Linaria dalmatica (L.) Mill. ssp. *dalmatica*
(= *L. genistifolia* (L.) Mill. ssp. *dalmatica* (L.) Maire & Petitm.)

Dalmatian toadflax

Family: Scrophulariaceae
Range: Throughout much of North America, including all western states.
Habitat: Open fields, pastures, riparian areas, rangeland and disturbed sites such as roadsides, forest clearings, and agricultural fields. Grows in most environments and can tolerate many soil types. Grows best in cool, semiarid climates and on dry, coarse soils at neutral to slightly alkaline pH. Although it often invades disturbed areas, it has been shown to move into relatively undisturbed prairies and riparian habitats. Tolerates sub-arctic conditions. It is one of the few weeds that have invaded the shortgrass steppe in eastern Colorado.
Origin: Native to Europe and the Mediterranean region and brought to North America as a garden ornamental in the mid to late 1800s.
Impacts: Dalmatian toadflax is a persistent, aggressive invader capable of forming dense colonies through adventitious buds from creeping root systems. These colonies can push out native grasses and other perennials, thereby altering the species composition of natural communities. The plant decreases forage for domestic livestock and some big game species and decreases habitat for associated animal communities. Dalmatian toadflax contains quinazoline alkaloids that could possibly pose toxicity problems to livestock if ingested in sufficient quantity, but intoxications of livestock have not been reported. Goats and sheep have been known to graze the plants with little effect.
Western states listed as Noxious Weed: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, Wyoming
California Invasive Plant Council (Cal-IPC) Inventory: Moderate Invasiveness

Dalmatian toadflax is an herbaceous perennial that can reach a height of 3 ft or more, with individual plants producing up to 25 stems in the first year of growth. Stems are rough and woody at the base becoming smooth, waxy and herbaceous toward the top. The leaves are waxy with a bluish green color, ovate to heart-shaped but sometimes lanceolate, 0.5 to 2.3 inches long, with smooth margins. The leaves are alternate and clasping on the upper portion of the stem. Dalmatian toadflax produces both taproots and creeping roots, with adventitious buds forming new individuals. Roots can grow 4 to 10 ft deep and can extend 10 ft from the parent plant.

The flowers resemble snapdragons with petals ranging from 0.75 to 1.5 inches long. Flowers are two-lipped, yellow, often with an orange, bearded throat and a long spur. They mature from the lower part of the stem upwards, and various stages of flowering and fruiting can be present on an inflorescence. The fruits are two-celled capsules with many irregularly-shaped, sharply angular, slightly winged, black seeds. Reproduction is by seed and vegetatively from creeping lateral roots. Most seed falls near the parent plant. Seed production and viability is highly variable, depending on out-crossing and presence of pollinators. A single plant can produce as many as 500,000 seeds per year. Seeds germinate in spring and fall when conditions become favorable. Seedlings compete poorly with established vegetation for soil moisture. Plants can rapidly colonize a site by vegetative reproduction from creeping roots. It is not known how long the seed

survive in the soil, but because they are so small, it is likely that they do not survive for more than a couple of years.

NON-CHEMICAL CONTROL

Mechanical (pulling, cutting, disking)	Hand pulling is only effective on seedlings before plants become established and the extensive creeping root system develops. Mowing can prevent the plant from going to seed, but mowing also stimulates vegetative reproduction from the lateral roots and rhizomes. Tilling on arable lands can be effective but tilling needs to be done every 7 to 10 days over the course of the season and repeated yearly for several years in order to eradicate resprouting root fragments.
Cultural	In some cases, grazing is not considered an effective control option. However, in Colorado, goat grazing has worked well, particularly when in combination with the biocontrol insect *Mecinus*. Overgrazing can reduce competition and increase site disturbance, creating an ideal environment for toadflax establishment. The plant is not preferred by grazing livestock and contains quinazoline alkaloids that are moderately toxic. Fire is not effective because the underground root system is not damaged and will resprout. Reseeding with competitive annual and perennial grasses reduces survival and helps prevent further spread.
Biological	Eight insects have been introduced and approved by the USDA-APHIS for release as biocontrol agents for both Dalmatian and yellow toadflax in the United States with varying success. *Brachypterolus pulicarius*, a shoot and flower feeding beetle, can reduce seed set on attacked plants by 74%. *Gymnaetron antirrhini* and *G. netum*, both seed-capsule feeding weevils, have been shown to impact seed production in these species. *Calophasia lunula*, a moth introduced from Eurasia, has been shown to defoliate up to 20% of a plant. Establishment in California is uncertain for these species. Another agent, the toadflax stem-mining weevil (*Mecinus janthiniformis*) was misidentified as *Mecinus janthinus* when first introduced in 1995. European research showed that the *Mecinus* attacking Dalmatian toadflax was actually *M. janthiniformis*, and that *M. janthinus* was attacking yellow toadflax. It has had substantial and dramatic impacts on Dalmatian toadflax populations in many western states and is even becoming established in California. The weevil damages the foliage but also destroys flower production. In Colorado, it has reduced Dalmatian toadflax populations 4 to 5 years following release.

CHEMICAL CONTROL

The following specific use information is based on published papers and reports by researchers and land managers. Other trade names may be available, and other compounds also are labeled for this weed. Directions for use may vary between brands; see label before use. Herbicides are listed by mode of action and then alphabetically. The order of herbicide listing is not reflective of the order of efficacy or preference.

GROWTH REGULATORS	
2,4-D Several names	**Rate:** 2 to 4 pt product/acre (0.95 to 1.9 lb a.e./acre). **Timing:** Postemergence when plants are growing rapidly. Applications in spring provide best control. **Remarks:** 2,4-D is a selective herbicide for broadleaf species. It was found to provide only fair control of Dalmatian toadflax in a California study. Good coverage is necessary. Efficacy is improved when tank-mixed with picloram, chlorsulfuron, or metsulfuron.
Aminocyclopyrachlor + chlorsulfuron *Perspective*	**Rate:** 4 to 6 oz product/acre plus 0.25 to 0.5% v/v surfactant **Timing:** Postemergence when plants are in the rosette stage or in mid-fall when plants are dormant. **Remarks:** *Perspective* provides broad-spectrum control of many broadleaf species. It gave excellent control in a California study and appears to be the best product for Dalmatian toadflax. Although generally safe to grasses, it may suppress or injure certain annual and perennial grass species. Do not treat in the root zone of desirable trees and shrubs. Do not apply more than 11 oz product/acre per year. At this high rate, cool-season grasses will be damaged, including bluebunch wheatgrass. Not yet labeled for grazing lands. Add an adjuvant to the spray solution. This product is not approved for use in California and some counties of Colorado (San Luis Valley).
Dicamba	**Rate:** 4 qt product/acre (4 lb a.e./acre) and water plus 0.25 to 0.5% v/v surfactant

Banvel, Clarity	**Timing:** Early postemergence in spring before toadflax reaches bloom stage. **Remarks:** Dicamba is a selective herbicide for broadleaf species. In a California study, 2 lb a.e./acre gave partial control of Dalmatian toadflax at the rosette stage, and poor control when applied at the bolting or dormant stage. It has a short soil residual activity. Repeated applications may be necessary for better control.
Picloram *Tordon 22K*	**Rate:** 1 to 2 qt product/acre (0.5 to 1 lb a.e./acre) plus 0.25 to 0.5% v/v surfactant **Timing:** Postemergence when plants are growing rapidly in spring before full bloom, or in late summer to early fall. **Remarks:** At 8 oz a.e./acre in a California study, picloram gave only partial control (80%) when applied at the dormant stage in mid-fall, and poor control at the rosette and bolting stages (< 60% control). Higher rates may be necessary in some areas. High levels of picloram can give long-term soil activity for broadleaves. *Tordon 22K* is a federally restricted use pesticide. It is not registered for use in California.
Picloram + 2,4-D *Tordon 101M*	**Rate:** 2 qt product/acre plus 0.25 to 0.5% v/v surfactant **Timing:** Postemergence when plants are growing rapidly in spring before full bloom. **Remarks:** May require annual treatment for 2 to 3 years. High levels of picloram can give long-term soil activity for broadleaves. It is not registered for use in California.
Picloram + chlorsulfuron *Tordon 22K + Telar*	**Rate:** 1 qt product/acre *Tordon 22K* + 1.25 oz product/acre *Telar* plus 0.25 to 0.5% v/v surfactant **Timing:** Postemergence when plants are growing rapidly, from bloom through fall. Fall treatments give best control. **Remarks:** High levels of picloram can give long-term soil activity for broadleaves. Retreatment may be necessary. *Tordon 22K* is a federally restricted use pesticide. It is not registered for use in California.
AROMATIC AMINO ACID INHIBITORS	
Glyphosate *Roundup, Accord XRT II*, and others	**Rate:** Broadcast treatment: 1 to 2 qt product (*Roundup ProMax*)/acre (1.1 to 2.25 lb a.e./acre). Spot treatment: 1.5 to 2% solution v/v *Roundup* (or other trade name) and water to thoroughly wet all leaves **Timing:** Postemergence when plants are growing rapidly. Applications in early spring provide best control. **Remarks:** Glyphosate is a nonselective systemic herbicide that may kill non-target partially-sprayed plants. Repeated applications may be necessary for complete control.
BRANCHED-CHAIN AMINO ACID INHIBITORS	
Chlorsulfuron *Telar*	**Rate:** 2 to 2.6 oz product/acre (1.5 to 1.95 oz a.i./acre) plus 0.25 to 0.5% v/v surfactant **Timing:** While most recommendations note that applications should be made postemergence when plants are growing rapidly in the bud to bloom stage, others have found that the best timing is when plants are in the rosette stage or when they are dormant in mid-fall. **Remarks:** Chlorsulfuron is a selective herbicide effective for controlling mainly broadleaves, but also some grasses. A California study showed best results with a rosette or dormant stage application at the highest rate (1.95 oz a.i./acre). Chlorsulfuron can be tank mixed with picloram or 2,4-D.
Imazapic *Plateau*	**Rate:** 12 oz product/acre (3 oz a.e./acre) plus 1 qt/acre methylated seed oil in the spray mix **Timing:** Postemergence in fall when the top 25% of the plant is necrotic. This typically occurs after a hard frost. **Remarks:** Imazapic is a selective postemergence herbicide effective for controlling broadleaf weeds and some grasses. In one study, it was not found to be very effective for the control of Dalmatian toadflax at 12 oz product/acre. It is not registered for use in California.
Imazapyr *Arsenal, Habitat, Stalker, Chopper, Polaris*	**Rate:** 3 pt product/acre (0.75 lb a.e./acre) plus 0.25 to 0.5% v/v surfactant **Timing:** Some reports note that the best timing is postemergence when plants are growing rapidly, whereas others show that a dormant application in mid-fall was the best timing. **Remarks:** Imazapyr is a preemergent and postemergence herbicide effective for controlling broadleaf weeds and grasses. In a California study using 3 pt product/acre, excellent control was

	only achieved with a mid-fall application to dormant plants. It has fairly long soil residual activity.
Metsulfuron *Escort*	**Rate:** 1.5 to 2 oz product/acre (0.9 to 1.2 oz a.i./acre) plus 0.25 to 0.5% v/v surfactant; efficacy is improved with the addition 2,4-D at a rate of 1 qt product/acre **Timing:** Early postemergence. **Remarks:** Metsulfuron is a selective herbicide for broadleaf species. In areas where desirable grasses are growing around toadflax, metsulfuron can be used without non-target damage. In one study, however, metsulfuron at 2 oz product/acre gave poor control regardless of timing from the rosette to the dormant stage. It is not registered for use in California.

RECOMMENDED CITATION: DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States*. Weed Research and Information Center, University of California. 544 pp.