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Noxious Weeds of Nebraska

Spotted and Diffuse Knapweed

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Spotted and Diffuse Knapweed

Spotted knapweed *(Centaurea stoebe L. ssp. micranthos* [Gugler] Hayek – *Centaurea maculosa* Lam. = *C. Biebersteinii* DC.) and diffuse knapweed *(C. diffusa* Lam.) are two of Nebraska's nine noxious weeds. They are also noxious in at least 17 other states. These are closely related species that are well adapted to a variety of habitats including open forests, rangelands, pastures, CRP lands, roadsides, and ditch banks *(Figure 1)*. *Centaurea* is a large genus of about 300 species, 34 of which are common U.S. weeds and 14 (e.g., yellow starthistle, *C. solstitalis* L. and Russian knapweed, *C. repens* L. = *Acroptilon repens* [L.] DC.) of which are included on the noxious weed list of at least one U.S. state. Other *Centaurea* species are used as ornamentals.

The knapweeds originated in the grasslands of southeastern Europe and Asia and were introduced to the United States as contaminants in alfalfa. Spotted knapweed and diffuse knapweed now infest over 5 million and 2 million acres of rangeland and pastures in the western United States, respectively, and about 7,000 acres in 17 counties of north and northeast Nebraska.

Spotted and diffuse knapweed reduce productivity of grazing lands and wildlife habitat and increase surface runoff, which can be detrimental to water and soil resources. The knapweeds displace native species and change plant community structure. Knapweeds also contain chemicals that are undesirable to livestock and potentially reduce the growth of native vegetation.

Economic losses associated with knapweed have not been estimated for Nebraska because the area of infestation is small. However, knapweeds have become major weeds of range and pasture in states north and west of Nebraska and are estimated to cost cattle producers $42 to $150 million annually in Montana. Their widespread occurrence and the documented degradation of rangelands and pastures in neighboring states, as well as their tendency to favor well-drained soils, make the knapweed species potentially very injurious to livestock production throughout Nebraska.

a

b

Figure 1. Dense infestations of spotted and diffuse knapweed can reduce productivity of grazing lands and wildlife habitat and increase surface runoff. The top photo (1a) shows a dense population of spotted knapweed in full bloom in Nebraska; *Figure 1b* shows sheep grazing during the rosette stage in early spring in Montana.

Biology

There have been discrepancies in the taxonomic description of the spotted knapweed found in Europe and North America. At least four scientific names have been assigned to spotted knapweed in the literature, and there is some documentation that spotted and diffuse knapweed can interbreed. This is important because while these species look alike during certain stages of development, they display considerable genetic variation and may vary in their susceptibility to management practices.

Spotted and diffuse knapweed belong to the Asteraceae, or sunflower, family. Knapweeds are biennial or short-lived perennial forbs that form deep tap-rooted rosettes and reproduce primarily by seed *(Figure 2)*. Seed production in a pure stand ranges from 450 to 4,500 seeds per square foot each year, and at least 5 percent of those seeds will remain alive and viable in soil for more than seven years. Site conditions and precipitation during the growing season have the greatest effect on seed production, with more seeds produced during wet years. Seeds are dispersed by wind, animals, or human activity (vehicles are a primary mode of dispersal).

Seeds germinate in the fall and early spring when moisture and temperature are suitable. Seedlings can mature into seed-producing adults in one year. Seedlings develop into rosettes, which then put most of their energy into growing roots. If rosettes do not bolt, they die back to the root crown to overwinter. Spotted knapweed root crowns can send underground stems up to an inch from the parent plant, each forming a rosette in the early spring. Plants bolt in early June, produce flowers from July through September, and mature seeds are formed by mid-August *(Figure 2)*. Most knapweed seeds are shed at maturity, but a few over-winter in the seed heads (which may be spread by tumbling in the case of diffuse knapweed).

Knapweeds can establish in most soil types but are most productive in sandy, well-drained soils and thrive in dry environments. They typically invade disturbed sites along roads and subsequently spread into disturbed (especially overgrazed) rangelands and pastures. Diffuse and spotted knapweed leaves and shoots produce an allelopathic compound that reduces germination of common range grasses, which allows the germination and establishment of knapweeds rather than desirable species. This allows knapweeds to invade any disturbed site, even in well-maintained range and pasture. Once established, both weeds can form pure stands with little forage value.

History

Spotted knapweed is native to central Europe and eastern to central Russia, Caucasia, and western Siberia. Diffuse knapweed is native to the eastern Mediterranean region to western Asia, and from the former Republic of the Soviet Union to western Germany. Spotted and diffuse knapweed were first introduced to the United States in contaminated alfalfa *(Medicago sativa L.)*. Spotted knapweed also was thought to have been introduced in soil discarded in ship ballast.

Spotted knapweed was first documented in North America in Victoria, British Columbia in 1893, and diffuse knapweed was first recorded in Washington in 1907. Both knapweeds spread in alfalfa seed and hay before they were considered problem weeds. The knapweeds were added to the Nebraska noxious weed list in 1992 because of their potential threat to the economic, social, and aesthetic well-being of rangelands and pastures in the state.

Figure 2. Life cycle of spotted and diffuse knapweed

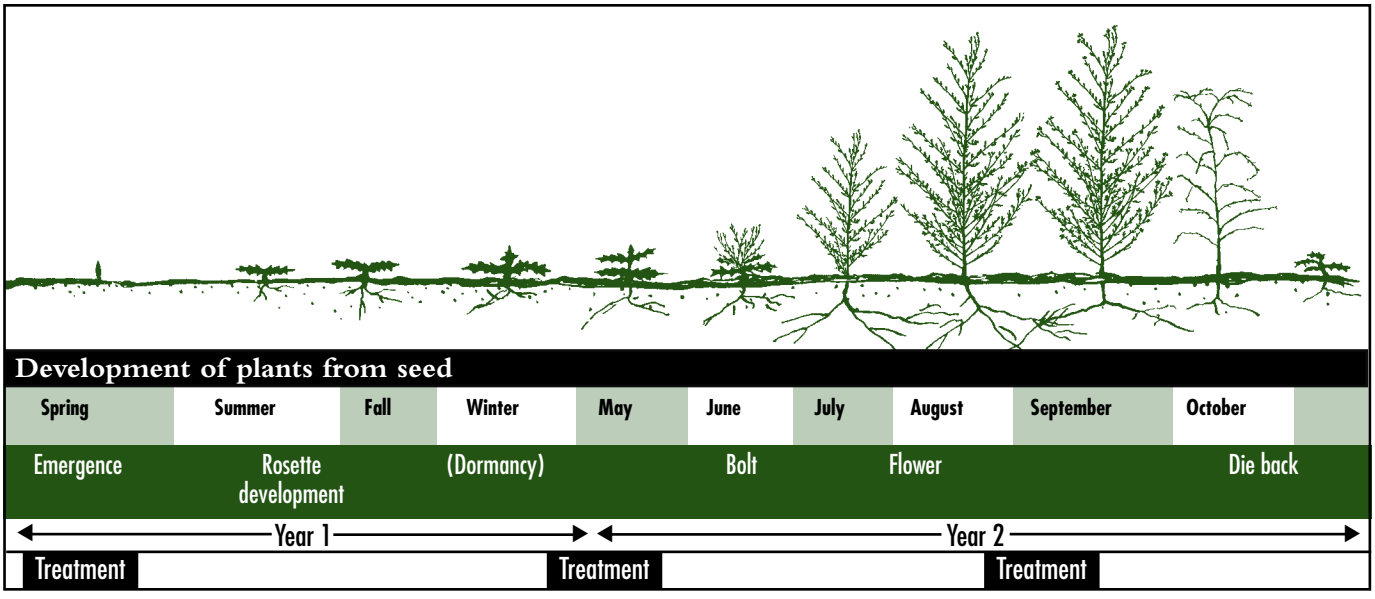

Figure 2. Life cycle of spotted and diffuse knapweed. Seedlings emerge in fall or early spring and form rosettes. Plants bolt in early June, produce f owers from July through September, and mature seeds are formed by mid-August.

Identification

Basal rosette leaves of both knapweeds are borne on short stalks and grow up to 8 inches long and 2 inches wide. Rosette leaves are deeply divided into lobes on both sides of the center vein. Lobes are oblong with the broadest part above the middle of the leaf *(Figure 3)*. Flowering stems stand 8 inches to 4 feet tall. Diffuse knapweed has many spreading branches that give it a ball-shaped, tumbleweed appearance, whereas spotted knapweed can have more of a Christmas tree-like shape because of its branching pattern *(Figure 4)*.

Stem leaves are alternate in arrangement, narrow, and typically 0.8 to 2 inches long. Lower stem leaves are divided into remote and narrow segments, while upper leaves are entire *(Figure 5)*. The flower head of both species is shaped like a miniature vase that is 0.25 inches wide by 0.5 inches tall that remains attached to the plant after maturity *(Figure 6)*. Flowers may be solitary or in clusters of two or three at the ends of a branch. Spotted knapweed flowers (25 to 35 per head) spread out from the top of the flower head with purple to pink or rarely white petals. Diffuse knapweed flower petals are mostly white but occasionally rose to lavender.

The flower head of both knapweeds is wrapped in yellow-green to brown bracts (leaf-like structures) that are marked with fine vertical streaks. Spotted knapweed bracts are tipped with a black comb-like fringe that gives the flower head a "spotted" appearance. Diffuse knapweed bracts are buff or brown at the tips, but not usually black. Bracts contain a distinctive 1/16- to 5/16-inch long terminal spine at the center of the comb *(Figure 6)*. Seeds of both species are encapsulated in a small (> 1/8 inch) brown to black achene (like a sunflower seed) with a ring of hairs growing out one end.

Figure 3. Distinguishing the knapweed species by rosette alone is difficult. Spotted knapweed rosette leaves may be nearly entire *(a)* to deeply divided with relatively wide lobes *(b and c)*, whereas diffuse knapweed tends to have more finely divided lobes *(d)*.

Figure 4. Diffuse knapweed has many spreading branches that give it a ball-shaped, tumbleweed appearance *(a)*, whereas spotted knapweed appears more Christmas-tree like, especially in dense stands *(b)*.

Figure 5. Stem leaves are alternate in arrangement and typically 0.8 to 2 inches long and narrow. Lower stem leaves are divided into remote and narrow segments, while upper leaves are more commonly entire.

a

b

Figure 6. The flower head of both species is shaped like a miniature vase. Spotted knapweed flowers are pink to purple *(a)* or rarely white, whereas diffuse knapweed flowers are usually white *(b)* but sometimes rose or purple. The most distinguishing characteristics of spotted and diffuse knapweed are the bracts surrounding the inflorescence. Spotted knapweed bracts are tipped with a black comb-like fringe that gives the flower head a "spotted" appearance *(a)*, whereas diffuse knapweed bracts are buff or brown at the tips, but not usually black, and tipped with a distinctive 1/16-5/16 inch long terminal spine *(b)*.

Figure 7. Seeds are enclosed in a small brown to black achene 1/8 inch long.

Control Methods

Knapweed infestations on public lands should be reported to the county weed office. The most cost-effective management method for these knapweeds is to prevent their spread from roadsides and open areas to pastures and rangelands. Diffuse knapweed plants should be removed and destroyed before they reach maturity and begin to tumble. Proper grazing management in range and pastures is essential to maintaining a community of desired plants that are resistant to knapweed invasion. Once an invasion occurs, knapweed infestations can be managed through the integration of cultural, mechanical, biological, and chemical control methods.

Cultural

Maintaining a community of desired plants that are sufficiently competitive to resist knapweed invasion is the most important means of keeping knapweed out of rangelands or pastures. Revegetation of open, disturbed, or knapweed-infested rangeland or pasture with aggressive desirable species has been shown to inhibit reinvasion, especially when combined with chemical or mechanical control measures. Several researchers have evaluated the effects of fertilizer application on rangeland restoration. Nitrogen fertilizer application on knapweed-infested rangeland may increase the severity of the knapweed infestation.

Mechanical Control

A single, low-intensity fire does not control knapweed. Rather, fire may increase its cover and density because burned areas create open niches that promote knapweed establishment and spread. Fire followed by herbicide treatments may improve the effectiveness of herbicide treatments. Cultivation to depths of 7 inches or more will control existing knapweed plants, but reestablishment from seed is common.

Cultivation in combination with the seeding of competitive perennial grasses may minimize knapweed reestablishment. Persistent and careful hand pulling can control knapweeds if the entire root crown is removed prior to seed production. This method will be effective only on single plants or very small infestations. Disturbance during hand-pulling may increase susceptibility of the site for reinvasion. The results of mowing are variable and not well documented. It appears that mowing during the late bud stage may be most effective, especially if combined with some chemical treatments.

Chemical Control

Chemical control of established populations of spotted and diffuse knapweed is expensive and eradication may be impossible. New small infestations should be intensively managed to prevent further invasion. Chemical control is most effective when plants are in the seedling or rosette stage *(Table 1)*. Tordon® 22k or Grazon® P + D will control both knapweeds for two to five years (shorter periods in coarse soils or with high precipitation). Do not use Tordon near water or where a coarse soil overlies groundwater 10 feet or less below the surface. Clarity® also may provide good control, but residual control of seedlings is shorter. An annual follow-up treatment with 2,4-D may be required to prevent reinfestation. Redeem® R & P, Transline®, or Curtail® will provide effective control with less soil residual than Tordon, Grazon, or Clarity.

Control is greatest when fall-applied, but a follow-up application may be required in spring to control seedlings. These herbicides (Redeem R & P,

Transline, Curtail) also have limited impact on non-target broadleaf plants. Applying 2,4-D alone will effectively control knapweed seedlings, but is not very effective after stem elongation. Repeated applications may be necessary. The amine formulation of 2,4-D can be applied along waterways but provides the least effective control. Recent research suggests that Plateau® may be effective, but little research with this compound has been conducted in Nebraska. While chemical control may temporarily eliminate knapweed plants, long-term restoration of desirable plant communities requires a combination of chemical, cultural, and biological management practices.

Biological Control

Livestock will graze knapweeds at low levels. Rosettes of first year knapweed plants have some nutritional value but are difficult to graze because of their low stature. Controlled, repeated grazing of knapweed by sheep during early spring and late fall was shown to reduce the number of young plants in Montana, but grazing by cattle only increased bare ground.

Natural enemies have been used to biologically control spotted and diffuse knapweed since 1970. To date, 13 natural enemies (all insects) from Eurasia have been introduced into North America for biological control of one or both knapweed species *(Table 2)*. Eight of these insects have been released for knapweed control in northeastern Nebraska *(Figure 8)*. All of these attack knapweed flower heads and five also attack the roots. Root-feeding insects may have the most detrimental effect on knapweed populations because they restrict the plant's ability to obtain soil resources (nutrients, water, etc.), which subsequently reduces the plant's competitiveness and seed production.

Several fungal and bacterial pathogens also biologically control these knapweeds. *Sclerotinia sclerotiorum*, a soil fungus native to North America, and *Pseudomonas syringae pv. syringae,* a bacteria, are associated with insect injury to plants. Some researchers believe that at least six biological control agents are needed to effectively control knapweed populations. Because many of the introduced biological control agents are increasing very slowly, the combined use of all available control methods and improved land management practices will provide the most effective long-term control of spotted and diffuse knapweed.

Table I.
Herbicide treatments for knapweed control.

Herbicide	Rate/acre	Application time	Expected duration of control (years)
2,4-D ester (4L)	1 quart	Rosette	<1
Curtail (clopyralid + 2,4-D)	2-3 quarts	Last bud to early rosette	1-2
Grazon P + D (picloram + 2,4-D)	3-4 pints	Rosette	2-5
Telar (chlorsulfuron)	1-2 oz	Mid-bolt to last bud	1-2
Redeem R & P (clopyralid + triclopyr)	1.5-2 quarts	Rosette to bud	1-2
Tordon 22k (picloram)	1-2 pints	Rosette to bud	2-5
Milestone (aminopyralid)	5-7 oz	Rosette to bolt	1-2

These recommendations were current as of January 2009. See "Guide for Weed Management in Nebraska" EC-130, for current information. It's available in print at local Extension offices or on the Web at http://www.ianrpubs.unl.edu/sendIt/ec130.pdf

Distribution

Small populations of spotted and diffuse knapweed can be found mainly in north central, northeast, and western Nebraska. An estimated 21 Nebraska counties had spotted or diffuse knapweed infestations in 2006 *(Figure 8)*, an increase from 10 counties in 1991. Even though the knapweeds are not currently major weeds of rangeland or pastures in Nebraska, the importance of these weeds in nearby states and their tendency to succeed in sandy, well-drained rangeland soils make them a major threat, primarily to cattle production, throughout Nebraska.

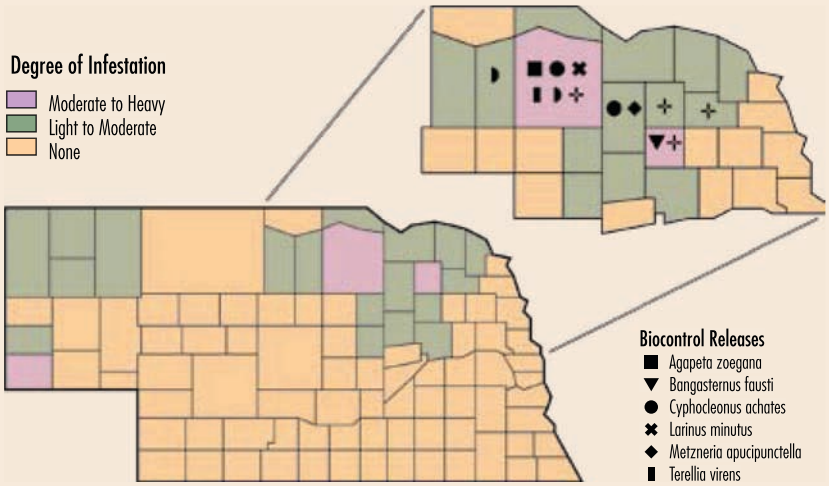

Figure 8. Primary habitat of spotted and diffuse knapweed infestations in Nebraska in 2006. The knapweeds are not limited to this area. All rangelands and pastures are susceptible. Symbols represent areas where biological control agents have been released for the management of spotted knapweed.

Note: Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by Extension is implied.

Table II.
Biological control insects released for management of spotted and diffuse knapweed.

Insect species[1]	Common name	Weed attacked[2]	Insect type
Agapeta zoegana★	Sulphur knapweed moth	SK, DK	Root-boring moth
Bangasternus fausti★	Broad-nosed seedhead weevil	SK, DK	Seedhead weevil
Chaetorellia acrolophi	Knapweed peacock fly	SK	Seedhead weevil
Cyphocleonus achates★	Knapweed root weevil	SK	Root-boring/gall weevil
Larinus minutus★	Lesser knapweed flower weevil	SK, DK	Seedhead weevil
Larinus obtusus	Blunt knapweed flower weevil	SK	Seedhead weevil
Metzneria paucipunctella★	Spotted knapweed seedhead moth	SK	Seedhead moth
Pelochrista medullana	Brown winged root moth	SK, DK	Root-boring moth
Pterolonche inspersa	Gray winged root moth	DK	Root-boring moth
Sphenoptera jugoslavica	Bronze knapweed root borer	DK	Root-boring/gall beetle
Terellia virens★	Green clearwing fly	SK	Seedhead weevil
Urophora affinis★	Banded gall fly	SK, DK	Seedhead weevil
Urophora quadrifasciata★	UV knapweed seedhead fly	SK, DK	Seedhead weevil

[1]An asterisk indicates that this species has been introduced for biological control of knapweeds in Nebraska *(Figure 8)*.
[2]SK = Spotted knapweed, DK = Diffuse knapweed

Additional Sources of Information

Distribution, Biology, and Management of Diffuse Knapweed *(Centaurea diffusa)* and Spotted Knapweed *(Centaurea maculosa)*. Written by R.L. Sheley, J.S. Jacobs, and M.F. Carpinelli and published in Weed Technology (12:353-362) in 1998.

The Biology of Candian Weeds. 6. *Centaurea diffusa* and *C. maculosa*. Written by A.K. Watson and A.J. Renny in the Canadian Journal of Plant Science (54:687-701) in 1974.

Proceedings of the First International Knapweed Symposium of the Twenty-First Century, March 15-16, 2001 in Coeur d' Alene, Idaho. Edited by L. Smith and published by USDA Agricultural Research Service, WRRC/EIW, 800 Buchanan St., Albany, CA 94710 in 2001.

A Message From the Nebraska Department of Agriculture

The State of Nebraska has had a noxious weed law for many years. Over the years, the Nebraska Legislature has revised this law.

The term "noxious" means to be harmful or destructive. In its current usage "noxious" is a legal term used to denote a destructive or harmful pest for purposes of regulation. When a specific pest (in this case, a weed) is determined to pose a serious threat to the economic, social, or aesthetic well-being of the residents of the state, it may be declared noxious.

Noxious weeds compete with crops, rangeland, and pastures, reducing yields substantially. Some noxious weeds are directly poisonous or injurious to man, livestock, and wildlife. The losses from noxious weed infestations can be staggering, costing residents millions of dollars due to lost production. This not only directly affects the landowner, but erodes the tax base for all residents of the state. The control of noxious weeds is everyone's concern and to everyone's benefit. The support of all individuals within the state is needed and vital for the control of noxious weeds within Nebraska.

It is the duty of each person who owns or controls land in Nebraska to effectively control noxious weeds on their land. County boards or control authorities are responsible for administration of noxious weed control laws at the county level. This system provides the citizens of Nebraska with "local control." Each county is required to implement a coordinated noxious weed program. When landowners fail to control noxious weeds on their property, the county can serve them with a notice to comply. This notice gives specific instructions and methods on when and how certain noxious weeds are to be controlled.

The Director of Agriculture determines which plants are to be deemed as "noxious" and the control measures to be used in preventing their spread. In Nebraska, the following weeds have been designated as noxious:

Canada thistle (*Cirsium arvense* (L.) Scop.)
Leafy spurge (*Euphorbia esula* L.)
Musk thistle (*Carduus nutans* L.)
Plumeless thistle (*Carduus acanthoides* L.)
Purple loosestrife (*Lythrum salicaria* L. and L. *virgatum* — including any cultivars and hybrids)
Knapweed (spotted and diffuse) (*Centaurea maculosa* Lam. and *C. diffusa* Lam.)
Saltcedar (*Tamarix ramosissima* Ledeb.) and small flower Tamarix (*Tamarix parviflora* DC.)
Phragmites (*Phragmites* sp.)

Whether farmer or rancher, landowner or landscaper, it's everyone's responsibility and everyone's benefit to aid in controlling these noxious weeds. If you have questions or concerns regarding noxious weeds in Nebraska, please contact your local county noxious weed control authority or the Nebraska Department of Agriculture.

Spotted Knapweed

Illustration by Renee' Lanik.

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