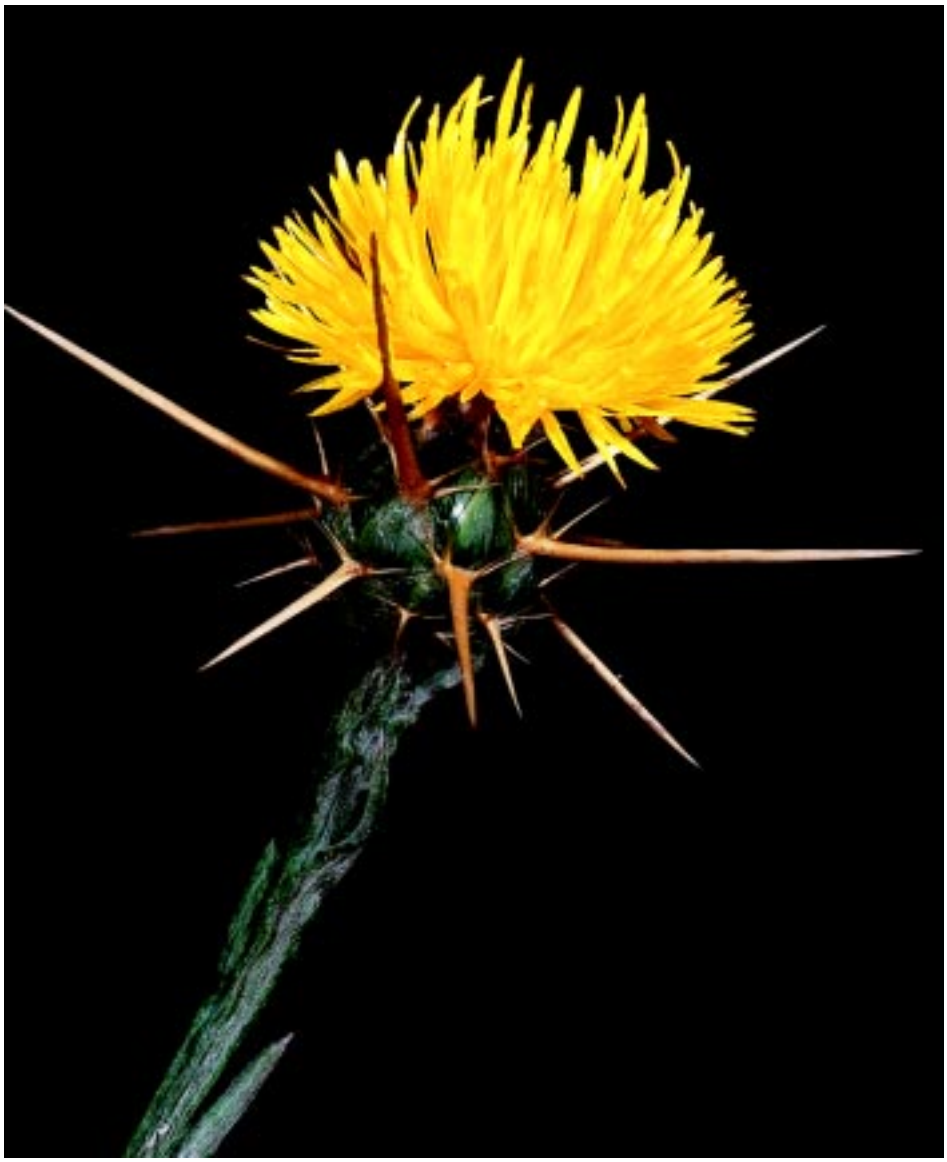
Managing YELLOW STARTHISTLE



A resource guide for managing Yellow Starthistle published by the El Dorado County Noxious Weed Management Group

Yellow Starthistle Biology

Yellow starthistle (YST) produces two types of seed. The seed with pappus (bristles), is spread more easily by wind or animals. The seed with no pappus falls near the parent plant. About 80% of starthistle seed germinates in the first year but it can remain viable when buried in the soil for over five years. Crop seed infested with yellow starthistle seed brought the plant to North America and facilitated spread in the USA.

Yellow starthistle seedlings may be found any time during the rainy season from fall to spring. Effective late-season control strategies such as mowing, tillage, prescribed burning, or postemergence herbicides should be conducted after seasonal rainfall events are completed, but before viable seeds are produced.

Yellow starthistle rosettes are the photosynthetic engines that power the future flowering of the plant. At this stage of development the roots are deep in the soil to collect moisture for flowering. Chemical control becomes difficult or even futile after this stage. Grazing or cutting hay at this stage may benefit YST as it provides more light to the rosette leaves. This photo shows YST growth during winter months.

Yellow starthistle flowers can produce 35 to over 80 seeds per flower depending upon the site. Large plants are capable of producing over 100,000 seeds. Unfortunately many people begin their control measures after the plants have started blooming. By this time viable seeds have already been produced and large numbers of spiney plants must be dealt with. **Late control is no control.**

Yellow Starthistle

Centaurea solstitialis (Asteraceae)

INTRODUCTION

Biology Yellow starthistle (referred to as YST in this document) is native to Eurasia and was introduced to California in circa 1850 via South America. It is a long-lived winter annual that is usually found below 6,000 feet elevation in dry, sunny areas where average annual rainfall is between 10 and 60 inches. YST seeds germinate from fall through spring, corresponding to the normal rainy season in California. After germinating, the plant initially allocates most of its resources to root growth. By late spring, roots can extend over 3 feet into the soil profile, although the portion above ground is a relatively small basal rosette (a rosette is a cluster of leaves produced on a very short stem). This allows YST to out-compete shallow-rooted annual species during the drier summer months. The competitive ability of YST also depends on light intensity at the soil surface during the seedling and rosette stages of development. YST proliferates at high light intensity and does poorly in low light.

The rosette stage extends through winter and spring. In late spring, May – June, plants "bolt" (produce erect stems), sending up tall, branched stalks that then produce the spiney yellow flower heads.

YST plants generally mature in late summer, long after most other annuals have senesced. Under some conditions, YST behaves as a biennial, surviving a second winter and regrowing the following spring. Seed maturation coincides with the progressive loss of the bright yellow pigment of the developing flowers. As flower color fades, the seeds quickly develop. Two types of seed are produced. The lighter-colored seeds with bristly hairs disperse quickly after maturity. Darker seeds usually lack hairs and persist in the flower head until the heads disintegrate in midwinter. Although most seeds germinate the following year or are eliminated by predation and pathogens, seed buried deep in the soil can survive for five or more years.

Distribution Recent reports indicate that yellow starthistle infests more than 15 million acres in California, and can be found in 56 of the 58 counties in the state. It is widespread throughout the foothill counties, including El Dorado. It is now common in open areas on roadsides, rangeland, wildlands, pastures, and waste areas.

Impacts YST lowers the yield and forage quality of rangelands and interferes with livestock grazing and forage harvesting. It is the most important roadside weed problem in much of California and has also caused problems in cultivated crops, orchards, and vineyards. YST reduces the value of and access to recreational areas, and it can also displace native plants. It forms dense infestations and rapidly depletes soil moisture, thus preventing the establishment of other species.

YST is poisonous to horses, causing a nervous disorder called "chewing disease" that is fatal once symptoms develop. Horses are the only animals known to be affected in this manner and should not be allowed to graze on YST. Cattle and goats can be grazed on YST to help manage it (see below).

California Department of Food and Agriculture (CDFA) noxious weed rating = C, generally a common, widespread weed. Action to retard its spread outside of nurseries is at the discretion of the County Agricultural Commissioner.

MANAGEMENT: Using an Integrated Approach

Successful management of YST improves with an integrated approach, using several control tactics in combination and with a clear goal in mind for the property concerned. It is important to realize that control of YST requires a vigorous and extended effort lasting at least three years. Seeds of YST can survive in the soil seed bank for up to eight years, so consistent monitoring for new plants is essential. In heavily-infested areas some type of herbicide or extensive mechanical control is most useful in the first year or two. These efforts can be followed up with less intensive measures, but persistence is required. Make a management plan with the help of professionals. Many ranchers, leasees and landowners begin their control efforts only after yellow starthistle has grown thick and tall, covering many acres. Chemical control must begin before biomass has built up, usually in the seedling or rosette stage and generally before 2-5% of the plants have open flowers.

The following control tactics can be used in a "strategic plan":

Prevention Prevention is the most cost-effective control method and should be considered whenever there is a chance of introducing or inadvertently encouraging YST. YST often first occurs after disturbance that either brings in seed or encourages conditions for seed germination and growth. This disturbance can be cultivation, poorly timed mowing, road building and maintenance, new construction sites or overgrazing.

Vehicles in the transportation of livestock or contaminated soil, sand or gravel often spread seeds. Cleaning of tractors and grading equipment prior to moving into non-infested areas can help prevent the spread of seeds. Hay or straw used as mulch along roadsides or disturbed areas can be a source of YST introduction. Rice straw or certified weed-free hay can be used for mulch or feed, and are both available from suppliers in California and Nevada. Roadside surveys following construction to detect and immediately eradicate new infestations can prevent seed production and subsequent spread.

YST also can be spread as a contaminant in grass seed. Only certified seed should be used for range or pasture seeding. YST seed may also come as a contaminant in all classes of hay, particularly grass hay. Carefully check hay shipments for evidence of YST. When feeding hay that is suspected of containing YST, place bales in one area and periodically check around feeding areas for signs of starthistle seedlings. Livestock that have fed in YST-infested areas should not be pastured or shipped to uninfested areas.

Control newly emerged seedlings to prevent establishment. It is important to control new infestations when they are small. Eradication is least expensive and most effective at this time.

TIPS for Preventing a Yellow Starthistle Infestation:

At construction sites:

- Request that equipment such as tractors and graders be cleaned before moving into non-infested areas.
- Request soil from non-contaminated sites.
- Conduct a roadside survey after construction is completed to detect and eradicate new infestations.
- Use a certified weed-free straw such as rice straw for mulch.

On pasture and rangelands:

- Use only certified seed for range or pasture seeding.
- Carefully check hay shipments for evidence of YST.
- If hay is suspected to contain YST, isolate suspected bales and check them periodically for seedling germination.
- Livestock pastured in YST infested areas should not be moved to uninfested areas.

In the urban landscape:

- Early detection and hand removal can be very effective.
- Landscaping and revegetation after disturbance can provide plant competition and shade YST out-preventing establishment.

Remember, YST first occurs after conditions that either bring in seed or encourage seeds already present to germinate and grow. Once a plant is established, it produces over 180,000 seeds!

Mechanical and Cultural Control Methods

Control Method	Timing	Application Considerations
Tillage	After the rainy season when soils are dry, but before YST seeds mature. 2-5% bloom	Control method for cultivated fields. If plants are small using a harrow may be sufficient. A disc is recommended to turn soil and up-root larger plants. Repeated cultivation may be necessary if done too early and a newflush of seedlings occurs.
Mowing	After the rainy season when soil moisture is low, but before YST seeds mature. 2-5% flower	Most effective on plants with high branching pattern. Mowing too early will not prevent seed production and flowering may occur below mower cutting height. A follow-up mowing may be necessary if significant growth and flowering occurs.
Grazing	During bolting season (May-June), one to three follow-ups at two week intervals	Grazing by sheep, goats or cattle can be effective for control if properly timed. Grazing too early, pre-bolt may actually increase starthistle. Rotational grazing is not necessary if stocking rate is adequate from bolting season for about 8 weeks following.
Prescribed Burning	Late spring before seed set, but after annual and perennial grasses have produced seed	Yellow starthistle will still be green in the late spring so there must be enough dry biomass from other vegetation to carry a fire. Do not burn in areas where insects have been released for biological control.
Manual Control, Hoeing Hand-pull	While plants are growing prior to seed maturing	Effective, but only practical in small, localized infestations. May be useful as follow up after other control methods.
Re-vegetation	Follow-up after implementing other control methods	Establishing vegetation i.e. legumes, perennial grasses, annual grasses to compete against starthistle is necessary to insure it will not become reestablished. Perennial grasses can be effective competition but are difficult to establish. Legumes are also effective but may be damaged by follow-up herbicide treatments.

Chemical Control Options.

Timing is critical for effective chemical control of YST: most herbicides are best effective in the rosette or bolting stage before 2-5% of the plants have open flowers. Integrating mechanical or cultural control methods will increase the possibility of success. **Note: Herbicides are considered pesticides and should only be used in accordance with their labels, as required by law. Herbicide drift and applicator safety are risks associated with using chemical materials. Contact your local Agricultural Commissioner's office (in El Dorado County at (530) 621-5520) to see if an Operator I.D. number, Private Applicators Certificate and/or a Restricted Materials Permit is required for the chemical you choose to use.**

Herbicide	Timing	Application Consideration
Clopyralid (Transline)	Late fall to bolting stage. Higher rates may be necessary later in season. Apply in early rosette stage, later applications will require higher rates. A single application at the recommended time will provide season-long control.	Although very selective, can injure legumes and members of the sunflower family. Can persist in soil and contaminate compost. Provides both pre-and postemergence full season control. No grazing restrictions. Very effective the first year of a long-term strategic management plan. Can also be used the second year. Pesticide I.D. number required. Contact Ag. Commissioner's office.
2,4-D (many names) **Dicamba** (Banvel) **Triclopyr** (Garlon, Remedy)	Late winter to early spring. Most effective on seedlings but can control mature plants up to flowering stage.	May injure desirable broadleaf plants. No residual control of seeds germinating after treatment. Treatment in the rosette growth stage provides better control than later applications. Triclopyr not as effective as Dicamba or 2,4-D on mature plants. Grazing restrictions. Best used as spot treatment near desirable perennial plants. Not effective as broadcast application in early years of management plan. 2,4-D & Dicamba require a restricted materials permit. Contact Ag. Commissioner's office.
Glyphosate (Round up) + many names	Best used to manage mature plants. Should not be applied to drought-stressed plants.	Non-selective, will injure desirable broadleaf and grass species. No residual control of seeds germinating after treatments. Grazing restrictions.

Biological Control Methods

Biological control is the use of natural enemies to control pest populations. Yellow starthistle is not a problem weed in its area of origin (southern Eurasia) because of an abundance of coevolved natural enemies that attack the plant. When weeds are introduced into a new area, they typically escape all or most of their natural enemies.

The United States Department of Agriculture (USDA), Agricultural Research Service has imported several species of flies and weevils from the Mediterranean home range of yellow starthistle. Potential biological control agents are screened in USDA facilities in Europe. After taxonomy, host specificity and health have been verified, the organisms are imported and undergo further tests in the U.S. After these tests potential agents are released in field trials. The California Department of Food and Agriculture (CDFA), Biological Control Program provides nursery sites for rearing the promising bio-control agents. When sufficient populations are reached, biologists from the County Agricultural Commissioner's staff gather the agents for release in areas where they may prosper. Additional information about CDFA's biological control program is available at www.cdfa.ca.gov/phpps/ipc/biocontrol/biocontrol_hp.htm.

All of these insects lay eggs in YST buds or flowers and their larvae feed on developing seed, hence reducing seed production. Land use at release sites should be limited to controlled grazing, judicious herbicide use or leaving the field fallow.

Most of these biological control insects have spread throughout the area, after multiple releases began in the 1990's.

It should be noted that biological control by itself will not eradicate any pest, but can lower pest populations while other control options are being implemented.

Biological Control Agents and Releases in El Dorado County

Bio-control Agent	Distribution	Local releases	Potential for Control, and Status	Generations per year
Hairy Weevil *Eustenopus villosus*	Widespread, slow spreader	50+ local releases since 1991	Infests up to 75% of seedheads, aggressive competitor, adults feed on buds, prefers hot dry interior areas, fog limits spread, control potential rated as **good** by CDFA, active June-July	1
Seed-head Weevil *Bangasternus orientalis*	Limited	Locally released since 1989	Infestations light, 10-20% of seedheads damaged, potential rated **poor** by CDFA. Active mid May to mid June	1
Seed-head Fly *Urophora sirunaseva*	Limited	Locally released since 1991	Infestations light, 10-20% of seedheads damaged, potential rated **poor** by CDFA	2-3
False Peacock Fly *Chaetorellia succinea*	Widespread, moves many miles a year	Migrated into county	Infestations moderate, 20-36% of seedheads damaged, potential rated **good** by CDFA	2-3
Peacock fly *Chaetorellia australis*	Fairly widespread	Migrated into county	Needs cornflower/bachelor button plants as early season host; is found in foothill areas of CA and in other western states	2-3

Competing Vegetation

Establishing competing vegetation offers a good long term solution to YST control. Management methods that don't consider what will replace the YST population run the risk of converting the vegetation to other undesirable weeds that require another set of management methods to control.

The site and existing vegetation needs to be evaluated, plants need to be selected that out compete YST and management methods need to be selected to establish the plants.

Most plant competition is for light, water and minerals. Management methods alter the dynamics of the competition for resources. Cutting, grazing or selective herbicide use reduces leaf area of selected species and this increases soil moisture and light for the remaining species. If the treatment is uniform it favors the species best able to recover from the treatment.

Competing species can be divided into three large groups: other weeds, non-native plants, and native plants.

Non-native European annual grasses provide effective competition on many sites. If left alone they will out compete the YST by growing above the YST when its in the rosette stage (winter to late spring). The abundant winter and spring growth of the grasses shades the YST plants and reduces their growth. The annual grasses develop large leaf areas in the spring and rapidly deplete the soil moisture in the late spring and early summer. These weakened YST plants go into the hot dry summer with reduced leaf and root area. Cutting hard when the spiny heads just show yellow can usually kill most plants at this stage. Also grazing the plants at the bolting stage is very effective. The plants can also be sprayed at this stage. If the grass plants are cut, grazed or selectively sprayed in the winter or spring, the YST will be much more vigorous.

An undesirable features of annual grasses is that many of them set seed that can be a problem with dogs, livestock and clothes. Their dry plants are a fire danger from late spring on.

Non-native European perennial pasture grasses are naturalized throughout the Sierra Foothills. Also seed is readily available inexpensively. These include Kentucky Bluegrass, Orchard Grass, Velvet Grass, Tall Fescue, Red Fescue types, Harding Grass and others. These grasses have been used for centuries in Europe for grazing and hay. There would actually be a very large list on non native plants that would grow in the Sierran Foothills.

"Going Native" is a good option. Establishing competing vegetation from original native species is very effective. The site should be surveyed and evaluated for existing native species. While existing native populations may be increasing or decreasing depending on current and past management practices, future management can get the natives to spread by activating existing seed banks and getting existing plants to grow more vigorously.

It is extremely important to understand that without continued maintenance, the vegetative cover you establish in place of yellow starthistle will merely revert back to it's previous condition, or possibly worse. The benefit to maintaining your landscape will not only provide an environment that will improve the ecological function and aesthetic value, but likely increase your property value as well.

Plant List

The following is a list of various California native plants that are recommended for providing competition with noxious and/or invasive weed species, as well as forage material for livestock and wildlife.

California brome - *Bromus carinatus*
Blue wildrye - *Elymus glaucus*
California fescue - *Fescuta californica*
Red fescue - *Fescuta rubra*
Meadow barley - *Hordeum brackyantherum*
Creeping wildrye - *Leymus tridicoites*
California oniongrass - *Melica californica*
Deergrass - *Muhlenbergia rigens*
Foothill needlegrass - *Nassella lepida*
Purple needlegrass - *Nassella pulchra*

Species Descriptions

California brome - *Bromus carinatus*

This species is typically found in elevation ranges between 0 to 11,483 feet. It is typically most productive in the cool season, but is active during summer, at elevations above 5,000 ft. Seeds of this grass mature in spring to summer. This grass is usually found in dry open areas along hillsides, meadows and disturbed areas. Bromus carinatus is useful in ranges and pastures but becomes fibrous when mature and will decline if overgrazed. This grass is inexpensive, easily maintained and can be a productive turf in un-irrigated areas, responding well to early spring and late summer mowing.

Blue Wildrye - *Elymus glaucus*

This species of large perennial bunchgrass typically ranges in elevations between 0 and 8,202 feet. Seeds of Elymus glaucus mature in late spring to summer, germinate easily and have vigorous seedlings. This grass tends to prefer moist soils but grows in a wide variety of conditions and is a good competitor. It provides good forage early in the season, also providing excellent wildlife habitat. Seed of the Elymus glaucus are inexpensive and common.

California Fescue - *Fescuta californica*

Seeds of Fescuta californica mature from late spring to early summer, but typically have a low germination rate. They like north facing slopes with part shade to full sun and particularly woodland areas. This bunchgrass is considered fair to good as forage for grazing and can stay green year round if watered.

Red fescue - *Fescuta rubra*
The seeds of this attractive grass mature in July and August and prefer cool to warm climates, ranging in elevations between 0 and 8,202 feet. Fescuta rubra does best in full sun but does tolerate heavy shade.

Meadow barley - *Hordeum brackyantherum*
This native grass ranges in elevations from 0 to 11,155 feet and is considered medium sized and fast growing perennial bunchgrass. This grass prefers moist soils in meadows and floodplains where rainfall is between 10 to 36 inches per year. It does well in erosion control with roots extending to deeper levels, where moisture is stored. It is considered to be excellent livestock forage and water-fowl habitat alike.

Creeping Wildrye - *Leymus tridicoites*
Seeds of the Leymus tridicoites experiences growth mainly in cool to warm seasons, maturing in late spring to early fall and range in elevation from 0 to 7,546 feet. Habitat for this native occurs mainly in heavy soils meadows in the foothills and mountain flats. It recovers well from grazing and is valuable as such, especially in meadows that become dry and are grazed through the summer months.

California Oniongrass - *Melica californica*
The growing season for Melica califonica occurs in during cool temperatures and seeds mature in mid-spring. This grass generally inhabits slopes and canyons of the foothills and prefers full sun to part shade. This species exhibits weak seedling vigor and is not flood tolerant, but is a fairly good forage for cattle and sheep.

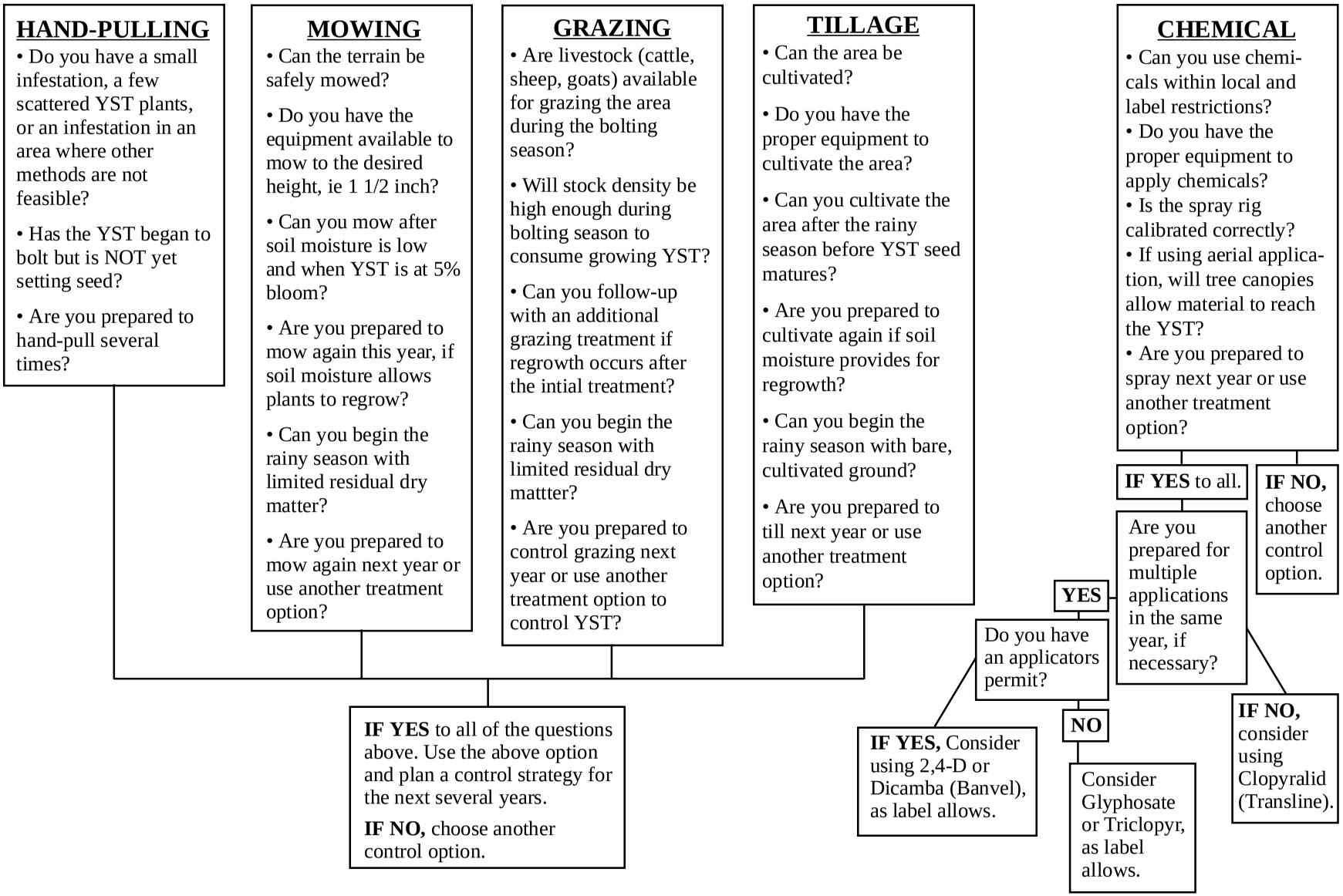
Deergrass - *Muhlenbergia*
This large and attractive bunchgrass is typically found along streams, the edge of meadows and hillsides, from the valley to the Sierras. It ranges in elevation from 0 to 7,054 feet, tolerating variable and extreme conditions.

Foothill needlegrass - *Nassella lepida*
Nassella lepida ranges in elevation from 0 to 5,577 feet and seed maturation occurring in mid to late spring. It is adapted to dry hills, chaparral, open woods and rocky slopes alike, doing best with no summer water once established.

Purple needlegrass - *Nassella pulchra*
This is considered to be a great plant fro dryland restoration and pasture improvement. It has a strong root system which is valuable for erosion control, but can cause injury to livestock due to awns located on the seeds. The seeds generally mature in the mid to late summer and range in elevation from 0 to 4,265 feet.

Chart 1: Integrated Pest Management (IPM) for Yellow Starthistle Control

Note: Late control after plants have bolted and seed has set, is no control. **Timing is critical for each control measure.**



Developing a YST Management Strategy

Eradication is not often possible once yellow starthistle has invaded an area, so then what?

A landowner should approach management of YST with the land-use goal in mind, for example:

- Is the land for pasture and the goal is to enhance forage quality?
- Is the goal to increase recreational value of the land?
- Is the goal for a productive garden, orchard, or urban landscape area?

Determining the land-use goal will greatly help to determine the proper management approach. Thinking through your YST management strategy may be easier if you take the time to complete a land owner weed management plan as demonstrated below. Such a plan can help you keep up with a clear timeline for your management strategies.

Land Owner Weed Management Strategic Plan
Workbook

Date ____ Approximate size of Property _____

I. Management Goals: Management goals describe the purpose/use of the property and what you are trying to achieve. Having clear management goals is key to developing a weed management plan. (A management goal may be to produce rangeland forage to support a cow-calf operation and to eliminate weeds that are poisonous or troublesome to livestock. Another management goal may be to restore an area with native vegetation and promote wildlife habitat.)
Management Goal(s) of your weed management program:

_____

_____

II. Weed Control Objectives: Objectives are derived from your management goals. They are formed by inventorying the weeds you have on your property, determining how they affect your management goals (For example, does the weed reduce forage? poison livestock? or crowd out native species?), and determining the most efficient ways to control those weeds. Sometimes a weed control objective will be to simply contain an infestation so that it does not become a problem, or to keep certain weeds off of your property.

_____

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_____

III. Weed Management Table: Briefly describe your management strategy (weed control methods to be used) over the next several years. Use the table below to list the weeds you plan to control, their location, and size of infestation. Use this table to track the changes in the weed infestation over time and track the cost (time and materials) of completing the treatments.

	Location(s) on Property	Infestation			Control Method(s)	How much time was spent on weed control?	How much money was spent on weed control?
		Size of Area	Weed Density	Weed Vigor			
Year 1 (____)							
Weed Name							
Year 2 (____)							
Weed Name							
Year 3 (____)							
Weed Name							
Year 4 (____)							
Weed Name							

IV. Avenues of introduction - how do you think the weeds arrived: (For example, seed carried by wind or animals, movement of soil, vehicle movement, etc.)

_____

_____

V. Monitoring Plan: (How will you tell that you've been successful - suggestions include annual photographs)

_____

_____

VI. Map: Draw a map of your property identifying the areas where weeds are present. Label each area with the weeds found and write in the control methods used.

RESOURCES, REFERENCES, CONTACTS, AND WEB SITES

El Dorado County Agricultural Commissioner's Office, 311 Fair Lane, Placerville, Ca. 530-621-5520. http://www.atasteofeldorado.com/weeds.html

University of California Cooperative Extension, El Dorado County
311 Fair Lane, Placerville, Ca. 530-621-5502. http://ceeldorado.ucdavis.edu

El Dorado County and Georgetown Divide Resource Conservation Districts, 100 Foni Road, Suite A
Placerville, Ca. 95667 530-295-5630

Agricultural Research magazine http://www.efn.org/~ipmpa/Noxystar.html

BLM Arcata, California-Noxious Weeds. www.ca.blm.gov/arcata/arcweeds.html

California Agriculture, Vol.53 No. 2, March-April 1999 http://danr.ucop.edu/calag/

California Agriculture, Vol. 55 No. 1, January-February 2001

California Department of Food and Agriculture Encycloweedia: Information on California's Noxious Weeds http://pi.cdfa.ca.gov/weedinfo

California Department of Food and Agriculture Biological Control Program, http://plant.cdfa.ca.gov/biocontrol/

IPM Access http://www.efn.org/~ipmpa/index.shtml
Yellow starthistle site, http://www.efn.org/~ipmpa/Noxystar.html

Progress in Yellow Starthistle Biological Control, News from the USDA Agricultural Research Service www.ars.usda.gov/is/pr/1999/99022.htm

University of California Statewide Integrated Pest Management Program, Pest Management Guidelines, www.ipm.ucdavis.edu/PMG/Pestnotes/pn7402.html

University of California Davis Weed Research Center http://wric.ucdavis.edu/
Yellow Starthistle site, http://wric.ucdavis.edu/yst/index.html

Weed free forage: in California http://www.extendinc.com/weedfreefeed/outlets.htm. In Nevada, contact Nevada Dept. of Agriculture at (775) 668-1180, ext. 269

Yellow Starthistle Biology and Control, University of California Publication, DANR #21541
Weed Guide-Yellow Starthistle (Centaurea solstitialis), www.agf.gov.bc/croplive/cropprot/weedguid/yellstar

Credits: Photographs were provided by The University of California Davis, Jack Kelly Clark photographer; California Department of Food and Agriculture, Integrated Pest Control Branch and Biological Control Program with the special help of Baldo Villegas; United States Department of Agriculture-Agricultural Research Service Western Regional Laboratory in Albany CA, Joe Balciunas, Exotic and Invasive Weeds Unit, and by Bob Case, Contra Costa County Department of Agriculture

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