| MN NWAC Risk Assessment Worksheet (04-2011) | Common Name | *Latin Name* |
|---|---|---|
| | **Spotted Knapweed** | ***Centaurea stoebe* L. ssp. *micranthos* (Gugler) Hayek, syn. = *C. biebersteinii*, old = C. *maculosa*** |
| **Reviewer** | **Affiliation/Organization** | **Date (mm/dd/yyyy)** |
| **Monika Chandler** | **MN Dept. of Agriculture** | **08/12/13** |

Spotted knapweed was first recorded in North America in 1893 (Roche and Talbott 1986). It was possibly introduced to this continent with shipments of alfalfa seed from either Asia Minor-Turkmenistan or with hybrid seed from Germany (Maddox 1979). Spotted knapweed has successfully invaded areas throughout most of temperate North America. Duncan (2005) calculated a 15.5% average annual rate of spread in the United States from 1893-2003.

Spotted knapweed is a short-lived perennial that reproduces quickly by seed and produces a chemical that is toxic to other plants and allows spotted knapweed to displace desirable vegetation. Once established spotted knapweed can form a monoculture and overtake large areas. Resulting infestations can reduce forage and wildlife habitat.

| Box | Question | Answer | Outcome |
|---|---|---|---|
| 1 | Is the plant species or genotype non-native? | Spotted knapweed is native to Europe and Asia and was formerly called *Centaurea maculosa* Lamarck. Ochsmann (2001) elucidated the taxonomy such that a diploid form (2n=18) and a tetraploid form (2n=36) were described. The diploid form is named *Centaurea stoebe* L. subsp. *stoebe* and is native to western and central Europe. The tetraploid form is present in North America, but is native to southern Europe and western Asia. It is named *Centaurea stoebe* L. subsp. *micranthos* (Gugler) Hayek with the synonyms *C. biebersteinii* and *C. micranthos* | Go to Box 3 |
| 3 | Is the plant species, or a related species, documented as being a problem elsewhere? | Yes. It is regulated in AZ, CA, CO, CT, ID, MA, MT, NE, NV, NM, ND, OR, SD, UT, WA and WY (USDA, NRCS. 2013). | Go to Box 6 |
| 6 | Does the plant species have the capacity to establish and survive in Minnesota? | Yes | Go to Box 7 |

| Box | Question | Answer | Outcome |
|---|---|---|---|
| | A. Is the plant, or a close relative, currently established in Minnesota? | Spotted knapweed was first recorded in Minnesota in 1918 (University of Minnesota Herbarium). Knapweed continues to spread in Minnesota. MDA survey results indicate the most severe infestations in the northwestern part of the state around Detroit Lakes and Park Rapids. However, severe infestations occur in many other regions. The southern portion of the state remains largely uninfested to date. | |
| 7 | Does the plant species have the potential to reproduce and spread in Minnesota? | Yes | |
| | A. Does the plant reproduce by asexual/vegetative means? | No, reproduction is by seed (Wilson and Randall 2003) | Go to Question C |
| | C. Does the plant produce large amounts of viable, cold-hardy seeds? | Yes. Since spotted knapweed is self-compatible (Watson and Renney 1974), a single plant can reproduce in the absence of other spotted knapweed plants. When available moisture levels are sufficient, each spotted knapweed plant can produce up to 20,000 seeds annually (Watson and Renney 1974). Shirman (1981) calculated that seed production is 1,000-fold above the amount needed to maintain observed levels of infestation. Seeds can remain viable for at least 8 years (Davis et al. 1993). | Go to Question F |
| | F. Are sexual propagules – viable seeds – effectively dispersed to new areas? | Yes, the seed can be moved by wind, water, wildlife, equipment, and vehicles. The movement of hay and gravel infested with knapweed seed allows knapweed to proliferate in new areas. | Go to Question I |
| | I. Do natural controls exist, species native to Minnesota, that are documented to effectively prevent the spread of the plant in question? | No | Go to Box 8 |
| 8 | Does the plant species pose significant human or livestock concerns or has the potential to significantly harm agricultural production, native ecosystems, or managed landscapes? | Yes | Go to Box 9 |

| Box | Question | Answer | Outcome |
|---|---|---|---|
| | A. Does the plant have toxic qualities, or other detrimental qualities, that pose a significant risk to livestock, wildlife, or people? | Forage for cattle and wildlife is reduced both by the loss of existing forage and by the low palatability of spotted knapweed to many herbivores. Harris and Cranston (1979) found that knapweed could reduce forage up to 88%. Native grasses and other desirable forage are decreased as spotted knapweed outcompetes desirable vegetation. Mature spotted knapweed has low nutrient value, tastes bitter, and has too much fibrous stem to be appealing to many mammalian grazers including cattle and elk (Watson and Renney 1974, Rice et al. 1997). Since cattle and wildlife avoid spotted knapweed, the remaining forage is at risk of overgrazing resulting in a greater competitive advantage for spotted knapweed. | Go to Box 9 |
| | B. Does, or could, the plant cause significant financial losses associated with decreased yields, reduced crop quality, or increased production costs? | Yes. All of these detrimental effects of spotted knapweed translate to serious economic costs. Hirsch and Leitch (1996) determined that in Montana, spotted knapweed causes annual losses of $42 million. Also, the recreational quality of knapweed infested lands can decrease (DiTomaso 2000). | Go to Box 9 |
| | C. Can the plant aggressively displace native species through competition (including allelopathic effects)? | Yes. Spotted knapweed reproduces quickly and is allelopathic (Fletcher and Renney 1963; Kelsey and Locken, 1987, Bais et al. 2003, and Weir et al. 2003, Perry et al. 2005) which means that it chemically inhibits the growth of other plants, allowing it to spread quickly forming monocultures that can span vast acreages. Seed from these infestations spreads and knapweed proliferates into ever expanding ranges. Knapweed overtakes desirable vegetation in pastures and natural areas. Plant diversity can be significantly reduced with a monotypic knapweed infestation (Tyser 1992, Tyser and Key 1988). Knapweed is capable of invading well-managed grasslands and natural areas (Lacey et al. 1990, Tyser and Key 1988). | Go to Box 9 |
| | D. Can the plant hybridize with native species resulting in a modified gene pool and potentially negative impacts on native populations? | Knapweeds and starthistles can hybridize (Wilson and Randall 2003). American starthistle (*C. americana*) is native to many states of the central US including WI and IA. Rothrock's knapweed (*C. rothrockii*) is native to AZ and NM. Alpine knapweed (*C. transalpina*) is documented in 8 states including MN. USDA, NRCS. 2013 | Go to Question E |

| Box | Question | Answer | Outcome |
|---|---|---|---|
| | E. Does the plant have the potential to change native ecosystems? | Spotted knapweed infestations can increase soil erosion. Cryptogam cover such as moss is reduced in knapweed infestations, potentially reducing moisture retention and soil stabilization (Tyser 1992). Lacey et al. (1989) determined that surface runoff and erosion are greater from knapweed dominated sites compared to bunchgrass dominated sites. This can have long-term consequences involving both topsoil loss and water quality degradation resulting from increased sediment runoff. | Go to Question F |
| 9 | Does the plant species have clearly defined benefits that outweigh associated negative impacts? | No, the benefits do not outweigh the negative impacts. However, Michigan beekeepers consider spotted knapweed a valuable nectar and pollen source. Michigan is the only state where beekeepers have voiced concern over the control of spotted knapweed. | Go to Box 10 |
| | A. Is the plant currently being used or produced and/or sold in Minnesota or native to Minnesota? | No | Go to Box 10 |
| 10 | Should the plant species be enforced as a noxious weed to prevent introduction &/or dispersal; designate as prohibited or restricted? | | |
| | A. Is the plant currently established in Minnesota? | Yes, see Box A Question 6 | Go to Question B |
| | B. Does the plant pose a serious human health threat? | Unlikely but there are some unsubstantiated reports of tumors after handling knapweed plants with bare hands. | Go to Question C |

| Box | Question | Answer | Outcome |
|---|---|---|---|
| | C. Can the plant be reliably eradicated (entire plant) or controlled (top growth only to prevent pollen dispersal and seed production as appropriate) on a statewide basis using existing practices and available resources? | A variety of tools are used to effectively manage spotted knapweed. These include hand-pulling, herbicides, biological control using insects, goat and sheep grazing and prescribed fire.<br><br>Very small infestations can be hand-pulled.<br><br>Hahn and Stachowski (2006) found that at 140 days after treatment with aminopyralid applied at a rate of 4 fl oz/acre, spotted knapweed was 50% controlled in a grass pasture. In contrast, Holden et al. (2007) demonstrated greater than 97% control with 2,4-D ester at 4 pt/acre, clopyralid plus 2,4-D at 2 pt/acre, aminopyralid at 5 oz/acre, and aminopyralid plus 2,4-D at 2 pt/acre. Concern for non-target broadleaf plants and environmental sensitivity of the site may influence herbicide choice. Knapweed seeds germinate throughout the growing season so seedlings may emerge after herbicides dissipate or leach into the soil (Jacobs and Sheley 1998). MacDonald et al. (2007) found no long-term decrease in knapweed density, biomass, or dominance with a single herbicide application.<br><br>MDA coordinates a biological control program focused on using seedhead and root weevils together to control large infestations.<br><br>Goats and sheep can consume spotted knapweed. Williams and Prather (2006) determined that goat grazing of spotted knapweed at the bud to bloom stage over a three year period reduced plant cover, plant density, and seedhead production.<br><br>At a site in Michigan, Emery and Gross (2005) found that annual summer burns for 3 years were consistently effective at reducing the spotted knapweed growth rate. In contrast, MacDonald et al. (2007) found annual spring burns for 3 years reduced knapweed populations and increased the growth of native warm-season grasses at a site in Michigan. | List as a prohibited/eradicate or control noxious weed depending on whether eradication is possible and reasonable |
| | | | |

| Box | Question | Answer | Outcome |
|---|---|---|---|
| | | | |
| **Final Results of Risk Assessment** | | | |
| | **Review Entity** | **Comments** | **Outcome** |
| | NWAC Listing Subcommittee | First review – 06/20/2013, Final Review 08/12/2013<br>Herbicide applications in combination with available biocontrols appear to be a suitable method for landowners to control large and small stands. | Continue listing as a Prohibited-Control species |
| | NWAC Full-group | Reviewed 12/18/2013 | Vote 13 – 0 to remain as a Prohibited-Control Species |
| | MDA Commissioner | Reviewed 02_24/2014 | Accepted NWAC's Recommendation to remain as a Prohibited-Control species |
| | File # MDARA00029SPKNAP_2_24_2014 | **Prohibited-Control Noxious Weed** | |

**References**


Bais, H.P., S.W. Travis, A.J. Kennan, F.R. Stermitz, and J.M. Vivanco. 2003. Structure-dependent phytotoxicity of catechins and other flavinoids: flavinoid conversions by cell-free protein extracts of *Centaurea maculosa* (spotted knapweed) roots. *Journal of Agricultural and Food Chemistry* 51:897-901.

Davis, E.S., P.K. Fay, T.K. Chicoine, and C.E. Lacey. 1993. Persistence of spotted knapweed (*Centaurea maculosa*) seed in soil. *Weed Science* 41:57-61.

DiTomaso, J.M. 2000. Invasive weeds in rangelands: Species, impacts, and management. *Weed Science* 48:255-265.

Duncan, C.L. 2005. Spotted Knapweed, pp. 51-68 *In* C.L. Duncan. and J.K. Clark [eds.], Invasive Plants of Range and Wildlands and Their Environmental, Economic, and Societal Impacts. Weed Science Society of America, Lawrence, KS.

Emery, S.M., and K.L. Gross. 2005. Effects of timing of prescribed fire on the demography of an invasive plant, spotted knapweed *Centaurea maculosa*. *Journal of Applied Ecology* 42:60-69.

Fletcher R.A., and A.J. Renney. 1963. A growth inhibitor found in *Centaurea* spp. *Canadian Journal of Plant Science* 43:475-481.

Hahn, R.R, and P.J. Stachowski. 2006. Knapweeds controlled in pastures and grass hayfields with new herbicide. *What's Cropping Up?* by Cornell University Cooperative Extension 16(5):1-3. www.css.cornell.edu/extension/WCU/Vol16No52006Sept-Oct.pdf (accessed July 2, 2008).

Harris, P., and R. Cranston. 1979. An economic evaluation of control methods for diffuse and spotted knapweed in western Canada. *Canadian Journal of Plant Science* 59:375-382.

Hirsch, S.A. and J.A. Leitch. 1996. The impact of knapweed on Montana's economy. Fargo, ND: Agricultural Experiment Station, North Dakota State University Agricultural Economics Report 355. 43 p.

Holden, C., R. Holder, and J. Stordahl. 2007. Long term management of spotted knapweed in a pasture. 2006 On-farm cropping trials northwest and west central Minnesota by University of Minnesota Extension. www.nwroc.umn.edu/Cropping_Issues/NW_Crop_trials/2006/**spotted_knapweed**_control_pasture.pdf (accessed July 2, 2008).

Jacobs, J.S., and R.L. Sheley. 1998. Observation: Life history of spotted knapweed. *Journal of Range Management* 51:665-673.

Kelsey, R.G., and L.J. Locken. 1987. Phytotoxic properties of cnicin, a sesquiterpene lactone from *Centaurea maculosa* (spotted knapweed). *Journal of Chemical Ecology* 13:19-33.

Lacey, J.R., C.B. Marlow, and J.R. Lane. 1989. Influence of spotted knapweed (*Centaurea maculosa*) on surface runoff and sediment yield. *Weed Technology* 3:627-631.

Lacey, J., P. Husby, and G. Handl. 1990. Observations on spotted and diffuse knapweed invasion into ungrazed bunchgrass communities in western Montana. *Rangelands* 12:30-32.

MacDonald, N.W., B.T. Scull, and S.R. Abella. 2007. Mid-spring burning reduces spotted knapweed and increases native grasses during a Michigan experimental grassland establishment. *Restoration Ecology* 15: 118-128.

Maddox, D.M. 1979. The knapweeds: Their economics and biological control in the western states, U.S.A. *Rangelands* 1:139-141.

Ochsmann, J. 2001. On the taxonomy of spotted knapweed (*Centaurea stoebe* L.) pp. 33-41. In L. Smith [ed.], Proceedings of the First International Knapweed Symposium of the Twenty-First Century. 15-16 March 2001, Coeur d'Alene, Idaho.

Perry, L.G., G.C. Thelen, W.M. Ridenour, T.L. Weir, R.M. Callaway, M.W. Paschke, and J.M. Vivanco. 2005. Dual role for an allelochemical: (±)-catechin from *Centaurea maculosa* root exudates regulates conspecific seedling establishment. *Journal of Ecology* 93:1126-1135.

Rice, P.M., Toney, J.C., Bedunah, D.J., and C.E. Carlson. 1997. Elk winter forage enhancement by herbicide control of spotted knapweed. *Wildlife Society Bulletin* 25:627-633.

Roche, B. and C. Talbott. 1986. The collection history of *Centaureas* found in Washington State. Washington State University Extension Service Bulletin XB 0978:15-20.

Runk, D. 2010. Invasive knapweed extermination efforts worry beekeepers. The Huff Post 12/20/2010 www.huffingtonpost.com/2010/12/21/efforts-to-kill-invasive-_n_799096.html (accessed August 12, 2013).

Shirman, R. 1981. Seed production and spring seedling establishment of diffuse and spotted knapweed. *Journal of Range Management* 34:45-47.

Tyser, R.W., and C.H. Key. 1988. Spotted knapweed in natural area fescue grasslands: An ecological assessment. *Northwest Science* 62:151-160.

Tyser, R.W. 1992. Vegetation associated with two alien plant species in a fescue grassland in Glacier National Park, Montana. *Great Basin Naturalist* 52:189-193.

USDA, NRCS. 2013. The PLANTS Database (http://plants.usda.gov, 11 August 2013). National Plant Data Team, Greensboro, NC 27401-4901 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.

Weir, T.L., H.P. Bais, and J.M. Vivanco. 2003. Intraspecific and interspecific interactions mediated by a phytotoxin, (--)-catechin, secreted by the roots of *Centaurea maculosa* (spotted knapweed). *Journal of Chemical Ecology* 29(11):2397-2412.

Williams, S., and T. Prather. 2006. Goats: A tool for controlling spotted knapweed. *Journal of Extension* 44 (5) Article 5RIB6 www.joe.org/joe/2006october/rb6.shtml .

Wilson, L.M., and C.B. Randall. 2003. Biology and Biological Control of Knapweed. USDA-Forest Service FHTET-2001-07. 2nd Edition.

**Images of the biological control of spotted knapweed**

| | | |
|---|---|---|
|  |  |  |
| Spotted knapweed reduction in cleared area of infestation by root-boring weevils. The sharp edge of the clearing the knapweed is a common sign of root weevil activity. | Root-boring weevils, *Cyphocleonus achates* | Seedhead weevils, *Larinus minutus* |