadflax treatments should attempt to eliminate live plants and disrupt seed and/or root production as much as possible. Later treatments should try to enhance the establishment and competition of native plants to further reduce toadflax populations.

A detailed management plan should be developed for sites infested with toadflax that considers both the combination of methods necessary for toadflax control as well as the condition and composition of native plants. Before spraying herbicide, evaluate each site closely to determine

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
Picloram[3]	Tordon 22K	1–2 quarts	0.5–1%	Late flower to post-bloom stage in the fall.	Persistent, selective herbicide. Re-treatment for several years may be required. Labeled for rangeland use.
Dicamba	Banvel, Clarity, Vanquish	1–2 quarts	3–5%	Same as above.	Same as above
Chlorsulfuron	Telar XP	2–2.6 ounces	Consult label	Same as above.	Apply as a high volume foliar spray using a minimum of 24 gallons of water per acre.
Aminocyclopyrachlor + chlorsulfuron	Perspective	7.5–8 ounces	Add 5–9 grams of dry flowable powder to 1 gallon of water. Consult label for directions.	Apply to fall rosettes for best control.	Persistent; selective; may cause temporary injury to some grass species. Labeled for non-crop use.
Imazapic	Plateau	8–12 fluid ounces Plateau + 1 quart methylated seed oil (MSO)	0.25–1.5%	Same as above.	Persistent, selective herbicide. Re-treatment for several years may be required. Use lower rate when cool season grasses are present.

[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 toadflaxes.

[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] Picloram is a restricted-use pesticide. A certified applicator's license is required for purchase and use.

whether seeding will be necessary or if the plant community will return naturally. Seeding is not typically needed when native grasses are common beneath toadflax, as grasses will increase rapidly in the following seasons after treatment. If seeding is needed after a spray treatment, then additional herbicide treatment can be used to complement seeding of desirable competitive species.

Follow-up monitoring and spot treatment of toadflax regrowth and seedlings should be anticipated for at least 3 to 4 years and possibly longer if complete eradication of toadflax is desired. 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 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 re-colonization and a return of the infestation to pretreatment levels.

Adaptive Management

Because toadflax species are difficult to control, it should be anticipated that ongoing management will be required for many years. Therefore, realistic goals and objectives should be established to manage toadflax 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 approach 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.

References and Further Information

Butler, M.D. and L.C. Burrill. 1994. Yellow Toadflax and Dalmatian Toadflax. A Pacific Northwest Extension Publication PNW135. Available at http://weeds.nmsu.edu/pdfs/yellow_toadflax_factsheet_11-06-05.pdf (accessed May 2010).

Cardina, J., C. Hern, T. Koch, and T. Webster. Undated. Ohio Perennial and Biennial Weed Guide. Published by Ohio State University Extension. Available at http://www.oardc.ohio-state.edu/weedguide/default.asp (accessed April 2010).

Davison, J.C., E. Smith, and L.M. Wilson. 2007. Livestock Grazing Guidelines for Controlling Noxious Weeds in the Western United States. Publication EB-06-05. Available at http://www.cnr.uidaho.edu/rx-grazing/Livestock_Graizng_Guidelines%28Davison_et_al.%202007%29.pdf (accessed May 2010).

Douglas County Weed Division. 2005. Integrated Weed Management of Dalmatian Toadflax. Castle Rock, CO. Available at http://www.douglas.co.us/publicworks/operations/documents/DalmationToadflax.pdf (accessed May 2010).

Duncan, K., K. McDaniel, and M. Renz 2005. Chemical Weed and Brush Control for New Mexico Rangelands. Las Cruces: New Mexico State Univ. College of Agriculture and Home Economics and Cooperative Extension Service. Pp. 6. Available at http://aces.nmsu.edu/pubs/_circulars/CR_597.pdf.

Hansen, R. Dalmatian and Yellow Toadflax. 1997. In C.R. Weeden, A.M. Shelton, and M.P. Hoffman. 1997. Biological Control: A Guide to Natural Enemies in North America. Cornell University, NY. Available at http://www.nysaes.cornell.edu/ent/biocontrol/weedfeeders/toadflax.html (accessed May 2010)

Invasive Plant Atlas of the United States. Available at http://www.invasive.org/weedus/index.html (accessed May 2010).

Jeffries, A. Undated. Toadflax Control Methods in the Methow Valley. Methow Valley Citizens Council Projects. Available at http://www.methow-valley-citizens-council.org/projects/LIDA/lida.htm (accessed May 2010).

Ogden, J.A.E. and M.J. Renz. 2005. Dalmatian Toadflax (*Linaria genistifolia* ssp. *dalmatica*). New Mexico State Univ. Department of Plant Extension Sciences, Las Cruces, NM. Available at http://weeds.nmsu.edu/pdfs/dalmatian_toadflax_factsheet_11-06-05.pdf (accessed May 2010).

Ogden, J.A.E. and M.J. Renz. 2005. Yellow Toadflax (Linaria vulgaris) New Mexico State University Department of Plant Extension Sciences, Las Cruces, NM. Available at http://weeds.nmsu.edu/pdfs/yellow_toadflax_factsheet_11-06-05.pdf (accessed May 2010).

Sing, S., R. De Clerck-Floate, R. Hansen, H. Pearce, C. Bell Randall, I. Tosevski, and S. Ward. 2016. Biology and Biological Control of Dalmatian and Yellow Toadflax (3rd ed.). FHTET-2016-01.USDA NRCS. 2010. The PLANTS Database. National Plant Data Center, Baton Rouge, LA. Available at http://plants.usda.gov (accessed 25 May 2010).

Whitson, T.D. (ed.), et al. Weeds of the West. Western Society of Weed Science in cooperation with Cooperative Extension Services. University of Wyoming, Laramie, WY. Available at http://plants.usda.gov/java/invasiveOne?pubID=WSWS (accessed March 2010).

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Dept. of the Interior, Washington, DC. Available at: https://www2.usgs.gov/sdc/doc/DOI-%20Adaptive%20ManagementTechGuide.pdf

Zouhar, K. 2003. Linaria spp. In Fire Effects Information System (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available at http://www.fs.fed.us/database/feis/ (accessed May 26, 2010).

Suggested Web Sites

Encycloweedia Datasheets by California Department of Food and Agriculture: http://www.cdfa.ca.gov/phpps/ipc/weedinfo/linaria.htm

For information about calibrating spray equipment: NMSU Cooperative Extension Service Guide A-613, *Sprayer Calibration*. Available at http://aces.nmsu.edu/pubs/_a/A613

Herbicide labels online: http://www.cdms.net/

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