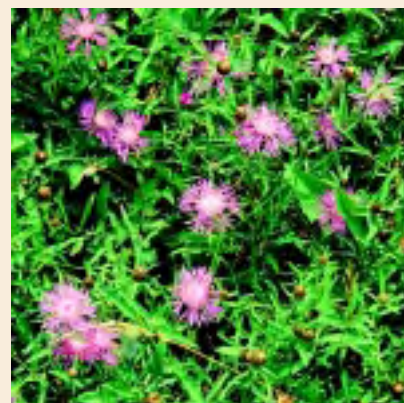


Noxious Weeds of Nebraska

Spotted and Diffuse Knapweed

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Spotted and Diffuse Knapweed

Spotted knapweed (*Centaurea maculosa* Lam. = *C. biebersteinii* DC.) and diffuse knapweed (*C. diffusa* Lam.) are two of Nebraska's seven 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 and pastures, Conservation Reserve Program lands, roadsides, and ditch banks (Figure 1). *Centaurea* is a large genus of over 400 species, 32 of which are common weeds of the United States and several of which [e.g., yellow starthistle, *C. solstitialis* L, and Russian knapweed, *C. repens* L. = *Acroptilon repens* (L.) DC.] have been identified officially as noxious weeds in nearby western states. Other *Centaurea* species are used as ornamentals. The knapweeds were introduced to the United States from the grasslands of southeastern Europe and Asia. Spotted knapweed now infests more than seven million acres and diffuse knapweed more than three million acres of rangeland and pastures in the western United States. In north and northeastern Nebraska they currently infest about 7,000 acres in 21 counties.

Negative impacts of spotted and diffuse knapweed include reduced productivity of grazing lands and wildlife habitat and increased 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, knap-



Figure 1. Dense infestations of spotted and diffuse knapweed can reduce productivity of grazing lands and wildlife habitat and increase surface runoff. Figure 1a (top) 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.

weeds have become major weeds of range and pasture in states north and west of Nebraska and are estimated to cost cattle producers \$42-\$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.

Biology

There have been discrepancies in the taxonomic description of spotted knapweed in Europe and North America. There have been at least four scientific names assigned to spotted knapweed in the literature, and some documentation that spotted and diffuse knapweed can interbreed. The importance of this is that, while these species look alike during certain stages of development, they do 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 deeply tap-rooted rosettes and reproduce primarily by seed (Figure 2). Seed production in a pure stand ranges from 450 to 4500 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

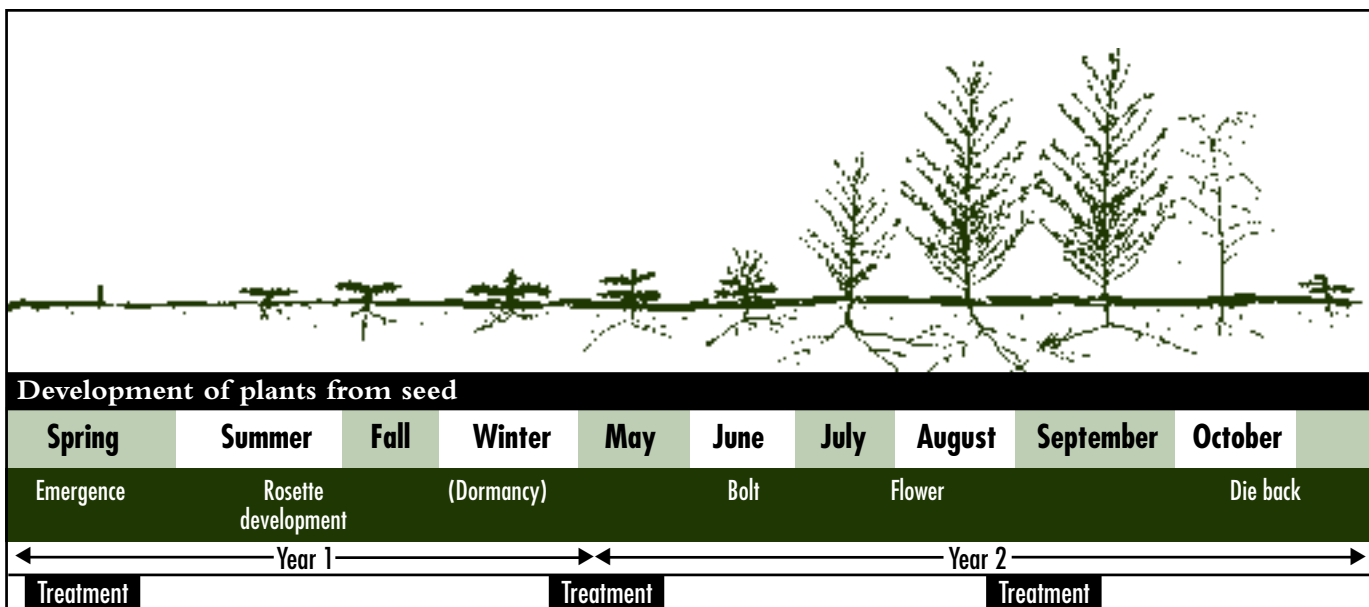
moisture and temperature are suitable. Seedlings germinating during this period can mature into seed-producing adults in one year. Seedlings develop into rosettes, which then put most of their energy into growing roots. If rosettes do not bolt, they die back to the root crown to overwinter. Spotted knapweed 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 form mature seeds 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).

The 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 initially, 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. This allows for the germination and establishment of the knapweeds instead of desirable species. Thus, both knapweeds are capable of invading any disturbed site, even in well-maintained range and pasture. Once established, both weeds have the capability to form pure stands that have little forage value.

History

Spotted knapweed is native to Eurasia, from central Europe east to central Russia, Caucasia, and western Siberia. Diffuse knapweed is native to the eastern Mediterranean region to western Asia, and from the former Republics 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 be introduced from 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 listed on 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



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 and typically 0.8 to 2 inches long and narrow. 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 and remains attached to the plant after maturity (Figure 6). They are solitary or can be 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 are 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 (less than 1/8 inch) brown to black achene (like a sunflower seed) with a ring of hairs growing out one end (Figure 7).



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 tends to have more finely divided lobes (d).



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



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.



Figure 6. The flower head of both species is shaped like a miniature vase. Spotted knapweed flowers are pink to purple or rarely white (*left*), whereas diffuse knapweed flowers are usually white but sometimes rose or purple (*right*). 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 (*left*), whereas diffuse knapweed bracts are buff or brown at the tips, but not usually black, and tipped with a distinctive 1/16- to 5/16-inch long terminal spine (*right*).



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

Mechanical

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 pulling by hand 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. Effects of mowing knapweed are not well documented and results are variable. Mowing during the late bud stage may be most effective, especially if combined with some chemical treatments.

Chemical

Chemical control of established populations of spotted and diffuse knapweed is expensive and eradication may be impossible; however, small and new 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 ground water 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 of established infestations is greatest when fall applied, but a follow-up application may be required in the spring to control seedlings.

Control Methods

The most cost-effective management tool is to prevent knapweeds from spreading from open areas and roadsides onto adjacent rangelands or pastures. Spread can be minimized by not driving through or grazing knapweed-infested areas. 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 the knapweeds 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.

These herbicides also have an impact on non-target broadleaf plants. Application of 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 and cultural management practices.

Biological

Livestock will graze knapweeds at low levels. Rosettes of first year knapweed plants are edible and offer some nutritive 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 knapweed plants in Montana, but grazing by cattle only increased bare ground.

The use of natural enemies to biologically control spotted and diffuse knapweed has been ongoing 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 II). Eight of these insects have been released for knapweed control in northeastern Nebraska (Figure 8). Eight of the insects attack knapweed flower heads while five 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 competitive ability and seed production.

In addition to insects, there are several fungal and bacterial pathogens that infect the 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

Table I.
Herbicide treatments for knapweed control.

Herbicide	Rate/acre	Application time	Expected duration of control (years)
Tordon 22k (picloram)	1 - 2 pints	Rosette to bud	2 - 5
Grazon P + D (picloram + 2,4-D)	4 pints	Rosette	2 - 5
Clarity (dicamba)	1 - 2 quarts	Bud to early bloom	1 - 2
Redeem R & P (clopyralid + triclopyr)	1.5 - 2 quarts	Rosette to bud	1 - 2
Transline (clopyralid)	0.66 - 1 pint	Mid-bolt to last bud	1 - 2
Curtail (clopyralid + 2,4-D)	2 - 3 quarts	Last bud or early rosette	1 - 2
2,4-D ester (4L)	1 quart	Rosette	<1

These recommendations were current as of July 1, 2002. See "Guide for Weed Management in Nebraska" EC-130, for current information. It's available in print at local Cooperative Extension offices or on the Web at <http://www.ianr.unl.edu/pubs/fieldcrops/ec130.htm>

Distribution

Small populations of spotted and diffuse knapweed can be found in north central, northeastern and western Nebraska. An estimated 21 Nebraska counties had spotted or diffuse knapweed infestations in 2000, 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.

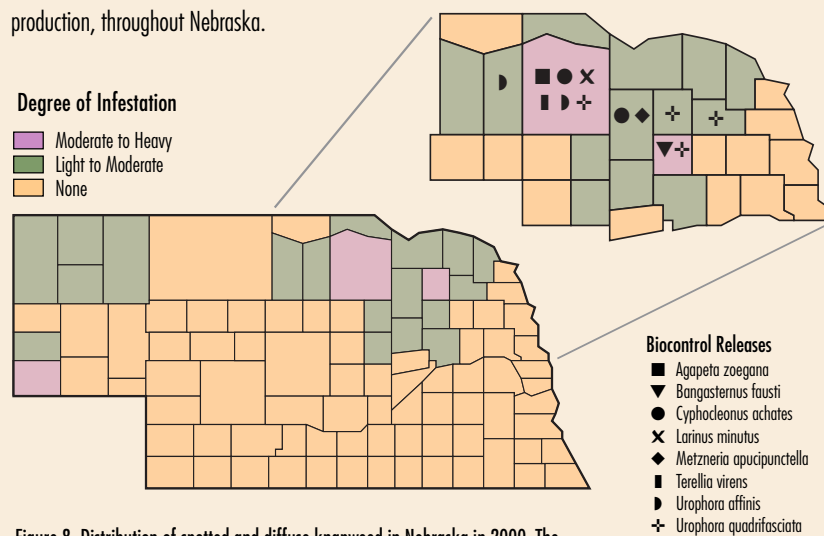


Figure 8. Distribution of spotted and diffuse knapweed in Nebraska in 2000. The knapweeds are not limited to this area. All rangelands and pastures are susceptible. Symbols represent areas where biological control agents have been released for the management of spotted knapweed in Nebraska.

increasing very slowly, the combined use of all available control methods and improved land management practices will be the most effective long-term control of spotted and diffuse knapweed.

Note: Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by Cooperative 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 ¹	Sulphur knapweed moth	SK, DK	Root-boring moth
Bangasternus fausti ¹	Broad-nosed seedhead weevil	SK, DK	Seedhead weevil
Chaetorellia acrolophi	Knapweed peacock fly	SK	Seedhead weevil
Cyphocleonus achates ¹	Knapweed root weevil	SK	Root-boring/gall weevil
Larinus minutus ¹	Lesser knapweed flower weevil	SK, DK	Seedhead weevil
Larinus obtusus	Blunt knapweed flower weevil	SK	Seedhead weevil
Metzneria paucipunctella ¹	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 ¹	Green clearwing fly	SK	Seedhead weevil
Urophora affinis ¹	Banded gall fly	SK, DK	Seedhead weevil
Urophora quadrifasciata ¹	UV knapweed seedhead fly	SK, DK	Seedhead weevil

¹This species has been introduced for biological control of knapweeds in Nebraska (Figure 8).

²SK = Spotted knapweed, DK = Diffuse knapweed.

Additional Sources of Information

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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 their control is to everyone's benefit. The support of all individuals within the state is needed and vital for the control of noxious weeds within Nebraska.

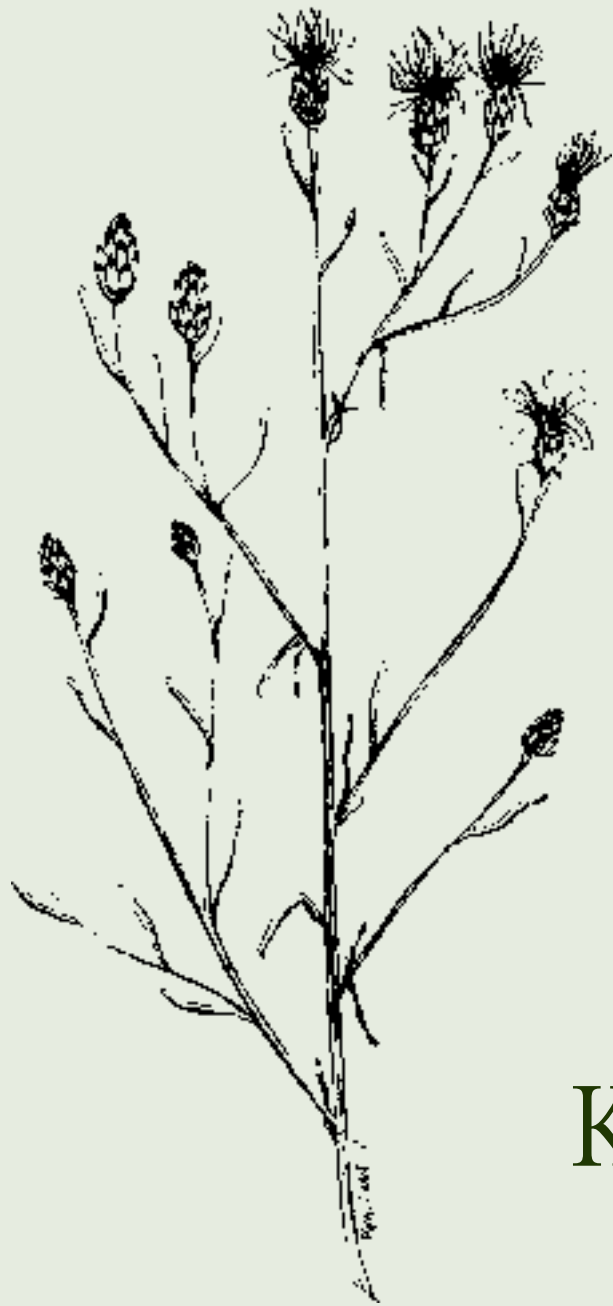
It is the duty of each person who owns or controls land in Nebraska to effectively control noxious weeds on their land. County boards or control authorities are responsible for administration of noxious weed control laws at the county level. This system provides the citizens of Nebraska with "local con-

trol". 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.)

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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