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)**:**	*Eragrostis curvula* (Schrad.) Nees (USDA 2005)
Synonyms:	*Eragrostis chloromelas* Steud, *Eragrostis curvula* (Schrad.) Nees var. *conferta* Stapf (USDA 2005); however, see Taxonomic Comment and Red Flag Annotation sections.
Common names:	Weeping lovegrass, zacate del amor
Evaluation date (mm/dd/yy)**:**	05/08/04
Evaluator #1 Name/Title:	Dana Backer/Conservation Ecologist
Affiliation:	The Nature Conservancy
Phone numbers:	(520) 622–3861
Email address:	dbacker@tnc.org
Address:	1510 East Ft. Lowell Rd., Tucson, Arizona 85719
Evaluator #2 Name/Title:	
Affiliation:	
Phone numbers:	
Email address:	
Address:	

List committee members:	D. Backer, C. Laws, G. Ferguson, J. Hall, M. Van Glider, P. Warren
Committee review date:	07/16/04
List date:	07/16/04
Re-evaluation date(s):	

Taxonomic Comment

The Plants Database (USDA 2005) considers *Eragrostis curvula* var. *conferta* (Boer's lovegrass) as a synonym for *Eragrostis curvula.* Because of the differences in environmental tolerances and ploidy between *E. c*. var. *conferta* and the species as a whole (Guertin and Halvorson 2003); however, for the purposes of this assessment *E. c*. var. *conferta* is considered a separate taxon and is not evaluated as part of *E. curvula*. See the Red Flag Annotation for additional details.

Table 2. Scores, Designations, and Documentation Levels

	Question	Score	Documentation Level	Section Scores	Overall Score & Designations
1.1	Impact on abiotic ecosystem processes	**D**	Other published material	**"Impact"** **Section 1 Score:** **C**	**"Plant Score"** **Overall Score:** **Low** **Alert Status:** **None**
1.2	Impact on plant community	**C**	Observational		
1.3	Impact on higher trophic levels	**C**	Observational		
1.4	Impact on genetic integrity	**U**	Observational		
2.1	Role of anthropogenic and natural disturbance	**C**	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:* **11 pts** **Section 2 Score:** **B**	
2.2	Local rate of spread with no management	**C**	Observational		
2.3	Recent trend in total area infested within state	**C**	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	**C**	Other published material		
2.7	Other regions invaded	**C**	Observational		 Information you should know.
3.1	Ecological amplitude	**A**	Other published material	**"Distribution"** **Section 3 Score:** **B**	
3.2	Distribution	**C**	Observational		

Red Flag Annotation

This assessment does not pertain to *Eragrostis curvula* var. *conferta* (Boer lovegrass). This taxon has different moisture and temperature limits relative to the species as whole and likely behaves differently in regard to its ecological impacts, invasiveness, and ecological amplitude. *Eragrostis curvula* var. *conferta* as a valid taxon is ambiguous as the U.S. Department of Agriculture Plants Database regards it as a synonym of *E. curvula*. Because of the differences in environmental tolerances and ploidy between *E. c.*

var. *conferta* and the species as a whole, for the purposes of this list [assessment] *E. c*. var. *conferta* is considered a separate taxon and is not evaluated as part of *E. curvula*.

Table 3. Documentation

Question 1.1 Impact on abiotic ecosystem processes *Score:* **D** *Doc'n Level:* **Other pub.**
Identify ecosystem processes impacted: Minor alteration-erosion, infiltration.
Rationale: In Walsh (1994): *Eragrotis curvula* benefits from fire; it generally increases (Wright et al. 1978) following fire and contributes to positive fire feedback cycle. Other studies of the response of *E. curvula* to fire in Oklahoma (Wright et al. 1978) and in Texas (Roberts et al. 1988) showed that the presence of *E. curvula* is not reduced. At this time, there is no indication that *E. curvula* is altering fire regimes in Arizona because it is present in low abundances. Although *E. curvula* was planted for soil conservation, no long-term studies have evaluated the efficacy of weeping lovegrass for soil conservation (W. Kruse, personal communication, 1994 in Walsh 1994). Whereas Garcia (1993) stated that weeping lovegrass provides excellent soil protection [New Mexico]. Moreover, Hitchcock (1951) identified weeping lovegrass as useful for erosion control. Weeping lovegrass has been seeded in central Arizona chaparral after brush removal to increase annual stream flow. Heavily transpiring, deep-rooted evergreen shrubs were replaced with weeping lovegrass and other shallow-rooted vegetation. Streamflow increased, and the increase has lasted for 18 years with maintenance (Hibbert et al. 1982).
Sources of information: See cited literature.

Question 1.2 Impact on plant community composition, structure, and interactions *Score:* **C** *Doc'n Level:* **Obs.**
Identify type of impact or alteration: Moderate alteration of plant community-composition, structure.
Rationale: From Guertin and Halvorson (2003): in one report (from Virginia) *E. curvula* was observed crowding out native grasses on site due to its aggressiveness, rapid growth and early establishment (VDCR 1999). Other reports from field experiments when *E. curvula* was grown as a crop, demonstrated western ragweed plants reduced *E. curvula* stands and productivity (Dalrymple 1970b), as did sandbur (Matizha and Dahl 1991). From Walsh (1994): *Eragrotis curvula* has been used for grassland revegetation in southern US (Hitchcock 1951), particularly after invasion by woody shrubs (Cox et al. 1987). *Eragrotis curvula* was seeded after several fires in Arizona but because of grazing, drought, and time, the vigor of weeping lovegrass was not sustained and was considered fair (Pond and Cable 1962, Lavin and Pase 1963). Pond (1961) observed that *E. curvula* stands in converted Arizona chaparral tend to decline 3 to 4 years after establishment when protected from grazing or fire [see also observations by Pond below]. *Eragrotis curvula* should probably not be planted if the management objectives are to establish and maintain native grasses (W. Kruse, personal communication, 1994 in Walsh 1994). Following a fire in Globe Arizona in 1952, the area was seeded with *E. curvula* in shrub-live oak. *Eragrotis curvula* tended to die out as the re-establishing oak brush thickened and, as a result, Pond (1961) noted an inverse proportion of *E. curvula* basal cover with shrub live oak cover. Thirty years after exotic plant seeding trials in the Tonto National Forest during 1945, E. curvula remained a component in the semi-desert grassland (Judd and Judd 1976). Walsh (1994) contains an incorrect statement relative to *E. curvula* being planted at Appleton-Whittell Research Sanctuary. The studies (see Bock et al. 1986 and Bock and Bock 1992) were plant and animal

responses to *E. curvula* var. *conferta* (Boer's lovegrass) and not *E. curvula*. Impacts of *E. curvula* on plant communities are not known but due to the similarity in morphology and physiology of the South African *Eragrostis* species and the documented impacts of *E. curvula* var. *conferta* and *E. lehmanniana,* it is inferred that these impacts would also apply to *E. curvula*. The following is from Bock et al. (1986):

> "Plant and animal populations were sampled between June 1984 and August 1985 in semidesert grasslands on mesas in Santa Cruz County, Arizona. Some areas had been seeded to weeping lovegrass [should be Boer's] and Lehmann lovegrass (*Eragrostis lehmanniana*); other areas had native grasses, forbs, and shrubs. The stands of exotic grasses differed consistently from native grasslands in terms of indigenous plants and animals. The exotic African lovegrasses covered more than 50 percent of the ground where they had been planted; they grew in tall, nearly monospecific stands. At these sites the native grass cover was reduced by nearly 60 percent compared to unseeded stands. Total native herb canopy, herb species richness, shrub density, and shrub canopy were significantly reduced on plots dominated by weeping lovegrass and Lehmann lovegrass."

Dan Robinett (personal communication, 2004) indicated he has not seen weeping lovegrass "act as an invasive species in the mountains of southern Arizona. In fact it usually persists only as a minor component of native communities in areas where it was seeded. I've seen it seeded at several locations in Cochise and Santa Cruz counties in the higher end of desert grasslands and lower end of plains grasslands and even where stands were established (in the 80s) they have died out by now."

Sources of information: See cited literature. Score based on inference drawn from the literature. Also considered personal communication with D. Robinett (Rangeland Management Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Tucson, Arizona, 2004).

Question 1.3 Impact on higher trophic levels *Score:* **C** *Doc'n Level:* **Obs.**

Identify type of impact or alteration: Minor impact on higher trophic levels.

Rationale: From Walsh (1994): forage value is fair for livestock and relatively poor for wildlife (Stubbendieck et al. 1986). Walsh incorrectly identifies impacts of *E. curvula* on hispid cotton rat (increased abundance), grasshoppers (reduced abundance) and birds (species dependent effects) from Bock et al. 1986 (taxa studied were *E. lehmanniana* and *E. curvula* var. *conferta*). There are no known studies of the impact of *E. curvula* on native wildlife species. Yet the potential exists for *E. curvula* to have impacts similar to other non-native lovegrasses.

Sources of information: See cited literature. Score based on inference drawn from the literature.

Question 1.4 Impact on genetic integrity *Score:* **U** *Doc'n Level:* **Obs**.

Identify impacts: A potential exists for *E. curvula* to hybridize with native *Eragrostis* species.

Rationale: "*Eragrostis curvula* is truly a "complex" and contains many different types of plants at many ploidy levels. Thankfully, most of them are apomictic and so hybridization with *E. intermedia* would be a very unusual event. There are rare sexual weeping lovegrasses out there, so it's at least possible that *E. curvula* could be involved in an interspecific hybridization event. Much less—really almost nothing—is known about *E. intermedia's* reproductive biology. Don't know whether it's sexual or apomictic or even its ploidy. This makes it just that much harder to predict what might happen." (S. Smith, personal communication, 2004).

Furthermore, B. Munda (personal communication, 2004), based on his work at the Tucson Plant Material Center, does not recall hybridization occurring between any of the non-native *Eragrostis* species. He thought the score should be a **C** (minor) or **D** (no known hybridization); however, because several native *Eragrostis* species occur in Arizona in the same ecological types as *E. curvula* (Kearney

and Peebles 1960), the Working Group could not completely rule out the possibility of hybridization with native Eragrostis even if such an event would be unlikely.
Sources of information: See cited literature. Also considered personal communications with S. Smith (Genetic Ecologist, University of Arizona, 2004) and B. Munda (Plant Resource Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Plant Material Center, Tucson, Arizona, 2004).

Question 2.1 Role of anthropogenic and natural disturbance in establishment *Score:* **C** *Doc'n Level:* **Other pub.**
Describe role of disturbance: Low invasive potential.
Rationale: In most places, weeping lovegrass does not actively colonize adjacent non-planted sites (Cox et al. 1988). In the past, weeping lovegrass was seeded in areas that had been disturbed by grazing, fire or erosion but this is not to imply that weeping lovegrass needs a disturbance to establish. In the Interior Chaparral zone under the Rim it persists where seeded but seems to only spread in disturbed areas (D. Robinett, personal communication, 2004). Where seeded along right-of-ways, it tends to stay there (B. Munda, personal communication, 2004).
Sources of information: See cited literature. Also considered personal communications with D. Robinett (Rangeland Management Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Tucson, Arizona, 2004) and B. Munda (Plant Resource Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Plant Material Center, Tucson, Arizona, 2004).

Question 2.2 Local rate of spread with no management *Score:* **C** *Doc'n Level:* **Obs.**
Describe rate of spread: Stable.
Rationale: Rate of spread by seeds is slow under the best conditions (Atkins and Smith 1967) and in most places weeping lovegrass does not actively colonize adjacent non-planted sites (Cox et al. 1988). Where seeded along right-of-ways, it tends to stay there (B. Munda, personal communication, 2004). *Eragrostis curvula* is not being used in seed mixes by the land management agencies (R. Lefevrer and L. Walker, personal communications, 2004).
Sources of information: See cited literature Also considered personal communications with B. Munda (Plant Resource Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Plant Material Center, Tucson, Arizona, 2004), R. Lefevrer (Forester, U.S. Department of Agriculture, Forest Service, Coronado National Forest, Tucson, Arizona, 2004), and L. Walker (Weed Specialist, Bureau of Land Management, Arizona Strip, St. George, Utah, 2004). Score based on inference drawn from the literature and personal communications.

Question 2.3 Recent trend in total area infested within state *Score:* **C** *Doc'n Level:* **Obs.**
Describe trend: Stable.
Rationale: Although several varieties of *E. curvula* have been introduced into different ecological types, it is assumed the extent of the range of infestation is not expanding; that is, the range of exploitation has been reached.
Sources of information: Personal communications with D. Robinett (Rangeland Management Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Tucson, Arizona, 2004) and B. Munda (Plant Resource Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Plant Material Center, Tucson, Arizona, 2004).

Question 2.4 Innate reproductive potential *Score:* **A** *Doc'n Level:* **Other pub.**
Describe key reproductive characteristics: Produces seeds in excess of 1000 per plant, self- and cross- pollinates; apomitic.

Rationale: See Worksheet A.	
Sources of information: See Worksheet A.	

Question 2.5 Potential for human-caused dispersal	*Score:* **A** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Hay, transportation corridors, in soils, intentional planting, sold commercially.	
Rationale: In the mid 1900s *E. curvula* was often seeded or was a component of a standard seed mix (including other non-natives such as *Melilotus officinalis*) for rangeland improvement and after wildfires (Hibbert et al. 1982; D. Robinett, personal communication, 2004). Natural Resources Conservation Service is not recommending weeping lovegrass for the purpose of forage, soil erosion, or revegetation after fire; however, it is still available commercially (B. Munda, personal communication, 2004). Coronado National Forest (R. Lefevrer, personal communication, 2004) and Arizona Bureau of Land Management (L. Walker, personal communication, 2004) are not using *E. curvula* in their respective seed mixes for post-fire seeding. From Guertin and Halvorson (2003): spread via animals (primarily livestock), hay, machinery and vehicles (Williamson 1997). *Eragrostis curvula* has been seeded extensively for erosion control along banks and slopes of highways and mine spoils, on revegetated sites (Dalrymple 1970a, Soil Conservation Service 1972), and range and pasture sites (Alderson and Sharp 1993). From Walsh (1994): intentional seeding for erosion and siltation control and restoration of shrub encroached chaparral (Hitchcock 1951, Wasser 1982). Also, cultivated as an ornamental grass (Hitchcock 1951, Kearney and Peebles 1960).	
Sources of information: See cited literature. Also considered personal communications with D. Robinett (Rangeland Management Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Tucson, Arizona, 2004), B. Munda (Plant Resource Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Plant Material Center, Tucson, Arizona, 2004), R. Lefevrer (Forester, U.S. Department of Agriculture, Forest Service, Coronado National Forest, Tucson, Arizona, 2004), and L. Walker (Weed Specialist, Bureau of Land Management, Arizona Strip, St. George, Utah, 2004).	

Question 2.6 Potential for natural long-distance dispersal	*Score:* **C** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Rare dispersal more than one kilometer.	
Rationale: *Eragrostis curvula* seeds are spread short distances by wind (Williamson 1997 in Guertin and Halvorson 2003).	
Sources of information: See cited literature.	

Question 2.7 Other regions invaded	*Score:* **C** *Doc'n Level:* **Obs.**
Identify other regions: No other ecological types besides those already invaded in Arizona.	
Rationale: Weeping lovegrass associates are recorded in sand dune vegetation in Woodward County, Oklahoma (Savage and Heller 1947 in Walsh 1994); however, the vegetation in that community differs from the sand dunes in Arizona. It is important to note that there are several varieties of *E. curvula* that were historically distributed as seed for forage, erosion control and revegetation. Each variety may have a range of tolerances and physical preferences.	
Sources of information: See cited literature. Score based on inference drawn from the literature.	

Question 3.1 Ecological amplitude *Score:* **A** *Doc'n Level:* **Other pub.**
Describe ecological amplitude, identifying date of source information and approximate date of introduction to the state, if known: *Eragrostis curvula* is native to South Africa (Ruyle and Young 1997) and was purposefully brought from Africa to the U.S. in 1932 (Crider 1945 in Cox et al. 1988) for soil conservation. Earliest records in the University of Arizona herbarium are from 1936 (SEINet 2004) with Soil Conservation Service in Tucson as the source. Early post-fire seeding dates from literature include 1956 (Pase and Pond 1964) and 1959 (Lavin and Pase 1963). *Eragrostis curvula* is well adapted to areas having 17 inches (432 mm) of precipitation or more (Ruyle and Young 1997) and well established stands persist with annual rainfall varying from 625 to 1075 mm in its natural communities of north central Tanzania (Cox et al 1988). When summer rainfall totals exceed 29.5 inches (750 mm), *E. curvula*'s plant production declines due to fungal infections, mites, nematodes, and plant competition (see authors in Cox et al. 1988). Mean minimum and mean maximum temperatures for *Eragrostis curvula* habitat is 10°C to 30°C (Cox et al. 1988). *Eragrostis curvula* is semi-hardy, moderately frost-resistant in southern areas; it most likely won't endure extended periods having temperatures below -10°F (-12.2°C) (Ruyle and Young 1997). From Walsh (1994): *Eragrostis curvula* grows well on a wide variety of non-saline, well-drained soils (Dahl and Cotter 1984), on coarse sands to fine clays (Soil Conservation Service 1972). It is adapted to and most persistent on sandy soils, growing well on sandy to sandy loams (Atkins and Smith 1967, Cox et al. 1988, Dahl and Cotter 1984).
Rationale: Invades at least three major ecological types in Arizona. In Arizona *E. curvula* reported from elevation ranges of 1500 to 1981 m (4921 to 6500 feet) (Cox et al. 1987, Knipe 1982, and Pase and Pond 1964 all in Walsh 1994). U.S. Forest Service used *E. curvula* for years at elevations above 5000 feet. It has been seeded all across the mountains of central and southern Arizona (D. Robinett, personal communication, 2004). Also see locations listed in question. 3.2. Common associates of weeping lovegrass include turbinella oak (*Quercus turbinella*), pointleaf manzanita (*Arctostaphylos pungens*), Pringle manzanita (*A. pringlei*), desert ceanothus (*Ceanothus greggii*), sugar sumac (*Rhus ovata),* skunkbush sumac (*R. trilobata*), hollyleaf buckthorn (*Rhamnus crocea),* Wright silktassel (*Garrya wrightii*), yellowleaf silktassel (*G. flavescens*), birchleaf mountain-mahogany (*Cercocarpus betuloides*), Mexican cliffrose (*Cowania mexicana*), and Lehmann lovegrass (*Eragrostis lehmanniana*) (Cable 1957, Davis 1989, Knipe 1982, Pond and Cable 1962 all in Walsh 1994).
Sources of information: See cited literature. Also considered information from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections; accessed June 21, 2004) and personal communication with D. Robinett (Rangeland Management Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Tucson, Arizona, 2004).

Question 3.2 Distribution *Score:* **C** *Doc'n Level:* **Obs.**
Describe distribution: Also noted in chaparral communities (Pond 1961), semi-desert grasslands (Judd and Judd 1976), and pinyon-juniper types in Arizona (Judd and Judd 1976, Voigt and Oaks 1985). Madrean woodlands and conifer forest (D. Robinett, personal communication, 2004). In Gila, Graham (Kearney and Peebles 1960), Coconino, and Yavapai Counties (McDougall 1973)
Rationale: From SEINet (2004): records have been collected from the following counties: Yavapai, Coconino, Gila, Graham, Pima, Cochise, Graham, Apache, Navajo, Santa Cruz. The following collection records were those that were not obviously found along the roads: 1. Beaver Creek (Stoneman Lake Road area) 2. Beaver Creek Watershed #1

3. Paradise Spring (Elden Mountain, Coconino County) along pipeline 4. Oak Spring (Elden Mtn, Coconino County) 5. Strawberry 6. Black Canyon on Mingus Mountain 7. APS site 15 miles east of Chino Valley 8. Oak Creek Canyon Switchbacks 9. Stocton Pass (9.5 miles east of Bonita) 10. Along Colorado River (122 river mile) in the Grand Canyon 11. Pine Valley/Jack's Canyon Wash (Sedona, Yavapai County) 12. Santa Cruz County, Sycamore Canyon, near Ruby, about 0.5 mile south of the Hank & Yank Springs entrance 13. Yavapai County, Lion Canyon, about 0.5 miles east of Weaver Creek, South Weaver Mountains, Yarnell 7.5' Quad 14. Santa Cruz County, Sycamore Canyon, W edge of Patagonia Mountains, along USFS-61, about 6 km east of National Forest boundary 15. Arizona, Santa Cruz County, about 2 miles SSE of Canelo in Coronado National Forest 16. Graham County, Jones Water Recreation Area-Crook National Forest 17. Gila County, U.S.Forest Service Experimental Area, Sierra Ancha Mountains 18. Gila County, Pinal Mountains, 12.8 miles south of Tonto National Forest boundary from Claypool along FR 651 at head of trail 193 19. Cochise County, Upper San Pedro River floodplain, Escapul Wash 20. Cochise County, Upper San Pedro River floodplain. Charleston Hills west, approximatey 1.5 miles north of Charleston Rd. approximately 20 miles west of San Pedro. Voucher for botanical inventory of San Pedro Riparian National Conservation Area. 21. Yavapai County, Munds Draw Quadrangle, northwest of Jerome, just west of Antelope Hills, 1.5 k southwest of Mormon Pocket Tank, Horseshoe Canyon, red sandstone canyon
Sources of information: See cited literature. Also considered information from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections; accessed June 21, 2004) and personal communication with D. Robinett (Rangeland Management Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Tucson, Arizona, 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: 1
Score : A

Note any related traits: From Walsh (1994): reproduces by seeds, primarily by apomixis although some sexual reproduction does occur (Voigt and Oaks 1985). If adequate moisture, *E. curvula* can reproduce in its first year of growth (Shoop and McIlvain 1970, Wasser 1982). Produces 300 to 1000 seeds per panicle (Phillips et al. 1991).

Weeping lovegrass reproduces by seeds; it does not have rhizomes or stolons (Atkins and Smith 1967). Weeping lovegrass produces tillers which grow outward from the edge of the clump. Dead stems prevent production of new tillers to the inside. After a few years without grazing or burning, the only live shoots in the decadent plant are in an outside ring enclosing dead material (Dahl and Cotter 1984). Although Stubbendieck at al. (1992 in Guertin and Halvorson 2003) suggest *E. curvula* reproduces by tillers, there is no discussion of quick spread of these vegetative structures.

A long period of grazing causes some plants in the pasture to be repeatedly grazed. Whenever a shoot is grazed or mowed so that little or no green leaves are left, it is forced to draw upon its stored food to grow new leaves. Continued frequent use of stored food can cause the plant to starve to death. This is the cause of most spot die-out in continuously grazed pastures (Shoop and McIlvain 1970).

Even though seeds are produced apomictically, pollination appears to be necessary for seed development; embryos failed to develop until several hours following anthesis. In field trials, seed set was equally as good under self-pollinating conditions as cross-pollinating (Streetman 1970).

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	**U**
	southwestern interior chaparral scrub	**C**
Desertlands	Great Basin desertscrub	
	Mohave desertscrub	
	Chihuahuan desertscrub	
	Sonoran desertscrub	
Grasslands	alpine and subalpine grassland	
	plains and Great Basin shrub-grassland	**U**
	semi-desert grassland	**C**
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	**U**
	Madrean evergreen woodland	**D**
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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