



## King County

Department of  
Natural Resources and Parks  
Water and Land Resources Division

### Noxious Weed Control Program

## BEST MANAGEMENT PRACTICES

### Spotted Knapweed

*Centaurea stoebe* ssp. *micranthos*  
(synonym *C. biebersteinii*,  
formerly *C. maculosa*)  
Asteraceae

### Class B Noxious Weed

**Legal Status in King County:** Spotted Knapweed is a Class B Noxious Weed (non-native species designated for control by State Law RCW 17.10 and by the King County Noxious Weed Control Board). The King County Noxious Weed Control Board requires property owners to control and prevent the spread of spotted knapweed on private and public lands throughout the county. Control is defined by state law as the prevention of all seed production. State quarantine laws prohibit transporting, buying, selling or offering spotted knapweed for sale or distributing plants, plant parts or seeds.



Photo by Norman E. Rees, USDA

## BACKGROUND INFORMATION

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### Impacts and History

- Spotted knapweed is native to Central, Eastern and Southeastern Europe and is thought to have been introduced into the United States from Asia Minor or Germany as a contaminant in alfalfa seed. Sources indicate its presence on Vancouver Island as early as 1893. It was first observed in Washington in 1923 in the San Juan Islands. Before it was considered to be a serious weed, it was spread in domestic hay and by human activities. Spotted knapweed has invaded rangeland throughout the western United States and Canada.
- This weed rapidly colonizes disturbed areas, but is capable of invading well-managed rangelands.
- Spotted knapweed often attains high densities on sunny wild lands—even when undisturbed by human or livestock activity. Knapweed tends to dominate sites at the expense of community diversity or forage production. It can occupy over 95 percent of the available plant community.
- Knapweed infestations can increase soil surface runoff and sedimentation of streams.

### Description

- **Plant:** Spotted knapweed in North America is a short-lived perennial forb (3-9 years) commonly growing to 2-4 feet (30 to 125 cm) in height with one to 10 upright stems, and has a

stout, elongated taproot. Seedlings usually stay in the rosette stage through the winter and continue growing in early April.

- **Leaves:** Leaves are pale to grayish green, and the leaf surface is rough. The basal leaves are up to 8 inches (20 cm) long, deeply lobed, and arranged in a rosette. Stem leaves, arranged alternately, are smaller (1 to 3 inches), less lobed and more linear in shape. Uppermost leaves are bract-like. The stem leaves grow from 1-3 inches in length. Basal leaves may be 8 inches in length.
- **Stems:** The slender, hairy stems are upright, stiff, and branched. Small plants usually have an unbranched stem and one flower head; large plants have a stem with many branches and can have over 100 flower heads. Stem height varies from two feet on upland sites to four feet on wetter sites. The majority of stem growth occurs in early summer.
- **Flowers:** Flowering occurs from May to October. Single thistle-like, pinkish-purple flower heads are 0.2 to 0.4 inch (5 to 10 mm) long and occur at the tips of terminal or auxiliary stems. Each flower head has 10 to 15 ray flowers. Each flower head has stiff bracts marked with fine, vertical streaks and tipped with dark, comb-like fringes that give the flower head a spotted appearance.
- **Seeds:** Seeds are 0.1 inch (2.5 mm) long, oval, and black or brown with pale, vertical lines. At the tip of each seed is a short, bristly pappus about half the length of the seed, enabling wind dispersal. Plants can produce about 1000 seeds, some of which can remain dormant for many years.

## Habitat

- Spotted knapweed is adapted to a range of habitats and soil types, but is especially suited to relatively dry or well-drained sites (Watson and Renney, 1974). In Europe and the Pacific Northwest, the plant is most aggressive in the forest steppe but can form dense stands in more moist areas on well-drained soils including gravel, and in drier sites where summer precipitation is supplemented by runoff (Sheley *et al.*, 1998). Spotted knapweed prefers more mesic sites than diffuse knapweed.
- Spotted knapweed spreads along heavily disturbed areas such as road ditches, agricultural field margins, railroad beds, pipelines, and recently installed utility lines. The plant will spread from these sites into rangelands, meadows and other open habitats.
- Knapweed is most common in disturbed habitats and overgrazed or poorly managed pastures.
- Spotted knapweed commonly occupies vacant, unmaintained land and parking areas.

## Reproduction and Spread

- Spotted knapweed reproduces solely by seed. Individual flower heads typically bloom from May through August (sometimes through October) for 2-6 days each. The bracts reopen after about 20 days and scatter seeds. Plants average about 1,000 seeds per plant. Seeds are viable for seven years, and germinate throughout the growing season. Seedlings emerging in fall develop into a rosette of leaves that resume growth in spring.
- Most seeds fall within 3 to 4 feet of the parent plant.
- Spotted knapweed can be spread by wind, water, wildlife, vehicles, contaminated hay, farm machinery, gravel distribution, logging equipment, and road construction. Motorized vehicles

are the greatest contributor to the spread of knapweed, and roadsides, railroads and construction equipment have been a major vector for knapweed spread.

## Local Distribution

The heaviest concentrations of spotted knapweed are in gravel pits, waste sites, unused fields, and rights-of-way in south and central King County. There are isolated plants and infestations along several river banks and highway and freeway edges throughout the county. There are very few infestations in pastures in King County.

## CONTROL INFORMATION

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### Integrated Pest Management

- The preferred approach for weed control is Integrated Pest Management (IPM). IPM involves selecting from a range of manual, mechanical, chemical, cultural and biological control methods to match the management requirements of a specific site. The goal is to maximize effective control and to minimize negative environmental, economic and social impacts.
- IPM means using an adaptive approach. Control methods should reflect the available time, funding, and labor of the participants, the land use goals, and the values of the community and landowners. Management will require dedication over a number of years, and allow for flexibility of methods used as appropriate to the current situation.

### Planning Considerations

- Learn to identify the weed and survey the area for weeds.
- For larger infestations, the strategy will depend on the land use of the site. Set long term management goals and select the best control methods for the site conditions.
- Persistence is necessary. Plan to revisit the site to control plants that have survived initial control efforts.

### Early Detection and Prevention

- Prevention is the key to weed control. Watch for knapweed near known infestations.
- Knapweed is easiest to find once it starts flowering in **June to July**. Monitor roadsides, waste and disturbed areas, pastures, rangeland, and trails for new infestations.
- Small infestations and individual plants can be effectively hand-pulled or dug up. Uprooting one plant can prevent thousands of new seedlings.
- If there are more plants than you can remove manually, treat them with an appropriate herbicide.
- Prevent plants from spreading away from existing populations by washing tools and boots and clean vehicles and animals that have been in infested areas.
- Clean mowing equipment carefully before moving to un-infested areas.
- If animals are being moved from an infested pasture to an un-infested pasture, it is best to hold them for at least five days so that the seeds pass out of the animals' digestive system

- Off-road vehicles create disturbances and carry weeds. Clean off-road equipment and avoid driving in infested areas.
- Communicate weed control needs and goals with neighbors and persons working in infested areas. Awareness will increase prevention.

## Manual

- If soils are moist, plants can be pulled after they bolt but before they flower. Typically this is from May to June.
- Plants in flower may form viable seeds even after they are pulled, so carefully bag and dispose of all flowering plants later in the season when seeds are forming.
- In areas where mature plants are pulled, there are usually many small rosettes and seeds left in the soil. Carefully search the area for rosettes and dig them up. Roots break off easily and re-sprout, so use a digging tool. Completely removing plants is easiest when the soil is loose or wet.
- Return to the same location in the following spring and summer to remove plants coming up from seeds already in the soil and continue to monitor the area for several years.

## Mechanical

- Rototilling or plowing will eliminate knapweed. Cultivating with a disk will control young plants and seedlings, but established plants can survive if the taproot remains.
- Mowing will **not** control knapweed effectively. Plants are able to re-sprout and flower again in the same season when mowed. Plants that are regularly mowed can persist as short-lived perennials or can flower below the level of the mower.

## Cultural

- In pastures, good grazing practices and management of grass and forage species will greatly improve control of knapweed. Seeding desirable species in any area will prevent weed infestations.
- Minimize disturbance and re-vegetate disturbed areas to avoid creating opportunities for seed germination. Manage for the species desired on the site.

## Chemical

- Herbicides should only be applied at the rates and for the site conditions and/or land usage specified on the label of the product being used. **Follow all label directions.**
- Herbicides are usually the best method to control large or established infestations in areas that cannot be tilled. For knapweed, it is most effective to apply selective broadleaf herbicides in the spring. Infested areas should not be mowed until after the herbicide has had a chance to work and the vegetation has died back.
- Herbicides may be used in accordance with Federal and State Law in critical areas and their buffers with certain restrictions. Refer to the **King County Noxious Weed Regulatory Guidelines** for a summary of current restrictions and regulatory compliance issues.

- Herbicides should be used as one tool in an integrated pest management approach. Cultural techniques such as fertilizing pastures or reseeded and establishing competing vegetation can minimize chemical use. Manual removal of survivors as follow-up can be effective.

## Specific Herbicide Information

**Selective Broadleaf Herbicides** are very effective in controlling knapweed, especially in pastures and grassy area. Most established grasses are not harmed by these selective herbicides and will compete with knapweed seedlings. However, selective herbicides can harm certain grasses, alfalfa, clover and other legumes. Soil type, water table depth and land use should be considered before using any herbicide.

Selective herbicides such as clopyralid (Stinger) and aminopyralid (Milestone) are the most effective herbicides for spotted knapweed control, having soil residual activity that provides extended control of germination, but must only be used in permanent pastures, rangeland or non-crop areas. Other selective herbicides recommended for spotted knapweed control are: clopyralid + 2,4-D (Curtail) and clopyralid + triclopyr (Redeem R&P).

Readily available selective herbicides effective in controlling knapweed include 2,4-D (many products), a combination treatment of dicamba and 2,4-D (e.g. Weedmaster or Weed-B-Gon) and a combination treatment of triclopyr and 2,4-D (e.g. Crossbow). If using 2,4-D, or triclopyr (Garlon), re-treatment will be necessary to control late-germinating plants. 2,4-D is most effective when plants are bolting.

**Glyphosate** (Roundup) will effectively kill individual knapweed plants or plants where damage to non-target species can be tolerated. Treatment with glyphosate should be combined with effective re-vegetation of the site to prevent seedlings from re-infesting the area.

**NOTE: Certain additional restrictions apply for products containing 2,4-D and Triclopyr BEE (e. g. Garlon 4, Crossbow). Refer to the King County Noxious Weed Regulatory Guidelines for more details.**

*The mention of a specific product brand name in this document is not, and should not be construed as an endorsement or as a recommendation for the use of that product.* Chemical control options may differ for private, commercial and government agency users. **For questions about herbicide use, contact the King County Noxious Weed Control Program at 206-296-0290.**

## Biological

Biological control is the deliberate introduction of insects, mammals or other organisms which adversely affect the target weed species, reducing the population and reproductive ability of the weed. Biological control is generally most effective when used on large infestations or in areas where it is difficult to use other control techniques. Because knapweed has severely infested large areas of rangeland in western United States, there has been considerable effort to find biological control agents. Since the 1960's, 14 agents have been released, 13 insect species and 1 fungus, and this combination of biocontrol agents is beginning to have some success. In King

County, the knapweed infestations are relatively small and biological control agents are not well-suited to prevent small, pioneering infestations.

- Biological control can take many years to have a significant impact on an infestation. Population density and the number of flowering plants can be greatly reduced but eradication is not possible with biocontrol.
- Any biological control plan needs to incorporate another non-chemical control method if the goal is to prevent all seed production.
- The seed-feeding weevils, *Larinus minutus*, (most often used for diffuse) and *L. obtusus* (most often used for spotted) and the root-mining weevil *Cyphocleonus achates* are the primary biocontrol agents used. Studies demonstrate that the combination of these species can be very effective in reducing knapweed populations in Montana. In eastern Washington, *L. minutus* has been effective in reducing weed infestations when adults build to outbreak populations and feed heavily on above-ground foliage and larvae attack flowering plants and reduce seed production. The combination of biocontrol and droughts in eastern Washington was likely important to the observed knapweed reductions.
- *Bangasternus fausti*, a seed-feeding weevil, is smaller, has a blunt snout and emerges earlier in the season than the *Larinus* beetles. It appears to co-exist with *Larinus* and may attack the earlier flowering plants that are missed by *Larinus* beetles.
- *Chaetorellia acrolophi* and *Terellia virens* are two relatively new seed-feeding flies. Because of the effectiveness and easy establishment of the *Larinus* beetles, the flies are not commonly used. However, at cool wet sites, where *Larinus* beetles do not readily establish, they are an important alternative option.
- The root-mining beetle, *Sphenoptera jugoslavica*, is fairly widespread in eastern Washington but its effectiveness has not been fully assessed.
- The seed-feeding moth, *Metzeneria paucipunctella*, is rarely redistributed in Washington because it attacks other biocontrol agents within the seed head and are subject to mortality from mice and parasitoids.
- The seed-feeding flies *Urophora affinis* and *U. quadrifasciata* are no longer distributed as biocontrol agents. They are found at almost every site and are considered ineffective.

## SUMMARY OF BEST MANAGEMENT PRACTICES

### **Small Infestations in Native and/or Desirable Vegetation**

- Prevent plants from forming seed.
- Pull plants by hand if soil is wet; the plants may need to be dug up if large or in dry compacted soil.
- Replace any divots created when removing the plants to lessen the amount of disturbed soil.
- Apply appropriate herbicide to actively growing plants.
- If using an herbicide in a grassy area, use a selective herbicide to avoid injury to the grass.
- Monitor site throughout growing season and remove any new plants.

## Large Infestations/Monocultures in Grassy Areas

- Mowing will not control knapweed. Mowing can be used if the infestation is found later in the year to keep the plants from flowering until an approved control method can be used. Do not mow plants that have gone to seed. Mowing may increase the number of stems.
- Large infestations can be controlled with selective herbicides. (See the Chemical section of this BMP). Suppression of large infestations of knapweed with a selective herbicide will greatly increase grass production, which in turn increases the suppression of the knapweed.
- Promote healthy grassy areas by seeding and fertilizing. Use a mix of grass and clover species to improve resistance to weeds. Fertilize according to the soil needs.
- Pastures should be managed to promote grass and clover vigor. Avoid overgrazing and move animals when grass is still about 3 inches tall. Cross fencing allows regrowth of grasses, decreasing weeds and increasing forage. Avoid grazing when soil is very wet because holes can be opened up to new weed infestations. For more information on pasture management, contact the King Conservation District (<http://www.kingcd.org>).
- Monitor for knapweed on edges of pastures and in disturbed areas along roads, fences and watering and feeding areas. Remove isolated plants before they flower.
- Severely infested pastures should be reseeded.

## Control in Riparian Areas

- Additional permits may be required for control of infestations in riparian areas. See Noxious Weed Regulatory Guidelines for more information ([http://dnr.metrokc.gov/wlr/lands/weeds/pdf/Noxious\\_Weeds\\_Regulatory\\_Guidelines.pdf](http://dnr.metrokc.gov/wlr/lands/weeds/pdf/Noxious_Weeds_Regulatory_Guidelines.pdf)).
- When large areas of weeds are removed, the cleared area needs to be replanted with native or non-invasive vegetation and stabilized against erosion. Refer to the King County Surface Water Design Manual for further information about sediment and erosion control practices (call 206-296-6519 or go to <http://dnr.metrokc.gov/wlr/Dss/Manual.htm> for information).
- Survey area and document extent of infestation.
- Focus on manual removal for small infestations if possible, and prevent seed production.
- Mowing can serve in the interim until more effective control measures can be utilized.
- For larger areas where herbicide use is warranted, spot spray using low pressure and large droplet size, or use wick or wiper techniques.
- Aminopyralid and amine formulations of 2,4-D and triclopyr can be used to edge of water.
- When large areas of weeds are removed, the cleared area needs to be replanted with native or non-invasive vegetation and stabilized against erosion.
- If a non-selective herbicide is used, the area should be re-seeded to prevent reinvasion by weeds.
- Infested areas will need to incorporate a management plan lasting for several years to control plants germinating from the seed bank.

## Control on Road Rights-of-Way

- Pull small infestations if possible, and prevent seed production.
- In most areas, spray with a selective broadleaf herbicide. Be sure to look for small rosettes and seedlings near the larger plants.

- Aminopyralid and amine formulations of 2,4-D and triclopyr can be used to the edge of water.
- Spot spray with glyphosate if weeds are in areas with no desirable grasses.
- Re-vegetate with desired species if necessary.
- If plants are about to flower, they can be mowed until a more effective control strategy can be used.

## References

- Pacific Northwest Weed Management Handbook. 2006. Oregon State University.
- Ochsmann, Jörg. 2005. The Knapweed pages. <http://www.centaurea.net>
- Story, J. Spotted Knapweed. Invasive Plants of the Eastern United States. Montana State University, Western Agricultural Research Center, Corvallis, Montana, USA.
- Watson, A. K. and A. J. Renney. 1974. The biology of Canadian weeds. *Centaurea diffusa* and *C. maculosa*. *Canadian Journal of Plant Science* 54: 687-701.
- Wilson, L. M. and C. B. Randall. 2003. Biology and Biological Control of Knapweed. USDA-Forest Service FHTET-2001-07. 2nd Edition.
- Sheley, R. L., J. S. Jacobs, and M. E. Carpinelli. 1998. Distribution, biology, and management of diffuse knapweed (*Centaurea diffusa*) and spotted knapweed (*Centaurea maculosa*). *Weed Technology* 12:353-362.

## Internet References (unknown authors)

- [http://www.ag.montana.edu/warc/biocontrol\\_agents\\_of\\_knapweed.htm](http://www.ag.montana.edu/warc/biocontrol_agents_of_knapweed.htm)
- <http://www.invasive.org/eastern/biocontrol/13Knapweed.html>