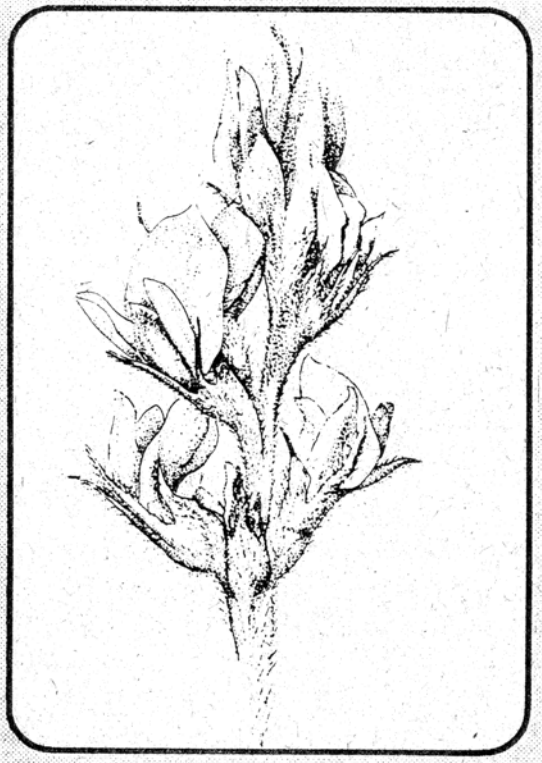
Prairie Bush Clover

Recovery Plan



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Cover illustration of a portion of the inflorescence of *Lespedeza leptostachya* (Prairie bush clover) by Vera Ming Wong, 1988.

Recovery Plan for

Prairie Bush-Clover (*Lespedeza leptostachya*)

September 1988

by

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DISCLAIMER

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Literature citations should read as follows:

U.S. Fish and Wildlife Service 1988. Lespedeza leptostachya Recovery Plan. U.S. Fish and Wildlife Service, Twin Cities, Minnesota. 41pp.

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Fish and Wildlife Reference Service
6011 Executive Boulevard
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PART I: INTRODUCTION

THE SPECIES

The prairie bush clover, (Lespedeza leptostachya) is an herbaceous perennial member of the pea family (Fabaceae). There are 40 members of this genus, of which 12 are native to North America (Clewell 1966a).

The sericeous stems of mature plants are erect, up to a meter tall, and may be either simple or branched. The linear or narrowly oblong leaflets of the trifoliate leaves are 2-4 cm long and 2-8 mm wide with appressed pubescence above and silky hairs below (Fox 1945). The longer terminal leaflets are less than half as wide as long, with petioles 2-10 mm long, (Figure 1). Vegetative characters of the species appear to vary somewhat throughout the range (Clewell 1966a).

Petals of the chasmogamous (open, potentially outcrossing), flowers are white, or yellowish-white (Fox 1945, Gambill 1953, Clewell 1966a) to light pink with a magenta mark in the center of the keel (Sather 1986, Smith 1986, Benish pers. comm.) and are between 4 and 6 mm in length. The cream-colored petals of closed, obligately self-pollinating cleistogamous flowers develop within and are usually surrounded by the calyx, which reaches a length of 4.5 to 5 mm when fully developed (Gleason and Cronquist 1963). Both types of flowers may occur on a single plant or an individual plant may exhibit cleistogamous flowers only. It is unknown if individuals can produce only chasmogamous flowers.

The sympatric Lespedeza capitata exhibits a more robust growth form and rounder leaflets than Lespedeza leptostachya. Lespedeza leptostachya has a spicate inflorescence with paired or single flowers borne cylindrically on spikes 2-4 cm long and 5-8 mm thick (Fernald 1950), whereas Lespedeza capitata has a globose, crowded inflorescence (Gleason 1952). The villous almost

white-wooly fruit pods of Lespedeza leptostachya are 3-4 mm long, equal to or barely exceeding the calyx, whereas those of Lespedeza capitata appear brown with only scattered hairs and are greatly exceeded by the calyx (Gleason 1952).

HISTORIC RANGE AND COLLECTION HISTORY

The former range of Lespedeza leptostachya included 27 counties in Minnesota, Wisconsin, Iowa and Illinois. The first specimens were collected by T. J. Hale in Wisconsin at Blue Mounds in Dane County in 1860 and in Grant and LaCrosse Counties in 1861. The history of subsequent collections and sightings of the species, suggests that prairie bush clover has always been found more often in Iowa than in the other three states (Watson 1983, Kurz and Bowles 1981, Alverson 1981, Smith 1986). Historic records for the species are summarized in Table 1. Figure 2 illustrates extant and historical distribution of Lespedeza leptostachya by county.

PRESENT RANGE AND STATUS OF POPULATIONS

Lespedeza leptostachya is endemic to midwestern prairies, and is presently known from 36 sites in 24 counties of northern Illinois, southern and western Wisconsin, southern Minnesota and Iowa (Figure 2). Table 2 summarizes the locations and status of extant populations.

Both the collection history and present distribution of Lespedeza leptostachya indicate that the species is most abundant in a "core" area which lies on drift of the Des Moines Lobe of the Wisconsin stage of glaciation, in northern Iowa and southern Minnesota. Habitats characteristic of core populations occur in conjunction with the Algona, Altamont, Bemis, and Humboldt stagnation moraines. These habitats are gentle, usually north-facing slopes of 10-15^{o} and with fine silty loam, fine sandy loam or clay loam. Specifically,

Figure 1. Whole plant, chasmogamous flowers and pods of Lespedeza leptostachya.

Table 1. Historic Collections of Lespedeza leptostachya.

State	County	Core or Peripheral	Initial date of report or collection	Site Name	Last known date of observation	Comments and Status
IL	McHenry	P		Union	1987	Could refer to extant site found 1986
	McHenry	P	1922	Crystal Lake	1922	Assumed extirpated
	Winnebago	P	1871	Fountaindale	1871	Assumed extirpated
	Winnebago	P	1950	Section 23	1950	Assumed extirpated
	Winnebago	P	1955	Shirland Twp	1955	Assumed extirpated
	Winnebago	P	1974	Rockford	1985	Extirpated in 1985
WI	Grant	P	1861	Potosi	1861	Location too general to verify
	Dane	P	1860	Blue Mounds	1860	Location too general to verify
	LaCrosse	P	1861	LaCrosse	1861	Location too general to verify
	Racine	P	1880	Barnes Prairie	1880	Prairie Destroyed
	Rock	P	1979	Rock Township	1979	Extirpated early 1980's
	Sauk	P	1970's	Spring Green Preserve	1970's	One plant in fenceline, 1970's, not observed since then
	Pierce	P	1980	Alexander Prairie	1981	No plants found in 1986
	Pierce	P	1970	Kinnickinic State Park	1970	No plants found in 1986
IA	Black Hawk	P	189?	By Waterloo	189?	Assumed extirpated
	Cerro Gordo	P	1959	N of Buffalo Slough	1959	Searched 1982, assumed extirpated
	Dickinson	C	1902	Milford	1902	Searched 1982, assumed extirpated
	Dickinson	C	1910	Terrace Park	1910	Searched 1982, assumed extirpated
	Dickinson	C	1948	Miller's Bay Prairie	1948	Searched 1982, assumed extirpated
	Dickinson	C	1921	Road to Manhattan	1921	Assumed extirpated
	Kossuth	C	1928	RR along Hwy 9	1928	Searched 1982, assumed extirpated
	Palo Alto	C	1944	S 8, T97, R34	1944	Searched 1982, assumed extirpated
	Winneshiek	P	1933	RR 1 mile W of Ridgeway	1933	Searched 1986, assumed extirpated
	Dickinson	C	1918	E of Little Sioux R	1918	Status unknown
	Dickinson	C	1919	NW of 2nd lookout	1919	Location too general to verify
	Dickinson	C	1938	Floete Prairie	1938	Searched in 1986, not relocated
	Dickinson	C	1965	S16, T99, R37	1965	Searched in 1988, not relocated
	Emmet	C	1900	Armstrong	1900	Status unknown
	Dickinson	C	1982	S13, T99, R36	1982	Searched in 1988, not relocated
	Dickinson	C	1982	S26, T99, R37	1982	Searched in 1988, not relocated
	Dickinson	C	1982	Bergmann Prairie S7, T100, R36	1982	Searched in 1988, not relocated
	Dickinson	C	1982	S35, T100, R38	1982	Searched 1988, not relocated
	Emmet	C	1922	High Lake Twp	1922	Status unknown
	Emmet	C	1947	4 Mile Lake Prairie	unknown	Status unknown
	Butler	P	1979	T90N R18W NW1/4 Sec 19	1979	Searched 1982, not relocated, heavily grazed
	Palo Alto	C	1922	Railroad north of Emmetsburg	1922	Searched 1982, not relocated
	Fayette	P	1897	(County)	unknown	Location too general to verify
	Floyd	P	1889	Near Marble Rock	1889	Status unknown,
	Hardin	P	1905	(County)	unknown	Location too general to verify
	Johnson	P	1913	(County)	unknown	Location too general to verify
	Lyon	P	1899	(County)	unknown	Report in county flora, unsubstantiated
	Madison	P	1904	(County)	unknown	Status unknown, too general to verify
	Sioux	P	1964	"State Park North of Hawarden"	1964	No state park here, status unknown but is a county park
	Story	P	1899	(County)	unknown	Could refer to site found 1985?
	Webster	C	1899	(County)	unknown	In state flora, unsubstantiated
MN	Rock	P	1884	(County)	unknown	In state flora, unsubstantiated
	Crow Wing	P	1890	Near Gull Lake	1890	Location too general to verify
EXCLUDED RECORDS						
IL	Adams		1942	Austin Creek		Specimen misidentified
	St. Clair/Monroe		1950	St. Clair County Line		Specimen misidentified
IA	Wapello		1953	Wapello County		Specimen misidentified
MO	Jefferson		1936	Jefferson County		Specimen misidentified

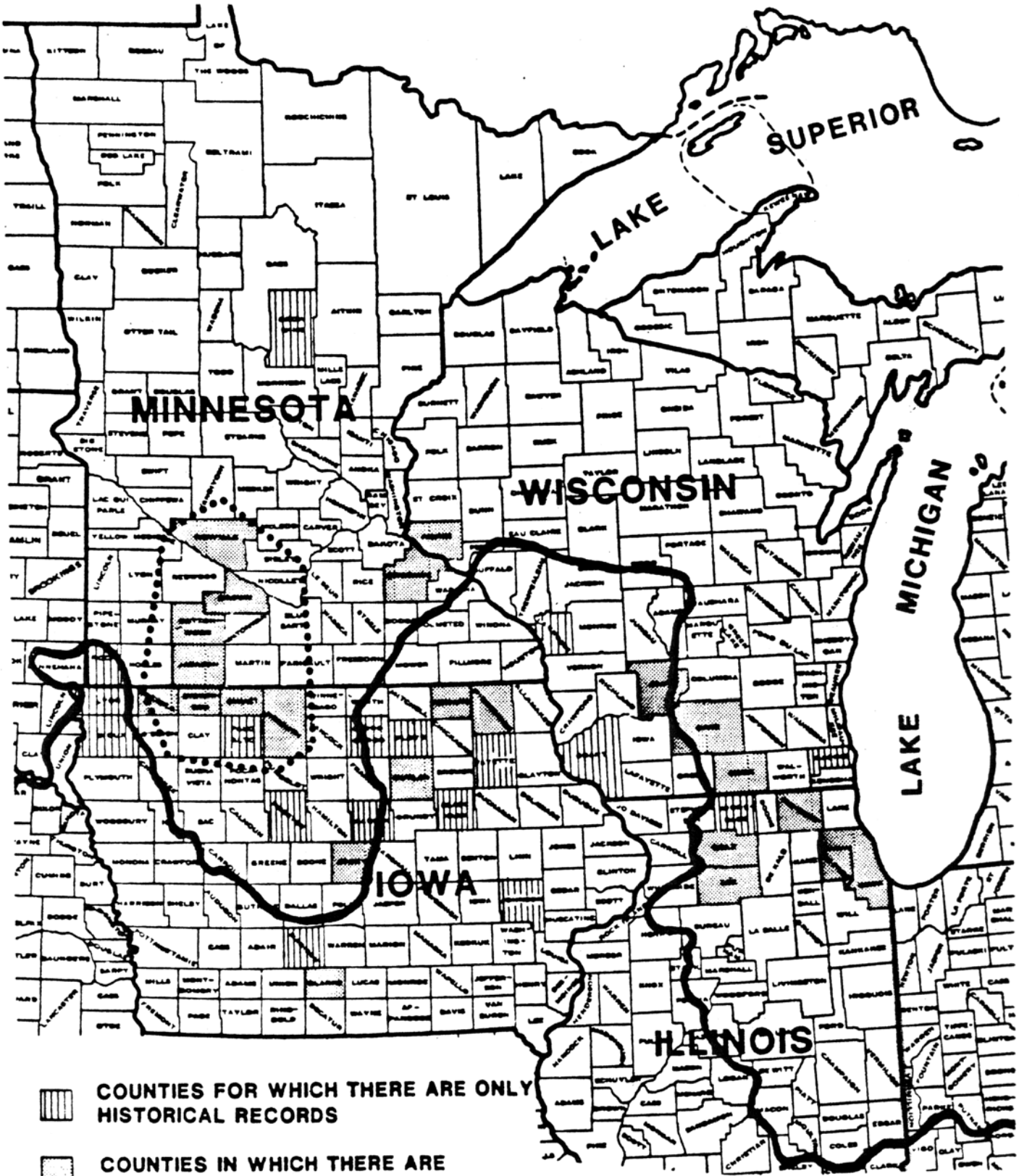

FIGURE 2: Present and historical distribution of Lespedeza leptostachya

Table 2. Known extant populations of Lespedeza leptostachya, as of 1989.

State	County	Site name	Ownership	Protection Status*	Range (Area)	# Plants	Last Seen
IA	Butler	Washington Prairie	Private	4	Peripheral	12	1987
	Clarke	Madison Prairie	Private	4	Peripheral	3000	1989
	Dickinson	Cayler	State	1	Core	4000	1987
	Dickinson	Freda Hafner Prairie	TNC/State	2/4	Core	1100	1987
	Dickinson	Lakeville Prairie #1	Private	4	Core	85	1986
	Dickinson	Lakeville Prairie #2	Private	4	Core	5	1988
	Emmet	Anderson Prairie	State	1	Core	281	1987
	Emmet	Fort Defiance State Park	State	3	Core	66	1987
	Howard	Hayden Prairie	State	1	Peripheral	20	1987
	Kossuth	Stinson Prairie	County/State	1	Core	45	1986
	Osceola	Wolter's Prairie	County	3	Core	75	1984
	Story	Franklin Prairie	Private	4	Core	95	1987
	Winneshiek	Ludwig Prairie	County	3	Peripheral	44	1987
IL	Cook	Shoe factory road	County	1	Peripheral	3	1989
	DuPage	Hinsdale Prairie	County	4	Peripheral	102	1989
	Lee	Nachusa grasslands/ Franklin Creek	TNC	2	Peripheral	318	1989
	Ogle	Nachusa grasslands/ Daysville	TNC	2	Peripheral	35	1989
	McHenry	Union Prairie	Private	2	Peripheral	35	1989
	McHenry	Hum Prairie	Private	2	Peripheral	4	1989
	Ogle	Stone Barn Prairie	TNC	2	Peripheral	5	1989
MN	Brown	North Star Road	Private	4	Core	4100	1989
	Brown	Stately Prairie	Private	4	Core	447	1989
	Cottonwood	Carson SNW	Private	4	Core	186	1989
	Cottonwood	Carson SSW	Private	4	Core	27	1989
	Cottonwood	Great Bend Prairie	Private	4	Core	30	1989
	Cottonwood	Red Rock/Delton Prairies	TNC, State, Pvt	2/3/4	Core	4000 est.	1989
	Goodhue	Stanton Prairie	Private	4	Peripheral	20 (believed extirpated)	1982
	Goodhue	McKnight Prairie	Private	3	Peripheral	23	1989
	Goodhue	Warsaw	Private	4	Peripheral	200 est.	1989
	Jackson	Kilen Woods State Park	State	1	Core	4219	1989
	Jackson	Belmont Prairie	Private	4	Core	700	1986
	Jackson	DesMoines Prairie	Private	4	Core	40	1980
	Jackson	Petersburg Prairie	Private	4	Core	20 (not relocated 1989)	1984
	Renville	Morton Outcrop	Private	4	Core	138	1988
WI	Dane	Westport Drumlin Prairie	State	1	Peripheral	100	1989
	Pierce	Riverfalls north and south	Private	4	Peripheral	64	1989
	Sauk	Schluckebier Prairie	TNC	2	Peripheral	100	1989
	Rock	Beloit Prairie	Township	3	Peripheral	18	1989
	Rock	Happy Hollow	Private	4	Peripheral	59	1989

* STATUS
1 Legally protected natural areas specifically managed for the protection of prairie bush clover populations.
2 Privately-owned or leased and managed natural areas.
3 Other publicly owned areas and areas owned by educational institutions, for which there may be conflicting uses.
4 Lands owned by private individuals or by corporations whose highest priority is not preservation as a natural area.

the Des Moines River basin and the Little Sioux basin seem to be of great importance for the species. Nine of the thirteen Iowa populations and nine of the twelve Minnesota populations lie within this "core" area.

"Peripheral" populations are defined as those outside the core area (Figure 2) and include two Minnesota populations, four Iowa populations and all seven Illinois and four Wisconsin populations.

Within the core area the habitat is consistent in slope, aspect, and substrate, whereas the habitat of peripheral populations appears to be more variable. Core populations are large, often numbering in the hundreds or thousands. Peripheral populations are smaller, numbering in the tens to hundreds (Table 2). Preliminary comparisons of range-wide data for population structure suggest that populations in the core area also exhibit a higher proportion of seedlings to flowering plants than do peripheral populations. It is unknown whether these apparent differences in population size and structure are an artifact of different sampling methods or if they reflect genetic or environmental differences between populations.

In addition to its natural occurrences and its one present reintroduction, at Harlem Hills Preserve in Winnebago County, Illinois, Lespedeza leptostachya is known to be under cultivation at eight locations including arboreta, private and state nurseries, and greenhouses.

HABITAT

Lespedeza leptostachya occurs on both undisturbed and disturbed sites. Several sites have been previously mowed, burned or grazed and portions of one and probably two were plowed decades before the plant was discovered.

Soils may be either deeply or shallowly underlain by till or sand, gravel rocks--most commonly by limestone, but also by sandstone, gneiss or quartzite. Several of the soil series on which Lespedeza leptostachya occurs are

characterized by a clay subsoil, in the case of the Grundy series underlain by a hardpan. Others, such as the Boone series, are sandy soils throughout or soils may be underlain by sand, as is the case for the O'Neill soils developed on outwash terraces of the Little Sioux River, Iowa.

Soil surveys are available for the counties in which 24 of the 36 sites are located. Eleven of these sites in Minnesota and Iowa lie on Clarion loams or silt loams, one of the most prevalent agricultural soils in northwestern Iowa and southwestern Minnesota. County soil surveys for 18 sites include the equivalent Seventh Approximation for the series. Twelve of these 18 sites lie on hapludolls.

A listing of sites and their respective soil series groups is included in Table 3. However, it should be cautioned that this information is based solely on comparing legal descriptions with soil atlases. In light of the variability of texture and permeability suggested by the range of subsoils (from sand to clay hardpan), these soils data should be considered in conjunction with other factors such as climate and slope exposure. No extensive field investigations have been conducted on soils at Lespedeza sites. In order better to understand the physical factors limiting the distribution and expansion of bush clover populations, comparable field investigations of soils are needed at Lespedeza leptostachya sites throughout the range.

Prairie bush clover occurs on several tracts characterized by bedrock outcrops. It does not occur directly on barren rocks, but it does occur in thin soil at the margins of the rocks. In Cottonwood County, Minnesota, Lespedeza leptostachya occurs on several tracts along a ridge of Sioux quartzite. At Morton, Minnesota, it occurs in association with a gneiss outcrop.

Species lists for sites suggest that prairie bush clover occurs in conjunction with typical prairie species throughout its range, but there is not

Table 3. Soil Series at Lespedeza leptostachya Sites.

SOIL SERIES	
Boone variant	Nachusa Grasslands, Franklin Grove, IL
Boone variant	Stone Barn, IL
Clarion clay loam	Kilen Woods State Park, MN
Clarion clay loam	Petersburg Prairie, MN
Clarion clay loam, steep	DesMoines Prairie, MN
Clarion clay loam, steep	Belmont Prairie, MN
Clarion loam	Lakeville Prairie #1, IA
Clarion loam	Anderson Prairie, IA
Clarion loam	Fort Defiance State Park, IA
Clarion loam, Nicollet loam	Franklin Prairie, IA
Clarion loam	Carson, MN
Cresco loam	Hayden Prairie, IA
Dubuque silt loam	River Falls N, WI
Dubuque silt loam	River Falls S, WI
Germantown clay loam	Red Rock/Delton West, MN
Germantown clay loam	Red Rock/Jeffers Petroglyph, MN
Germantown clay loam	Red Rock/Delton Central, MN
Germantown clay loam	Red Rock Preserve, MN
Gotham loamy sand, LaCrosse sandy loam	Schluckebier, WI
Griswold loam, Kidder silt loam	Westport Drumlin, WI
Grundy silt loam, Shelby loam	Madison, IA
Jasper silt loam and Boone variant	Nachusa Grasslands, Daysville, IL
Lorenzo loam	Shoe Factory road, IL
No soil survey available	Wolters Prairie, IA
No soil survey available	Morton, MN
O'Neill fine sandy loam, O'Neill loam	Freda Hafner Prairie, IA
Rockton loam, Waukegon loam	Ludwig Prairie, IA
Rodman sandy loam, Lorenzo loam	Beloit, WI
Saude, Terril and Rockton loams	Washington, IA
Sogn loam, Copaston loam	Stanton Prairie, MN
Soil Survey in progress	Stately, MN
Soil Survey in progress	North Star, MN
Storden loam	Great Bend Prairie, MN
Storden loam	Lakeville Prairie #2, IA
Symerton & Verna silt loams, Pishkum silty clay loam	Hinsdale, IL
Terril sandy loam, Bellechester sand or Estherville loam	McKnight, MN
Tromel silt loam	HUM, IL
Warsaw silt loam	Union, IL
Webster silty loam, Clarion loam	Stinson Prairie, IA
Webster silty loam, Clarion fine sandy loam	Cayler Prairie, IA

a single assemblage of species with which it is constantly associated at all sites. Analysis of species lists available from sixteen sites throughout the range of Lespedeza leptostachya indicates that 33 species occur at 6 or more sites where prairie bush clover is present. Most available data are site lists. More research is needed to determine which species directly co-occur with Lespedeza leptostachya.

Perhaps because Lespedeza leptostachya is favored by mesic microenvironments, its populations are often subject to invasion by woody plants and appear to be detrimentally affected by competition. The following woody species have been reported from prairie bush clover sites: Ceanothus sp., Crataegus sp., Juniperus virginiana, Populus tremuloides, Prunus spp., Quercus macrocarpa, Quercus velutina, Rhus glabra, Rhus typhina, Symphoricarpos occidentalis, and Vitis riparia.

The most heavily shaded site is River Falls north, Wisconsin, where the concentration of bush clover plants was previously found in areas now shaded by Quercus velutina and Populus tremuloides (Richardson pers. comm.). It is now most abundant on an open roadside. Stem counts at this site in 1986 revealed 32 plants in the wooded area, and 118 in the open roadside ditch. Mowing of the ditch in 1987 appears to have reduced the visible population.

Removal of woody competition is presently underway at Westport Drumlin Prairie State Natural Area, Wisconsin and Prairie Bush Clover Scientific and Natural Area, Kilen Woods State Park Minnesota. Although the population at Morton, Minnesota, has not been previously monitored, most of the suitable habitat is heavily invaded by sumac, suggesting a need for monitoring and perhaps for brush removal. There are many areas with vegetation and soils that appear suitable for Lespedeza leptostachya but in which the species does not grow. The reasons for this absence in apparently suitable habitat are presently unknown.

SPECIES BIOLOGY

Lespedeza leptostachya is a perennial species. Plants under cultivation have been observed to flower the same year they germinated, whereas wild plants may require 5 or more years to reach maturity. Mature plants have been observed to flower repeatedly over four sequential sampling seasons, with very low mortality (Smith 1986). It is estimated that individual plants frequently live ten years or more.

Lespedeza leptostachya reproduces by seed. Established plants usually send up a single stem from each root, but can on occasion send up 2 or three. Both chasmogamous (potentially outcrossing) and cleistogamous (obligately self-fertilizing) flowers are produced. Both flower types can be produced synchronously on a single plant, or plants may bear all cleistogamous flowers. It is unknown if individual plants can bear only chasmogamous flowers. Studies in 1986 at 2 sites in Wisconsin and Minnesota suggest that approximately 3 times as many cleistogams are produced as chasmogams, with roughly 3/4 of all cleistogams forming pods. However, because the majority of chasmogamous flowers dry up and fall off without ever developing seed only about 1/6 of all chasmogamous flowers produce mature pods (Sather 1986, 1988, Benish pers. comm.). At the present time the pollinator is unknown. In two seasons of field work at Westport Drumlin Prairie and Red Rock Preserve no pollinators have been observed visiting chasmogamous flowers (Sather 1988; Benish pers. comm.). The cause of the apparent lack of pollinators is unknown. Preliminary data suggest that as many as 560 pods may be produced on a single plant, with an average of 235 pods per plant (Sather 1986). Actual seed production may be substantially lower and varies from site to site. In one study, only 20% of pods contained seeds (Baskin pers. comm.) and in another only 2% (Cole pers. comm.). Recent studies at a third site suggest much higher success rates (McCone pers. comm.).

Seed longevity for some members of the genus is reportedly long and some seeds may remain viable after passing through the digestive system of bobwhite quail (Clewell 1966b). Alverson (1981) has suggested that long retention of seed viability in the soil may account for the reappearance of Lespedeza leptostachya at Schluckebier Prairie, Wisconsin. However, neither longevity or seed viability after ingestion has been investigated for Lespedeza leptostachya.

It has been reported (Clewell 1966b) that seeds of the genus Lespedeza require scarification in order to germinate. However, preliminary data suggest that this may not be true for Lespedeza leptostachya. Studies are presently underway at the University of Kentucky to determine the germination requirements of the species.

Under natural conditions in Jackson County, Minnesota, seed germination begins in May and continues through July. Seedlings and young plants put on their full complement of seasonal growth within their first three or four weeks after emergence. Adult plants continue to grow rapidly until the onset of flowering in mid July. Growth and development of terminal inflorescences continues into early September. The production of chasmogamous flowers ends in mid August, but cleistogamous flowering extends into early September. Early developing seeds matured by late August but late developing seeds in terminal positions do not mature until early October.

Herbivory by small mammals or rabbits appears to increase during the season of seed maturation. Signs of herbivory have been noted throughout the range, but damage appears to reach significant levels only in localized situations. Data from Red Rock Preserve, Minnesota indicate that mature plants subjected to late season herbivory are reduced in average height and exhibit a significant reduction in average pod production the year after herbivory. These observations suggest that repeated removal of plant tops during seed maturation could have a long-term impact on reproductive potential.

Infestation by Cuculionid or Brucid beetles is evidenced by small larval exit holes that are frequently seen on pods in southwestern Minnesota populations. The actual rate of infestation and identity of the seed predators remain unknown at the present time.

Observations indicate that mature plants lose their leaves at the time the seeds mature, which can begin as early as the first week of September, but peaks in the latter half of that month. Young plants appear to retain their leaves in green condition later into the autumn than do mature plants.

Population size and structure appear to vary throughout the range. Peripheral populations of Lespedeza leptostachya vary from 12 to 648 individuals, with a total of 1,923 individuals and average population size of 113. Estimates of density in 1986 range from .3 to 1.9 plants per m^2. Populations in the core area appear to be larger, varying from 15 to 8,376 individuals, with a total of 22,607 plants and average population size of 1,256. Average measured densities from sample plots in the core area range from 2.6 plants per m^2 (Nekola 1985) to 13.9 plants per m^2 with maximum densities as high as 150 plants per m^2 (Smith 1986).

Preliminary data suggest that population structure of western or core populations appears to be more heavily weighted toward seedling and juvenile plants, whereas eastern, peripheral populations are dominated more by mature flowering plants. There is a need for comparable data of similar sample size from throughout the range to test whether these apparent differences can be substantiated. If peripheral populations prove to be dominated by mature fruiting plants, research efforts may need to focus on factors that might be limiting seedling germination or survival in peripheral populations. Another such factor could be the absence of a key mycorrhizal symbiont. At the present time there have been no experimental studies of biology of Lespedeza -

mycorrhizal symbiosis. Although plants propagated at the Mason nursery in Illinois were successful in fumigated soil, suggesting that a symbiont may not be necessary for growth, the question remains whether mycorrhizal associations might be beneficial in natural populations.

Because of Lespedeza leptostachya's apparent heavy reliance on self-fertilization there is a high probability of genetic isolation in geographically isolated populations. Genetic isolation could help explain the variability in habitat requirements, population attributes and biological responses of core and peripheral populations. Studies are underway to determine the genetic variability within and between populations of Lespedeza plants in Minnesota, Iowa and Wisconsin (Cole 1987). Before definitive statements can be made regarding the status of prairie bush clover populations the full range of genetic variability must be explored from populations throughout the range.

PAST AND PRESENT THREATS

Although the original range of Lespedeza leptostachya included parts of four states, available habitat within this range has been greatly reduced by agricultural activity. A large proportion of presently-known occurrences of the species are on sites underlain by agriculturally-favorable loam soils but rendered unsuitable to agriculture because of steep topography, the presence of bedrock outcrops, or proximity to urban areas. It is likely that the species was more frequent within its present range before European settlement.

Present day threats from agriculture are three-fold. Direct conversion to row crops destroyed one site in Rock County, Wisconsin since 1979. At least five sites are presently being grazed: Madison Prairie, Iowa, Stone Barn Road, Illinois; Stanton Prairie Minnesota; Stately, Minnesota and Delton West of the Red Rock Prairies, Minnesota. The population at Anderson Prairie, Iowa was

damaged when it was accidentally sprayed with herbicide in 1985 but appears to have recovered. The population at Stately, Minnesota was damaged by herbicide in 1988 at the time of its discovery. The long-term effect of this damage is unknown but merits monitoring because some of the presently known sites are immediately adjacent to agricultural crops.

In addition to threats immediately associated with agricultural operations, Lespedeza leptostachya populations are threatened by rural residential development. This threat is greatest for privately-owned populations in urbanizing areas such as in Story County, Iowa, and River Falls, Wisconsin.

The dynamics of Lespedeza leptostachya reinvasion and/or longevity and viability of the seed bank are not fully understood. Portions of at least two presently-known sites appear to have been previously cultivated (Schluckebier Prairie, Wisconsin and Red Rock Preserve, Minnesota) and others have a history of grazing.

Several stations for the species are located on or near public rights-of-way. A large proportion of the population at River Falls, Wisconsin, occurs along a roadside. The population at Hinsdale Prairie, Illinois, owned by the County Authority of DuPage County, is threatened by both highway expansion and pipeline easement. Two prairies in McHenry County, Illinois, are owned by the Chicago Northwestern Railroad and threatened by railroad herbicide use.

Quarry activities destroyed one population near Rockford, Illinois, in 1985, and could threaten a second population near Morton, Minnesota.

In addition to these anthropogenic threats to the species, the biology of Lespedeza leptostachya is not sufficiently known to provide adequate understanding of threshold population sizes, loss of pollinators, threats from disease, predation, hybridization and competition, and responses to grazing and fire. Also unknown is the genetic variability of the species both within and

between populations in the core and peripheral areas. Several of the peripheral populations are very small and could be lost because of unknown inherent biological factors.

Lespedeza leptostachya occurs sympatrically with Lespedeza capitata at least 12 of its 36 known sites. Hybrid populations have been observed in Renville and Cottonwood Counties Minnesota; in Lee County, Illinois; and in Emmet County, Iowa. During the 1986 growing season, Lespedeza leptostachya and Lespedeza capitata reached their peak of flowering at the same time. It is unknown whether there are any natural isolating mechanisms preventing hybridization, although, considering their high degree of co-occurrence and simultaneous flowering period such mechanisms seem likely. In two seasons of fieldwork hymenopteran pollinators visiting Lespedeza capitata at Red Rock Preserve, Minnesota, were never observed to visit Lespedeza leptostachya. This is one of many areas in which a further understanding of the genetics and reproductive biology of the species would be very useful, especially since the apparent incidence of both chasmogamy and hybridization appears to differ throughout the species range. On the basis of present knowledge, hybridization does not appear to present a serious threat to populations of prairie bush clover.

Herbivory by both insects and mammals may contribute to mortality. Insect herbivory has been reported for Illinois, Minnesota and Iowa populations. Young leaves and growing tips of young plants are damaged by insects throughout the summer. There is evidence of infestation by Cuculionid or Brucid beetles in Minnesota populations. At times damage by mammals may reach significant proportions in localized areas. Although reappearance of plants has been observed after a years' hiatus it is unknown what proportion of plants experiencing such herbivory may reappear.

Tentative evidence suggests that Lespedeza leptostachya is detrimentally affected by woody invasion but no data are available adequately to evaluate the threats. Ongoing studies at Westport Drumlin Prairie, Wisconsin, may clarify the effects of shading (Benish pers. comm.). Studies in Minnesota may provide data on competition from woody species as well as response to prescribed burns.

PRESENT PROTECTION STATUS AND MONITORING EFFORTS

Lespedeza leptostachya was first recommended for federal listing in the 1975 Smithsonian Report on endangered, threatened or extinct plants [Ripley et. al) and included as a category I species in an updated notice of review for plants published in the December 15, 1980 Federal Register (45 FR 82480). Lespedeza leptostachya was finally listed as Threatened in the January 9, 1987 Federal Register (52 FR 781-784). In addition to the protection afforded by the Endangered Species Act of 1973, as amended, Lespedeza leptostachya is listed as endangered in Iowa, Illinois, and Minnesota and as threatened in Wisconsin. Illinois law protects endangered and threatened plants found on state nature preserves, prohibits taking of endangered plants without written permission of the landowner and prohibits sale of endangered plants. Iowa regulations prohibit removal, possession and sale of any plant species on the Federal and State lists. Minnesota statutes prohibit taking, transporting and sale of state endangered and threatened plants from all lands except ditches, roadways and certain types of agricultural and forest lands. Wisconsin regulations prohibit any person from removing or transporting any endangered or threatened wild plant away from its native habitat on public property, or from property he or she does not own or control, except in the course of forestry or agricultural practices or in the construction or maintenance of a utility facility. Although all these laws offer Lespedeza leptostachya some form of protection, the degree of protection varies from state to state both because of

varying strength of the laws and because of ownership patterns. The destruction of prairie bush clover populations through habitat degradation or direct conversion on privately owned agricultural lands is not precluded by any of the existing laws. Only those sites within legally protected preserve systems managed for their natural or scientific values are considered fully protected (Status 1), although the five preserves of The Nature Conservancy are very highly ranked for protection (Status 2). The level of protection afforded by other publicly or privately managed preserves, such as Minnesota's Red Rock/Jeffers Petroglyph and McKnight Prairie may depend on available funding and policies of changing managers (Status 2). Preserves and parks owned by other public agencies with potential conflicting uses (such as departments of transportation, county authorities and parks) are not considered fully protected (Status 3). Privately-owned lands are considered unprotected (Status 4), although there are cases of well-informed and highly interested owners.

Protection of peripheral populations is much poorer than for core populations (Table 2), especially in light of the fact that several of the largest core populations are presently protected. Increased protection of peripheral sites should be among the highest priorities for species recovery.

Population monitoring is presently conducted on an annual basis at 7 native sites in Illinois, 3 sites in Wisconsin, 7 sites in Iowa and 3 sites in Minnesota. Methods vary from walking census techniques in small populations to complete counts of gridded populations and/or monitoring of randomly drawn sample plots in larger populations. Monitoring is conducted by the Minnesota DNR, the Wisconsin DNR, the Iowa DNR, the Illinois Department of Conservation, The Nature Conservancy offices in Minnesota, Wisconsin and Iowa and independent investigators in Minnesota and Wisconsin.

Effects of shrub removal are under investigation at Westport Drumlin Prairie, State Natural Area, Wisconsin and Kilen Woods State Park, Minnesota.

Response to fire is being monitored at Freda Hafner Kettlehole Preserve, Iowa, and Kilen Woods State Park, Minnesota. Intensive demographic studies have been conducted at Kilen Woods State Park for the last 5 years and at Freda Hafner Kettlehole Preserve, Iowa for 3 years. Demographic monitoring is underway at 2 sites in Illinois. A 2-year study of the phenology of prairie bush clover was initiated at Kilen Woods State Park in 1986, with complementary investigations of flowering phenology and reproductive biology begun concurrently at Red Rock Preserve, Minnesota (Sather 1986, 1988; Smith 1986). The latter study included investigation of the reproductive response of plants to 1986 herbivory during the 1987 season.

Summary of basis for recovery activities

The range has been divided into core and peripheral areas. It is unclear whether the size of the range has retracted because the most peripheral historical collection in Crow Wing County, Minnesota, is somewhat questionable. It is clear that there has been a great loss of habitat within the historic range. It appears that there were 20 historical records within the core area and 28 historical records within the peripheral area. Eighteen of the 36 extant occurrences lie within the core area and 17 of them in the peripheral area. These figures suggest that the species has been lost from more sites and more counties in the peripheral than the core area.

Only six of the extant sites are considered "fully protected" and three of these lie within the core area (Table 2). All privately-owned sites or publicly-owned rights-of-way are vulnerable to habitat destruction or degradation. Direct loss remains the most important threat to the species, but grazing, fire suppression or inappropriate fire frequencies, woody invasion, herbicide drift and right-of-way maintenance also present hazards to the species. When viewed as a group the Illinois populations appear to be in

greatest jeopardy because 3 of the 7 known sites are on rights-of-way and one is being grazed.

The largest populations in the core area are fully or partially protected (Table 2) and monitored, but small populations within the core area are not well protected and only one of these sites is intermittently monitored. There is a need to bring these small populations under protection and into monitoring programs.

Studies of large core populations indicate that under certain conditions Lespedeza leptostachya has the potential of rapid population growth. It is unclear whether there is some threshold population size at which this rapid increase begins, whether the increase is density dependent, or whether there are some "ideal" habitat conditions or management regimes that are not fully understood. Lespedeza leptostachya is generally perceived as a plant of "dry-mesic" prairies on well to excessively-drained sites. Its known associated species are a suite of ubiquitous prairie plants and exotic species It does not require "pristine" habitats. Even with the severe loss of native prairie over the last century there would appear to be more habitat available than the species is using. It is unclear whether this is because of particular microhabitat preferences (as yet unknown) or because seed sources are unavailable.

Despite the fact that populations can produce large numbers of seedlings under certain conditions, low seed set and or low numbers of seedlings at other locations suggest that seed production and seedling recruitment may be the most limiting stages of the life cycle. If small populations are to be increased, further research is needed to determine the factors limiting seed set and recruitment and whether there are management techniques that will reliably enhance population growth.

PART II: RECOVERY

Objective:

Protect and bring under appropriate management a minimum of twenty viable naturally-occurring populations of prairie bush-clover within the core habitat area, and protect and manage a minimum of fifteen viable naturally-occurring populations (representing the full range of habitat types) outside the core habitat area. Once these objectives have been achieved, the prairie bush-clover will be considered for delisting.

Step-down Outline:

The step-down outline lists tasks that need to be undertaken in order to meet the recovery objective. Steps (or tasks) are not necessarily presented in order of importance. Some tasks are already underway, while others may not be initiated for several years. A detailed explanation of these tasks is presented in the narrative section of this plan.

1. Protect selected viable populations and their habitat.

   The steps required to assure adequate protection and management vary from population to population. Because each state has different mechanisms for protection of public lands, county-owned areas or state parks may be considered fully protected in one state and not in another. The main criterion for determining whether an area is fully protected is whether it has been dedicated as a State Nature Preserve or Scientific and Natural Area, not whether it is in county or state ownership. Some populations remain in several different ownerships and therefore appear both in steps 111 and 112 of the following outline.

   11. Initiate landowner awareness and permanent protection activities.

      111. Secure all portions of unprotected populations.

         11101. Washington Prairie, Iowa

11102. Madison Prairie, Iowa

11103. Lakeville Prairie #1, Iowa

11104. Lakeville Prairie #2, Iowa

11105. Freda Hafner Prairie, Iowa

11106. Franklin Prairie, Iowa

11107. Hinsdale Prairie, Illinois

11108. Stone Barn Prairie, Illinois

11109. Great Bend Prairie, Minnesota

11110. Red Rock/Delton West, Minnesota

11111. Red Rock/Delton Central, Minnesota

11112. Red Rock/Delton East, Minnesota

11113. Stanton Prairie, Minnesota

11114. Belmont Prairie, Minnesota

11115. DesMoines Prairie, Minnesota

11116. Petersburg Prairie, Minnesota

11117. Morton Outcrop, Minnesota

11118. Stately Prairie, Minnesota

11119. North Star Prairie, Minnesota

11120. Carson Prairie, Minnesota

11121. Riverfalls North, Wisconsin

11122. Riverfalls South, Wisconsin

11123. Beloit Prairie, Wisconsin

112. Stabilize protection with long-term management plans and agreements.

11201. Freda Hafner Prairie, Iowa

11202. Fort Defiance State Park, Iowa

11203. Stinson Prairie, Iowa

11204. Wolters Prairie, Iowa

11205. Ludwig Prairie, Iowa

11206. Stone Barn Prairie, Illinois

11207. Nachusa Grasslands, Illinois

11208. HUM Prairie, Illinois

11209. Union Prairie, Illinois

11210. Red Rock/Delton, West, Minnesota

11211. Red Rock/Delton, East, Minnesota

11212. McKnight Prairie, Minnesota

11213. Schluckebier Prairie, Wisconsin

2. Provide appropriate management at each protected site.

3. Inventory to locate additional populations.

   31. Search historical sites where prairie bush clover has been found and habitat is still present.

   32. Identify and search potential new sites.

4. Monitor population trends at known sites.

5. Establish artificial seed banks for selected populations.

6. Provide appropriate public information.

   61. Prepare and distribute brochures and other graphic materials on recovery efforts.

   62. Prepare appropriate articles for local press releases.

   63. Establish liaison with public utility companies and local units of government.

7. Conduct appropriate research.

   71. Determine important habitat parameters.

      711. Characterize soils.

   72. Increase knowledge of species and population biology.

      721. Determine life history.

      722. Determine population structure and dynamics.

723. Assess competition.

724. Assess predation.

725. Determine natural seed bank.

73. Study the response of populations to a variety of potential management techniques.

731. Determine the effects of fire.

732. Determine the effects of grazing.

733. Determine the effects of mowing.

734. Determine the effects of pesticides.

735. Determine the effects of shrub and tree removal.

74. Determine genetic diversity within and between populations.

Narrative

1. Protect selected viable populations and their habitat.

The selection of populations to be protected should be based on biological and management considerations. This requires an evaluation of each population to assess parameters such as population vigor, habitat stability and defensibility. For example, a large population (more than 1,000 individuals) with a good representation of age and reproductive classes should be a high priority for preservation. However, all natural plant populations experience fluctuations in size, and small depleted populations may have the capacity to expand and recover under ideal habitat conditions.

Emphasis should also be placed on acquiring populations that occupy different habitat types. Habitat is largely defined by physical factors such as soil characteristics, moisture regime, slope, aspect, and geological and glacial history. Presumably by protecting a greater variety of habitats we are also protecting a greater range of genotypic diversity within the species.

The amount of land necessary to assure the survival of a given population must include the habitat of the entire population or, in the case of large dispersed populations, the majority of individuals. Potential habitat adjacent to the population should also be acquired to allow for future expansion of the population. In all cases, adequate buffer against encroachment from adjacent lands must be acquired.

Adequate protection for a population of Lespedeza leptostachya can be achieved only when a public agency holds fee title, long-term lease or other legal interest, to the habitat in which the population occurs. Any lease agreement must allow legal access for management purposes, and must also

provide authority to control all non-compatible land use practices. However, control by a public agency does not in itself constitute adequate protection. For example, public lands are often managed for purposes of recreation, transportation, agriculture or mining, which may be incompatible with the preservation of Lespedeza leptostachya. Therefore, the primary management objective for the site must be the protection and preservation of the population of Lespedeza leptostachya. It is also necessary that a detailed management plan be prepared for each population. Only after all these conditions have been met can the population be considered adequately protected.

Voluntary, non-binding agreements with private land owners do not provide an adequate level of protection because of the lack of legal obligation on the part of the land owner. Even ownership by most private conservation organizations is inadequate because privately owned land can be easily condemned for public development projects. Furthermore, private organizations cannot provide the assurance of perpetual ownership and management in the manner of a public agency.

11. Initiate landowner awareness and permanent protection activities.

111. Secure all portions of unprotected populations.

11101. Washington Prairie, Iowa

11102. Madison Prairie, Iowa

11103. Lakeville Prairie #1, Iowa

11104. Lakeville Prairie #2, Iowa

11105. Freda Hafner Prairie, Iowa

11106. Franklin Prairie, Iowa

11107. Hinsdale Prairie, Illinois

11108. Stone Barn Prairie, Illinois

11109. Great Bend Prairie, Minnesota

11110. Red Rock/Delton West, Minnesota

11111. Red Rock/Delton Central, Minnesota

11112. Red Rock/Delton East, Minnesota

11113. Stanton Prairie, Minnesota

11114. Belmont Prairie, Minnesota

11115. DesMoines Prairie, Minnesota

11116. Petersburg Prairie, Minnesota

11117. Morton Outcrop, Minnesota

11118. Stately Prairie, Minnesota

11110. North Star Prairie, Minnesota

11120. Carson Prairie, Minnesota

11121. Riverfalls North, Wisconsin

11122. Riverfalls South, Wisconsin

11123. Beloit Prairie, Wisconsin

112. Stabilize protection with long-term management plans and agreements.

11201. Freda Hafner Prairie, Iowa

11202. Fort Defiance State Park, Iowa

11203. Stinson Prairie, Iowa

11204. Wolters Prairie, Iowa

11205. Ludwig Prairie, Iowa

11206. Stone Barn Prairie, Illinois

11207. Nachusa Grasslands, Illinois

11208. HUM Prairie, Illinois

11209. Union Prairie, Illinois

11210. Red Rock/Delton, West, Minnesota

11211. Red Rock/Delton, East, Minnesota

11212. McKnight Prairie, Minnesota

11213. Schluckebier Prairie, Wisconsin

2. Provide appropriate management at each protected site.

The management needs of the prairie bush clover are largely unknown at this time. However, there is an obvious need to secure each site from the effects of gross human disturbances such as conversion to cropland, roadbuilding etc. It also seems prudent at this time, to exclude herbicides, grazing, and mowing, on the assumption that these activities are harmful to populations of L. leptostachya.

Prescribed burns may be useful to control encroaching shrubs and trees, but the effect of fire on L. leptostachya is not fully known. If fire is used, it should be restricted to early spring (before May 15 in the core area) to avoid destroying seedlings. If spring burns are ineffective in controlling shrubs, it may be necessary to resort to hand cutting. In any case, no more than one-half of any population should be burned in any one year.

3. Inventory to locate additional populations.

To reach the recovery goal where Lespedeza leptostachya can be considered for delisting, additional populations have to be found. Searches for new populations should take place throughout the range of the species. The Natural Heritage Inventory (or equivalent program) in each state should be the lead agency responsible for locating new populations.

31. Search historical sites where prairie bush clover has been found and habitat is still present.

In locations where prairie bush clover has been found but populations are not currently known, the species may still be present in a natural seed bank or in small numbers that are difficult to locate. These sites should be surveyed at three to five year intervals to see if populations are present.

32. Identify and search potential new sites.

Prairies that appear to meet the habitat requirements for the species should be identified and searched. Sites with degraded habitat should be included in the search. References from herbarium records, botanical literature, and professional and amateur botanists should also be examined.

4. Monitor population trends at known sites.

In order to establish population trends and to document effectiveness of recovery efforts, all populations on public lands or otherwise accessible to conservation interests will be censused at regular intervals of between one to three years. The census will recognize three reproductive/size classes 1) flowering plants, 2) non-flowering plants greater than 12 cm in height, and 3) immature plants less than 12 cm in height. All stems from a single root crown shall be considered one plant. All individuals in small populations will be counted, but in large populations only samples will be counted. Management or other human activities affecting the population since the previous census, such as burning, grazing or mowing, will be noted. General weather conditions and any known variance from the norm since the last census will be noted. Additional information helpful to the research and reestablishment efforts of this plan, that can be obtained on the census visit, will be noted. The census

will be conducted by Natural Heritage staff or other state agency personnel where possible. Private conservation organization personnel and citizen volunteers may also be used.

A second level of monitoring is recommended for populations that are suspected of declining in size or number. In this case, sample plots will be established, and monitored annually for the production and survivorship of seedlings.

5. Establish artificial seed banks for selected populations.

To prevent possible loss of specific populations and to provide for future propagation and/or experimentation, seeds should be collected and deposited with the Center for Plant Conservation for seed bank storage. A total of at least 500 mature seeds taken from at least 10 different plants in each selected population are to be collected and transferred to a permanent seed storage facility. The seeds, and any plants derived from them, will be segregated by population. This will prevent inadvertent mixing of genotypes and possible confusion over the source of plant material.

6. Provide appropriate public information.

The public needs to be made aware of the rarity of this species and how its habitat has declined. Unless the public understands the importance of saving this threatened species, protection and recovery will be difficult. The objectives and methods of the recovery program need to be explained to the public.

61. Prepare and distribute brochures and other graphic materials on recovery efforts.

A variety of brochures and posters are needed to respond to specific inquiries from the public and to provide general information at visitor contact points. At least one display should be prepared and placed in Botanical Gardens or Arboreta within the species range as well as in parks and preserves where populations occur.

62. Prepare appropriate articles for local press releases.
News releases help to generate positive public opinion toward conservation of endangered and threatened species.
Articles pertaining to the preservation of the species need to be prepared for both popular and scientific publications, including local newspapers. Monitoring and management techniques and information should be made available to the public.

63. Establish liaison with private landowners, public utility companies and local units of government.
Private landowners, local utility companies, railroads, and local units of government need to be made aware of those populations of Lespedeza leptostachya found within their boundaries to encourage their cooperation with recovery efforts, and to aid them in compliance with herbicide labelling requirements.

7. Conduct appropriate research.

71. Determine important habitat parameters.

711. Characterize Soils.
Soil type is an important habitat parameter that may affect the distribution of Lespedeza leptostachya. The physical and

chemical properties of the soils at each site need to be analyzed to determine the range of soil types inhabited by natural populations.

72. Increase knowledge of species biology and population biology.

721. Determine life history.

Certain aspects of the life history of Lespedeza leptostachya are still unknown. Unanswered questions include: How long do individual plants live? How quickly do they reach reproductive maturity? Do individuals habitually remain dormant some years in response to environmental or biological stimuli? Is the plant a noduled legume that benefits from a mycorrhizal association? How long can seeds remain dormant in the soil? What factors limit seed production? What are the natural pollinators and have pollinators been eliminated from some populations? What functions of the population are density dependent? These questions can best be answered by long-term observations of marked individuals within natural populations. Laboratory and greenhouse experiments may also be useful.

722. Determine population structure and dynamics.

It is important to develop a predictive model to relate population structure to long-term changes in the population size and vigor. Such a model would allow the development of an index to evaluate the stability of populations. The necessary data can be collected using permanent plots and long-term demographic sampling.

723. Assess competition and soil disturbance.

Determine the extent and effects of soil disturbance and competition from other plant species. The greatest degree of competition may come from woody shrubs and sod-forming grasses.

The role of soil disturbance in natural communities is not understood at this time.

724. Assess predation.

Determine the degree and effect of predation on populations and individuals, especially as it pertains to seed production and germination.

725. Determine natural seed bank.

Collect soil samples from within populations at different times of the year. Seeds of Lespedeza leptostachya can then be separated from the soil and tested for germination.

73. Study the response of populations to a variety of potential management techniques.

This will require designed experiments involving natural populations, but experiments should never risk damage to a significant portion of any population.

731. Determine the effects of fire.

Fire is a natural event in the habitats occupied by Lespedeza leptostachya. In cases where fire has been suppressed by human activities, it is possible to reinstate fire as a management prescription. The timing and interval of prescribed burns may have a profound effect on the populations, so cautious experimentation is needed. Because growing season fires appear to be harmful to populations only dormant season (spring and fall) fires will be studied.

732. Determine the effects of grazing.

Because populations of Lespedeza leptostachya occur on grazing land, it is important to understand the effects of grazing on the health of the populations, particularly, the timing and stocking rates employed. Studies of the effects on

reproduction, survivorship and nutrient storage of the plants should have the highest priority.

733. Determine the effects of mowing.

Some of the populations have a history of mowing for the commercial production of wild hay. The effects of hay mowing are largely unknown, but could be extremely important to the long-term survival of populations. Mowing after early July could eliminate an entire seed crop, and annual mowing at that time of the year could result in total reproductive failure leading to population extinction. Designed experiments involving mechanical clipping of permanent study plots at different times of the year would yield valuable information.

734. Determine the effects of pesticides.

Agricultural pesticides are potential threats to populations of Lespedeza leptostachya, but the actual effects are not known. In particular, there is need for research to determine the effect of insecticides on pollinators. It is also important to evaluate the effects of various types of herbicides, as well as the methods of application, dates and rates of application.

735. Determine impact of shrub and tree removal.

Shading from woody species appears to have a detrimental effect on prairie bush clover populations. Research is needed to assess the effect of shrub and tree removal on population structure and persistence. Mowing for purposes of shrub control could be a valuable management tool but, like hay mowing, timing may be critical.

74. Determine genetic diversity within and between populations.

The purpose is to determine minimum population parameters that must be reached to sustain individual populations and the species as a whole.

PART III

IMPLEMENTATION

The Implementation Schedule that follows outlines actions and costs for the Lespedeza leptostachya recovery program. It is a guide for meeting the objectives elaborated in Part II of this plan. This schedule indicates the general category for implementations, recovery plan tasks, corresponding outline numbers, task priorities, duration of tasks, ("ongoing" denotes a task that once begun should continue on an annual basis), which agencies are responsible to perform these tasks, and estimated costs for FWS tasks. These actions, when accomplished, should bring about the recovery of Lespedeza leptostachya and protect its habitat.

KEY TO IMPLEMENTATION SCHEDULE

General Category (Column 1)

Information Gathering - I or R (research)*

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

Recovery Action Priorities

1 = an action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

2 = an action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

3 = all other actions necessary to provide for full recovery of the species.

Continuous - Tasks that will continue once they are initiated

Ongoing - Tasks now being implemented

IA - Iowa Department of Natural Resources

IL - Illinois Department of Conservation

MN - Minnesota Department of Natural Resources

WI - Wisconsin Department of Natural Resources

TNC - The Nature Conservancy

FWS - Fish and Wildlife Service

OES - Office of Endangered Species

HA - Holden Arboretum

NSA - Nebraska Statewide Arboretum

IMPLEMENTATION SCHEDULE
PRAIRIE BUSH-CLOVER

GEN. CAT.	PLAN TASK	TASK #	PRIORITY #	TASK DURATION (YEARS)	RESPONSIBLE AGENCY: FWS REGION	FWS PROGRAM	OTHER AGENCIES	FISCAL YEAR COSTS (EST.): FY-1	FY-2	FY-3	COMMENTS
A-1,2, 3,6	Initiate landowner awareness and secure viable unprotected populations	11, 111	2	Ongoing	3	OES	IA, IL, MN, WI TNC	100,000	150,000	150,000	Total project cost cost est. at $450,000, and will require additional time
M-3	Stabilize protected populations w/management plans and cooperative agreements	112	2	Ongoing and continuous	3	OES	IA, IL, MN, WI, TNC	8,000	8,000	8,000	
M-3	Provide appropriate management at each protected site	2	2	Ongoing	3	OES	IA, IL, MN, WI	5,000	10,000	20,000	
I-1	Inventory to locate new populations	3 31,32	2	2	3	OES	IA, IL, MN, WI	20,000	5,000		
M-3	Monitor existing populations	4	2	Ongoing and continuous	3	OES	IA, IL, MN, WI	13,000	13,000	13,000	
M-7	Establish seed banks	5	3	2	3	OES	IA, IL, MN, WI		3,000	3,000	
O-1	Prepare and distribute brochures and other graphic material	61	3	2	3	OES	IA, IL, MN, WI, HA, NSA	15,000	5,000		
O-1	Prepare appropriate articles for local press releases	62	3	Continuous	3	OES	IA, IL,	500	500	500	
O-1	Initiate and implement liaison with private landowners, public utility companies and local units of Government	63	3	3	3	OES	IA, IL,	7,500	7,500	5,000	
I-3	Determine important habitat parameters	71	2	3	3	OES	IA, IL, MN, WI	5,000	5,000	5,000	
R-7,9, 10	Conduct research on species and population biology	72,721 722,723 724,725	2	3	3	OES	IA, IL, MN, WI, HA, NSA	15,000	15,000	15,000	
R-4,12	Determine response of species to various management techniques	73,731 732,733 734,735	2	Ongoing	3	OES	IA, IL, MN, WI,	12,000	12,000	12,000	
R-3,14	Determine genetic diversity	74	2	Ongoing	3	OES	IA, IL, MN, WI, HA, NSA, TNC	10,000	10,000	10,000	Est. 5 years will be necessary to complete this task - $ 10,000/year

LITERATURE CITED

Aikman, J. M. and R. F. Thorne. 1956. The Cayler Prairie: An ecologic and taxonomic study of a northwest Iowa prairie, Proc. Ia. Acad. Sci 63:177-200.

Alverson, W. 1981. Status report for Lespedeza leptostachya in Wisconsin. Available from The Bureau of Endangered Resources, Wisconsin Department of Natural Resources.

Baskin, C. 1986. Department of Biology, University of Kentucky. October. Conversation with N. Sather, Minnesota Department of Natural Resources.

Beck, M. W., J. A. Elwell, G. S. Hall and G. B. Bodman. 1928. Soil survey of Jackson County, Minnesota. United States Department of Agriculture, Bureau of Chemistry and Soils. 23 pp. and maps.

Benish, N. 1986. Department of Horticulture, University of Wisconsin. September. Telephone conversation with N. Sather, Minnesota Department of Natural Resources.

Betz, R. 1983. Department of Biology, Northeastern Illinois University, Letter addressed to John Schwegman, Illinois Department of Conservation, Available from Illinois Department of Conservation.

Christiansen, P. 1986. Unpublished species list for Hayden Prairie. 11 pp. Available from Dr. Paul Christiansen, Department of Biology, Cornell College, Mount Vernon, Iowa.

Clewell, A. F. 1966a. North American species of Lespedeza. Rhodora 68:359-405.

Clewell, A. F. 1966b. Natural history, cytology, and isolating mechanisms of the native North American Lespedezas. Tall Timbers Research Station Bulletin, No. 6, Tallahassee, Florida. 30 pp.

Cole, C. T. 1987. Population genetics of prairie bush clovers, Lespedeza leptostachya and L. capitata. Poster session presented at Annual meeting, The Nature Conservancy, Minnesota Chapter. November 14, 1987. St. Paul, MN.

Fassett, N. C. 1939. The Leguminous Plants of Wisconsin. University of Wisconsin Press. 157pp.

Fernald, M. L. 1950. Gray's Manual of Botany. 8th ed. New York. The American Book Company. p. 927.

Fox, W. B. 1945. The Leguminosae of Iowa. Am. Midl. Nat. 34:207-230.

Gambill, W. G. 1953. The Leguminosae of Illinois. Ill. Biolog. Monographs, 22:78.

Geib, W. J., M. J. Edwards, E. H. Templin, and H. R. Lathrop. 1929. Soil Survey of Pierce County, Wisconsin. United States Department of Agriculture. Bureau of Chemistry and Soils, 33 pp. and maps.

Gleason, H. A. 1952. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. New York: Hafner Press. Vol. 2, p. 436.

Gleason, H. A. and A. Cronquist. 1963. Manual of the Vascular Plants of Northeastern United States and Adjacent Canada. New York: D. Van Nostrand Company. p. 415.

Glenn-Lewin, D. 1976. The vegetation of Stinson Prairie. Report to Iowa State Preserves Advisory Board. 31 pp. Available from Iowa Conservation Commission.

Gray, D. S. and F. W. Reich. 1923. Soil Survey of Emmet County, Iowa. United States Department of Agriculture, Bureau of Soils, 33 pp. and maps.

Iowa Conservation Commission, 1984. Unpublished species lists for Wolter's Prairie and Raymond/Troe Prairie, Iowa. Available from Iowa Conservation Commission.

Isely, D. 1955. North-Central Hedysareae. Iowa State College Journal of Science 30:33-118.

Kurz, D. R. and M. L. Bowles. 1981. Status report on Lespedeza leptostachya. Report to Illinois Department of Conservation, Springfield. 7 pp. Available from Illinois Department of Conservation.

McCone, M. 1988. Carleton College. Conversation with Nancy Sather, Minnesota DNR.

Nekola, J. 1985. A summary of baseline information from a study of the response of Lespedeza leptostachya Engelm. to fire management of the Freda Hafner Kettlehole Preserve, Dickinson County, Iowa. Report to The Nature Conservancy, Iowa Field Office, Available from The Nature Conservancy, Iowa Field Office.

O'Neal, A. M. and C. B. Boatwright. Soil Survey of Clarke County, Iowa. United States Department of Agriculture, Bureau of Chemistry and Soils. 24 pp. and maps.

Richardson, J. 1986. Department of Biology, University of Wisconsin, River Falls. Conversation on field tour with Mark Martin and June Dobberpohl. Wisconsin DNR; Welby Smith and Nancy Sather, Minnesota DNR; Joyce Bender, The Nature Conservancy; and Bill Harrison, U.S. Fish and Wildlife Service.

Ripley, S. D. et al. 1975. Report on Endangered and Threatened Plant Species of the United States. House Document No. 94-51, Smithsonian Institution, Washington D.C. 200pp.

Roefer, F. 1983. A Profile of Jeffers Petroglyph Prairie. Guidebook prepared for the Minnesota Historical Society. Available from Minnesota Historical Society.

Sather, N. P. 1986. Studies of Lespedeza leptostachya at Red Rock Prairie Minnesota. Report to The Nature Conservancy, Minnesota Field Office. Available from The Nature Conservancy, Minnesota Field Office.

Sather, N. P. 1988. Studies of Lespedeza leptostachya at Red Rock Prairie, Minnesota, 1987. A report to The Nature Conservancy, Minnesota Office.

Smith, W. R. 1981. Status report on Lespedeza leptostachya Engelm. Available from Minnesota Natural Heritage Program, Minnesota Department of Natural Resources.

Smith, W. R. 1986. Botanist, Minnesota Natural Heritage Program, Minnesota Department of Natural Resources. Unpublished data. Demography of Lespedeza leptostachya at Kilen Woods State Park, Minnesota.

Smith, W. R. 1986. Population biology of Lespedeza leptostachya. Proceedings of the California Rare Plant Conference, Sacramento, Nov. 4-9, 1986 (in press).

Stebbins, G. L. 1950. Variation and Evolution in Plants. Columbia University Press, New York.

United States Department of Agriculture, Soil Conservation Service. 1968. Soil Survey of Winnishiek County, Iowa. 225 pp. and maps.

United States Department of Agriculture, Soil Conservation Service. 1976. Soil Survey of Goodhue County, Minnesota. 129 pp. and maps.

United States Department of Agriculture, Soil Conservation Service. 1979a. Soil Survey of DuPage and part of Cook Counties, Illinois. 217 pp. and maps.

United States Department of Agriculture, Soil Conservation Service. 1979b. Soil Survey of Cottonwood County, Minnesota. 142 pp. and maps.

United States Department of Agriculture, Soil Conservation Service. 1980. Soil Survey of Ogle County, Illinois. 242 pp. and maps.

United States Department of Agriculture, Soil Conservation Service. 1982. Soil Survey of Butler County, Iowa. 209 pp. and maps.

United States Department of Agriculture, Soil Conservation Service. 1983. Soil Survey of Kossuth County, Iowa. 185 pp. and maps.

United States Department of Agriculture, Soil Conservation Service. 1984. Soil Survey of Story County, Iowa. 149 pp. and maps.

United States Department of Agriculture, Soil Conservation Service. 1985. Soil Survey of Lee County, Illinois. 236 pp. and maps.

United States Fish and Wildlife Service. 1987. Determination of Threatened Status for Lespedeza leptostachya (Prairie bush clover) Federal Register 52:781-784.

United States Fish and Wildlife Service. 1980. Review of Plant Taxa for Listing as Endangered or Threatened Species. Federal Register 45: 82480-82569.

Upham, W. 1884. Catalog of the Flora of Minnesota. Geological and Natural History Survey of Minnesota. The 12th Annual Report for the year 1883. Johnson, Smith, and Harrison. 193pp.

Watson, W. C. 1983. Status report of Lespedeza leptostachya in Iowa for Iowa Conservation Commission. Available from Iowa Conservation Commission.