

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):	<i>Euphorbia esula</i> L. (USDA 2005)
Synonyms:	None identified at the species level by USDA (2005).
Common names:	Leafy spurge
Evaluation date (mm/dd/yy):	05/07/04
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Committee review date:	06/23/04 and 10/22/04
List date:	6/23/04; revised 10/22/04
Re-evaluation date(s):	

Table 2. Scores, Designations, and Documentation Levels

Question		Score	Documentation Level	Section Scores	Overall Score & Designations
1.1	Impact on abiotic ecosystem processes	A	Other published material	<p>“Impact”</p> <p>Section 1 Score:</p> <p>A</p>	<p>“Plant Score”</p> <p>Overall Score:</p> <p>High</p> <p>Alert Status:</p> <p>Alert</p>
1.2	Impact on plant community	A	Reviewed scientific publication		
1.3	Impact on higher trophic levels	B	Reviewed scientific publication		
1.4	Impact on genetic integrity	U	Other published material		
				<p>“Invasiveness”</p> <p><i>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:</i></p> <p>19 pts</p> <p>Section 2 Score:</p> <p>A</p>	<p>Something you should know.</p>
2.1	Role of anthropogenic and natural disturbance	A	Other published material		
2.2	Local rate of spread with no management	A	Observational		
2.3	Recent trend in total area infested within state	B	Observational		
2.4	Innate reproductive potential	A	Other published material		
2.5	Potential for human-caused dispersal	A	Other published material		
2.6	Potential for natural long-distance dispersal	A	Other published material		
2.7	Other regions invaded	B	Other published material		
				<p>“Distribution”</p> <p>Section 3 Score:</p> <p>C</p>	
3.1	Ecological amplitude	B	Observational		
3.2	Distribution	D	Observational		

Table 3. Documentation

Note: Leafy spurge (*Euphorbia esula*) is well-studied in the Great Plains and Rocky Mountain geographic areas, where ecological impacts have been documented. Because extensive populations of this species have not gained a foothold in Arizona, a majority of the sources used in this document are from other western states. Although these studies were conducted outside of Arizona, the Working Group found the reported observations and trends compelling.

Question 1.1 Impact on abiotic ecosystem processes	Score: A Doc'n Level: Other pub.
<p>Identify ecosystem processes impacted: Deep, penetrating root system could potentially alter water table levels depending on local hydrology. Oils in the plant cause leafy spurge burn hot, which could affect natural fire regimes. It is suspected that leafy spurge alters soil chemistry by the production of alleopathic chemicals.</p>	
<p>Rationale: Leafy spurge is a long-lived perennial herb with an extensive root system. Seedling roots without competition can penetrate to depths of 3 feet and 40 inches laterally in four months. Mature root systems can reach depths of 26 feet and lateral rooting extends at a rate of 15 feet per year. Infestations with stem densities of 1,000 plants per square yard are not uncommon (Butterfield and Strubbendieck 1999).</p> <p>From Hirsch and Leitch (1998): As the vegetation cover changes from more diverse (on Conservation Reserve Program land in ND) to less diverse, increased soil erosion will result. "No research or case study describing a functional relationship between leafy spurge and water runoff and soil erosion exist, so an assumption was made by others (Leistriz et al. 1993) to quantify the overall effect. A leafy spurge monoculture would conservatively reduce the soil and water conservation benefits of post Conservation Reserve Program vegetation cover by 25% (Leistriz et al. 1993).</p> <p>Leafy spurge has no historic fire regime in North America, because of this fact, leafy spurge may alter fire intensity within the communities where it occurs. Leafy spurge contains 7 to 9 % oil, which produces nearly as much energy (7758 BTUs per pound (4306 kcal/kg)) as wood when combusted. In the Arizona ecotypes of alpine and subalpine grasslands, and montane conifer forests where leafy spurge occurs, the presence of this plant could have the potential to increase the intensity of fire, thus negatively affecting native vegetation not adapted to burn as intensely (Davis 1990 in Simonin 2000).</p> <p>A Montana study found that litter from leafy spurge did not effect native seed germination, but had subtle effects on growth of native grass seedlings, which may indicate that it has an unknown effect on soil properties (Butterfield and Stubbendieck 1999, Olson and Wallander 2002).</p> <p>Sources of information: See cited literature.</p>	

Question 1.2 Impact on plant community composition, structure, and interactions	Score: A Doc'n Level: Rev. sci. pub.
<p>Identify type of impact or alteration: Leafy spurge is extremely competitive for resources, forming monospecific stands and displacing native vegetation in many cases (Hirsch and Leitch 1998).</p>	
<p>Rationale: <i>Euphorbia esula</i> presents a management problem because it is a long-lived, aggressive perennial weed that tends to displace all other vegetation in pasture, rangeland, and native habitats (see Hirsch and Leitch 1998). Yield reductions of desirable forage species associated with stands of leafy spurge have been reported to decrease from 10 to 100% (Reilly and Kaufman 1979). Infestations with stem densities of 1,000 plants per square yard are not uncommon (Butterfield and Strubbendieck 1999). Forbs and grasses in natural areas overtaken by leafy spurge may be completely displaced in a few years if the infestation is left unchecked (Butterfield and Strubbendieck 1999). The western prairie fringed orchid (<i>Platanthera praeclara</i> Sheviak and Bowles) is a threatened species of the tallgrass prairie. Invasion by leafy spurge is a serious threat to western prairie fringed orchid habitat (Kirby et al. 2003).</p>	
<p>Sources of information: See cited literature.</p>	

<p>Question 1.3 Impact on higher trophic levels</p>	<p>Score: B Doc'n Level: Rev. sci. pub.</p>
<p>Identify type of impact or alteration: Leafy spurge changes vegetation structure of native species that provide habitat and forage for wildlife, resulting in decreased use by ungulates and declines in nesting success with bird species. Leafy spurge plants produce milky sap which irritates the mouth and digestive tract of livestock and even causes death. It also is a nectar source for many species of insects. Documentation on the effects of leafy spurge outbreaks are not available for Arizona, as this species has not infested large areas in our state. Information on impacts to wildlife was taken from studies in other western states where leafy spurge populations are causing considerable problems for livestock and wildlife.</p>	
<p>Rationale: A study in Theodore Roosevelt National Park in North Dakota, showed that leafy spurge infestations had significant impacts on forage values for bison, deer and elk, as bison and deer used leafy spurge infested areas 83% and 70% less than non-infested sites, respectively (Trammell and Butler 1995). A study by Scheiman et al. (2003) examined nest densities and success rates on grassland sites in North Dakota and found that nest densities of some species were lowest on highly infested sites, yet overall, leafy spurge presence did not affect nest site selection. However, the study did show that nesting success was negatively affected by spurge cover. Leafy spurge infestations cause structural changes in vegetation and alter resource availability affecting bird community composition.</p>	
<p>The presence of leafy spurge influences foraging behavior of cattle as studies show cattle prefer foraging in areas without heavy infestations (Lym and Kirby 1987). Leafy spurge irritates the mouth and digestive tract of cattle. The milky latex, distributed throughout the plant, is a gastric irritant that may produce death in cattle (Caesar et al. 1993). Based on these studies involving livestock and data on ungulates from Theodore Roosevelt National Park (Trammell and Butler 1995), leafy spurge infestations are replacing native forage that is unable to be utilized.</p>	
<p>Leafy spurge is palatable to goats and sheep, but the degree to which leafy spurge provides forage for livestock and wildlife was examined by the U.S. Fish and Wildlife Service in the western states of Montana, North Dakota, Utah, and Wyoming (Dittberner and Olson 1983). The degree of use by horses and cattle in all four states was poor, and use by pronghorn, elk, mule deer, and white-tailed deer was poor with the exception of white-tailed deer populations in North Dakota, which used leafy spurge a fair amount. The same authors examined the degree to which leafy spurge provides cover for wildlife, small mammals and small nongame birds and found leafy spurge cover was good for pronghorn in North Dakota, and poor for pronghorn and elk in Utah and North Dakota; good for mule deer in North Dakota and poor mule deer in Utah; good for white-tailed deer in North Dakota; fair for small mammals in Utah; and poor for those in Wyoming. Cover value was poor for both small non-game birds and upland game birds in Utah.</p>	
<p>Leafy spurge reduces wildlife habitat benefits, affecting the kinds and numbers of animals the land can support (Wallace 1991 in Hirsch and Leitch 1998). Flowers of leafy spurge are insect pollinated. The flowers produce copious amounts of pollen and nectar. A survey in Saskatchewan showed 8 orders, 39 families, and 60 species of insects on the flowers of leafy spurge (Best et al. 1980).</p>	
<p>Sources of information: See cited literature.</p>	

<p>Question 1.4 Impact on genetic integrity</p>	<p>Score: U Doc'n Level: Other pub.</p>
<p>Identify impacts: Impacts of leafy spurge hybridization with natives in the same genus are unknown.</p>	
<p>Rationale: Leafy spurge may be confused with a native spurge, <i>Euphorbia lurida</i>, which grows in Apache, Coconino, Yavapai, Greenlee, Graham, Cochise, and Pima Counties. There are several other native species of Euphorbia in Arizona and genetic impacts are unknown.</p>	
<p>Sources of information: Kearney and Peebles (1960).</p>	

Question 2.1 Role of anthropogenic and natural disturbance in establishment	<i>Score: A Doc'n Level:</i>
Other pub.	
Describe role of disturbance: Leafy spurge often dominates bottomlands, flood plains, and riverbanks. It is primarily found in pastures, abandoned cropland, and in areas disturbed by development, yet also invades sites that are undisturbed.	
Rationale: This species can establish independent of any known natural or anthropogenic disturbance. Results from a study in Theodore Roosevelt National Park found that leafy spurge is able to invade sites within the wilderness area of a national park that received relatively little anthropogenic disturbance (Rabie 2002). Grazing lands, recreation areas, and wildlife areas are infested with leafy spurge (in North Dakota; Messersmith and Lym 1990 in Hirsch and Leitch 1998).	
Sources of information: See cited literature; also see Lajeunesse et al. (1999), Hirsch and Leitch (1998), and DiTomaso (2000).	
Question 2.2 Local rate of spread with no management	<i>Score: A Doc'n Level: Obs.</i>
Describe rate of spread: Leafy spurge populations in Arizona are increasing, but less rapidly with management over the last 5 years. A 1990 survey found 44,000 acres in Colorado infested with leafy spurge. In 2002 the Colorado Department of Agriculture conducted a follow-up survey and found more than 73,800 infested acres of leafy spurge. Leafy spurge infestations now cover more than 1.1 million hectares in the northern Great Plains and the intermountain West. The rate of spread doubled every 10 years for the past 30 years (Wallace et al. 1992); infestation doubled in size in 10 years when left unchecked (in North Dakota; Leitch et al. 1994).	
Rationale: Leafy spurge continues to spread at an estimated rate of 8 to 14 percent per year in the intermountain West (Whitson 1998).	
Sources of information: See cited literature. Also considered personal communication with L. Moser (Botanist, U.S. Department of Agriculture, Forest Service, Coconino National Forest, Flagstaff, Arizona, personal observations from 1999 to the present on the Coconino National Forest, communicated 2004). Working Group members decided that their was enough evidence from other locations to infer the rate of spread of leafy spurge would double in <10 years in Arizona in the absence of management.	
Question 2.3 Recent trend in total area infested within state	<i>Score: B Doc'n Level: Obs.</i>
Describe trend: Increasing, but less rapidly that doubling its range in <10 years.	
Rationale: Arizona's infested areas are located in Coconino and Apache Counties, which may be at the southern edge of leafy spurge's range. According to some sources, leafy spurge can spread rapidly as evidenced by the doubling of the acreage infested by leafy spurge in North Dakota from 1973 to 1982, a period of 9 years (reported in Biesboer [1996] without citation). Leafy spurge has been referred to as an "ecological generalist," with a range of environmental tolerances, which could allow for its spread to continue south to the Mogollon Rim. Observations from L. Moser (personal communication, 2004), report a leafy spurge infestation at Broliar Park near Mormon Lake expanding to the south 1 to 2 miles in the last two years.	
Sources of information: See cited literature. Also considered information from the Western Weed Coordinating Committee website (available online at: http://weedcenter.org/wwcc/docs/projects2001.html ; accessed May 2004). Score based on personal communication with L. Moser (Botanist, U.S. Department of Agriculture, Forest Service, Coconino National Forest, Flagstaff, Arizona, 2004) and Working Group discussion.	
Question 2.4 Innate reproductive potential	<i>Score: A Doc'n Level: Other pub.</i>
Describe key reproductive characteristics: Leafy spurge reproduces via seed and vegetatively from shoots arising from root buds.	
Rationale: Although most seed production is the result of cross-pollination, self-pollination can produce viable seed in great numbers. One study estimated that within one dense patch of leafy spurge, 2500	

seeds were produced in a single square meter of land. Seeds in soil remain viable 5 to 8 years. Despite the potential for great amounts of seed production, vegetative reproduction is the primary means by which this species takes over an area. Plants rarely produce flowers the first year unless there is a lack of competition from other plants (Butterfield and Stubbendieck 1999).

From Biesboer (1996): Fruits ripen and seeds are dispersed from mid- to late-July in the United States. The number of seeds produced per stalk varies from 252 seeds in habitats where spurge competes with native grasses to about 200 seeds where spurge competes with annual weeds and crested wheatgrass (Selleck et al. 1962). Seed yield can be very high. In Saskatchewan, leafy spurge patches were calculated to produce 24 to 3400 lbs of seed per acre (Selleck et al. 1962).

Seeds of leafy spurge have a rather high germination rate of 60 to 80% (Bakke 1936, Bowes and Thomas 1978). Seed may remain dormant for about 5 to 8 years following maturity, but 99% of the germination occurs within the first two years (Selleck et al. 1962). The optimal temperature for germination is 30 to 32 C.

Sources of information: See cited literature, also see Lajeunesse et al. (1999).

Question 2.5 Potential for human-caused dispersal *Score: A Doc'n Level: Other pub.*

Identify dispersal mechanisms: Seeds and root fragments are spread in mud on equipment, motorbikes, or regular vehicles. Leafy spurge is a contaminant in crop seed, feed grain, and hay. Sheep graze leafy spurge and are capable of spreading the seed in their fleece and feces.

Rationale: There are numerous opportunities for dispersal to new areas. Sheep can pick up leafy spurge seed in their fleece and will consume and pass viable seed. However, viability of seed recovered from feces was highly variable and almost always lower than seed collected in the field. Despite reduced seed numbers and viability, sheep have the potential to spread leafy spurge and should be managed accordingly (Olsen et al. 1997).

Sources of information: See cited literature; also see Lajeunesse et al. (1999).

Question 2.6 Potential for natural long-distance dispersal *Score: A Doc'n Level: Other pub.*

Identify dispersal mechanisms: Dispersal via animals or abiotic mechanisms is frequent; animals, water.

Rationale: From Biesboer (1996 and references cited therein): The seeds are forcibly ejected from the capsules and can travel up to 15 yards from the parental plant. The seed may be ejected up to 4.6 m from the parent and distributed fairly uniformly from 0.3 to 4.0 m from the plant. The seeds can also float and initial infestations often occur along stream or river banks where seeds have floated into appropriate habitat. Birds have been implicated in spreading seed but documentation is limited except for sharptail grouse.

Also spread on feet or fur of animals, including sheep. Viable seed is transported in dung of sheep, goats, rodents, birds and somewhat by whitetail deer that ingest the mature plants (Blockenstein et al. 1987, Olsen et al. 1997).

Sources of information: See cited literature; also see Lajeunesse et al. (1999).

Question 2.7 Other regions invaded *Score: B Doc'n Level: Other pub.*

Identify other regions: Leafy spurge was introduced to North America as an ornamental in 1829, and by as early as the 1900s infestations had spread to the west coast of North America. *Euphorbia esula* is presently a major economic concern in the northwestern and north-central states of the United States and in the adjacent prairie regions of the provinces of Canada. States with the greatest infestations include Colorado, Idaho, Minnesota, Montana, Nebraska, North Dakota, Oregon, South Dakota, Wisconsin, and

Wyoming (Biesboer 1996). It is found from 1300 to 2880 m in Utah (Welsh et al. 1987). A 2002 survey found that leafy spurge infests 78,000 acres of land in Colorado.
Rationale: Leafy spurge invades riparian habitats that are not yet invaded in Arizona.
Sources of information: See cited literature; also see Simonin (2000) for information about habitats from which leafy spurge is known to occur. Also considered information in The Atlas of the Vascular Plants of Utah (available online at: http://www.gis.usu.edu/Geography Department/utgeog/utvatlas/ut-vascatlas.html ; accessed May 2004) and the Colorado State County Extension website (available online at: http://www.ext.colostate.edu/pubs/natres/03107.html ; accessed May 2004).

Question 3.1 Ecological amplitude	<i>Score: B Doc'n Level: Obs.</i>
Describe ecological amplitude, identifying date of source information and approximate date of introduction to the state, if known: There are only four records in Arizona herbaria of <i>Euphorbia esula</i> . The earliest one was collected in 1970 in Coconino County, 1/4 mile S. of Big Springs Ranger Station, Kaibab National Forest.	
From Lajeunesse et al. (1999) and Biesboer (1996): Leafy spurge is well adapted to many habitat types ranging from riparian to dry hillsides. <i>Euphorbia esula</i> occurs primarily in untilled, non-cropland habitats, which include disturbed and undisturbed sites such as abandoned cropland, pastures, rangelands, woodlands, prairies, roadsides, and wastelands. It is tolerant of a wide range of habitats and may occur in rich damp soils such as on the banks of streams or on extremely nutrient poor, dry soils typified by the rangelands of the west. It is most aggressive in semi-arid situations where competition from associated species is less intense. For this reason, infestations generally occur and spread rapidly on dry hillsides, dry prairies, or rangelands. In Colorado it is known leafy spurge has become a serious weed in most western states because it tolerates a broad range of growing conditions. It is often associated with open habitats and is equally at home on dry sandy soils as on moist heavy clays. The plants tend to occur on all soils but tend to grow most rapidly in course- textured soils.	
Rationale: This species invades only two major ecological types in Arizona at this time.	
Sources of information: See cited literature. Also considered information from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections ; accessed October 2004) and observations by Working Group members.	

Question 3.2 Distribution	<i>Score: D Doc'n Level: Obs.</i>
Describe distribution: Only one general area of infestation is known in the Flagstaff region, and it is located on Forest Service land at Broliar Park beyond Mormon Lake. Approximately 25 to 35 acres remain infested at this site. Leafy spurge is reported from the Big Springs area of the North Rim and in Kaibab National Forest near Grandview.	
Rationale: Distribution is limited at this time in Arizona.	
Sources of information: Northern Arizona Weed Council database (available online at: http://www.infomagic.net/~tnc/weedcouncil/database.htm ; accessed May 2004), SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections ; accessed October 2004), and Western Weed Coordinating Committee website (available online at: http://weedcenter.org/wwcc/docs/projects2001.html ; accessed May 2004). Score based on observations in Arizona.	

Worksheet A. Reproductive Characteristics

Complete this worksheet to answer Question 2.4.

Reaches reproductive maturity in 2 years or less	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Dense infestations produce >1,000 viable seed per square meter	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	2 pt.
Populations of this species produce seeds every year.	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Seed production sustained for 3 or more months within a population annually	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Seeds remain viable in soil for three or more years	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	2 pt.
Viable seed produced with <i>both</i> self-pollination and cross-pollination	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Has quickly spreading vegetative structures (rhizomes, roots, etc.) that may root at nodes	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Fragments easily and fragments can become established elsewhere	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	2 pt.
Resprouts readily when cut, grazed, or burned	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Total pts: 10			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	
	southwestern interior chaparral scrub	
Desertlands	Great Basin desertscrub	
	Mohave desertscrub	
	Chihuahuan desertscrub	
	Sonoran desertscrub	
Grasslands	alpine and subalpine grassland	D
	plains and Great Basin shrub-grassland	
	semi-desert grassland	
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	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).

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