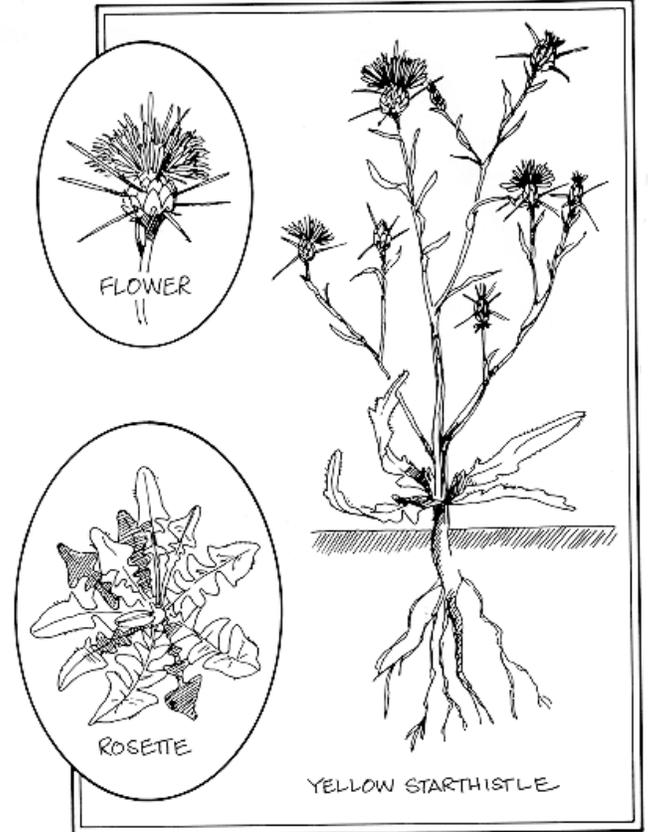


YELLOW STARHISTLE *Centaurea solstitialis*

Life History/Identification:

Yellow starthistle, an annual plant with dandelion-yellow flowers and sharp spines, is closely related to biennial thistles and knapweeds. Yellow starthistle can produce up to 150,000 seeds per plant, and seeds can persist more than ten years in the soil. The roots of this plant develop faster than native perennial grasses and can out-compete them by capturing moisture and nutrients before the native plants begin to grow. Yellow starthistle begins germination and emergence of seedling leaves in the fall or with spring warm-up. In early spring, the plant forms a basal rosette (a cluster of leaves that lay close to the ground) of 7-8 leaves. Growth continues until it sends up a flower stalk in late May and June. Leaves close to the ground (basal leaves) are deeply lobed or dandelion-like, while upper leaves are entire and sharply pointed. In late spring, infested areas take on a characteristic blue-green color when seen from distance. Flowers bloom from mid-July through the first autumn frost. Large plants can be 4 feet tall and have over 100 flower heads. By fall, the plants take on a straw-colored appearance. There are two types of seeds; some with a parachute-like plume of hairs that are wind-distributed and others that contain no plume and fall to ground below plant. By December, yellow starthistle flower heads have lost most of their spines, but their white, cottony heads may persist until mid-spring.



Northern Arizona Localities:

The largest known population of yellow starthistle is in the Camp Verde area. There are isolated populations mapped south of Cottonwood and north of Montezuma's Well. The first population identified above 6000 ft is in Flagstaff at the Wildcat Sewage Treatment Plant and downstream on the Rio de Flag. A major concern here is that the frequent traffic into the plant and to the Rio de Flag may transport seeds to other areas. This is believed to be how plants were transported to the front entrance of the Peaks Ranger District and to the haul route to Robinson Crater.

Origin & Impacts:

Yellow starthistle is native to the Mediterranean region of Europe and was introduced to North America before 1820. It was likely transported to the Pacific Northwest via contaminated hay. It may have arrived in Arizona in the same manner, or by transport on construction equipment. In rangelands, yellow starthistle forms solid stands that reduce or eliminate forage production and grazing capacity. It infests 3 million acres in Idaho, California, Oregon and Washington. The plant has been invading Idaho lands at an astounding rate of about 6,000 acres per year since 1981. Consumption of yellow starthistle causes a permanent neurological disorder ("chewing disease") in horses and laboratory test animals. The first clinical signs are abnormalities in walking or movement, followed by an inability to eat or drink, and finally permanent brain damage or death. The symptoms of chewing disease may not appear until several weeks or months after the horse has eaten yellow starthistle.

Control:

Integrated pest management systems are most effective, combining the suppression of yellow starthistle with the enhancement of perennial grass species. Overgrazing gives starthistle an ecological advantage over grasses, however sheep, goats, and cattle eat yellow starthistle before spines form on the plant.

Cultural Control:

Prevent yellow starthistle from becoming established. Do not drive through areas that are infested with yellow starthistle. Check vehicles for attached starthistle plants when leaving infested areas. Purchase hay that is certified as being weed-free.

Mechanical Control:

Hand pulling or grubbing yellow starthistle is most effective for small infestations, perimeter populations, or along riparian zones. Pull plants after they have bolted and before their flowers have bloomed. Repeat every 2-4 weeks during the growing season, removing as much of the root as possible. Cultivation, where feasible, will control (reduce) yellow starthistle within two years. Tilling must be done five or six times a year, two weeks apart, starting in June. Remember that seeds may stay dormant in the soil for at least ten years. Mowing is not recommended, as plants can produce side branches with more flowers. A study in California found that the number of plants can be reduced by burning the areas at least three years in a row just as the plants are beginning to flower. For burning to be a useful control agent in Northern Arizona, biannual burn/torch plans must coincide with Flagstaff's biannual rainfall.

Chemical Control (*Noted here are chemical control techniques that have been used in other areas. Always check with weed specialists or chemical suppliers before treatment to ensure correct dosage and application. Mention of these products does not imply endorsement by the USDA Forest Service, Northern Arizona Weed Council or The Nature Conservancy.*):

Selective herbicides applied at the correct time may control weeds long enough to establish competitive grasses. Initial treatment should be in early spring, with follow-up before plants bolt. *Clopyralid*, has both pre-emergence and post-emergence activity on yellow starthistle. The most effective timing for application is when yellow starthistle is in the early rosette stage. Applications earlier may not provide full-season control and later applications will require higher rates. A single application at the recommended time will provide season-long control. *Clopyralid* is effective at rates as low as 1.5 oz a.e./acre.

Dicamba is very effective at controlling yellow starthistle at rates as low as 0.25 lb a.i./acre. When yellow starthistle rosettes are small, about 1 to 1.5 inches across, the 0.25 lb a.i./acre rate works well, but higher rates (0.5 to 0.75 lb a.i./acre) are needed if plants are larger.

Triclopyr at 0.5 lb a.i./acre provides complete control of yellow starthistle seedlings. Larger plants require rates up to 1.5 lb a.i./acre. *2,4-D* has also been used, but plants should not be treated more than once every 2-3 years to minimize selection for herbicide-resistant yellow starthistle plants.

Biological Control (*No exotic species should be introduced into an ecosystem without extensive research into the long-term effects. Mention of the species below does not imply appropriateness for use in Northern Arizona.*):

There are 8 introduced insect species that have been imported in the control of yellow starthistle in North America: three seed-head weevils and five flies. All of these biological agents attack the flower head with the goal of reducing seed production and plant spread. However, due to the large number of seeds that a yellow starthistle produces, insects alone cannot completely control an infestation.

Note: No single control method, or any one-year treatment program, will ever achieve effective control of an area infested with yellow starthistle. The fast growth, high seed viability, and long seed dormancy of this plant require long-term cooperative integrated management programs and planning in order to contain and reduce yellow starthistle infestations.

SAN FRANCISCO PEAKS WEED MANAGEMENT AREA
SPECIES ACTION PLAN #1
YELLOW STARHISTLE (*Centaurea solstitialis* L.)



Life History/Identification:

Yellow starthistle, an annual with dandelion–yellow flowers and sharp spines, is closely related to biennial knapweeds. Yellow starthistle can produce up to **150,000 seeds per plant**, and seeds can persist more than **ten years in soil**. The roots of this plant develop faster than native perennial grasses and can out-compete them by capturing moisture and nutrients before the native plants begin to grow.

In Northern Arizona yellow starthistle begins germination and emergence of seedling leaves either in late summer /early fall after the monsoon type rains, or with spring warm-up. In early spring the plant forms a basal rosette (a

cluster of leaves that lay close to the ground) of 7-8 leaves. In late spring, infested areas take on a characteristic **blue-green color** when seen from a distance.

Root growth continues until it sends up a flower stalk in late May or June. Leaves close to the ground (basal leaves) are deeply lobed like a dandelion, while upper leaves are entire and sharply pointed. Flowers bloom from mid-July through the first hard frost of the season. Large plants can be 4 feet tall and have over 100 flower heads. Plants that have germinated in July or early August will still complete their lifecycle before winter, although they usually are smaller plants with fewer flowers. Yellow starthistle can produce seed when only 3 or 4 inches tall. There are two types of seeds; the majority of the seeds have a parachute-like plume of hairs, the rest of the seeds have no plume, are retained in the seedhead longer and fall straight to the ground between November and February. By fall the plants will dry out to a **silvery-gray straw-like skeleton**.

By December, yellow starthistle flower heads have lost most of their spines, but their white cottony heads may persist until mid-spring. Studies of yellow starthistle seed dispersal suggest that more than 90% of the seeds fall within 2 feet of the parent plant, creating a slow invasion front. However, approximately 95% of the seeds are viable and 10% of the seeds can remain dormant for more than ten years, allowing yellow starthistle to re-invade sites rapidly following most control applications.

Impacts:

Native to the Mediterranean region of Europe, yellow starthistle was introduced to North America in alfalfa seed shipped to California before 1820. Likely transported via contaminated hay, this plant now covers over 30 million acres in North America, 20 million in California alone. In rangelands and open wildlands, yellow starthistle forms solid stands that sharply reduce or eliminate, forage production, wildlife value, economic value and biological diversity. The plant has been invading western states at rates of 6000 – 20,000 acre/year/state since 1981.



Northern Arizona Localities:

The largest known population is at the Wildcat Sewage Treatment Plant and downstream on the Rio de Flag. A major concern is that frequent traffic into the plant and to the Rio de Flag may transport seeds to other areas. This is believed to be

how plants were transported to the front entrance of the Peaks Ranger District and to the haul route to Robinson Crater. Yellow starthistle is found in other parts of Arizona in Payson, Young, and the Verde Valley.

Yellow starthistle is a **restricted and prohibited noxious weed in Arizona**. Arizona Administrative Code **R3-4-244 & R3-4-245** revised July 1999 established three categories of noxious weeds in our state:

Regulated – Are well-established widespread weeds like field bindweed and burclover, which should be controlled but are not likely to be quarantined. **Restricted** – Are species invading various areas throughout the state like Russian, diffuse and spotted knapweed, yellow starthistle, and camelthorn. The Department of Agriculture is supposed to quarantine any product or land infested with these plants, and notify the owner of the restrictions and required treatments. If nothing is done to remove or destroy the noxious weed the state can complete the required actions and put a lien on the property for the cost.

Prohibited - Are those weeds Arizona wishes to prevent from entering the State, it includes most of the restricted noxious weeds as well as many of those that aren't in the state according to our present knowledge like purple starthistle and squarrose knapweed. The quarantine is very similar to above, but it refuses entry into the state unless treatment is undertaken.

If any other population of yellow starthistle is found in the Flagstaff area or all of N. Arizona, please contact us for help creating a management plan:

Laura P. Moser, coordinator

Tel: 520-527-3423

Fax: 520-527-3620

Email: lmoser@fs.fed.us

San Francisco Peaks Weed Mngt. Area

2323 Greenlaw Lane

Flagstaff, AZ 86004

Control:

An **integrated** combination of methods will be needed to successively control such an aggressive and adaptable noxious weed. **Prevention** and detection of new populations, as well as eradication and containment of existing populations all need to be addressed to achieve control over yellow starthistle. **Mapping** of distribution and extent as well as consistent monitoring are also necessary to determine which combinations of control methods will be most effective in each circumstance. Most local land management agencies have adopted policies to map and monitor noxious weed populations through the collaboration of South West Exotic Mapping Project (USGS).

Prevention is the most effective and least expensive method of control. Maintenance of a vigorous, competitive plant community will control or reduce the rate of yellow starthistle spread. Plan activities to avoid areas infested with yellow starthistle if possible. If not, cleaning all equipment, tires, boots and hooves when leaving infested areas will prevent the creation of new infestations. Purchase only certified weed-free hay, and don't allow livestock to graze infested areas in summer and fall. Reseeding any disturbed sites with vigorous, hardy, early successional natives will also deter establishment of new yellow starthistle seedlings. Prevention is important and must be continued at all times to prevent new infestations, but something also has to be done as quickly as possible about the existing populations.

Re-vegetation, no control plan will be effective unless re-establishment of preferred vegetation is considered. In most cases in open spaces, adjacent roads and neighborhoods, native plants are the best choice. It is important to use vigorous, early-successional species that will be able to compete with any exotics left in the seedbank.

2. Mechanical Control:

The first step most often taken in an attempt to control weeds is a physical or mechanical one: dig 'em, pull 'em, mow 'em, plow 'em, burn 'em, destroy those weeds somehow. These tools can be very effective if timed carefully and used in combination; if not they will simply prepare a perfect seedbed for more weeds to come.

Hand pulling or grubbing yellow starthistle is most **effective for small infestations**, perimeter populations, or along riparian zones. Pull after plants have bolted and before flowers have bloomed. Repeat every 2-4 weeks for the growing season removing as much of the root as possible. If flower buds have already formed, bag all plants until they can be burned in a hot fire at a controlled site.

Cultivation, where feasible, **will control** (reduce) yellow starthistle within two years. Tilling must be done five or six times a year, two weeks apart, starting in June. Remember that seeds may stay dormant in the soil for at least ten years.

Mowing is not recommended, as plants produce side branches with more flowers. Mowing can be used to stress the weeds once they grow above desirable grasses during revegetation as long as no more precipitation is expected that year, very unlikely with N. Arizona's biannual rainfall.

Burning could be an **under-utilized tool** to control yellow starthistle infestations in the Flagstaff area if a biannual burn plan was considered to coincide with the biannual rainfall. In the past most cases of yellow starthistle in N. Arizona were treated with burn early or very late in the season when fire danger was lowest. With this type of treatment, size and seed production will be increased because

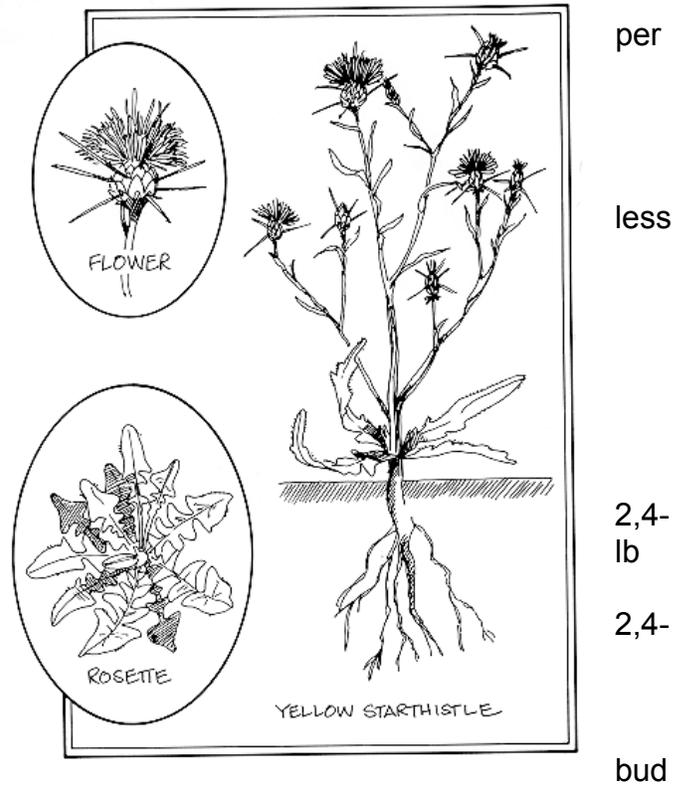


area
with
one
plant
of the

plants ability to quickly capture the newly released nutrients that were tied up in dead plant material. However, in California extensive research has been done on the timing and frequency of burns with noted success in reducing starthistle populations. According to Hastings and DiTomaso (1996) early spring and fall burning are not appropriate for yellow starthistle control in California; "Burning must occur after the annual and perennial grasses have cured and set their seeds, but before yellow starthistle seed has matured". They found they could burn safely with air temperatures as high as 32°C (89°F), and relative humidity as low as 25%. After three July-annual burns they found 99% reduction in seeds per square meter and 96% reduction of seedlings per square meter. Fire intensity appeared not to be a critical factor in the reduction of yellow starthistle, however sufficient heat was required to scorch foliage, stem-girdle plants, and stimulate seed germination (200 to 205°C average soil surface). Timing was the most important factor, burning should occur in the late floral bud stage, when less than 10 % of the flower buds have opened. In areas of dense yellow starthistle coverage not enough fine fuels existed to burn, therefore spot treatments of selective herbicides were used and grass seed was broadcast to allow burning the following year. In northern Arizona, it will probably be necessary to burn a second time each year in late September because our late summer rains allow a second chance at growth and maturation for the yellow starthistle.

3. Chemical Control: *Noted here are chemical control techniques in use in other areas. Always check with weed specialists or chemical suppliers to ensure correct dosage and application. Mention of these products does not imply endorsement by the Northern Arizona Weed Council, San Francisco Peaks Weed Management Area, the USDA Forest Service, nor the Nature Conservancy.*

Chemical control is a **costly but effective tool** for controlling yellow starthistle in highly productive soils, high-risk areas, or around the perimeter of large infestations to contain spread. As mentioned above it can be effectively combined with other mechanical treatments to reduce cost. Or if manpower is the limiting factor chemical treatment can be used first to reduce the population, then after revegetation has begun hand-pulling could be used to prevent remaining plants from going to seed. Selective soil residual, foliar, or pre-emergent herbicides applied at the correct time and rate may control yellow starthistle long enough to establish competitive grasses. Picloram (Tordon™ or Amdon™) at a rate of .25 lb active ingredient acre to seedlings, rosettes, or plants beginning to bolt provided broadleaf selective systemic control for three years for Callihan et al.(1989). Well-established grasses are unaffected at this rate, but grass plants with than four leaves may be killed. Triclopyr (Garlon 4™) another broadleaf-selective herbicide in combination with burning and reseedling of grasses has been used to effectively reduce a yellow starthistle population and establish a dense cover of annual and perennial grasses (Hastings and DiTomaso 1996). Dicamba (Banvel™) and/or D (low volatile ester or amine) at a rate of 0.5 ai/ac can be used in sensitive areas such as riparian zones, control lasts about one year. D should not be used in one area more than once every 2-3 years to minimize selection for herbicide-resistant yellow starthistle plants. Clopyralid at 1.2 lb ai/ac applied before the stage can be used to effectively control yellow starthistle in areas with a high water table.



4. Biological Control: *No exotic species should be introduced into an ecosystem without extensive research into the long-term effects. Mention of the below species does not imply appropriateness for use in N. Arizona.*

Eight introduced insect species have been imported in the control of yellow starthistle in North America: three seed-head weevils and five flies. All of these biological control agents attack the flower head with the goal of reducing seed production and plant spread. Insects alone will not eliminate an infestation, however they will enhance other control techniques and reduce the rate of expansion of large existing infestations. Biological control is most appropriate in populations large enough to be beyond control by any other means. Contact the Flagstaff agricultural extension agent (774-1868) & APHIS/NBCI (www.aphis.usda.gov/nbcj) for availability, status, and information before beginning a biological control program.



No single control method, nor any one-year treatment program will ever achieve effective control of an area infested with yellow starthistle. For example mechanical control combined with herbicide treatment can be more effective than mechanical treatment alone. Herbicide treatment

followed by seeding with competitive grasses has been successful in many parts of the western U.S. The use of herbicides in combination with insect control is successful on large populations. One example of this technique would be to release the insects near the center of the infestation, and then spray the edges to reduce or prevent the spread of the infestation. The fast growth, high seed viability and long seed dormancy of this plant require long-term cooperative integrated management programs and planning to contain and reduce yellow starthistle infestations.

References:

- Arizona Noxious Weed List in Arizona Administrative Code **R3-4-244 & R3-4-245**, July 1999
Biology and Management of Noxious Rangeland Weeds; 1999 , edited by: Sheley, R.L.; Petroff, J.K.;
Oregon State Univ. Press; 438 pp.
- Burril, L.C.; Cudney, D.W.; Dewey, S.A.; Lee, R.D.; Nelson, B.E.; Parker, R.; 1991 , edited by: Whitsun, T.D.;
Weeds of the West; Univ. of Wyoming; 630 pp.
- Fire Effects Database - FEIS (www.fs.fed.us/database/feis/plants/forb)
- Hastings, M.S.; DiTomaso, J.M.; 1996 , Fire Controls Yellow Star Thistle in California Grasslands, Res. & Mgt.
Notes 14:2 Winter 1996
- Radosevich, S.R.; Holt, J.; Ghersa, C.; 1996 , *Weed Ecology: implications for management*, 2nd ed. 589 pp.

Moser, L; D. Crisp. San Francisco Peaks Weed Management Area fact sheet on *Centaurea solstitialis*.
Coconino National Forest.