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)**:**	*Schismus arabicus* Nees; *Schismus barbatus* (Loefl. ex L.) Thellung (USDA 2005).
Synonyms:	*Schismus arabicus*: None listed in USDA (2005); *Schismus barbatus*: *Festuca barbata* Loefl. ex L. (USDA 2005).
Common names:	*Schismus arabicus*: Arabian schismus, Mediterranean grass; *Schismus barbatus*: Common Mediterranean grass, Mediterranean grass.
Evaluation date (mm/dd/yy)**:**	09/15/03
Evaluator #1 Name/Title:	Katy Brown
Affiliation:	The Nature Conservancy (Volunteer)
Phone numbers:	(520) 327−6862
Email address:	Pbrown5@mindspring.com
Address:	4357 E. Monte Vista, Tucson, Arizona 85712
Evaluator #2 Name/Title:	Dana Backer
Affiliation:	The Nature Conservancy
Phone numbers:	(520) 622−3861: ext. 3437
Email address:	dbacker@tnc.org
Address:	1510 E. Fort Lowell Rd., Tucson, Arizona 85719

List committee members:	09/19/03: D. Backer, C. Barclay, Katy Brown, P. Guertin, F. Northam, R. Parades, W. Sommers, J. Ward, P. Warren 03/01/05: D. Baker, D. Casper, J. Filar, E. Geiger, J. Hall, H. Messing, B. Munda, F. Northam
Committee review date:	09/19/03 and 03/01/05
List date:	09/19/03; revised 03/01/05 (addressed Consistency Review Panel comments)
Re-evaluation date(s):	

Taxonomic Comment

Schismus arabicus and *S. barbatus* are prevalent in parts of the Sonoran Desert and most of the Mohave Desert. These species are difficult to distinguish in the field and their taxonomic uniqueness is in question (P. Jenkins, University of Arizona Herbarium, personal communication, 1999 in Esque and Schwalbe 2002). These two *Schismus* species are often referred to together and will be treated collectively in this evaluation, with the exception of ecological amplitude (question 3.1).

Table 2. Scores, Designations, and Documentation Levels

Question		Score	Documentation Level	Section Scores	Overall Score & Designations
1.1	Impact on abiotic ecosystem processes	**B**	Reviewed scientific publication	**"Impact"** **Section 1 Score:** **B**	**"Plant Score"** **Overall Score:** **Medium** **Alert Status:** **None**
1.2	Impact on plant community	**A**	Reviewed scientific publication		
1.3	Impact on higher trophic levels	**C**	Observational		
1.4	Impact on genetic integrity	**D**	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:* **11 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	**C**	Other published material		
2.4	Innate reproductive potential	**A**	Reviewed scientific publication		
2.5	Potential for human-caused dispersal	**C**	Observational		
2.6	Potential for natural long-distance dispersal	**C**	Other published material		
2.7	Other regions invaded	**C**	Observational		RED FLAG **NO** Something you should know.
3.1	Ecological amplitude	**A**	Other published material	**"Distribution"** **Section 3 Score:** **A**	
3.2	Distribution	**A**	Observational		

Table 3. Documentation

Question 1.1 Impact on abiotic ecosystem processes *Score:* **B** *Doc'n Level:* **Rev. sci. pub.**
Identify ecosystem processes impacted: Provides increased fuel for fire and readily re-establishes after fire, creating a fuel/fire positive cycle. May also alter soil ecology.
Rationale: Fire: *Schismus* occupy spaces between shrubs (Brooks 1998) and individual plants can remain rooted and upright for up to two years following death, thus accumulating biomass that potentially contributes to increased frequency and fire extent (Brooks 1998, 1999, 2000; studies conducted in Mojave Desert). Esque 1999 (in Guertin and Halvorson 2003) states that "*Schismus barbatus* (and *S. arabicus*) are the primary species fueling desert wildfires in the upland habitats of the Mojave Desert, potentially threatening the biodiversity of the desert." (This is supported in Brooks and Esque 2002). Fires in the Sonoran Desert up to elevations of 3500 feet have been fueled to a large extent by non-native annual grasses, including *Schismus* (Esque and Schwalbe 2002). However, the Sonoran Desert rain pattern produces less winter rain than the Mojave Desert and the density of *Schismus* is not as great in the Sonoran area (relative to Mojave); as a result, the impact of *Schismus* by itself may have a lesser impact on the fire regime (Working Group discussion). However, the Working Group also noted that *Schismus* occurs with a suite of other non-native annuals in the Sonoran Desert, which in combination contribute to the ability to fuel fire and produce a continuous coverage of fuel. The role alien annual grasses can play in community change is well documented for the Great Basin Desert (Billings 1990); Esque and Schwalbe (2002) suggest *Bromus rubens* (red brome) and *Schismus* to be those species with the most potential in the Sonoran desert. Soil ecology: "…*Schismus barbatus* can use soil nitrogen at increased levels and at faster rates than the native species, inhibiting their growth rate; this may be due to the plant's increased consumption of soil water (Brooks 1998 in Brooks and Pyke 2000). It is not clear if this is a significant alteration of the soil ecology, or simply a competitive edge.
Sources of information: See cited literature and inference by the Working Group members.

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: Reduces the presence and germination of native annual plants and altars structure and composition. Long term effects are unknown.
Rationale: Displacement of native species by *Schismus* has not been documented (Brooks and Esque 2002). Brooks (2000) cites personal communications with Clarke (University of California, Riverside, 1998) that indicates *Schismus*, in arid and semi arid regions of California, had risen from relative obscurity to one of the dominant annual grasses during the 1940s, while the similar native annual grass, six-weeks fescue (*Vulpia octoflora*), became less common. Felger (2000) observed *Schismus* to form dense stands during years of favorable winter rains sometimes to the exclusion of native ephemerals. The first stems and leaves often spread out close to the ground, excluding or preventing other plants from sprouting (Guertin and Halvorson 2003). Brooks and Esque (2002) suggested densely packed *Schismus* seedlings and accumulated plant litter may inhibit germination of native annual plants as has been documented with other alien seedlings (Inouye 1980). After good rains, mass germination of *Schismus barbatus*, *Bromus rubens*, and *Hordeum murinum* produce dense stands that suppress other ephemerals (Burgess et al. 1991) Seed bank studies by Pake and Venable (1996) and Loria and Noy-Meir (1979–1980 in Gutterman 1996a, as cited in Guertin and Halvorson 2003) show that *Schismus* uses a seed banking strategy for survival through unfavorable times. During the study periods, numbers and percentage of *Schismus* seed in the seed bank increased (conditions were favorable), while the number of seed species in the seedbank went down. Germination studies show less than 25% germination rate for the seed per season.

Native desert plant communities are often poorly adapted to fire (Brooks and Esque 2002) and in some desert ecosystems fire is not a natural component (Humphrey 1974). This suggests that native annual plants, in particular native annual grasses, do not form the continuous fine fuel beds to facilitate fire. This is in contrast to *Schismus*, which forms continuous coverage of upright and rooted vegetation as discussed by Brooks (1998, 2000). Thus, it is inferred that the plant community structure and composition is being altered not only by the presence of *Schismus* but by introducing fire to non-fire adapted plant communities.

Because *Schismus* is one of the fastest-maturing desert annuals, proceeding from germination to reproduction faster than many other desert annuals (Szarek et al. 1982), it can effectively compete for limiting nutrients with native annual plants (Brooks 1998 in Brooks 2000). "…*Schismus barbatus* can use soil nitrogen at increased levels and at faster rates than the native species, inhibiting their growth rate; this may be due to the plant's increased consumption of soil water (Brooks 1998 in Brooks and Pyke 2000).

Sources of information: See cited literature. Also considered Working Group inference.

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

Identify type of impact or alteration: Impact on desert tortoise nutrition, health, and habitat.

Rationale: From Oftedal (2003): Tortoises have adapted to certain desert areas with an available plant diet sufficiently high in PEP (Potassium Excretion Potential), which is necessary to maintain health during times when sufficient water for drinking is not available. Oftedal hypothesizes that *Schismus,* based on its potential to out compete higher PEP value native plants during summer rainy seasons, causes an impact on desert tortoise nutrition and health due to the lower PEP value available. This agrees with Avery's hypothesis (2003) that exotic plant introductions lead to a reduction in food choices for desert tortoises and a nutrient imbalance due to the consumption of lower quality forage plants.

Schismus barbatus seeds are eaten by rodents (Brooks 1995 in Wilken and Hannah 1998). Leaves of *Schismus* (of low nutritional quality) and other plant parts are eaten by desert tortoises (Barboza 1995, Nagy et al. 1998 in Wilken and Hannah 1998, Oftedal et al. 2000). Brooks and Esque (2002) suggest the desert tortoise is one species threatened by altered fire regimes due to alien plant invasions.

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

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

Identify impacts: No known impact; no hybridization with natives.

Rationale: *Schismus arabicus* and *S. barbatus* produce viable hybrids with each other (Faruqi and Quraish 1979 in Guertin and Halvorson 2003), but no mention was found of hybridization with native species. There are no native *Schismus* in Arizona (Kearney and Peebles 1960).

Sources of information: See cited literature.

Question 2.1 Role of anthropogenic and natural disturbance in establishment *Score:* **B** *Doc'n Level:* **Other pub.**

Describe role of disturbance: Moderate invasive potential.

Rationale: Abundant where grazing, off-roach vehicle use, or construction of linear corridors—for example, right of ways—has reduced shrub cover and disturbed the soil (Brooks 2000). Wind and sheet flooding are primary dispersal mechanisms (Brooks 2000, Gutterman 2003 in Guertin and Halvorson 2003 [cited as In Press]). *Schismus* presence along roadsides and in arroyos/washes (Felger 1990 in Guertin and Halvorson 2003) suggests both natural and/or anthropogenic disturbance are required for establishment. Beatley (1966 in Esque and Schwalbe 2002) from work in Nevada suggests *Schismus* can invade and establish in relatively undisturbed communities. In Arizona it can self-seed in undisturbed habitats (Burgess et al. 1991).

Sources of information: See cited literature. Score based in part on inference from literature and personal observations of Working Group members.

Question 2.2 Local rate of spread with no management	*Score:* **B** *Doc'n Level:* **Obs.**
Describe rate of spread: Increases, but less rapidly than doubling in 10 years.	
Rationale: Due to competition with other annual plants (alien or non-native) and the dependence on seasonal rainfall, the local rate of spread is increasing but not doubling in less than ten years. Abundant by 1940s in Sonoran and Mojave deserts (Esque and Schwalbe 2002).	
Sources of information: See cited literature. Score based on inference from the literature.	

Question 2.3 Recent trend in total area infested within state	*Score:* **C** *Doc'n Level:* **Other pub.**
Describe trend: Stable.	
Rationale: *Schismus barbatus* was naturalized in central Arizona by 1931 (Felger 1990, Kearney 1931 in Burgess et al. 1991) and in southern Arizona by 1949 (Gould 1949 in Burgess et al. 1991). By the 1970s *Schismus* species were found in all of the desert counties of Arizona in great abundance (Esque and Schwalbe 2002). *Schismus arabicus* and *S. barbatus* are presently listed among the most abundant of annual plant species in the Lower Colorado River Valley subdivision of the Sonoran Desert and into the Arizona Upland subdivision (Burgess et al. 1991and Pake and Venable 1995 in Esque and Schwalbe 2002).	
Sources of information: See cited literature.	

Question 2.4 Innate reproductive potential	*Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Describe key reproductive characteristics: Winter germinating annual, self-pollinating, self-fertilizing; (Faruqi and Quraish 1979 in Guertin and Halvorson 2003) producing an average (in one study) of 112.4 seeds per plant (Loria and Noy-Meir 1979–1980 in Gutterman 1996a, as cited in Guertin and Halvorson 2003). Small seeds escape being eaten. Wind carries the seeds or blows the senesced plants, which drop seeds as they go. Seeds and plant parts carrying seeds are also dispersed by sheet water. Differentiated germination rates. Seed banking studies (Pake and Venable 1996) show that *Schismus* uses a seed banking strategy with a less than full germination rate per season. Whereas Pake and Venable (1996) did not specifically study the seed viability after 3 years, it is inferred that the seed will last that long as a survival strategy to survive drought years. It has been observed that *Schismus* reappears in an area after unfavorable years.	
Rationale: Seeds have been germinated after being stored two or more years (Gutterman papers [various] in Guertin and Halvorson 2003). Also see Worksheet A.	
Sources of information: See cited literature. Also considered inference by the Working Group members.	

Question 2.5 Potential for human-caused dispersal	*Score:* **C** *Doc'n Level:* **Obs.**
Identify dispersal mechanisms: None specifically cited.	
Rationale: No mention was made in the literature of specific human dispersal means; however, Brooks (2000) states that in areas of human disturbance, such as off road vehicle use, grazing or construction of linear corridors, *Schismus* abundance is higher. Seeds are small and are dispersed by water or when the senesced plant is blown about by wind.	
Sources of information: Score based on observations and inference from various Working Group members.	

Question 2.6 Potential for natural long-distance dispersal	*Score:* **C** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Wind and sheet water disperses seed, but may not be as far as 1 km on an occasional basis.	

Rationale: Different sizes of dispersal units (caryopsis, bracts, and spikelets) limit the distance that they can disperse from the parent. Plants are low to the ground and seeds become trapped in soil cracks. Larger "units" are trapped by other land features and litter, (Gutterman papers [various] in Guertin and Halvorson 2003).

Wind: "seed is often retained within the inflorescence, and will disperse when detached from the plant and is blown along the ground for short distances" (Brooks 2000). Drezner et al. (2001 in Guertin and Halvorson 2003) report that on the Hassayampa River Preserve in Arizona, *S. barbatus* is dispersed by animals but the mechanism was not stated.

Sources of information: See cited literature.

Question 2.7 Other regions invaded	*Score:* **C** *Doc'n Level:* **Obs.**
Identify other regions: No ecological types have been invaded outside of Arizona other than those that have already been invaded here.	
Rationale: Occurs only in ecological types already invaded in Arizona.	
Sources of information: Score based on information from various authors and Working Group members.	

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: *Schismus* grasses were first documented in Arizona (floodplain of Gila River, near Sacaton in 1926 (Felger 1990). *Schismus arabicus* was present in Arizona by 1933 with the first collection made at the Desert Laboratory in Tucson 1968 (Burgess et al. 1991).	
Rationale: By the 1970s *Schismus* species were found in all of the desert counties of Arizona in great abundance (Esque and Schwalbe 2002). *Schismus arabicus* and *S. barbatus* are presently listed among the most abundant of annual plant species in the Lower Colorado River Valley subdivision of the Sonoran Desert and into the Arizona Upland subdivision (Burgess et al. 1991 and Pake and Venable 1995 in Esque and Schwalbe 2002). *Schismus barbatus* reported in Mohave, Yavapi, Gila, Pinal, Maricopa, Yuma, Pima, and Santa Cruz counties (Gould 1951). Highly successful invaders in Sonoran and Mojave deserts (Burgess et al. 1991). Abiotic preferences: *Schismus* prefers sandy soils on desert sand flats (Kearney and Peebles 1960, Felger 1990). Occupy elevational range of 1000 to 4000 feet for *S. barbatus* and 1000 to 2500 for *S. arabicus* (Kearney and Peebles 1960). *Schismus arabicus*, but not *S. barbatus*, is found in dune habitat (Warren and Laurenzi 1987, Felger et al. 2003).	
Sources of information: See cited literature. Also considered personal observations by Working Group members.	

Question 3.2 Distribution	*Score:* **A** *Doc'n Level:* **Obs.**
Describe distribution: See question 3.1 and Worksheet B.	
Rationale: See question 3.1 and Worksheet B.	
Sources of information: See cited literature in question 3.1. Primarily considered personal observations by 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: Exact number of years of seed viability not known. Direct studies were not found, but studies using seed 2+ years old were found (Gutterman [various]; see other references). Pake and Venable (1996) show that *Schismus* uses a seed banking strategy.

Worksheet B. Arizona Ecological Types

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

Major Ecological Types	Minor Ecological Types	Code*
Dunes	dunes	**B** (*S. arabicus* only)
Scrublands	Great Basin montane scrub	
	southwestern interior chaparral scrub	
Desertlands	Great Basin desertscrub	
	Mohave desertscrub	**A**
	Chihuahuan desertscrub	**C**
	Sonoran desertscrub	**A**
Grasslands	alpine and subalpine grassland	
	plains and Great Basin shrub-grassland	
	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	
	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

Avery, H.W. 2003. Challenges to a changing plant community: food selectivity and digestive performance of desert tortoises fed native vs. exotic forage plants. Poster session: Ecology, Conservation, and Husbandry. Available at http://nytts.org/proceedings/posters.htm; accessed September 2003.

Barboza, P. 1995. Nutrient balances and maintenance requirements for nitrogen ad energy in desert tortoises (*Xerobates agassizii*) consuming forages. Comparative Biochemistry and Physiology 112:537–545.

Beatley, J.C. 1966. Ecological status of introduced brome grasses (*Bromus* spp.) in desert vegetation of southern Nevada. Ecology 47:548–554.

Billings, W.D. 1990. *Bromus tectorum*, a biotic cause of ecosystem impoverishment in the Great Basin. In G.M. Woodell (ed.), The earth in Transition: Patterns and Processes of Biotic Impoverishment. Cambridge University Press, Cambridge.

Brooks, M. 1995. Benefits of protective fencing to plant and rodent communities of the Western Mojave Desert, California. Environmental Management 19:65–74.

Brooks, M.L. 1998. Ecology of a Biological Invasion: Alien Annual Plants in the Mojave Desert. Doctoral dissertation. University of California, Riverside.

Brooks, M.L. 1999. Alien annual grasses and fire in the Mojave Desert. Madroño 46:13–19.

Brooks, M.L. 2000. *Schismus arabicus* Nees; *Schismus barbatus* (L.) Thell. Pages 287–291 in C.C. Bossard, J.M. Randall, and M.C. Hoshovsky (eds.), Invasive Plants of California's Wildlands. University of California Press, Berkeley.

Brooks, M.L., and D.A. Pyke. 2000. Invasive plants and fire in the deserts of North America. Pages 1–14 in K.E. Galley and T.P. Wilson (eds.), Proceedings of the Invasive Species Workshop: The Role of Fire in the Control and Spread of Invasive Species. Fire Conference 2000. The First National Congress on Fire Ecology, Prevention, and Management, Nov. 27-Dec. 1, 2000. Miscellaneous Publication No. 11. Tall Timbers Research Station, Tallahassee, Florida.

Brooks, M.L., and T.C. Esque, 2002. Alien plants and fire in desert tortoise (*Gopherus agassizii*) habitat of the Mojave and Colorado Deserts. Chelonian Conservation and Biology 4:330–340.

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.

Drezner, T.D., P.L. Fall, and J.C. Stromberg. 2001 Plant distribution and dispersal mechanisms at the Hassayampa River Preserve, Arizona, USA. Global Ecology and Biogeography 10:205–217.

Esque, T.C. 1999. Managing fire and invasive plants in the Mojave Desert: defining an integrated research program to address knowledge gaps. In Presentation Abstracts, Mojave Desert Science Symposium, February 25–27, 1999. U.S. Geological Survey, Western Ecological Research Center. Available online at: http://www.werc.usgs.gov/mojave-symposium/abstracts.html; accessed September 2003.

Esque, T.C., and C.R. Schwalbe. 2002. Alien annual grasses and their relationships to fire and biotic change in Sonoran desertscrub. Pages 165–194 in B. Tellman (ed.), Invasive Exotic Species in the Sonoran Region. The University of Arizona Press and the Arizona-Sonora Desert Museum, Tucson, Arizona

Faruqi, S.A., and H.B. Quraish. 1979. Studies on Libyan grasses. V. Population variability and distribution of *Schismus arabicus* and *S. barbatus* in Libya. Pakistan Journal of Botany 11:167–172.

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. 93 p.

Felger, R.S. 2000. Flora of the Gran Desierto and Rio Colorado of Northwestern Mexico. The University of Arizona Press, Tucson. 673 p.

Felger, R.S., D.S. Turner, and M.F. Wilson. 2003. Flora and vegetation of the Mohawk Dunes, Arizona. *Sida* 20:1155–1187.

Gould, F. 1949. Arizona plant records—II. Leaflets in Western Botany 5:167–170.

Gould, F.W. 1951. Grasses of the Southwestern United States. The University of Arizona Press, Tucson. 352 p.

Guertin, P., and W.L. Halvorson. 2003. Status of Fifty Introduced Plants in Southern Arizona Parks. U.S. Geological Survey, Sonoran Desert Research Station, School of Natural Resources, University of Arizona, Tucson. Available online at: http://sdrsnet.srnr.arizona.edu/index.php?page=datamenu&lib=2&sublib=13.

Gutterman, Y. 1996a. Temperatures during storage, light and wetting affecting caryopses germinability of *Schismus arabicus*, a common desert annual grass. Journal of Arid Environments 33:73–85.

Gutterman, Y. 2003. The inhibitory effect of Negev Desert loess soil on the fast germinating caryopses of *Schismus arabicus* (Poaceae). Journal of Arid Environments 54:619–631.

Humphrey, R.R. 1974. Fire in the deserts and desert grassland of North America. Pages 365–400 in T.T. Kozlowski and C.E. Ahlgren (eds.), Fire and Ecosystems. Academic Press, New York.

Inouye, R.S. 1980. Density-dependent germination response by seeds of desert annuals. Oecologia 6:235–238.

Kearney, T.H. 1931. Plants new to Arizona. Journal of the Washington Academy of Science 21:63–80.

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.

Loria, M., and I. Noy-Meir. 1979–1980. Dynamics of Some Annual Populations in a Desert Loess Plain, Israel Journal of Botany 28:211–225.

Nagy, K., B. Henen, and D. Vyas. 1998. Nutritional quality of native and introduced food plants of wild desert tortoises. Journal of Herpetology 32:260–267.

Oftedal, O.T., S. Hillard, and D. Morafka. 2000. Juvenile Desert Tortoises Enhance Nutritional Status by Foraging Choice: Data from the 1998 El Nino at the Fort Irwin Study Site. 25th Annual Meeting and Symposium of the Desert Tortoise Council, April 21–24, 2000. Abstracts.

Oftedal, O.T. 2003. Are Desert Tortoises Nutritionally Constrained by a Shortage of High PEP Plants, and if so, what do we do? 28th Annual Meeting and Symposium of the Desert Tortoise Council, February 21–23, 2003, Abstracts.

Pake, C. E., and E. L. Venable. 1995. Is coexistence in Sonoran Desert annual plants mediated by temporal variation in reproductive success. Ecology 76:246–261.

Pake, C.E., and D.L Venable. 1996. Seed banks in desert annuals: implications for persistence and coexistence in variable environments. Ecology 77:1427–1435.

Szarek, S.R., S.D. Smith, and R.D. Ryan. 1982. Moisture stress effects on biomass partitioning in two Sonoran Desert annuals. American Midland Naturalist 108:338–345.

[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.

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.

Warren, P.L., and A.W. Laurenzi. 1987 Rare Plant Survey of the Yuma District. Final report of P.O. No. AZ-950-PH6-0540, U.S. Bureau of Land Management, Yuma District Office.

Wilken, D., and L. Hannah. 1998. *Schismus arabicus* Nees (Poaceae) Mediterranean Grass; Santa Barbara Botanic Garden, for Channel Islands National Park. Available online at http://usgssrv/.usgs.nau.edu/swepic/factsheets/schismus_spp.pdf; accessed September 2003.

Other References of Interest Not Cited in the Text

Gutterman's citations are numerous and Guertin and Halvorson's (2003) review of Gutterman's work was referenced in some places in the text as a collection of Gutterman's work on *Schismus*. In addition to specifically cited papers, the following papers were reviewed by Guertin and Halvorson (2003):

Gutterman, Y. 1989. *Schismus arabicus*. In A.H. Halevy (ed.), CRC Handbook of Flowering. Vol. VI. CRC Press, Boca Raton, Florida. 753 p.

Gutterman, Y. 1993. Seed germination in desert plants. Springer-Verlag, Berlin. 253 p.

Gutterman, Y. 1994. Strategies for seed dispersal and germination in plants inhabiting deserts. The Botanical Review 60:373–425.

Gutterman, Y. 1996b. Effect of day length during plant development and caryopsis maturation on flowering and germination, in addition to temperature during dry storage and light during wetting, of *Schismus arabicus* (Poaceae) Journal of Arid Environments 33:439–448.

Gutterman, Y. 2000. Environmental factors and survival strategies of annual plant species in the Negev Desert, Israel. Plant Species Biology 15:113–125.

Gutterman, Y. 2001a. The drought tolerance of the dehydrated root of *Schismus arabicus* seedling and regrowth after rehydration, affected by caryopsis size, darkness and duration of dehydration. Israel Journal of Plant Sciences 49:123–128.

Gutterman, Y. 2001b. Phenotypic germination plasticity according to caryopsis size in *Schismus arabicus*, a common annual grass occurring in the Negev Desert of Israel. Seed Science Research 11:173–178.

Gutterman, Y., and G.P. Chapman. 1992. Ecophysiology of Negev upland annual grasses. Pages 145–162 in Desertified Grasslands: Their Biology and Management. Papers presented at an International Symposium, February 27 to March 1, 1991, London, England. Linnean Society Symposium Series No. 13. Academic Press, London, England.

Gutterman, Y., and M. Evanari. 1994. The influences of amounts and distribution of irrigation during the hot and dry season on emergence and survival of some desert winter annual plants in the Negev Desert of Israel. Israel Journal of Plant Science 42:1–14.