CUSHENBURY MILKVETCH
Astragalus albens Greene

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Management Status: Federal: Endangered
California: S1.1, G1 (CDGF, 1998)
CNPS: List 1B, R-E-D code 3-3-3 (Skinner and Pavlik, 1994)

General Distribution:

Cushenbury milk-vetch is found in the northeast end of the San Bernardino Mountain range in San Bernardino County, California. With rare exceptions, it is restricted to carbonate and carbonate-related soils and outcrops from 4000-6600 ft. (1300-2000 m). Its range extends from a ridgetop just east of Dry Canyon to the southeast through Lone Valley, east of Baldwin Lake, to upper Burns Canyon. An unverified population at Box 'S' Springs, two to three miles northwest of Cushenbury at 3600 ft. (1100 m), is its northernmost and lowest reported location.

Distribution in the West Mojave Planning Area:

Cushenbury milk-vetch primarily occurs on U.S. Forest Service lands just outside the WMPA, but extends northward and downslope onto private or BLM lands in Furnace, Bousic, Marble, and Cushenbury Canyons, below Monach Flat and Blackhawk Mountain, at Round Mountain, and at Terrace Springs.

Natural History:

Cushenbury milk-vetch is an herbaceous member of the pea family (Fabaceae), and was first collected by Parish and Parish (Greene, 1885). Several prostrate stems, each 2-12 in. (0.5-3 cm) long, emerge from the base. The leaves and stem have appressed silvery-white hairs, giving the plant a smooth, sleek, gray appearance. The pinnately-compound leaves have 5-9 leaflets which are elliptic to oval-shaped, have obtuse tips, and are each 0.2-0.4 in. (5-10 mm) long. Flowers occur in racemes on 0.8-2.0 in. (2-5 cm) long peduncles. The calyces are about 0.16 in. (4 mm) long, and also bear the silky silvery-white hairs. The papillionaceous corolla is pink to purplish, with both banner and keel 0.3-0.4 in. (7-10) mm in length, exceeding the wing length. The sessile fruits have two locules, are about 0.4-0.7 in. (10-18 mm) long, crescent-shaped, three-sided, and densely strigose (Hickman, 1993; Munz, 1974; Barneby, 1964). This fruit shape helps to distinguish the Cushenbury milkvetch from Bear Valley milk-vetch (*A. leucolobus)* which may also grow sympatrically on carbonate soils (USFWS 1997). It also resembles Mojave milk-vetch (*A. mohavensis)* from the northern Mojave Desert, but Mojave milk-vetch is not pubescent, as is the Cushenbury milk-vetch (Isely, 1984).

Cushenbury milk-vetch has been described both as an annual and as a short-lived perennial herb (Barneby, 1964; Greene, 1885; Hickman, 1993; Munz, 1974; Skinner and Pavlik, 1994). Little is known of its life history. Greene reported that a “good proportion” of the plants flower precociously and are monocarpic, especially in years of low rainfall (Greene, 1885). However, it is not known whether the plants typically flower and fruit the first year, how long they live, or what conditions might cause them to act as annuals in some cases or perennials in other cases.

Flowering occurs from late March to mid-June. Pods ripen at least as early as May, and become stiff and papery with long hairs as they mature.

Pollen vectors are most likely small bees, given the flower shape and color (Faegri and Van der Pijl, 1978). It is not known if this species is self-compatible. Most Cushenbury milk-vetch reproduction presumably occurs by seed, and seeds have been found to have high viability (Tierra Madre Consultants, 1996). Vegetative reproduction has never been reported. Seeds require scarification, and greenhouse experiments have shown that seedlings are susceptible to damping off when grown in pots (Tierra Madre Consultants, 1996). It has long been known that seeds remain dormant in the soil during drought years (Greene, 1885), but the numbers of viable seeds present in the soil and the length of time they can remain viable is unknown. The extent of seed predation, the numbers and kinds of seed predators, and seed dispersal mechanisms are also unknown.

Habitat Requirements:

Generally Cushenbury milk-vetch is restricted to carbonate soils (Gonella and Neel, 1995; Tierra Madre Consultants, 1992), but one account reported populations from non-carbonate soils. Subsequent surveys have not supported this finding (Tierra Madre Consultants, 1992), and it is likely that these plants were on carbonate alluvium that had been deposited over granite bedrock, as is often the case in populations below 5000 ft. (1600 m) elevations (USFWS, 1997). More recently, Cushenbury milk-vetch plants have been found on granitic soil (Psomas and Associates, 1996), but it is likely that these plants fell into the site, along with some carbonate substrate, during a debris slide. It is expected that, as larger species move into the disturbed area, the Cushenbury milk-vetch plants will be eliminated (Psomas and Associates, 1996). It often occupies areas with an open canopy, less litter accumulation (2.3%), higher per cent calcium (average 21.3%), and shallower slope angles (average 12.1) than other carbonate sites that do not support these plants (Gonella and Neel, 1995; USFWS, 1994).

Cushenbury milk-vetch has been reported from Joshua tree woodland and blackbush scrub communities, but is most commonly found in pinon-juniper woodland. It has been reported growing with dominant species Utah juniper *(Juniperus osteosperma),* joint fir *(Ephedra viridis),* paper bag plant *(Salazaria mexicana), mo*untain mahogany *(Cercocarpus ledifolius),* Mojave yucca *(Yucca schidigera*), manzanita *(Arctostaphylos glauca),* flannel bush *(Fremontodendron californicum),* Great Basin sagebrush *(Artemisia tridentata),* and needlegrass (*Stipa coronata)* (CDFG 1997; Gonella and Neel, 1995).

Population Status:

It has been estimated that there are between 5000-10,000 Cushenbury milk-vetch plants throughout the entire range (USFWS, 1997), and the total number probably varies annually depending on rainfall (Barneby, 1964; USFWS, 1997). Estimates from previous surveys in 1988 indicated a total of just over 2000 plants (Barrows, 1988), but more detailed surveying in subsequent years with greater rainfall led to the increase in estimated number of plants. The population center with the most dense population is most likely in Lone Valley, with 3172 Cushenbury milk-vetch plants found at the proposed Right Star mine site in 1991 (USFS, 1992). However, the variation due to environmental conditions, coupled with the unknown nature of the soil seed population and inability to survey all potential habitat, make it very difficult to develop any reliable estimate of population size.

In general, occurrences of Cushenbury milk-vetch within the WMPA are at the lower elevational edge of the range of this species, and are less dense than those at higher elevations. However, very large areas within the WMPA may support these plants, thus total numbers of plants may be as great as or greater than those found at higher elevations. Reliable estimates for numbers of plants within each general occurrence area in the WMPA are not available, and many areas of potential habitat within the WMPA have not been adequately surveyed. Some data are available from counts taken within general occurrence areas in different years. The following table summarizes available data:

General WMPA area	**No. plants**	**Sources of information**
Furnace Canyon	100[a,c]	Barrows, 1988; CNDDB, 1997
Bousic Canyon	50[a]	Barrows, 1988; USFS, 1995
Cushenbury Canyon	100[b]	USFS, 1995; Henderson, 1998
N. of Monarch Flat	198[b,c]	Barrows, 1988; Henderson, 1995; USFS, 1995
N. of Blackhawk Mt.	78[b]	USFS, 1995; Leverett, 1995
Round Mountain	130[b]	Egan, 1993; Rutherford, 1993; USFS, 1995
Terrace Spring	219[b,c]	Barrows, 1988; Rutherford, 1993; Egan, 1993; USFS, 1995

[a]Highest number of plants found when counts were made at same location in different years.
[b]Sum of highest counts made from different sites within same general area in same year or different years.
[c]Occurrence only partially in WMPA.

Threats Analysis:

Mining. There are at least three multinational companies that currently mine carbonate products within the range of the Cushenbury milk-vetch. The actual amount of product material removed by the mining companies is much lower than the amount of earth that is disturbed during the removal process. Habitat may be destroyed from mining activities such as construction of quarries, access and haul roads, staging areas, processing plants, and dumping of overburden piles on occupied habitat (USFWS, 1997). By 1992, at least 1600 acres (648 hectares) of carbonate soil habitat had been destroyed (USFS, 1992). About 70% of the claims (over 400 acres) have easy access and high resource value, and have current and planned mining (URCEM, 1996).

Other threats. OHV activity, recreational shooting, and competition from exotic species also have impacted Cushenbury milk-vetch habitat, at least in USFS land (USFS, 1992), but these impacts are much less severe than those from mining (USFS, 1992).

Summary. Most of the populations within the WMPA are potentially threatened by human activities. The following table summarizes existing and potential threats to Cushenbury milk-vetch in each general area of occurrence within the WMPA:

General WMPA area	Existing and potential threats	Sources of information
Furnace Canyon	Mining, currently no plans to use quarry Proposed hydroelectric project	CDFG, 1997; USFS, 1992
Bousic Canyon	Mining, population along old road bed	CDFG, 1997
Cushenbury Canyon	Mining, possibly extirpated from type	USFWS, 1997; CDFG,

	locality by cement dust; new powerline proposed along existing right of way; illegal trash dumping; shooting	1997
N. of Monarch Flat	roads provide OHV access	Henderson, 1995
N. of Blackhawk Mt.	roads provide OHV access	USFWS, 1997
Round Mountain	Grazing, mining potential is being investigated; roads provide OHV access	USFWS, 1997
Terrace Spring	Mining, quarry currently closed, but interest in use of tailings.	USFWS, 1997

Constraints to Recovery and Restoration

Natural Recolonization. There appears to be some potential for natural recolonization of slightly disturbed sites by Cushenbury milk-vetch (Barrows, 1988; Tierra Madre Consultants, 1992; USFWS, 1997). This species has been observed on little used roads and on two small quarries that have been abandoned for 20 to 25 years (USFS, 1992). There is no indication that they can tolerate continuous disturbance or high levels of disturbance, such as active quarrying or continual usage of roads (Sanders 1992; Tierra Madre Consultants, 1992). That this species can tolerate a degree of disturbance does not mean that disturbed sites are preferred. At Right Star mine site in Lone Valley, there were significantly fewer Cushenbury milkvetch plants per acre in previously disturbed areas than in adjacent undisturbed areas. A greater proportion of juvenile plants were found in undisturbed areas, possibly indicating more recruitment when there is less disturbance (USFS, 1992).

Propagation. It is uncertain whether Cushenbury milkvetch plants could be propagated in a greenhouse for purposeful revegetation. Although an attempt to germinate seeds was successful as long as seeds were scarified, the necessity to keep soil moist for seedling establishment encouraged the growth of the root rot fungus, *Pythium*, which probably caused death of all of the seedlings in the study (Tierra Madre Consultants, 1996). In a trial revegetation program at Gordon Quarry, Cushenbury milk-vetch plants were salvaged, potted, and kept in a greenhouse prior to relocation and transplant to a field site, but all plants died in the greenhouse. However, plants were observed later in the Gordon Quarry, evidently recolonizing naturally (Tierra Madre Consultants, 1992).

Genetic Characteristics. Cushenbury milk-vetch populations experience extreme fluctuations due to amounts of annual precipitation (Barneby, 1964; USFWS, 1994). This could possibly lead to genetic bottlenecks, which could result in loss of genetic diversity (Barrett and Cohn, 1991). However, recent isozyme research has shown a surprisingly high degree of heterozygosity for an endemic species (Neel, 1999). The maintenance of genetic diversity through years with low populations is likely due to the soil seed bank. Although there are currently no seedbank data, Cushenbury milk-vetch population increases following rainy seasons indicate that seeds must persist in the soil for at least several years.

Human disturbances, such as road building and quarry excavation, cause habitat fragmentation which might eventually restrict gene flow and also lead to loss of genetic diversity and long term population viability (Beeby, 1993).

Biological Standards:

After extensive surveys in Forest Service and WMPA lands, the USFS identified areas suitable for establishment of a series of reserves to protect plant habitats, create buffer zones and corridors to connect protected areas, and provide long-term management and monitoring. Cushenbury milk-vetch occurs within three of these designated areas in the WMPA, including Partin Mine area at Terrace Springs, an area north of Monarch Flat, and an area southeast of the Specialty Minerals headquarters in Bousic Canyon.

The Bureau of Land Management staff have proposed the creation of two areas of critical environmental concern that lie within the WMPA and that include known Cushenbury milk-vetch populations, as well as other carbonate endemic species (Egan, 1993). One of these areas includes Round Mountain and Terrace Spring, and the other is an area north of Monarch Flat.

The U.S. Fish and Wildlife Service recently produced a draft recovery plan for carbonate endemic plants of the San Bernardino Mountains, including Cushenbury milk-vetch. The goals of the plan are to protect sufficient habitat for species persistence by establishment of a reserve system on federally owned lands with buffer zones around the reserves, to monitor populations, and to maintain or perhaps even expand existing populations through reintroductions of plants. Although there have been several criticisms of the draft recovery plan, especially that it lacks detail (White, 1997; USFS, 1998), the USFWS believes that the plan should simply serve as a guide for the other agencies that will actually carry out more specific management plans. The USFWS final recovery plan is currently being developed, and should be published in 1999.

Cooperation among agencies, private land owners, and mining companies will be necessary to develop and carry out an integrated plan to ensure the long term conservation of Cushenbury milk-vetch. An integrated network of reserves, rather than numerous, small, isolated protected areas are necessary to maintain long term viability of Cushenbury milk-vetch populations (Neel, 1997). Building a reserve system may entail trading of lands between agencies and private land owners, establishment of mitigation banks, acquisition of lands, and establishing a minerals withdrawal, so that relinquished claims are not subject to being reclaimed. Without cooperation of all parties, it will be difficult to ensure that reserves will be large enough (USFS, 1998) and contiguous enough to be effective in the conservation of this species.

Research Needs:

Reserve Location and Design. Further research is needed to obtain information necessary for appropriate selection of reserve sites as well as for management of Cushenbury milk-vetch. The specific areas already designated may turn out to be the best locations for recovery plan reserves, and it would be a good strategy to secure these lands as temporary reserves as soon as possible before any more habitat is destroyed. However, just because these areas have the highest number of carbonate endemic species, establishment of reserves in these locations does not ensure long-term population viability of any or all of the carbonate endemic taxa involved. Establishing a reserve for all carbonate endemics does not take into account habitat preferences for each species to be protected (Gonella and Neel, 1995). In addition, these areas may not represent the genetic diversity present within this taxon, and may not represent the ecological range of the taxon, both of which are important criteria in establishing effective reserves (Neel, 1999).

It is recommended that reserves should be set up at a variety of elevations and geographic locations, so that random events, such as fires or flash floods, would not impact all reserves at one time (White, 1997; Neel, 1995), and that each reserve site should include unoccupied habitat into which the species can move in the future (White, 1997).

Life History Research Needs. If data were available on recruitment and reproductive success in various areas within its range, efforts could be directed toward establishing reserves in those sites where the Cushenbury milk-vetch gets established and produces viable seed most readily. Research is needed to determine if the plants always flower and fruit the first year, how long they live, and what conditions influence their life history strategy. This information would be useful in conservation management by helping to predict future reproductive effort and population fluctuations.

If seed bank information were available (such as seed bank population size, numbers and kinds of seed predators, and the extent of seed predation) the genetic repercussions of random population variation due to climate could be more predictable, potential rates of recolonization of disturbed areas might also be determined with more accuracy, and there would be greater precision in determining how large preserves and buffers must be to maintain population viability. If seed dispersal mechanisms were known, there would be a better understanding of potential for natural recolonization.

Research on Habitat Requirements. It would be helpful to obtain information about mycorrhizal associations (White, 1997), and to use available information about soil mineral nutrient content and texture preferences for this species (Gonella and Neel, 1995); reserves could be established and revegetation efforts could be directed only in areas which meet those requirements. To understand data gleaned from monitoring population fluctuations, it is imperative to know how rainfall affects population size from year to year, so these effects can be separated from those from human activities.

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