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)**:**	*Melilotus alba* Medikus; *Melilotus officinalis* (L.) Lam. (USDA 2005)
Synonyms:	*Melilotus alba*: none identified in USDA (2005); *Melilotus officinalis*: *Melilotus albus* Medik., *Melilotus albus* Medik. var. *annuus* Coe (USDA 2005)
Common names:	*Melilotus alba*: white sweetclover; *Melilotus officinalis*: yellow sweetclover
Evaluation date (mm/dd/yy)**:**	06/15/2004
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Committee review date:	07/16/04
List date:	07/16/04
Re-evaluation date(s):	

Taxonomic Comment

Different authorities address the taxonomy of *Melilotus alba* and *M. officinalis* differently. The taxonomy followed here is that of USDA (2005), which identifies these two taxa as separate species.

Table 2. Scores, Designations, and Documentation Levels

Question		Score	Documentation Level	Section Scores	Overall Score & Designations
1.1	Impact on abiotic ecosystem processes	**C**	Other published material	**"Impact"** **Section 1 Score:** **C**	**"Plant Score"** **Overall Score:** **Medium** **Alert Status:** **None**
1.2	Impact on plant community	**C**	Other published material		
1.3	Impact on higher trophic levels	**D**	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:* **14 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**	Observational		
2.4	Innate reproductive potential	**A**	Other published material		
2.5	Potential for human-caused dispersal	**B**	Other published material		
2.6	Potential for natural long-distance dispersal	**A**	Observational		
2.7	Other regions invaded	**C**	Other published material		RED FLAG YES Something you should know.
3.1	Ecological amplitude	**A**	Other published material	**"Distribution"** **Section 3 Score:** **A**	
3.2	Distribution	**A**	Observational		

Red Flag Annotation

Melilotus spp. is invasive in a number of ecosystems/plant communities in Arizona. *Melilotus* spp. also may be used, however, in semiarid habitats in northern Arizona for reclamation purposes where it has been difficult to reestablish native species after disturbances such as fire. Once suitable native alternatives can be identified and successfully restored in these areas, use of *Melilotus* spp. for reclamation purposes should be discontinued.

Table 3. Documentation

Note: *Melilotus alba* and *M. officinalis* are being evaluated collectively because they are similar in the areas they invade, their impacts, reproductive biology, and physiology. They are indistinguishable except for their flower color. When the literatures refers to a specific species and not both collectively, it is noted in the Rationale section. If there are distinctions between these two species, these will be noted. Although much of the information was from Turkington et al. (1978), because this journal article is a summary article its documentation level will be considered as "Other published material."

Question 1.1 Impact on abiotic ecosystem processes *Score:* **C** *Doc'n Level:* **Other pub.**
Identify ecosystem processes impacted: Change in soil nutrients (nitrogen fixation) and potential to alter fire regime by adding fine fuels. Affect soil stabilization.
Rationale: *Melilotus albus* and *M. officinalis* both have root nodules, have a symbiotic relationship with *Rhizobium* bacteria (Turkington et al. 1978), and enrich soil nutrient levels of nitrogen (Sauer 1988). The plants have their highest nitrogen content in the fall while vegetative (Dunham 1933 in Turkington et al. 1978). Nitrogen enrichment, while important, is probably only a moderate factor and would be dependent upon the plant community it invades. In humid regions of western Canada, sweet clover has improved soil fertility and soil structure (Greenshields 1957 in Turkington et al. 1978). In addition to increasing available soil nitrogen, *M. officinalis* improves drainage, aerates the soil, and increases water absorption in heavy clay soils (Smith and Gorz 1965 in Sullivan 1992). Sweetclover is used for soil stabilization and erosion control on mine sites, road cuts, overgrazed rangeland, and following fires (see numerous authors in Sullivan 1992, Uchytil 1992). Because the species is annual or biennial, the accumulation of above ground biomass and fine fuel could alter fire regimes in some habitats (inference). Numerous studies on *M. alba* documented that fire stimulates germination (see Glenn-Lewin et al. 1990, Heitlinger 1975, and Kline 1986 all in Uchytil 1992). The season of burning plays a role in the mortality of both sweet clovers (see examples in Sullivan 1992, Uchytil 1992).
Sources of information: See cited literature. Also applied inference.

Question 1.2 Impact on plant community composition, structure, and interactions *Score:* **C** *Doc'n Level:* **Other pub.**
Identify type of impact or alteration: Changes composition, perhaps only on a short-term basis, and competes with native species for resources.
Rationale: Sweetclovers appear to have a negative impact on grain crops (primarily economical) and in prairies. It has been suggested that they may be more of an aesthetic problem than an ecological problem on prairie preserves in Minnesota (R. Johnson, Director of Stewardship, The Nature Conservancy, Minnesota Field Office, personal communication, 1987 in Eckhart 1987). Sweetclovers potentially displace native nitrogen fixers, in particular, plants like scurf pea (*Psoralia* spp.) and annual lupin (*Lupinus pusillus*) (W. Litzinger, personal observations, 2004). From Turkington et al. (1978): Sweetclovers are considered noxious in several states because they sometimes occurs as "an adulteration in other crops" (cited from York and Pammel 1919). Sweetclovers attract pollinators and may compete with native plants for pollinators. Competition for pollinators could potentially reduce the reproductive potential of native plants (inference). Sweetclovers do not persist in shaded sites. Isolated plants growing in partial shade are less vigorous than those in open areas and produce few seeds. This suggests that sweetclover populations require an open habitat and do not compete well as other species invade (inference). Sweetclovers can form dense stands along streambanks after disturbance (flooding), but sweet clovers are early successional and do not persist (discussion by Working Group, July 2004).

Sources of information: See cited literature. Also considered unpublished field observations by W. Litzinger (Professor, Prescott College, Prescott, Arizona, 2004), discussions by the Working Group, and inference.

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

Identify type of impact or alteration: Minor alteration to higher trophic levels. Provides cover for small mammals.

Rationale: Sweetclovers are an important honey bee forage plant and cultivated forms are planted for honey production. *Melilotus officinalis* is also attractive to other bee species and halictids and *M. alba* is attractive to a wider array of insects, including wasps and flies (Coe and Martin 1920 In Turkingtson et al. 1978). In several western states (Utah, Colorado, Wyoming, Montana, and North Dakato), *M. officinalis* and/or *M. alba* are good for cover for small mammals, birds, waterfowl, and ungulates such as deer and pronghorn (see numerous authors in Sullivan 1992 and Uchytil 1992).

In South Dakota, bison tend to avoid it while cattle consume it quite readily (M. Heitlinger, Director of Stewardship, The Nature Conservancy, Midwest Region, personal communication, 1987 in Eckardt 1987). Cattle, however, can develop a condition known as sweetclover disease (Greenshields 1957) from feeding on spoiled sweetclover hay (Turkington et al. 1978). Ridley (1930 in Guertin and Halvorson 2003) reports that *Melilotus* seeds have been recorded to be eaten by horses and birds and are found in dung and bird's coups.

Melilotus appears to have primarily positive impacts, though these impacts are not well-documented. As a result, the resultant score is negligible impact.

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

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

Identify impacts: No known hybridization.

Rationale: Natural interspecific hybrids in *Melilotus* are rare and most reports of natural hybrids are subject to doubt (Stevenson 1969 in Turkington et al. 1978). Sweetclovers in cultivation are varieties and not hybrids (Turkington et al. 1978). No native congeners 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: Sweetclovers invade human and natural disturbed habitats (particularly flooding). They quickly colonize open areas and require full sun (Turkington et al. 1978).

Rationale: *Melilotus alba* is an early colonizer of disturbed sites and will usually be eliminated in an area when perennial species come in (Turkington et al. 1978). Other researchers have detailed its persistence in many native and established tallgrass prairies; however, its abundance in these communities was probably due to periodic disturbance (fire) (Heitlinger 1975 and Kline 1986 both in Uchytil 1992).

Sources of information: See cited literature.

Question 2.2 Local rate of spread with no management *Score:* **B** *Doc'n Level:* **Obs.**

Describe rate of spread: As noted elsewhere, unless the habitat is maintained in an open condition, sweetclovers do not maintain populations because they require full sun (Turkington et al. 1978).

Rationale: Given the overall increase in disturbance in Arizona wildlands, it seems reasonable to infer that local populations of sweetclover are increasing, but probably not doubling in <10 years.

Sources of information: Based on Working Group discussion/observations.

Question 2.3 Recent trend in total area infested within state	*Score:* **C** *Doc'n Level:* **Obs.**
Describe trend: Stable	
Rationale: Sweetclovers do not seem to be expanding into new niches with the state. In recent times their distribution appears stable.	
Sources of information: Based on Working Group discussion/observations.	

Question 2.4 Innate reproductive potential	*Score:* **A** *Doc'n Level:* **Other pub.**
Describe key reproductive characteristics: From Turkington et al. (1978): Sweetclovers can be an annual or biennial, thus they reach reproductive maturity in less than two years. They can produce between 14,000 to 350,000 seeds per plant. Various studies showed seeds can remain viable for approximately 40 years. *Melilotus alba* is both self- and cross-pollinated (Barcikowska 1966, Gorz and Haskins 1971). It can flower any month of the year. *Melilotus alba* growing in the open with little competition produced 200,000 to 350,000 seeds and *M. officinalis* seldom produced more than 100,000 seeds (in Ontario; Coe 1917 cited in Heitlinger 1975).	
Rationale: See Worksheet A.	
Sources of information: See cited literature.	

Question 2.5 Potential for human-caused dispersal	*Score:* **B** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Moderate level; hay and seed contaminant; roadways; railways; hikers; waste areas.	
Rationale: From Turkington et al. (1978): Sweetclovers have been cultivated as a forage crop [early-mid 1900s] yet their use as a hay crop is restricted due to the coarseness of their stems (Stevenson 1937). Dispersed as a crop seed contaminant and in hay. In recent years, the overall use of sweetclover in North America has declined. Used for commercial seed production (Smith and Gorz 1965). Cultivated by beekeepers; sweetclover dispersion has probably been hastened by beekeepers (Heitlinger 1975).	
Sources of information: See cited literature.	

Question 2.6 Potential for natural long-distance dispersal	*Score:* **A** *Doc'n Level:* **Obs.**
Identify dispersal mechanisms: Frequent long-distance dispersal. Dispersed by wind, water, (Turkington et al. 1978) and animals (study at Hassayampa Preserve; Drezner et al. 2001).	
Rationale: From Turkington et al. (1978): Seeds can be blown over short distances (a few meters) by strong winds but rain wash and stream flow are probably much more important for dispersal. Seeds float. *Melilotus* can frequently move long distances by water along riparian systems (Working Group discussion).	
Sources of information: See cited literature. Also considered Working Group discussion and use of inference.	

Question 2.7 Other regions invaded	*Score:* **C** *Doc'n Level:* **Other pub.**
Identify other regions: No other ecological types besides those invaded in Arizona (based on information in Sullivan 1992 and Uchytil 1992).	
Rationale: Originating in Europe and Asia, sweetclovers are now cosmopolitan weeds throughout the temperate regions of the world (Sauer 1988). From Guertin and Halvorson (2003): *Melilotus albus* is native to Africa (northern Egypt, northern Libya), temperate Asia (Middle East to western Siberia and China), tropical Asia (India, Pakistan, Bhutan, Myanmar), and Europe (GRIN 2000). *Melilotus officinalis* is native to temperate Asia (Middle East to	

eastern Siberia and western China), tropical Asia (northern India, northern Pakistan), and Europe (GRIN 2000).

Melilotus albus was entered into the 1739 'Flora Virginica' by Gronovius (Stevenson 1969 in Turkington et al. 1978). *Melilotus officinalis* was introduced into North America in the 18th century as a forage crop (Sullivan 1992).

Sources of information: See cited 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: First collection record in Arizona based on records in SEINet (2004):

Melilotus alba: Coconino County, Camp Junipine, Oak Creek Canyon. July 1935. Although there is a record from 1910 in Flagstaff, there is no other info.

Melilotus officinalis: Coconino County, SW Forest Experimental Station near Flagstaff October 1929 and in a natural area [L.N. Goodding] Coconino County, Jacob Reservoir, Kaibab Plateau, August 1948.

From Turkington et al. (1978): Both *M. alba* and *M. officinalis* are adapted to a wide range of climatic conditions. They have long taproots and are drought tolerant and winter hardy, but cannot withstand prolonged flooding. *Melilotus alba* is somewhat more tolerant to standing water than *M. officinalis* and is occasionally found on gravelly, open river banks subject to periodic flooding. Sweetclovers are found on a wide range of soil types and textures from clay and loam to dune sand and river gravel. *Melilotus alba* is found most commonly on calcareous soils (Dunham 1933). Both *M. alba* (Shestakov and Vladimirov 1973) and *M. officinalis* (Lavado and Nella 1972) are apparently salt tolerant. They can also grow on soils of moderately low fertility (Smith and Gorz 1965).

Rationale: Sweetclovers appear to have broad ecological amplitudes and occur within a number of ecological types in Arizona. Known locations in Grand Canyon National Park (from Makarick 1999):

Melilotus alba:
South Rim – Common and abundant along roadsides and in waste places.
North Rim – Cape Royal.

Melilotus officinalis:
South Rim – Common along the roadsides and in disturbed areas.
North Rim – Greenland Lake
Inner Canyon – Roaring Springs, Havasu Canyon
Inner Gorge – Common along the river from Lees Ferry to Vaseys Paradise (RM 32).
Inner Canyon – Scattered locations

SEINet (2004) included only records within the last 9 years. Did not include any records that specifically stated roadside. These records are:

Melilotus alba: floodplain of Upper San Pedro (SPRNCA; Cochise Co.); Lower San Pedro River near Cooks Lake (Pinal Co.); near Springs in Tonto National Forest (Maricopa Co); long Verde River on the Verde Ranch (Yavapai Co.); Whiskey Creek (Apache Co.); West Fork of Oak Creek Canyon within wilderness area of Red Rock/Secret Mt. (Coconino NF).

Melilotus officinalis: few records for *M. officinalis* were collected within the last 9 years. Those that were collected within that time period are primarily the same as the collections for *M. alba* and include Seven Springs Wash in Tonto National Forest, West Fork of Oak Creek Canyon including within the wilderness area, in Ramsey Canyon of the Huachuca Mountains. Some records prior to 1995 applicable to either of the two species include: Sierra Wilderness Area (near Hunt Spring, Tonto NF); Weaver Creek; Silver Spur Meadow at mouth of Bonita Canyon in Chiracahua NM; top of Signal Peak; Turkey Flat in Pinaleno Mountains; Sycamore Canyon Wilderness; Roaring Springs Canyon, Grand Canyon NP; Audubon Research Ranch; Southwest Research Station in Cave Creek, Ciricauhua Mtns; and Moonshine Springs in Sheridan Mountains, Prescott.
Sources of information: See cited literature. Also considered personal observations by W. Litzinger (Professor, Prescott College, Prescott, Arizona, 2004) and SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections; accessed July 14, 2004).

Question 3.2 Distribution	*Score:* **A** *Doc'n Level:* **Obs.**
Describe distribution: Sweetclovers appear to be widespread and common throughout the ecological types where they occur in Arizona.	
Rationale: No specific information is available, but observations of occurrences, at least in the northern Arizona region, indicate that at the minimum sweetclovers are commonly found throughout the ecological types in the region.	
Sources of information: Personal observations by W. Litzinger (Professor, Prescott College, Prescott, 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: 9 Total unknowns: 0

Score : A

Note any related traits:

Worksheet B. Arizona Ecological Types

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

Major Ecological Types	Minor Ecological Types	Code*
Dunes	dunes	
Scrublands	Great Basin montane scrub	**C**
	southwestern interior chaparral scrub	**C**
Desertlands	Great Basin desertscrub	**C**
	Mohave desertscrub	
	Chihuahuan desertscrub	
	Sonoran desertscrub	
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	**A**
	montane wetlands	
	playas	
Riparian	Sonoran riparian	**A**
	southwestern interior riparian	**A**
	montane riparian	**B**
Woodlands	Great Basin conifer woodland	**B**
	Madrean evergreen woodland	**C**
Forests	Rocky Mountain and Great Basin subalpine conifer forest	
	montane conifer forest	**D**
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

Barcikowska, B. 1966. Self-fertility and inbreeding depression in white and yellow sweet clover (*Melilotus albus* Desr. and *Melilotus officinalis* (L.) Desr.). Genetica Polonica 7:1–11.

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.

Coe, H.S. 1917. Sweetclover: growing the crop. Farmer's Bulletin 797. U.S. Department of Agriculture.

Coe, H.S., and J.N. Martin. 1920. Sweet-clover seed. Bulletin 844. Part 2. U.S. Department of Agriculture.

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 Biogeograpghy 10:205–217.

Dunham, R.S. 1933. Effect of method of sowing on the yield and root and top development of sweetclover in the Red River Valley. Journal of Agricultural Research 47:979–995.

Eckardt, N. 1987. *Melilotus alba* (white sweetclover) and *Melilotus officinalis* (yellow sweetclover). Element Stewardship Abstract. The Nature Conservancy. Available online at: http://tncweeds.ucdavis.edu/esadocs/documnts/melialb.html; accessed July 2004.

Gorz, H.J., and F.A. Haskins. 1971. Cross-fertilization in *Melilotus alba*. Crop Science 11:767–768.

Greenshields, J.E. 1957. Sweet clover in western Canada. Publication 998. Canadian Department of Agriculture, Ottawa, Ontario. 14 p.

[GRIN] Germplasm Resources Information Network (online database). 2000. United States Department of Agriculture, Agricultural Research Service, National Genetic Resources Program, National Germplasm Resources Laboratory, Beltsville, Maryland. Available online at: http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl.

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; accessed November 2004.

Glenn-Lewin, D.C., L.A. Johnson, T.W. Jurik [and others]. 1990. Fire in central North American grasslands: vegetative reproduction, seed germination, and seedling establishment. Pages 28–45 in S.L. Collins and L.L.Wallace (eds.), Fire in North American Tallgrass Prairies. University of Oklahoma Press, Norman.

Heitlinger, M.E. 1975. Burning a protected tallgrass prairie to suppress sweetclover, *Melilotus alba* Desr. Pages 123–132 in M.K. Wali (ed.), Prairie: A Multiple View. University of North Dakota Press, Grand Forks.

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.

Kline, V.M. 1986. Response of sweet clover (*Melilotus alba* Desr.) and associated prairie vegetation to seven experimental burning and mowing treatments. Pages 149−152 in G.K. Clambey and R.H. Pemble (eds.), The Prairie: Past, Present and Future: Proceedings, 9th North American Prairie Conference.July 29 to August 1, 1984, Moorhead, Minnesota. Tri-College University Center for Environmental Studies, Fargo, North Dakota.

Lavado, R.S., and J.C. Nella. 1972. Modifications to a saline-alkaline soil after 2 years of cropping with forage species. Idia 291:77−80.

Makarick, L.J. 1999 Draft Exotic Plant Plan for Grand Canyon National Park. National Park Service, Grand Canyon National Park, Arizona.

Ridley, H.N. 1930. The Dispersal of Plants Throughout the World. L. Reeve and Co., Ltd., Ashford, Kent. 744 p.

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

Shestakov, I.L., and P.M. Vladimirov. 1973. Salt tolerance of cultivated plants and kinetics of uptake of ash elements during the reclamation of saline soils in Moldavia. Pages 279−284 in Voprosy soleustoĭchivosti rasteniĭ. Tashkent, Uzbek, SSR, 'Fan'.

Smith, W. K., and H.J. Gorz. 1965. Sweetclover improvement. Advances in Agronomy 17:163−231.

Stevenson, G.A. 1969. An agronomic and taxonomic review of the genus *Melilotus* Mill. Canadian Journal of Plant Science 49:1−20.

Stevenson, T.M. 1937 Sweet clover studies on habit of growth, seed pigmentation and permeability of the seed coat. Sci. Agric. 17:627−654.

Sullivan, J. 1992. *Melilotus officinalis*. In Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Intermountain Fire Science Laboratory Missoula, Montana (producer). Available online at http://www.fs.fed.us/database/feis/plants/forb/meloff/all.html; accessed June 2004.

Turkington, R. A., P.B. Cavers, and E.A. Rempel. 1978. The Biology of Canadian weeds. 29. *Melilotus albus* Desr. And *Melilotus officinalis* (L.) Lam. Canadian Journal of Plant Sciences 58:523−537.

Uchytil, R. 1992. *Melilotus alba*. In Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Intermountain Fire Science Laboratory Missoula, Montana (producer). Available online at http://www.fs.fed.us/database/feis/plants/forb/meloff/all.html; accessed June 2004.

[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.

York, G.W., and L.H. Pammel. 1919. Sweet clover a weed. Amer. Bee J. 59:412–413.

Other References of Interest Not Cited in the Text

McDougell, W.B. 1973. Seed Plants of Northern Arizona. Northern Arizona Society for Science and Art, Flagstaff, Arizona.

Olson, W.W. 1975. Effects of controlled burning on grassland within the Tewaukon National Wildlife Refuge. Master's thesis. North Dakota University of Agriculture and Applied Science, Fargo. 137 p.

Stevens, O.A. 1932. The number and weight of seeds produced by weeds. American Journal of Botany 19:784–794.