San Bernardino Mountains Carbonate Endemic Plants Recovery Plan

Erigeron parishii
Parish's daisy

Eriogonum ovalifolium var. *vineum*
Cushenbury buckwheat

Astragalus albens
Cushenbury milk-vetch

Lesquerella kingii ssp. *bernardina*
San Bernardino Mountains bladderpod

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U. S. Fish and Wildlife Service
Region 1, Portland, Oregon

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Approved: ____________XXXXXXX____________
Regional Director, Region 1, U.S. Fish and Wildlife Service

Date: ______________________________

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LITERATURE CITATION

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EXECUTIVE SUMMARY

CURRENT SPECIES STATUS: Four of the plants are endangered: *Eriogonum ovalifolium* var. *vineum* (Cushenbury buckwheat), *Astragalus albens* (Cushenbury milk-vetch), *Lesquerella kingii ssp. bernardina* (San Bernardino Mountains bladderpod), and *Oxytheca parishii* var. *goodmaniana* (Cushenbury oxytheca). *Erigeron parishii* (Parish's daisy) is threatened. The five species were listed on August 24, 1994 (59 *Federal Register* 48652).

HABITAT REQUIREMENTS AND LIMITING FACTORS: The five plant species are restricted to limestone, dolomite, or other carbonate rock substrates of the San Bernardino Mountains, San Bernardino County, California. *Erigeron parishii* is also found in the Little San Bernardino Mountains, also in San Bernardino County. Little is known about their life history and specific ecological requirements. The plants are perennials except *Oxytheca parishii* var. *goodmaniana*, which is an annual. The primary threat is limestone mining.

RECOVERY OBJECTIVE: Reclassification of the endangered taxa to threatened status and the delisting of *Erigeron parishii*. Delisting of the four endangered plants will be feasible if habitat conservation can be accomplished for these plants on Federal lands in the context of the mining laws.

RECOVERY CRITERIA: The four endangered plants (*Eriogonum ovalifolium* var. *vineum*, *Astragalus albens, Oxytheca parishii* var. *goodmaniana*, and *Lesquerella kingii* ssp. *bernardina*) can be considered for downlisting and the threatened *Erigeron parishii* for delisting when:

- Sufficient habitat has been protected for existing populations of the plants to persist in their ecological contexts. The system of permanent biological reserves for these plants' habitats will be designed to protect the largest populations, the best habitat, and to be manageable.
- Potential buffer zones for these reserve lands shall have been identified, albeit not necessarily secured, to meet this criterion. The interim estimate of additional lands needed for habitat connectivity, buffers, and natural community context is 1,860 hectares (4,600 acres).

• Early detection of population instability or other problems in the reserve system is assured through population monitoring/habitat management programs.
• The chance that the most narrowly-distributed species might go extinct due to random naturally occurring events has been reduced through reintroductions or expansions of existing populations.

ACTIONS NEEDED:

1. Protect significant extant populations by developing a system of reserves on Federally owned land. Initially, preserves covering about 2,000 hectares (5,000 acres) are needed, based on known areas occupied by the plants. The reserve system includes buffer zones and maintenance of selected habitat connections. The land managing agencies will conserve these plants in the context of applicable laws (including the mining laws) and regulations.
2. Restore habitat and conduct reintroductions and/or population enhancements where appropriate and feasible.
3. Identify and implement appropriate management measures.
4. Monitor populations.
5. Conduct limited surveys and taxonomic assessments to find new populations and resolve questions about the identity of several populations identified in the text.

IMPLEMENTATION PARTICIPANTS: Recovery will be largely accomplished by the U. S. Forest Service, U. S. Bureau of Land Management, California Department of Fish and Game, and the U. S. Fish and Wildlife Service.

TOTAL ESTIMATED INITIAL COST OF RECOVERY: $ 780,000.

DATE OF RECOVERY: About 7 years are required for research and monitoring to determine the need for population enhancement or reintroductions. Other work needed to determine the feasibility of recovery should be completed by then. Seven years is thus the minimum time required for downlisting of the endangered species and delisting of the threatened one. The recovery rates for the five species depend on the future nature and extent of mining within their ranges. If mining issues are resolved quickly, recovery for most all of the species could be feasible in 12 to 15 years.

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PART I. INTRODUCTION, BACKGROUND, AND RECOVERY ISSUES

OVERVIEW

The San Bernardino Mountains in southern California support a wide diversity of natural habitats that are the result of geographic position between desert and coastal environments, elevational zonation, and uncommon geological substrates such as carbonate outcrops (primarily limestone and dolomite). The San Bernardino National Forest, which encompasses most of the San Bernardino Mountains, occupies less than 1 percent of the land area within the State, yet contains populations of more than 25 percent of all native Californian plant species.

Carbonate outcrops occur in several bands running on an east-west axis along the desert-facing slopes of the San Bernardino Mountains, with separate (i.e., *disjunct*) patches occurring just to the south of Sugarlump Ridge and to the east as far as the Sawtooth Hills. These outcrops are remnants of an ancient formation of sandstone, shale, and limestone, through which the granitic core of the Transverse Ranges has emerged (Fife 1988). The carbonate rock provides a unique habitat to which a number of plants are restricted (i.e., the plants are *endemic* to carbonate substrates in this area). Limestone mining is the primary threat to these plants.

The five plants addressed in this recovery plan, *Erigeron parishii* (Parish's daisy), *Eriogonum ovalifolium* var. *vineum* (Cushenbury buckwheat), *Astragalus albens* (Cushenbury milk-vetch), *Lesquerella kingii* ssp. *bernardina* (San Bernardino Mountains bladderpod), and *Oxytheca parishii* var. *goodmaniana* (Cushenbury oxytheca) (herein collectively called the carbonate plants), are restricted primarily to carbonate deposits or their derived soils. Due to threats posed by limestone mining, urban development, and off-road vehicles, *Erigeron parishii* was listed as threatened and the four other plants were listed as endangered on August 24, 1994 (59 *Federal Register* 48652). Critical habitat has not been designated.

• *Erigeron parishii* (Parish's daisy) (recovery priority 8)[1], with a range approximately 56 kilometers (35 miles) long, is the most widely ranging of the five plants. *Erigeron parishii* is now known from approximately 50 separate occurrences. Surveys conducted after the plant was listed doubled the number of known populations, which had been fewer than 25 with a total of about 16,000 individuals. Estimates of numbers of individuals are not available for the new sites.

• *Eriogonum ovalifolium* var. *vineum* (Cushenbury buckwheat) (recovery priority 9) is limited in distribution to the belt of carbonate substrates on the north slopes of the San Bernardino Mountains from the White Mountain Management Unit east to Rattlesnake Canyon. The known range extends about 40 kilometers (25 miles). The total population is estimated at approximately 13,000 individuals, with only a quarter of the plant's occurrences having more than 1,000 individuals each (Barrows 1988b).

• *Astragalus albens* (Cushenbury milk-vetch) (recovery priority 8) is currently known from about 33 occurrences scattered throughout the eastern half of the carbonate belt, running from Furnace Canyon southeast to the head of Lone Valley, a range of 24 kilometers (15 miles). Although the number of individuals during the drought (Barrows 1988c) was estimated at 2,000, the total is likely to be larger in years of substantial rainfall. In fact, several known populations collectively contained more individuals during

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1 The Fish and Wildlife Service assigns recovery priorities to endangered and threatened species. High priority goes to species facing a high degree of threat, with a high potential for recovery. The species in this plan are all priority 8 (for full species) or 9 (for subspecies or varieties), reflecting a moderate degree of threat and high recovery potential. Priority rankings go from 1 (high threat, high recovery potential, genus consisting of a single species) to 18 (low threat, low recovery potential, subspecies or variety).

the 1992 field season than had previously been reported. This increase is thought to be partly due to favorable rainfall during March 1992, which resulted in many seedlings becoming established. Part of the increase is, however, attributable to a more thorough survey effort. For example, a survey of the Top Spring-Smarts Ranch Road area found several thousand individuals, making it the largest known population of the species. Population estimates for 1992 place the number of individuals between 5,000 and 10,000 (SBNF 1995).

• *Lesquerella kingii* ssp. *bernardina* (San Bernardino Mountains bladderpod) (recovery priority 9) is known from two areas, on either side of Bear Valley. One cluster of occurrences is on the north side of the valley, near the east end of Bertha Ridge, adjacent to the community of Big Bear City. The other cluster is centered on the north-facing slope of Sugarlump Ridge to the south of the valley, approximately 10 kilometers (6 miles) south of the Bertha Ridge occurrences. The total number of individuals in the Bertha Ridge occurrences was estimated at 25,000 in 1980 and less than 10,000 in 1988; however, it is unclear whether this was only an apparent change due to differences in sampling techniques or real change caused by drought conditions (Wilson and Bennett 1980, Calif. Natural Diversity Data Base 1990). In 1991, the Sugarlump Ridge populations contained approximately 10,000 individual plants (CNDDB 1991). Anecdotal reports suggest that population sizes increased following the end of the drought (M. Neel, San Bernardino National Forest, pers. comm. 1995, M. Meyer, California Department of Fish and Game, pers. comm. 1995). This taxon occupies the smallest area of the five carbonate plants.

•*Oxytheca parishii* var. *goodmaniana* (Cushenbury oxytheca) (recovery priority 9) occupies the second smallest area of the carbonate endemics, and exists in the smallest numbers. The estimated number of plants in 1990 was fewer than 3,000, in four populations. U. S. Forest Service surveys in 1992-1995 located 14 additional populations (CNDDB 1992; SBNF 1995). However, three of these recently-discovered populations, at the eastern end of the range, differ morphologically from other representatives of this taxon and therefore their taxonomic identity is unclear (B. Henderson, in litt. 1996).

One of the *Oxytheca parishii* var. *goodmaniana* populations is near Cushenbury Spring Several other populations are in the vicinities of Cushenbury, Marble, Arctic, Wild Rose, and Furnace Canyons . Two other populations, one of them bisected by a road, are near the abandoned Green Lead gold mine. Portions of the remaining populations are to the north of Holcomb Valley and in the White Mountain Management Unit. The three recently-discovered, eastern-most populations are along the Helendale Fault near Tip Top Mountain, Mineral Mountain, and Rose Mine, 19 kilometers (12 miles) southeast of previously-known populations. Plants in these new populations are best assigned to *O. p.* var. *goodmaniana*, at least until their taxonomic placement can be evaluated by an expert in the systematics of the genus.

Because *Oxytheca parishii* var. *goodmaniana* is an annual species, the number of individuals fluctuates depending on winter and spring rainfall and temperatures favorable to seed germination and seedling establishment. However, the low number of occurrences, as well as individuals, makes it possible that the species could become extinct due to randomly occurring events (*stochastic* extinction).

SPECIES DESCRIPTIONS AND HABITATS

Collectively, the ranges of these five taxa span 56 kilometers (35 miles) and a range of elevation from 1,220 meters (4,000 feet) at the base of the mountains to approximately 2,440 meters (8,000 feet). Very little is known about the life history and population dynamics of these plants, including their pollination biology. They occur as components in the understory of a variety of plant communities, including Jeffrey pine-western juniper woodland, pinyon-juniper woodland, pinyon woodland, and blackbush scrub.

Pinyon-juniper woodland communities dominate the desert-facing slopes above 1,220 meters (4,000 feet) in elevation, and grade into a Joshua tree woodland at lower elevations (Vasek and Thorne 1988). Pinyon-juniper woodlands extend up to almost 2,100 meters (7,000 feet) in elevation, where they intergrade with a Jeffrey pine woodland on drier sites or mixed conifer forest on wetter sites. Open forests of lodgepole pine and limber pine are found at the highest elevations. Within the juniper-pinyon woodlands, the plant species composition varies considerably. The structurally dominant species are *Pinus monophylla* (pinyon pine) or *Juniperus osteosperma* (Utah juniper), and more rarely *Juniperus occidentalis* (western juniper) or *Juniperus californica* (California juniper), occasionally occurring together. Holland (1986) has referred to Mojavean pinyon woodland, Mojavean juniper woodland, and blackbush scrub as separate communities. The understory varies with slope and elevation, but typically includes species such as *Cercocarpus ledifolius* (mountain mahogany), *Ephedra viridis* (Mormon tea), *Yucca schidigera* (Mojave yucca), *Yucca brevifolia* (Joshua tree), and *Encelia virginensis* (encelia). Patches of local dominance by *Coleogyne ramosissima* (blackbush) on lower elevation desert facing slopes, or *Arctostaphylos* sp. (manzanita) on more interior canyons, are common.

***Erigeron parishii* (Parish's daisy)**

This small perennial herb of the aster family (Asteraceae) reaches 1 to 3 decimeters (4 to 12 inches) in height and blooms from May though June. The linear leaves are covered with soft, silvery hairs. Up to 10 solitary flower heads are borne at the tips of leafy stems; ray flowers are deep rose to lavender, and heads have greyish green and glandular phyllaries (bracts). *Erigeron parishii* was first described by Asa Gray in 1884 based on specimens collected by Samuel B. Parish in Cushenbury Canyon in 1881. The plant has sometimes been confused with *Erigeron utahensis*, a plant found on carbonate substrates in the mountains of the Mojave Desert and in Utah, Colorado, and Arizona, but differs from the latter in the structure of the pappus and its silvery-white rather than grey-green stem.

The plant is typically associated with pinyon woodlands, pinyon-juniper woodlands, and blackbush scrub from 1,220 to 1,950 meters (4,000 to 6,400 feet) in elevation. It usually grows on dry, rocky slopes, shallow drainages, and outwash plains on substrates derived from limestone or dolomite. Some populations occur on a granite/limestone interface, usually a granitic parent material overlaid with limestone materials washed down from above. Two small outlying populations at the eastern edge of its range near Pioneertown have been reported to occur on limestone alluvium above quartz monzonite substrates (A. Sanders, University of California Riverside, pers. comm. 1992). Old herbarium specimens of this plant were collected from Rattlesnake Canyon south of Old Woman Springs and from the Little San Bernardino Mountains. These locations have not been surveyed in over 50 years and merit additional field surveys (Andy Sanders, University of California, Riverside, pers. comm., 1992).

***Eriogonum ovalifolium* var. *vineum* (Cushenbury buckwheat)**

This low, densely-matted perennial of the buckwheat family (Polygonaceae) has whitish-cream flowers, darkening to a reddish or purple color with age, and are borne on flowering stalks reaching 1 decimeter (4 inches) in height. May through June is the flowering season. The round to ovate leaves are white-woolly on both surfaces and are 0.7 to 1.5 centimeters (0.3 to 0.6 inch) long. The diameter of mats is typically 1.5 to 2.5 decimeters (6 to 10 inches), but may reach up to 5 decimeters (20 inches) in especially well developed individuals. The plant was first collected by S.B. Parish near Rose Mine, San Bernardino Mountains, in 1894, and was described as *Eriogonum vineum* by John Kunkel Small in 1898. Nelson (1911) published the combination *E. ovalifolium* var. *vineum*. Jepson (1943) used the combination of *E. ovalifolium* var. *vineum*. Munz (1959) accepted the work of Stokes (1936), and recognized it as *E. ovalifolium* ssp. *vineum*, in his flora of California. Reveal (1968) clarified the relationship of the plant to *E. ovalifolium* var. *nivale*, with which it had been confused, and used the name *E. ovalifolium* var. *vineum* (Reveal and Munz 1968). Three other varieties of *Eriogonum* *ovalifolium* are distinguished on the basis of floral and leaf characteristics, but none of them occur in the San Bernardino Mountains.

Eriogonum ovalifolium var. *vineum* inhabits openings in pinyon woodland, pinyon-juniper woodland, Joshua tree woodland, and blackbush scrub communities between 1,400 and 2,400 meters (4,600 and 7,900 feet) in elevation. Other habitat characteristics include open areas with little accumulation of organic material, canopy cover generally less than 15 percent, and powdery fine soils with rock cover exceeding 50 percent. The plant typically occurs on moderate slopes, although a few occurrences are on slopes greater than 60 percent. On gentler, north-facing slopes, it co-occurs with *Astragalus albens*. Recent fieldwork by H. Brown (Pleuss-Staufer Inc., in litt. 1992) has refined the information on the carbonate geology of the San Bernardino Mountains. *Eriogonum ovalifolium* var. *vineum* occurs on limestone substrates in the White Knob area, and from Arctic/Bousic Canyon west to Terrace Springs, south to Top Spring, and along the north side of Lone Valley to Tip Top Mountain. The plant also occurs on dolomite in the Bertha Ridge area, north Holcomb Valley, Jacoby Canyon, and along Nelson Ridge (Brown in litt. 1992). A population in Furnace Canyon is on mixed granite, limestone, and dolomite. A population on Heartbreak Ridge is on carbonate substrates (not specified as to whether limestone or dolomite). Surveys by Barrows (1988b) resulted in a slight range extension of the plant in the Rattlesnake Canyon drainage. Additional surveys by SBNF found two previously unknown populations, one near Jacoby Springs and one just north of Mineral Mountain (California Natural Diversity Data Base (CNDDB 1992). Tierra Madre Consultants (TMC) found a previously unknown population west of White Mountain (TMC 1992), extending the plant's known range west by 1.6 kilometers (1 mile). A dozen other extensions of existing occurrences were reported by SBNF and TMC. All were within the known range of the plant (CNDDB 1992, TMC 1992; SBNF 1995).

***Astragalus albens* (Cushenbury milk-vetch)**

This small silvery-white perennial herb is a member of the pea family (Fabaceae). The slender stems are decumbent, grow to 3 decimeters (1 foot) in length, and support leaves consisting of 5 to 9 small leaflets. The purple flowers, which bloom from March to May, occur toward the ends of the branches in 5-to 14-flowered racemes and develop 8- to 11-seeded pods. *Astragalus albens* was described based on a collection made by Parish and Parish 3 years earlier (Greene 1885). Rydberg (1927) placed the species in his new genus *Hamosa*. Rupert Barneby (1964) synonomized *Hamosa,* returning the species to *Astragalus*. *Astragalus leucolobus*, a common associate on carbonate soils, is distinguished from *A. albens* by its differently-shaped pods and by cobwebby pubescence (fine hairs) on the leaflets, which are strongly folded along the midrib.

Astragalus albens is typically found on carbonate substrates along rocky washes and gentle slopes within pinyon woodland, pinyon-juniper woodland, Joshua tree woodland, and blackbush scrub communities. *Erigeron parishii* and *Eriogonum ovalifolium* var. *vineum* occur with *Astragalus albens* at several locations. Most occurrences are found between 1,500 and 2,000 meters (5,000 and 6,600 feet) in elevation on soils derived directly from decomposing limestone bedrock. Three occurrences are found below 1,500 meters (5,000 feet) in elevation in rocky washes that have received limestone outwash from erosion higher in the drainages. According to Brown (in litt. 1992), two populations occur on granite substrates (Gordon Quarry and Granite Peaks), and one occurs on granite and quartzite (Cactus Flat). Other habitat characteristics include an open canopy cover with little accumulation of organic material, rock cover exceeding 75 percent, and gentle to moderate slopes (5 to 30 percent).

***Lesquerella kingii* ssp. *bernardina* (San Bernardino Mountains Bladderpod)**

This silvery, short-lived perennial member of the mustard family (Brassicaceae) is 1 to 2 decimeters (4 to 8 inches) tall. The plant has yellow flowers at the ends of the stems. Its basal leaves are ovate and have long stalks (petioles). The type material was collected by

Frank W. Peirson at the east end of Bear Valley in 1924. In 1932, Munz described this plant as *L. bernardina*. In 1958, Munz combined *L. bernardina* with *L. kingii*, and designated the plant as *L. kingii* ssp. *bernardina* (Wilson and Bennett 1980). *L. kingii* ssp. *kingii* is found in the mountains of the eastern Mojave Desert and the Inyo-White ranges extending into Nevada. It is distinguished from *L. kingii* ssp. *bernardina* by its smaller petals and styles.

All of the populations of *Lesquerella kingii* ssp. *bernardina* occur on dolomite (Brown in litt. 1992) substrate consisting of either brown, sandy soils with white rocks or on large rock outcrops. The dolomite substrates that support the *Lesquerella kingii* ssp. *bernardina* lie south and west of those that support most of the populations of the other four plants under discussion. However, near the east end of Bertha Ridge, the southernmost population of *Eriogonum ovalifolium* var. *vineum* occurs close to one colony of *Lesquerella kingii* ssp. *bernardina*. Slopes are typically gentle to moderate and are both north and south-facing between 2,100 and 2,700 meters (6,800 and 8,800 feet) in elevation. The taxon is found in open areas with little accumulation of organic material, within Jeffrey pine-western juniper woodlands and white fir forest. The plant appears to tolerate low levels of human disturbance: scattered plants were found growing on old roads (Myers and Barrows 1988).

***Oxytheca parishii* var. *goodmaniana* (Cushenbury oxytheca)**

This small, wiry annual is a member of the buckwheat family (Polygonaceae). The type material was collected by Parish and Parish in 1882 near Cushenbury Spring. Collections of this species were mistakenly identified as *O. parishii* var. *abramsii* or *O. watsonii* until Barbara Ertter (1980) described the variety *goodmaniana* in honor of George J. Goodman, who was the first to recognize both the distinctiveness of the variety and its close relationship to *O. parishii*. The plant stands 0.5 to 3 decimeters (2 to 12 inches) tall with a basal rosette of leaves 1 to 3 centimeters (0.4 to 1.2 inches) long and stems with bracts at the nodes. The flowers consist of six small white to rose or greenish-yellow "petals", technically sepals. Clusters of 3 to 12 flowers have at their bases a distinct reduced leaf (involucral bract). *Oxytheca parishii* ssp. *goodmaniana* is distinguished from the other three *Oxytheca parishii* varieties by its involucral bracts, which have only four to five awns, rather than seven or more. Except for the north Holcomb Valley population, which occurs on dolomite, all populations of *Oxytheca parishii* ssp. *goodmaniana* known as of 1992 are on limestone or a mixed lithology of limestone and dolomite (TMC 1992).

Ecological Understanding

Limited investigations have been conducted into the ecology of the five carbonate endemic plants. Revegetation trials conducted under the direction of the U. S. Forest Service, Big Bear Ranger District, San Bernardino National Forest on former limestone quarry sites provide some ongoing insights into community ecology on the carbonate substrates (M. Neel, San Bernardino National Forest, pers. comm., 1995). In the most focused study on the endangered taxa, habitat characteristics were documented for *Eriogonum ovalifolium* var. *vineum* and *Astragalus albens* with an orientation toward potential habitat restoration (Gonella 1994, Gonella and Neel 1995). Ongoing surveys by the Big Bear Ranger District have expanded knowledge of these species' distribution patterns. Ecological patterns revealed by these surveys suggest that mineral resource development has destroyed individual plants and likely whole populations. Because more habitat is likely to be lost due to mining, and because inactive mines must be reclaimed, greater understanding is needed on how to restore all five taxa to disturbed areas.

Among the gaps in the ecological understanding of these carbonate endemic species is the absence of information about pollination ecology, seed dispersal mechanisms, and seedbank dynamics. Anecdotal observations of increases in population sizes of *Lesquerella kingii* ssp. *bernardina* following cessation of the drought of the late 1980s (M. Neel, pers. comm., 1995; M. Meyer, California Department of Fish and Game pers. comm., 1995), suggest that a persistent seedbank may be necessary for this taxon's survival. Although valuable data derived from anecdotal observations may emerge through ongoing surveys sponsored by the U. S. Forest Service, focused studies are almost certainly necessary to obtain the information needed to conserve these species quickly and adequately.

Gene flow or migration between populations likely maintains the genetic vigor of the species and thus decreases the likelihood of extinction. Though the carbonate habitat by nature is somewhat fragmented and limited within the San Bernardino Mountains, a recovery strategy must consider the function of the system and therefore the connectivity of habitat for potential pollinators, and other means of gene flow between populations.

Gonella and Neel's focused studies on the habitat characteristics of *Astragalus albens* and *Eriogonum ovalifolium* var. *vineum* (Gonella 1994, Gonella and Neel 1995) revealed particular natural community affinities for the two taxa, and confirmed their endemism to carbonate substrates. The five vegetation types of concern are as follows: 1) blackbush (*Coleogyne ramossissima*) scrub, 2) pinyon-juniper (*Pinus monophylla - Juniperus osteosperma*) woodlands; and pinyon-juniper woodlands, characterized by the presence of 3) blackbush scrub (*Coleogyne ramosissima*), 4) flannelbush (*Fremontodendron californicum*), or 5) manzanita (*Arctostaphylos glauca*).

Astragalus albens is found primarily in blackbush scrub, pinyon-juniper woodlands with blackbush, and pinyon-juniper woodlands with flannelbush. Occurrences of the milk-vetch in the two blackbush-related communities were "characterized by relatively gentle slopes, high percentage of cobble, gravel and soil, and low overstory cover." In pinyon-juniper woodlands with flannelbush, where the milk-vetch most frequently occurred, the slopes were also relatively gentle (Gonella 1994). *Eriogonum ovalifolium* var. *vineum* is primarily associated with pinyon-juniper woodlands with flannelbush, pinyon-juniper woodlands with manzanita, and, to a lesser extent, pinyon-juniper woodlands with blackbush. The two former vegetation types were typified by relatively moderate to steep slopes, overstory cover, and shrub cover. These were the most common vegetation types were the most common of all types represented in the study area (Gonella 1994). Pinyon-juniper woodlands with blackbush were also associated with relatively steep slopes. These vegetation types were further characterized by additional dominant and indicator species, other descriptive vegetation measures, and environmental variables.

Comparing the geographic and ecological distributions of non-listed limestone/dolomite specialist plants with the listed specialist plants would be useful. A nonlisted species, *Phacelia douglasii,* has been identified as an indicator of the specific microsite preferences of the listed *Eriogonum ovalifolium* var. *vineum*. Although this buckwheat is associated with the two most common vegetation types in the study area, the species is clearly restricted to particular microsites within those vegetation types. This information may at least be useful in searching for new populations of the *Eriogonum.*

These ecological studies have revealed important clues to the nature of suitable reintroduction habitat for these species, should losses to minerals development or future population viability analyses indicate that experimental reintroductions are warranted. While the vegetation affinities point to shared environmental preferences among the associated species, they also suggest a potential importance of ecological affiliations. For example, an important pollinator of a carbonate plant may also depend on other species associated with the preferred vegetation type for food, cover or breeding requirements. Similarly, an important animal seed dispersal agent might require or prefer specific features of a particular vegetation type, including relationships with other animals that might be specific to that vegetation type. It may be assumed that such natural community relationships are important for any of the carbonate endemic plant species. In the absence of more specific knowledge, the best approach is preservation of connected habitat that is likely to contain necessary elements for pollinators or other dispersal agents.

Furthermore, the harsh climatic influences that play upon the north slope of the San Bernardino Mountains may be partially alleviated by the vegetation present there. Vegetation may influence 1) soil structure, moisture, fertility and biotic relationships, 2) albedo (proportion of light reflected from a surface to that received by it) and the resulting ambient temperatures at or near the soil surface, 3) the turbulence patterns of wind moving across the soil surface, and 4) the local climate. Removal of vegetation cause local climate changes that may adversely affect populations near the cleared vegetation (Segal *et al.* 1988, Pielke and Avissar 1990). Although such effects may be particularly obvious at the boundaries between native communities and such disturbances, they can affect sites some distance from the disturbance (Pielke and Avissar 1990). Maintenance of natural community integrity is an important consideration in the design of endangered species reserves, as well as in habitat restoration and/or population enhancement efforts.

THREATS

Limestone mining is the imminent and primary threat facing these species. Direct removal of mined materials, disposal of overburden on adjacent unmined habitat, and road construction destroy or modify these plants' habitats. Some of the most common consumer products that utilize limestone include "plastics, cement, paint, crayons, glue, fabrics, resins, rubber products, antacids, polyesters, drywall mud, carpet backing, paper, stucco, chewing gum, toothpaste, insecticides, glass, PVC pipe, putty, floor tiles, roofing shingles, calcium supplements"and "acid neutralization" (Brown 1995). The carbonate deposits of the San Bernardino Mountains constitute one of only three "major white, high purity calcium carbonate producers" (Brown 1995) west of the Mississippi River and the only one in California.

Lesser threats to their habitat include sand and gravel mining, off-highway vehicle use, recreational and urban development, and power line and hydroelectric development projects.

Limestone is a locatable mineral under the Mining Act of 1872, as are gold and silver, therefore, it is open to claim on Federal lands that have not been withdrawn. A claim holder may patent the claim, making it private property. Nearly all of the approximately 13,210 hectares (32,620 acres) of carbonate substrates within the San Bernardino Mountains are currently under claim. This includes habitat for all five species. Recent calculations by Brown (in litt. 1992. Original measurements in acres) break down the 13,210 hectares (32,620 acres) into the following component substrates: 4,040 hectares (9,980 acres) of dolomite (30.6 percent), 7,910 hectares (19,530 acres) of limestone (59.9 percent); and 1,260 hectares (3,110 acres) mixed limestone and dolomite (9.5 percent). None of the claims have been patented since the listing of the carbonate plants. All of the plants, except *Lesquerella kingii* ssp. *bernardina*, have some occurrences on previously patented , therefore private, lands.

The first burst of mining activity in the San Bernardino Mountains occurred in the 1860's with the discovery of gold in Holcomb Valley. Historically, gold was extracted by both underground mining and placer mining. Today, only small-scale and weekend prospecting for gold continues. However, gold-bearing alluvium in Holcomb Valley has a low to medium potential for development in the future, and good potential exists for a large gold extraction operation in the Blackhawk area (U. S. Forest Service 1988). Fluctuations in gold prices make it difficult to predict the economic attractiveness of mine development. At the time of writing, the price of gold was low. Several silver mines were also in operation during the late 1800's in Cushenbury Canyon and near Blackhawk Mountain.

In the surrounding Lucerne Valley mining district, the first limestone mines started operation in the 1940's; the current annual production of limestone is approximately 3.3 million tons (U. S. Forest Service 1988). Limestone production, however, typically represents only the fraction of material removed from the mine site as product. The ratio of disturbed material to product material may range from 1:1 up to more than 10:1. U. S. Forest Service records show that ratios at Riverside Cement (Partin Limestone Products, Inc.) between 1972 and 1977 ranged from 4.9:1 to 13:1, and averaged 7.1:1. A 1988 calculation for the same operator placed the ratio at 6.7:1 (U. S. Forest Service 1988). Based on a production of 3.3 million tons of limestone and a 5:1 ratio of disturbed material to limestone in 1988, 16.5 million tons of waste material would be generated. A typical mine site consists of an open or terraced pit, haul roads and staging areas, and the processing plant. The overburden (materials, including non-marketable limestone, removed to reach marketable limestone) is redistributed to piles on site. The amount of nonmarketable lower-grade limestone left onsite depends upon the limestone product market. The direct impacts, to the five carbonate plants, from limestone mining include the removal and destruction of individuals and habitat from mining, construction of haul roads, and deposition of overburden piles on top of currently occupied habitat. Operations targeting pharmaceutical grade limestone tend to create more exploratory roads and access roads relative to the size of the quarry operations and product yields.

Most of the mined limestone is being processed by three operators located along the base of the north slope of the mountains. Because of the limited availability of limestone in the western United States, those claims currently not under production are still being maintained in anticipation of a future market, to prevent claims from being mined by competing companies, or in anticipation of leasing out claims for the extraction of other valuable minerals (e.g., gold and silver).

Apart from impacts associated with gold and limestone mining, several species are threatened by habitat destruction resulting from other activities. Sand and gravel mining proposed for several washes on the lower desert-facing slopes may impact at least one occurrence of *Erigeron parishii* (TMC 1989). Urban development has encroached upon several occurrences of *Lesquerella kingii* ssp. *bernardina* near Big Bear and threatens *Erigeron parishii* near Pioneertown.

Other impacts include the destruction of individual plants and habitat through off-highway vehicle and other recreational use. The U. S. Forest Service has proposed construction of two new sections of the integrated off-highway vehicle road system; these will potentially affect populations of all taxa except *Lesquerella kingii* ssp. *bernardina*.

A proposed hydroelectric generation plant, which includes the use of an old mine quarry to hold water and new ground disturbance for construction of water delivery pipelines, would likely negatively affect populations of all taxa except *Lesquerella kingii* ssp. *bernardina*. However, this proposal is currently on hold. Construction of a proposed 115-kilovolt power line could also negatively affect populations of all taxa except *Lesquerella kingii* ssp. *bernardina*.

The effects of mining activities extend beyond direct impacts to habitat. Habitat fragmentation and edge effects result in a larger impact to the carbonate plants. Among the most obvious potential problems, habitat fragments may be too small to support viable populations of animals serving as pollinators or seed dispersal agents for the endangered plant taxa. Animals may be unable to move among isolated habitats, potentially resulting in the loss of these species from habitat fragments. Such effects at the scale of individual populations can cumulatively result in local extirpation or extinction of an entire taxon.

Edge effects, a corollary of habitat fragmentation, occur at the interfaces of any two or more habitat types, but are more pronounced for natural communities bordered by human disturbances. Edge effects reduce the integrity of a site as habitat fragments get smaller. Edge effects in the carbonate plants' environments can include disturbances of soil moisture, light, temperature and wind patterns. These effects influence microclimate and the potential for invasion by weedy opportunistic species. Some of these potential impacts, which are most pronounced at habitat edges adjacent to human disturbance, are discussed in the following sections.

The carbonate plants' soil moisture regimes may be affected by activities far removed from habitat edges. Alterations to habitat hydrology could negatively impact carbonate plant populations. Of the five plants, *Erigeron parishii* is the one most associated with dry washes, but *Astragalus albens* occurs in rocky washes, too. However, even the species not specifically associated with drainages may also be affected by hydrological alterations. Diversions or increased flows could alter soil moisture. Similarly, impediments to drainage could result in 1) untimely inundation, potentially extirpating populations, or 2) prolonged periods of soil saturation, potentially increasing disease and/or competition from other plant species. For these reasons, any proposed activities within the watersheds of the endangered and threatened taxa should be closely scrutinized for their potential to influence the hydrological integrity of endangered species reserves.

Soil compaction, an impact caused by on-site disturbance, can also impact endangered species' soil moisture relations. Such compaction could arise from the use of heavy equipment or simply through unmanaged human foot traffic. In any case, because soil compaction is difficult to reverse, every effort should be made to prevent it from occurring. Monitoring and adaptive management directives should be developed to reduce the potential for ongoing activities that create soil compaction within carbonate plant habitat and direct activities to other locales.

Another factor that can impact soil moisture relations is windblown sedimentation exacerbated by human land disturbances. In Cushenbury Canyon area, the effects of wind-blown dust due to past mining and mineral processing operations are evidenced by thick layers of clay-like sediments covering the soil surface. Such layers of wind-deposited particles could impact habitat directly by altering: 1) water infiltration and drainage patterns, 2) soil pH and other features of soil chemistry, and 3) light penetration into soil seed banks. The first two of these could influence seedling survivorship, adult fitness (including resistance to disease and predation), and reproduction. The third could prevent seed germination.

In addition to dust problems, general air pollution causes direct injury to plant tissues, changes in soil/moisture chemistry, and reduction in overall plant fitness. Cumulative impacts could result in a reduction of mediating shrub cover that could affect soil temperature and plant germination. General air pollution has also been shown to impact the ecology of soil microorganisms that may influence the soil environment.

Cryptobiotic soil crusts are generally composed of algae, mosses, lichens, some xerophytic liverworts, and cyanobacteria (Harper and Marble 1988). The habitat of the carbonate plants has not been surveyed for the presence or absence of cryptobiotic (or cryptogamic) organisms/soil crusts. However, considering the importance of crusts in other high desert communities (see Belnap 1991a, 1991b, 1994; Harper and Marble 1988), their possible role in the ecology of carbonate endemic plants should not be overlooked.

Changes in light regime may adversely affect plants. Harmful alterations might occur in two ways: 1) changes in amount of reflected light during daylight hours, and 2) changes in ambient night lighting. Night lighting can alter flowering, germination, and other physiological processes (Kasperbauer 1994, Sage and Reid 1994). Inhibition of photosynthetic processes can result from abrupt changes in the plant's light environment (e.g., removal of nearby vegetation). Increased reflected light may alter the moisture regime for areas surrounding mine operations. Artificial night lighting can affect a plant's photoperiod response or may alter the distribution, movement, and behavior of pollinators or seed dispersers. The most significant sources of artificial light in the immediate carbonate plant environment are current mining operations. Important populations of the carbonate plants exist adjacent to mines, so light-regime threats may in some cases be significant. The open pits are glaringly white, seen from a great distance and painful even with sunglasses on. It seems reasonable that this would leave the surrounding habitat drier than habitat not receiving reflected light.

Habitats of most of the carbonate endemic plants are subject to harsh environmental conditions. Removal of vegetation, such as occurs on mine sites, can cause microclimatic changes that could negatively affect individual and population viability. It is likely that revegetation of former quarry sites in the area will require incremental habitat restoration extending over periods of years and possibly decades. Re-establishment or enhancement of plant communities and habitat should begin before attempting to re-introduce the endangered species. As discussed in the Ecological Understanding section, above, such vegetation may relieve the climatic and physiological/morphological effects of bare soil.

Additional impacts can arise from accidental or emergency activities (e.g., firefighting responses). To reduce the threat of accidental incursions into endangered species habitats during such activities, a protocol for emergency response should be developed. This protocol should include a means of alerting emergency response teams to the location and sensitivity of habitats occupied by listed species.

Carbonate plants are threatened throughout their ranges. The third-largest of the limestone quarries, with an annual production of approximately 500,000 tons is located in the vicinity of White Mountain (= White Knob) (Tierra Madre 1992), an outcrop that rises to 2,100 meters (6,900 feet) in elevation above the desert community of Lucerne Valley. The westernmost occurrences of *Erigeron parishii*, *Eriogonum ovalifolium* var. *vineum*, and *Oxytheca parishii* var. *goodmaniana* are here, and their proximity to current mining operations indicates that these plants formerly occurred on the mining site itself. Under a recently County-approved mining plan of operations, the westernmost populations of *Erigeron parishii* and one of the two westernmost populations of *Eriogonum ovalifolium* var. *vineum* will soon be eliminated. As compensation, the County of San Bernardino has directed the mining company to sponsor horticultural studies and experimental reseeding on reclaimed portions of the mine site.

Habitat at Furnace Canyon for *Erigeron parishii* and *Eriogonum ovalifolium* var. *vineum* was removed by quarry operations, including the construction of haul roads and the dumping of overburden at quarry sites. These sites were mostly abandoned before 1974. In the areas adjacent to the quarry sites, remnants of the original populations of *Erigeron parishii*, *Eriogonum ovalifolium* var. *vineum*, and *Astragalus albens* are still found. A proposed hydroelectric plant would have affected these populations and a population of *Oxytheca parishii* var. *goodmaniana*. This proposal is no longer active, but could possibly be revived.

The second-largest active limestone quarry, with an annual production of 800,000 tons, is operating in the vicinity of Marble Canyon, a few miles east of Furnace Canyon. Expansion of an overburden pile is eliminating a sizable population of *Astragalus albens*. The County of San Bernardino has approved expansion of this operation into private land in Arctic Canyon and Cushenbury Quarry. The expansion will affect, by a low estimate, 0.4 acres of *Erigeron parishii*, 1.2 acres of *Astragalus albens*, 14.6 acres of *Eriogonum ovalifolium* var. *vineum*, and 9.1 acres of *Oxytheca parishii* var. *goodmaniana*. Although some of these occurrences overlap, the expansion significantly affects these species. To mitigate the effects, the County of San Bernardino requires dedication in a conservation easement of habitat with the same densities of plants at a three-to-one ratio, plus investigation into the restoration of mined areas. However, the County of San Bernardino does allow for the mining of two thirds of the conservation easement if reclamation produces equivalent densities of plants. Though this does not adequately mitigate the loss of the plants, it does represent the start of preserving populations on private lands in this area (Liliburn Corporation 1996).

Six kilometers (4 miles) east of Furnace Creek is the deeply-incised Cushenbury Canyon, where a mining operation produces 2 million tons of limestone annually, making it the largest of the active limestone mines. The rocky slopes surrounding Cushenbury Canyon have *Erigeron parishii*, *Eriogonum ovalifolium* var. *vineum*, and *Astragalus albens*. A number of populations have already been negatively affected by mining and road construction. Until mitigation measures were implemented several years ago, dust from the rock crushing operation was settling on the slopes downwind from the operation. The resulting (and still present) cement-like crust that formed on the slopes is thought to inhibit the growth and survival of a number of plant species, including populations of *Erigeron parishii*, *Eriogonum ovalifolium* var. *vineum*, and *Astragalus albens*. Despite dust mitigation measures, even on relatively windless days, plumes of dust are observed rising into the air from mine operations (M. Myer, California Department of Fish and Game, pers. comm., 1996).

One population of *Oxytheca parishii* ssp. *goodmaniana* was also rediscovered in the Cushenbury Canyon area in 1978. Two other populations have been located through San Bernardino National Forest surveys. A few populations of *Erigeron parishii* occur on alluvial substrates below the mouth of Cushenbury Canyon and a recent proposal to mine these alluvia for sand and gravel would threaten these populations. A 115-kilovolt power line proposed for construction through Cushenbury Canyon may affect *Erigeron parishii*, *Eriogonum ovalifolium* var. *vineum*, *Oxytheca parishii* ssp. *goodmaniana*, and *Astragalus albens*.

Erigeron parishii, *Eriogonum ovalifolium* var. *vineum*, and *Astragalus albens* occur 3.2 kilometers (2 miles) to the east of Cushenbury Canyon on Blackhawk Mountain, which rises to an elevation of 2,000 meters (6,700 feet). Historically, gold and silver were mined near Blackhawk Mountain, which currently supports one of the best assemblages of the carbonate endemic species. Old roads bisect the habitat, but the lack of limestone mining has left much of the landscape intact.

The east flank of Blackhawk Mountain drops down into Blackhawk Canyon and Grapevine Creek. On the east side of Grapevine Creek, the terrain rises to the twin peaks of East Knob and West Knob. Three species, *Erigeron parishii*, *Eriogonum ovalifolium* var. *vineum*, and *Astragalus albens*, occur in this area. Just below East Knob and West Knob, a small mine is currently closed. Its annual production had been 40,000 tons. However, another operator is investigating reopening this quarry.

Round Mountain is east of Blackhawk Mountain. This area has populations of *Erigeron parishii*, *Eriogonum ovalifolium* var. *vineum*, and *Astragalus albens*. The adjacent quarry is closed, but there are investigations into the potential for mining on the mountain.

South and east from Blackhawk Mountain, the carbonate belt follows Arrastre Creek, which parallels the Helendale Fault. A cluster of occurrences of *Erigeron parishii* and *Eriogonum ovalifolium* var. *vineum* are scattered on the rocky slopes west of Horsethief Flat. In 1990, the U. S. Forest Service surveyed a significant population of *Astragalus albens* near the head of Lone Valley in the Top Springs-Smarts Ranch Road area, in preparation for review of a new proposal to mine. After 1990, the claim changed ownership and a new proposed plan of operations was submitted for review by the U. S. Forest Service. The proposal is to expand the existing 1.6 acre quarry to 11 acres over the next ten years then expand to 37 acres over the next fifty years. The U. S. Forest Service is preparing a draft Environmental Statement (DEIS) and the County of San Bernardino is preparing a draft Environmental Impact Report (DEIR) analyzing the impacts of the current proposal. The proposed mine expansion would potentially affect a key population of *Astragalus albens* plus populations of *Erigeron parishii* and *Eriogonum ovalifolium* var. *vineum*. Farther up the Arrastre Creek drainage, another dozen occurrences of these three species are scattered along Nelson Ridge and an unnamed ridge that flank Long Valley for a distance of approximately 6.4 kilometers (4 miles). The Helendale Fault area is not being mined, although some assessment work is underway. Historic mining may have affected the endemic plants.

Above Lone Valley, the main fork of Arrastre Creek slowly climbs for another 6.4 kilometers (4 miles) toward the Rose Mine Valley-Tip Top Mountain area. Scattered occurrences of *Eriogonum ovalifolium* var. *vineum* are found along this stretch. Some of the densest stands of *Eriogonum ovalifolium* var. *vineum* have been bisected by motorcycle and jeep trails near Rose Mine Valley (Krantz 1979b). This recreational activity continues.

Farther to the south and east, the tributaries of Arrastre Creek run off the north and west slopes of Tip Top Mountain, which rises to an elevation of 2,000 meters (6,700 feet). On the south and east side of Tip Top Mountain, tributaries flow into the Rattlesnake Canyon drainage. Along this drainage is another cluster of occurrences of *Erigeron parishii* and *Eriogonum ovalifolium* var. *vineum*. Significant new populations of *Oxytheca parishii* ssp. *goodmaniana* were found by U. S. Forest Service surveys in 1992 near Tip Top Mountain and nearby Mineral Mountain. The easternmost occurrences for *Eriogonum ovalifolium* var. *vineum* and perhaps *Oxytheca parishii* ssp. *goodmaniana* are a few miles east of Tip Top Mountain. Historic mining has affected *Erigeron parishii* and *Eriogonum ovalifolium* var. *vineum*. Krantz (1979b) noted that a dirt road leading to an abandoned quarry had bisected habitat for both plants. *Erigeron parishii* may be able to tolerate some disturbance, as evidenced by its occurrence along roadsides, while *Eriogonum ovalifolium* var. *vineum* is absent from roadsides in this area (Krantz 1979a, 1979b).

Scattered patches of carbonate substrate occur outside the main belt that traverses the San Bernardino Mountains. On the east end of Bertha Ridge, north of Bear Valley, several small patches of *Lesquerella kingii* ssp. *bernardina* and *Eriogonum ovalifolium* var. *vineum* occur. These populations are adjacent to the community of Big Bear and are subject to impacts associated with urban development. Surveys by Myers and Barrows (1988) indicated that several occurrences of *Lesquerella kingii* ssp. *bernardina* have been reduced in size since the previous surveys were completed in 1980 (Wilson and Bennett 1980).

At the northern edge of Holcomb Valley, *Oxytheca parishii* var. *goodmaniana* is found near an old gold mine site. A low to moderate potential exists for the reactivation of mining activity in this area in the future, depending on the price of gold (U. S. Forest Service 1988).

On the north-facing slope of Sugarlump Ridge on the south side of Bear Valley, several large populations of *Lesquerella kingii* ssp. *bernardina* were recently discovered. One of these populations may be affected by the proposed expansion of a downhill ski area (Michael Brandman & Associates 1990), however, the U. S. Forest Service completed a formal consultation with the U.S. Fish and Wildlife Service on the proposed expansion to minimize its effects on the endangered *Lesquerella*. Further monitoring of recreational impacts to these populations may be warranted as part of the recovery process. While activities associated with skiing may typically leave these populations undisturbed under the cover of snow, early or late-season activity could cause soil compaction. Other threats and limitations to recovery include habitat fragmentation, alterations to the habitat's hydrological regime, and wind-blown sediment. Devising solutions for relieving these threats and maintaining the native community context is complicated by the lack of ecological knowledge of these species as well as population viability considerations.

In summary, approximately 76 per cent of all the populations of these five species are under claim or in private ownership and subject to mining or are threatened by other disturbance. Broken down by species, the percentages are: *Astragalus albens* 97 per cent, *Eriogonum ovalifolium* var. *vineum* 75 per cent, *Erigeron parishii* 73 per cent, *Lequerella kingii* ssp. *bernardina* 1 per cent, and *Oxytheca parishii* var. *goodmaniana* 79 percent. The only large areas of carbonate substrates not under claim are on the south side of Bear Valley near Sugarlump Ridge, where only *Lequerella kingii* ssp. *bernardina* occurs. Claims that are not currently being mined are being maintained either in anticipation of expanding operations once current quarry supplies are depleted (as a means of keeping competing companies from mining the claims) or in anticipation of leasing the claims to extract other valuable minerals.

Reserve design must take into account other threats and ecological aspects of the carbonate plants. In the absence of more specific ecological information, recovery of the five carbonate endemic plant taxa must depend on general principles of conservation biology and landscape ecology.

One particularly relevant general principle is that plants restricted to specialized soils (including limestone and serpentine) can usually be cultivated on more ordinary soils, but it does not follow that they can be conserved by planting them on ordinary soils. While the plants might grow on such sites, they would be unlikely to persist in competition with plants that are not restricted to specialized habitats.

CURRENT CONSERVATION MEASURES

A few disjunct occurrences of *Erigeron parishii* are in and near the Burns Preserve and Pioneertown, on broad alluvial fans of the upper desert about 24 kilometers (15 miles) south and east of Tip Top Mountain. The Burns Reserve is protected through the auspices of the Natural Reserve System of the University of California. Although the Pioneertown site has been proposed for urban development, the Nature Conservancy has secured a voluntary agreement with the landowner to protect the *Erigeron parishii* at this site.

The California Environmental Quality Act (CEQA), enacted in 1970, provides for mitigation of project impacts to sensitive plant and animal species through an environmental review process. The California Department of Fish and Game is charged with working with State and local agencies and project proponents to reduce or prevent impacts of projects to rare and listed species.

CEQA requirements, handled by County of San Bernardino, for the proposed expansion of limestone mining operations into Arctic Canyon resulted in the dedication of at least 60 acres of privately-owned occupied habitat into a conservation easement and investigation into restoration of quarries. For every acre restored to occupation by the carbonate plants, one acre will be removed from the conservation easement. Mitsubishi Mining Corp. recently proposed a similar mitigation strategy for expansion of their operations on private lands.

The U. S. Forest Service is developing a strategy to conserve carbonate plants on the San Bernardino National Forest while accommodating other land uses. The goals of the strategy are: 1) to protect the plants and the ecosystems upon which they depend, 2) to guide impact minimization and compensation for unavoidable impacts, 3) to streamline reviews of activities in areas determined to be refuges, and 4) to guide habitat restoration. Tasks to implement the conservation strategy include the development of preserve designs. The U. S. Forest Service is coordinating with stakeholders and agencies, including the Service, in the development of this strategy.

Consistent with this strategy, the U. S. Forest Service recently completed a formal consultation under section 7 of the Endangered Species Act with the Service on the Bear Mountain Ski Resort Expansion Plan (reference number: 1-6-95-F-5). The proposed project avoided undisturbed habitat of *Lesquerella kingii* ssp. *bernardina* and minimized impacts to individuals that occur in a previously-disturbed area. Undisturbed occurrences are designated as areas within which development activities are prohibited. The prohibited activities include, but not limited to: operation of vehicles, removal or modification of vegetation, or any other modification of habitat. Impacts to individual plants occurring on previously-graded ski runs were minimized by reducing the project's footprint of disturbance to 0.55 acres. However, the owners of the ski area currently do not plan to expand the proposed ski runs due to Forest Service requirements involving the California spotted owl and flying squirrel.

The U. S. Forest Service is also preparing a Draft Environmental Impact Statement on the revised plan of operations for the proposed operations near Lone Valley. Under section 7 of the Act, the U. S. Forest Service (and the Bureau of Land Management) must consult with the Service on reviews of mining plans of operation if the operations may affect a listed species. A plan of operations has not yet been formally submitted.

RECOVERY STRATEGY

The majority of the populations of these plants occur on Federal lands, primarily U. S. Forest Service but also Bureau of Land Management. Therefore, the recovery of the carbonate plants depends on populations on Federal lands, all the more so because the Endangered Species Act protects plants on Federal land, but in general not on private lands. The primary threat to these plants is the removal and fragmentation of habitat by limestone mining on these Federal lands as well as private lands. Mining operations on public lands require an approved plan of operations. USFS and/or BLM approval of plans of operations are subject to consultation under section 7 of the Endangered Species Act. Section 7 requires Federal agencies to insure that any action it authorizes is not likely to jeopardize any listed species. This legal requirement provides the underpinning for the primary recovery approach, which is to protect essential populations in their habitat, with conservation of the habitats' ecological contexts and connectivity between the populations.

These plants will be conserved by: 1) protecting essential populations, 2) maintaining habitat connectivity among the populations, where it appears necessary, and 3) maintaining the physical and biological environment with which these taxa have evolved. At a minimum, habitat reserves should be designed to contain contiguous, buffered habitat, take into account long-term sustainability, potential geographic distributional shifts in response to climate change, and include the possibility of reintroduction/expansion of carbonate plant populations. A carefully designed system of reserves will enable the conservation and recovery of the carbonate community along with continuing mineral exploration and development.

Threats other than habitat destruction exist, but they are secondary in importance. They may be reduced/eliminated through U. S. Forest Service or Bureau of Land Management land management actions, such as rerouting off-highway vehicles and access control—fencing populations adjacent to development, and stopping unauthorized activities. Developmental impacts on private lands can only be addressed through review under CEQA.

The carbonate endemic plants were listed as endangered or threatened as a group because they belong to the same ecosystem, occupy carbonate substrates, and have the same threats. Protection of the carbonate plants depends on protecting the integrity of their natural community context. It is expected that these species will be conserved as a group and reclassified to threatened status and/or delisted as a group.

The reserves may be set aside though a variety of procedures. Public lands may placed in reserves and managed through land management mandates and procedures of the Forest Service and Bureau of Land Management. These may include mitigation through approval of plans of mining operations, withdrawals, OHV and other recreational activity management. Opportunities may arise to protect populations on private lands through mitigation resulting from environmental review and San Bernardino County approvals under the California Environmental Quality Act (CEQA).

The Forest Service's Carbonate Plant Conservation Strategy is under development and will be the means of conserving these plants. The Conservation Strategy should include monitoring and management actions. Experiments should be conducted with habitat restoration for areas disturbed by mining or roads, although restoration should not be allowed to substitute for conservation of extant populations.

PART II. RECOVERY

A. RECOVERY OBJECTIVE AND CRITERIA

RECOVERY OBJECTIVE

The primary objective of this Recovery Plan is the downlisting to threatened status of *Eriogonum ovalifolium* var. *vineum, Astragalus albens, Oxytheca parishii* var. *goodmaniana*, and *Lesquerella kingii* ssp. *bernardina* and the delisting of *Erigeron parishii*. Delisting will become the objective when it becomes evident that Federal land management agencies can develop an adequate habitat reserve system under existing mining laws and their mandates to manage land and conserve endangered species.

RECLASSIFICATION CRITERIA

To reclassify the endangered *Eriogonum ovalifolium* var. *vineum, Astragalus albens, Oxytheca parishii* ssp. *goodmaniana*, and *Lesquerella kingii* ssp. *bernardina* to threatened status, sufficient habitat must be protected for extant populations to persist in their indigenous ecological contexts. Accordingly, downlisting from endangered to threatened status may be considered when these criteria are met:

Downlisting Criterion # 1: The priority ranked habitat areas have been protected. Priority for protection shall be determined according but not limited to 1) population size, 2) habitat quality, 3) manageability/defensibility of site, and 4) connectivity. The initial preserve area should be 2,000 hectares (5,000 acres) based on known areas occupied by the plants and should include protection for the threatened species, *Erigeron parishii* (which is discussed separately addressed under the delisting objective and criteria).

Priority areas and populations include, but are not limited to, the following: 1) Sites within the White Mountain Management Unit; 2) populations just north/northeast of Hitchcock

Spring; 3) upper Crystal Creek Drainage; 4) upper Furnace Canyon and prioritized populations in the lower Furnace Canyon area; 5) populations just north of Holcomb Valley; 6) Arctic Canyon; 7) Marble Canyon; 8) Bertha Ridge and slopes to Big Bear Lake; 9) Monarch Flats and northern slopes; 10) eastern and western Slopes of Cushenbury Canyon including the vicinity of Whiskey Springs; 11) Burnt Flat; 12) Blackhawk Mountain and slopes; 13) Round Mountain; 14) Grapevine Creek; 15) Top Spring/Lone Valley/Squirrel Spring; 16) Granite Spring; 17) Arrastre Creek/Rose Mine Valley; 18) Rattlesnake Canyon; 19) Sugarlump/Sugarloaf Mountain; and 20) the outlying populations of *Erigeron parishii* in the Little San Bernardino Mountains. The species and ecosystem-level attributes of these priority areas make them necessary for the survival and recovery of these species. Taxonomic assessment of the eastern populations of *Oxytheca parishii* var. *goodmaniana* may affect the recovery priority and reserve needs of this variety.

To count toward reclassification of the plants, reserves must have been designed to minimize or eliminate indirect threats due to adjacent land uses. This includes protection of carbonate plant habitat from human disturbance to hydrology, soil integrity, fire ecology, habitat microclimates, and light regimes. Appropriate management and restorative measures should reduce habitat-degrading effects such as surface disturbances, windblown sediments, fugitive night lighting, and off-highway vehicle use.

Downlisting Criterion #2: Protect additional lands needed to complete otherwise isolated reserves, to protect new populations that may be discovered in the future, and to provide strategic buffer zones and potential population reintroduction and/or expansion areas. The interim estimate of additional lands needed to secure habitat connectivity, buffers, and natural community context is 1,860 hectares (4,600 acres), including lands to meet Delisting Criterion #2 for *Erigeron parishii*. This figure may be further refined as additional information becomes available.

Downlisting Criterion #3: Adaptive population monitoring/adaptive management programs must be functioning so that early detection is assured for any population instability or other problems in the reserve system. Studies will have shown whether there is a need for reintroductions and/or augmentations of existing populations. Research results to support adaptive management will be available, including at least preliminary results on pollination ecology, seed dispersal mechanisms, population dynamics, microclimate effects of vegetation removal/bare areas, seedbank dynamics, and fire ecology.

DELISTING CRITERIA FOR THE ENDANGERED TAXA

The reserve system designed to allow downlisting is intended to suffice for delisting, provided that monitoring and research demonstrate that the reserves work as planned to remove the threats identified during the listing process. As monitoring and research results become available, delisting criteria will be established

DELISTING CRITERIA FOR THREATENED *ERIGERON PARISHII*

Natural community integrity is important to the long-term sustainability of populations of *Erigeron parishii*. Any tasks implemented to satisfy the following criteria must be in conjunction with tasks implemented for the other four carbonate plants. Reserve design, implementation, and management parameters are the same for *Erigeron parishii* and the four endangered carbonate plants.

The recovery objective will be considered fulfilled and delisting of *Erigeron parishii* may be considered when the following criteria have been met:

Delisting Criterion #1: Consistent with Downlisting Criterion #1, essential extant populations of *Erigeron parishii* are conserved on public lands specified in Downlisting

Criterion #1 for the endangered plants, plus lands where *Erigeron parishii* is the only listed plant, in order to represent the southeastern portion of *Erigeron*'s range, with connections to other populations and reserves. Priority of protection will be determined by the ranking factors in Downlisting Criterion #1 for the four other carbonate plants (excepting the need for *Erigeron parishii* sites to represent the southeastern portion of its range).

Delisting Criterion #2: Any additional lands necessary to connect otherwise isolated reserve areas, provide strategic buffer zones and potential population reintroduction/ expansion areas are protected. This criterion may be fulfilled in conjunction with Downlisting Criterion #2.

Delisting Criterion #3: Early detection of problems in the reserve system is assured through adaptive population monitoring/adaptive management programs. Protocols for responding to problems are in place. Ecological restoration of human-disturbed sites (closed OHV [off-highway vehicle] roads, abandoned quarries, etc.) that formerly affected *Erigeron parishii* habitat is in progress.

Decisions on delisting the species would be made after thorough review of all relevant information and opportunity for public comment.

B. Narrative Outline of Recovery Tasks

Priority 1 Recovery Tasks

I. Identify, design, and establish carbonate endemic plant species reserves encompassing the extant populations of the five taxa.

A. **Identify reserve areas**. Design reserve lands to provide the greatest possible habitat connectivity among priority areas, to encompass the indigenous ecological diversity associated with the carbonate endemic species, and to provide buffer zones for populations under imminent threat of potential impacts from conflicting adjacent land uses.

1. **Design reserve areas to include habitat connections and buffer zones.** A list of priority reserve areas is included in the downlisting criteria on page 30. These reserves should include appropriate connectivity among populations within the indigenous ecosystem as much as possible. Additionally, they should include appropriate buffer zones.

2. **Complete surveys for the five carbonate plants** on potentially suitable habitat on public lands. Upon completion of the surveys in progress by the San Bernardino National Forest, survey coverage should be re-evaluated to ensure that all appropriate lands have received attention. Additional surveys should be completed as needed.

3. **Identify high conflict areas** where quarrying is consistent, harmful, or devastating to the prospects for recovery of these plants.

B. Protect reserves with extant populations through the following means (other means may be possible): land acquisition, approvals of mining plans of operation, mineral withdrawals, density transfer-type arrangements, conservation banks, implementation of plans of operations, and/or conservation easements. Provide for the protection of priority areas with immediate threats. The U.S. Forest Service's conservation strategy will be of great importance. Habitat on private lands may be protected through a combination of landowner cooperation and/or mitigation requirements as the result of proposed projects.

PRIORITY 2 RECOVERY TASKS

II. Identify and conserve additional habitat needed to recover the species.

A. Identify additional public reserve lands necessary to conserve any recently-discovered populations or to provide buffer zones and habitat connectivity. Establish these reserve lands to encompass extant populations of lower priority.

1. **Survey for *Erigeron parishii* in the southeast portion of its range, in** suitable habitats on public lands, including the Little San Bernardino Mountains and Joshua Tree National Park. The purpose of these surveys is to determine the location and numbers of these outlying populations. Prioritize completion of surveys so that lands most threatened by potentially conflicting land uses receive first attention.

2. **Identify and establish additional reserves** based results of the *Erigeron parishii* surveys.

3. **Conserve additional habitat necessary to recover species.** Use same considerations in incorporating additional areas, such as buffers or additional populations, into the reserves as stated in *Downlisting Criterion #2*.

III. **Answer ecological and management questions described in *Downlisting Criterion #2*.**

A. **Evaluate the feasibility and necessity of experimental reintroduction and/or enhancement of existing populations.** Potentially suitable habitat for reintroduction or enhancement should be considered in reserve design. Include investigation into microclimatic needs. Reintroduction should be investigated because it may enhance conservation efforts and possibly provide information on specific ecological requirements. But reintroduction has not yet been successfully demonstrated, so it is not, by itself, a conservation measure.

B. **Evaluate management problems and indirect effects.** Investigations should include, but are not limited to, dust and dust control measures, fire ecology, and hydrology.

C. **Evaluate ecological questions** relevant to the long-term management of these plants. The factors include, but are not limited to, pollination ecology, population dynamics, and seed bank analysis.

IV. **Identify monitoring programs needed to support adaptive management** and initiate them.

A. **Identify monitoring priorities and develop adaptive management guidelines.** Change management practices as needed to maintain viability of conserved populations.

1. **Identify monitoring targets and develop an appropriate monitoring strategy and reserve management guidelines**. Work with an interdisciplinary team for identification. Integrate research results from task number II.B. into management guidelines. The strategy and guidelines should provide for:
   - Monitoring of trends in density, number, and distribution of the carbonate plants, accounting for seasonal and annual variation. Other monitoring may also be needed.
   - Ensuring that management strategy intrudes minimally into natural ecological habitat dynamics.

2. **Implement monitoring of reserve lands and any activities that could potentially impact the carbonate plants and/or reserves**. Cooperate with the affected public agencies and entities on monitoring.

B. **Implement adaptive management guidelines in reserves, working with affected agencies**. Expand management guidelines as new information becomes available.

1. **Implement management measures for activities in vicinity of reserves.** Minimize threats, including indirect effects, to the habitats within the reserves. Find ways to prevent or minimize harmful effects of mining.

2. **Identify reserve sites that are or may be subject to chronic impacts from off-site sources and take remedial measures.** Where projects or other impacting activities are currently ongoing, an attempt should be made to solicit the assistance of land holders, Federal, State, county, and any applicable municipal agencies in reducing impacts to the listed species. Where unavoidable proposed activities on lands adjacent reserves have the

potential to impact reserve sites, agencies should solicit the assistance of land holders and project proponents to design facilities and operations to minimize effects.

a. **Reduce wind-borne sedimentation from point sources such as mining operations**. Work with the mine operators to develop enhanced dust control strategies. Such monitoring will help define the spatial requirements for effective buffer zones.

b. **Reduce fugitive night lighting on reserve lands**. Encourage the installation of shields or other measures to direct light only to the work surfaces actually needing illumination.

c. **Select off-highway vehicle (OHV) roads on public lands for closure and initiate closures**, as described in Downlisting Criterion #2. Initial administrative closure should include, at minimum, erection of physical barriers to prevent further OHV use of closed roads.

d. **Investigate methods to expedite the reclamation of quarries and other disturbed areas**.

e. **Develop emergency response protocols**. These protocols will plan for minimal-to-no disturbance to endangered or threatened species habitats during emergency response efforts such as fire-fighting, flood protection, search and rescue operations or other potentially damaging activities. Coordination must include applicable agencies such as California Department of Forestry and Fire Protection, pertinent flood control authorities, and other State and local agencies or entities.

PRIORITY 3 RECOVERY TASKS

V. **Evaluate recovery efforts and implement corrective measures.**

A. **Evaluate completeness of reserve design and monitoring** of populations. Institute necessary changes to include important populations and best reserve design.

B. **Evaluate management activities, enhancement efforts, or other activities** to ensure populations benefit. Analyze the statuses of protected and unprotected populations and the effectiveness of recovery activities.

C. **Establish and implement any additional measures needed to fully recover and delist the five carbonate plants**. This recovery plan provides for the data and information that will be needed to evaluate delisting criteria.

VI. **Begin to establish a public constituency for the endangered taxa** by developing and implementing a public education program.

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Part III. Implementation Schedule

A summary of scheduled actions and costs associated with this recovery program follows. The scheduling priority for each task and the responsible agency is indicated. Implementation of all tasks listed in the Implementation Schedule will lead to the downlisting of *Eriogonum ovalifolium* var. *vineum*, *Astragalus albens*, San Bernardino bladderpod, and *Oxytheca parishii* ssp. *goodmaniana*. Initiation of these actions is subject to availability of funds.

Priorities in column one of the implementation schedule are assigned as follows:

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2: An action that must be taken to prevent a significant decline in population or habitat quality, or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to meet the recovery objectives.

Acronyms used in the Implementation Schedule

BLM Bureau of Land Management
CDFG California Department of Fish and Game
USFWS United States Fish and Wildlife Service
USFS United States Forest Service
TBD To be determined

IMPLEMENTATION SCHEDULE FOR CARBONATE PLANT RECOVERY

Priority No.	Task No.	Task Description	Task Duration	Responsible Agencies	Total Cost	Estimated Costs. All figures are in $1000s, by fiscal year									
						98	99	00	01	02	03	04	05	06	07
1	I.A.1.	Design reserve areas	2	USFS BLM USFWS CDFG	80	40	40								
1	I.A.2.	Complete surveys	3	USFS BLM	35	15	10	10							
1	I.A.3.	Identify high conflict areas	2	USFS BLM USFWS CDFG	15	10	5								
1	I.B.	Implement protection of identified reserves	TBD	USFS BLM USFWS CDFG	TBD										
2	II.A.1.	Survey for *Erigeron parishii* over southeast portion of range	3	USFS BLM	35	15	10	10							
2	II.A.2.	Identify and establish additional reserves based on task II.A.1.	1	BLM USFWS CDFG	TBD										
2	II.A.3.	Conserve additional habitat necessary to recover species	TBD	BLM USFS	TBD										
2	III.A.	Evaluate reintroduction and enhancement	4	USFS BLM USFWS CDFG	90	15	10	10	10	10	10	10	15		
2	III.B.	Evaluate management problems and indirect effects	2	USFS BLM USFWS CDFG	40	20	20								
2	III.C.	Evaluate ecological questions	3	USFS BLM USFWS CDFG	90	30	30	30							
2	IV.A.1	Identify monitoring strategy and targets, & management guidelines	2	USFS BLM USFWS CDFG	30	15	15								
2	IV.A.2	Implement monitoring of reserve lands	10	USFS BLM	65	10	10	8	7	5	5	5	5	5	5
2	IV.B.1.	Implement management measures in vicinity of reserves	10	USFS BLM	110	15	20	20	15	10	10	5	5	5	5

Priority No.	Task No.	Task Description	Task Duration	Responsible Agencies	Total Cost	Estimated Costs. All figures are in $1000s, by fiscal year									
						98	99	00	01	02	03	04	05	06	07
2	IV.B.2.a.	Initiate wind-borne sedimentation reduction measure	6	USFS BLM USFWS CDFG	30	5	5	5	5	5	5				
2	IV.B.2.b.	Initiate fugitive light reduction measures	6	USFS BLM USFWS CDFG	30	5	5	5	5	5	5				
2	IV.B.2.c.	Identify and initiate OHV road closures	6	USFS BLM USFWS CDFG	20	10	5	5							
2	IV.B.2.d.	Investigate methods to expedite reclamation of quarries and other disturbed areas	1	USFS BLM USFWS CDFG	10									10	
2	IV.B.2.e.	Develop protocols for emergency activities within habitat	2	USFS BLM USFWS CDFG	5	3	2								
3	V.A.	Evaluate completeness of reserve design	2	USFS BLM USFWS CDFG	20		10	5							5
3	V.B.	Evaluate management activities and enhancement efforts	5	USFS BLM USFWS CDFG	25						5	5	5	5	5
3	V.C.	Establish additional measures for delisting.	2	USFS BLM USFWS CDFG	20									10	10
3	VI. A.	Implement public education program	10	USFS BLM USFWS CDFG	30	5	5	5	3	2	2	2	2	2	2
				Cost Totals	**780**	**213**	**202**	**113**	**45**	**37**	**42**	**27**	**32**	**37**	**32**

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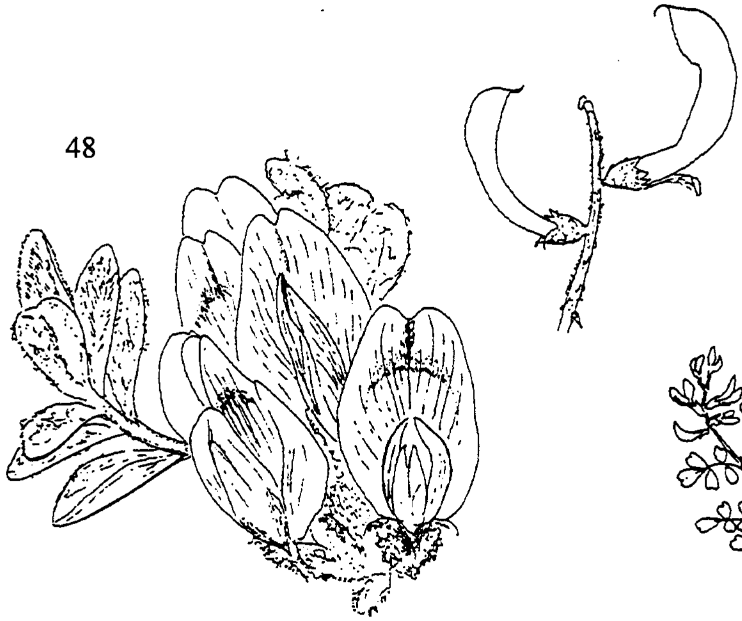
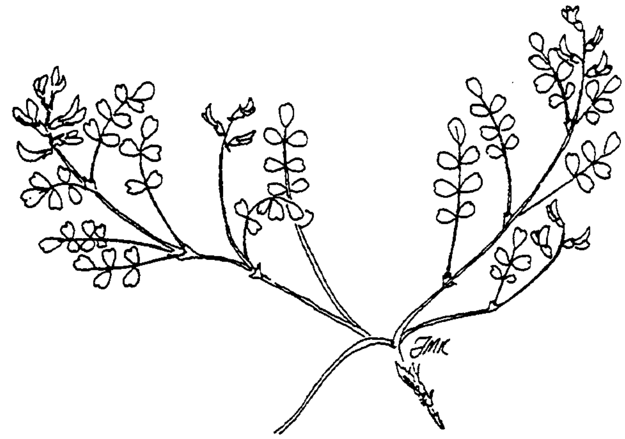
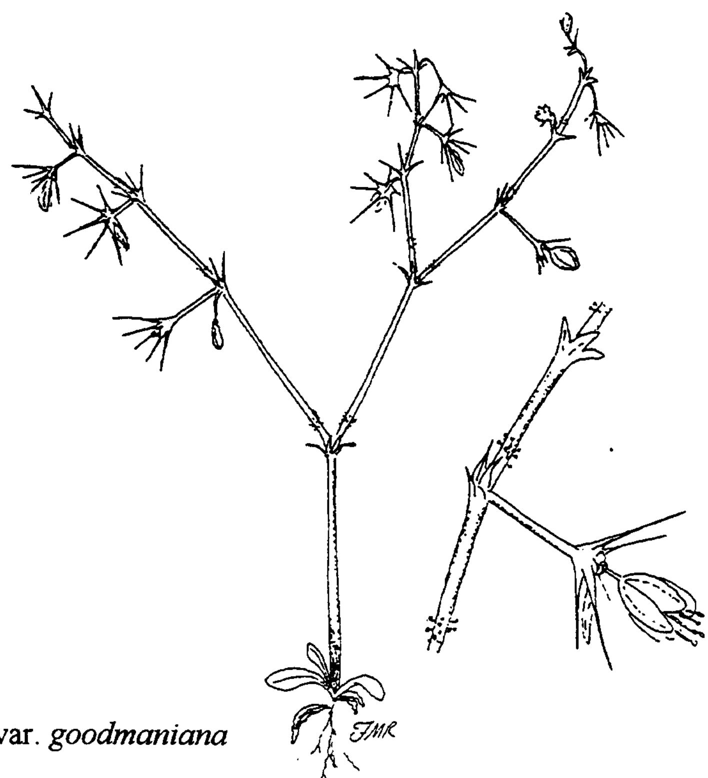


Astragalus albens (flowers and fruit)



Astragalus albens (plant)

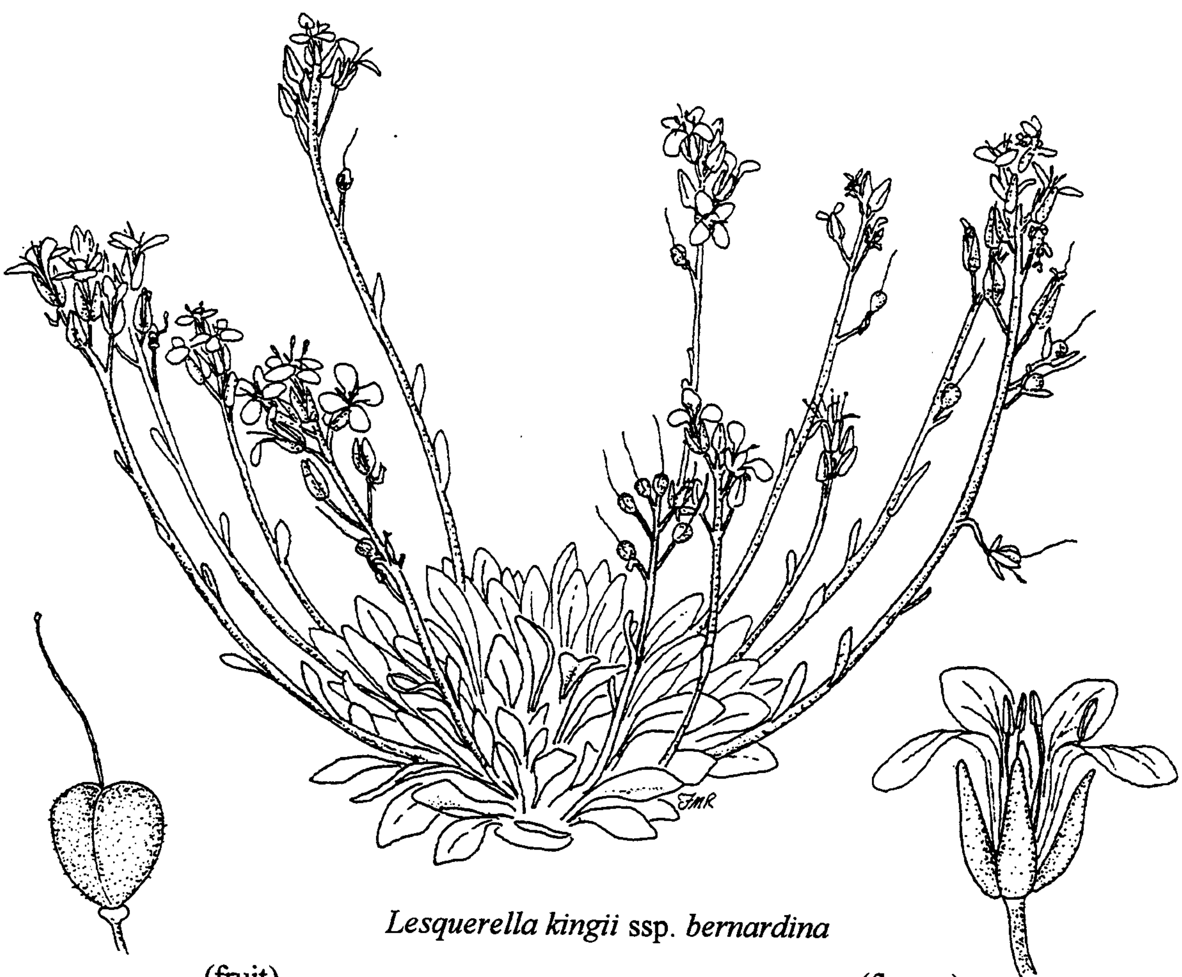
Eriogonum ovalifolium var. *vineum*



Oxytheca parishii var. *goodmaniana*

Figure 1

Erigeron parishii (plant)

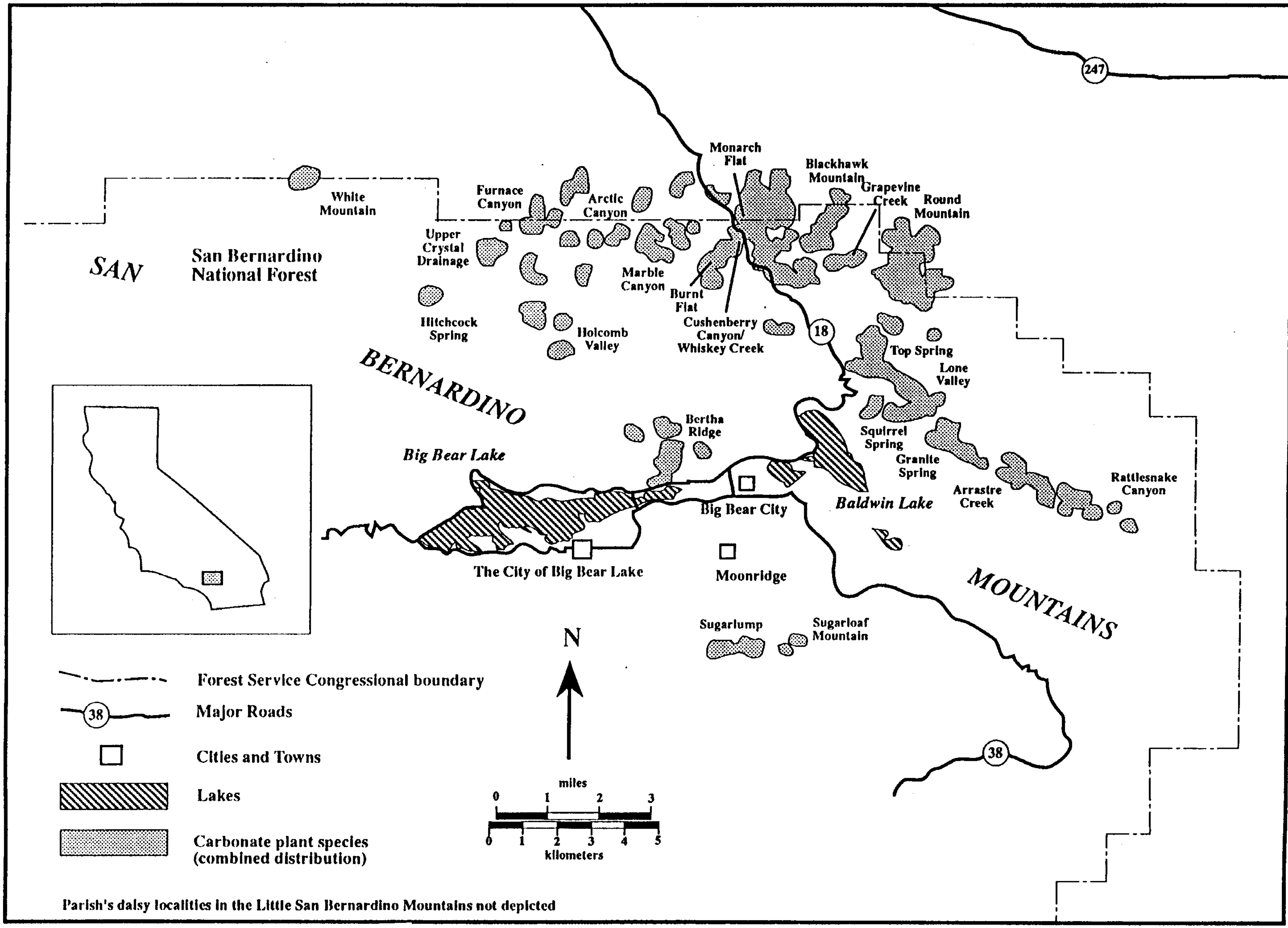


Lesquerella kingii ssp. *bernardina*

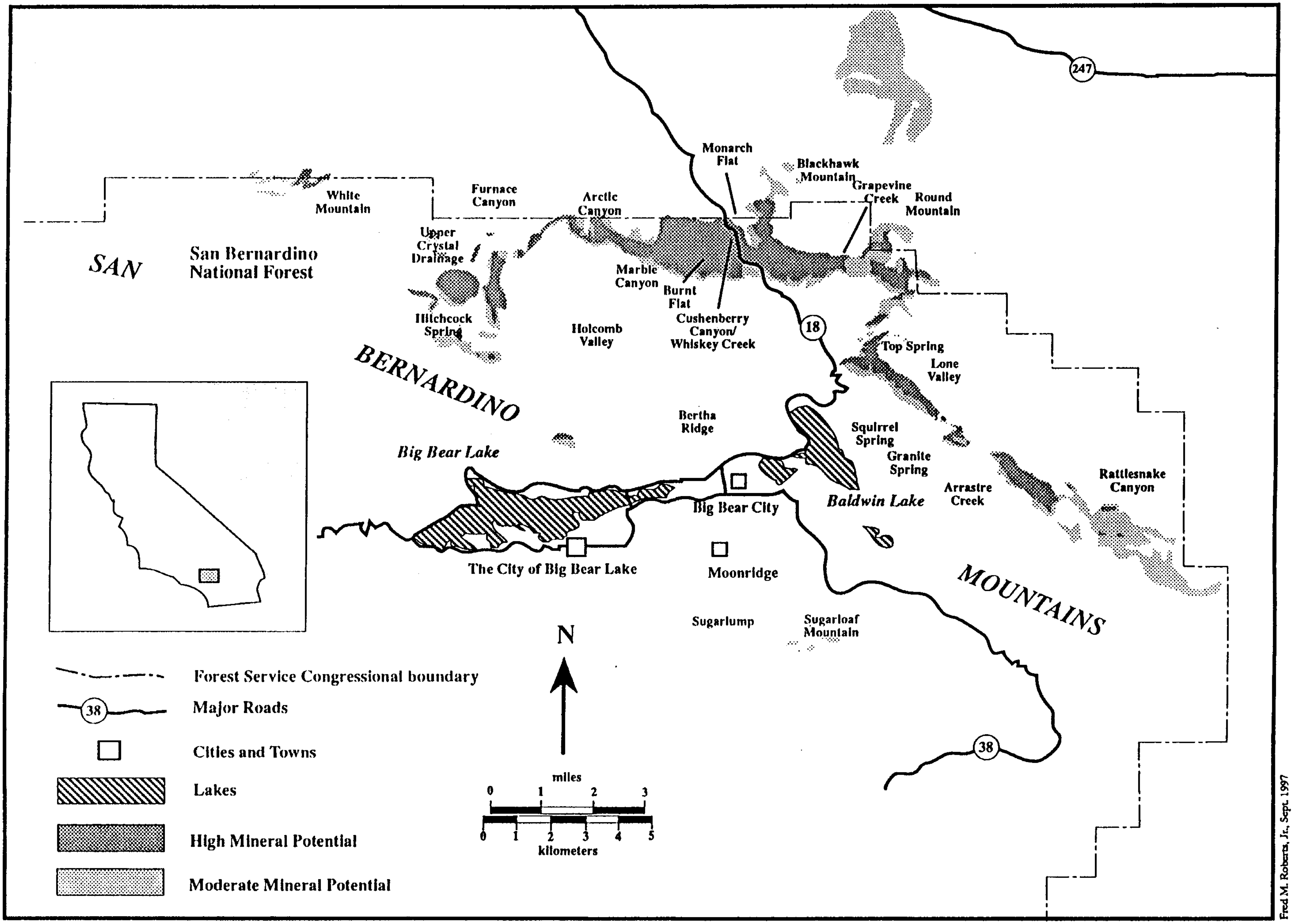
(fruit)

(flower)

Figure 2.



Map 1 Generalized Carbonate Endemic Species Locations



Map 2 Mineral Potential

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