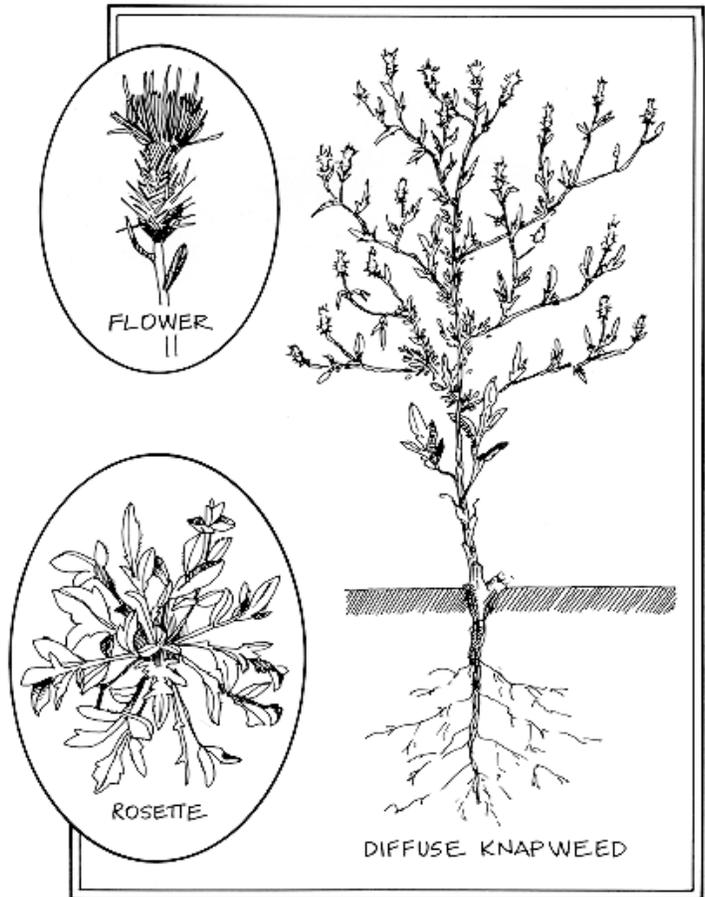


DIFFUSE KNAPWEED *Centaurea diffusa*

Life History/Identification:

Most plants of this species live to be two to six years old and are capable of spreading only by seed. One hundred plants per acre can produce more than one million seeds on dry rangeland. Seeds of this plant have been shown to remain viable in soil for at least 12 years. During the first year of growth, after the seeds germinate, the plant takes on the form of a small cluster of gray-green, lobed leaves that lay close to the ground (in botanical terms, this is called the basal rosette). During the second year, the basal rosette produces a densely branched, leafy stem. At the ends of most branches, a number of small flowers are produced. They are wrapped in a cluster of small, spiny bracts (this entire structure of bracts and flowers is called the flowering head). Each flower within the flowering head produces a single, small seed at the top of which are attached numerous, what appear to be short, course hairs. The plants grow most actively from April to October, flowers are produced from June until September, and the seeds set from July to October.



Flagstaff Localities:

Diffuse knapweed was first introduced to the Pacific Northwest at the turn of the century as a contaminant in alfalfa seed imported from Europe. The first collection of this plant in Arizona was made August 5, 1979 along Hwy 89, seven miles north of Flagstaff near Black Mountain Homes. It now dominates the landscape along Industrial Blvd. east of Steves Blvd, the open, disturbed fields in the vicinity of the Country Club exit off of I-40, considerable acreage north and east of the Flagstaff Mall, and numerous smaller areas around schools, public playgrounds and parks.

Economic Impact:

If we continue to allow this species to spread unabated, this Eurasian non-indigenous plant will soon be the dominant vegetation in vacant lots and waste/construction areas in our city. As more and more people come into contact with this prickly plant, it will spread into open spaces in Flagstaff (parks and along the urban trail), pasture lands, and along trails into our national forests. Once in the forest, diffuse knapweed has shown us that it will not simply stay along trails. Many national forests in Montana and Idaho have thousands of infested acres where knapweed has been able to out compete native plants. In many places it effectively crowds everything else out. Because diffuse knapweed is not readily edible to our local wildlife, the encroachment of these plants will have pronounced effects on native antelope, deer, elk, rodents, and birds and grazing livestock by severely restricting their habitat. Knapweeds growing along streams and watersheds increase erosion and damage aquatic life. The United States government estimates that noxious weeds, predominantly knapweeds, consume 4,600 acres of public land each day. In Union County, Oregon, it has been estimated that 100 acres of public forest and grazing lands are overrun by knapweed every 24 hours.

Control:

Cultural Control:

Prevention is the most effective and least expensive method of control. Do not drive through areas infested by knapweed. Check vehicles for attached knapweed plants in tires and grills when leaving an infested area. Do not purchase hay that is infested with diffuse knapweed. Practice sound pasture management to prevent overgrazing. Reseed disturbed sites with vigorous, hardy, native plants in order to deter the establishment of knapweed seedlings.

Mechanical Control:

Hand pulling or grubbing diffuse knapweed is most effective on small infestations, perimeter populations, along riparian zones, or following an herbicide treatment. Pull small patches before the plant goes to seed. Seed any disturbed area with perennial grass or grass-legume cover. If the plant's life cycle is considered, burning could be an under-utilized tool to control diffuse knapweed infestations in the Flagstaff area.

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 Northern Arizona Weed Council or The Nature Conservancy.):*

- 1) Transline™ is effective at 1 pint per acre. Recommended for early spraying. It is better than Tordon™ because it is not a groundwater contaminant and will not kill trees. This chemical may be 2 to 3 times more expensive than Tordon™.
- 2) Tordon 22K™ (chemical name: picloram) at 1 pint per acre: This is the Dow Agrosciences recommendation. They recommend spraying in the spring, and re-treatment will vary with soil and climatic conditions. This is also the recommended treatment for yellow starthistle. Drawbacks: this compound is a groundwater contaminant and will kill trees.
- 3) Apply Banvel™ at 2.2 liters/acre in 100-200 L water/ha when knapweed is actively growing. This treatment will not provide residual control. Re-treatment will be necessary. Note: this amount was recommended in January of 1984 for pastures, rangeland, and non-cropland by Crop Protection Section, Plant Industry Branch, Saskatchewan Agriculture, and should be verified.
- 4) Some agencies recommend applying a combination of either Banvel™ or Tordon™ with 2,4-D or a combination of Banvel™ and Tordon™ in order to lessen the effect on native grasses. No amounts were given for the combined treatments. Pre-manufactured mixes of certain chemicals (2,4-D mixed with picloram or others) exist under the tradenames Pathway™, Stinger™, Curtail™ (all manufactured by Dow Agrosciences), Weedmaster™, and others.

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 twelve introduced insect species that have been imported for the control of diffuse knapweed in North America. Most of these biological control agents attack the flower head with the goal of reducing seed production and plant spread. Biological control is most appropriate in populations large enough to be beyond control by any other means.

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

SAN FRANCISCO PEAKS WEED MANAGEMENT AREA

SPECIES ACTION PLAN #2

DIFFUSE KNAPWEED

Centaurea diffusa L.



Life History/Identification:

Diffuse knapweed is an introduced biennial/perennial forb with one erect, diffusely branched stem growing 0.3 to 3 feet tall. Most plants of this species live to be 2 to 6 years old and are capable of spreading only by seed. One hundred plants per acre can produce more than **one million seeds** on dry rangeland. Flowers are primarily pollinated by insects, although a small amount of pollen is transported by wind. 71% of seeds exhibit dormancy and can remain viable in the ground for at least **12 years**. In the fall, diffuse knapweed plants break off at ground level and tumble along the ground dispersing seeds. Seeds are also spread as the spiny bracts attach to animal fur, hay, clothing, and vehicles.

In Northern Arizona diffuse knapweed begins

germination and emergence of seedling leaves either with spring snow melt in, or after the late summer /early fall rains. The seedling forms a basal rosette of 7-8 leaves, a cluster of gray-green lobed leaves that lay close to the ground. Taproot growth must continue until crown reaches a minimum of 1/5 inch (5mm) and a vernalization period is also required before flowering will occur. During the second year the plant produces a densely branched leafy stem with a number of small flowers at the ends of most branches. The flowers are wrapped in a cluster of small spiny bracts that point out from the flowering head. Each flower within the flowering head produces a single small seed at the top of which are attached numerous, short, coarse hairs.



Diffuse knapweed is **allelopathic**, producing and releasing into the environment substances that are toxic to other plants, there by giving them another competitive advantage over natives once established in a site. Diffuse knapweed has evolved to spread by tumbling in the wind, the urn shape flowering head gradually distributes the seed over very wide areas. Diffuse knapweed is an early successional species that is shade intolerant. Road and utility right-of ways, landfills, and overgrazed rangeland are especially likely to be colonized by diffuse knapweed.

Impacts:

Diffuse knapweed was first introduced to the Pacific Northwest at the turn of the century as a contaminant in alfalfa seed imported from Europe. Since the 1930's it has spread like wildfire across the western states. Diffuse knapweed replaces wildlife and livestock forage on rangeland and pasture thereby reducing biodiversity and land value, while increasing soil erosion and costs of roadside maintenance. Economic and ecological impacts are measured in loss of forage diversity and production. However availability is more important than palatability and more and more species are utilizing knapweed as a forage source especially during the winter months.

Northern Arizona Localities:

Diffuse knapweed is native to the grasslands and shrub steppes of the eastern Mediterranean and western Asia. The first collection of this plant in Arizona was made Aug. 5, 1979 along Hwy 89, 7 miles north of Flagstaff near Black Mountain Homes. It dominates the landscape along Industrial Blvd. east of Steves Blvd., the open fields in the vicinity of the Country Club, I-40 east of Butler, considerable acreage northeast of Flagstaff Mall, and numerous smaller areas around schools, public playgrounds and parks throughout Flagstaff.

Diffuse Knapweed 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 diffuse knapweed 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:

San Francisco Peaks Weed Mngt. Area

2323 Greenlaw Lane

Flagstaff, AZ 86004

lmoser@fs.fed.us

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 diffuse knapweed. **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).

1. Cultural Control:

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 diffuse knapweed spread. Plan activities to avoid areas infested with diffuse knapweed if possible. If not possible, 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 diffuse knapweed 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 diffuse knapweed is most **effective on small infestations**, perimeter populations, along riparian zones, or following an herbicide treatment. Dig up at least 4 inches of rosette taproot or pull up taproot after plants have bolted and before flowers have bloomed. Repeat at least three times during the growing season (rosette stage, bolting stage, and late flowering stage), 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, may control (reduce) diffuse knapweed if an annual grain or cover crop is planted before reseeding to perennial grasses. Tilling must be done two or three times a year, starting in May or alternate control treatments should be planned. Remember that seeds stay dormant in the soil for at least **twelve** years, so long term follow-up will be necessary.

Mowing is **not recommended** for control, as plants produce side branches with more flowers. Mowing can be used to extend the period of maximum herbicide effectiveness. Mowing will stress remaining 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 diffuse knapweed infestations in the Flagstaff area if a biannual burn plan was considered to coincide with the biannual rainfall. In the past most cases of diffuse knapweed in N. Arizona were treated with one burn early or very late in the season when humidity was high and fire danger was lowest. With this type of treatment, plant size and seed production will be increased because of the plants ability to resprout from the taproot and quickly capture the newly released nutrients that were tied up in dead plant material. Because of the vigorous new growth after a fire this is an effective way to prepare a site for herbicide treatment, but fire alone has shown mixed results.

However, in California extensive research has been done on the timing and frequency of burns with noted success in reducing yellow starthistle populations, a closely related species. 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". 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 diffuse knapweed. **Spot-burning** with a propane torch or flamethrower may provide the fire intensity needed to damage the seed and developing plants, and avoid the problem of a discontinuous fuel base. Further investigation is necessary to validate the effectiveness of fire control in Northern Arizona.

- 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 diffuse knapweed 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 diffuse knapweed long enough to establish competitive grasses. Picloram (Tordon™ or Amdon™) at a rate of .25 lb active ingredient per 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 less than four leaves may be killed. Triclopyr (Garlon 4™) another broadleaf-selective herbicide in combination with burning and reseeding of grasses has been used to effectively reduce a diffuse knapweed population and establish a dense cover of annual and perennial grasses (Hastings and DiTomaso 1996). Dicamba (Banvel™) and/or 2,4-D (low volatile ester or amine) at a rate of 0.5 lb ai/ac can be used in sensitive areas such as riparian zones, control lasts about one year. 2,4-D should not be used in one area more than once every 2-3 years to minimize selection for herbicide-resistant diffuse knapweed plants. Clopyralid at 1.2 lb ai/ac applied before the bud stage can be used to effectively control diffuse knapweed in areas with a high water table.

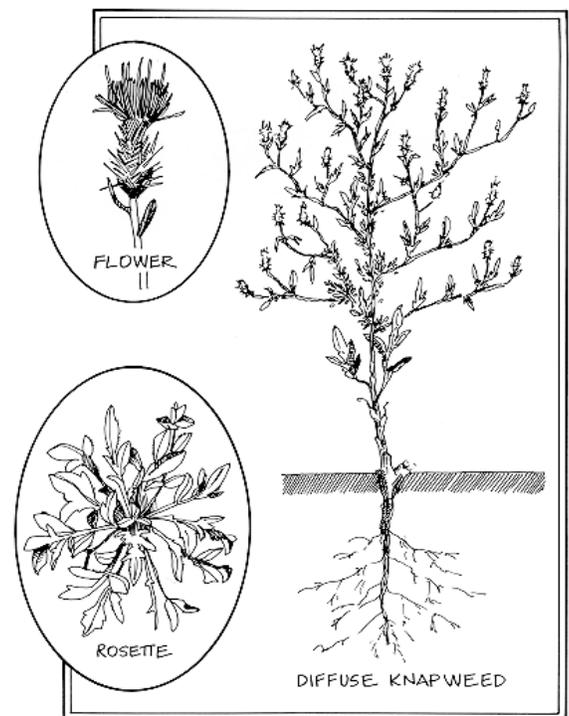
4. Biological Control: *No exotic species should be introduced into an ecosystem without extensive research into the long-term effects. Mention of the below species does not imply appropriateness for use in N. Arizona.*

Twelve introduced insect species have been imported in the control of diffuse knapweed in North America: eight seed-head feeding insects and four root feeding insects. Most of these biological control agents attack the flower head with the goal of reducing seed production and plant spread, while root feeders reduce rosette survivorship. Insects alone will not eliminate an infestation, however they will enhance control 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/nbc) for availability, status, and information.

No single control method, nor any one-year treatment program will ever achieve effective control of an area infested with diffuse knapweed. The fast growth, high seed viability, fast rate of spread and long seed dormancy of this plant require long-term cooperative integrated management programs and planning to prevent, contain and reduce diffuse knapweed infestations.

References:

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