DRAFT WRITTEN FINDINGS OF THE
WASHINGTON STATE NOXIOUS WEED CONTROL BOARD
Proposed Class B Noxious Weed Listing

Scientific Name: *Centaurea melitensis* L.

Common Name: Malta starthistle, Tocalote, Maltese starthistle or centaury, Napa thistle

Family: Asteraceae

Legal Status: Proposed Class B noxious weed

Images: left, basal rosette, image by Joseph M. DiTomaso, University of California - Davis, Bugwood.org; center, flowerhead with purple-red tipped spiny bracts, image by, Rich Old; right, stem with blooming flowerheads, image by Andrea Moro, image licensed under a Creative Commons Attribution Non Commercial Share-Alike 3.0 License.

Description and Variation:

Overall habit:

Centaurea melitensis is an annual that begins as a basal rosette of leaves and then grows stems up to around 3 feet tall, though often shorter, with spiny yellow flowerheads that resemble yellow starthistle, *Centaurea solstitialis* (DiTomaso and Healy 2007). Plants have simple to branching wiry stems, covered in hairs, being loosely gray-tomentose (Keil and Ochsmann 2006).

Roots:

Centaurea melitensis develops taproots which do not grow as deeply into the soil as *Centaurea solstitialis* (DiTomaso and Healy 2007).

Stems:

Plants grow one to a few main stems that branch toward the top of the plant (Keil and Ochsmann 2006). Stem leaf bases extend down the stem, giving a winged appearance (DiTomaso and Gerlach 2000). Stem wings measure up to 3mm at their widest (DiTomaso and Healy 2007). Stems are grayish-green, covered in stiff, jointed, multicellular hairs, sometimes minutely scabrous and minutely resin-gland dotted (Keil and Ochsmann 2006).

Leaves:
Like stems, leaves are often grayish-green, covered in stiff hairs and minute resin glands. Often, the older leaves have sparse, fine, white cottony hairs that do not hide the stiff hairs and resin glands (DiTomaso and Healy 2007). Basal rosette leaves and lower stem leaves have petioles or tapering leaf bases, with leaf blades that are oblong (longer than wide with nearly parallel sides) to oblanceolate (much longer than wide, with widest point toward the tip, tapering to the base) in shape and 0.8 to 6 inches (2 to 15 cm) long. Leaf margins are entire to toothed, or pinnately lobed (deeply lobed) (Keil and Ochsmann 2006). The terminal lobe is usually the largest and rounded at the tip (DiTomaso and Healy 2007).

Stems leaves are alternate and become linear to oblong or oblanceolate moving up the stem, 0.4 to 2 inches (1 to 5 cm) long, with margins that are entire, toothed or wavy (DiTomaso and Healy 2007, Keil and Ochsmann 2006).

Basal rosettes and sometimes lower stem leaves may wither by the time plants begin to flower (DiTomaso and Healy 2007).

Images: left, open and unopened flowerheads, image by: Franco Folini, Creative Commons Attribution-Share Alike 2.0 Generic; right, stem shown to scale with penny, image by 2009 William R. Carr [Usage].

Flowers:
Like *Centaurea solstitialis*, flowerheads of Malta starthistle, *Centaurea melitensis*, are comprised of yellow disk flowers, called florets. Flowerheads are single or in leafy clusters of two to three, sessile or have stems (peduncles) (Keil and Ochsmann 2006). Base of flowerhead is egg-shaped, 8-15 mm, loosely cobwebby-tomentose or becoming glabrous. Involucral bracts at base of flowerhead are arranged in 5 to 10 rows (Porras and Muñoz 2000b). Main bracts have a slender, central spine at the tip, 5-10 mm (-12 mm) long that is often purplish to brownish colored. At the base of the central spines are lateral spines,

usually in 3 to 4 pairs, with the upper pair near the middle of the central spine (DiTomaso and Healy 2007). The yellow disk florets can be sterile or fertile.

Centaurea melitensis has a unique flowering and reproductive strategy in the Asteraceae family as it has both cleistogamous flowerheads (self-fertilizing flowers that do not open) and chasmogamous flowerheads (flowers open and can be cross-pollinated). It develops flowerheads in three main stages:

- Initial, self-fertilizing (cleistogamous) flowerheads: earliest flowerheads produced, one to four, and located at or near the base of plant or on axils of main branches (Porras and Muñoz 2000b). Plants may or may not produce these types of flowerheads. These flowerheads do not open, produce only fertile florets, no sterile florets, and a lesser number of florets than the flowerheads with opening florets.
- Fully opening florets that are able to cross-pollinate (chasmogamous) flowerheads: these flowerheads develop during the middle phase of flowering and are located near to the top of the plant (Porras and Muñoz 2000b). These flowerheads have sterile and fertile florets. The stamens and stigma extend beyond the corolla of the floret to allow cross-pollination, but they do often self-pollinate.
- Final self-fertilizing (cleistogamous) flowerheads: flowerheads developed toward the end of the flowering period on the main axis of the plant or on first- and second-order branches. These flowerheads do not open and contain only fertile florets, no sterile florets (Porras and Muñoz 2000b).

Flowerhead production is variable, ranging from 1-100 or more per plant (DiTomaso and Healy 2007). Flowerheads of self-fertilizing flowerheads are smaller than flowerheads that open and allow cross-pollination (Porras and Muñoz 2000b).

Images : left, unopened flowerheads with purplish, spine-tipped bracts, image, 2011 Barry Breckling; this image has a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 (CC BY-NC-SA 3.0) license; right, *Centaurea melitensis* rosette with a first stage self-fertilizing flowerhead in the center, image credit: David Thornburg, CC BY-NC (Attribution-Non-Commercial).

Fruit:

Each fertilized floret can produce a dry, single-seed fruit with attached bristles, called a cypselae. Cypselae are dull white, to gray to tan, often with slightly darker stripes, and are about 2 to 3 mm long (Keil and Ochsmann 2006). The pappus is made up of many white to pale tan, unequal, stiff bristles, 1 to 3m long (Keil and Ochsmann 2006). The base is deeply notched with a scar where the fruit used to be attached (DiTomaso and Healy 2007) and where an elaiosome develops (Porras and Muñoz 2000c).

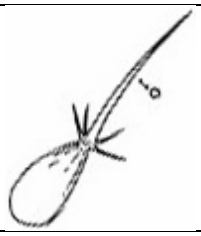
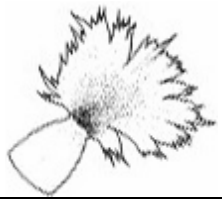
From the 3 phases of flowerheads: (all Porras and Muñoz 2000c)

- Initial self-fertilizing (cleistogamous) flowerheads: These cypselae are larger and thicker and have a shorter pappus. Elaiosomes on these fruits average 50% thicker than the fruits produced by the fully-opening flowers.
- Fully-opening, potentially outcrossing flowers: Fruits produced here are smaller with a more developed, longer pappus and the thinnest elaiosome.
- Final stage self-fertilizing flowers: These fruits are similar in size to the fully-opening flowers and have a short pappus. Its elaiosome thickness is intermediate between the other two types.

Image: left, *Centaurea melitensis* seed, a cypselae; right, flowerhead shown to scale with less colored central bracts, image by Forest and Kim Starr - Plants of Hawaii - Image licensed under a Creative Commons Attribution 3.0 License, permitting sharing and adaptation with attribution.

Similar Species:

	Habit	Leaves	Flower	Bracts	
Malta starthistle, *Centaurea melitensis*	Typically shorter than yellow starthistle, growing up to 3 feet tall. Grayish green color covered in stiff hairs and glandular dots.	Basal and lower leaf margins entire to deeply lobed, rounded larger lobe at tip.	Flowerheads smaller than yellow starthistle; about ½ to 5/8 inch; self-fertilizing flowerheads do not open.	Central spine about 0.2 to 0.5 inches, 5 to 10 mm (-12mm) long, tinged purple to brown; dense to sparse cob-webby hairs.	 © Ron Vanderhoff
Yellow starthistle, *Centaurea solstitialis*	Branched stems with wings, grayish-green, plant covered in	Basal and lower leaves deeply lobed, upper	Flowerheads terminal, up to an 1 inch; made up of	Tip of bract with still, straw-colored spine, up to 1 inch long	Image from PNW 432

	woolly hairs, up to 3.3 feet	stem leaves smaller, thin and pointed	small, yellow flowers		
Bighead knapweed, *Centaurea macrocephala*	Tall perennial, grows up to 5.6 feet	Light-green, broadly lance-shaped with toothed edges and pointed tips	Large, solitary flowerheads are 1 to 3 inches in diameter; flowers yellow	Bracts light green to golden, with thin, papery, fringed margins, no sharp central spine.	Image from PNW 432 
Purple starthistle, *Centaurea calcitrapa*	Forms a rosette with cluster of spines at center; multiple branched stems; bushy growth habit; young plants covered with cobwebby hairs, becoming hairless with age.	Basal and lower leaves deeply lobed and divided; upper stem leaves narrow and undivided.	Flowerheads narrow; made up of light to dark purple flowers; seeds without a pappus (plume)	Bracts with spine tips, up to 1.2 inches long	

(Keil 2013, WSNWCB and Winterowd 2003)

Left: *Centaurea melitensis*; right: *Centaurea solstitialis*. Elsinore Peak vic, W and S, 5-26-12. © Ron Vanderhoff.

Habitat:

Centaurea melitensis is native to the Mediterranean region in Europe and is adapted to weather conditions found along the west coast of the United States of cool, wet winters and warm, dry summers. It thrives in open, disturbed habitats such as grasslands, rangelands, creek beds, fields, pastures, roadsides and waste places (DiTomaso and Healy 2007). In California, plants have also established in less disturbed to undisturbed communities such as pine-oak woodlands, chaparral, coastal dunes and bluffs and even serpentine habitats, wetlands, and alluvial fans (Consortium of California Herbaria 2010 in Moroney and Rundel 2013). Keil and Ochsmann (2006) note plants can grow from sea level up to 4,921 feet (1,500 meters), while DiTomaso and Healy (2007) note plants can grow at elevations up to 7,218 feet (2,200 meters).

Herbarium records in Washington record plants growing on gravel banks, dry sandy beaches, a steep rocky bank along a highway, and among rocky outcrops on a south facing grassy slope (Consortium of Pacific Northwest Herbaria 2017).

Geographical Distribution:

Centaurea melitensis is native to the Mediterranean region, from southern Europe and northern Africa. The USDA GRIN database (USDA ARS 2017) specifically lists *C. melitensis* native to:

- Northern Africa: Algeria, Libya, Morocco, Tunisia
- Southern Europe: Bosnia and Herzegovina, Croatia, Greece, Italy, Montenegro, France, Portugal, Spain

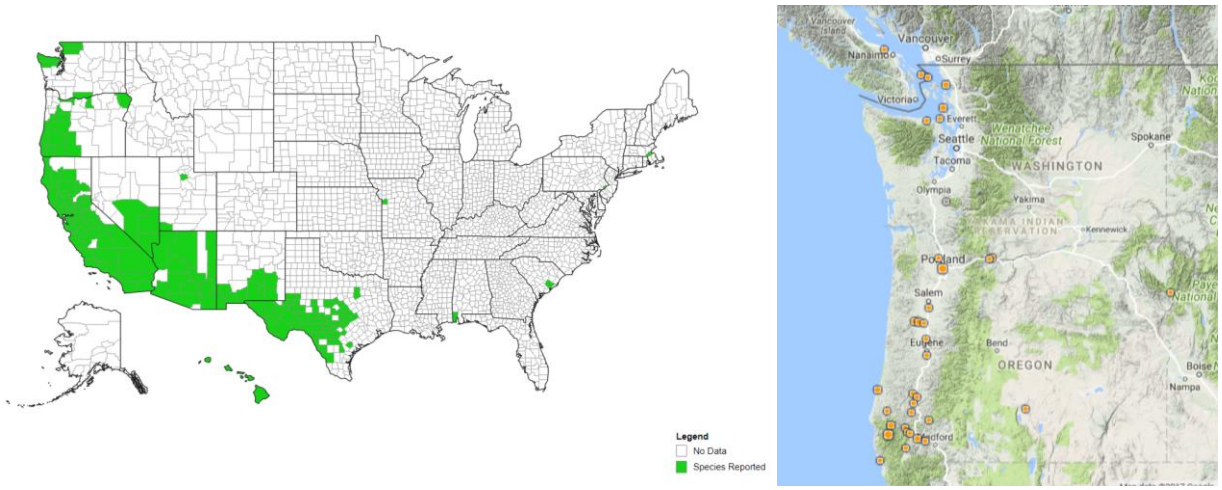
USDA GRIN database (USDA ARS 2017) lists *Centaurea melitensis* naturalized or adventive in:

- Africa: Kenya, Eritrea, Ethiopia, South Africa
- Macaronesia: Cape Verde; Portugal: Azores, Madeira Islands; Spain: Canary Islands
- Australia and New Zealand
- United States: Illinois, Missouri, Wisconsin, Massachusetts, New Jersey, Pennsylvania, Idaho, Oregon, Washington, California, Arizona, Nevada, Utah, New Mexico, Texas, Alabama, Georgia, Mississippi, Hawaii
- Canada: British Columbia
- Mexico: Baja Norte
- New Caledonia
- South America: Argentina, Chile, Uruguay, Ecuador, Peru
- Europe: Belgium, Czech Republic, Germany, Poland, Switzerland, Norway, United Kingdom

History:

Centaurea melitensis is thought to have been introduced to California with the Spanish missionaries in the late 18th century, with reference to it being in an adobe brick of a building constructed in 1797 in San Fernando (Hendry 1931 in DiTomaso and Gerlach 2000). Seeds are then thought to have been spread as a seed contaminant in grain crops and then established in cultivated fields (DiTomaso and Gerlack 2000).

The earliest herbarium record from California is from 1861, over 60 years after its initial discovery in the adobe bricks in 1797, while earliest herbarium records from Oregon and Washington date back to the 1880's.



Maps: left, county level presence/absence distribution information of *Centaurea melitensis* in the United States by EDDMapS 2017; right, map of herbarium records of *Centaurea melitensis* in Washington and Oregon (orange dots), Consortium of Pacific Northwest Herbaria 2017.

Washington:

The earliest record of *Centaurea melitensis* in Washington is from a herbarium specimen collected in June of 1881 (WS138787) on Suksdorf Farm, at Bingen, on the Columbia River, by the well-known botanist Wilhelm Suksdorf (Marion Ownbey Herbarium 2017). Since then, all other records of *Centaurea melitensis* in Washington State, except two, are from 1939 or earlier. These early records include a collection in 1896 at Port Townsend in Jefferson County (WS27485); a collection on Whidbey Island in

Island County on July 1, 1897 (WS27486); a collection in Sequim on a gravel bank in August of 1931 (WTU21636); a collection from 1937 on a dry, sandy beach at Port Francis on Portage Island, Whatcom County (WS90503); and a collection on a sandy beach on Eliza Island in Whatcom County in 1939 (WS1000229) (Consortium of Pacific Northwest Herbaria 2017, Marion Ownbey Herbarium 2017).

After 1939, only two records of *Centaurea melitensis* have been made in Washington. The first record is from a herbarium collection in Klickitat County along State Highway 14 near Bingen, on a steep rocky bank, August 10, 1985 (WTU337883) (Consortium of Pacific Northwest Herbaria 2017). Then in 2016, *Centaurea melitensis* was discovered near the peak of Eagle Cliff on Cypress Island in Skagit County (WTU 409303). It was discovered by the Samish Tribe Department of Natural Resources during a prairie/bald survey-assessment. The population found was fairly small, growing among rocky outcrops on a grassy south-facing slope and was subsequently removed by hand, bagged and taken off site (EDDMapSWest 2016).

Images: left, *Centaurea melitensis* infestation and right, close up of *Centaurea melitensis* in bloom at the Cypress Island population discovered in 2016, both images credit: Bud Hardwick.

In a survey of County Noxious Weed Coordinators conducted in July of 2017, other than the Cypress Island population in Skagit County, no other Coordinator is aware of *Centaurea melitensis* currently growing in their counties (WSNWCB 2017).

Listings:

Centaurea melitensis is listed as a Category A noxious weed in Nevada, a Class B noxious weed in New Mexico and a noxious weed in California (National Plant Board 2017, CA Dept. of Food and Agriculture 2015).

Growth and Development:

Centaurea melitensis seeds commonly germinate after fall rains (DiTomaso and Healy 2007). Seeds have been found to germinate over a wide range of temperatures (Bain 2013). Seedlings form rosettes of basal leaves that remain as rosettes through the winter (DiTomaso and Healy 2007). In the spring, initial self-fertilizing flowerheads may form at the base of the plant or on the axils of the main branches (Porras and Muñoz 2000c). Stems develop in the spring, branching more toward the top, with flowerheads forming throughout. References from the United States note flowers blooming from April through July (DiTomaso and Healy 2007), or even as late as through September (Hitchcock et al. 1955). In a study of *Centaurea melitensis* in Spain, where it is native, the initial self-fertilizing flowerheads were

Image: senesced flowerhead of *Centaurea melitensis* with retained central spine of involucral bracts, image credit: Jordan Zylstra.

produced from March to April, the blooming, non-self-fertilizing flowerheads were produced from April to May, and the final, self-fertilizing flowerheads were produced from May to June (Porras and Muñoz 2000c).

After flowering, seed maturity, and dispersal, flowerheads senesce and often retain their central spines but typically shed the loose receptacle and dense fuzzy hairs, leaving behind a shallow bowl of bracts with spines (DiTomaso and Healy 2007). This is opposite to yellow starthistle, *Centaurea solstitialis*, where senesced flowerheads shed their central spines and retain their fuzzy centers (DiTomaso and Healy 2007).

Reproduction:

Centaurea melitensis is an annual that reproduces by seed and typically completes its lifecycle earlier than yellow starthistle, *Centaurea solstitialis* (DiTomaso et al. 2013). Seed production per plant is highly variable with 1 to 60 seeds produced per flowerhead and 1 to 100 flowerheads produced per plant (Gerlach unpubl. data in DiTomaso and Gerlach 2000). Seed germination studied in Spain found that seeds from opening flowers germinated quickly and had a high germination rate (Porras and Muñoz 2000c). Seeds from the final, self-fertilizing flowerheads (produced at the end of the flowering period) also had rapid germination. Seeds from the initially produced, self-fertilizing flowerheads were the slowest, had the lowest germination rate and germinated at the coolest temperatures (Porras and Muñoz 2000c). All seedlings from the three types of flowerheads had an over 80% survivability rate (Porras and Muñoz 2000c).

Seeds fall near the parent plant and also may be dispersed a short distance by wind (Porras and Muñoz 2000c). Seeds can then be further dispersed by people, animals, water and soil movement (DiTomaso and Healy 2007). Stace (1993) noted in the United Kingdom seeds were mainly dispersed in wool and birdseed. In its native range, seeds are also dispersed by myrmecochory, seed dispersal by ants that are attracted to the elaiosomes on the base of the fruit structure, enticing the ants to take the seeds back to their anthills (Porras and Muñoz 2000c). Some seeds also remain in the old flowerheads until early fall (Bain 2013).

It is not known for certain how long *Centaurea melitensis* seeds may remain viable in the seedbank. DiTomaso et al. (2013) theorized that the seed longevity of *C. melitensis* may be similar to *Centaurea solstitialis*, meaning that few seeds produced were viable beyond 4 years, but some seeds may survive for up to 10 years under certain conditions. Porras and Muñoz (2000c) also concluded some of *C. melitensis* seeds, from the initial self-fertilizing flowerheads, may have some dormancy.

Wild oat (*Avena* species) litter may have allelopathic properties that limit *Centaurea melitensis* seed germination (Tinnin and Muller 1972 in DiTomaso and Gerlach 2000).

Economic Importance:

Detrimental:

Though Malta starthistle, *Centaurea melitensis*, is not as competitive as yellow starthistle, *Centaurea solstitialis*, it still causes detrimental impacts to ecosystems. In the United States, *Centaurea melitensis* is the most widespread in California, though not as abundant as *Centaurea solstitialis*, it is more common in some locations such as Santa Cruz Island (Barthell et al. 2003). Besides invading disturbed habitats, *C. melitensis* can also invade native plant communities (see distribution). *Centaurea melitensis* can grow in cultivated fields and has been noted to degrade agricultural systems (DiTomaso and Gerlach 2000). Forage plants may become less accessible with starthistle invasions, and livestock typically avoid grazing plants with spiny flowerheads (USDA Forest Service 2015). *Centaurea melitensis* can injure people and animals due to its spiny flowerheads.

In California, infestations of *Centaurea melitensis* have displaced native plant species and impacted wildlife. *Centaurea melitensis* was shown to reduce the reproductive capacity of an endangered California endemic sunflower, *Pentachaeta lyonii* (Moroney et al. 2011). It also negatively impacts another endangered forb in California, *Acanthomintha ilicifolia*, the San Diego thornmint (USFW 2009). By competing for resources such as nutrients, light and water, *Centaurea melitensis* reduces the biomass and reproductive output of San Diego thornmint when growing together (Bauder and Sakrison 1999 in USFW 2009).

DiTomaso et al. (2013) also note that *Centaurea melitensis* may also increase soil erosion and reduce water percolation, but since it dies back earlier than *Centaurea solstitialis*, it is not as likely to have as large an impact on soil moisture depletion.

Horses may be poisoned and develop "chewing disease" or E.N.E. (Equine *nigropallidal encephalomalacia*) if they ingest large quantities (86 - 200% body weight) of yellow starthistle, *Centaurea soltitialis* over 1 to 2 months. *Centaurea melitensis* is suspected of producing the disease, but as yet its toxicity has not been confirmed experimentally (Burrows and Tyrl 2013). The disease is characterized by acute inability to eat or drink, and the horses may die from dehydration and starvation. Only horses are affected. Chemical substances in *C. solstitialis* are somehow altered in the processes of digestion and metabolism producing a toxin which causes death of nerve centers in the brain controlling normal eating and drinking mechanisms. There is no cure. Horses in south central Washington have contracted chewing disease and died.

<u>Beneficial:</u>
Centaurea melitensis, Malta starthistle, has not been noted to have any significant beneficial impacts. DiTomaso et al. (2013) noted that *C. melitensis* is used medicinally in Spain, where it is native.

Unlike *Centaurea solstitialis*, which are obligate out-crossers and attract a high number of honey bee (Apis spp.) visits, *Centaurea melitensis* attracts a relatively low number of honey bees (Thorp et al. 2000 in Barthell et al. 2003).

<u>Control methods:</u> (from DiTomaso et al. 2013 unless otherwise noted)
It is important to use an integrated weed management plan when controlling invasive plant populations. Using a combination of methods that can be adapted over time as on the ground conditions change can provide successful control of populations. Monitoring and additional control work will be essential to prevent *C. melitensis* from reestablishing. Since *Centaurea melitensis* is an annual, it is key to deplete the seedbank with multiple years of management to control infestations (DiTomaso et al. 2006). Where *Centaurea melitensis* populations are limited, plants should be removed quickly before additional seed can be produced and spread.

Removing invasive species can open up a habitat to reinvasion if follow-up management does not occur (Kyser et al. 2013). By planting a variety of desirable species, a community will be present to provide competition and shading to weed seedlings and to also provide a food source for pollinators. When possible, carry out control methods when pollinators are not active on plants. Wear protective clothing when working among plants with developed flowerheads to avoid injury from the spines. Also, make sure to clean equipment, tires and shoes when leaving infestations to prevent spread.

Mechanical methods:

Removal methods such as hand-pulling, mowing, or cultivation (when used to prevent seed production), should reduce and eventually eliminate the infestation when carried out; however, long seeds remain viable in the seedbank (up to 4 years, in some conditions potentially up to 10 years). DiTomaso et al. (2013) recommend using the same mechanical control methods used on yellow starthistle to control *Centaurea melitensis*, as they are expected to be effective.

Centaurea melitensis plants can be hand-pulled, making sure to remove as much of the taproot as possible. The best time to pull plants is either as rosettes or after they have bolted but before they have produced viable seed—so before they begin to flower. Do not leave any above ground plant parts or plants may recover. Repeatedly hoeing plants can also be effective at controlling small infestations (USDA Forest Service 2015). Bag and trash pulled plants as unopened flowerheads may be self-fertilizing and can produce viable seed. Plants may be easier to pull if they are under stress from competing vegetation.

Repeated mowing can provide control of *Centaurea melitensis.* When it's feasible to use, mowing should take place only when plants are in late bud or early bloom stage (USDA forest service 2015). Mowing should occur regularly at a height that will remove the lowest branches. Leaves should not be left below the level of the cut (USDA forest service 2015). Mowing may not be possible in rough or steep terrain. If mowing mature plants that are in flower, collect mowed material to prevent dispersing the seed. Make sure mowing does not hinder other management methods happening on site.

USDA Forest Service (2015) reports that frequent tillage, 5 or 6 times a year at 2 week intervals, with a plow or disc, can control *Centaurea melitensis*. This method is typically used on agricultural lands and roadsides but may not be appropriate in wildlands or rangelands as it may damage other desirable species or cause other detrimental impacts.

Cultural Methods:

There have not been any studies conducted on the effectiveness of using prescribed fires as a control method for *Centaurea melitensis*. Fire may not be an effective control method as the timing with *C. melitensis*'s lifecycle is much earlier than *Centaurea solstitialis* and burning could possibly damage desirable species. Also, infestations of *C. melitensis* are typically not dense enough to provide fuel to carry a fire (DiTomaso and Healy 2013).

Biological Control:

Grazing may provide some control of *Centaurea melitensis,* but no studies have been conducted on its effectiveness. It is possible that grazing results may be similar to that of *Centaurea solstitialis*. Short-duration, intensive grazing may be part of an effective control strategy to manage *C. melitensis*, especially when combined with other control methods (USDA Forest Service 2015). Sheep, goats and cattle may graze plants in the early spring before seedheads have formed (USDA Forest Service 2015).

Avoid having horses feed on *Centaurea melitensis* plants in case it may cause chewing-disease, and ensure other suitable forage is available for other livestock (USDA Forest Service 2015).

No specific biological control agents have been researched and released to control *Centaurea melitensis* (DiTomaso and and Gerlach 2000). In California, the false peacock fly (*Chaetorellia succinea*) and hairy weevil (*Eustenopus villosus*) will also attach *Centaurea melitensis*, but to a lesser degree than they attach yellow starthistle, *Centaurea solstitialis* (DiTomaso and Healy 2007). The hairy weevil is used to control *Centaurea solstitialis* in Washington (WSU IWCP 2017), but it is unknown if it would have any effect on *Centaurea melitensis* since there are currently no known populations of this plant in Washington. A small seedhead-feeding beetle (*Lasioderma haemorrhoidale*) was also unintentionally introduced to California from the Mediterranean region, but it has had little effect in controlling the *C. melitensis* (DiTomaso and Healy 2007).

Chemical Control:

Use herbicide control in combination with other control methods to reduce usage when possible. If using a foliar spray, treat plants when pollinators are not present or are the least active.

Centaurea melitensis is not currently included in The Pacific Northwest Weed Management Handbook but check back as this resource is continually updated: https://pnwhandbooks.org/ .

The USDA Forest Service (2015) and DiTomaso et al. (2013) make herbicide recommendations that can be used for *Centaurea melitensis* control. Listed below are some examples from these publications, with examples of product names* in parentheses:

- Clopyralid (Transline), applied at the early rosette stage through bolting to bud stage.
- Aminopyralid (Milestone), applied postemergence and preemergence; applying to seedlings up to mid-rosette stage.
- Aminocyclopyrachlor+chlorsulfuron (Perspetive), applied to rosettes through bolting stage; although it is generally safe to grasses, it may injure or suppress certain annual or perennial grass species.
- Glyphosate (Roundup), a non-selective herbicide, applied to rapidly growing plants—from bolting to beginning of flowering, is very effective for late season control.

(*These product names are provided as examples only and do not serve endorsements of these particular brands.)

Make sure to read and follow all instructions on the herbicide label.

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