Centaurea virgata Lam. ssp. *squarrosa* (Boiss.) Gugler
(= *Centaurea squarrosa* Willd.; *Centaurea triumfettii* All.)

Squarrose knapweed

Family: Asteraceae
Range: California, Nevada, Oregon and Utah.
Habitat: Fields, roadsides, disturbed open sites, grassland, rangeland, especially degraded rangeland, and logged areas. Squarrose knapweed is more adaptable to drought and cold temperatures than spotted knapweed and diffuse knapweed. Like other knapweeds, it seldom persists in shaded places.
Origin: Native to Asia.
Impacts: Like other knapweeds, squarrose knapweed is a highly competitive, noxious weed. Dense stands can exclude desirable vegetation and wildlife in natural areas.
Western states listed as Noxious Weed: Arizona, California, Nevada, Utah
California Invasive Plant Council (Cal-IPC) Inventory: Moderate Invasiveness

Squarrose knapweed is a bushy, herbaceous, taprooted perennial that grows to about 3 ft tall. The leaves are alternate and variously covered with short to medium interwoven grayish hairs. The upper leaves are entire and linear; the lower stem leaves are 4 to 8 inches long and deeply pinnate-lobed one to two times. Plants are basal rosettes in fall and winter, bolting to produce erect, highly branched flowering stems in late spring and summer.

The flowerheads consist of spiny or comb-like phyllaries and pink to pale purple disk flowers. The spiny phyllaries usually reflex downward. This characteristic distinguishes squarrose from diffuse knapweed. The achenes either lack a pappus or have a short bristly pappus (2 to 2.5 mm long). Plants reproduce only by seed. While seeds of most *Centaurea* species fall near the parent plant, squarrose knapweed seedheads detach from the parent plant as a unit and tumble along the ground, dispersing seed to a greater distance. In addition, they can disperse by clinging to the wool, hair or fur of animals. It is not known how long seeds remain viable in the soil, but it is assumed that survival would be similar to other *Centaurea* species, 2 to 5 years, with a few seeds surviving longer.

NON-CHEMICAL CONTROL

Mechanical (pulling, cutting, disking)	Hand pulling is practical for scattered plants, or for areas where other control methods are not feasible and sufficient labor is available. Repeated hand pulling is necessary during the season and over many years. Results of hand removal are expected to be similar to diffuse knapweed, for which successful control was reported when plants were hand removed 3 times a year (spring, summer, and late summer) over a period of 5 years. Every effort should be made to remove the entire taproot with little soil disturbance. If not possible, then cut the root 2 to 4 inches below the soil surface to remove much of the reproductive crown. Gloves should be worn when hand pulling. The best timing is before plants produce viable seed. Hand pulling has not been effective in all areas. When dry soils, it may be difficult to remove the root crown and this can lead to rapid reestablishment. Mowing typically doesn't kill knapweeds; cut plants generally survive and recover to set seed. Plants mowed at the rosette stage will quickly recover, and mowing too late (after seed set) can disperse seed. However, mowing at the late bud to early bloom stage will reduce seed production. Mowing can also remove dead growth to improve herbicide coverage. A program of cutting only bolted plants, particularly at the early bloom stage, for several consecutive years is expected to greatly suppress squarrose knapweed. Cultivation is effective when repeated, but squarrose knapweed typically doesn't infest areas conducive to

	tillage.
Cultural	There is no direct information on management of squarrose knapweed with grazing or prescribed burning, but it is expected that this species should respond like diffuse or spotted knapweed.
Biological	Squarrose knapweed is closely related to both diffuse and spotted knapweeds. As a result, several seed-feeding biological control insects introduced for those species have attacked squarrose knapweed. In northern California, larvae of these species have reduced seed production by over 99% for many years now. The most effective appear to be the broad-nosed seedhead weevil *Bangasternus fausti*, and the two weevils *Larinus minutus* and *L. obtusus*. Because squarrose knapweed plants can survive for 8 or more years, management with biological control agents will require a few more years to monitor.

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:** 1 to 2 qt product/acre (0.95 to 1.9 lb a.e./acre) **Timing:** Postemergence from rosette to beginning of bolting, or fall rosette. Optimal at early flowering stage. **Remarks:** Control is only temporary and does not prevent seedling establishment the following year. Generally requires repeat applications. 2,4-D is not considered as effective as other growth regulator herbicides for season-long control. It is broadleaf-selective and may injure other non-target species, particularly crop plants. 2,4-D has no soil activity. Do not apply ester formulation when outside temperatures exceed 80°F. Amine forms are as effective as ester forms at the small rosette stage, and amine forms reduce the chance of off-target movement.
Aminocyclopyrachlor + chlorsulfuron *Perspective*	**Rate:** 4.75 to 8 oz product (*Perspective*)/acre **Timing:** Postemergence and preemergence. Postemergence applications are most effective when applied to plants from the seedling to the mid-rosette stage. **Remarks:** Aminocyclopyrachlor gives control of squarrose knapweed similar to aminopyralid. *Perspective* provides broad-spectrum control of many broadleaf species. 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).
Aminopyralid *Milestone*	**Rate:** 5 to 7 oz product/acre (1.25 to 1.75 oz a.e./acre) **Timing:** Postemergence and preemergence. Postemergence applications are most effective from the rosette to the bolting stage. Effective control can also be obtained with a fall application to new regrowth. **Remarks:** Aminopyralid is one of the most effective herbicides for the control of squarrose knapweed. It is safe on grasses although preemergence application at high rates can greatly suppress invasive annual grasses, such as medusahead. Aminopyralid has a longer residual and higher activity than clopyralid. Other members of the Asteraceae and Fabaceae are very sensitive to aminopyralid. For postemergence applications, a non-ionic surfactant (0.25 to 0.5% v/v spray solution) enhances control under adverse environmental conditions; however, this is not normally necessary. Other premix formulations of aminopyralid can also be used for diffuse knapweed control. These include *Opensight* (aminopyralid + metsulfuron; 1.5 to 2 oz product/acre) and *Forefront HL* (aminopyralid + 2,4-D; 2 to 2.6 pt product/acre), both applied at the rosette to bolting stages.
Clopyralid *Transline*	**Rate:** 0.67 to 1.33 pt product/acre (4 to 8 oz a.e./acre). Use higher rate for older plants or dense stands. **Timing:** Preemergence to seedlings or postemergence to seedlings or mature plants. Postemergence applications are generally best in spring, from beginning of bolting up to the bud stage. Can also

	apply to fall regrowth. Results are best if applied to rapidly growing weeds. **Remarks:** While clopyralid is very safe on grasses, it will injure many members of the Asteraceae, particularly thistles, and can also injure legumes, including clovers. Most other broadleaf species and all grasses are not injured.
Clopyralid + 2,4-D *Curtail*	**Rate:** 2 to 4 qt *Curtail*/acre **Timing:** Same as for clopyralid. **Remarks:** The addition of 2,4-D can increase the damage to other non-target broadleaf species. Add a non-ionic surfactant.
Dicamba *Banvel*, *Clarity*	**Rate:** 1 to 2 pt product/acre (0.5 to 1 lb a.e./acre). Use higher rate for older plants or dense stands. **Timing:** Postemergence from rosette to beginning of bolting, or fall rosette. Optimal at early flowering stage. **Remarks:** Dicamba is a broadleaf-selective herbicide often combined with other active ingredients. It is not typically used alone to control squarrose knapweed. Dicamba can also be mixed with 2,4-D (1 pt dicamba + 2 pt 2,4-D/acre) or picloram (1 to 2 pt dicamba + 0.5 to 1 pt picloram/acre) for spot treatments.
Picloram *Tordon 22K*	**Rate:** 1 to 2 pt product/acre (4 to 8 oz a.e./acre). Use higher rates for older plants or dense stands. **Timing:** Postemergence and preemergence. With postemergence application, optimally treat at rosette to mid-bolting stage (before flowering to prevent current year seed production), or fall rosette stage. Apply when plants are growing rapidly. Under favorable growing conditions, application in summer can be effective if higher application volumes are used. **Remarks:** Picloram is a broadleaf herbicide and gives a broader spectrum of control than aminopyralid, aminocyclopyrachlor, and clopyralid, and has much longer soil residual activity. Lower rates may require annual spot treatments. Treatment made in bud stage may not prevent seed production in the year of application. Picloram has been shown to provide selective control of squarrose knapweed for 3 to 4 years. Although well-developed grasses are not usually injured by labeled use rates, some applicators have noted that young grass seedlings with fewer than four leaves may be killed. Do not apply near trees. Picloram is a restricted use herbicide. It is not registered for use in California. Control with lower rates may be improved by tank mixing with dicamba or 2,4-D; picloram and dicamba (0.25 to 0.5 pt/acre + 0.125 to 0.25 pt/acre) and picloram plus 2,4-D (0.5 to 1 pt picloram + 1 to 2 pt 2,4-D/acre). A backpack sprayer or a wiper is highly recommended in small areas to minimize damage to non-target plants.
AROMATIC AMINO ACID INHIBITORS	
Glyphosate *Roundup*, *Accord XRT II*, and others	**Rate:** Broadcast foliar treatment: 3 qt product (*Roundup ProMax*)/acre (3.375 lb a.e./acre). Spot treatment: 1.5% v/v solution **Timing:** Postemergence to rapidly growing knapweed when most plants are at bud stage. **Remarks:** Glyphosate will only provide control during the year of application; it has no soil activity and will not kill seeds or inhibit germination the following season. Glyphosate is nonselective. To achieve selectivity, it can be applied using a wiper or spot treatment to control current year's plants.

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.