Plant Assessment Form

For use with the "Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands" by the California Exotic Pest Plant Council and the Southwest Vegetation Management Association (Warner et al. 2003)

Printable version, February 28, 2003
(Modified for use in Arizona, 07/02/04)

Table 1. Species and Evaluator Information

Species name (Latin binomial)**:**	*Centaurea biebersteinii* DC. (USDA 2005)
Synonyms:	*Acosta maculosa* auct. non Holub, *Centaurea maculosa* auct. non Lam. (USDA 2005)
Common names:	Spotted knapweed
Evaluation date (mm/dd/yy)**:**	04/23/04
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Committee review date:	08/06/04
List date:	08/06/04
Re-evaluation date(s):	

Table 2. Scores, Designations, and Documentation Levels

Question		Score	Documentation Level	Section Scores	Overall Score & Designations
1.1	Impact on abiotic ecosystem processes	**B**	Other published material	**"Impact"** **Section 1 Score:** **B**	**"Plant Score"** **Overall Score:** **Medium** **Alert Status:** **None**
1.2	Impact on plant community	**A**	Other published material		
1.3	Impact on higher trophic levels	**B**	Reviewed scientific publication		
1.4	Impact on genetic integrity	**C**	Other published material		
2.1	Role of anthropogenic and natural disturbance	**A**	Other published material	**"Invasiveness"** *For questions at left, an A gets 3 points, a B gets 2, a C gets 1, and a D or U gets=0. Sum total of all points for Q2.1-2.7:* **16 pts** **Section 2 Score:** **B**	
2.2	Local rate of spread with no management	**B**	Observational		
2.3	Recent trend in total area infested within state	**B**	Observational		
2.4	Innate reproductive potential	**A**	Other published material		
2.5	Potential for human-caused dispersal	**B**	Other published material		
2.6	Potential for natural long-distance dispersal	**B**	Reviewed scientific publication		
2.7	Other regions invaded	**B**	Other published material		RED FLAG **YES** Something you should know.
3.1	Ecological amplitude	**A**	Observational	**"Distribution"** **Section 3 Score:** **B**	
3.2	Distribution	**D**	Observational		

Red Flag Annotation

Centaurea biebersteinii likely has not yet reached its full invasive potential in Arizona. Its ecological impacts and reproductive capacity are well documented in other states, especially in Montana. *Centaurea biebersteinii* has great potential to increase its abundance and areal extent in Arizona on sites that are subjected to fire suppression, mechanical fuel treatment (that is, thinning), or timber harvest activities on public lands.

Table 3. Documentation

Question 1.1 Impact on abiotic ecosystem processes *Score:* **B** *Doc'n Level:* **Other pub.**
Identify ecosystem processes impacted: Spotted knapweed can alter fire regimes where populations are dense in ponderosa pine forest community types. Spotted knapweed infestations have been associated with increases in bare ground, surface water runoff, and stream sedimentation rates.
Rationale: Spotted knapweed occurs primarily in bunchgrass and open ponderosa pine forest community types in the Intermountain West, especially Montana. The historical fire regimes of these communities were relatively frequent, low-severity surface fires. Spotted knapweed did not occur in these communities at the time in which these fire regimes were functioning, but has established since fire exclusion began. It is unclear how this type of fire regime might affect spotted knapweed populations. It is also unclear how the presence of spotted knapweed might affect these fire regimes, though it has been observed that spotted knapweed does not carry ground fire as readily as grasses. Therefore, dense knapweed infestations can alter the fire regime by changing the fuel characteristics and thus reducing the fire return interval at a given site (Xanthopoulous 1988, J. McGowan-Stinski, personal communication in Zouhar 2001). Dense populations of spotted knapweed have influenced increased bare ground, surface water runoff and stream sedimentation rates. In a Montana study runoff and sediment yield in plots dominated by spotted knapweed were 56% and 192% higher respectively as compared to bunchgrass vegetation types (Lacey et al. 1989).
Sources of information: See cited literature.

Question 1.2 Impact on plant community composition, structure, and interactions *Score:* **A** *Doc'n Level:* **Other pub.**
Identify type of impact or alteration: Spotted knapweed infestations reduce plant species richness and diversity, as well as pose serious impacts on foothill grasslands and a rare plant species in Montana. Spotted knapweed has developed many ways to outcompete native plants including production of chemical allelopathy, and root colonization by mycorrhizal fungi allowing greater resource uptake.
Rationale: Spotted knapweed is considered a serious threat to rangelands in Montana, Washington, Idaho, Oregon, Wyoming, and British Columbia. In Montana, the primary habitat for spotted knapweed are the foothill grasslands in western Montana and Bedunah (1992) speculated that because of spotted knapweed invasions, this grassland is becoming an endangered vegetation type. In studies by Tyser and associates that measured spotted knapweed populations in roadside areas and adjoining grasslands in Glacier National Park, spotted knapweed infestations were found to reduce plant species richness and diversity (Tyser 1990, Tyser and Key 1988) and cryptogam cover (Tyser 1992) and increase the amount of bare ground (Tyser and Key 1988). Lesica and Shelly (1996) also found that spotted knapweed reduced seed germination and seedling establishment of a rare Montana endemic forb, Mt. Sapphire rockcress (*Arabis fecunda*). Chemical allelopathy of spotted and diffuse knapweeds has been charged with negatively impacting other herbaceous species. However, cnicin concentrations in soil tests are lower than those found to be toxic in in-vitro experiments. So in determining the ecological success of spotted knapweed allelopathy is not considered as important as resource competition. Allelopathic activity of cnicin may be enhanced, however, when large quantities of stem and leaf tissue from live or dead spotted knapweed plants come in direct contact with the soil surface, as when plants are trampled or mowed and the effects of grazed lands infested with knapweed and cnicin levels has not been explored. More recent experimental evidence suggests that knapweed's advantage over its North American neighbors could be attributed to differences in the effects of its root exudates and how they, in turn, affect competition for resources, thus linking allelopathy and resource competition (Locken and Kelsey 1987). Experimental evidence suggests that spotted knapweed gains dominance in part by its ability to out-compete native grasses for nutrients such as nitrogen and phosphorus (Harvey and Nowierski 1989).

Other evidence suggests that the competitive advantage shifts from spotted knapweed to native plants such as bluebunch wheatgrass as succession proceeds and nutrients become less available (Krueger *et al* 2001). Spotted knapweed has the ability to rapidly develop a fine and deep penetrating root system that is colonized by arbuscular mycorrhizal fungi, which may contribute to its competitive dominance over native grasses by allowing for greater resource acquisition (Marler et al. 1999a, b).

Fertilization in spotted knapweed requires cross-pollination between flowers on different plants (obligately xenogamous). This can limit the reproductive success of isolated individuals, but it also promotes genetic diversity, and may thereby improve competitive ability (Harrod and Taylor 1995).

Sources of information: See cited literature.

Question 1.3 Impact on higher trophic levels *Score:* **B** *Doc'n Level:* **Rev. sci. pub.**

Identify type of impact or alteration: Spotted knapweed infestations have been associated with reductions in forage production and wildlife habitat; however, there have been some examples where spotted knapweed is important forage, seed and nectar source for some species.

Rationale: Large reductions in available forage and wildlife in Montana use have been reported on knapweed-infested range (Bedunah and Carpenter 1989). Large-scale infestations of spotted knapweed can impede access to more desirable forage for livestock and wildlife, especially when the presence of old, dried knapweed stems creates a dense and spiny overstory (Watson and Renney 1974). Reports of forage losses for elk vary, and probably do not consider the possibility of elk using spotted knapweed as forage. Reports on wildlife use of spotted knapweed are also varied. Bedunah (1992) cites several studies suggesting large potential losses of elk range to spotted knapweed, though he indicates that quantifying the effects of infestation on elk populations is complicated by their mobility. A spotted knapweed infestation is considered more detrimental to elk than to deer because spotted knapweed replaces grasses that are preferred by elk, while deer have a diet of predominantly shrubs and conifers that spotted knapweed does not replace (Lavelle 1986). Elk use increased following removal of spotted knapweed with herbicides on sites in Montana (Rice 2000).

The importance of spotted knapweed to livestock and wildlife depends upon the size and density of the infestation, the availability of other forage plants, and the season. Spotted knapweed was preferred by deer and elk over other plant species on sites with dense knapweed cover. It was suggested that deer and elk did not frequently use the spotted knapweed sites in this study because cervid densities were relatively low and other forage was available. The authors suggest that when estimating carrying capacity of a cervid range, spotted knapweed can be considered a potential food source, because when animal densities are high and food choices are limited, elk and deer will consume spotted knapweed (Wright and Kelsey 1997).

Flowers are pollinated by insects, and spotted knapweed is heavily visited by several species of bees. Rodent utilization of spotted knapweed seed has been suggested (Watson and Renney 1974). Spotted knapweed is a nectar source for the endangered Karner blue butterfly in Wisconsin (Haack 1993).

Sources of information: See cited literature; also see Zouhar (2001).

Question 1.4 Impact on genetic integrity *Score:* **C** *Doc'n Level:* **Other pub.**

Identify impacts: It is unknown whether hybridization occurs.

Rationale: Hybridization readily occurs between *Centaurea* species. However, it is unknown whether hybridization could occur between non-native and native species in Arizona. *Centaurea rothrockii* occurs in the Chirichauas and Huachuca Mountains and it is unknown at this time whether *C. biebersteinii* even exists in the same area, and if present, would hybridize with our native species.

Sources of information: See Kearney and Peebles (1960); also considered personal communication with R. Scott (Professor, Northern Arizona University, Biological Sciences, Flagstaff, Arizona).

Question 2.1 Role of anthropogenic and natural disturbance in establishment *Score:* **A** *Doc'n Level:* **Other pub.**
Describe role of disturbance: Spotted knapweed infestations are associated and increase with disturbance, especially logging, yet it also is capable of invading undisturbed wilderness sites.
Rationale: Spotted knapweed not only readily occupies disturbed sites, but it also invades relatively undisturbed perennial native plant communities in the northern Intermountain region (Lacey et al. 1989, Tyser and Worley 1992, DiTomaso 2000), and it invades wilderness areas all over Montana (Kummerow 1992). In Glacier National Park, spotted knapweed colonized undisturbed rough fescue grasslands adjacent to roadside spotted knapweed infestations. Spotted knapweed establishes and dominates on dry, disturbed sites, especially along roads (Tyser and Worley 1992). In western Montana, the success of spotted knapweed increases with site disturbance and soil moisture stress. Disturbance intensity has the greatest influence in habitat types moister than the Douglas-fir group, with coarse soil texture and steep slopes adding to success. In grass and shrub habitat types, south aspect and disturbance intensity are important variables for spotted knapweed success (Willard et al. 1988). Spotted knapweed is well adapted to open forested areas, especially after logging or other disturbances (Zouhar 2001).
Sources of information: See cited literature.

Question 2.2 Local rate of spread with no management *Score:* **B** *Doc'n Level:* **Obs.**
Describe rate of spread: Spotted knapweed occurs at roadsides on the Arizona Strip and in Sedona, which are increasing, but less rapidly (with treatment).
Rationale: The density of spotted knapweed infestations are related to the level of soil moisture, and disturbance, the higher level of moisture and disturbance in the soil, the greater the stem density. Once a population has been established, it is able to form solid stands because of the ability to occupy different soil rooting zones and niches. Working group members observed that the major limiting factor to establishment of spotted knapweed in Arizona is lack of moisture.
Sources of information: Sheley et al. (1999) and Working Group member observations and discussion.

Question 2.3 Recent trend in total area infested within state *Score:* **B** *Doc'n Level:* **Obs.**
Describe trend: In 1997 spotted knapweed populations were reported from Coconino, Yavapai and Navajo counties. Current Southwest Exotic Plant Mapping Program (SWEMP)-Cain Crisis map records (2004) show that Arizona infestations are still within the boundaries of those counties. There are high concentrations of spotted knapweed observations in the southern region of Coconino county. Estimates of acreage infested with spotted knapweed in 2000 by Duncan (2001) for Arizona was 1800 acres. Current federal and state efforts are being made by Forest Service and county extension agents to control populations.
Rationale: Populations are expanding, but less rapidly.
Sources of information: See cited literature; also considered personal communications with L. Moser (Botanist, U.S. Department of Agriculture, Forest Service, Coconino National Forest, Flagstaff, Arizona) and J. Schalau (Assistant Agent, Agriculture and Natural Resources, University of Arizona Cooperative Extension, Yavapai County) and SWEMP-Cain Crisis map records (available at: http://cain.nbii.gov/cgibin/mapserv?map=../html/cain/crisis/crisismaps/crisis.map&mode=browse&layer=state&layer=county; accessed online on February 10, 2004).

Question 2.4 Innate reproductive potential *Score:* **A** *Doc'n Level:* **Other pub.**
Describe key reproductive characteristics: Spotted knapweed is a biennial/perennial plant that can live up to nine years and reproduces primarily by seed.

Rationale: A population of plants may produce about 5,000 to 40,000 seeds/m^2/year. Spotted knapweed plants may remain in the rosette stage for 1 to 4 years, producing flowering stems the 2nd year or later (Tyser and Key 1988). Flowering during the year of seedling emergence is rare Spotted knapweed reproduces almost entirely from seed. Plants are also able to extend lateral shoots below the soil surface that form rosettes adjacent to the parent plant, and multiple rosettes on a single spotted knapweed root crown are common (Watson and Renney 1974).

Sources of information: See cited literature; also see Zouhar (2001) and Sheley et al. (1999).

Question 2.5 Potential for human-caused dispersal *Score:* **B** *Doc'n Level:* **Other pub.**

Identify dispersal mechanisms: Seeds are transported by human recreation, vehicles, bikes and equipment. Spotted knapweed seeds are contaminants in crop seed and hay, and may readily establish through fuel reduction activities.

Rationale: Seeds mixed with soil and mud may be carried by vehicles or other equipment that, in turn, create an ideal seedbed for spotted knapweed establishment (Watson and Renney 1974). Spread of seeds on logging trucks, off-road vehicles, and trail bikes has contributed greatly to the spread of knapweed into new areas in British Columbia. Working Group members observed that seeds are spread by hikers into new areas and that fuel reduction/forest thinning equipment and activities have the potential to introduce spotted knapweed into new areas. Spotted knapweed seeds are transported in crop seed and hay (Strang et al. 1979).

Sources of information: See cited literature; also see Sheley et al. (1999) and Zouhar (2001). Also considered Working Group member observations.

Question 2.6 Potential for natural long-distance dispersal *Score:* **B** *Doc'n Level:* ***Rev. sci. pub.***

Identify dispersal mechanisms: Seeds are dispersed by wind, and by passing animals or rodents and birds. Seeds remain viable in domestic sheep and mule deer feces.

Rationale: As soon as bracts open, any movement of the stem (e.g. by wind or passing animals) expels the loosely held seeds from the head with a flicking action. The seeds usually land within 3 to 4 feet (0.9-1.2 m) of the parent plant. In this way, spotted knapweed populations spread outward and downwind from the perimeter of existing stands (Watson and Renney 1974). Dispersal of achenes over long distances is facilitated by animals and birds. Wallander et al. (1995) show that both domestic sheep and mule deer excrete viable seeds of spotted knapweed in their feces for 7 to 10 days after consumption, respectively. Spotted knapweed seeds can also be transported in rivers and other watercourses. Most seeds are shed upon maturity; very few overwinter in seedheads.

Sources of information: See cited literature.

Question 2.7 Other regions invaded *Score:* **B** *Doc'n Level:* **Other pub.**

Identify other regions: Spotted knapweed is native to eastern Europe, though it now occurs in western and central Europe. It was introduced to North America, probably as a contaminant in alfalfa (*Medicago sativa*) seed and/or ship's ballast, in the late 1800s. In 1920 the distribution of spotted knapweed in North America was limited to the San Juan Islands, Washington. By 1980 it had spread to 48 counties in the Pacific Northwest. Between 1980 and 1998, the known range of spotted knapweed included 326 counties in the western United States, including every county in Washington, Idaho, Montana, and Wyoming.

In the Southwest it occurs in Sedona, Arizona and in Ponderosa pine ecological types in Coconino National Forest. In Utah it is known from the counties of Piute, Duchesne, Tooele, Washington, Utah, Millard, Kane, San Juan, Salt Lake, Juab, Grand, Uintah, Wasatch, Beaver and Cache (Welsh et al 1987).

Rationale: Spotted knapweed invades alpine and subalpine grassland ecological types in Montana, and has not yet invaded those types in Arizona.

Sources of information: See cited literature; also see Zouhar (2001). In addition, consideration was given to the observations of Working Group members and data from the Atlas of the Vascular Plants of Utah (available online at: http://www.gis.usu.edu/Geography-Department/utgeog/utvatlas/ut-vascatlas.html; accessed on February 10, 2004) and the SEInet (Southwest Environmental Information Network), Arizona collections search (available online at: http://seinet.asu.edu/collections/selection.jsp; accessed on February 10, 2004).

Question 3.1 Ecological amplitude	*Score:* **A** *Doc'n Level:* **Obs.**
Describe ecological amplitude, identifying date of source information and approximate date of introduction to the state, if known: Spotted knapweed is native to central Europe and east to central Caucasia, and western Siberia. Spotted knapweed is primarily a problem in Montana, and habitat types that are susceptible to invasion include: Great Basin Desert Scrub, alpine and subalpine grassland, plains and Great Basin shrub-grassland, pinyon-juniper, spruce-fir, ponderosa pine, wet meadows and montane riparian areas. It has been observed at elevations ranging from 1,900 to more than 10,000 feet and in areas receiving from 8 to 79 inches in precipitation annually. It does especially well in coarse-textured soils that are well-drained with low water holding capacity.	
Rationale: Spotted knapweed invades five major ecological types in Arizona.	
Sources of information: See Zouhar (2001) and Sheley et al. (1999). In addition, consideration also was given to the observations of Working Group members and information from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections; accessed February 10, 2004).	

Question 3.2	*Score:* **D** *Doc'n Level:* **Obs.**
Describe distribution: In 2000 Arizona had 1,800 acres infested with spotted knapweed mainly in montane habitats.	
Rationale: Spotted knapweed occurs in Coconino National Forest, and Yavapai county near Sedona in Arizona. More research needs to be completed on distribution of spotted knapweed in Arizona.	
Sources of information: See Zouhar (2001) and Duncan (2001). In addition, consideration also was given to the observations of Working Group members and data from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections; accessed February 10, 2004).	

Worksheet A. Reproductive Characteristics

Complete this worksheet to answer Question 2.4.

Reaches reproductive maturity in 2 years or less	**Yes**	**No**	**1 pt.**
Dense infestations produce >1,000 viable seed per square meter	**Yes**	**No**	**2 pt.**
Populations of this species produce seeds every year.	**Yes**	**No**	**1 pt.**
Seed production sustained for 3 or more months within a population annually	**Yes**	**No**	**1 pt.**
Seeds remain viable in soil for three or more years	**Yes**	**No**	**2 pt.**
Viable seed produced with *both* self-pollination and cross-pollination	**Yes**	**No**	**1 pt.**
Has quickly spreading vegetative structures (rhizomes, roots, etc.) that may root at nodes	**Yes**	**No**	**1 pt.**
Fragments easily and fragments can become established elsewhere	**Yes**	**No**	**2 pt.**
Resprouts readily when cut, grazed, or burned	**Yes**	**No**	**1 pt.**
	Total pts: 7 Total unknowns: 0		
	Score : A		

Note any related traits:

Worksheet B. Arizona Ecological Types

(*sensu* Brown 1994 and Brown et al. 1998)

Major Ecological Types	Minor Ecological Types	Code*
Dunes	dunes	
Scrublands	Great Basin montane scrub	
	southwestern interior chaparral scrub	
Desertlands	Great Basin desertscrub	**U**
	Mohave desertscrub	
	Chihuahuan desertscrub	
	Sonoran desertscrub	
Grasslands	alpine and subalpine grassland	
	plains and Great Basin shrub-grassland	**D**
	semi-desert grassland	
Freshwater Systems	lakes, ponds, reservoirs	
	rivers, streams	
Non-Riparian Wetlands	Sonoran wetlands	
	southwestern interior wetlands	
	montane wetlands	**D**
	playas	
Riparian	Sonoran riparian	
	southwestern interior riparian	
	montane riparian	**D**
Woodlands	Great Basin conifer woodland	**D**
	Madrean evergreen woodland	
Forests	Rocky Mountain and Great Basin subalpine conifer forest	
	montane conifer forest	**D**
Tundra (alpine)	tundra (alpine)	

*A means >50% of type occurrences are invaded; B means >20% to 50%; C means >5% to 20%; D means present but ≤5%; U means unknown (unable to estimate percentage of occurrences invaded).

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