

WEED RISK ASSESSMENT FORM

Botanical name: *Centaurea biebersteinii* DC

Common name: spotted knapweed

Assessors: Irina Lapina Matthew L. Carlson, Ph.D.
 Botanist, Alaska Natural Heritage Program, University of Alaska Anchorage, 707 A Street, Anchorage, Alaska 99501
 tel: (907) 257-2710; fax (907) 257-2789
 Assistant Professor, Alaska Natural Heritage Program, University of Alaska Anchorage, 707 A Street, Anchorage, Alaska 99501
 tel: (907) 257-2790; fax (907) 257-2789

Reviewers: Michael Shephard Julie Riley
 Vegetation Ecologist Forest Health Protection State & Private Forestry, 3301 C Street, Suite 202, Anchorage, AK 99503 (907) 743-9454; fax 907 743-9479
 Horticulture Agent, UAF Cooperative Extension Service 2221 E. Northern Lights Blvd. #118 Anchorage, AK 99508-4143
 tel: (907) 786-6306

Jeff Conn, Ph.D. Jamie M. Snyder
 Weed Scientist, USDA Agricultural Research Service PO Box 757200 Fairbanks, Alaska 99775 tel: (907) 474-7652; fax (907) 474-6184
 UAF Cooperative Extension Service 2221 E. Northern Lights Blvd. #118 Anchorage, AK 99508-4143
 tel: (907) 786-6310 alt.tel: (907) 743-9448

Roseann Densmore, Ph.D.
 Research Ecologist, US Geological Survey, Alaska Biological Science Center, 1101 East Tudor Road Anchorage, AK 99503
 tel: (907) 786-3916, fax (907) 786-3636

Outcome score:

A. Climatic Comparison		
This species is present or may potentially establish in the following eco-geographic regions:		
1	South Coastal	Yes
2	Interior-Boreal	Yes
3	Arctic-Alpine	No
This species is unlikely to establish in any region in Alaska		

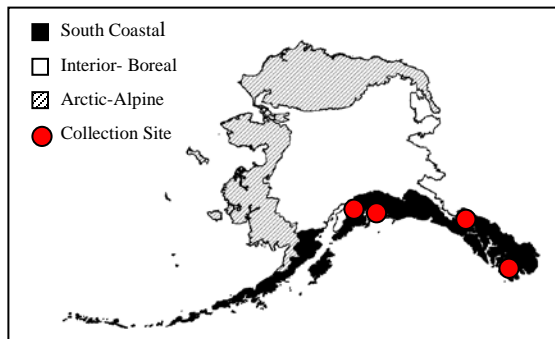
B.	Invasiveness Ranking	Total (Total Answered*) Possible	Total
1	Ecological impact	40 (40)	34
2	Biological characteristic and dispersal ability	25 (25)	22
3	Ecological amplitude and distribution	25 (25)	21
4	Feasibility of control	10 (10)	9
	Outcome score	100 (100) ^b	86
	Relative maximum score [†]		0.86

* For questions answered "unknown" do not include point value for the question in parentheses for "Total Answered Points Possible."

[†] Calculated as ^a/_b.

A. CLIMATIC COMPARISON:

1.1 Has this species ever been collected or documented in Alaska?	
Yes	Yes – continue to 1.2
	No – continue to 2.1
1.2. Which eco-geographic region has it been collected or documented (see inset map)? <i>Proceed to Section B. Invasiveness Ranking.</i>	
Yes	South Coastal
Yes	Interior-Boreal
No	Arctic-Alpine



Documentation: Spotted knapweed has been recorded in Skagway, Valdez, Prince of Wales Island (South Coastal) and along Turnagain Arm (Interior-Boreal) (AK Weeds Database 2004, J. Snyder – pers. comm.).

Sources of information:

AK Weeds Database. 2004. Database of exotic vegetation collected in Alaska. University of Alaska, Alaska Natural Heritage Program – US Forest Service – National Park Service Database. Snyder J.M., UAF Cooperative Extension Service. 2221 E. Northern Lights Blvd. #118 Anchorage, AK 99508-4143 Tel: (907) 786-6310 alt.tel: (907) 743-9448.

2.1. Is there a 40% or higher similarity (based on CLIMEX climate matching) between climates any where the species currently occurs and

a. Juneau (South Coastal Region)?

Yes – record locations and similarity; proceed to Section B.
Invasiveness Ranking

No

b. Fairbanks (Interior-Boreal)?

Yes – record locations and similarity; proceed to Section B.
Invasiveness Ranking

No

c. Nome (Arctic-Alpine)?

Yes – record locations and similarity; proceed to Section B.
Invasiveness Ranking

No

– If “No” is answered for all regions, reject species from consideration

Documentation: Using CLIMEX matching program, climatic similarity between Nome and areas where the species is documented is very low. This suggests that establishment in arctic and alpine Alaska may be not possible.

Sources of information: CLIMEX for Windows, Version 1.1a. 1999. CISRO Publishing, Australia.

B. INVASIVENESS RANKING

1. ECOLOGICAL IMPACT

1.1. Impact on Natural Ecosystem Processes

- | | |
|--|----|
| A. No perceivable impact on ecosystem processes | 0 |
| B. Influences ecosystem processes to a minor degree (e.g., has a perceivable but mild influence on soil nutrient availability) | 3 |
| C. Significant alteration of ecosystem processes (e.g., increases sedimentation rates along streams or coastlines, reduces open water that are important to waterfowl) | 7 |
| D. Major, possibly irreversible, alteration or disruption of ecosystem processes (e.g., the species alters geomorphology; hydrology; or affects fire frequency, altering community composition; species fixes substantial levels of nitrogen in the soil making soil unlikely to support certain native plants or more likely to favor non-native species) | 10 |
| U. Unknown | |

Score

8

Documentation:

Identify ecosystem processes impacted:

Erosion of topsoil has been shown to increase after spotted knapweed invasion. Surface run-off had approximately three times more sediments in *Centaurea biebersteinii*-dominated sites compared with adjacent native bunchgrass sites (Rice et al. 1997).

Rational:

Sources of information:

Rice, P.M., J.C. Tonye, D.J. Bedunah and C.E. Carlson. 1997. Plant community diversity and growth form responses to herbicide applications for control of *Centaurea maculosa*. *Journal of Applied Ecology* 34: 1397-1412.

1.2. Impact on Natural Community Structure

- A. No perceived impact; establishes in an existing layer without influencing its structure 0
- B. Influences structure in one layer (e.g., changes the density of one layer) 3
- C. Significant impact in at least one layer (e.g., creation of a new layer or elimination of an existing layer) 7
- D. Major alteration of structure (e.g., covers canopy, eradicating most or all layers below) 10
- U. Unknown

Score 7

Documentation:

Identify type of impact or alteration:

Spotted knapweed is capable of forming dense stands in natural communities, reducing native plant diversity.

Rational:

Sources of information:

Wisconsin Department of Natural Resources: abstract. Non-native plants. Spotted Knapweed (*Centaurea maculosa*). 2004. <http://www.dnr.state.wi.us> [2004 September 8].

1.3. Impact on Natural Community Composition

- A. No perceived impact; causes no apparent change in native populations 0
- B. Influences community composition (e.g., reduces the number of individuals in one or more native species in the community) 3
- C. Significantly alters community composition (e.g., produces a significant reduction in the population size of one or more native species in the community) 7
- D. Causes major alteration in community composition (e.g., results in the extirpation of one or several native species, reducing biodiversity or change the community composition towards species exotic to the natural community) 10
- U. Unknown

Score 9

Documentation:

Identify type of impact or alteration:

Spotted knapweed reduces native plant population size, decreases plant diversity, reduces forage quality, and habitats.

Rational:

Sources of information:

Wisconsin Department of Natural Resources: abstract. Non-native plants. Spotted Knapweed (*Centaurea maculosa*). 2004. <http://www.dnr.state.wi.us> [2004 September 8].

1.4. Impact on higher trophic levels (cumulative impact of this species on the animals, fungi, microbes, and other organisms in the community it invades)

- A. Negligible perceived impact 0
- B. Minor alteration 3
- C. Moderate alteration (minor reduction in nesting/foraging sites, reduction in habitat connectivity, interference with native pollinators, injurious components such as spines, toxins) 7
- D. Severe alteration of higher trophic populations (extirpation or endangerment of an existing native species/population, or significant reduction in nesting or foraging sites) 10
- U. Unknown

Score 10

Documentation:

Identify type of impact or alteration:

This species may likely affect spawning habitats by increasing surface runoff and sedimentation (UAF) Winter-ranging elk may avoid foraging in habitats dominated by *Centaurea biebersteinii* (Rice et al. 1997). Knapweeds are allelopathic, inhibiting the establishment and growth of surrounding vegetation (Whitson et al. 2000).

Rational:

Sources of information:

Rice, P.M., J.C. Tonye, D.J. Bedunah and C.E. Carlson. 1997. Plant community diversity and growth form responses to herbicide applications for control of *Centaurea maculosa*. Journal of Applied Ecology 34: 1397-1412.

Snyder J.M., UAF Cooperative Extension Service. 2221 E. Northern Lights Blvd. #118 Anchorage, AK 99508-4143 Tel: (907) 786-6310 alt.tel: (907) 743-9448.

UAF – University of Alaska Fairbanks, Cooperative Extension Service. Reducing the spread of non-native invasive plants in Alaska. Voluntary codes of conduct for the gardening public. Publication No. FGV-00142.

Whitson, T.D., L.C. Burrill, S.A. Dewey, D.W. Cudney, B.E. Nelson, R.D. Lee, R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming. 630 pp.

Total Possible	40
Total	34

2. BIOLOGICAL CHARACTERISTICS AND DISPERSAL ABILITY

2.1. Mode of reproduction

- A. Not aggressive reproduction (few [0-10] seeds per plant and no vegetative reproduction) 0
- B. Somewhat aggressive (reproduces only by seeds (11-1,000/m²) 1
- C. Moderately aggressive (reproduces vegetatively and/or by a moderate amount of seed, <1,000/m²) 2
- D. Highly aggressive reproduction (extensive vegetative spread and/or many seeded, >1,000/m²) 3
- U. Unknown

Score	3
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Documentation:

Describe key reproductive characteristics (including seeds per plant):

Spotted knapweed reproduces only by seed. However, lateral root sprouting is possible (Carpinelli 2003, Mauer et al. 1987). Average plants produce about 1,000 seeds (Lym and Zollinger 1992, Mauer et al. 1987, Wisconsin DNR 2004), but large individuals may produce over 20,000 seeds (Royer and Dickinson 1999).

Rational:

Sources of information:

Carpinelli M. 2003. Spotted knapweed *Centaurea biebersteinii* DC. Plant Conservation Alliance, Alien Plant Working Group. Available:

<http://www.nps.gov/plants/alien/fact/cebi1.htm> [September 21, 2004].

Lym, R.G. and R.K. Zollinger. 1992. Spotted Knapweed (*Centaurea maculosa* Lam.). North Dakota State University. NDSU Extension Service.

<http://www.ext.nodak.edu/extpubs/plantsci/weeds/w842w.htm>

Mauer, T., M.J. Russo, M. Evans. 1987 Element Stewardship Abstract for *Centaurea maculosa* Spotted Knapweed. The Nature Conservancy, Arlington, VA.

Royer, F. and R., Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.

Wisconsin Department of Natural Resources: abstract. Non-native plants. Spotted Knapweed (*Centaurea maculosa*). 2004. <http://www.dnr.state.wi.us> [2004 September 8].

2.2. Innate potential for long-distance dispersal (bird dispersal, sticks to animal hair, buoyant fruits, wind-dispersal)

- A. Does not occur (no long-distance dispersal mechanisms) 0
- B. Infrequent or inefficient long-distance dispersal (occurs occasionally despite lack of adaptations) 2
- C. Numerous opportunities for long-distance dispersal (species has adaptations such as pappus, hooked fruit-coats, etc.) 3

U. Unknown

Score 2

Documentation:

Identify dispersal mechanisms:

Seeds lack pappus. However, dispersal by wind as well as transportation by rodents, and livestock has been reported (Mauer et al. 1987).

Rational:

Sources of information:

Mauer, T., M.J. Russo, M. Evans. 1987 Element Stewardship Abstract for *Centaurea maculosa* Spotted Knapweed. The Nature Conservancy, Arlington, VA.

2.3. Potential to be spread by human activities (both directly and indirectly – possible mechanisms include: commercial sales, use as forage/revegetation, spread along highways, transport on boats, contamination, etc.)

- | | |
|---|---|
| A. Does not occur | 0 |
| B. Low (human dispersal is infrequent or inefficient) | 1 |
| C. Moderate (human dispersal occurs) | 2 |
| D. High (there are numerous opportunities for dispersal to new areas) | 3 |
| U. Unknown | |

Score 3

Documentation:

Identify dispersal mechanisms:

Humans are the primary factor for spotted knapweed movement. Seeds are dispersed on vehicles, heavy machinery, and even light aircraft. It is also widely dispersed as a contaminant in hay, commercial seed, and floral arrangements (Lym and Zollinger 1992, Mauer et al. 1987).

Rational:

Sources of information:

Lym, R.G. and R.K. Zollinger. 1992. Spotted Knapweed (*Centaurea maculosa* Lam.). North Dakota State University. NDSU Extension Service.

<http://www.ext.nodak.edu/extpubs/plantsci/weeds/w842w.htm>

Mauer, T., M.J. Russo, M. Evans. 1987 Element Stewardship Abstract for *Centaurea maculosa* Spotted Knapweed. The Nature Conservancy, Arlington, VA.

2.4. Allelopathic

- | | |
|------------|---|
| A. No | 0 |
| B. Yes | 2 |
| U. Unknown | |

Score 2

Documentation:

Describe effect on adjacent plants:

Knapweeds are allelopathic, inhibiting the growth of surrounding plants (Lym and Zollinger 1992, Royer and Dickinson 1999, Whitson et al. 2000).

Rational:

Sources of information:

Lym, R.G. and R.K. Zollinger. 1992. Spotted Knapweed (*Centaurea maculosa* Lam.). North Dakota State University. NDSU Extension Service.

<http://www.ext.nodak.edu/extpubs/plantsci/weeds/w842w.htm>

Royer, F. and R., Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.

Whitson, T.D., L.C. Burrill, S.A. Dewey, D.W. Cudney, B.E. Nelson, R.D. Lee, R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming. 630 pp.

2.5. Competitive ability

- A. Poor competitor for limiting factors 0
- B. Moderately competitive for limiting factors 1
- C. Highly competitive for limiting factors and/or nitrogen fixing ability 3
- U. Unknown

Score 3

Documentation:

Evidence of competitive ability:

Knapweed is able to out-compete neighboring plants for moisture and nutrients due to its early spring growth (Royer and Dickinson 1999).

Rational:

Sources of information:

Royer, F. and R., Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.

2.6. Forms dense thickets, climbing or smothering growth habit, or otherwise taller than the surrounding vegetation

- A. No 0
- B. Forms dense thickets 1
- C. Has climbing or smothering growth habit, or otherwise taller than the surrounding vegetation 2
- U. Unknown

Score 2

Documentation:

Describe grow form:

Spotted knapweed often forms dense stand up to 6 feet tall (Royer and Dickinson 1999).

Rational:

Sources of information:

Royer, F. and R., Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.

2.7. Germination requirements

- A. Requires open soil and disturbance to germinate 0
- B. Can germinate in vegetated areas but in a narrow range or in special conditions 2
- C. Can germinate in existing vegetation in a wide range of conditions 3
- U. Unknown

Score 3

Documentation:

Describe germination requirements:

Spotted knapweed seeds germinate over a wide range of soil conditions and temperatures regimes (Schirman 1981).

Rational:

Sources of information:

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

2.8. Other species in the genus invasive in Alaska or elsewhere

- A. No 0
- B. Yes 3
- U. Unknown

Score 3

Documentation:

Species:

Centaurea cyanus L., C. diffusa Lam., C. iberica Trev. Ex Spreng., C. pratensis Thuill., C. solstitialis L., C. virgata Lam. var. squarrosa (Willd.) Boiss (Whitson et al. 2000).

Sources of information:

Whitson, T.D., L.C. Burrill, S.A. Dewey, D.W. Cudney, B.E. Nelson, R.D. Lee, R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming. 630 pp.

2.9. Aquatic, wetland, or riparian species

- A. Not invasive in wetland communities 0
- B. Invasive in riparian communities 1
- C. Invasive in wetland communities 3
- U. Unknown

Score

1

Documentation:

Describe type of habitat:

It typically invades along highways, waterways, railroad ways, pipelines, grasslands, and open forests (Lym and Zollinger 1992, Rice et al. 1997). Spotted knapweed establishes primarily in non-wetland or riparian sites, however it can invade streambanks and nearby meadows (Snyder and Shephard 2004).

Rational:

Sources of information:

Lym, R.G. and R.K. Zollinger. 1992. Spotted Knapweed (*Centaurea maculosa* Lam.). North Dakota State University. NDSU Extension Service. <http://www.ext.nodak.edu/extpubs/plantsci/weeds/w842w.htm>

Rice, P.M., J.C. Tonye, D.J. Bedunah and C.E. Carlson. 1997. Plant community diversity and growth form responses to herbicide applications for control of *Centaurea maculosa*. Journal of Applied Ecology 34: 1397-1412.

Snyder, C. and M. Shephard. 2004. Spotted knapweed. United States Department of Agriculture. Prepared by Forest Service Alaska Region. Leaflet R10-TP-125 May 2004.

Total Possible

25

Total

22

3. DISTRIBUTION

3.1. Is the species highly domesticated or a weed of agriculture

- A. No 0
- B. Is occasionally an agricultural pest 2
- C. Has been grown deliberately, bred, or is known as a significant agricultural pest 4
- U. Unknown

Score

4

Documentation:

Identify reason for selection, or evidence of weedy history:

Spotted knapweed generally is not a problem in cultivated fields. However, it is a one of the most problematic weeds in rangelands and pastures (Royer and Dickinson 1999, Whitson et al. 2000).

Rational:

Sources of information:

Lym, R.G. and R.K. Zollinger. 1992. Spotted Knapweed (*Centaurea maculosa* Lam.). North Dakota State University. NDSU Extension Service. <http://www.ext.nodak.edu/extpubs/plantsci/weeds/w842w.htm>

Royer, F. and R., Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.

Whitson, T.D., L.C. Burrill, S.A. Dewey, D.W. Cudney, B.E. Nelson, R.D. Lee, R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming.

3.2. Known level of impact in natural areas

- | | | |
|----|---|---|
| A. | Not known to cause impact in any other natural area | 0 |
| B. | Known to cause impacts in natural areas, but in dissimilar habitats and climate zones than exist in regions of Alaska | 1 |
| C. | Known to cause low impact in natural areas in similar habitats and climate zones to those present in Alaska | 3 |
| D. | Known to cause moderate impact in natural areas in similar habitat and climate zones | 4 |
| E. | Known to cause high impact in natural areas in similar habitat and climate zones | 6 |
| U. | Unknown | |

Score

6

Documentation:

Identify type of habitat and states or provinces where it occurs:

Spotted knapweed invades nearly undisturbed grasslands and open forests in Montana, Idaho, Colorado, Massachusetts, North Dakota, and Wisconsin (K. Boggs – pers. comm., Lym and Zollinger 1992, Rice et al. 1997, Wisconsin DNR 2004). It is widespread in wild land in British Columbia (Canada) (MAFF 2004).

Sources of information:

Boggs, K.W. Plant Ecologist, Alaska Natural Heritage Program, University of Alaska Anchorage, 707 A Street, Anchorage, Alaska 99501 Tel: (907) 257-2783 - Pers. comm.

Lym, R.G. and R.K. Zollinger. 1992. Spotted Knapweed (*Centaurea maculosa* Lam.). North Dakota State University. NDSU Extension Service.
<http://www.ext.nodak.edu/extpubs/plantsci/weeds/w842w.htm>

MAFF - Ministry of Agriculture, Food and Fisheries. 2004. Pest management. Government of British Columbia. Available:
<http://www.agf.gov.bc.ca/cropprot/weeds.htm> [September 21, 2004].

Rice, P.M., J.C. Tonye, D.J. Bedunah and C.E. Carlson. 1997. Plant community diversity and growth form responses to herbicide applications for control of *Centaurea maculosa*. *Journal of Applied Ecology* 34: 1397-1412.

Wisconsin Department of Natural Resources: abstract. Non-native plants. Spotted Knapweed (*Centaurea maculosa*). 2004. <http://www.dnr.state.wi.us> [2004 September 8].

3.3. Role of anthropogenic and natural disturbance in establishment

- | | | |
|----|--|---|
| A. | Requires anthropogenic disturbances to establish | 0 |
| B. | May occasionally establish in undisturbed areas but can readily establish in areas with natural disturbances | 3 |
| C. | Can establish independent of any known natural or anthropogenic disturbances | 5 |
| U. | Unknown | |

Score

3

Documentation:

Identify type of disturbance:

Anthropogenic disturbances such as overgrazing and mechanical soil disturbance accelerate its invasion in natural areas. Both biotic and abiotic soil disturbances (e.g., frost heave, small mammal burrowing, and trampling and grazing by native ungulates) can facilitate *Centaurea biebersteinii* invasion (Tyser and Kye 1988). Once a stand is established, it may invade relatively undisturbed adjacent areas (Mauer et al. 1987).

Rational:

Sources of information:

Mauer, T., M.J. Russo and M. Evans. 1987 Element Stewardship Abstract for *Centaurea maculosa* Spotted Knapweed. The Nature Conservancy, Arlington, VA.

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

3.4. Current global distribution

- | | | |
|----|---|---|
| A. | Occurs in one or two continents or regions (e.g., Mediterranean region) | 0 |
| B. | Extends over three or more continents | 3 |

- C. Extends over three or more continents, including successful introductions in arctic or subarctic regions 5
- U. Unknown

Score

3

Documentation:
 Describe distribution:
 Spotted knapweed is native to central and southeastern Europe. Now it occurs also in northern Europe, North America, Asia, and Australia (Weeds Australia 1998).
 Rational:

Sources of information:
 Weeds Australia. 1998. Noxious Weed List. On Line Database.
<http://www.weeds.org.au/noxious.htm>

3.5. Extent of the species U.S. range and/or occurrence of formal state or provincial listing

- A. 0-5% of the states 0
- B. 6-20% of the states 2
- C. 21-50%, and/or state listed as a problem weed (e.g., “Noxious,” or “Invasive”) in 1 state or Canadian province 4
- D. Greater than 50%, and/or identified as “Noxious” in 2 or more states or Canadian provinces 5
- U. Unknown

Score

5

Documentation:
 Identify states invaded:
 It occurs in nearly all states of the United States (USDA 2002). It is listed as noxious in 15 American states and in 4 Canadian provinces (Invaders Database System 2003, USDA 2002).
 Rational:

Sources of information:
 Invaders Database System. The University of Montana. 2003. Montana Noxious Weed Trust Fund. Department of Agriculture. <http://invader.dbs.umt.edu/>
 USDA (United States Department of Agriculture), NRCS (Natural Resource Conservation Service). 2002. The PLANTS Database, Version 3.5 (<http://plants.usda.gov>). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Total Possible

25

 Total

21

4. FEASIBILITY OF CONTROL

4.1. Seed banks

- A. Seeds remain viable in the soil for less than 3 years 0
- B. Seeds remain viable in the soil for between 3 and 5 years 2
- C. Seeds remain viable in the soil for 5 years and more 3
- U. Unknown

Score

3

Documentation:
 Identify longevity of seed bank:
 Seeds remain viable in the soil up to five years (Lym and Zollinger 1992). After eight years about 30% of seeds may be viable (Mauer et al. 1987).
 Rational:

Sources of information:
 Lym, R.G. and R.K. Zollinger. 1992. Spotted Knapweed (*Centaurea maculosa* Lam.). North Dakota State University. NDSU Extension Service.

<http://www.ext.nodak.edu/extpubs/plantsci/weeds/w842w.htm>
 Mauer, T., M.J. Russo and M. Evans. 1987 Element Stewardship Abstract for
Centaurea maculosa Spotted Knapweed. The Nature Conservancy, Arlington,
 VA.

4.2. Vegetative regeneration

- | | |
|---|---|
| A. No resprouting following removal of aboveground growth | 0 |
| B. Resprouting from ground-level meristems | 1 |
| C. Resprouting from extensive underground system | 2 |
| D. Any plant part is a viable propagule | 3 |
| U. Unknown | |

Score 2

Documentation:

Describe vegetative response:

Lateral root-sprouting is possible for *Centaurea biebersteinii* (Carpinelli 2003, M. Shephard – pers. com.).

Rational:

Sources of information:

Carpinelli M. 2003. Spotted knapweed *Centaurea biebersteinii* DC. Plant Conservation Alliance, Alien Plant Working Group. Available:

<http://www.nps.gov/plants/alien/fact/cebi1.htm> [September 21, 2004].

Mauer, T., M.J. Russo and M. Evans. 1987 Element Stewardship Abstract for *Centaurea maculosa* Spotted Knapweed. The Nature Conservancy, Arlington, VA.

Shephard, M., Vegetation Ecologist, USDA, Forest Service, Forest Health Protection, State and Private Forestry, 3301 C Street, Suite 202, Anchorage, Alaska 99503 Division. Tel: (907) 743-9454 - Pers. comm.

4.3. Level of effort required

- | | |
|---|---|
| A. Management is not required (e.g., species does not persist without repeated anthropogenic disturbance) | 0 |
| B. Management is relatively easy and inexpensive; requires a minor investment in human and financial resources | 2 |
| C. Management requires a major short-term investment of human and financial resources, or a moderate long-term investment | 3 |
| D. Management requires a major, long-term investment of human and financial resources | 4 |
| U. Unknown | |

Score 4

Documentation:

Identify types of control methods and time-term required:

Long-term control requires a combination of management techniques. Several years of monitoring are required to exhaust the seed bank. Most knapweed control has been conducted in agricultural settings and little information is available for the use of herbicides in native communities (Lym and Zollinger 1992, Rice et al. 1997). A number of biological control agents have been moderately successful in Montana and other western states (Story et al. 1989, Story et al. 1991).

Rational:

Sources of information:

Lym, R.G. and R.K. Zollinger. 1992. Spotted Knapweed (*Centaurea maculosa* Lam.). North Dakota State University. NDSU Extension Service.

<http://www.ext.nodak.edu/extpubs/plantsci/weeds/w842w.htm>

Rice, P.M., J.C. Tonye, D.J. Bedunah and C.E. Carlson. 1997. Plant community diversity and growth form responses to herbicide applications for control of *Centaurea maculosa*. *Journal of Applied Ecology* 34: 1397-1412.

Story, J.M., K.W. Boggs, and R.M. Nowierski. 1989. Effect of two introduced seed head flies on spotted knapweed. *Montana AgResearch Winter* 1989: 14-17.

Story, J.M., K.W. Boggs, and W.R. Good. 1991. First report of the establishment of *Agapeta zoegana* L. (Lepidoptera: Cochylidae) on spotted knapweed,

Total Possible	10
Total	9

Total for 4 sections Possible	100
Total for 4 sections	86

References:

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