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 diffusa* Lam. (USDA 2005)
Synonyms:	*Acosta diffusa* (Lam.) Soják (USDA 2005)
Common names:	Diffuse knapweed, white knapweed, tumble knapweed
Evaluation date (mm/dd/yy)**:**	02/10/04
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Committee review date:	04/16/04
List date:	04/16/04
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**	Other published material		
1.4	Impact on genetic integrity	**U**	Other published material		
2.1	Role of anthropogenic and natural disturbance	**B**	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:* **17 pts** **Section 2 Score:** **A**	
2.2	Local rate of spread with no management	**A**	Observational		
2.3	Recent trend in total area infested within state	**A**	Observational		
2.4	Innate reproductive potential	**A**	Other published material		
2.5	Potential for human-caused dispersal	**A**	Other published material		
2.6	Potential for natural long-distance dispersal	**B**	Other published material		
2.7	Other regions invaded	**C**	Other published material		
3.1	Ecological amplitude	**A**	Observational	**"Distribution"** **Section 3 Score:** **B**	RED FLAG **NO** Something you should know.
3.2	Distribution	**C**	Observational		

Table 3. Documentation

Question 1.1 Impact on abiotic ecosystem processes *Score:* **B** *Doc'n Level:* **Other pub.**
Identify ecosystem processes impacted: Diffuse knapweed infestations increase soil erosion and increased surface runoff. Plants produce allelopathic substances that alter the nutrient and mineral dynamics of the soil.
Rationale: Results of diffuse knapweed infestations on disturbed sites increase soil erosion and create a sustained decline of biological productivity in semi-arid and arid lands. Often the declines are associated with manmade stresses or in conjunction with a natural extreme event like fire or a hailstorm, or prolonged drought (Sheley et al. 1998). A study by Kelsey and Locken (1987) showed that cnicin did not inhibit germination, but effectively retarded the root growth of other plants. The data suggests that within their Montana study site, cnicin was not functioning as an allelopathic compound. It is unclear from the research whether the presence of cnicin in the soils has the ability to alter the mineral or mycorrhizal associations that benefit plant nutrient uptake.
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: Plants produce allelopathic substances that inhibit productivity of native plants which are not adapted to compete with this chemical in the soil, thus are more readily invaded. Diffuse knapweed can dominate a site over time and persist in monotypic stands, thus occluding native canopy and reducing native species diversity. Diffuse knapweed suppresses other vegetation presumably by intense competition for limited soil water.
Rationale: Diffuse knapweed leaves contain an allelopathic chemical, cnicin that prevents other species from establishing allowing formation of pure diffuse knapweed stands (Fletcher and Renney 1963). Invading exotic plants are thought to succeed primarily because they have escaped their natural enemies, not because of novel interactions with their new neighbors. A study by Calloway and Aschehoug (2000), however, demonstrated that *Centaurea diffusa*, has much stronger negative effects on grass species from North America than on closely related grass species from communities to which *Centaurea* is native. *Centaurea*'s advantage against North American species appears to be due to differences in the effects of its root exudates and how these root exudates affect competition for resources. Cnicin inhibits root growth of other plants, and destroys their ability to compete for limited soil moisture and nutrients. The highest concentrations of cnicin are found in the leaves of diffuse knapweed and the compound may makes its way into the soil by way of leaching or decomposition of leaves or both. The extent to which the cnicin and plant materials are toxic to their own seeds was not determined as difficulties were encountered in attempting to germinate knapweed seeds (Fletcher and Renney 1963). However, field observations indicate diffuse knapweed seedlings readily develop in close proximity to mature plants (Zouhar 2001). Associated grasses that remove moisture and nutrients from the rooting zone of diffuse knapweed can retard its spread through vegetated areas. Other non-native species, such as crested wheatgrass (*Agropyron cristatum*) have been shown to stress, and inhibit, diffuse knapweed invasion by limiting available soil moisture during the critical seedling growth stage (Carpenter and Murray 2000). Kelsey and Bedunah (1989) provided evidence that, although cnicin could be isolated from knapweed tissues at varying concentrations and reduce seedling development of some species. They found that concentrations of cnicin are too low to affect other vegetation and allelopathy does not appear to be a large factor in competitive ability of diffuse knapweed. Also, when the foliage, which contains the chemical, was applied at three times the normal litter production, no reduction of grass growth was attributed. This study chalked knapweed invasions up to poor range management (Roché and Roché 1999).

Sources of information: See cited literature; also see Kelsey and Locken (1987).

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

Identify type of impact or alteration: Reduces biodiversity and replaces wildlife forage on rangeland.

Rationale: Diffuse knapweed contains the allelopathic chemical cnicin, which can suppress the growth of other species and allow diffuse knapweed to grow in single-species stands. The densities of these stands can range from 1–500 plants/m^2. These stands can produce up to 40,000 seeds/m^2, which enables the infestation to proliferate rapidly, and reduces biodiversity of native plants that provide forage and cover to native fauna (Carpenter and Murray 2000). Diffuse knapweed causes reductions in wildlife populations due to the decrease in native forage production (Roche and Roche 1988). One study done by Miller (1990) in British Colombia demonstrated that mule deer, white-tailed deer and California bighorn sheep diets were comprised of 80% diffuse knapweed rosettes and 18% grass as snow receded in January and February, and only through the bolting stage of the plant's development. Plants form low rosettes and may remain in this form for one to several years depending on environmental conditions (Carpenter and Murray 2000). However, prior to snowfall, when other forage is available the diets of the same animals were 80% grass, 18% forbs and 2% shrubs, demonstrating that animals are utilizing knapweed when other plants are not available. Diffuse knapweed is also a source of pollen and nectar for honeybees (Roché and Roché 1999). Effects on native pollinators is not known.

Knapweeds are often considered poor forage for grazing animals; on rangeland, mature diffuse knapweed is generally unpalatable to livestock, as the spines may cause injury to the mouth and digestive tract of grazing animals (Carpenter and Murray 2000). Infestations can greatly reduce dryland forage production with estimated losses of up to 88% in some areas (Harris and Cranston 1979). In a Montana economic study, utilizing surveys by weed boards and an input-output model, the impacts of spotted, diffuse and Russian knapweed were assessed for grazing capacity and wildlife habitat and watershed capacity on wildlands. The study found that total direct and secondary economic impacts exceeded $42 million, which could support an estimated 518 jobs for the state (Roché and Roché 1999).

Sources of information: See cited literature.

Question 1.4 Impact on genetic *Score:* **U** *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. diffusa* 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:* **B** *Doc'n Level:* **Other pub.**

Describe role of disturbance: Grazing practices, roads and trails, construction, landslides, native animal browsing and burrowing-any type of activity that creates disturbance.

Rationale: Diffuse knapweed is an early success ional species that establishes best on disturbed ground. The density of a diffuse knapweed stand is often correlated with the level of soil disturbance. Grazing at high levels, which reduces native plant competition, encourages diffuse knapweed on rangelands (Roché and Roché 1999). It has the capability of invading undisturbed habitats, but often infestations are less dense. However, Lacey et al. (1990) reports that disturbances need not be recent and a disturbance can be as insignificant as rodent activity or one hailstorm to allow a diffuse knapweed invasion to take hold.

Sources of information: See cited literature; also see Carpenter and Murray (2000).

Question 2.2 Local rate of spread with no management *Score:* **A** *Doc'n Level:* **Obs.**
Describe rate of spread: Increases rapidly (doubling in <10 years).
Rationale: Lacey (1989) reported approx 3.1 million acres in the western U.S. infested with diffuse knapweed. Since the 1989 summary, it has been expanding rapidly. In addition, Lacey (1989) reports 30,000 acres infested in Colorado in 1989; in 1997 it occupied a reported 100,000 acres (however, see Duncan 2001 in Zouhar 2001 for a different estimate. Carpenter and Murray (2000) report that the area infested by diffuse knapweed is increasing an estimated 18 percent per year. Many reports vary widely as Sheley (2001) reports that estimates of infestation size are extremely subjective because of survey groundrules. Observations from local botanists from the Coconino National Forest report populations increasing at 15 to 20% per year, even with treatment.
Sources of information: See cited literature; also see Roché and Roché (1999). In addition, consideration was given to personal observations of L. Moser (Botanist, U.S. Department of Agriculture, Forest Service, Coconino National Forest, Flagstaff, Arizona) and B. Phillips (Zone Botanist, U.S. Department of Agriculture, Forest Service, Coconino National Forest, Flagstaff, Arizona).

Question 2.3 Recent trend in total area infested within state *Score:* **A** *Doc'n Level:* **Obs.**
Describe trend: Increasing rapidly (doubling in total range statewide in <10 years).
Rationale: States surveyed in 1988 and then again in 2001 showed that diffuse knapweed infestations were doubling in <10 years. Utah in 1988 had 25 acres and in 2001, 1,300 acres were reported. Colorado had 30,000 acres of diffuse knapweed in 1988 and 83,000 acres in 2001. Arizona was not reported in 1988 but had 1,800 acres in 2001, but because of the trends in both Utah and Colorado the Working Group agreed that these trends are likely similar in Arizona.
Sources of information: Duncan (2001) in Zouhar (2001). In addition, consideration was given to observations of Working Group members.

Question 2.4 Innate reproductive potential *Score:* **A** *Doc'n Level:* **Other pub.**
Describe key reproductive characteristics: Diffuse knapweed is a biennial or short-lived perennial that reproduces primarily by seed.
Rationale: Fertilization in diffuse knapweed requires cross-pollination between flowers on different plants. This can limit the reproductive success of isolated individuals, but it also promotes genetic diversity and may thereby improve competitive ability. Watson and Renney (1974) reported that diffuse knapweed is self-compatible, but the results of Harrod and Taylor (1995) refute this assertion. Diffuse knapweed has a large, perennial taproot that may survive fire if the root crown is not killed, and/or establish from seed after fire (Zouhar 2001). Seed can remain viable in soil for up to 12 years (Roché and Roché 1999). A single diffuse knapweed plant can produce up to 18,000 seeds and a stand of diffuse knapweed can produce up to 40,000 seeds per square meter (Carpenter and Murray 2000).
Sources of information: See cited literature.

Question 2.5 Potential for human-caused dispersal *Score:* **A** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Seeds spread along transportation corridors, such as highways, railroads, and trails; seed are transported by humans on foot and in vehicles, grazed or lands with disturbance are more susceptible to invasion. Diffuse knapweed is a seed contaminant in hay, and present in seed harvested from wild populations for restoration and erosion control projects.
Rationale: Seeds of diffuse knapweed have a plume of bristle-like hairs, resembling scales that easily cling to objects, shoes and clothing, and on vehicle chassis. Diffuse knapweed is not common on cultivated lands or irrigated pasture because it cannot tolerate cultivation or excessive moisture, but is common on fence lines.
Sources of information: Watson and Renney (1974), Carpenter and Murray (2000), and Working Group member observations.

Question 2.6 Potential for natural long-distance dispersal *Score:* **B** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Seeds dispersed by wind, and tumbling.
Rationale: Wind dispersal of individual seeds does not carry them far from actual parent plant, however, most of the heads remain closed until the plant dries up and during the second year of growth, diffuse knapweed often detaches from root crown and the entire plant is carried by winds as a tumble-weed, allowing seeds to be individually dispersed over long distances.
Sources of information: See Carpenter and Murray (2000).

Question 2.7 Other regions invaded *Score:* **C** *Doc'n Level:* **Other pub.**
Identify other regions: Diffuse knapweed is currently found from Yukon in the north, throughout most of western Canada, east to Ontario. In the United States, the primary range of diffuse knapweed is the western states, from Washington, Idaho and Montana south to New Mexico and Arizona. Maddox (1979) notes that diffuse knapweed is more common on the western side of the Great Basin, and spotted knapweed is more common on the eastern side (in Zouhar 2001).
Rationale: In Utah the antelope bitterbrush/bunchgrass shrub steppe is highly susceptible to invasion by diffuse knapweed, as well as the La Sal Mountain range, and Welsh et al. (1987), report it is probably throughout middle elevations of the state. In Colorado diffuse knapweed invades more than 145,000 acres in the shortgrass steppe along the Front Range, including the foothills. Adjacent montane zones and the lower elevation pinyon-juniper-oak (*Pinus-Juniperus-Quercus* spp.) brush zones are also susceptible. Diffuse knapweed is also found on upland sites in pinyon and juniper woodlands in the interior west. Presently, diffuse knapweed invades in the above listed ecotypes elsewhere, but only in those types it has already invaded in Arizona.
Sources of information: See cited literature; also see Zouhar (2001). In addition, consideration was given to observational information from 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 11, 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: The earliest record of diffuse knapweed in North America is from an alfalfa field in Washington state in 1907 (Zouhar 2001). In Utah it is known from Iron, San Juan, Utah, Sanpete, and Juab counties from 1360 m to 1970 m in elevation. In Colorado diffuse knapweed is reported from Delta, Montrose, San Miguel, Dolores, Montezuma, La Plata and Archuleta counties (Roché and Roché 1999). The first collection of this plant in Arizona was made August 5, 1979 along Highway 89, seven miles north of Flagstaff near Black Mountain Homes (Coconino National Forest Weed Information records).
Rationale: Diffuse knapweed is reported to be invasive in the following communities: douglas-fir, ponderosa pine, fir-spruce, sagebrush, pinyon-juniper, mountain grasslands, plains grasslands, desert grasslands (Zouhar 2001).
Sources of information: See cited literature; also considered 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 11, 2004) and Coconino National Forest Weed Information records.

Question 3.2 Distribution *Score:* **C** *Doc'n Level:* **Obs.**
Describe distribution: In Arizona, it is found in Navajo Nation botanical records from Apache County. Southwest Exotic Plant Mapping Program (SWEMP)-Cain Crisis map records (2004) report infestations densest in Coconino county, but also occurring in Navajo and Apache counties.
Rationale: Reported from National Park Service species databases in ROMO, YUHO, GRCA, FOBU and MEVE.

Sources of information: Kearney and Peebles (1960), Navajo Nation botanical records, 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 11, 2004, and observations from Working Group members.

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: 8 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	**D**
	southwestern interior chaparral scrub	**D**
Desertlands	Great Basin desertscrub	**D**
	Mohave desertscrub	
	Chihuahuan desertscrub	
	Sonoran desertscrub	**D**
Grasslands	alpine and subalpine grassland	
	plains and Great Basin shrub-grassland	**D**
	semi-desert grassland	**D**
Freshwater Systems	lakes, ponds, reservoirs	
	rivers, streams	
Non-Riparian Wetlands	Sonoran wetlands	
	southwestern interior wetlands	
	montane wetlands	
	playas	
Riparian	Sonoran riparian	
	southwestern interior riparian	
	montane riparian	
Woodlands	Great Basin conifer woodland	**D**
	Madrean evergreen woodland	
Forests	Rocky Mountain and Great Basin subalpine conifer forest	
	montane conifer forest	**C**
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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