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)**:**	*Pennisetum ciliare* (L.) Link (USDA 2005)
Synonyms:	*Cenchrus ciliaris* L. (USDA 2005)
Common names:	Buffelgrass
Evaluation date (mm/dd/yy)**:**	04/02/03
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List committee members:	05/20/03: D. Backer, J. Brock, D. Casper, P. Guertin, J. Hall, R. Parades, S. Rutman, J. Ward 05/21/04: D. Backer, K. Brown, D. Casper, G. Ferguson, D. Foster, P. Guertin, J. Hall, C. Laws, D. Madison, F. Northam, J. Ward
Committee review date:	05/20/03 and 05/21/04
List date:	05/20/03; revised 05/21/04
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	**A**	Reviewed scientific publication	**"Impact"** **Section 1 Score:** **A**	**"Plant Score"** **Overall Score:** **High** **Alert Status:** **None**
1.2	Impact on plant community	**A**	Reviewed scientific publication		
1.3	Impact on higher trophic levels	**A**	Observational		
1.4	Impact on genetic integrity	**D**	Reviewed scientific publication		
2.1	Role of anthropogenic and natural disturbance	**A**	Reviewed scientific publication	**"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:* **18 pts** **Section 2 Score:** **A**	
2.2	Local rate of spread with no management	**A**	Other published material		
2.3	Recent trend in total area infested within state	**B**	Observational		
2.4	Innate reproductive potential	**A**	Reviewed scientific publication		
2.5	Potential for human-caused dispersal	**A**	Reviewed scientific publication		
2.6	Potential for natural long-distance dispersal	**B**	Other published material		
2.7	Other regions invaded	**B**	Observational		
3.1	Ecological amplitude	**A**	Observational	**"Distribution"** **Section 3 Score:** **A**	RED FLAG **YES** Something you should know.
3.2	Distribution	**A**	Observational		

Red Flag Annotation

At present *Pennisetum ciliare* is only occasionally observed in semi-desert grasslands and Chihuahuan desertscrub and has not been observed in southwestern interior chaparral scrub and Madrean evergreen woodland. Invasion into these "cooler" ecological types could increase or begin if the new cold-tolerant

cultivar "Frio" is released into Arizona. Continued development of cold tolerance or drought tolerance in *P. ciliare* cultivars poses a significant ecological threat if such cultivars are released into Arizona wildlands.

Table 3. Documentation

Note: Levels of documentation were updated on September 5, 2003 by D. Backer and J. Ward after more explicit definitions of the levels of documentation were agreed upon by the Working Group. The assessment was revisited on May 21, 2004 to discuss addition of a Red Flag Annotation to reflect potential expansion of *Pennisetum ciliare*'s ecological amplitude in response to release of a cold-tolerant cultivar (Hussey and Burson 2005).

Question 1.1 Impact on abiotic ecosystem processes *Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Identify ecosystem processes impacted: Potentially dramatic changes in the fire regime by initiation of a positive feedback grass/fire cycle in ecotype without large frequent fires.
Rationale: Numerous authors (Felger 1990, Van Devender et al. 1997, Esque and Schwalbe 2000, Williams and Baruch 2000, Búrquez-Montijo et al. 2002) have concluded that continued buffelgrass expansion is likely to initiate a positive feedback grass/fire cycle (D'Antonio and Vitousek 1992) in the Arizona-upland subdivision of the Sonoran Desert, which will severely alter ecosystem function. Their conclusion is based on: (1) observations of a large increase in the amount and continuity of dead standing biomass in areas where buffelgrass has invaded (J. Ward, personal observations, 2001) in an ecosystem with naturally distinct vegetation patches and infrequent large fires (Schmid and Rogers 1988), (2) clear evidence that buffelgrass supports and benefits from fire (t' Mannetje et al. 1983, Lazarides et al. 1997) but the natives do not (McLaughlin and Bowers 1982), (3) general evidence that introduced African grasses increase the frequency and intensity of fires in the Americas (D'Antonio and Vitousek 1992) and specific evidence for buffelgrass in Sonora, Mexico (Búrquez-Montijo et al. 2002). However, although various lines of evidence support the likelihood of initiation of a buffelgrass/fire cycle in Arizona, it is yet to be clearly realized and documented without the confounding effects of human-caused initiations.
Sources of information: See cited literature. Also considered personal observations of J. Ward (U.S. Department of Agriculture, Agricultural Research Service, Jornada Experimental Range, observations of buffelgrass stands in Saguaro National Park, Arizona during field surveys from June to November 2001).

Question 1.2 Impact on plant community composition, structure, and interactions *Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Identify type of impact or alteration: Development of a semi-continuous structural layer not previously present. Apparent reduction of native plant recruitment and displacement of shorter-lived perennials in dense stands.
Rationale: Buffelgrass establishes and forms dense stands in an ecotype that does not naturally support dense grass cover (Búrquez-Montijo et al. 2002). Casual observation indicates a lack of new recruits of long-lived species including Saguaros in dense buffelgrass patches in Saguaro National Park (J. Ward, personal observations, 2001). On rocky slopes of Tumamoc Hill, competes with brittlebush (*Encelia farinosa*) for shallow soil moisture; in stands of buffelgrass, brittlebush has not reestablished following a decline attributed to freezing (Burgess et al. 1991). In research on Tumamoc Hill near Tucson, A. Elits (personal communication, 2004) has found that buffelgrass is competing with palo verde trees. There is a negative impact on the palo verde trees but the factor is not known. "…not aware of any studies that specifically show that buffelgrass is displacing or outcompeting native plant without some type of disturbance [factor]."

Sources of information: See cited literature. Also considered personal observations of J. Ward (U.S. Department of Agriculture, Agricultural Research Service, Jornada Experimental Range, observations of buffelgrass stands in Saguaro National Park, Arizona during field surveys from June to November 2001) and personal communication with A. Elits (Graduate Student, Ecology and Evolutionary Biology, University of Arizona, Tucson, 2004).

Question 1.3 Impact on higher trophic levels *Score:* **A** *Doc'n Level:* **Obs.**
Identify type of impact or alteration: Likely changes in food resources and habitat structure. Impact likely severe for desert specialists that are infrequent in grasslands (e.g., desert tortoises and some lizards), which will probably suffer the greatest impact due to a conversion from desert to grassland.
Rationale: Changes in structure/cover alter predator/prey relationships as observed with desert iguana in Altar Valley following an increase in another introduced grass (*Bromus rubens* [red brome]) and increases in fire result in direct mortality above natural level as observed with desert tortoises in Saguaro National Park. Inferences based on observation.
Sources of information: Personal communication with C. Schwalbe (Research Scientist, U.S. Geological Survey and University of Arizona, Tucson, observations in Pima County, Arizona from 1978 to 2003).

Question 1.4 Impact on genetic integrity *Score:* **D** *Doc'n Level:* **Rev. sci. pub.**
Identify impacts: None identified.
Rationale: Buffelgrass is apomictic and only rarely undergoes genetic recombination (Bashaw 1962). There are no closely allied native species in Arizona (Kearney and Peebles 1960).
Sources of information: See cited literature.

Question 2.1 Role of anthropogenic and natural disturbance in establishment *Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Describe role of disturbance: Buffelgrass is able to establish and spread in areas without known disturbance.
Rationale: Formal studies have not been conducted, but buffelgrass occurs in areas without apparent natural or human-caused disturbance in Sonora (Búrquez-Montijo et al. 2002, on Tumamoc Hill (Burgess et al. 1991), in Organ Pipe National Monument (Rutman and Dickson 2002) and in Saguaro National Park (unpublished non-native plant inventory data, 1997 to 2003).
Sources of information: See cited literature. Also considered unpublished inventory data from Saguaro National Park.

Question 2.2 Local rate of spread with no management *Score:* **A** *Doc'n Level:* **Other pub.**
Describe rate of spread: Increases rapidly, doubling in <10 years.
Rationale: Survey transects of Ironwood Forest National Monument northwest of Tucson indicate that buffelgrass expanded locally between 2001 and 2002 during a period of record low rainfall (Dimmitt 2003). Transects on Tumamoc Hill in 1983 reported buffelgrass presence (Burgess et al. 1991); these transects have not been reread (J. Bowers, personal communication, 2003). Arizona Department of Transportation records buffelgrass occurrences along roadsides (ADOT 2003); data or report not assessed by the evaluator. Numerous anecdotal reports of large rapid increases along roadsides. No experimental information on rate of spread was available.
Sources of information: See cited literature. Also considered presentation information by M. Dimmitt (Impact of recent weed invasions on desert ecosystems. Presentation at Arid Southwest Lands Habitat Restoration Conference, California Desert Managers Group, March 3–7, 2003. Proceedings accessible online at: http://www.dmg.gov/resto-pres/wed-15-dimmitt.pdf; accessed May 2003), personal communication with J. Bowers (U.S. Geological Survey, Desert Laboratory, Tucson, Arizona, 2003),

and information from the Arizona Department of Transportation (ADOT), Natural Resources, Noxious Weeds website (available online www.dot.state.az.us; accessed November 4, 2003).

Question 2.3 Recent trend in total area infested within state	*Score:* **B** *Doc'n Level:* **Obs.**
Describe trend: Increasing, but less rapidly than doubling in total area infested in <10 years.	
Rationale Observations of large increases in the number and size of patches, particularly at the northern extent of their range. Arizona Department of Transportation survey information (see question 2.2) could potentially be used to begin to understand patterns relative to road corridors.	
Sources of information: Arizona Department of Transportation (ADOT), Natural Resources, Noxious Weeds website (available online www.dot.state.az.us; accessed November 4, 2003) and personal communication with S. Rutman (Botanist, National Park Service, Organ Pipe Cactus National Monument, Ajo, Arizona, 2003).	

Question 2.4 Innate reproductive potential	*Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Describe key reproductive characteristics: Apomictic perennial grass. Frequent and high seed production with high innate germination rate and short dormancy period.	
Rationale: Buffelgrass is apomictic (Bashaw 1962, Highnight et al. 1991) and can produce seeds in first year and in response to both summer and winter precipitation in both urban and wildland areas in Pima County (J. Ward, personal observations, 2001). Common buffelgrass, the cultivar in southeastern Arizona, averaged 89 seeds per inflorescence and 357 inflorescences per plant in irrigated pastures in south Texas (Evers et al. 1969). Field studies have not been conducted, however, inflorescence production in Arizona appears to be much lower, perhaps 5 to 10% of this value (J. Ward, personal observations, 2001). When given optimal temperature and moisture, seeds collected from natural areas and stored in field conditions in Tucson displayed a germination rate of 20% after 2 months and from 35 to 85% after 11 months depending on location in the field (J. Ward, unpublished data, 2003).	
Sources of information: See cited literature. Also considered personal observations of J. Ward (U.S. Department of Agriculture, Agricultural Research Service, Jornada Experimental Range, observations of buffelgrass stands in Saguaro National Park, Arizona during field surveys from June to November 2001) and unpublished data of J. Ward (ongoing work in Tucson, Arizona, 2003).	

Question 2.5 Potential for human-caused dispersal	*Score:* **A** *Doc'n Level:* **Rev. sci pub.**
Identify dispersal mechanisms: Widely used for pasture development in Texas and Sonora, Mexico and used to stabilize mine tailings in southeastern Arizona. Dispersed along road corridors and foot trails via human traffic.	
Rationale: Conservative estimates indicate that by 1988, 600,000 ha had been converted to buffelgrass pasture in Sonora and 700,000 ha in Texas (Hanselka 1988). In southeastern Arizona, buffelgrass is seeded to stabilize mine tailings. It is common along roadsides through desert regions of Arizona and locations of roadside patches are recorded by the Natural Resources division of Arizona Department of Transportation as part of their inventory for noxious weeds (ADOT 2003). Buffelgrass is common along migrant corridors from Mexico in Organ Pipe National Monument (Rutman and Dickson 2002).	
Sources of information: See cited literature; also see Cox et al. 1988. Also considered information from the Arizona Department of Transportation (ADOT), Natural Resources, Noxious Weeds website (available online www.dot.state.az.us; accessed November 4, 2003).	

Question 2.6 Potential for natural long-distance dispersal	*Score:* **B** *Doc'n Level:* **Other pub**.
Identify dispersal mechanisms: Dispersed by wind and wildlife.	
Rationale: Isolated patches of buffelgrass occur on relatively remote ridges away from human traffic in Saguaro National Park (unpublished non-native plant inventory data, 1997 to 2003). "The seeds' relatively high wing load encourages wind dispersal, and the barbed bristles loosely hook on skin, fur,	

and moving vehicles" (Búrquez-Montijo et al. 2002:133). Evidence that buffelgrass travels long distances: buffelgrass found in San Manuel, along the San Pedro River and the closest population is in the Catalina Mountains north of Tucson (T. Van Devender, 2004, personal communication).
Sources of information: See cited literature. Also considered personal communication with T. Van Devender (Scientist, Arizona-Sonora Desert Museum, Tucson, Arizona, 2004) and unpublished inventory data from Saguaro National Park.

Question 2.7 Other regions invaded *Score:* **B** *Doc'n Level:* **Obs.**.
Identify other regions: Invades regions of the Chihuahuan Desert in Big Bend National Park (P. Guertin, personal communication, 2004). Observations of buffelgrass in the oak woodlands in Sonora (R. Paredes, personal communication, 2003).
Rationale: Buffelgrass has not been found in the Chihuahuan Desert nor the oak woodland of Arizona. This discrepancy is potentially due to cold intolerance (Cox et al. 1988) as the Chihuahuan Desert in Big Bend and the oak woodland in Sonora are warmer than in Arizona.
Sources of information: See cited literature. Also considered personal communications with P. Guertin (U.S. Geological Survey, Sonoran Desert Field Station, Tucson, Arizona, 2004) and R. Parades (Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora [IMADES], 2003).

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: Buffelgrass observed in the semi-desert grassland, Sonoran riparian, and Sonoran desertscrub.
Rationale: Observations of buffelgrass have been made in the semi-desert grassland of the Catalina Mountains (D. Casper, personal communication, 2004) and the Sonoran riparian ecological type at Chimenea and Rincon Creek of Saguaro National Park (D. Foster, personal communication, 2004). However, it appears as if in Arizona, buffelgrass is only extensively invasive in the Sonoran Desert. Buffelgrass is not common above 1250 m in Saguaro National Park (unpublished non-native plant inventory data, 1997 to 2003). Higher altitude biomes appear to be too cold for buffelgrass. This status may potentially change due to release of new cold-tolerant varieties (Hussey and Burson 2005). Earliest record encountered for buffelgrass field trials in southeastern Arizona was 1941 (USDA, SCS unpublished data).
Sources of information: Personal communications with D. Casper (Biological Technician, National Park Service, Organ Pipe Cactus National Monument, Ajo, Arizona, 2004) and D. Foster (Botanist, National Park Service, Saguaro National Park, 2004). Also considered unpublished inventory data from Saguaro National Park and unpublished establishment trial records of the United States Department of Agriculture, Soil Conservation Service (USDA, SCS), Tucson Plant Materials Center, Tucson, Arizona. The latter were accessed and reviewed by J. Ward in March 2001

Question 3.2 Distribution *Score:* **A** *Doc'n Level:* **Obs.**
Describe distribution: >50% of Sonoran Desert occurrences have buffelgrass.
Rationale: Observations of buffelgrass collectively reported by the committee members in most of the major Sonoran desert ranges. Found in Chihuahuan desertscrub and desert grasslands at 1127 to 1345 meters (T. Van Devender, personal communication, 2004)
Sources of information: Personal communication with T. Van Devender (Scientist, Arizona-Sonora Desert Museum, Tucson, Arizona, 2004) and the collective observations of 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: 7 Total unknowns: 1

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	
	Mohave desertscrub	
	Chihuahuan desertscrub	**D**
	Sonoran desertscrub	**A**
Grasslands	alpine and subalpine grassland	
	plains and Great Basin shrub-grassland	
	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	**D**
	southwestern interior riparian	
	montane riparian	
Woodlands	Great Basin conifer woodland	
	Madrean evergreen woodland	
Forests	Rocky Mountain and Great Basin subalpine conifer forest	
	montane conifer forest	
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).

Literature Cited

Bashaw, E.C. 1962. Apomixis and sexuality in buffelgrass. Crop Science 2:412–415.

Brown, D.E. (ed.). 1994. Biotic Communities: Southwestern United States and Northwestern Mexico. University of Utah Press, Salt Lake City. 342 p. [Plus companion 60-inch by 48-inch map, Biotic Communities of the Southwest].

Brown, D., F. Reichenbacher, and S. Franson, S. 1998. A Classification of North American Biotic Communities. University of Utah Press, Salt Lake City. 141 p.

Burgess, T.L., J.E. Bowers, and R.M. Turner. 1991. Exotic plants at the Desert Laboratory, Tucson, Arizona. Madroño 38:96–114.

Búrquez-Montijo, A., M.E. Miller, and A. Martínez-Yrízar. 2002. Mexican grasslands, thornscrub, and the transformation of the Sonoran Desert by invasive exotic buffelgrass (*Pennisetum ciliare*). Pages 126–146 in B. Tellman (ed.), Invasive Exotic Species in the Sonoran Region. The University of Arizona Press and the Arizona-Sonora Desert Museum, Tucson.

Cox, J.R., M.H. Martin, F.A. Ibarra, J.H. Fourie, N.F.G. Rethman, and D.G. Wilcox. 1988. The influence of climate and soils on the distribution of four African grasses. Journal of Range Management 41:127–139.

D'Antonio, C.M., and P.M Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle and global change. Annual Review of Ecology and Systematics 23:63–87.

Esque, T.C., and C. Schwalbe. 2000. Non-native grasses and fire create double jeopardy. People, Land, and Water. Department of the Interior. Available online at: http://www.usgs.gov/invasive_species/plw/grassfire.html.

Evers, G.W., E.C. Holt, and E.C. Bashaw. 1969. Seed production characteristics and photoperiodic responses in buffelgrass, *Cenchrus ciliaris* L. Crop Science 9:309–310.

Felger, R.S. 1990. Non-Native plants of Organ Pipe Cactus National Monument, Arizona. Technical Report No. 31. U.S. Geological Survey, Cooperative Park Studies Unit, The University of Arizona and National Park Service, Organ Pipe Cactus National Monument, Ajo, Arizona. 93 p.

Hanselka, C.W. 1988. Buffelgrass—South Texas wonder grass. Rangelands 10:279–281.

Highnight, K.W., E.C. Bashaw, and M.A. Hussey. 1991. Cytological and morphological diversity of native apomictic buffelgrass, *Pennisetum ciliare* (L.) Link. Botanical Gazette 152:214–218.

Hussey, M.A., and B.L. Burson. 2005. Registration of 'Frio' buffelgrass. Crop. Sci. 45:411–412.

Kearney, T.H., and R.H. Peebles (and collaborators). 1960. Arizona Flora. 2nd edition with supplement by J.T. Howell and E. McClintock and collaborators. University of California Press, Berkeley. 1085 p.

Lazarides, M., K. Cowley, and P. Hohnen. 1997. CSIRO Handbook of Australian Weeds. CSIRO, Australia.

McLaughlin, S.P., and J.E. Bowers. 1982. Effects of wildfire on a Sonoran Desert plant community. Ecology 63:246–248.

Rutman, S., and L. Dickson. 2002. Management of buffelgrass on Organ Pipe Cactus National Monument, Arizona. Pages 311–318 in B. Tellman (ed.), Invasive Exotic Species in the Sonoran Region. The University of Arizona Press and the Arizona-Sonora Desert Museum, Tucson.

Schmid, M.K. and G.F. Rogers. 1988. Trends in Fire Occurrence in the Arizona Upland subdivision to the Sonoran Desert, 1955, to 1982. Southwestern Naturalist 33:437–444.

t' Mannetje, L., S.J. Cook, and J.H. Wildin. 1983. The effects of fire on a buffelgrass and Siratro pasture. Tropical Grasslands. 17:30–39.

[USDA] U.S. Department of Agriculture, Natural Resources Conservation Service. 2005. The PLANTS Database, Version 3.5. Available online at: http://plants.usda.gov. Data compiled from various sources by Mark W. Skinner. National Plant Data Center, Baton Rouge, Louisiana.

Van Devender, T.R., R.S. Felger, and A. Burquez-M. 1997. Exotic plants in the Sonoran Desert region, Arizona and Sonora. 1997 Symposium Proceedings, California Exotic Pest Plant Council. Available online at: http://endangered.fws.gov/r/fr94547.html; accessed April 2003.

Warner, P.J., C. Bossard, M.L. Brooks, J.M. DiTomaso, J.A. Hall, A. M. Howald, D.W. Johnson, J.M. Randall, C.L. Roye, M.M. Ryan, and A.E. Staton. 2003. Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands. Available online at: www.caleppc.org and www.swvma.org. California Exotic Pest Plant Council and Southwest Vegetation Management Association. 24 p.

Williams, D.G., and Z. Baruch. 2000. African grass invasion in the Americas: ecosystem consequences and the role of ecophysiology. Biological Invasions 2:123–140.