

TAG PETITION 04-05 (<http://www.aphis.usda.gov/ppq/permits/tag/petition.html>)

Title: Proposed Host Specificity Plant List for Testing Potential Biological Control Agents of Kudzu

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Targeted Weed: *Pueraria montana* var. *lobata* (Willd.) Maesen & S. Almeida
= *Pueraria lobata* (Willd.) Ohwi
Common name: Kudzu
This weed is targeted for the first time

Proposed Agents: None proposed yet (host test list only)

Studies will be conducted in China at the Chinese Academy of Sciences, Beijing (Jianghua Sun) and in the U.S. at the USDA-ARS Quarantine Laboratory in Newark, DE (J. Hough-Goldstein) and at the North Carolina Department of Agriculture and Consumer Services Beneficial Insects Laboratory Quarantine in Cary, NC (K. Kidd).

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Abstract:

This host plant list is to notify TAG of our intent to begin a biological control program for the control of kudzu. Kudzu is a recognized noxious weed and is considered a potential target for biological control. After a thorough review of the known scientific information on this weed, we have identified 50 native and 9 introduced plants that we recommend be tested in addition to kudzu to determine the potential risk of a candidate biological control agent, and have provided our rationale and justification for their selection. When a potential biological control agent is identified for kudzu, we foresee selecting plants from this list for host specificity testing. By submitting this list, we are not necessarily recommending that all the listed plants be tested for every potential biological control agent.

I. Introduction

Nature of the Problem

1. History of Introduction and Spread

Pueraria montana var. *lobata* (kudzu) was introduced to the Southeastern United States in 1876 as an ornamental at the Plant Exhibition of the Philadelphia Centennial Exposition. Kudzu was soon found to be useful not only as an ornamental, but also for forage and as a cover crop for erosion control (Stevens, 1976). At the turn of the century, kudzu was available through mail order catalogs and was actively planted for many years. In the 1940s, the U.S. Government was offering \$8 per acre as an incentive for farmers to plant kudzu. By 1946, about 3 million acres had been planted on farms (Everest et al., 1991; Pieters, 1932). However, kudzu soon became unmanageable and escaped cultivation, invading wastelands, road and power line rights-of-way, and natural and industrial forest sites. By the 1950s, kudzu was widely recognized as a problem. In 1953, the USDA removed kudzu from the list of cover plants permissible under the Agricultural Program and stopped advocating its use. Finally, in 1970, the USDA listed kudzu as a common weed in the South. In 1993, kudzu was listed in a report by Congress as one of the most harmful non-indigenous plant species in the United States (US Congress, 1993).

2. Present Distribution in North America

The present distribution of kudzu in North America includes the following states: Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Hawaii, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, and West Virginia (USDA-NRCS, 2004; Watson, 1989). Kudzu has also been reported in Washington State near Vancouver and in Douglas and Clackamas Counties in Oregon (Haubrich, 2001; Invaders Database, 2004).

3. Sectors Affected and Magnitude of the Problem

By the early 1990s, kudzu was estimated to infest seven million acres (Everest et al., 1991), although other estimates are lower (e.g. Corley et al., 1997, 2 million acres). The heaviest infestations are in the Southeastern United States, especially in Alabama, Georgia, and Mississippi. Infested land types include forests, parks, farms, rights-of-way, and city and metropolitan areas (Everest et al., 1991).

4. Consensus that Weed is a Suitable Target for Control

The following states list kudzu as noxious and/or quarantined (USDA-NRCS, 2004): Florida, Illinois, Kansas, Missouri, Oregon, Pennsylvania, Texas, Washington, and West Virginia. However, it should be noted that many state noxious weed lists are not very inclusive and often do not list species that are known to be problems. Kudzu is certainly a problem in states where it is not listed, and is recognized as an undesirable invasive plant pest throughout the South (Munger, 2002). Kudzu's ability to quickly overgrow and crush or smother even fully mature trees has made it the most important forest weed in the Southeast (Everest et al., 1991).

Proposed Action

After a thorough review of the known scientific information on this weed, we are submitting a list of plants that might be at risk if a biological control agent were to be released, along with our rationale and justification for their selection. When potential biological control agents for kudzu are imported into the U.S., we foresee selecting plants from this list for host specificity testing based on the availability of resources and the biology of the agent. For example, if the potential biological control agent required tap-rooted plants for development, we would select tap-rooted plants from the list for our host specificity tests. We recommend testing the more closely related plant taxa first and expanding the tests as resources allow. By submitting this list, we are not necessarily recommending that all the listed plants on this list be tested for every potential biological control agent. Your comments on the accuracy and thoroughness of this list would be appreciated.

II. Target Weed Information

Taxonomy of the Target Weed

1. Classification

Pueraria montana var. *lobata* (Willd.) Maesen & S. Almeida = *Pueraria lobata* (Willd.) Ohwi belongs to the Fabales order, Fabaceae family, Papilionoideae subfamily, Phaseoleae tribe, Glycininae subtribe, and *Pueraria* genus.

2. Identifier

According to Ward (1998a), kudzu in the United States should bear the name *Pueraria montana* var. *lobata* (Willd.) Maesen & S. Almeida, but *Pueraria lobata* (Willd.) Ohwi currently remains a legitimate name as well. Improper synonyms include *Dolichos hirsutus* Thunb., *Dolichos lobatus*

Willd., *Neustanthus chinensis* Benth., *Pachyrhizus thunbergianus* Siebold & Zucc., *Pueraria hirsuta* (Thunb.) C. Schneider, *Pueraria lobata* var. *thomsonii thomsonii* (Benth.) Maesen, and *Pueraria thunbergiana* (Siebold & Zucc.) Benth.

3. Problems in Identification or Taxonomy

For decades the Asian leguminous vine known as kudzu bore the name *Pueraria lobata* (Willd.) Ohwi. A revision of the genus *Pueraria* by Maesen (1985) resulted in 17 recognized species. Of these only the familiar kudzu, *Pueraria lobata* (Willd.) Ohwi, was of widespread distribution outside of Asia. *Pueraria lobata* was renamed *P. lobata* var. *lobata* (Willd.) Maesen in reference to its lobed leaflets, although this trait is also sometimes present in the other varieties. In addition to *P. lobata* var. *lobata*, two other taxa which occur throughout southeastern Asia were recognized as varietally distinct: *Pueraria lobata* var. *montana* (Lour.) Maesen and *Pueraria lobata* var. *chinensis* (Ohwi) Maesen and Almeida. Maesen found the three varieties to be highly variable but adequately separated by flower and fruit characteristics, primarily differences in size. Later, Almeida reviewed Maesen's study, and determined that the use of *lobata* for the specific epithet of these varieties was in violation. The correct specific epithet was determined to be *montana*. As now corrected, kudzu in the southeastern United States should bear the name *Pueraria montana* var. *lobata* (Willd.) Maesen & S. Almeida, but *Pueraria lobata* (Willd.) Ohwi currently remains a legitimate name as well (Ward, 1998a). Recent genetic work suggests that the species (now varieties) formerly known as *P. montana* and *P. lobata* can be separated using randomly amplified polymorphic DNAs (RAPDs, Jewett et al., 2003) and intersimple sequence repeats (ISSR) analysis (J. Sun et al., unpublished data). These authors suggest that in fact these entities may be separate species, with *P. lobata* the species present in the US. However, because *P. montana* var. *lobata* is the name listed in the USDA, ARS, National Genetic Resources Program Online Database (USDA-ARS, 2002), we will use this name in the present petition.

4. Origin and Location of Herbarium Specimens and Date of Depository

We have not undertaken a survey of herbaria to determine the extent of kudzu specimens. However, germplasm of *Pueraria montana* var. *lobata* is maintained at the Southern Regional Plant Introduction Station (USDA-ARS, 2002).

Description of the Target Weed

Kudzu is a perennial, clonal, semi-woody, trailing or climbing deciduous vine with large trifoliate leaves. The leaf stalks and stems are covered with rusty-brown hairs. The vine is supported by large, fibrous, starchy, tuberous roots that can reach depths of 18 feet. Kudzu's flowers are purple and fragrant. Seeds are formed in flattened pods covered with long, rusty-brown hairs.

Taxonomically Related Plants and Their Distributions

Although there are about 17 species of *Pueraria* native to Asia, there are no *Pueraria* native to North America (Lackey, 1981; Ward, 1998a; USDA-NRCS, 2004). In addition to *P. montana* var. *lobata*,

Pueraria phaseoloides (Roxb.) Benth. has been introduced to the United States and is found in Hawaii, Puerto Rico, and the Virgin Islands (Kartesz and Kartesz, 1980; USDA-NRCS, 2004).

Distribution of the Target Weed

1. Native Range and Areas of Introduction

Kudzu is thought to have originated in China (Shurtleff and Aoyagi, 1977). Its native range is also considered to include Japan, Korea, Taiwan, Thailand, Vietnam, Indonesia, Malaysia, Papua New Guinea, Phillipines, Fiji, New Caledonia, Solomon Islands, Tonga, and Vanuatu (USDA-ARS, 2002). Kudzu has been widely introduced and is now naturalized in Queensland, Australia, parts of South America, South Africa, and the United States (Holm et al., 1979; USDA-ARS, 2002).

2. Present Distribution and Area of Potential Spread in North America

States in the U.S. in which kudzu has been reported are listed on p. 4. Kudzu is continuing to spread northward, and in China is found at latitudes similar to Maine. Westward range expansion is currently limited by drought during seedling establishment. Northward range expansion is limited by the low temperature sensitivity of overwintering stems (Sasek and Strain, 1990). However, although leaves and young stems are highly frost-sensitive, older stems are able to withstand cold winters (Sorrie and Perkins, 1988). Thus, there appears to be no biological reason why kudzu could not survive in California, Washington, Oregon, and other northern states. While some predict that kudzu may not become troublesome in the northern and western states (Sorrie and Perkins, 1988), others predict the continuing increase in the atmospheric CO₂ concentration may allow kudzu to exert increased ecological influence both northward and westward (Sasek and Strain, 1990).

3. Genetic Variability of Kudzu

Pappert et al. (2000) studied the genetic variability and clonal diversity in 20 Southeastern U.S. populations using 14 allozyme loci. Within the U.S. range of kudzu, over 92% of the loci were polymorphic and overall genetic diversity was 0.29. Such high levels of genotypic diversity indicate that local sites are often colonized by several propagules (most likely seeds) and/or that sexual reproduction occurs within populations after establishment. An excess of heterozygosity was observed in populations with few unique genets, implying that selection for highly heterozygous individuals may occur in populations of kudzu. Such high levels of genetic diversity are consistent with multiple introductions over an extended period of time. Jewett et al. (2003) used randomly amplified polymorphic DNAs (RAPDs) on plants from 4 sites in the U.S. and 9 sites in China, with the Chinese sites including 2 populations of *P. thomsonii* (also known as *P. montana* var. *chinensis* or var. *thomsonii* [Ward, 1998b]), and one population of *P. montana* (or *P. montana* var. *montana*). As in Pappert et al. (2000), the U.S. populations in this study were again found to demonstrate considerable genetic variation. Sun et al. (manuscript in prep.) used ISSR analysis on kudzu (called *P. lobata* in this study) from 19 U.S. states, and from 2 populations in China. Also included from China were 3 populations of *P. thompsoni*, 5 populations of *P. montana*, and single populations of two other Chinese *Pueraria* species. This study showed genetic differentiation among the five species in China but low differentiation (but high overall genetic diversity) among the 19 U.S.

populations. The U.S. populations were most similar to two *P. lobata* populations in China; however there was overall high genetic differentiation between Chinese and American samples, as expected because the source of kudzu in the U.S. is Japan, not China.

4. Habitats/Ecosystems Where Weed is found in North America

Kudzu is typically found in open, disturbed areas such as abandoned fields, roadsides, and forest edges (Munger, 2002). It is relatively shade intolerant (Carter and Teramura, 1988). Kudzu is present in all federal park and forest lands in the south, except in Central Florida. Kudzu will grow on a wide range of soil types but does best on deep, loamy soils (as opposed to light sands or heavy clay soils).

Life History of the Target Weed

The large, fibrous, starch-laden roots of kudzu allow plants to rapidly regrow in spring or after being cut, often at the rate of up to 10 inches/day and 60 ft/yr (Shurtleff and Aoyagi, 1977). In older patches, these roots can reach a depth of 18 ft and weigh 200 to 300 lbs., allowing kudzu to obtain moisture for growth when other species cannot. Vines and roots grow from a root crown that is positioned on the soil surface. Vines can spread in all directions, rooting every few feet from the nodes to form new plants. Mature stands usually have a plant every 1 to 2 sq. ft. and may contain tens of thousands of plants per acre. Kudzu can spread by seed, vine cuttings, or transplanted root crowns. Kudzu seeds show physical dormancy, and will not germinate until the seed coats are made permeable to water (Susko et al. 1999, 2001). Thus, like many other species in the Fabaceae, kudzu probably has long-lived seeds that can develop a persistent seedbank. Under natural temperature and moisture conditions in North Carolina, a small percentage of intact seeds were found to germinate from spring through fall, with only about 11% of seeds germinating during the first growing season (Susko et al., 2001). A variety of methods were successful in breaking dormancy in the laboratory, including mechanical and chemical scarification and exposure to moist and dry heat treatments. The authors suggest that in nature, long exposure to warm temperatures during the growing season is the primary mechanism for breaking dormancy, and that this method is adaptive because it spreads germination over a period that favors rapid plant growth. Brief, high intensity fires also produce conditions that should stimulate germination (Susko et al., 2001).

Impacts of the Target Weed

1. Beneficial Uses

Kudzu has long been semi-domesticated in Japan and China where it is used as a forage crop and harvested for its root starch, fiber, and medicinal qualities (Shurtleff and Aoyagi, 1977). The main uses of kudzu in the United States have been for erosion control and as a forage crop. While kudzu is still valued as a soil-conserving plant for erosion control on steep slopes and embankments, less invasive species are now available for stabilization purposes. Kudzu produces forage that is high quality and quite palatable to livestock. However, the use of kudzu as a forage plant has definite limitations. Although kudzu grows rapidly, plants actually produce relatively low forage yields, usually around 2 to 3 tons of dry matter per acre per year. In addition, producers find kudzu difficult

to cut and bale because of its viney growth habit. Although grazers readily eat kudzu, frequent defoliation over 3 to 4 years can destroy stands (Everest et al., 1991). Therefore, kudzu has little value as a grazing crop except on a temporary basis, for example as a low-input supplemental drought feed or as a protein bank for summer or autumn grazing (Terrill et al., 2003). Kudzu is not often used medicinally in the United States. However, current research may lead to new medicines made from kudzu. Research at Harvard Medical School has revealed a drug extracted from the roots that may help alcoholics control their drinking problems. Kudzu is also a source of daidzein, which can be used to fight inflammation and microbial infections, dilate coronary arteries, promote the estrous cycle, and relax muscles (Adams, 1996). Other isoflavonoids, including genistein, daidzin, genistin and puerarin, have also been identified in different plant parts of kudzu and may also prove medically important (Kirakosyan et al., 2003). Recent studies of isoflavones within the family Fabaceae indicate that kudzu has unusually high levels of genistein and daidzein compared with other edible legumes (Kaufman et al., 1997; Kirakosyan et al., 2003). Kudzu provides excellent cover for bobwhites and other wildlife. Kudzu seeds are a major winter food of bobwhites (*Colinus virginianus*) in Georgia (McRae, 1980). An additional suggested use of kudzu has been as a medium for yeast and ethanol production (Tanner et al., 1979).

2. Social and Recreational Uses

Although kudzu is not widely used for food and fiber in the United States, several individuals and small companies are making use of kudzu. For example, craftspeople use kudzu to make baskets, paper, textiles, and cloth. One company markets kudzu blossom jelly and syrup. Kudzu roots and leaves are used in cooking and several kudzu cookbooks have been marketed. Kudzu has also been used in the south as a shade producing plant.

3. Impact on Threatened and Endangered Species

We know of no studies that have been performed to determine the effects of kudzu invasion on threatened and endangered species in the Southeast. However, it can be assumed that kudzu does affect threatened, endangered, and sensitive species due to its ability to smother and crowd out other species.

4. Economic Losses

Kudzu causes considerable damage to commercial forestry and young plantations. In a 3-year study on effects of various herbicides and densities of planted loblolly pines, Harrington et al. (2003) showed that burning stimulated vigorous sprouting of kudzu, which eventually reclaimed all growing space in unsprayed plots, primarily by reducing available light. Even high-density plantings of pines had no impact on the unsprayed plots because the kudzu was able to overtop, suppress, and ultimately kill over 90% of planted seedlings. Britton et al. (2002) cited estimates of economic losses to potential forest productivity from kudzu infestations at \$48 per acre per year, and control costs by power companies alone at \$1.5 million per year.

5. Health Dangers

Kudzu infestations of power lines disrupt electric power to urban and rural households on a regular basis. Such infestations present an electrical hazard to young children playing near the vine-entangled power lines.

6. Effects on Native Plant and Animal Populations

As noted by Munger (2002) “although kudzu has been established in North America for nearly a century, there are no published reports as of this writing (2002) that document long-term successional patterns in kudzu-dominated communities.” Kudzu infestations are typified by a continuous blanket of monospecific foliage, which undoubtedly results in large-scale alteration of biotic communities (Munger, 2002). Kudzu monocultures appear to be replacing the species-rich forests of the south and east and affecting the associated wildlife, recreation, and aesthetic values. Other non-native plant species, such as Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), and mimosa (*Albizia julibrissin*), often grow with kudzu and compound the displacement of native communities.

7. Impact of Current Weed Control on Non-target Plants

Conventional control measures such as herbicides and mechanical treatments are non-selective and themselves affect non-target plants. For example, picloram, when used to control kudzu, can severely injure or kill many desirable non-target plants, including trees (Munger, 2002). Because picloram is relatively persistent, it may injure plants for several growing seasons. Picloram can also leach through sandy soils or be lost in surface water runoff and contaminate streams and groundwater.

8. Other

The vigorous growth of kudzu on abandoned lots and low-value land creates aesthetically unpleasant situations, further increasing kudzu's unpopularity.

Alternative Management Options

1. Historical Options

Overgrazing, burning, mowing, plowing, digging roots, and applying herbicides have been the control methods of choice since 1955. These methods work to a limited extent but all have problems.

2. Current Options

The historical options listed above remain the main methods of control for kudzu. Manual cutting of the vines is currently the most common method of control around electrical poles and facilities. Effective herbicide treatments for eradicating kudzu on forest and non-crop lands exist but these treatments often cost more than the land value and require multiple treatments for 4 to 10 years. Because of the water solubility of picloram, the most effective herbicide, care must be exercised in

wet areas. Herbicides and/or application technology are not currently available for eradicating infestations in urban and suburban areas and on some federal lands where the effective herbicides are prohibited. The use of grazing to control kudzu has definite limitations. Kudzu produces relatively low forage yields and frequent defoliation can leave large rooted plants. Kudzu can also be difficult to cut and bale. Thus, very few patches are utilized for grazing today. Grazing is most valuable within a framework of integrated pest management, where it can be used in combination with other methods for eradication. Repeated burning has some control potential, especially when used in combination with other methods such as grazing and herbicides. Winter burning prior to summer herbicide treatment is currently recommended to locate hidden application hazards and to control small plants (Munger, 2002). Where equipment can be used, kudzu may be eradicated by excavating the roots or it can be weakened by frequent removal of the vines and foliage. However, many infestations are on steep and eroded terrain that hinders the use of equipment. Little research has addressed the depth of mechanical scraping or mowing frequency required to eliminate patches of differing ages. Combining sustained herbicide use with competition from a densely planted smother crop (such as loblolly pine) shows some promise for containing the spread of kudzu (Harrington et al., 2003).

In summary, all methods of control developed to date take considerable investment in time and money and are capable of eliminating only small infestations. In addition, most of the current control methods are non-selective and affect non-target species. Despite the current options, kudzu remains a serious pest, indicating the need for additional control options.

3. Potential Options

Biological control is a potentially cost-effective and environmentally sound method for controlling kudzu. In a study evaluating 19 invasive weeds in southern environments for biological control suitability, kudzu was found to be a good potential target because of the lack of closely related species in the United States and the current absence of effective methods of control (Pemberton, 1996). Another positive factor was the presence of natural enemies in Northeast Asia, including some that appear to be specialists. A potential conflict is the presence of many important crop species in the same family, which will necessitate a relatively large host specificity testing program.

Several preliminary surveys were conducted to examine the exotic natural enemies associated with kudzu. In 1986, Bob Pemberton of USDA-ARS examined *Pueraria montana* var. *lobata* populations near Seoul and western South Korea; near Tokyo, Nagoya, and Yamaguchi, Japan; and on the northeastern portion of Kyushu Island, Japan. The flowers and developing fruits were fed on by a number of Lepidoptera, including larvae that were probably *Lampides boeticus* Korot (Lepidoptera: Lycaenidae). The leaves were frequently mined by an agromyzid fly, the beetle *Trachys auricollis* E. Saunders (Coleoptera: Buprestidae), and various Lepidoptera including *Liocrobyla lobata* Kuroko (Lepidoptera: Gracillariidae) and *Microthauma* sp. (Lepidoptera: Lyonetiidae) in Japan. Other Lepidoptera observed were leaf folders, possibly *Charema* sp. (Lepidoptera: Pyralidae), leaf rollers, leaf skeletonizers, and general defoliators including a *Clanis* sp. (Lepidoptera: Sphingidae). Kudzu leaves were often severely galled by a fly, probably *Calopedila puerariae* Shinji (Diptera: Cecidomyiidae). Larvae of an unknown borer were found in the growing tips of the vines. The woody stems of the plants were commonly attacked by the large

weevil, *Mesalcidodes trifidas* Puscoe (Coleoptera: Curculionidae), which formed spherical galls 3 to 6 cm in diameter. A smaller weevil, *Eugnathus distinctus* Roelofs (Coleoptera: Curculionidae) is reported to feed on the roots and is thought to be common in Japan, Korea, and China. An unknown rust was also observed on the leaf blades and petioles. What appeared to be a mosaic virus was seen to infect leaf blades (Pemberton, 1989). Other insects recorded on kudzu in Japan include: the pod-miner, *Ophiomyia puerarivora* Sasakawa (Diptera: Agromyzidae); the stink bug, *Megacopta punctissimum* Montandon (Heteroptera: Plataspidae); and the spider mite, *Schizotetranychus leguminosus* n. sp. (Acarina: Tetranychidae) (Ehara, 1973; Hibino and Ito, 1983; Sasakawa, 1981). In India, kudzu was found to be moderately susceptible to the root-knot nematodes, *Meloidogyne incognita* and *M. javanica* (Patel et al., 1989). In Pakistan, 8 species of insects and mites were recorded from surveys of *Pueraria tuberosa*. One species, *Callosobruchus* sp. nov., appeared to be a restricted feeder. The literature survey for the Pakistani survey produced 21 insect species associated with the *Pueraria* genus. Of these, only *Bruchus ademptus* Sharp. (Coleoptera: Bruchidae), recorded from *P. hirsuta* in Japan, appears to be restricted in host range (Baloch et al., 1977).

Systematic survey sites were established in Anhui Province, China, in 1999, funded by the USDA Forest Service, and additional sites were subsequently added in Guangdong and Shaanxi Province (Britton et al., 2002). Preliminary host range testing in China indicated that at least four species, two chrysomelid beetles, a curculionid beetle, and a sawfly, may be host-specific and warrant additional testing in US quarantine facilities (Jianghua Sun, unpublished data).

Other sources record some of the natural enemies associated with kudzu in the United States. Diseases recorded on *Pueraria montana* var. *lobata* in the U.S. include: *Alternaria* sp., *Botryosphaeria dothidea*, *B. obtusa*, *B. ribis*, *Corticium microsclerotium*, *Diplodia puerariae*, *Eutypella scoparia*, *Leptosphaerulina argentinensis*, *Microthyrium* sp., *Mycosphaerella pueraricola* = *Cercospora pueraricola*, *Phomopsis* sp., *Phymatotrichopsis omnivora*, *Phytomonas medicaginis* var. *phaseolicola*, *Pseudocercospora puerariicola*, *Pseudomonas syringae* pv. *phaseolicola*, *Stictis radiata*, and *Rhizoctonia microsclerotia* (Bain and Presley, 1947; Farr et al., 1989). Insects include *Astraptus anaphus annetta* Evans (Lepidoptera: HesperIIDae), which feeds on a various legumes and is found in the extreme south of Texas (Kendall, 1976).

Pseudomonas syringae pv. *Phaseolicola* was examined as a potential bioherbicide of kudzu, but proved ineffective as a control measure (Zidack and Backman, 1996). North Carolina State University researchers have introduced parasitized soybean loopers, *Pseudoplusia includens* (Walker) into fields of kudzu (Bragg, 1997). Subsequent work showed kudzu to be a poorer quality host for the looper than soybean (Kidd and Orr, 2001). A Montana State University researcher is evaluating the potential of the plant pathogenic fungi, *Sclerotinia sclerotiorum* and *S. rolfsii* as biological control agents for kudzu. Because these fungi are not host specific, auxotrophic strains would be required (Pilgeram, 1998).

Information on Potential Biological Control Agents

Specific potential biological control agents are not addressed in this petition. We will address this section when potential agents are identified and a release petition is submitted.

IV. Categories of Test Plants

This section proposes plants for host specificity testing of biological control agents of kudzu in North America. The list is based on the strategy of A. J. Wapshere (1974), a phylogenetic approach in which closely related species are theorized to be at greater risk of attack than are distantly related species. The complete list of plant species recommended for testing is presented in Table 1 (pp. 27-30). Following is our justification for the selections in each Category.

Category 1: Genetic types of *Pueraria montana* var. *lobata* (varieties, races, forms, genotypes, apomicts, etc.)

Because U.S. populations of kudzu have been found to demonstrate considerable genetic variability and biological control agents may differ in their response to different genetic types, we propose to test kudzu from four different locations: Georgia, North Carolina, Delaware, and the far west (Oregon or Washington). By testing plants from these locations we will attempt to cover most of the genetic types present in the United States. However, as more genetic knowledge becomes available, these accessions should be reviewed and additional ones added as necessary, especially if differences are found in the response of insects to these four populations.

Category 2: North American species in the same genus as *Pueraria montana* var. *lobata*, divided by subgenera (if applicable), including economically and environmentally important plants.

As noted, there are no *Pueraria* sp. native to North America. *Pueraria phaseoloides* is listed as present in the U.S. (Kartesz and Kartesz, 1980; USDA-NRCS, 2002), but because it is an introduced species found in Hawaii, Puerto Rico, and the Virgin Islands, we do not recommend it for testing.

Category 3: North American species in other genera in the Fabaceae family, divided by subtribe, tribe, and subfamily, including economically and environmentally important plants.

The Fabaceae (= Leguminosae) is the third largest plant family and includes some of the world's most economically important species. In developing our list of plants to be tested, we followed the classification system presented in *Advances in Legume Systematics, Part 1* (Polhill and Raven, 1981) which details the most recent thinking on legume systematics. According to this work, the Fabaceae is divided into 3 subfamilies, 42 tribes, and numerous subtribes. However, new technology and field work continuously contribute additional information and place legume systematics in a state of flux, with not all researchers agreeing on a single classification system.

Pueraria montana var. *lobata* belongs to the Fabales order, Fabaceae family, Papilionoideae subfamily, Phaseoleae tribe, and Glycininae subtribe.

Species in the same subtribe (Glycininae) as *Pueraria montana* var. *lobata*:

Worldwide there are 16 genera of Glycininae, almost all native to the Old World. Species native to the continental United States are *Amphicarpaea bracteata* and four *Cologania* species: *C.*

angustifolia, *C. lemmonii*, *C. pallida*, and *C. pulchella* (Kartesz and Kartesz, 1980; Lackey, 1981; USDA-NCRS, 2004). We propose testing all five native species, even though the *Cologania* species are found in the southwestern U.S. where kudzu is not (or is only marginally) established. In addition, there are two economically important introduced species: *Glycine max* [soybean] and *Neonotonia wightii* [pasture legume]. We propose to test *Glycine max* but not *Neonotonia wightii*, which is only cultivated in Hawaii.

Species in different subtribes in the same tribe (Phaseoleae):

The tribe Phaseoleae contain the largest number of genera and the most economically important species of all the Fabaceae tribes. Economically important species in the tribe are listed in Table 2 (pp. 31-32). The Phaseoleae are characterized by trifoliolate leaves and twining stems, although other characters are also used to define the tribe. There are seven Phaseoleae subtribes in addition to the Glycininae. The bulk of the Phaseoleae, including the Diocleinae, Phaseolinae, more remotely the Glycininae, and probably the Kennediinae, form one large natural group. The remainder of the Phaseoleae are probably of independent origin (Lackey, 1981). *Pueraria* has many primitive Diocleinae-like features, although its morphological diversity places it with other more specialized genera in the Glycininae. There has been little comparative phytochemistry of the Phaseoleae except the study of the free amino acid canavanine, which is usually absent from the Glycininae. Leucoanthocyanins are also absent in the Glycininae.

Subtribe Diocleinae

Worldwide there are 13 genera in this subtribe. Four genera are represented in the continental United States: *Canavalia*, *Dioclea*, *Galactia*, and *Pachyrhizus*. The *Canavalia* species present in the continental United States are *C. brasiliensis*, a native species found in Florida; *C. ensiformis*, an economically important introduced species; *C. gladiata*, an economically important introduced species; and *C. rosea*, a native species found in the Southern United States. We recommend testing *Canavalia ensiformis* and *Canavalia rosea*. *Dioclea multiflora* is the only *Dioclea* species present in the continental United States and we recommend it be tested. Sixteen species of *Galactia* are native to the Southern United States: *G. canescens*, *G. elliotii*, *G. erecta*, *G. floridana*, *G. heterophylla*, *G. marginalis*, *G. microphylla*, *G. mollis*, *G. parvifolia*, *G. pinetorum*, *G. regularis*, *G. smallii*, *G. striata*, *G. texana*, *G. volubilis*, and *G. wrightii*. In addition, *G. longifolia* is an introduced species found in Texas and Puerto Rico. Depending on availability, we propose to test two species of concern, *Galactia pinetorum* and *Galactia smallii* (see Category 4). *Pachyrhizus erosus* [yambean], an economically important native species found in Florida, is the only native *Pachyrhizus* in the continental U.S. and we recommend it be tested. All species recommended for testing are found in the southeast within the range of kudzu. We believe that by testing these 6 species in the Diocleinae subtribe we will be able to infer whether any non-tested species in this subtribe may be at risk.

Subtribe Phaseolinae

Worldwide there are 23 genera in this subtribe. The genera native to North America are *Dolichopsis*, *Macroptilium*, *Oxyrhynchus*, *Phaseolus*, *Ramirezella*, *Strophostyles*, and *Vigna*, although only *Phaseolus*, *Strophostyles*, and *Vigna* are native to the continental United States. There are 10 species of *Phaseolus* native to the continental United States: *P. acutifolius*, *P. angustissimus*, *P. filiformis*, *P. grayanus*, *P. maculatus*, *P. parvulus*, *P. polymorphus*, *P.*

polystachios, *P. ritensis*, and *P. supinus*. Of these, *P. acutifolius* [teparty bean], *P. maculatus* [prairie bean], *P. polystachios* [beanvine], and *P. ritensis* [Santa Rita Mountain bean] are considered economically important. There are also several economically important introduced *Phaseolus* species including *P. coccineus* [scarlet runner], *P. lunatus* [lima bean], and *P. vulgaris* [string/kidney bean]. We recommend testing *Phaseolus supinus*, a species of concern (see Category 4), *Phaseolus maculatus*, *Phaseolus polystachios*, and *Phaseolus vulgaris*. There are 3 species of *Strophostyles* native to the continental United States: *S. helvula*, *S. leiosperma*, and *S. umbellata*. All three species have wide distributions and are found in the southeastern states. We recommend testing *Strophostyles umbellata* because it is perennial while *S. helvula* and *S. leiosperma* are annuals. *Vigna adenantha* is the only *Vigna* species native to the continental United States although there are many economically important introduced *Vigna* species including *V. angularis* [adzuki bean], *V. hosei* [Sarawak bean], *V. luteola* [hairypod cowpea], *V. mungo* [black gram], *V. radiata* [mung bean], *V. speciosa* [wandering cowpea], and *V. unguiculata* [blackeyed pea]. We recommend testing *Vigna adenantha*, *Vigna luteola*, and *Vigna unguiculata*. Other economically important Phaseolinae species introduced in the United States are: *Lablab purpureus* [hyacinthbean], *Oxyrhynchus volubilis* [twining bluehood], *Macroptilium atropurpureum* [purple bushbean], *Macroptilium gibbosifolium* [variableleaf bushbean], *Macroptilium lathyroides* [wild bushbean], and *Psophocarpus tetragonolobus* [winged bean]. We recommend testing *Lablab purpureus* [hyacinthbean], *Oxyrhynchus volubilis* [twining bluehood], and *Macroptilium atropurpureum* [purple bushbean]. We believe that by testing these 11 species in the Phaseolinae subtribe, we will be able to infer whether any non-tested species in the Phaseolinae subtribe may be at risk. All species recommended for testing are found in the southeast within the range of kudzu except for *Phaseolus supinus* which is endemic to Arizona.

Subtribe Cajaninae

Worldwide there are 13 genera in this subtribe. *Rhynchosia* is the only genus native to the continental United States, although two *Cajanus* species have been introduced. There are 14 native *Rhynchosia* species: *R. americana*, *R. cinerea*, *R. cytisoides*, *R. difformis*, *R. edulis*, *R. latifolia*, *R. michauxii*, *R. minima*, *R. parvifolia*, *R. precatorea*, *R. reniformis*, *R. senna*, *R. swartzii*, and *R. tomentosa*. Of these we propose testing *Rhynchosia minima* [least snoutbean] and *Rhynchosia tomentosa* [twining snoutbean] which are considered economically important and are found in the southeastern states. *Cajanus cajan* [pigeonpea] is an economically important shrub introduced to Florida, Maryland, Hawaii, Puerto Rico, and the Virgin Islands and *C. scarabaeoides* [cajanus] is an introduced shrub found in Maryland. We recommend testing *Cajanus cajan*. All species recommended for testing are found in the southeast within the range of kudzu.

Subtribe Clitoriinae

Worldwide, there are 4 genera in this subtribe. Two genera, *Centrosema* and *Clitoria*, contain species present in the continental United States. There are 2 native species of *Centrosema*, *C. arenicola* and *C. virginianum*, and one introduced species, *C. sagittatum*. All three species are found within the range of kudzu. We recommend testing *Centrosema virginianum* [butterfly pea] and *Centrosema sagittatum* [arrowleaf butterfly pea] which are both considered economically important. There are also two native *Clitoria* species, *C. fragrans* and *C. mariana* and one economically important introduced species, *C. ternatea* [Asia pigeonwings]. *Clitoria fragrans* is a threatened

species (see Category 4). We recommend testing *C. fragrans* (depending on availability), *C. mariana*, and *C. ternatea*.

Subtribe Erythrinae

Worldwide there are 9 genera in this subtribe. The three genera present in the continental United States are *Apios*, *Erythrina*, and *Mucuna*. There are 2 native species of *Apios*; *A. americana* [groundnut] is an economically important species and *A. priceana* is a threatened species (see Category 4). Both are found within the range of kudzu and are recommended for testing. There are 4 native *Erythrina* species, *E. coralloides*, *E. crista-galli*, *E. flabelliformis*, and *E. herbacea*. *E. crista-galli* and *E. herbacea* are economically important and are found within the range of kudzu. *E. coralloides* is also economically important but is native to Arizona while *E. flabelliformis* is native to Arizona and New Mexico. There are also several economically important introduced *Erythrina* species including *E. falcata* [evergreen coraltree], *E. speciosa* [pink coraltree] and *E. variegata* [tiger's claw]. We recommend testing *E. crista-galli* and *E. herbacea*. There are 2 *Mucuna* species native to the continental United States, *M. pruriens* and *M. sloanei*. Both are annuals and are found within the range of kudzu. We recommend testing *Mucuna pruriens*.

The two remaining subtribes (Kennediinae and Ophrestinae) contain no species native or economically important to the United States, and thus no species are recommended for testing. By testing the above 30 species, we will be testing several species from each of the five Phaseoleae subtribes present in the continental United States, and will obtain sufficient information to infer if a potential biological control agent is likely to attack plants in Phaseoleae subtribes other than the Glycininae.

Species in different tribes in the same subfamily (Papilionoideae):

According to Polhill and Raven (1981), the Papilionoideae subfamily is divided into 32 tribes. Of these, the following 23 tribes contain genera found in North America: Sophoreae, Dalbergieae, Abreae, Tephrosieae, Lonchocarpeae (or Lonchocarpinae), Robinieae (including Sesbanieae), Indigofereae, Desmodieae, Phaseoleae, Psoraleeae, Amorpheae, Aeschynomeneae, Galegeae, Hedysareae, Loteae, Coronilleae, Viciae, Cicereae, Trifolieae, Brongniartieae, Crotonarieae, Thermopsidae, and Genisteae (Kartesz and Kartesz, 1980; Polhill and Raven, 1981).

According to Kartesz and Kartesz (1980) the following genera are represented in North America in each of these tribes (with the exception of the Phaseoleae which are described above):

Sophoreae: *Cladrastis*, *Ormosia*, *Sophora*, and *Myrospermum*

Dalbergieae: *Andira*, *Dalbergia*, *Machaerium*, and *Pterocarpus*

Abreae: *Abrus*

Tephrosieae: *Derris*, *Lonchocarpus*, *Piscidia*, *Pongamia*, *Tephrosia*, and *Wisteria*

Robinieae: *Corynella*, *Coursetia*, *Cracca*, *Diphysia*, *Genistidium*, *Gliricidia*, *Olneya*, *Robinia*, *Sabinea*, *Sesbania*, and *Sphinctospermum*

Indigofereae: *Indigofera*

Desmodieae: *Alysicarpus*, *Christia*, *Desmodium*, *Kummerowia*, and *Lespedeza*

Psoraleae: *Pediomelum*, *Psoralea*, and *Psoralidium*

Amorpheae: *Amorpha*, *Dalea*, *Errazurizia*, *Eysenhardtia*, *Marina*, *Parryella*, and *Psorothamnus*
Aeschynomeneae: *Aeschynomene*, *Arachis*, *Chapmannia*, *Nissolia*, *Pictetia*, *Stylosanthes*, and
Zornia

Galegeae: *Alhagi*, *Astragalus*, *Caragana*, *Colutea*, *Galega*, *Glycyrrhiza*, *Oxytropis*, and
Sphaerophysa

Hedysareae: *Hedysarum* and *Onobrychis*

Loteae: *Anthyllis* and *Lotus*

Coronilleae: *Coronilla*, *Ornithopus*, and *Scorpiurus*

Vicieae: *Lathyrus*, *Lens*, *Pisum*, and *Vicia*

Cicereae: *Cicer*

Trifolieae: *Medicago*, *Melilotus*, *Ononis*, *Trifolium*, and *Trigonella*

Brongniartia: *Brongniartia*

Crotolarieae: *Crotolaria*

Thermopsidaeae: *Thermopsis*, *Baptisia*, and *Pickeringia*

Genisteae: *Cytisus*, *Lupinus*, *Pettaria*, *Spartium*, and *Ulex*

Of the represented genera, the following are listed as economically important (USDA-ARS, 2002; Zomlefer, 1994): *Aeschynomene* [jointvetch], *Amorpha* [false indigo], *Arachis* [peanuts], *Astragalus* [milkvetch], *Baptisia* [wild indigo], *Cicer* [chickpeas], *Cladrastis* [yellowwood], *Crotalaria* [rattlebox], *Dalbergia* [rosewood], *Dalea* [prairie clover], *Derris* [derris], *Desmosium* [tick-trefoil], *Glycyrrhiza* [licorice], *Indigofera* [indigo], *Lathyrus* [sweetpea], *Lens* [lentils], *Lespedeza* [lespedeza], *Lonchocarpus* [lancepod], *Lupinus* [lupine], *Medicago* [alfalfa], *Melilotus* [sweet-clover], *Oxytropis* [locoweed], *Pedimelum* [Indian breadroot], *Piscidia* [fish-poison tree], *Pisum* [peas], *Psoralidium* [scurfpea], *Robinia* [locust], *Sesbania* [riverhemp], *Sophora* [necklacepod], *Stylosanthes* [pencilflower], *Tephrosia* [hoarypea], *Thermopsis* [goldenbanner], *Trifolium* [clover], *Vicia* [Faba beans/vetch], and *Wisteria* [wisteria]. Genera with federally listed threatened, endangered, or candidate species include *Aeschynomene*, *Amorpha*, *Astragalus*, *Baptisia*, *Crotolaria*, *Dalea*, *Indigofera*, *Lathyrus*, *Lespedeza*, *Lotus*, *Lupinus*, *Oxytropis*, *Sesbania*, *Trifolium*, and *Vicia* and additional genera contain species of concern (see Category 4).

Given the limited resources available for host specificity testing, it is not practical to test all species or even a representative from all the genera in the Papilionoideae subfamily. Nor do we believe it is practical to test the economically important and federally listed threatened, endangered, or candidate species. Instead, depending on availability, we propose to test the federally listed species that occur within the present range of kudzu in the continental United States. These include: *Aeschynomene virginica*, *Amorpha herbacea* var. *crenulata* (= *A. crenulata*), *Astragalus applegatei* (Oregon), *Astragalus bibullatus*, *Baptisia arachnifera*, *Crotolaria avonensis*, *Dalea carthagenensis* var. *floridana*, *Dalea foliosa*, *Indigofera mucronata* var. *keyensis*, *Lespedeza leptostachya*, *Lupinus aridorum*, *Lupinus sulphureus* ssp. *kincaidii* (Oregon and Washington), and *Trifolium stoloniferum*. However, because obtaining seeds and/or plant material of threatened, endangered, and sensitive species can be difficult and can further decimate populations, it may not be possible to test the listed species in sufficient numbers to obtain statistically valid data. If we find this to be the case when we begin collecting plant material for testing, we propose to substitute a more common native member from each genus. We believe that by testing these 13 species in 9 different tribes, we will obtain sufficient information to infer if a potential biological control agent is likely to attack plants in the

Papilionoideae subfamily outside the Phaseoleae tribe, including any non-tested economic and ecologically important species.

Species in different subfamilies in the same family (Fabaceae):

According to Polhill and Raven (1981), besides the Papilionoideae, there are two additional subfamilies in the Fabaceae family, the Caesalpinoideae and Mimosoideae, each of which is divided into five tribes. The Mimosoideae is more closely linked to the Caesalpinoideae than the Papilionoideae and contains 50-60 genera, most of which are African. Kartesz and Kartesz (1980) list the following Mimosoideae genera as present in North America: *Acacia*, *Adenanthera*, *Albizia*, *Anadenanthera*, *Calliandra*, *Desmanthus*, *Dichrostachys*, *Ebenopsis*, *Entada*, *Inga*, *Leucaena*, *Lysiloma*, *Neptunia*, *Pithecellobium*, *Prosopis*, *Mimosa*, and *Schranckia*. Of these genera, *Acacia*, *Albizia*, *Calliandra*, *Desmanthus*, *Ebenopsis*, *Leucaena*, *Lysiloma*, *Neptunia*, *Prosopis*, and *Mimosa* contain species which are considered economically important in the United States (USDA-ARS, 2002). There are no federally listed species or species of concern in the continental United States (see Category 4). Caesalpinoideae genera are primarily found in South America, tropical Africa, and Southeast Asia and are poorly represented in North America. However, the following genera are listed as present in North America: *Bauhinia*, *Cassia*, *Ceratonia*, *Cercis*, *Chamaecrista*, *Cynometra*, *Delonix*, *Gleditsia*, *Gymnocladus*, *Haematoxylon*, *Hoffmannseggia*, *Hymenaea*, *Mezoneuron* = *Caesalpinia*, *Parkinsonia*, *Peltophorum*, *Senna*, *Stahlia*, and *Tamarindus* (Kartesz and Kartesz, 1980). Of these genera, *Bauhinia*, *Cassia*, *Cercis*, *Chamaecrista*, *Delonix*, *Gleditsia*, *Gymnocladus*, *Hoffmannseggia*, *Parkinsonia*, and *Senna* contain species which are considered economically important in the United States (USDA-ARS, 2002). In addition, *Chamaecrista* contains a federally listed candidate species, *Hoffmannseggia* contains a federally listed endangered species, and *Caesalpinia*, *Chamaecrista*, and *Senna* contain species of concern in the continental United States (see Category 4).

Because there are a large number of species which are more closely related to kudzu and limited resources are available for host specificity testing, we do not plan to test many species in different subfamilies. However, we do propose to test a member from each genus that contains species of concern in the continental United States (see Category 4 for rationale). As such we recommend testing *Chamaecrista fasciculata*, *Chamaecrista lineata*, *Hoffmannseggia glauca*, *Caesalpinia brachycarpa*, and *Senna ripleyana*.

Category 4: Threatened, endangered, and sensitive species in the Fabaceae family, divided by subgenus, genus, subfamily, and tribe (see Table 3, pp. 33-40).

Table 3 details all federally endangered, threatened, proposed, and candidate species in the Fabaceae listed by the U.S. Fish and Wildlife Service. Also detailed are federal species of concern. These are taxa that have been withdrawn from proposed listing and taxa that were listed in 1993 as Category 2 or 3 species. In 1996, the U. S. Fish and Wildlife Service completed an exhaustive review of the 1993 list. Listing of Category 2 and Category 3 species was discontinued although the Service remains concerned about and acknowledges the need for further biological and field study of these species. We have not detailed the Fabaceae taxa listed as sensitive by individual states, Canadian Provinces, and Mexico. The Fabaceae is a large family, the lists would be extensive, and it would be

impractical to test all the sensitive species. We believe that by testing the proposed species we will be able to infer if a potential biological control agent is likely to attack non-tested sensitive plants in the Fabaceae family. The species in this category selected for testing are marked with an asterisk within Table 1.

Species in the same subtribe (Glycininae) as *Pueraria montana* var. *lobata*:

None.

Species in different subtribes in the same tribe (Phaseoleae):

Four of the subtribes have threatened, endangered, or sensitive species in the continental United States. The Clitoriinae has one federally threatened species (*Clitoria fragrans*). The Diocleinae has one federally endangered species (*Galactia smallii*) and one species listed as Category 2 (*Galactia pinetorum*). The Erythrinae has one federally threatened species (*Apios priceana*). The Phaseolinae has one Category 2 species (*Phaseolus supinus*). All other listed species in the Phaseoleae tribe are not found in the continental United States (see Table 3). Depending on availability of seed/plant material, we recommend testing all the species of concern. We believe that by testing these species along with the Phaseoleae species detailed in Category 3, we will be able to infer if the threatened, endangered, or sensitive species in the Phaseoleae tribe are at risk of attack.

Species in different tribes in the same subfamily (Papilionoideae):

There are numerous threatened, endangered, candidate, and species of concern in different tribes in the Papilionoideae subfamily (see Table 3 for list). Of the federally listed species, those that occur within the present range of kudzu in the continental United States are proposed for testing (see Table 4, p. 41, for possible seed sources). However, because obtaining seeds and/or plant material of threatened, endangered, and sensitive species can be difficult and can further decimate populations, it may not be possible to test the listed species in sufficient numbers to obtain statistically valid data. If we find this to be the case when we begin collecting plant material for testing, we propose to substitute a more common native member from each genus.

Species in different subfamilies in the same family (Fabaceae):

There is one federally endangered species in the continental United States, *Hoffmannseggia tenella*, and one candidate species, *Chamaecrista lineata* var. *keyensis*. There are also three species of concern in the continental United States, *Caesalpinia brachycarpa*, *Chamaecrista fasciculata* var. *macrosperma*, and *Senna ripleyana*. Because obtaining seeds and/or plant material of threatened, endangered, and sensitive species can be difficult and can further decimate populations, we propose not to test the threatened or endangered species at this level of phylogenetic separation from kudzu. Thus, we propose to test *Hoffmannseggia glauca* rather than the endangered, *H. tenella*. Of the three species of *Hoffmannseggia* listed as present in the United States (*H. glauca*, *H. oxycarpa*, and *H. tenella*), *H. glauca* is the most widely distributed. Depending on availability, we do propose to test *Caesalpinia brachycarpa*, *Chamaecrista fasciculata* (although not necessarily *C. fasciculata* var. *macrosperma*), *Chamaecrista lineata* (although not necessarily *C. lineata* var. *keyensis*) and *Senna*

ripleyana. However, if any of these species are unavailable, there are numerous native species within these genera that could serve as substitute species for testing.

Category 5: North American species in other families in the Fabales order that have some phylogenetic, morphological, or biochemical relationship to the target weed, including economically and environmentally important plants.

Both Cronquist and Dahlgren list the Mimosaceae and Caesalpiniaceae as the only families other than the Fabaceae in the Fabales order; however, Thorne places the Fabaceae in the Rutales order along with the following 20 families: Rutaceae, Rhabdodendraceae, Cneoraceae, Simaroubaceae, Picramniaceae, Ptaeroxylaceae, Meliaceae, Burseraceae, Anacardiaceae, Leitneriaceae, Tepuianthaceae, Coriariaceae, Sapindaceae, Sabiaceae, Melianthaceae, Akaniaceae, Bretschneideraceae, Moringaceae, Surianaceae, and Connaraceae. To complicate matters further, a number of researchers have placed the Fabaceae in the Rosales order. Dickison provides a detailed review of the systems of classification (1981). Despite the seeming disagreement, Dickison describes rather widespread agreement regarding the position of the Fabaceae in the general system. The Connaraceae and Chrysobalanaceae have been consistently recognized as the families having the closest relationships to the Fabaceae. The Crossosomataceae also has a “marginally greater phytochemical similarity” with the Mimosoideae of the Fabaceae than to any of its other putative relatives, although the similarity values are still quite low (Dickison, 1981). Evidence has also accumulated to ally the Fabales with the Sapindales, and more closely with the Sapindaceae than the Connaraceae (Polhill, Raven, and Stirton). The Mimosaceae and Caesalpiniaceae are now considered subfamilies of the Fabaceae so we have treated them as such (see Category 3). Since, at this time, the remaining families identified as being most closely related are placed in orders other than the Fabales, we address these families in greater detail in Category 6.

Category 6: North American species in other orders that have some morphological or biochemical relationship to the target weed, including economically and environmentally important plants.

Species in other orders that are phylogenetically related to the Fabaceae:

The families currently believed to be the most closely related to the Fabaceae are the Sapindaceae in the Sapindales order and the Connaraceae, Chrysobalanaceae, and Crossosomataceae in the Rosales order.

Worldwide there are about 150 Sapindaceae genera comprising roughly 2000 species. Of these, 13 genera and 18 species are listed as present in the continental United States (USDA-NRCR, 2004). These are *Cardiospermum corindum*, *Cardiospermum dissectum*, *Cardiospermum halicacabum*, *Cardiospermum microcarpum*, *Cupania glabra*, *Cupaniopsis anacardioides*, *Dodonaea viscosa*, *Exothea paniculata*, *Harpullia arborea*, *Hypelate trifolia*, *Koelreuteria elegans*, *Koelreuteria paniculata*, *Melicoccus bijugatus*, *Sapindus saponaria*, *Serjania brachycarpa*, *Serjania incisa*, *Ungnadia speciosa*, and *Urvillea ulmacea*. All are perennial species found within the range of kudzu. Of these, *Cupaniopsis anacardioides* [carrotwood], *Harpullia arborea* [harpullia], *Koelreuteria elegans* [flamegold], *Koelreuteria paniculata* [goldenrain tree], and *Melicoccus*

bijugatus [Spanish lime] are introduced. We recommend testing *Cardiospermum halicacabum*, *Sapindus saponaria*, and *Koelreuteria paniculata* which are the most widely distributed species. Testing these three species should allow us to infer if a potential biological control agent poses a risk to non-target species in the Sapindaceae family.

Worldwide the Connaraceae contains 17 genera and about 350 species of woody plants. There are no species listed as present in the continental United States so we do not recommend any species for testing (USDA-NRCR, 2004).

Worldwide there are 17 genera and about 420 species of trees in the Chrysobalanaceae family. Of these, the two species listed as present in the continental United States are *Chrysobalanus icaco* and *Licania michauxii*. Both are native perennial species found within the range of kudzu and are recommended for testing.

The Crossosomataceae is a small family from western North America which contains three genera and the following 8 species: *Apacheria chiricahuensis*, *Crossosoma bigelovii*, *Crossosoma californicum*, *Glossopetalon clokeyi*, *Glossopetalon planitierum*, *Glossopetalon pungens*, *Glossopetalon spinescens*, and *Glossopetalon texense* (USDA-NRCR, 2004). Of these, only *Glossopetalon planitierum*, *G. spinescens*, and *G. texense* are found within the present range of kudzu. However, we recommend testing one species from each genus including *Apacheria chiricahuensis*, *Crossosoma bigelovii*, and *Glossopetalon spinescens*.

We believe that by testing 8 species in the two most closely related orders to the Fabales, we will be able to infer if a potential biological control agent poses a risk to non-target species in the Sapindales or Rosales orders. If a potential biological control agent poses low risk to species within these orders, we believe the potential agent will pose a similarly low risk to all non-tested plant species in other orders.

Species in other orders with biochemical characteristics in common with the Fabaceae:

We have found no evidence that links the Fabaceae biochemically with any additional orders other than the Sapindales and Rosales, so do not recommend any additional species for testing. Furthermore, we have found no literature describing any chemotaxonomic links between kudzu and any other plant species.

Selected cultivated species in other orders:

We have found no evidence that links the Fabaceae with any additional cultivated species in other orders so do not recommend any additional species for testing. If a potential biological control agent poses low risk to the 8 species we are testing in the two most closely related orders, we believe the potential agent will pose a similarly low risk to all non-tested plant species in other orders, including cultivated species. Furthermore, given the large number of cultivated species within the Fabales order itself, we believe the limited resources available for host specificity studies are better apportioned to testing the more closely related species.

Category 7: Any plant on which the biological control agent or its close relatives (within the same genus) have been previously recorded to feed and/or reproduce.

This category will be addressed at a later date for any potential biological control agents that are identified for testing.

V. Petitioner's Summary and Perspective of Risk

We believe that by testing the 59 proposed plant species (plus any additional species identified at a later date in Category 7) we would be able to infer the host range of a potential biological control agent. However, given the expense of host specificity testing and the often limited availability of the potential biocontrol agents with which to perform the tests, we do not necessarily recommend testing all 59 plant species. Instead, we foresee selecting species from this list based on the availability of resources and the biology of the agent. We recommend testing the more closely-related plant taxa first and expanding the tests as resources allow. Because of the importance of the Fabaceae family both environmentally and economically, we believe any potential biological control agents that are not specific to the genus *Pueraria* should either not be approved for release in the United States or receive a detailed risk-benefit analysis before being considered for approval.

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TABLE 1

List of Plant Species Recommended for Testing to Determine the Potential Host Ranges of Candidate Biological Control Agents of *Pueraria montana* var. *lobata* in the United States

Plant Species [common name]	Origin ^a	Life Cycle ^b	Range
CATEGORY 1: Genetic types of <i>Pueraria montana</i> var. <i>lobata</i>			
<i>P. montana</i> var. <i>lobata</i> 1 [kudzu]	I	P	GA
<i>P. montana</i> var. <i>lobata</i> 2 [kudzu]	I	P	NC
<i>P. montana</i> var. <i>lobata</i> 3 [kudzu]	I	P	DE
<i>P. montana</i> var. <i>lobata</i> 4 [kudzu]	I	P	OR or WA
CATEGORY 2: Species in the same genus as <i>Pueraria montana</i> var. <i>lobata</i> None in North America.			
CATEGORY 3: Species in the other genera in the Fabaceae family			
<u>Species in the same subtribe (Glycininae) as <i>Pueraria montana</i> var. <i>lobata</i></u>			
<i>Amphicarpaea bracteata</i>	N	P	AL,AR,CT,DE,FL,GA,IL,IN,IO,KS, KY,LA,MA,MD,ME,MI,MO,MN, MS,MT,NC,ND,NE,NH,NJ,NY,OH, OK,PA,RI,SC,SD,TN,TX,VA,VT,WI,WV
<i>Cologania angustifolia</i>	N	P	AZ,NM,TX
<i>Cologania lemmonii</i>	N	P	AZ
<i>Cologania pallida</i>	N	P	AZ,NM,TX
<i>Cologania pulchella</i>	N	P	NM
<i>Glycine max</i> [soybean]	I	A	AL,AR,DE,FL,GA,IL,IN,IO,KY,LA, MA,MD,MI,MN,MO,MS,NC,NJ, NY,OH,PA,SC,TN,VA,WI,WV,PR
<u>Species in different subtribes in the same tribe (Phaseoleae)</u>			
<u>Subtribe Diocleinae:</u>			
<i>Canavalia ensiformis</i>	I	P	AL,AR,AZ,FL,GA,IL,KS,MS, MO,OK,TX,PR,VI
<i>Canavalia rosea</i>	N	P	AL,FL,LA,MS,TX,PR,VI
<i>Dioclea multiflora</i>	N	P	AL,AR,FL,GA,IL,KY,LA,MS,TN,TX
<i>Galactia pinetorum</i> *	N	P	FL
<i>Galactia smallii</i> *	N	P	FL
<i>Pachyrhizus erosus</i> [yambean]	N	P	FL,HI,PR,VI
<u>Subtribe Phaseolinae:</u>			
<i>Lablab purpureus</i> [hyacinthbean]	I	P	FL,GA,HI,LA,MD,NY, OH,PA, VA,WV,PR,VI
<i>Macroptilium atropurpureum</i> [purple bushbean]	N	P	AZ,FL,HI,TX,PR
<i>Oxyrhynchus volubilis</i> [twining bluehood]	I	P	TX
<i>Phaseolus maculatus</i> [prairie bean]	N	P	AZ,NM,TX

<i>Phaseolus polystachios</i> [beanvine]	N	P	AL,AR,CT,DE,FL,GA,IL,IN,IO,KY, LA,ME,MD,MI,MS,MO,NE, NJ,NY,NC,OH,OK,PA,SC,SD, TN,TX,VA,WV,PR
<i>Phaseolus supinus</i> *	N	P	AZ
<i>Phaseolus vulgaris</i> [string/kidney bean]	N	A	CT,FL,KY,MA,ME,MI,MO, NH,NY,PA, RI,SC,UT,PR,VI
<i>Strophostyles umbellate</i>	N	P	AL,AR,DE,FL,GA,IL,IN, KY,LA,MD,MS, MO,NJ,NY,NC,OH,OK,PA, RI,SC,TN,TX,VA
<i>Vigna adenantha</i>	N	P	FL,HI,PR
<i>Vigna luteola</i> [hairy cowpea]	I	P	AL,FL,GA,LA,MS,NC,PA, SC,TX,VA,PR,VI
<i>Vigna unguiculata</i> [blackeyed pea]	I	A	AL,DE,FL,GA,IL,IN,LA, MD,MI,MS,MO, NC,PA,SC,TX,VA,PR,VI
<u>Subtribe Cajaninae:</u>			
<i>Cajanus cajan</i> [pigeonpea]	I	P	FL,HI,MD,PR,VI
<i>Rhynchosia minima</i> [least snoutbean]	N	P	AL,AR,FL,GA,HI,LA,MS, MO,TX,PR,VI
<i>Rhynchosia tomentosa</i> [twining snoutbean]	N	P	AL,DE,FL,GA,KY,LA,MD, MS,NC,SC,TN,TX,VA,WV
<u>Subtribe Clitoriinae:</u>			
<i>Centrosema sagittatum</i> [arrowleaf butterfly pea]	I	P	FL
<i>Centrosema virginianum</i> [butterfly pea]	N	P	AL,AR,DE,FL,GA,KY,LA, MD,MS,NJ,NC, OK,SC,TN,TX,VA,PR,VI
<i>Clitoria fragrans</i> *	N	P	FL
<i>Clitoria mariana</i>	N	P	AL,AZ,AR,DE,FL,GA,IL,IN, IO,KS,KY,LA,MD,MS,MO, NJ,NY,NC,OH,OK,PA,SC, TN,TX,VA,WV
<i>Clitoria ternatea</i>	I	P	FL,HI,VI,TX,PR
<u>Subtribe Erythrinae:</u>			
<i>Apios Americana</i> [groundnut]	N	P	AL,AR,CO,CT,DE,FL,GA IL,IN,IO,KS,KY, LA,MA,MD,ME,MI,MN,MS, MO,NE,NH,NJ,NY,NC,ND, OH,OK,PA,RI,SC,SD,TN, TX,VT,VA,WV,WI
<i>Apios priceana</i> *	N	P	AL,IL,KY,MD,MS,TN
<i>Erythrina crista-galli</i>	N	P	FL,GA,MS,PR
<i>Erythrina herbacea</i>	N	P	AL,AR,FL,GA,LA,MS,NC,SC,TX
<i>Mucuna pruriens</i>	N	A	FL,NC,SC,PR,VI

Species in different tribes in the same subfamily (Papilionoideae)

<u>Tribe Aeschynomeneae</u>			
<i>Aeschynomene virginica</i> *	N	A	DE,MD,NJ,NC,PA,SC,VA
<u>Tribe Amorphaeae</u>			
<i>Amorpha herbacea</i> var. <i>crenulata</i> (= <i>A. crenulata</i>)*	N	P	FL
<i>Dalea carthagenensis</i> var. <i>floridana</i> *	N	P	FL
<i>Dalea foliosa</i> *	N	P	AL,IL,TN
<u>Tribe Crotalariaeae</u>			
<i>Crotalaria avonensis</i> *	N	P	FL
<u>Tribe Desmodieae</u>			
<i>Lespedeza leptostachya</i> *	N	P	IA,IL,MN,WI
<u>Tribe Galegeae</u>			
<i>Astragalus applegatei</i> *	N	P	OR
<i>Astragalus bibullatus</i> *	N	P	TN
<u>Tribe Genisteae</u>			
<i>Lupinus aridorum</i> *	N	P	FL
<i>Lupinus sulphureus</i> ssp. <i>kincaidii</i> *	N	P	OR,WA
<u>Tribe Indogefereae</u>			
<i>Indigofera mucronata</i> var. <i>keyensis</i> *	N	A,P	FL
<u>Tribe Thermopsidaeae</u>			
<i>Baptisia arachnifera</i> *	N	P	GA
<u>Tribe Trifolieae</u>			
<i>Trifolium stoloniferum</i> *	N	P	AR,IL,IN,KS,KY,MO,OH,WV

Species in different subfamilies in the same family (Fabaceae)

<u>Subfamily Caesalpinoideae, Tribe Caesalpinieae</u>			
<i>Caesalpinia brachycarpa</i> *	N	P	TX
<i>Hoffmannseggia glauca</i> **	N	P	AZ,CA,CO,KS,NV,NM,OK,TX
<u>Subfamily Caesalpinoideae, Tribe Cassieae</u>			
<i>Chamaecrista fasciculata</i> *	N	A	AL,AR,CT,DE,FL,GA,IL,IN, IO,KS,KY,LA, MD,MA,MI,MN,MS,MO,NE,NJ,NM, NY,NC,OH,OK,PA,RI,SC,SD,TN, TX,VA,WV,WI
<i>Chamaecrista lineate</i> *	N	P	FL,PR,VI
<i>Senna ripleyana</i> *	N	P	TX

CATEGORY 4: Threatened, endangered, or sensitive species in the Fabaceae family

Species selected for testing marked with * in Category 3, above; complete list in Table 3; if not available a different species in the same genus may be substituted

** Species has been substituted. See text for justification.

CATEGORY 5: Species in other families in the Fabales order

No other families are currently listed in the Fabales order

CATEGORY 6: Species in other orders that have some relationship to *Pueraria montana* var. *lobata*

Species in other orders that are phylogenetically related to the Fabaceae:

Order Sapindales, Family Sapindaceae

<i>Cardiospermum halicacabum</i>	N	A/B/P	AL,AR,CT,DE,FL,GA,HI,IL,IN, KS,KY,LA, MA,MI,MS,MO,NJ,NY, OH,OK,PA,PR,SC,TN,TX,VI
<i>Koelreuteria paniculata</i> [goldenrain tree]	I	P	IL,IN,KS,KY,LA,MD,MA,NY,NC,OH,PA, TN,TX,UT,VA,WV
<i>Sapindus saponaria</i>	N	P	AL,AZ,AR,CO,FL,GA, HI,KS,LA, MS,MO, NM,OK,PR,TX,VI

Order Rosales, Family Chrysobalanaceae

<i>Chrysobalanus icaco</i>	N	P	FL,PR,VI
<i>Licania michauxii</i>	N	P	AL,FL,GA,LA,MS,SC

Order Rosales, Family Crossosomataceae

<i>Apacheria chiricahuensis</i>	N	P	AZ,NM,PR,VI
<i>Crossosoma bigelovii</i>	N	P	AZ,CA,NV
<i>Glossopetalon spinescens</i>	N	P	AZ,CA,CO,ID,MT,NV,NM, OK,OR,TX,UT,WA,WY

Species in other orders with biochemical characteristics in common with the Fabaceae:

None recommended for testing

Selected cultivated species in other orders:

None recommended for testing

^aOrigin: I, Introduced; N, Native.

^bLife Cycle: A, Annual; B, Biennial; P, Perennial.

TABLE 2
List of Economically Important Species in the Phaseoleae Tribe

Plant Species	Common Name	Subtribe	Range ^a
Species in the same genus as <i>Pueraria montana</i> var. <i>lobata</i> in the United States, Canada, or Mexico			
<i>Pueraria phaseoloides</i>	Tropical kudzu	Glycininae	HI,PR
Species in the same subtribe (Glycininae) as <i>Pueraria montana</i> var. <i>lobata</i> in the United States			
<i>Amphicarpaea bracteata</i>	American hogpeanut	Glycininae	AL,AR,CT,DE,FL,GA,IL,IN,IO,KS, KY,LA,MA,MD,ME,MI,MO,MN, MS,MT,NC,ND,NE,NH,NJ,NY,OH, OK,PA,RI,SC,SD,TN,TX,VA,VT, WI,WV
<i>Glycine max</i>	Soybean	Glycininae	AL,AR,DE,FL,GA,IL,IN,IO,KY,LA, MA,MD,MI,MN,MO,MS,NC,NJ, NY,OH,PA,SC,TN,VA,WI,WV,PR
<i>Neonotonia wightii</i>	Pasture legume	Glycininae	HI
Species in different subtribes in the same tribe (Phaseoleae) in the United States			
<i>Apios americana</i>	Groundnut	Erythrinae	AL,AR,CO,CT,DE,FL,GA,IL,IN,IO, KS,KY,LA,MA,MD,ME,MI,MN, MO,MS,NC,ND,NE,NH,NJ,NY,OH, OK,PA,RI,SC,SD,TN,TX,VA,VT, WA,WV
<i>Cajanus</i> spp.	Pigeon pea	Cajaninae	FL,HI,MD,PR,VI
<i>Canavalia</i> spp.	Jackbean	Diocleinae	AL,AZ,AR,FL,GA,HI,IL,KS,LA, MO,MS,OK,PR,TX,VI
<i>Centrosema</i> spp.	Butterfly pea	Clitoriinae	AL,AR,DE,FL,GA,KY,LA,MD,MS, NC,NJ,OK,PR,SC,TN,TX,VA,PR,VI
<i>Clitoria</i> spp.	Butterfly pea	Clitoriinae	FL,HI,TX,PR,VI
<i>Erythrina</i> spp.	Erythrina	Erythrinae	AZ,FL,GA,MS,NC to TX,PR,Mex
<i>Lablab purpureus</i>	Bonavist bean	Phaseolinae	FL,GA,HI,LA,MD,NV,OH,PA,VA, WI,WV,PR
<i>Macroptilium</i> spp.	Bushbean	Phaseolinae	AZ,FL,HI,NM,PR,TX
<i>Mucuna</i> spp.	Mucuna	Erythrinae	FL,HI,NC,PR,SC,VI
<i>Oxyrhynchus volubilis</i>	Twining bluehood	Phaseolinae	TX
<i>Pachyrhizus erosus</i>	Yam bean	Diocleinae	FL,HI,PR,VI
<i>Phaseolus</i> spp.	Bean	Phaseolinae	AL,AR,AK,CA,CT,DE,FL,GA,IL, IN,IO,KY,LA,MA,MD,ME,MI,MO, MS,NC,NE,NH,NJ,NM,NY,OH,OK, PA,PR,RI,SC,SD,TN,TX,UT,VA, WV,VI
<i>Psophocarpus tetragonolobus</i>	Winged bean	Phaseolinae	FL

<i>Rhynchosia</i> spp.	Snoutbean	Cajaninae	AL,AR,DE,FL,GA,HI,KY,LA,MD, MS,NC,PR,SC,TN,TX,VA,VI,WV
<i>Vigna</i> spp.		Phaseolinae	AL,DE,FL,GA,HI,IL,IN,LA,MD, MI,MO,MS,NC,PA,PR,SC,TX, VA,VI

^a Range: Postal abbreviations have been used for U.S. states; DomRep = Dominican Republic; Mex = Mexico; PR = Puerto Rico; VI = Virgin Islands.

SOURCES FOR TABLE 2

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TABLE 3
List of Threatened, Endangered, or Sensitive Species in the Fabaceae Family

Plant Species	Common Name	Classification ^a	Status ^b	Historic Range ^c
Species in the same genus as <i>Pueraria montana</i> var. <i>lobata</i> in the United States, Canada, or Mexico				
None				
Species in the same subtribe (Glycininae) as <i>Pueraria montana</i> var. <i>lobata</i> in the United States				
None				
Species in different subtribes in the same tribe (Phaseoleae) in the United States				
Species currently listed, proposed for listing, or candidate				
<i>Apios priceana</i>	Price's potato bean	Erythrinae	T	AL,IL,KY,MS,TN
<i>Canavalia molokaiensis</i>	'Awikiwiki	Diocleinae	E	HI
<i>Canavalia napaliensis</i>	Jack-bean	Diocleinae	C	HI
<i>Canavalia pubescens</i>	Jack-bean	Diocleinae	C	HI
<i>Clitoria fragrans</i>	Pigeon wings	Clitoriinae	T	FL
<i>Galactia smallii</i>	Small's milkpea	Diocleinae	E	FL
<i>Vigna o-wahuensis</i>	(None)	Phaseolinae	E	HI
Species of concern				
<i>Galactia eggersii</i>	Eggers' milkpea	Diocleinae	C2	VI
<i>Galactia pinetorum</i>	Pineland milkpea	Diocleinae	C2	FL
<i>Phaseolus supinus</i>	Supine bean	Phaseolinae	C2	AZ,Mex
Species in different tribes in the same subfamily (Papilionoideae) in the continental United States.				
Species currently listed, proposed for listing, or candidate				
<i>Aeschynomene virginica</i>	Sensitive joint-vetch	Aeschynomemeae	T	DE,MD,NC,NJ, PA,VA
<i>Amorpha crenulata</i>	Crenulate lead-plant	Amorpheae	E	FL
<i>Astragalus albens</i>	Cushenbury milk-vetch	Galegeae	E	CA
<i>Astragalus ampullarioides</i>	Shivwits milk-vetch	Galegeae	E	UT
<i>Astragalus applegatei</i>	Applegate's milk-vetch	Galegeae	E	OR
<i>Astragalus bibullatus</i>	Guthrie's ground-plum	Galegeae	E	TN
<i>Astragalus brauntonii</i>	Braunton's milk-vetch	Galegeae	E	CA
<i>Astragalus clarianus</i>	Clara Hunt's milk-vetch	Galegeae	E	CA
<i>Astragalus cremnophylax</i> var. <i>cremnophylax</i>	Sentry milk-vetch	Galegeae	E	AZ
<i>Astragalus desereticus</i>	Deseret milk-vetch	Galegeae	T	UT
<i>Astragalus equisolensis</i>	Horseshoe milk-vetch	Galegeae	C	UT
<i>Astragalus holmgreniorum</i>	Holmgren milk-vetch	Galegeae	E	AZ,UT
<i>Astragalus humillimus</i>	Mancos milk-vetch	Galegeae	E	CO,NM
<i>Astragalus jaegerianus</i>	Lane Mtn. milk-vetch	Galegeae	E	CA
<i>Astragalus lentiginosus</i> var. <i>coachellae</i>	Coachella Valley milk-vetch	Galegeae	E	CA

<i>Astragalus lentiginosus</i> var. <i>piscinensis</i>	Fish Slough milk-vetch	Galegeae	T	CA
<i>Astragalus magdalenae</i> var. <i>piersonii</i>	Peirson's milk-vetch	Galegeae	T	CA
<i>Astragalus montii</i>	Heliotrope milk-vetch	Galegeae	T	UT
<i>Astragalus osterhoutii</i>	Osterhout milk-vetch	Galegeae	E	CO
<i>Astragalus pycnostachys</i> var. <i>lanosissimus</i>	Ventura marsh milk-vetch	Galegeae	E	
<i>Astragalus phoenix</i>	Ash Meadows milk-vetch	Galegeae	T	NV
<i>Astragalus robbinsii</i> var. <i>jesupi</i>	Jesup's milk-vetch	Galegeae	E	NH,VT
<i>Astragalus tener</i> var. <i>titi</i>	Coastal dunes milk-vetch	Galegeae	E	CA
<i>Astragalus tortipes</i>	Sleeping Ute milk-vetch	Galegeae	C	CO
<i>Astragalus tricarinatus</i>	Triple-ribbed milk-vetch	Galegeae	E	CA
<i>Baptisia arachnifera</i>	Hairy rattleweed	Thermopsidae	E	GA
<i>Crotalaria avonensis</i>	Avon Park harebells	Crotalariaeae	E	FL
<i>Dalea carthagenensis</i> var. <i>floridana</i>	Florida prairie-clover	Amorpheae	C	FL
<i>Dalea foliosa</i>	Leafy prairie-clover	Amorpheae	E	AL,IL,TN
<i>Indigofera mucronata</i> var. <i>keyensis</i>	Asian indigo	Indigofereae	C	FL
<i>Lespedeza leptostachya</i>	Prairie bush-clove	Desmodieae	T	IA,IL,MN,WI
<i>Lotus dendroideus</i> ssp. <i>traskiae</i>	San Clemente Island Broom	Loteae	E	CA
<i>Lupinus aridorum</i>	Scrub lupine	Genisteae	E	FL
<i>Lupinus nipomensis</i>	Nipomo Mesa lupine	Genisteae	E	CA
<i>Lupinus sulphureus</i> ssp. <i>kincaidii</i>	Willamette Valley lupine	Genisteae	T	OR,WA
<i>Lupinus tidestromii</i>	Clover lupine	Genisteae	E	CA
<i>Oxytropis campestris</i> var. <i>chartacea</i>	Fassett's locoweed	Galegeae	T	WI
<i>Sesbania tomentosa</i>	'Ohai	Robineae	E	HI
<i>Trifolium amoenum</i>	Showy Indian clover	Trifolieae	E	CA
<i>Trifolium stoloniferum</i>	Running buffalo clover	Trifolieae	E	AR,IL,IN,KS,KY, MO,OH,WV
<i>Trifolium trichocalyx</i>	Monterey clover	Trifolieae	E	CA
<i>Vicia menziesii</i>	Hawaiian vetch	Vicieae	E	HI

Species of concern

<i>Amorpha georgiana</i> var. <i>confusa</i>	Carolina lead-plant	Amorpheae	C2	NC
<i>Amorpha georgiana</i> var. <i>georgiana</i>	Georgia lead-plant	Amorpheae	C2	GA,NC,SC
<i>Amorpha ouachitensis</i>	False indigo	Amorpheae	C2	AR,OK
<i>Astragalus aequalis</i>	Clokey's milk-vetch	Galegeae	C2	NV
<i>Astragalus amphioxys</i> var. <i>musimonum</i>	Crescent milk-vetch	Galegeae	C2	AZ,NV
<i>Astragalus ampullarius</i>	Gumbo milk-vetch	Galegeae	C2	AZ,UT

<i>Astragalus anisus</i>	Gunnison milk-vetch	Galegeae	C2	CO
<i>Astragalus anserinus</i>	Goose Creek milk-vetch	Galegeae	C2	ID,NV,UT
<i>Astragalus atratus</i> var. <i>inseptus</i>	Fairfield milk-vetch	Galegeae	C2	ID
<i>Astragalus brandegeei</i>	Brandegee's milk-vetch	Galegeae	C2	CO
<i>Astragalus cobrensis</i> var. <i>maguirei</i>	Coppermine milk-vetch	Galegeae	C2	AZ
<i>Astragalus collinus</i> var. <i>laurentii</i>	Laurent's milk-vetch	Galegeae	C2	OR
<i>Astragalus cremnophylax</i> var. <i>myriorrhaphis</i>	Cliff milk-vetch	Galegeae	C2	AZ
<i>Astragalus cronquistii</i>	Cronquist milk-vetch	Galegeae	C2	CO, UT
<i>Astragalus cusickii</i> var. <i>sterilis</i> (= <i>A. sterilis</i>)	Sterile milk-vetch	Galegeae	C2	ID, OR
<i>Astragalus deanei</i>	Deane's milk-vetch	Galegeae	C2	CA
<i>Astragalus debequaeus</i>	Debeque milk-vetch	Galegeae	C2	CO
<i>Astragalus deterior</i>	Cliff-palace milk-vetch	Galegeae	C2	CO
<i>Astragalus diaphanus</i> (= <i>A. daiphanus</i> var. <i>diumus</i>)	Transparent milk-vetch	Galegeae	C2	OR, WA
<i>Astragalus douglasii</i> var. <i>perstrictus</i>	Jacumba milk-vetch	Galegeae	C2	CA
<i>Astragalus drabelliformis</i>	Bastard draba milk-vetch	Galegeae	C2	WY
<i>Astragalus ertterae</i>	Ertter's milk-vetch	Galegeae	C2	CA
<i>Astragalus eurylobus</i>	Needle Mountain milk-vetch	Galegeae	C2	UT
<i>Astragalus funereus</i>	Black wooly-pod	Galegeae	C2	CA, NV
<i>Astragalus geyeri</i> var. <i>triquetrus</i>	Geyer's milk-vetch	Galegeae	C2	AZ, NV
<i>Astragalus gilmanii</i>	Gilman's milk-vetch	Galegeae	C2	CA, NV
<i>Astragalus gilviflorus</i> var. <i>purpureus</i>	Plains milk-vetch	Galegeae	C2	WY
<i>Astragalus hamiltonii</i>	Hamilton milk-vetch	Galegeae	C2	UT
<i>Astragalus howellii</i>	Howell's milk-vetch	Galegeae	C2	OR
<i>Astragalus hypoxylus</i>	Huachuca Mountain milk-vetch	Galegeae	C2	AZ, Mex
<i>Astragalus jejunus</i> var. <i>articulatus</i>	Starveling milk-vetch	Galegeae	C2	WY
<i>Astragalus kerrii</i>	Kerr's milk-vetch	Galegeae	C2	AZ
<i>Astragalus knightii</i>	Knight's milk-vetch	Galegeae	C2	NM
<i>Astragalus lentiformis</i>	Lens pod milk-vetch	Galegeae	C2	CA
<i>Astragalus lentiginosus</i> var. <i>ambiguus</i>	Freckled milk-vetch	Galegeae	C2	AZ
<i>Astragalus lentiginosus</i> var. <i>antoniuis</i>	Freckled milk-vetch	Galegeae	C2	CA
<i>Astragalus lentiginosus</i> var. <i>micans</i>	Shining milk-vetch	Galegeae	W	CA
<i>Astragalus lentiginosus</i> var. <i>pohilii</i>	Pohil's milk-vetch	Galegeae	C2	UT
<i>Astragalus lentiginosus</i> var. <i>scorpionis</i>	Scorpion milk-vetch	Galegeae	C2	NV, UT
<i>Astragalus lentiginosus</i>	Sodaville milk-vetch	Galegeae	W	CA, NV

<i>var. sesquimetralsis</i>				
<i>Astragalus lentiginosus</i>	Big-bear milk-vetch	Galegeae	C2	CA
<i>var. sierrae</i>				
<i>Astragalus leucolobus</i>	Bear Valley wooly-pod	Galegeae	C2	CA
<i>Astragalus limnocharis</i>	Cedar Breaks milk-vetch	Galegeae	C2	UT
<i>var. limnocharis</i>				
<i>Astragalus michauxii</i>	Sandhills milk-vetch	Galegeae	C2	GA,NC,SC
<i>Astragalus microcymbus</i>	Skiff milk-vetch	Galegeae	C2	CO
<i>Astragalus mohavensis</i>	Curve-podded Mojave	Galegeae	C2	CA,NV
<i>var. hemigyryus</i>	milk-vetch			
<i>Astragalus mollissimus</i>	Withered wooly milk-vetch	Galegeae	C2	TX
<i>var. marcidus</i>				
<i>Astragalus molybdenus</i>	Leadville milk-vetch	Galegeae	C2	CO,UT
<i>Astragalus neglectus</i>	Cooper's milk-vetch	Galegeae	C2	MI,MN,OH,WI
<i>Astragalus nutriosensis</i>	Nutriosa milk-vetch	Galegeae	C2	AZ
<i>Astragalus occarpus</i>	Descanso milk-vetch	Galegeae	C2	CA
<i>Astragalus oophorus</i>	Egg milk-vetch	Galegeae	W	NV
<i>var. clokeyanus</i>				
<i>Astragalus oophorus</i>	Lavin's milk-vetch	Galegeae	C2	CA,NV
<i>var. lavinii</i>				
<i>Astragalus oophorus</i>	Egg milk-vetch	Galegeae	C2	NV,UT
<i>var. lonchocalyx</i>				
<i>Astragalus pachypus</i>	Jaeger's bush milk-vetch	Galegeae	C2	CA
<i>var. jaegeri</i>				
<i>Astragalus paysonii</i>	Payson's milk-vetch	Galegeae	C2	ID,OR
<i>Astragalus peckii</i>	Peck's milk-vetch	Galegeae	C2	OR
<i>Astragalus preussii</i>	Preuss' milk-vetch	Galegeae	C2	UT
<i>var. cutleri</i>				
<i>Astragalus proimanthus</i>	Precocious milk-vetch	Galegeae	C2	WY
<i>Astragalus proximus</i>	Aztec milk-vetch	Galegeae	C2	CO,NM
<i>Astragalus pulsiferae</i>	Suksdorf's milk-vetch	Galegeae	C2	CA,WA
<i>var. suksdorfii</i>				
<i>Astragalus ravenii</i>	Raven's milk-vetch	Galegeae	C2	CA
(= <i>A. monoensis</i> var. <i>ravenii</i>)				
<i>Astragalus remotus</i>	Spring Mountain milk-vetch	Galegeae	C2	NV
<i>Astragalus ripleyi</i>	Ripley milk-vetch	Galegeae	C2	CO,NM
<i>Astragalus robbinsii</i>	Western milk-vetch	Galegeae	C2	NV
<i>var. occidentalis</i>				
<i>Astragalus sabulosus</i>	Cisco milk-vetch	Galegeae	C2	UT
<i>Astragalus schmolliae</i>	Schmoll milk-vetch	Galegeae	C2	CO
<i>Astragalus serpens</i>	Plateau milk-vetch	Galegeae	C2	UT
<i>Astragalus sinuatus</i>	Whited milk-vetch	Galegeae	C2	WA
<i>Astragalus solitarius</i>	Weak milk-vetch	Galegeae	C2	NV,OR
<i>Astragalus subcinereus</i>	Silver's milk-vetch	Galegeae	C2	UT
(= <i>A. subcinereus</i> var. <i>basalticus</i>)				
<i>Astragalus tegetarioides</i>	Bastard milk-vetch	Galegeae	C2	CA,OR
<i>Astragalus tener</i>	Sacramento Valley	Galegeae	C2	CA
<i>var. ferrisae</i>	milk-vetch			
<i>Astragalus tiehmii</i>	Tiehm's milk-vetch	Galegeae	C2	NV

<i>Astragalus traskiae</i>	Trask's milk-vetch	Galegeae	C2	CA
<i>Astragalus tyghensis</i> (= <i>A. spaldingii</i> var. <i>tyghensis</i>)	Tygh Valley milk-vetch	Galegeae	C2	OR
<i>Astragalus uncialis</i>	Currant milk-vetch	Galegeae	C2	NV,UT
<i>Astragalus vexilliflexus</i> var. <i>nubilus</i>	White Cloud's milk-vetch	Galegeae	C2	ID
<i>Astragalus webberi</i>	Webber's milk-vetch	Galegeae	C2	CA
<i>Astragalus xiphoides</i>	Gladiator milk-vetch	Galegeae	C2	AZ
<i>Astragalus yoder-williamsii</i>	Osgood Mtns. milk-vetch	Galegeae	C2	ID,NV
<i>Baptisia calycosa</i> var. <i>calycosa</i>	Florida wild indigo	Thermosideae	C2	FL
<i>Baptisia calycosa</i> var. <i>villosa</i> (= <i>B. calycosa</i> var. <i>hirsuta</i> = <i>B. hirsuta</i>)	Hairy wild indigo	Thermosideae	C2	FL
<i>Baptisia simplicifolia</i>	Scareweed	Thermosideae	C2	FL
<i>Brongniartia minutifolia</i>	Little-leaf brongniartia	Brongniartieae	C2	TX,Mex
<i>Dalea bartoni</i>	Cox's dalea	Amorpheae	C2	UT
<i>Dalea flavescens</i> (= <i>Dalea flavescens</i> var. <i>epica</i>)	Hole-in-the-rock prairie-clover	Amorpheae	C2	UT
<i>Dalea reverchonii</i>	Comanche-peak prairie-clover	Amorpheae	C2	TX
<i>Dalea sabinalis</i>	Sabinal prairie-clover	Amorpheae	C2	TX
<i>Dalea tentaculoides</i>	Gentry's indigobush	Amorpheae	W	AZ
<i>Desmodium humifusum</i>	Ground-spreading tick-trefoil	Sophoreae	C2	CT,DE,MA,MD, NJ,NY,PA
<i>Desmodium lindheimeri</i>	Lindheimer's tickseed	Sophoreae	C2	TX,Mex
<i>Genistidium dumosum</i>	Brush-pea	Robinieae	C2	TX,Mex
<i>Hedysarum occidentale</i> var. <i>canone</i>	Western sweetvetch	Hedysareae	C2	UT
<i>Lathyrus biflorus</i>	Two-flowered lathyrus	Vicieae	W	CA
<i>Lathyrus grimesii</i>	Grime's pea	Vicieae	C2	CA
<i>Lathyrus jepsonii</i> ssp. <i>jepsonii</i>	Delta tule-pea	Vicieae	C2	CA
<i>Lotus argophyllus</i> var. <i>niveus</i>	Santa Cruz Island silver hosackia	Loteae	C2	CA,Mex
<i>Lotus crassifolius</i> var. <i>otayensis</i>	Otay lotus	Loteae	C2	CA
<i>Lotus nuttallianus</i>	Prostrate hosackia	Loteae	C2	CA,Mex
<i>Lotus rubriflorus</i>	Red-flowered lotus	Loteae	C2	CA
<i>Lotus unifoliatius</i> var. <i>helleri</i> (= <i>L. purshianus</i> var. <i>helleri</i>)	Heller's bird's foot trefoil	Loteae	C2	GA,NC,SC,VA
<i>Lupinus antoninus</i>	Anthony Peak lupine	Genisteae	C2	CA
<i>Lupinus citrinus</i>	Orange lupine	Genisteae	C2	CA
<i>Lupinus citrinus</i> var. <i>deflexus</i>	Mariposa lupine	Genisteae	W	CA
<i>Lupinus constancei</i>	Lassicus lupine	Genisteae	C2	CA
<i>Lupinus crassus</i>	Paradox lupine	Genisteae	C2	CO
<i>Lupinus cusickii</i>	Cusick's lupine	Genisteae	C2	ID,OR,WA
<i>Lupinus duranii</i>	Mono Lake lupine	Genisteae	C2	CA
<i>Lupinus excubitus</i> var. <i>medius</i>	Mountain Springs bush lupine	Genisteae	C2	CA

<i>Lupinus eximius</i> (= <i>L. arboreus</i> var. <i>eximius</i>)	San Mateo tree lupine	Genisteae	C2	CA
<i>Lupinus guadalupensis</i>	Guadalupe Island lupine	Genisteae	C2	CA,Mex
<i>Lupinus luteolus</i> (= <i>L. milo-bakeri</i>)	Milo Baker's lupine	Genisteae	C2	CA
<i>Lupinus ludovicianus</i>	San Luis lupine	Genisteae	C2	CA
<i>Lupinus magnificus</i> var. <i>magnificus</i>	Panamint Mountains lupine	Genisteae	C2	CA
<i>Lupinus oreganus</i> var. <i>oreganus</i> (= <i>L. biddlei</i>)	Biddle's lupine	Genisteae	C2	OR
<i>Lupinus padre-crowleyi</i>	DeDecker's lupine	Genisteae	C2	CA
<i>Lupinus spectabilis</i>	Shaggy-hair lupine	Genisteae	C2	CA
<i>Lupinus westianus</i>	Gulfcoast lupine	Genisteae	C2	FL
<i>Marina orcuttii</i> var. <i>orcuttii</i>	California marina	Amorpheae	C2	CA
<i>Orbexilum macrophyllum</i> (= <i>Psoralea macrophylla</i>)	Bigleaf scurfpea	Psoraleeae	3A/C2*	IN,KY,NC
<i>Oxytropis arctica</i> var. <i>barnebyana</i> (= <i>O. sordida</i> ssp. <i>barnebyana</i>)	Barneby's locoweed	Galegeae	C2	AK
<i>Oxytropis campestris</i> var. <i>wanapum</i>	Field locoweed	Galegeae	C2	WA
<i>Pediomelum aromaticum</i> (= <i>P. aromaticum</i> var. <i>tuihi</i>)	Aromatic Indian breadroot	Psoraleeae	C2	UT
<i>Pediomelum castoreum</i>	Beaver Indian breadroot	Psoraleeae	C2	AZ,CA,NV,UT
<i>Pediomelum megalanthum</i> var. <i>epipsulum</i> (= <i>Pediomelum epipsilum</i>)	Intermountain Indian breadroot	Psoraleeae	C2	AZ,UT
<i>Pediomelum humile</i>	Rydberg's scurf-pea	Psoraleeae	C2	TX,Mex
<i>Pediomelum pariensis</i>	Paria River Indian breadroot	Psoraleeae	C2	UT
<i>Pediomelum pentaphyllum</i>	Three-nerved scurf-pea	Psoraleeae	C2	NM,TX,Mex
<i>Psorothamnus polyadenius</i> var. <i>jonesii</i>	Jone's dalea	Amorpheae	C2	UT
<i>Psorothamnus thompsonae</i> var. <i>whitingii</i>	Whiting's dalea	Amorpheae	C2	AZ,UT
<i>Sophora leachiana</i>	Western necklacepod	Sophoreae	C2	OR
<i>Tephrosia angustissima</i>	Narrowleaf hoarypea	Tephrosieae	C2	FL
<i>Tephrosia mohrii</i>	Pineland hoary-pea	Tephrosieae	C2	AL,FL,GA
<i>Thermopsis californica</i> var. <i>semota</i> (= <i>T. macrophylla</i> var. <i>semota</i>)	Velvety false-lupine	Thermopsideae	C2	CA
<i>Thermopsis macrophylla</i> (= <i>T. macrophylla</i> var. <i>agnina</i>)	Santa Barbara false-lupine	Thermopsideae	C2	CA
<i>Trifolium andinum</i> var. <i>podocephalum</i>	Intermountain clover	Trifolieae	C2	NV
<i>Trifolium barnebeyi</i>	(None)	Trifolieae	C2	WY
<i>Trifolium bolanderi</i>	Parasol clover	Trifolieae	C2	CA
<i>Trifolium calcaricum</i>	Running glade clover	Trifolieae	C2	TN,VA
<i>Trifolium frscanum</i> (= <i>T. andersonii</i> var. <i>friscanum</i>)	Frisco clover	Trifolieae	C2	UT
<i>Trifolium leibergii</i>	Leiberg's clover	Trifolieae	C2	OR,NV
<i>Trifolium neurophyllum</i>	White Mountain clover	Trifolieae	C2	AZ,NM

(= *T. longipes* var. *neurophyllum*)

<i>Trifolium owyheense</i>	Owyhee colver	Trifolieae	C2	ID,OR
<i>Trifolium rollinsii</i>	Rollin's clover	Trifolieae	C2	NV
(= <i>T. macilentum</i> var. <i>rollinsii</i>)				
<i>Vicia ocalensis</i>	Ocala vetch	Vicieae	C2	FL

**Species in different subfamilies in the same family (Fabaceae) in the continental United States
Species currently listed, proposed for listing, or candidate**

<i>Caesalpinia kawaiense</i>	Uhiuhi	Caesalpinieae	E	HI
<i>Chamaecrista glandulosa</i> var. <i>mirabilis</i>	Jamaican Broom	Cassieae	E	PR
<i>Chamaecrista lineata</i> var. <i>keyensis</i>	Big Pine partridge pea	Cassieae	C	FL
<i>Hoffmannseggia tenella</i>	Slender rush-pea	Caesalpinieae	E	TX
<i>Kanaloa kahoolawensis</i>	Kohe malama malama o kanaloa	Mimosoideae	E	HI
<i>Serianthes nelsonii</i>	Hayun lagu	Ingeae	E	Guam, Rota
<i>Stahlia monosperma</i>	Cobana negra	Caesalpinieae	T	PR, DomRep

Species of concern

<i>Acacia koaia</i>	Koai'e	Acacieae	C2	HI
<i>Caesalpinia brachycarpa</i>	Broad-pod rush-pea	Caesalpinieae	C2	TX
<i>Caesalpinia culebrae</i>	Mato amarillo	Caesalpinieae	C2	PR
<i>Caesalpinia portoricensis</i>	Mato	Caesalpinieae	3B	PR
<i>Chamaecrista fasciculata</i> var. <i>macrosperma</i> (= <i>Cassia fasciculata</i> var. <i>macrosperma</i>)	Sleepingplant	Cassieae	C2	MD, VA
<i>Mimosa quadrivalvis</i> var. <i>urbaniana</i> (= <i>Schrankia portoricensis</i>)	Zarzarilla	Mimoseae	C2	PR
<i>Senna riplejana</i>	Ripley's senna	Cassieae	C2	TX, Mex

^aClassification: Subtribe is listed for species in the Phaseoleae tribe; tribe is listed for all others.

^bStatus:

Listed Species:

E = Endangered.

T = Threatened.

C = Candidates, Taxa for which the U.S. Fish and Wildlife Service has sufficient information on biological status and threats to propose them as endangered or threatened species.

Species of Concern: In 1996, the U. S. Fish and Wildlife Service completed an exhaustive review of the 1993 list. Listing of Category 2 and Category 3 species was discontinued although the Service remains concerned about and acknowledges the need for further biological and field study of these species.

3A = Taxa for which the U.S. Fish and Wildlife Service has persuasive evidence of extinction. If rediscovered, such taxa might have a high priority for listing.

3B = Taxa which have names that, on the basis of current taxonomic understanding, do not represent distinct taxa meeting the definition of "species." Such taxa could be reevaluated in the future on the basis of new information.

C2 = Category 2, In 1993, the U. S. Fish and Wildlife Service assigned Category 2 status to taxa for which the Service had information indicating that proposing to list as threatened or endangered was

possibly appropriate, but for which sufficient data on biological vulnerability and threat were not currently available to support proposed rules.

C2* = Category 2 taxa believed extirpated in the wild.

W = Withdrawn, Species withdrawn from proposed listing. The service will continue to monitor the status of these species and may reevaluate the need for their listing at any time in the future.

^cHistoric Range: Postal abbreviations have been used for U.S. states; DomRep = Dominican Republic; Mex = Mexico; PR = Puerto Rico; VI = Virgin Islands.

SOURCES FOR TABLE 3

USDI-US Fish & Wildlife Service. 2004. Threatened and Endangered Species System (TESS).
http://ecos.fws.gov/tess_public/TESSWebpage

USDI-US Fish & Wildlife Service. 1997. Endangered and threatened species, Review of plant and animal taxa; Proposed Rule:50 CFR Part 17.

USDI-US Fish & Wildlife Service. 1994. Endangered and threatened wildlife and plants: 50 CFR 17.11 & 17.12.

USDI-US FISH & Wildlife Service. 1993. Plant taxa for listing as endangered or threatened species; Notice of Review: Federal Register Part IV-50 CFR Part 17.

TABLE 4

List of Potential Sources of Threatened, Endangered, and Sensitive Species Proposed for Testing

<i>Apios priceana</i>	Missouri Botanical Garden	www.mobot.org
<i>Aeschynomene virginica</i>	New England Wildflower Society	www.newfs.org
<i>Amorpha herbacea</i> var. <i>crenulata</i>	Fairchild Tropical Garden	www.ftg.org
<i>Astragalus applegatei</i>	Berry Botanic Garden	www.berrybot.org
<i>Astragalus bibullatus</i>	Missouri Botanical Garden	www.mobot.org
<i>Baptisia arachnifera</i>	Chattahoochee Nature Center Greenhouse	www.chattnaturecenter.com
<i>Clitoria fragrans</i>	Florida Division of Forestry	www.fl-dof.com
<i>Crotalaria avonensis</i>	Bok Tower Gardens	www.boktower.org
<i>Dalea carthagenensis</i> var. <i>floridana</i>	No Source Identified	
<i>Dalea foliosa</i>	Missouri Botanical Garden	www.mobot.org
<i>Galactia pinetorum</i>	No Source Identified	
<i>Galactia smallii</i>	Fairchild Tropical Garden	www.ftg.org
<i>Indigofera mucronata</i> var. <i>keyensis</i>	No Source Identified	
<i>Lespedeza leptostachya</i>	Chicago Center for Endangered Plants	www.chicagobotanic.org
<i>Lupinus aridoru</i>	Florida Division of Forestry	www.fl-dof.com
<i>Lupinus sulphureus</i> ssp. <i>kincaidii</i>	Tom Kaye	kayet@bcc.orst.edu
<i>Phaseolus supinus</i>	Desert Legume Program	ag.arizona.edu/bta/bta20.html
<i>Trifolium stoloniferum</i>	Missouri Botanical Garden	www.mobot.org