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)**:**	*Salsola collina* Pallas; *Salsola paulsenii* Litv.; *Salsola tragus* L. (USDA 2005).
Synonyms:	*Salsola collina*: None listed in USDA (2005); *Salsola paulsenii*: None listed in USDA (2005); *Salsola tragus*: *Salsola australis* R. Br., *Salsola iberica* (Sennen & Pau) Botsch. ex Czerepanov, *Salsola kali* L. ssp. *ruthenica* (Iljin) Soó, *Salsola kali* L. ssp. *tragus* (L.) Celak., *Salsola kali* L. ssp. *tenuifolia* Moq., *Salsola pestifer* A. Nels., *Salsola ruthenica* Iljin (USDA 2005).
Common names:	*Salsola collina*: Slender Russian thistle, spineless Russian thistle; *Salsola paulsenii*: Barbwire Russian thistle; *Salsola tragus*: Prickly Russian thistle, common Russian thistle, tumbling thistle, tumbleweed
Evaluation date (mm/dd/yy)**:**	08/23/03, 05/04, and 07/04
Evaluator #1 Name/Title:	Dr. Kathryn A. Thomas
Affiliation:	USGS, Southwest Biological Science Center
Phone numbers:	(928) 556–7327
Email address:	Kathryn.Thomas@usgs.gov
Address:	2255 N. Gemini Drive, Flagstaff, Arizona 86001
Evaluator #2 Name/Title:	Janice K. Busco
Affiliation:	U.S. Geological Survey
Phone numbers:	See above
Email address:	Janice.Busco@nau.edu
Address:	See above

List committee members:	08/26/03: W. Austin, D. Backer, R. Hiebert, L. Makarick, L. Moser, T. Olson, B. Phillips, K. Thomas, K. Watters 06/23/04: W. Albrecht, D. Backer, J. Brock, J. Busco, J. Hall, C. Laws, L. Moser, B. Phillips, K. Watters
Committee review date:	08/26/03 and 06/23/04
List date:	06/23/04
Re-evaluation date(s):	

Taxonomic Comment

Salsola tragus is the correct name for the widespread, narrow-leaved, weedy representative of the *S. kali* aggregate (Mosyakin 1996 and Rilke 1999 in Flora of North America Editorial Committee 2004). *Salsola tragus*, however, has been known in North American and European botanical literature under numerous names (for detailed synonymy see Mosyakin 1996 and Rilke 1999 in Flora of North America Editorial Committee 2004). *Salsola tragus* is an extremely polymorphic species consisting of several more or less distinct races (subspecies or segregate species). Several varieties may be recognized within *S. tragus*; many of them are just morphological variants of little or no taxonomic value (Flora of North America Editorial Committee 2004).

According to USDA (2005) and the Flora of North America Editorial Committee (2004), *S. kali* L. is comprised of the subspecies ssp. *kali* and ssp. *pontica* and does not occur in Arizona. In some references the name *Salsola kali* ssp. *tragus* has frequently been truncated to *S. kali* resulting in confusion; however, USDA (2005) identifies *S. kali* ssp. *tragus* as a synonym for *S. tragus*.

Some additional taxonomic confusion also is possible. For example, the name *S. kali* has often been misapplied to other species in this aggregate, *S. collina* has frequently been misidentified *as S. tragus*, and intermediate and possibly hybrid forms between *S. paulsenii* and *S. tragus* are common along margins of the range of the species and in secondary, synanthropic (human altered) localities (Flora of North America Editorial Committee 2004).

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	**B**	Other published material		
1.3	Impact on higher trophic levels	**D**	Reviewed scientific publication		
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:* **15 pts** **Section 2 Score:** **B**	
2.2	Local rate of spread with no management	**B**	Other published material		
2.3	Recent trend in total area infested within state	**C**	Observational		
2.4	Innate reproductive potential	**A**	Reviewed scientific publication		
2.5	Potential for human-caused dispersal	**A**	Other published material		
2.6	Potential for natural long-distance dispersal	**A**	Other published material		
2.7	Other regions invaded	**C**	Observational		RED FLAG **NO** Something you should know.
3.1	Ecological amplitude	**A**	Observational	**"Distribution"** **Section 3 Score:** **A**	
3.2	Distribution	**B**	Observational		

Table 3. Documentation

Note: All three *Salsola* species occurring in Arizona are evaluated collectively herein based on the assumption that they each behave ecologically similar in Arizona and that often the literature doesn't distinguish one species from another.

Question 1.1 Impact on abiotic ecosystem processes *Score:* **B** *Doc'n Level:* **Other pub.**
Identify ecosystem processes impacted: Hydrologic regime (streamflow) may be altered; fire size and frequency may be increased when the plant is present.
Rationale: Skeletons of plants can block stream channels (Morisawa 1999, Wallace et al. 1968); burns easily because stems arranged so much air circulation within plant (Young 1991 in Howard 1992), increases fuel load of an area by retaining original shape for some time before decomposing (Evans and Young 1970) and increases the rate of spread of fires when burning skeletons roll into unburned areas (Young 1991 in Howard 1992).
Sources of information: See cited literature.

Question 1.2 Impact on plant community composition, structure, interactions *Score:* **B** *Doc'n Level:* **Other pub.**
Identify type of impact or alteration: Competition with native plants probable, particularly in drought circumstances; can accelerate revegetation in certain circumstances; competes with agricultural plants for space, water, nutrients (Wallace et al. 1968). It has positive as well as negative effects; it will grow where no other plant species will (Howard 1992). Increases to dominant on Navajo Nation, Petrified Forest National Monument, Colorado River in drought years (documentation below in rationale). Can potentially be a vector for fire (Evans and Young 1970, Young 1991 in Howard 1992) thus changing plant communities that are not well-adapted to fire.
Rationale: Barbara Phillips (personal communication, 2004) reports, and Daniella Roth (personal communication, 2004) confirms, that during drought *Salsola* spp. are some of the only plants surviving in washes on the Navajo Nation. Kate Watters (personal communication, 2004) reports increase of *Salsola* spp. on the Colorado River with drought and disturbance and of individual populations along the Colorado River with and without control. Kathryn Thomas (personal observations, 2004) reports increase of *Salsola* spp. in monitoring plots at Petrified Forest National Monument in drought years. Fire ecology: Russian thistle aids in spreading fire. It burns easily because the stems are spaced in an arrangement that allows for maximum air circulation (Young 1991 in Howard 1992). In addition, dead plants contribute to fuel load by retaining their original shape for some time before decomposing (Evans and Young 1970). The rolling action of the plant spreads prairie wildfire quickly. Russian thistle colonizes a burn when off-site; abscised plants blow across it, spreading seed (Young 1991 in Howard 1992). Presence of Russian thistle on disturbed sites if topsoil present. Roots are readily invaded with mychorrhizal fungi which are pathogenic to root since association is not formed. Russian thistle declines while mychorrhizal fungi population increases and are present to augment successional species next moving into disturbed site (Allen and Allen 1988). Dead Russian thistle provides microshading for other establishing plant species (Grilz et al. 1988). Species in this family may get curly top virus as it is an alternate host for beet leafhopper that vectors curly-top virus of sugar beets, tomatoes, and curcurbits (DeLoach et al. 1986, CDFA 2004). Competitive with native plants (Morisawa 1999); although no specific studies cited for native plants, it is known competitor with agricultural plants for space, water, nutrients (Wallace et al. 1968). Impact on native plant populations may be more severe on sandy substrates and during drought (Thomas et al. 2003).

Sources of information: See cited literature. Also considered personal observations by K. Thomas (Vegetation Ecologist, U.S. Department of the Interior, U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, Arizona, 2004) and personal communications with B. Phillips (Zone Botanist, U.S. Department of Agriculture, Forest Service, Coconino, Kaibab, and Prescott National Forests, 2004), D. Roth (Botanist, Navajo Nation, Flagstaff, Arizona, 2004), and K. Watters (Research Technician, National Park Service, Southern Colorado Plateau Network, Flagstaff, Arizona, 2004).

Question 1.3 Impact on higher trophic levels *Score:* **D** *Doc'n Level:* **Rev. sci. pub.**
Identify type of impact or alteration: Negligible impact; causes no perceivable change in higher trophic level populations, communities or interactions.
Rationale: Minor component in bison, mule deer and elk diet (DeLoach et al 1986, Peden et al. 1974, Short 1979, USDA 1937), important prairie dog food (Bonham and Lerwick 1976), pronghorn show high preference for summer growth in years with high precipitation (Beale and Smith 1970), seeds eaten by granivorous birds, including scaled and Gambel's quail (Anderson and Ohmart 1984, DeLoach et al. 1986, Disano et al. 1984), small mammals consume seeds (DeLoach et al. 1986), provides hiding cover for small mammals, songbirds, upland game birds and waterfowl (Dittberner and Olson 1983), sage grouse have used it for nesting cover (Hulet et al. 1986), eaten by cattle and sheep (DeLoach et al 1986, Young 1991 in Howard 1992); can cause mouth ulcerations in young lambs and rain softened Russian thistle has laxative effect on livestock which can harm weakened animals (Cook et al. 1954, USDA 1937). Found in desert tortoise habitat in Mojave Desert (Brooks and DeFalco 1999); eaten by Gambel and scaled quail on the Santa Rita Experimental Range (Medina 2003).
Sources of information: See cited literature.

Question 1.4 Impact on genetic integrity *Score:* **D** *Doc'n Level:* **Other pub.**
Identify impacts: There are no known native *Salsola* species in North America. No known impact.
Rationale: No reference to genetic impacts to *Salsola* species. Hybridization occurs between *Salsola* species, but there are no native *Salsola* species in North America (Kearney and Peebles 1960, Flora of North America Editorial Committee 2004).
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 with natural and anthropogenic disturbance. This species can readily establish in areas with natural disturbance and colonizes burns from off site.
Rationale: Grazing, drought, and disturbed soil facilitates Russian thistle establishment. *Salsola* spp. are early successional species adapted to disturbed lands (Rutledge and McLendon 1996 [cited as 2002] in Guertin and Halvorson 2003, Thomas et al. 2003). *Salsola* spp. colonize burns from off site (Young 1991 in Howard 1992).
Sources of information: See cited literature.

Question 2.2 Local rate of spread with no management *Score:* **B** *Doc'n Level:* **Other pub.**
Describe rate of spread: Increasing but less rapidly than doubling in <10 years.
Rationale: Drought conditions in Arizona may be causing increase in populations (Thomas et al. 2003). Populations will naturally die out in areas with topsoil. *Salsola* spp. are also shade intolerant so they will die out if shaded (DeLoach et al. 1986, Allen and Allen 1988, Allen et al. 1989, and Grilz et al. 1988 in Howard 1992). Unknown population longevity in sandy soils and where plant species are more widely spread (Thomas et al. 2003). Increased seed germination and establishment with available soil nitrogen (Crompton and Bassett 1985). In Nevada pulses of nitrate-rich dust, synchronous with spring emergence, and other nutrient additions via aeolian dust may have stimulated invasion of dune-mantled

uplands by *S. paulsenii* (Blank et al 1999). Drought conditions in Arizona may be causing increase in populations (Thomas et al. 2003).
Sources of information: See cited literature.

Question 2.3 Recent trend in total range infested within state *Score:* **C** *Doc'n Level:* **Obs.**
Describe trend: Stable.
Rationale: *Salsola tragus was* first noted in Arizona in 1893 (Guertin and Halvorson 2003) and was well established by 1913 (Burgess et al. 1991 in Guertin and Halvorson 2003), was noted as common along northern Arizona railways in 1904 (Burgess et al. 1991). *Salsola paulsenii* was probably introduced to the far western United States between 1891 and 1913 and was collected near Barstow, California in 1913 (Beatley 1973). *Salsola collina* was collected in Kansas in 1923, but misidentified and subsequently reported for the first time in North America from Minnesota in 1938; reports for California are based based on specimens cited by S. Rilke (1999 in Flora of North America Editorial Committee 2004). The actual distribution of *S. collina* seems to be underestimated due to the common and constant confusion with atypical forms of *S. tragus. Salsola tragus* is an extremely polymorphic species consisting of several more or less distinct races (subspecies or segregate species). Several varieties may be recognized within *S. tragus*: however, these deviant forms are just morphological variants of little or no taxonomic value (Flora of North America Editorial Committee 2004).
Sources of information: See cited literature. Score based on inference drawn from the literature and Working Group consensus.

Question 2.4 Innate reproductive potential *Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Describe key reproductive characteristics: High reproductive potential. Large number of seeds produced, up to 250,000 per plant (Young 1991 in Howard 1992). Seeds do not have high viability: a year (Young 1991 in Howard 1992) to several years (Parker 1972 and Rutledge and McLendon 1996 [cited as 2002] in Guertin and Halvorson 2003). Seed germination from soil seed bank drops off sharply after first year and was not found to occur after year three in a four-year study in Canada (Crompton and Bassett 1985).
Rationale: See Worksheet A.
Sources of information: See cited literature.

Question 2.5 Potential for human-caused dispersal *Score:* **A** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Skeletons caught by vehicles, trains (Sauer 1988 in Guertin and Halvorson 2003); skeletons caught by fences; transported in ship ballast (Drezner et al 2001, Ridley 1930 in Guertin and Halvorson 2003) and contaminated crop seeds (Rutledge and McLendon 1996 [cited as 2002] in Guertin and Halvorson 2003).
Rationale: High, there are numerous opportunities for dispersal to new areas.
Sources of information: See cited literature.

Question 2.6 Potential for natural long-distance dispersal *Score:* **A** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: The skeletons of dead plants readily breaks at the plant stem and rolls across landscape with wind, dispersing seeds as it moves. Winged seeds also provide additional long distance dispersal mechanism. (Crompton and Bassett 1985).
Rationale: Frequent long-distance dispersal
Sources of information: See cited literature.

Question 2.7 Other regions invaded	*Score:* **C** *Doc'n Level:* **Obs.**
Identify other regions: It is difficult to determine the extent of each species invasion because species identifications are so muddled. Munz (1974 in Guertin and Halvorson 2003) first reported *Salsola paulsenii* from North America in 1968. Its current range is in California, Nevada, Utah, and Arizona. It may be expected in the future also in New Mexico and Texas (Flora of North America Editorial Committee 2004). According to Howard (1992), *Salsola tragus* is native to Eurasia and is distributed throughout most arid and semiarid regions of the world. In North America, Russian thistle occurs from British Columbia east to Labrador and south through the conterminous United States to northern Mexico (Hitchcock and Cronquist 1964, DeLoach et al 1986). It is most common in central and western regions of Canada and the United States and along the Atlantic and Gulf coasts. Limited southern and eastern inland populations occur along waste areas and railroad tracks (Young 1991 in Howard 1992). Russian-thistle is adventitious in Hawaii (St John 1973). From the Flora of North America Editorial Committee (2004 and references therein): *Salsola collina* was reported in North America for the first time from Minnesota. It was collected in Kansas in 1923, but misidentified. Later it was discovered in Colorado, Iowa and Missouri. Reports of *S. collina* for Arizona and New York are based on specimens cited by Rilke (1999). Its actual distribution seems to be underestimated due to the common and constant confusion with deviant forms of *S. tragus*. In the future, *S. collina* may be found to occur within the major portion of the present range of *S. tragus.*	
Rationale: *Salsola* spp. invade elsewhere, but only in ecological types already invaded within the state. These species have been within the state for over 100 years. Their ranges may be filled and all communities that can be invaded have been. Another line of thought, however, is that the extent of invasion may not be complete since continued disturbance and ongoing drought may be encouraging the species proliferation and spread (Guertin and Halvorson 2003).	
Sources of information: See cited literature. Score based on inference drawn from the literature.	

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: *Salsola* spp. have a broad ecological amplitude that probably includes all but the highest elevations within the state. *Salsola* spp. were introduced into the state over 100 years ago. As demonstrated in the literature, it is capable of establishing in many plant communities that are within a certain elevation. *Salsola* spp. are prevalent in disturbed areas. In addition to direct anthropogenic disturbances, in the southwest there are a number of natural disturbances that potentially favor *Salsola* spp. invasion into natural communities including drought, wind, and high grazing pressure. *Salsola tragus* was first noted in Arizona in 1893 (Guertin and Halvorson 2003) and was well established by 1913 (Burgess et al. 1991 in Guertin and Halvorson 2003). It was noted as common along northern Arizona railways in 1904 (Burgess et al. 1991). *Salsola tragus* is found in disturbed areas, roadsides, cultivated fields, coastal and riparian sands, semi-deserts, deserts, eroded slopes; 0 to 2500 m throughout North America (except the southeast). Parker (1972) lists *Salsola tragus* as occurring in chaparral (scrublands, more specifically southwestern interior chaparral scrub), grasslands, freshwater systems and woodlands (pinyon juniper and forests (yellow pine) in Arizona. *Salsola tragus* is found in the pinyon-juniper woodland on land in the Arizona strip administered by BLM (ERI 2003). *Salsola collina* was collected in Kansas in 1923, but misidentified and subsequently reported for the first time in North America from Minnesota in 1938; reports for California are based on specimens cited by Rilke (1999). *Salsola collina* is found in waste places, roadsides, railway areas, cultivated fields,	

disturbed natural and semi-natural plant communities, 100 to 2000 m elevation, with patchy distribution throughout northeastern and north central North America and patches within the four corners states. *Salsola paulsenii* was probably introduced to the far western United States between 1891 and 1913 and was collected near Barstow, California in 1913 (Beatley 1973). *Salsola paulsenii* is found in sandy soils, disturbed natural and semi-natural plant communities, semi-deserts, deserts, eroded slopes, sand dunes and sandy waste places at 0 to 1900 m in Arizona, California, Colorado, Nevada, and Utah (Flora of North America Editorial Committee 2004). *Salsola paulsenii* has been found on upland dunes that are not highly disturbed or degraded. Occurs within an *Achnatherum hymenoides, Psorothamnus polydenius* and *Atriplex confertifolia* community adjacent to a Lake Lahontan playa in Nevada since 1990 (Blank et al. 1999).
Rationale: Present in five major and seven minor ecological types and possibly occurs in more. See Worksheet B.
Sources of information: See cited literature. Score based on inference drawn from the literature and the observations of Working Group members. Also considered information for *S. paulsenii* from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections; accessed 2005).

Question 3.2 Distribution *Score:* **B** *Doc'n Level:* **Obs.**
Describe distribution: Russian thistle is known to occur in many ecological types; however, its distribution within each type has not been explicitly quantified. It is highly likely that it can occur in any of the ecological types within Arizona outside of tundra; however, the severity of infestation will likely differ depending upon local conditions.
Rationale: The Southwest Exotic Plant Mapping Program (SWEPIC 2003) database shows *Salsola* spp. distributed within eight major ecological types; however, data points are coarse and observations have not been made by the authors of this assessment (K. Thomas and J. Busco) and other Working Group members that document the presence of Russian thistle among wildland occurrences of three of these major ecological types: Non-Riparian Wetlands, Riparian, and Forests. No systematic survey of *Salsola* spp. has been made throughout the state to quantify all ecological types in which *Salsola* spp. occur, nor can any accurate estimate be made of the percentage of those ecological systems that are actually invaded. The percentage values in Worksheet B are estimates. Recent surveys in national parks indicate that *Salsola* spp. may be more prevalent than previously considered (SWEPIC 2003).
Sources of information: See cited literature. Also considered observations by K. Thomas (Vegetation Ecologist, U.S. Department of the Interior, U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, Arizona, 2004), J. Busco (U.S. Department of the Interior, U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, Arizona, 2004), and other 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: 0		
	Score : A		

Note any related traits: Main stems break at ground after senescence and roll with wind or get caught in mobile objects (i.e., trains), thus aiding dispersal.

Worksheet B. Arizona Ecological Types
(*sensu* Brown 1994 and Brown et al. 1998)

Major Ecological Types	Minor Ecological Types	Code*
Dunes	dunes	**D**
Scrublands	Great Basin montane scrub	
	southwestern interior chaparral scrub	**B**
Desertlands	Great Basin desertscrub	**B**
	Mohave desertscrub	
	Chihuahuan desertscrub	
	Sonoran desertscrub	**B**
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	**C**
	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

Allen, E.B., and M.F. Allen. 1988. Facilitation of succession by the nonmycothrophic colonizer *Salsola kali* (Chenopodiaceae) on a harsh site: effects of mycorrhizal fungi. American Journal of Botany 75:257–266.

Allen, M.F., E.B. Allen, and C.F. Friese. 1989. Responses of the non-mycotrophic plant *Salsola kali* to invasion by vesicular-arbuscular mycorrhizal fungi. New Phytologist 111:45–49.

Anderson, B.W., and R.D. Ohmart. 1984. Avian use of revegetated riparian zones. Pages 626–631 in R.E. Warner and K.M. Hendrix (eds.), California Riparian Systems: Ecology, Conservation, and Productive Management: Proceedings of a Conference. September 17–19, 1981, Davis, California. University of California Press, Berkeley.

Beale, D.M., and A.D. Smith. 1970. Forage use, water consumption, and productivity of pronghorn antelope in western Utah. Journal of Wildlife Management 34:570–582.

Beatley, J.C. 1973. Russian-thistle (*Salsola*) species in Western United States. Journal of Range Management 26:225–226.

Blank, R.R., J.A. Young, and F.L. Allen. 1999. Aeolian dust in a saline playa environment, Nevada, USA. Journal of Arid Environments 41:365–381.

Bonham, C.D., and A. Lerwick. 1976. Vegetation changes induced by prairie dogs on shortgrass range. Journal of Range Management 29:221–225.

Brooks, M.L., and L DeFalco. 1999. Exotic Plant Species in Desert Tortoise Habitat. In Twenty-Fourth Annual Meeeting and Symposium of the Desert Tortoise Council, March 5–8 1999. Available online at: http://www.deserttortoise.org/abstract/abstracts1999/sgabs3.html; accessed March 2004.

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. Madrono 38:96–114.

[CDFA] California Department of Food and Agriculture. 2004 Russian thistle (*Salsola* spp.). In E.A. Healy, S. Enloe, J.M. DiTomaso, B. Roberson, N. Dechoretz, S. Schoenig, P. Akers, L. Butler, and J. Garvin (eds.), Encycloweedia. University of California, Department of Vegetable Crops, Weed Science Program, Non-Cropland Weed Group, University of California Extension Service, Davis. Available online at:
http://www.cdfa.ca.gov/phpps/ipc/weedinfo/salsola.htm; accessed March 2004

Cook, C.W., L.A. Stoddart, and L.E. Harris. 1954. The nutritive value of winter range plants in the Great Basin as determined with digestion trials with sheep. Bulletin 372. Utah State University, Agricultural Experiment Station, Logan. 56 p.

Crompton, C.W. and L.G. Bassett. 1985. The biology of Canadian weeds. 65. *Salsola pestifer* A. Nels. Canadian Journal of Plant Science 65:379–388.

DeLoach, C.J., P.E. Boldt, H.A. Cjordo [and others]. 1986. Weeds common to Mexican and U.S. rangelands: proposals for biological control and ecological studies. Pages 49–68 in D.R. Patton, V. Gonzales, C.E. Medina, L. Alvin [and others] (technical coordinators), Management and Utilization of Arid Land Plants: Symposium Proceedings. February 18–22, 1985, Saltillo, Mexico. Gen. Tech. Rep. RM-135. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Dittberner, P.L., and M.R. Olson. 1983. The plant information network (PIN) data base: Colorado, Montana, North Dakota, Utah, and Wyoming. FWS/OBS-83/86. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC. 786 p.

Disano, J. B., W. Anderson, J.K. Meents, and R.D. Ohmart.1984. Compatibility of biofuel production with wildlife habitat enhancement. Pages 739–743 In R.E. Warner and K.M. Hendrix (eds.), California Riparian Systems: Ecology, Conservation, and Productive Management. University of California Press, Berkley.

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.

[ERI] Ecological Restoration Institute. 2003. Arizona Strip District Pinyon-Juniper Treatment Demonstration Project Environmental Assessment EA-AZ-010-03-14. Available online at: http://azwww.az.blm.gov/env_docs/old/pinyon_junip_ea.pdf; accessed March 2004.

Evans, R.A., and J.A. Young. 1970. Plant litter and establishment of alien annual weed species in rangeland communities. Weed Science 18:697–703.

Flora of North America Editorial Committee (eds.) 2004. Flora of North America North of Mexico. Volume 4. Magnoliophyta: Caryophyllidae, Part 1. Flora of North America Association, New York and Oxford. Available online at: http://www.efloras.org/volume_page.aspx?volume_id=1004, go to Chenopodiaceae, *Salsola*; accessed May 2004.

Grilz, P., L. Delanoy, and G. Grismer. 1988. Site preparation, seeding, nurse crop methods tested in dune restoration (Saskatchewan). Restoration and Management Notes 6:47–48.

Guertin, P., and W.L. Halvorson. 2003. Status of Fifty Introduced Plants in Southern Arizona Parks. U.S. Geological Surevy, 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; accessed November 2004.

Hitchcock, C.L., and A. Cronquist. 1964. Vascular plants of the Pacific Northwest. Part 2: Salicaceae to Saxifragaceae. University of Washington Press, Seattle. 597 p.

Howard, J.L. 1992. *Salsola kali*. In Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, Montana (Producer). Available online at: http://www.fs.fed.us/database/feis/; accessed July 2004.

Hulet, B.V., J.T. Flinders, J.S. Green [and others]. 1986. Seasonal movements and habitat selection of sage grouse in southern Idaho. Pages 168−175 in E.D. McArthur and B.L. Welch (compilers), Proceedings—Symposium on the Biology of *Artemisia* and *Chrysothamnus.* July 9−13, 1984, Provo, Utah. Gen. Tech. Rep. INT-200. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah.

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.

Medina, A. 2003. Gambel and scaled quail diets on the Santa Rita Experimental Range. Pages 133−140 M.P.McClaran, P.F. Ffolliott, and C.B. Edminster (technical coordinators), Santa Rita Experimental Range: 100 Years (1903 to 2003) of Accomplishments and Contributions. Conference Proceedings, October 30—November 1, 2003, Tucson, Arizona. RMRS-P-30. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, Utah.

Morisawa, T. 1999. Weed Notes: *Salsola kali*. The Nature Conservancy, Wildland Invasive Species Team. Available online at: http://tncweeds.ucdavis.edu/moredocs/salkal10.html; accessed March 2004.

Mosyakin, S. L. 1996. A taxonomic synopsis of the genus *Salsola* (Chenopodiaceae) in North America. Ann. Missouri Bot. Gard. 83:387−395.

Munz, P.A. 1974. A Flora of Southern California. University of California Press, Berkeley. 1086 p.

Parker, K.F. 1972. An Illustrated Guide to Arizona Weeds. The University of Arizona Press, Tucson, Arizona. 338 p.

Peden, D.G., G.M. Van Dyne, R.W. Rice, and R.M. Hansen. 1974. The trophic ecology of *Bison bison* L. on shortgrass plains. Journal of Applied Ecology 11:489−497.

Ridley, H.N. 1930. The Dispersal of Plants throughout the World. L. Reeve and Co., Ltd., Ashfork, Kent United Kingdom.

Rilke, S. 1999. Revision der Sektion *Salsola* s.l. der Gattung *Salsola* (Chenopodiaceae). Bibliotheca Botanica (Stuttgart) 149:1−190.

Rutledge, C.R., and T. McLendon. 1996. An Assessment of Exotic Plant Species of Rocky Mountain National Park. Department of Rangeland Ecosystem Science, Colorado State University. 97 p. Available online from the Northern Prairie Wildlife Research Center, Jamestown, North Dakota at: http://www.npwrc.usgs.gov/resource/othrdata/explant/explant.htm. (Version 15Dec98). Go to the Literature Review Summary Information for Remaining Exotic Species and then click on *Sasola iberica*. Accessed March 2004.

Sauer, J.D. 1988. Plant Migration: The Dynamics of Geographic Patterning in Seed Plant Species. University of California Press, Berkeley. 282 pp.

Short, H.L. 1979. Deer in Arizona and New Mexico: Their Ecology and a Theory Explaining Recent Population Decreases. General Technical Report RM-70. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 25 p.

St. John, H. 1973. List and Summary of the Flowering Plants in the Hawaiian Islands. Cathay Press Limited, Hong Kong. 519 p.

[SWEPIC] Southwest Exotic Plant Information Clearinghouse. 2003. Southwest Exotic Mapping Program database. Available online at: http://www.usgs.nau.edu/swepic/swemp/maps.html); accessed May 2004.

Thomas, K., B.D. Anderson, and R. Hunt. 2003. Petrified Forest National Park Weed Inventory and Mapping Project. Annual Report FY 2002. U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, Arizona. 52 p.

[USDA] U.S. Department of Agriculture, Forest Service. 1937. Range Plant Handbook. Washington, DC. 532 p.

[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.

Wallace, A., W.A. Rhods, and E.F. Frolich. 1968. Germination behavior of *Salsola* as influenced by temperature, moisture, depth of planting, and gamma irradiation. Agronomy Journal 60:76–78.

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.

Young, J.A. 1991. Tumbleweed. Scientific American 264:82–87.