Glenn Lukos Associates, Inc. and Sapphos Environmental, Inc., "Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County, California" (2000)

Revised Report:
Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County, California

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EXECUTIVE SUMMARY

On May 1, 1999, the San Fernando Valley spineflower (*Chorizanthe parryi* var. *fernandina)* was discovered along the outer southern rim of Laskey Mesa at Ahmanson Ranch, Ventura County, California. Previously, this small native annual plant was presumed to be extinct. Its historic range extended from near Elizabeth Lake in Los Angeles County through San Bernardino and Orange counties. It was previously last seen in 1929. The San Fernando Valley spineflower (SFVS) is one of over a dozen vascular plants presumed to be extinct in California that have been rediscovered in the last ten years.

At the Ahmanson Ranch Project, SFVS is found only on, or immediately adjacent to, Laskey Mesa. Plants are locally distributed in 14 areas totaling approximately 5.9 acres of habitat concentrated mostly along the southern rim of the Mesa. These "areas" range in size from as few as 8 to over 15,000 individual plants with a total population size of approximately 23,000 plants. Associated soils are three USDA soil mapping units: the San Andreas, Santa Lucia, and the Zamora series, and the parent material is the Modelo Formation, which here consists mostly of massive interbedded siltstones and shales (*mudstone*). On the steep, south and southwest side of the Mesa, long-term differential weathering of these Modelo rocks give rise to an irregular ridge-and-bench topography. These relatively flat benches, and their local colluvial soil wedges, form the general geomorphic and soil substrates that support the largest, and preferred native habitats of SFVS. These thin, fine-sand colluvial soils are well-drained, acidic, friable, and low in nitrogen and organics. Also, SFVS appears to do equally well in compacted soils and other disturbed substrates associated with ongoing human activities at Ahmanson Ranch.

SFVS is clearly a plant of open habitats, free of shade and competing plants. Only a small fraction of the plants grow among tall grasses or shrubs, and all significant clusters of plants are on open-soils. These areas are not only in full sunlight, but strikingly free of dense exotic grasses that dominate Laskey Mesa almost everywhere apart from the SFVS habitat patches, roads and trails, and areas of native scrub. In the requirements for sunny, low-competition habitats, SFVS shares similar site characteristics of other rare spineflowers such as *C. pungens* var. *hartwegiana* and *Dodecahema leptoceras*. Historically, loss and fragmentation of habitat are the most likely reasons for the decline of SFVS, but today, conversion of open-soil habitats to exotic grassland appears to be the primary threat to SFVS.

This report examines several factors that apparently play an important role in the maintenance of these low-competition, open-soil habitats occupied by SFVS at Ahmanson Ranch: 1) thin, shallow soils over bedrock (natural and man-made); 2) compacted soils; and 3) biotic interactions, such as the presence of mycorrhizal fungi, which immobilize nitrate and exclude exotic weeds. A number of restoration and management techniques have been successfully tested in the past that can be used to create, enhance, and maintain the type of habitat that SFVS requires. Land suitable for potential habitat enhancement is found within and adjacent to the existing spineflower habitat areas along the southern rim of the Mesa and in the Community Open Space. Potential habitat restoration land is also found in the dedicated open space areas underlain by the Modelo rocks. It would appear that SFVS is not pollinator- or reproductively-limited. SFVS is presumably pollinated by a diverse suite of insect visitors, many of which could be significant pollinators, including ants. Although the non-native Argentine ant (which frequently excludes native ants) is abundant onsite, the reproductive success of SFVS has not suffered, which may indicate that this spineflower is a facultative selfer. A facultative selfer means that pollination within a flower or between flowers on the same plant produces viable seed; often, plants of disturbed habitats are facultative selfers. Importantly, SFVS may be a facultative mycorrhizal host: mycorrhizal fungi promote the establishment and growth of native plants and suppress the vigor and density of exotic weeds. Therefore, there is every reason to believe that this plant can be restored in historic localities, and successfully managed onsite by a combination of methods that incorporate a knowledge of its biology.

PRELIMINARY OUTLINE FOR A CONSERVATION & MANAGEMENT PLAN

HABITAT CHARACTERISTICS

- Wide range of tolerance to soil types, chemistry, and compaction.
- Prefers acidic, fine-sand colluvium, low in nitrogen, and possibly permeated with mycorrhizal mycelium.
- Shade and competition intolerant.
- Hardy plant which exploits disturbance by natural bioturbation and anthropogenic processes.

BIOLOGIC FRAMEWORK

I. Appears to support a diversity of pollinators and reproductive strategies.
II. Abundant seed-set per year.
III. Potentially a mycotropic species.
IV. Possibly locally dispersed by small mammals.
V. Conservation of southern ridge-and-bench topography will protect historic seed bank.

RESTORING AND MAINTAINING OPEN-SOIL HABITATS

I. Utilize biologic techniques to immobilize nitrate to control exotic grasses.
II. Build a below-ground network of mycorrhizal hyphae with "net-building" vascular plants.
III. Use alternative methods to create and maintain compacted, thin- and open- soil habitats.
IV. High potential for habitat restoration and/or enhancement is associated with the southern "historic seed bank" rim of Laskey Mesa, and in dedicated open space areas underlain by Modelo rocks.
V. Preventing the eventual encroachment of exotic grasses into existing SFVS habitat.

CONSERVATION CONCLUSIONS

I. SFVS is a good candidate for a restoration program.
II. SFVS can be sustained onsite through good management practices.

I. INTRODUCTION

This letter report summarizes the preliminary findings of the discovery of the San Fernando Valley spineflower (SFVS - *Chorizanthe parryi* var. *fernandina* (Wats.) Jeps.) at Ahmanson Ranch in Ventura County, California [Regional and Vicinity Maps; Exhibits 1 & 2, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. Prior to its discovery at Ahmanson Ranch, SFVS was presumed to be extinct (Hickman 1993; Skinner and Pavlik 1994) due to loss and fragmentation of habitat and invasion by exotic vegetation. It was previously last seen in 1929 (Skinner et al. 1995). The Ahmanson Ranch population is comprised of nearly 23,000 plants distributed in 14 areas covering approximately 5.9 acres of sandy soil habitats associated with the Modelo formation. SFVS habitat areas occur mostly along the outer, southern edge of Laskey Mesa which is located in the southeastern corner of the Ahmanson Ranch project site. The purpose of this report is to provide information to aid the Resource Management Program, which includes a Plant Community Management Plan, and to provide documentation for potential impacts to SFVS as a result of implementing the 2,800-acre Ahmanson Ranch development project.

The Ahmanson Land Company has formed a project team comprised of leading scientists to study the biology of SFVS. The preliminary results of their ongoing research has been incorporated into this document. Full reports documenting their work will be included in the final SFVS report, including: Dr. Ted St. John (soil biota and restoration ecology), Dr. C. Eugene Jones (pollination and reproductive biology), Dr. Roy Shlemon (geomorphology and soils), Dr. James L. Reveal (botany), Dr. Garn Wallace (soil fertility analysis), and Dr. Brad Blood/Peter Bloom (small mammals/wildlife). In addition, Michael Wall and Valerie Souza of the Rancho Santa Ana Botanic Garden (RSABG) have collected approximately 2,500 viable seeds to be placed in their germ plasm/research program, and approximately 5,000 which are being stored for use by Ahmanson Ranch in order to develop a conservation program. RSABG has prepared a report describing their seed collection protocol and the results of seed viability and germination studies which has been forwarded to Ahmanson Land Company, the U.S. Fish and Wildlife Service and the California Department of Fish and Game.

II. THE AHMANSON RANCH PROJECT

A. Location

The 2,800-acre *Ahmanson Ranch* project site is situated within the larger Ahmanson Ranch Specific Plan Area on the southern flank of the Simi Hills, north of the 101 Freeway in the southeastern corner of Ventura County. The eastern boundary of the *Specific Plan Area* adjoins an unincorporated area within the County of Los Angeles, and the cities of Hidden Hills and Calabasas. To the west, the *Specific Plan Area* abuts the 2,633-acre *Ahmanson Ranch Public Open Space Dedication Area*. To the north is the unincorporated community of Bell Canyon and undeveloped portions of the Simi Hills. The U.S. Geological Survey (USGS) topographic map for the Ranch is the Calabasas Quadrangle (dated 1952 and photo revised in 1967).

B. Description

Ahmanson proposes development of a residential and commercial master-planned community to be located on 2,800 acres in the southeastern corner of an approximately 5,400-acre property known as Ahmanson Ranch. The development includes single and multi-family housing, a public and a private golf course, and commercial, civic, and industrial facilities. More than one-third of the approximately 2,800-acre development (approximately 915 acres) will be dedicated to the Community Service Area (CSA) as community open space. The Ahmanson Ranch Master Plan has also dedicated the remaining 2,600 acres of undeveloped land on the property to the Mountains Recreation and Conservation Authority (MRCA).

In addition, approximately 10,000 acres of open space land has passed into public ownership and has been preserved in connection with the proposed project as directed by Ventura County's conditions of approval. In 1992, Liberty Canyon was acquired and preserved by the Santa Monica Mountains Conservancy, and in 1993, Jordan Ranch was acquired and preserved by the National Park Service (NPS) as the Palo Comado Unit of the SMMNRA. The Las Virgenes Canyon portion of the Ahmanson Ranch has been dedicated to the MRCA for inclusion in the adjacent SMMNRA. All three of these contiguous, newly created parklands represent a large part of the northern watershed of Malibu Creek. Additionally, Ahmanson purchased Runkle Ranch and Corral Canyon and dedicated these properties to the MRCA to be preserved as open space. Preservation will ensure that these parklands will continue to serve as vital wildlife corridors linking the Santa Monica Mountains with the Simi Hills, the Santa Susana Mountains, and ultimately the San Gabriel Mountains. This large scale, preconstruction open space preservation will also effectively serve to offset temporal loss of onsite wetland/riparian habitats.

C. History

The Ahmanson Land Company, the owner of the approximately 2,800-acre Ahmanson Ranch development site, originally submitted a development plan to the Ventura County Board of Supervisors for approval in July of 1988. Ahmanson Ranch revised its original plan and agreed to effectuate the transfer of the nearly 10,000 acres of open space. Ventura County approved the Ahmanson Ranch project through approval of the Ahmanson Ranch Specific Plan, covering approximately 5,400 acres, in December 1992.

D. Natural Resource Management

The Ahmanson Ranch project is governed by the Ahmanson Ranch Specific Plan. One component of the Specific Plan is the Resource Management Program, which is a program developed to protect and enhance the natural resources within the Specific Plan area. The Resource Management Program includes, among other things, a Habitat Management Program which consists of a Plant Community Management Plan and a Wildlife Management Plan.

III. EXISTING SITE CONDITIONS

The Ahmanson Ranch development site is located approximately three miles north of the Santa Monica Mountains and lies within the southern portion of the Simi Hills in the Transverse Ranges geomorphic province. The Transverse Ranges are mountains and basins that structurally trend nearly east-west, and transverse to the southeast-northwest orientations of the Sierra Nevada and Coast and Peninsular Ranges. The western Transverse Ranges are underlain by Cretaceous and Tertiary age sedimentary deposits over a basement of harder igneous and metamorphic rocks. At Ahmanson Ranch, from north to south, the geologic structure becomes increasingly more complex. Older rocks occur in the northern section of the project area, and the younger Miocene units dominate the southern portion of the site. Most of the site is characterized by steep, highly dissected terrain.

Topographically, the Ahmanson Ranch may be divided into five physiographic subunits: 1) the moderately smooth, low to high rolling hills forming most of the southern half of the site; 2) Laskey Mesa in the southeast; 3) a low area in the extreme southeast corner of the Ranch; 4) the steep-crested rugged hills in the northernmost portion of the Ranch; and 5) the Las Virgenes Canyon floor which includes the floodplains of its major tributaries.

Generally, as a result of these complex geologic and topographic conditions, the hills and upland regions support a thin veneer of soils or weathered rock, whereas the low-lying canyon bottoms contain thick deposits of alluvium and colluvium. The patterning of vegetation also generally reflects these regional geomorphic and geologic features. Riparian forests of willows (*Salix laseolepis* and *S. lasiandra*) and cottonwoods (*Populus fremontii*), and coast live oak (*Quercus agrifolia*) woodlands occupy the canyon bottoms. Valley oak (*Quercus lobata*) savanna tends to occupy gently rolling hills and slopes with deeper soils. Coastal sage scrub (CSS) occupies the warmer and/or drier sites with thin soils. Native grasslands dominated by purple needle-grass (*Nassella pulchra*) are abundant on the north-facing slopes, while chaparral occupies the higher steep-sided formations in the north, and exotic annual grasslands generally occupy the rounded low hills and mesas in the shale-dominated southern portions of the site.

Grazing, which has historically occurred over most of the area, and other man-induced disturbances have greatly modified the vegetation which has replaced many native plant habitats with exotic annual grasslands. The abundance of non-native invertebrates onsite also reflects a long history of anthropogenic landscape change. Fire has also historically played a major role in the region by contributing to the frequency of disturbance, and aiding the spread and establishment of exotic annual grasslands. Since 1967, over 140,000 acres on and immediately surrounding Ahmanson Ranch have burned. In 1980, a 3,000-acre fire burned Las Virgenes Canyon, and the Dayton Fire of 1982 burned 42,540 acres including portions of the Ranch and most of Laskey Mesa.

The Ahmanson Ranch Specific Plan Area is characterized by the following prominent topographic features, all of which were surveyed extensively for the presence of SFVS and other listed species:

<u>Laskey Mesa</u> - This mesa is an approximately 200-acre plateau comprised primarily of disturbed non-native grassland, and occasionally with sparse native grasses and oak savanna, and is located in the southeastern portion of the Specific Plan Area. The southern slopes and ridges adjacent to the Mesa

are vegetated with CSS, and to the north, its slopes often support oak savanna with intervening patches of annual grasslands, CSS, and purple needle-grass habitats. Scattered across Laskey Mesa, and mostly concentrated along the southern portion of the Mesa, are siltstone and shale outcrops which support sparse vegetation. Such areas support thin, low-organic soils which often exhibit high potential for SFVS due to low competition from the non-native annual grasses. Laskey Mesa is discussed in detail below.

Valley Floors and Canyons - The central portion of the Ahmanson Ranch Specific Plan Area consists of a series of valley floors and canyons. The valley floor associated with the eastern portion of Las Virgenes Canyon varies in width from several hundred feet to portions that are very narrow. Vegetation of the canyon bottoms typically consists of dense oak and riparian corridors and open savanna. Large areas of the valley floors, as well as the adjacent slopes, are vegetated with dense non-native grasses consisting mostly of ripgut (*Bromus diandrus*), wild oats (*Avena fatua*), and Italian ryegrass (*Lolium multiflorum*). Mosaics of non-native grassland and patches of CSS occur on the slopes.

North-Central Hills - The north-central portion of the Specific Plan Area is characterized by a series of finger-like ridges that trend southerly from the drainage divide with Bell Canyon to the north of the Ranch. Large areas of rugged terrain with steep canyons and pronounced ridges and peaks are vegetated with non-native grasslands, CSS dominated by purple sage (*Salvia leucophylla*), and dense chaparral.

Northwest Hills - The northwest portion of the Specific Plan Area is steep and boulder-strewn with an elevation difference from the valley floor to the northern property line of nearly 1,000 feet. Chaparral is the predominant vegetation of this area.

Escorpion Canyon - The northeast corner of the Specific Plan Area is characterized by rocky outcrops and steep slopes covered with chaparral and walnut woodlands. Oak woodlands and native and non-native grasslands are located in the valley floor.

A. SFVS Habitat Area: Site History and Physical Conditions

The SFVS is concentrated along the south-facing edges and adjacent areas (rarely on the top) of Laskey Mesa, which is a northward-sloping plateau in the southeastern part of the Ahmanson Ranch development site [Existing Spineflower Habitat Areas; Exhibit 3, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. This population of SFVS is comprised of 14 "areas" covering approximately 6.6 acres of open-soil habitats concentrated along the outer southern rim of Laskey Mesa. (These 14 areas have been delineated for the purposes of mapping and as a means to characterize the habitat of SFVS.) This Mesa is a nearly level to rolling grassland plateau which rises approximately 300 feet above the adjacent valley floor with an average elevation of approximately 1,200 feet MSL. This site is vegetated almost entirely with thick exotic annual grasses and weeds dominated by ripgut grass, red brome (*Bromus madritensis* ssp. *rubens*), oat grasses (*A. sativa* and *A. barbata*), and tocalote (*Centaurea melitensis*). Native ruderal forbs such as vinegar weed (*Trichostema lanceolatum*), dove weed (*Eremocarpus setigerus*), and tarplant (*Hemizonia fasciculata*) are infrequent. Occasionally, native bunch-grasses such as purple needle-grass are locally established, and small shrubs of pinebush (*Ericameria palmeri* var. *pachylepis*) and

California sagebrush (*Artemisia californica*) are also present. Sparse CSS mostly dominated by buckwheat (*Eriogonum fasciculatum*) comprises a transitional community with the non-native grasslands along the outer rim of the mesa. Rarely present on the Mesa are valley and coast live oaks.

Historically, Laskey Mesa was utilized for grazing and much of the Mesa has been disturbed. The Mesa has been used for filming operations for commercials and movies. Many abandoned roads and cattle trails are apparent, and old corrals and fence lines are still visible. Further, the Mesa is crossed by easements for oil and gas lines. Thus trench backfill and earthmoving equipment tracks have similarly modified the natural landscape. The presence of widespread exotic grasses and abundant non-native invertebrates likewise document anthropically induced landscape disturbance. Only along the extreme southern edge of Laskey Mesa, the steep, ridge-like front, might disturbance have been minimal. But even here old road and bulldozer cuts are evident. Such site disturbance may, in fact, have contributed to the survival of the SFVS in the Laskey Mesa area, and may provide evidence that SFVS is compatible with certain types of human disturbances. Also, the spineflower is locally common as linear bands in the median and in tire tracks of abandoned dirt roads. Apparently, soil compaction and road disturbance have removed the exotic grasses to permit spineflower germination [Photos 1 & 2; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)].

Most of Laskey Mesa is mapped as Zamora loam, 2 to 9 percent slopes (ZmC). The outer terraces and slopes along its southern and eastern perimeter are mapped mostly as the San Andreas sandy loam, 30 to 50 percent slopes (SbF). Laskey Mesa is underlain by the Modelo Formation. This Miocene-age marine sedimentary formation is composed of siltstones, shale, diatomaceous siltstone and shales, sandstone, and minor limestones. These rocks are exposed in old roadbeds, rarely on the mesa-top, and frequently as shallow ridge-and-bench forming outcrops along the outer southern rim.

IV. SAN FERNANDO VALLEY SPINEFLOWER

The discussion below summarizes relevant information regarding taxonomy, distribution, legal status, ecology and reproductive biology, vascular plant associations, soil biology, and population trends and threats extracted from the literature and/or developed from observations and data collected during site visits to Ahmanson Ranch.

A. Taxonomy, Distribution, and Legal Status

Chorizanthe (Greek, chorizo, to divide, and anthos, the divided calyx) is a genus of low annuals (or perennials in South America) in the buckwheat family (Polygonaceae). They are frequently dichotomously or trichotomously branched, erect to prostrate, with alternate entire leaves that lack stipules. The upper leaves commonly are reduced to opposite or whorled bracts and the flowers are enclosed in a spine- or bristle-tipped involucre, hence, the common name spineflower.

SFVS is a prostrate, spreading, decumbent annual. The leaves are basal, oblanceolate to oblong-lanceolate, 2-7 cm long, strigose, more so below than above, and narrowing to the short petiole; the lower bracts are similar to leaves, entire, becoming reduced and acrerose above. The inforescences are cymose, open, and the involucres are aggregated at the ends of the branches in small clusters, the floral tube is 6-ribbed, urceolate, 1.5-2 mm long, appressed-canescent, the teeth straight or merely curved, divergent, sometimes widely so, the outer 3 are commonly longer than the tube, and the inner 3 short, never hooked. The flowers are white, 2.5-3 mm long, glabrous, the tepals unequal, the outer ones oblong-obovate to oblong, the inner ones linear-lanceolate; stamens 9; achenes grayish, 2-2.3 mm long. The decumbent habit, white flowers, subequal perinanth lobes, and the presence of straight involucral awns are important taxonomic characters that clearly distinguish SFVS from other similar taxa [Photo 3; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)].

The type specimen of SFVS is from San Fernando Canyon (Goodman, 1934), "near the San Fernando railroad station," Los Angeles County, California (Brown 1884). Apparently, it has always been rare or local (Abrams 1904; Davidson and Moxley 1923). The type locality may account for many of its known collections. Most of the historic collections date from the 1920s or before; one of these comes from near Castaic, dated 1929 (Reveal and Hardham 1989). The historic range of SFVS represents scattered sites in Los Angeles, Orange, and San Bernardino counties (Reveal and Hardham 1989) in regions that are presently heavily urbanized, such as Burbank or Santa Ana. Some of these historic sites, although greatly modified since the time of the collections, may still support suitable habitat for SFVS, including: Mt. Lowe, San Fernando - Pacoima, Little and Big Tujunga Washes (both flood control areas), Elizabeth Lake, and Chatsworth Park, all in Los Angeles County and below 2,500 m (4,000 feet). "Hills near Santa Ana" is the only known collection of SFVS from Orange County. Most of the San Bernandino County collections lack site-specific data (Reveal and Hardham 1989). For further regional references see the CalFlora Occurrence Database [Appendix A], and the following USGS maps: Calabasas, Del Mar, Mount Wilson, San Fernando, Sunland, Newhall/Val Verde, Lake Hughes, Orange/Black Star Canyon/El Toro, all 7.5'.

Parry's spineflower (*Chorizanthe parryi* Wats. var. *parryi*) is easily distinguished from SFVS by its hooked involucral awns and perinanth lobes that are distinctly unequal. There are several other species of *Chorizanthe* that may occupy the same or similar habitats within the historic range of SFVS. SFVS can be separated from these species by the combination of decumbent habit, entire bracts, involucre with six straight teeth, and subequal tepals. One other species of *Chorizanthe* occurs with SFVS at Ahmanson Ranch and can be easily recognized by its flower color: *C. staticoides*, which has pink to reddish flowers. In addition, *Lastarriaea coriacea* is locally common in open, sandy substrates on and around Laskey Mesa. It is an annual species in the Polygonanceae similar in appearance to *Chorizanthe*. It is identified by its lack of a true involucre and a greenish perinanth with hooked awns. In Los Angeles and Ventura counties it occupies sunny habitats in coastal sage scrub, gravel washes, and sandy alluvial scrub.

SFVS is a CNPS List 1A species (List 1A plants are presumed to be extinct in California) and has been designated a federal Candidate species by the U.S. Fish and a Wildlife Service (Federal Redister Vol. 64, No. 205, p. 57541 (October 25, 1999). The state of California has not listed it under the California Endangered Species Act (California Department of Fish and Game Natural Diversity Database, June 1999).

B. Population Size and Distribution of SFVS at Ahmanson Ranch

At Ahmanson Ranch, SFVS is found only on, or immediately adjacent to, Laskey Mesa where it occurs in 14 areas mostly concentrated along the outer, southern and southwest slopes of the Mesa at an elevation of approximately 1,200 feet MSL. These 14 areas total approximately 5.9 acres, and have been mapped using Global Positioning Satellite (GPS) technology [Existing Spineflower Habitat Areas; Exhibit 3, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. The field study has documented that this population consisted of approximately 23,000 plants in 1999. Table 1 provides a list of these 14 areas, the size of each unit, the number of SFVS plants, and the USDA soil mapping unit. The outer, irregular ridge-and-bench topography of the plateau may have served as a refuge for SFVS during the historic grazing practices that occurred in this region, and protected the seed bank from destruction by headward slope dissection and erosion, which importantly, also has preserved the geomorphic character of the Mesa.

C. Population Structure and Genetics

Current studies indicate that most annuals are not genetically variable. However, preliminary genetic studies on the closely related Parry's spineflower indicate that it is genetically polymorphic (Ellstrad 1993). Due to recent investigations within the subfamily Eriogonideae (which includes the genus *Chorizanthe)*, Dr. James L. Reveal recommends that genetic documentation of the Laskey Mesa population be completed in the near future (pers. *communication;* J.L. Reveal August 26, 1999).

D. Previous Studies in *Chorizanthe* and Related Plants

Ellstrand (1992, 1993, 1994, 1995, 1996) conducted a 5-year monitoring program at the Shipley Reserve in western Riverside County that included population monitoring and limited genetic studies on *Parry's Spineflower*. Monitoring results indicated wide fluctuations in population size that could not be correlated to rainfall patterns alone. It may be that a wide range of environmental conditions influence germination and establishment of this taxon, including timing and amount of rainfall, temperature, and competition with other species (e.g., nonnative grasses). During the third year of this study, much of the spineflower habitat was burned by a wildfire. Patches scorched by the fire had no spineflowers the following year. The critical factor in germination appeared to be whether the fire was intense enough on the local scale to scorch the litter and fine dry ground cover. These results are consistent with germination studies on var. *parryi* that detected a significant, negative correlation with both charate and cool burn treatments (Ogden 1999). Plants did appear, however, in the first post-fire year where no scorching had occurred (Ellstrand 1994). In these cases, plants were generally larger than in previous years and exhibited increased fecundity, as measured by seed production. Comparisons of plant fecundities between adjacent burned and unburned sites, in conjunction with lower rainfall amounts in the post-fire year, provide evidence that larger plant size may be due to effects of the fire (Ellstrand 1994).

McGraw and Levin (1998) studied the role of soils and shade intolerance in the narrow edaphic endemic, the Ben Lomand spineflower (*C. pungens* var. *hartwegiana*). This taxon is restricted to patches of well-drained, low-nutrient soil of sandhill habitats of the Santa Cruz Mountains in central California. These authors concluded that soil type is not a limiting factor in the taxon's distribution, but intolerance to shade is the major cause of the plants' restriction to open, sandy areas. McGraw and Levin (1998) also suggest that preservation of this federally-listed endangered taxon should include artificial and/or natural disturbance as a part of a management regime. Kluse (1994) also studied the effects of habitat on the demographic performance of this taxon.

However, most other recent studies have focused on the slender-horned spineflower (*D. leptoceras*), which include habitat analysis (Allen 1996), population biology (Ferguson et al. 1996), geomorphic analysis (Wood and Wells 1996), and seed germination, viability, and dormancy testing (Gordon-Reedy and Mistretta 1997; Ogden 1999).

E. Geomorphology and Soils

Laskey Mesa is a constructional surface formed by the approximate 10-15 degree northeastern dip of a resistant siltstone bed within the Modelo formation. The Modelo here consists mostly of massive interbedded siltstones and shale (mudstone). These beds range in thickness from about 2 to 15 feet. On the steep, south and southwest side of the Mesa, differential weathering of the siltstone and shale give rise to an irregular ridge-and-bench topography [Photo 4; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. The relatively flat benches, and their local colluvial wedges, form the general geomorphic and soil (pedogenic) substrate that supports the largest, and preferred habitat areas for the SFVS [Photo 5; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. From a general soil-mapping standpoint, the Modelo mudstones are the parent material for the "Zamora loam" and the siltstones give rise to the "San Andreas sandy loam" and the "Santa Lucia silty clay loam" (Ventura County Soil Survey).

Reconnaissance shows that the Laskey Mesa Modelo beds strike mainly to the northwest. The resultant northeast dip has caused increasing accumulation of colluvium over most of the Mesa-top, particularly downslope to the north and northeast. This accretion forms a cumulic soil profile, one that "grows upward" with time, which promotes formation of weak, but thick organic horizons that are susceptible to constant bioturbation (A/C profiles). These conditions provide habitat for the proliferation of exotic grasses, but not for SFVS.

Where cropping occurs along the south edge of Laskey Mesa, the interbedded and differentially weathered Modelo siltstone and mudstones are being dissected by headward erosion of a first-order drainage tributary to the East Las Virgenes Canyon. These ridge-forming siltstone beds are readily delimited by their vegetation lineaments; mainly narrow linear bands of native CSS. In contrast, the interbedded mudstones are generally slope formers. Where mantled by a veneer of silt and fine sand derived from overlying siltstone units, the mudstones are covered by cumulic soils that support an assemblage of exotic grassland species. These cumulic soils are high in organic material and are hydrophobic in nature; these parameters influence depth of moisture and aeration that promote exotic grasses. Field observations show that the SFVS is preserved in, and probably favors, the colluvial fine-sand substrates concentrated along the edge of the Mesa which are stripped of excess nutrients; particularly where the "shading" exotic grasses have been removed or otherwise diminished in vigor by soil conditions.

Soil Descriptions

The SFVS habitats in the Laskey Mesa area are associated with the USDA mapping units Zamora loam, 2 to 9 percent slopes (ZmC), the San Andreas sandy loam, 30 to 50 percent slopes (SbF), and the Santa Lucia shaly silty clay loam, 15 to 30 percent slopes (SeE). The following descriptions are extracted from the Ventura County Soil Survey. Additional information for each soil series is attached as Appendix B [Soil Series Data].

San Andreas Soils Series

The most prevalent soil series associated with the occurrence of SFVS is the San Andreas soils. This soil series consists of well-drained sandy loams 60 inches deep over soft sandstone and loose sandy and gravely deposits. These soils formed in upland areas and have slopes of 30 to 50 percent. The vegetation is usually annual grasses and forbs, brush, and scattered oaks. San Andreas soils occur with Arnold, Calleguas, Gaviota, and Saugus soils. They are used primarily for range and for watershed. San Andreas sandy loam, 30 to 50 percent slopes (SbF) is a steep soil of the uplands. SFVS most commonly occurs on benches and the gentle sloping portions of this soil unit on and adjacent to Laskey Mesa. The surface layer is of this soil unit is dark grayish-brown and brown, slightly acid and medium acid sandy loam about 20 inches thick. The subsoil is brown, medium acid and strongly acid heavy sandy loam about 17 inches thick. At a depth of about 37 inches it is light yellowish brown, strongly acid loamy coarse sand. Permeability of this soil is moderate. Runoff is rapid, and the erosion hazard is severe. The available water holding capacity is 4.5 to 7 inches in the 60 inches of effective rooting depth. Inherent fertility is medium. This soil is used primarily for range and for watershed.

TABLE 1
SFVS HABITAT AREA PROFILE

AREA NO.	HABITAT AREA (SF)	NUMBER OF SFVS	PERCENT OF POPULATION [1]	SOIL ASSOCIATION
1	1,380	630	2.7	Santa Lucia
2	2,155	300	1.3	Santa Lucia
3	6,816	486	2.1	San Andreas
4	16,306	3,125	13.6	San Andreas/Zamora
5	44,000	2,047	8.9	San Andreas/Zamora
6	1,340	125	0.5	San Andreas
7	3,065	25	0.1	Zamora
8	2,725	431	1.9	Zamora
9	420	25	0.1	Zamora
10	173,225	15,089	65.7	San Andreas/Zamora
11	690	8	0.0	Zamora
12	735	115	0.5	Zamora
13	2,275	48	0.2	Zamora
14	60	500	2.2	San Andreas
TOTAL	255,192 sf. (5.86 ac.)	22,954	99.8%	

1 Numbers may not total due to rounding.

Zamora Soils Series

The Zamora series consists of well-drained loams that have a clay loam subsoil. These soils formed on alluvial fans and benches in alluvium derived predominantly from sedimentary rocks. They have slopes of 2 - 15 percent. The vegetation usually associated with this soil mapping unit is annual grasses and forbs. Zamora soils occur with Azule, Garretson, Rincon, and Sorrento soils. They are used for citrus crops, vegetables and field crops, urban development, and rangeland.

Zamora loam, 2 to 9 percent slopes (ZmC) is a gently sloping to moderately sloping soil of alluvial fans. It is most frequently associated with the top of Laskey Mesa, and therefore, some of the SFVS habitat areas overlap with the San Andreas soils. The surface layer is dark grayish-brown and brown, slightly acid and neutral loam about 17 inches thick. The subsoil is brown, neutral clay loam about 23 inches thick. It is underlain by pale-brown, mildly alkaline sandy loam that extends to a depth of more than 60 inches. Permeability of this soil is moderately slow. Surface runoff is slow to medium, and the erosion hazard is slight. The available water holding capacity is 7.5 to 10 inches in the 60 inches of effective rooting depth. Inherent fertility is medium. This soil is used for citrus and field crops, urban development, and for range.

Santa Lucia Soils Series

The third soil series associated with only two habitat areas of SFVS at Ahmanson Ranch is the Santa Lucia shaly silty clay loam, 15 to 30 percent slopes (SeE), and is located to the northwest corner of Laskey Mesa. The Santa Lucia series consists of well-drained shaly silty clay loams 20 to 36 inches deep over fractured, diatomaceous shales. These soils formed in upland areas and frequently have slopes of 15 to 75 percent. The vegetation is annual grasses and brush. Santa Lucia soils occur with Calleguas, Gazos, Linne, and Nacimiento soils. They are used primarily for range and for watershed, and the less steep slopes are used for citrus crops and urban development.

The surface horizon of the Santa Lucia shaly silty clay loam is gray or dark gray in hue. This horizon is shaly or very shaly silty clay loam to shaly or very shaly silty clay in texture and ranges from 20 to 26 inches in thickness. It is slightly acid to medium acid. Where present, the C horizon is gray or grayish brown in hue and ranges from very shaly silty clay loam to very shaly silty clay in texture and is more than 35 percent clay. This horizon ranges from 0 to 10 inches in thickness and is slightly acid to medium acid. The percentage of shale exceeds 15 percent in the upper part of the A horizon and 50 percent in the lower part of the A horizon and in the C horizon. Depth to fractured, diatomaceous shale ranges from 20 to 36 inches. Included within this soil mapping are areas of Calleguas shaly loam; Gazos silty clay loam; Linne silty clay loam; Nacimiento silty clay loam; a soil similar to the Santa Lucia soil but less than 20 inches deep; and soils that have a grayish-brown or dark grayish-brown surface layer. Permeability is moderate. Surface runoff is medium to rapid, and the erosion hazard is moderate to severe. The available water holding capacity is about 2.5 to 5 inches in the 20 to 36 inches of effective rooting depth. Inherent fertility is medium.

Neither the Santa Lucia, Zamora, or the San Andreas soil mapping units are common elsewhere at Ahmanson Ranch or throughout the historic range of SFVS. Although the characteristics of these soils were reviewed for onsite surveys of SFVS, these USDA mapping units cannot be correlated as a primary indicator of the plant's historic habitat in southern California. A preliminary review of the soils associated with the historic localities of SFVS indicate that the USDA mapping units in and near these localities are associated with well- to excessively-drained coarse or fine sandy loams that are neutral to slightly acid, and are characterized by a moderately rapid subsoil permeability.

Additionally, all other open-soil habitats off Laskey Mesa were examined at Ahmanson Ranch, none of which support SFVS. Although these sparsely vegetated areas appear to be suitable habitat, these mostly thin-soil shale areas are produced as a result of bedding-plain landslides which strip the seed bank and native vegetation from the upper soil horizons. Also, many of the other open-soil sites at Ahmanson Ranch are underlain by clay substrates and/or heavy loams derived from older Cretaceous and Paleocene rocks which are generally poorly-drained and are often characterized by high levels of sodium.

Habitat Areas

The population of SFVS at Ahmanson Ranch is comprised of 14 habitat areas delineated for the purposes of mapping and as an aid to characterize its biology [Existing Spineflower Habitat Areas; Exhibit 3, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. Seven areas were specifically selected for soil-geomorphic observation, and include: Area 2 (Santa Lucia soils), a small site northwest of Laskey Mesa; Areas 4, 5 and 10 (mostly San Andreas soils), the principal spineflower areas on the south side of the Mesa; Area 7 (Zamora soils), a small area on the north side of the Mesa; Area 9 (Zamora soils), a probable disturbed site adjacent to a road and gas-line easement; and Area 14 (mostly San Andreas soils), an area on the extreme east side of the Mesa [Existing Spineflower Habitat Areas; Exhibit 3, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. At each of these habitat areas, SFVS is frequently associated with bioturbation (the churning of a sediment by organisms), and shows a preference for growing in micro-depressions which may be due to slight differences in moisture regimes that could aid germination. The endangered *Dodecahema leptoceras*, and the rare *Gilmania luteola* (which is restricted to barren alkaline scrub in Death Valley) can also occur in depressional habitats that provide the added benefit of improved moisture regimes.

SFVS Area 2

Area 2 is northwest of Laskey Mesa SFVS [Existing Spineflower Habitat Areas; Exhibit 3, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. It occurs on a hilltop that has been significantly disturbed by roads and probable movement of heavy equipment. The SFVS here is present in low density; but it exemplifies the presence of SFVS in an area that has been previously cleared by man. In this case, inadvertent bedrock "discing" by heavy equipment has created cross-slope rills that have now trapped a thin veneer of sediments that give rise to a substrate for spineflower colonization. The adjacent siltstone bedrock is devoid of soil and exotic grasses. Apparently, there is no shading or competition in this micro-habitat, and the SFVS has survived.

SFVS Area 4

Area 4 supports over 3,000 SFVS plants with a mean density of 19% [Vegetative Surveys, Table 1; Appendix C]. In width, the area stretches from approximately 30 to 50 feet east of the drainage divide on the top of the Mesa, to probably 40 or more feet down the south slope. Relatively resistant siltstone beds are marked by the alignment of CSS. Silt and fine-sand colluvium derived from Modelo siltstone mantles lower mudstone units. Where these soils are more than a few feet thick, gopher, kangaroo rat, and other heteromyid spoil piles are abundant. Some of the new piles seemingly bury the SFVS; but elsewhere, often within a few feet, the spineflower has taken advantage of the increased bioturbation tilth and permeability, and SFVS is relatively abundant, often reflected by "spineflower rings" [Photo 6; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. The conditions in Area 4 shows well that the SFVS apparently germinates and flourishes in the absence of exotic grasses, and in these deeper, thin-soil, low-organic habitats. Bioturbation by fossorial animals may represent natural disturbance regimes that are colonized by SFVS (possibly the preferred habitat in pre-European conditions), as well as modern man-made disturbance, such as roadbeds.

SFVS Area 5

Areas 5 and 10 are the largest habitat areas on the Laskey Mesa [Existing Spineflower Habitat Areas; 3] provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999). In aggregate, these areas form a somewhat linear array on the south side of the Mesa. Each area contains subareas of variable spineflower density. However, for mapping purposes, these patches have been combined. Area 10 is discussed in detail below.

Area 5 similarly demonstrates the areal relation of SFVS habitat and residual soil weathering and local colluviation. Nearby abandoned roads also attest to the presence of the spineflower in man-made disturbed areas. The taller, exotic grasses border the roads; however, the median and areas adjacent to tracks are generally devoid of such grasses, and it is here where the spineflower is observed.

Area 5 also extends well downslope on the south side of the Mesa [Existing Spineflower Habitat Areas; Exhibit 3, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. Although some road disturbance is obvious, apparently the colluvial benches may also be the most "natural" area for SFVS habitation. The south-to-north wind velocity is probably reduced when passing over the south rim of Laskey Mesa. This phenomenon may therefore also be a factor to account for local spineflower distribution. Additionally, as observed on old road tracks, expandable clay, derived from weathering of Modelo mudstones, provides local habitat for solitary bees and other potential spineflower pollinators [Photo 7; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)].

SFVS Area 7

Area 7 is representative of a minor SFVS habitat on the north side of Laskey Mesa [Existing Spineflower Habitat Areas; Exhibit 3, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. Here, too, the area has been clearly disturbed. In fact, the spineflower was observed only where exotic grasses have been partially cleared or low-cropped by vehicles along an infrequently used road, and possibly owing to trenching and construction of an oil pipeline which stripped soil from shallow bedrock. In Area 7 the SFVS also occurs in colluvium less than about 1-inch thick. This is sufficiently thin to negate gopher or kangaroo rat bioturbation, but apparently sufficiently deep to allow spineflower germination. Here, too, micro-topography and soil apparently control spineflower location occurrence, for most colluvial wedges are "trapped" in 1-2- inch deep bedrock irregularities or in bedrock joints and fractures that collect overland flows which provides added moisture.

SFVS Area 9

Area 9 [Existing Spineflower Habitat Areas; Exhibit 3, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)] also illustrates the local distribution of the SFVS in disturbed terrain. Here, adjacent to a road and within an up to 50-ft wide utility easement, the spineflower is observed only where exotic grasses have either been wholly or partially removed from over exposed bedrock, and in open soils where biotic interactions may have reduced the density and vigor of exotic grasses. The SFVS survives in very thin soil, probably not a desired substrate, but one that limits competition from other plant species.

SFVS Area 10

Area 10 is the largest SFVS habitat on the south rim of Laskey Mesa [Existing Spineflower Habitat Areas; Exhibit 3, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. Spineflower density ranges from sparse to moderately dense; and most plants form a somewhat linear pattern, either marking the median and adjacent tracks of a roadbed apparently abandoned about eight years ago or they track the north-striking Modelo rock outcroppings in colluvial benches and wedges. The roadbed is on or near the present drainage divide. However, a natural SFVS seedbed area may well occur south of the divide, on relatively steep, well-lit slopes that retain a veneer of colluvium derived from the weathering of upslope siltstone. Indeed, the Area 10 local topography lends itself to experiments for possible SFVS re-seeding. The south-slope ridges (Modelo siltstone) and terraces (Modelo mudstones and colluvium) may be cleared of exotic grasses by one or a combination of many techniques, ranging from hand-cleaning to discing, to herbicide use or controlled burning.

SFVS Area 14

Area 14 delimits an outlier of spineflowers on the extreme northeast side of Laskey Mesa [Existing Spineflower Habitat Areas; Exhibit 3, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. Here, traces of Modelo siltstone are marked by alignments of CSS. The relationship of the SFVS and bioturbation are also apparent in this area. Where there are but a few, thin heteromyid spoil piles, the spineflower habitat is present; however, where colluvium thickness exceeds a few inches or so, bioturbation apparently accelerates growth of exotic grasses, thus leading to shading and demise of spineflower habitat.

F. Vascular Plant Associations

The habitat of SFVS is characterized by sparse assemblages of low-growing herbaceous forbs and grasses (exotic and native species), and sparse CSS shrub species. The species diversity of the SFVS habitat areas is clearly dominated by native ruderal plants; however, many sites do support a sparse cover of exotic grasses. Table 2 provides a preliminary list of associated vascular plants.

Indicator Species

Allen (1996) used ordination techniques to identify one or more indicator plant species for the slender-horned spineflower (*D. leptoceras)*. These plants would have been more common species with the same habitat requirements as the rare plant, and could have been used to help select suitable restoration sites. Unfortunately, no indicator species was consistently associated (and substantially limited to) SFVS habitat. It appears that like *D. leptoceras*, SFVS has no clear indicator plant species, but the limited range of conditions among the Laskey Mesa population of SFVS does not allow for a meaningful search for potential indicator species. Examination of the field sites, and of quantitative vegetation data from three of the habitat areas [Vegetative Surveys; Tables 1-3; Appendix C] shows no evident indicator species.

Allen (1996) found densities much higher than SFVS for the related *D. leptoceras*. However, our survey methods are not comparable. Our plots were located semi-randomly within patches of SFVS, and can be used to estimate the number of plants within the patches. Allen's plots were subjectively placed over spots that had high plant density, and did not claim to measure the abundance of plants in the experimental areas.

TABLE 2:
PRELIMINARY LIST OF VASCULAR PLANT ASSOCIATES
(* indicates a non-native taxon)

Artemisia californica
Asclepias fascicularis
**Avena barbata*
**Brassica nigra*
**Bromus diandrus*
**B. hordeaceus*
**B. madritensis rubens*
**Centaurea melitensis*
Chorizanthe staticoides
Clarkia sp.
Encelia californica
Eremocarpus setigerus
Ericameria palmeri var. *pachylepis*
E. pinifolia
Eriogonum elongatum
E. fasciculatum
E. gracile
**Erodium botrys*
Filago californica
Gnaphalium californicum
Gutierrezia californica
Hemizonia fasciculata
Heterotheca grandiflora
**Hypochoeris glabra*
**Lactuca serriola*
**Lamarckia aurea*
Lastarriaea coriacea
**Lolium multiflorum*
Lotus purshianus
L. scoparius
L. strigosus
Lupinus cf. *bicolor*
Lessingia filaginifolia
**Marrubium vulgare*
**Medicago polymorpha*
Micropus californicus
Nassella lepida
N. pulchra
Opuntia littoralis
Pectocarya linearis ssp. *ferocula*
Pectocarya sp.
Salvia leucophylla
S. mellifera
**Schismus barbatus*
**Silene gallica*
Stephanomeria virgata
Stylocline gnaphalioides
Trichostema lanceolatum
Uropappus lindleyi
Vulpia octoflora
**V. myuros*
Yucca whipplei

G. Ecology

Our understanding of the ecology and the reproductive biology of many of California's common native annuals is not complete and information for most rare species is virtually non-existent. To date, only cursory information is available in the literature regarding a habitat description for SFVS. For example: "gravely to sandy soils, often in washes, mostly in coastal sage scrub" (Reveal 1979) or "sandy places, generally in coastal or desert scrub" (Hickman 1993). At Ahmanson Ranch, SFVS does not grow in loose sand (which, for example, is a common habitat for species of *Oxytheca)* as one might gather from the literature, but plants do very well on compacted soils of abandoned roadbeds and other unexpected man-made habitats. Therefore, the preliminary information presented herein is especially valuable to the conservation and recovery of SFVS.

Historically, the primary habitat of SFVS was apparently deeper soils of sparse CSS, colluvial sand benches, and possibly valley grasslands which were all likely to support mosaics of open-soil, low-nutrient habitats prior to the invasion of exotic grasses. Today, however, SFVS also survives on shallow soils over bedrock, and thin soils eroded from sedimentary rocks where competition from the exotics is limited. However, a range of bulk densities values typical of spineflower sites has yet to be established. Knowledge of target bulk densities would be useful in developing methodologies which utilize soil compaction as a weed exclusion technique.

From a micro-habitat standpoint, a veneer of silty sand, often less than an inch thick, can give rise to at least low-density stands of the spineflower in shallow depressions only a few centimeters deep [Photo 8; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. This occurs even on bedrock (Modelo sedimentary rocks) where rills formed by natural overland flow or inadvertently by "Caterpillar tracks" serve as "dams " to trap sediments that provide suitable habitat for SFVS.

Fossorial rodent activity (mostly pocket gophers of the genus *Geomys*) was noted at several habitat areas [Existing Spineflower Habitat Areas; Exhibit 3, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)] and testifies to the presence of relatively deep soils which are noteworthy, since these SFVS areas exclude invasion of exotic weeds. Germinating SFVS was noted on the tops and sides of numerous fresh mounds [Photo 9; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. Other studies have documented that the spatial distribution of some plants is dependent upon gopher activities which maintain bare soil patches and full sunlight (Davis et al. 1997).

Small mammals present at the Mesa (e.g., pocket gophers, kangaroo rats, pocket mice, white-footed mice, and voles - Hall 1981, Jameson and Peeters 1988) could potentially utilize SFVS seed as a food resource (although SFVS seed may be too small for most heteromyids), but may likely represent potential vectors of local dispersal. Kangaroo rats and pocket mice especially, are known to utilize open space habitats and to forage on locally abundant seed resources (Reichman and Price 1993). These rodents are well known to cache seed throughout their home range and in storage dens in their burrows (Bowers 1986; Rebar 1995; Reichman and Price 1993). The small size of the spineflower seed suggest that small mammals which could only utilize these flowers as a food resource if they clip and store entire branches and clusters of involucres at harvesting (especially of larger plants), and then store them in burrows and consume the seed at a later time. The spiny clusters further suggest the possibility of adventitious dispersal by attachment to fur of traveling small- and medium-sized mammals.

Fire has historically played a major role in the Simi Hills by contributing to the spread and establishment of exotic annual grasslands. In 1980, a 3,000-acre fire burned Las Virgenes Canyon, and the Dayton Fire of 1982 burned 42,540 acres including portions of the Ranch and most of Laskey Mesa. At this time, no information is available as to whether SFVS is tolerant of fire or if it could benefit from burning, and as such, it can not be considered a "fire follower."

Soil Factors

The spineflower populations at Ahmanson Ranch are found on three soils of or adjacent to Laskey Mesa. Some properties of each soil series, ranging from shaly silty clays to sandy loams, are shown in Appendix B [Soil Series Data]. The fact that SFVS is found on dissimilar soil types on immediately adjacent portions of the Mesa implies that it has a wide range of tolerance for soil properties. Thus, we can say that SFVS is not limited to a narrow range of soil types.

McGraw and Levin (1998) found *C. pungens* var. *hartwegiana* to grow better on soils that did not support it in nature; thus it is unlikely that soil chemistry is critical. Allen (1996) found the related *D. leptoceras* to be confined to nutrient-poor soils in the field, but did not test plant growth in richer soils. She concluded that the species might require poor soils. In fact, the species grew readily in greenhouse trials (ERCE 1991), showing that it did not have an absolute requirement for the soil chemical conditions found in its natural habitat. Accordingly, SFVS can tolerate nutrient-poor soils, and apparently, may be confined to these by intolerance to competition with more vigorous species which are able to preempt more favorable organic soils.

Allen (1996) found soils occupied by the related *D. leptoceras* to be nutrient-poor with small variability in chemical properties. However, soil physical properties are generally more important to native plant species than chemistry, because most natives compensate for poor soils with increased root growth and with symbiotic associations. Soil physical properties, especially soil compaction, often limit the extent of root growth (Alexander and Poff 1985). Allen (1996) did not consider soil compaction, but assigned the unexplained distribution of *D. leptoceras* to "some unmeasured edaphic or biotic factor." However, she noted that the plant was sometimes found in tire tracks, an observation that might have suggested a link with soil compaction and low competition. McGraw and Levin (1998) found that *C. pungens* var. *hartwegiana* is mostly limited to open areas such as "trails and old roads" (page 125), again suggesting a relationship with soil compaction/low-competition habitats.

An important distinction may be made between soil factors that may be required by the spineflower and soil factors that exclude competing grasses, thus allowing growth of SFVS. The SFVS does not appear to require certain soil factors, just as *C. Pungnes* var. *hartwegiana* did not require them (McGraw and Levin 1998). In fact, strict soil requirements are very unlikely to have applied to *D. leptoceras*, even though that study (Allen 1996) believed that the plants had a narrow range of soil requirements.

Exclusion of Competing Plants

Accordingly, research and management efforts should be directed toward factors that exclude competing exotic grasses, rather than a search for factors required by SFVS. On the basis of field observations and some preliminary data, the most likely factors that exclude exotic grasses from the open areas occupied by SFVS include:

Limited soil depth: The ability of SFVS to grow on extremely shallow soils is best illustrated on exposed outcrops of the siltstone that gives rise to the San Andreas soil. These are observable commonly on the south-facing edge of the Mesa [see Photo 10; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)], and in other patches such as Areas 12 and 13. The exposed siltstone is mostly unvegetated, but there are pockets of soil in some cases which are only a few centimeters deep, or less, but nevertheless support good growth of SFVS. Many such sites lack annual grasses, or have only a very sparse growth of stunted plants, usually with only a single flower remaining from the past growing season. Preliminary analysis of soil compaction samples has established that some spineflower sites are found on very compacted soils, while others are not [see Appendix D provided in GLA (1999)]. Soil compaction may constitute a mechanism that prevents growth of exotic grasses while not inhibiting growth of spineflower. However, a range of bulk density values typical of spineflower sites has yet to be established. Knowledge of target bulk densities will be useful in methodologies which utilize soil compaction as a weed exclusion technique.

Keeley and Baer-Keeley (1992) noted the importance of shallow soil for *Pentachaeta lyonii*. They did not propose creating shallow soil for restoration, but instead suggested controlling exotics with herbicides and weeding.

While limited soil depth is almost certainly able to exclude exotic grasses while allowing growth of spineflower, it is not the only such factor. SFVS may be observed on Zamora soils that are much thicker than the San Andreas soils noted above.

Soil compaction: Soil compaction often limits the extent of root growth (Alexander and Poff 1985). They offered a table of soil bulk densities (a measure of compaction) that could support plant growth in soils of various textures. Compaction prevents root growth by presenting pores finer than the diameter of the growing root tips (Taylor 1974). Since plants vary widely in diameter of their root tips (St. John 1980), there are clearly differences in their tolerance for compacted soil. These differences can be readily observed on compacted fill slopes, a common setting for restoration of native vegetation, where coarse-rooted native perennials almost universally fail, while much finer rooted exotics and a few annual native species may find useable habitat. On the most highly compacted sites, vegetation is altogether absent or is limited to the finest-rooted species, such as certain tiny annual wildflowers and SFVS [see Photos 1 & 2; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)].

Certain of the habitat areas, especially those on Zamora soil, show signs of severe compaction. These are primarily on roads, which are well known to be too compacted for the growth of most plants. Soil compaction may be measured by bulk density, the weight of soil per unit of original field volume. Samples for bulk density analysis were taken on August 19, 1999 (Area 4), and on August 24, 1999 from Areas 12 and 13. Complete soil analysis is in progress, but preliminary results showed that occupied sites differed significantly in bulk density from adjacent non-occupied, weedy sites. Cores of a depth of 10 centimeters were taken at a fixed distance (10 cm) north of spineflower plants within the occupied areas, and at locations selected by tossing brightly colored objects within the adjacent weedy areas. The preliminary data are shown in [Bulk Density Study, Tables 4-6; Appendix D].

Note that while the mean bulk density is clearly higher within spineflower patches, not all portions of the spineflower patches are more compacted than weedy areas. In other words, compaction may be one factor that can maintain an open site suitable for spineflowers, but it is not the only mechanism that can do so.

Wood and Wells (1996) prepared soil descriptions from locations near wild populations of *D. leptoceras*, without study of soil compaction, but depth of horizons and texture were reported for some sites. These sites were purposely removed from the endangered plant populations, and soil texture does not entirely agree with the texture observed on occupied sites by Allen (1996). The depth of soil layers was not from occupied sites and was not compared to rooting depth, and thus offers no useful comparative information for this study.

Most occupied, weed-free SFVS sites can be interpreted in terms of either limited soil depth or soil compaction, but we are left to explain a few sites on soil loose enough and deep enough to support gopher activity. Those appear to be kept open by root competition from neighboring shrubs, which is discussed below.

Competition from nearby native shrubs: St. John (1988) reviewed the published evidence that ruderal plant species (roughly equivalent to weeds) benefited, at the expense of native plants, from soil temporarily enriched in soluble forms of nitrogen, particularly nitrate. Disturbed sites of the type usually occupied by ruderals typically have a larger share of total nitrogen in the form of nitrate than do undisturbed, native sites. It appears that the remaining open, occupied sites, those on relatively deep Zamora soil, are being maintained by roots of adjacent subshrubs. The subshrub species that is most consistently associated with such areas is *Ericameria palmeri* var. *pachylepis*. Other shrubs found in the CSS and occasionally on the edge of the Mesa include *Artemisia californica*, *Salvia* sp., and *Grindelia* sp. [Photo 11; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. However, none of these species appear to maintain a bare, low-competition zone as effectively as *E. palmeri*.

The mechanism by which native plants maintain a bare zone has been in dispute during the second half of this century, and any of several mechanisms no doubt apply in particular circumstances. Riefner et al. (1998) and St. John (1999) presented arguments for a role of mycorrhizal roots, densely permeating the soil volume, in quickly removing soluble forms of nutrients and thus preventing or greatly retarding the growth of nutrient-dependent ruderals. It is likely that in the right circumstances (soil readily permeable to shrub roots; abundant mycorrhizal inoculum) *E. palmeri* can form a particularly dense network of roots and mycorrhizal mycelium. Observations by St. John in a native plant nursery and at San Onofre State Beach (Riefner et al. 1998) have indicated that species related to *E. palmeri* are particularly active in building a dense network of mycorrhizal mycelium.

Note that not all *E. palmeri* shrubs are surrounded by bare zones. These may be particular stands that have less effective root penetration into surrounding soil, or for one reason or another lack adequate inoculum of mycorrhizal fungi (see below). In any case, those shrubs have not created suitable SFVS habitat.

H. Phenology and Seed Production

Although very little is known about the phenology of SFVS, based on our field observations, its life cycle conforms to the basic seasonal pattern which is similar to many other winter-spring native annuals of the California Mediterranean-type of climate. Apparently, a portion of seed in the seedbank germinates following sufficient rain in late fall or early winter, matures, then bolts and produces multiple branches, flowers between April and May/June, then dies. However, unlike many native California annuals, after the leaves wither its sturdy central branches and involucral clusters remain intact for many months after flowering until the plants are crushed or broken; the individual involucres remain closed possibly until next years' rainfall. The involucral spines may act as a dispersal mechanism, attaching seed clusters to traveling animals, and possibly as a safe-site adaptation which may help anchor the seed clusters to its preferred sandy substrates.

SFVS, as most other species of *Chorizanthe*, produces a single, one-seeded flower within each involucre (Hickman 1993). Conservative estimates during field studies have determined a broad range of 60 to 300 involucres can be produced per individual plant [Photo 12; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. Also, preliminary study of samples from three sets of 30 involucres examined at the RSABG seed lab have determined that approximately 50% of these involucres develop potentially viable seed (RSABG letter 27 July 1999). Therefore, during a good year, the Laskey Mesa population of SFVS could easily produce over a million viable seeds per year.

Accordingly, these preliminary data suggest that habitat loss and fragmentation, and poor competitive abilities with exotic weeds may be the primary reasons for the decline of many localized *Chorizanthe* species in the wild [Photo 13; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)].

Seed germination and viability data is available for *Chorizanthe parryi* var. *parryi* and a related taxon, *Dodecahema leptoceras*. Germination rates for *C. parryi* var. *parryi* ranged from 23-39% (X=27%) when seeds were not pretreated; subsequent testing (i.e., excision and staining) indicated that total seed viability in these samples ranged from 80-96% (X=86.5%). Pre-treating seeds with cold-moist stratification resulted in germination rates ranging from 49-86% (X=65.4%); further testing of these seeds indicated that total viability ranged from 91-100% (X=95.4%). Subjecting seeds to a charate treatment resulted in germination rates of 0-15% (X=5%), while a cool burn treatment resulted in germination rates of 0-1% (X= <1%). Viability testing was not conducted for the latter two tests due to the difficulty of recovering seed (Ogden 1999). Long-term seed viability testing of these accessions indicated a negligible drop in viability over 5 years (from 100% to 99%). The seed testing program for *C. parryi* var. *parryi* indicated that (1) cold-moist stratification induced higher germination than no pre-treatment of seeds; (2) charate and cool burn treatments resulted in negative germination results relative to germination with no pre-treatment (a similar, negative response to fire was observed for this taxon under natural conditions); (3) var. *parryi* appears to germinate in response to specific environmental conditions (e.g., light, amount and timing of rainfall) rather than heat (fire) or chemicals (charate) produced from fire; and (4) seed viability may be retained at relatively high rates in a controlled storage setting (Ogden 1999). Germination tests for *Dodecahema leptoceras* under greenhouse conditions produced a germination rate of 47% with no pre-treatment, 85% with cold-stratification, and 24% with charate treatment (ERCE 1991; Gordon-Reedy and Mistretta 1997). For all of the above-referenced tests, sample sizes were N = 100.

Seed of SFVS has been collected according to a protocol developed by the Rancho Santa Ana Botanic Garden for rare and/or sensitive species. Detailed germination tests are in progress.

I. Pollination and Reproductive Biology

Knowledge of the reproductive and pollination biology of SFVS is also important to the conservation of the plant.

Invertebrate activity in and around the open-soil and sparsely vegetated habitats of SFVS was noted during casual, non-systematic observations. Velvet ants (*Pseudomethoca anthacinae*), stink bugs (*Eleodes* sp.), jumping spiders (*Phidippus* cf. *johnsoni; Habronattus* sp.), robber-flies (*Diogmites* cf. *fragilis*), seed harvester ants (*Messor andrei*), native fire ants (*Solenopsis xyloni*), tachinid flies (possibly in the genus *Archytas*), and small grasshoppers (possibly in the genus *Trimerotropis*) were among the most frequently observed. The seed harvester ant was observed to collect materials from a number of species of plants associated with the SFVS habitat. Two non-native isopods, the common pillbug (*Armadillidium vulgare*) and the dooryard sowbug (*Porcellio laevis*) are extremely abundant. Unexpectedly, the Argentine ant (*Linepithema humile*) is also frequent at Laskey Mesa including native plant habitats (Hovore Associates 1999). According to Hovore Associates (1999), the large numbers of these non-native invertebrates indicate a long history of substrate disturbance.

Ants, mostly of the *Dorymyrex insanus* complex (identified by Roy Snelling 1999), were active and frequent visitors to the flowers of SFVS [Photo 14; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. Although ants are not normally considered to be significant pollination vectors (Faegri and van der Pjil 1979), more recent texts have cited several examples (Proctor et al. 1996). Although Argentine ants are common at Ahmanson Ranch, and have been known to exclude native species such as *Dorymyrex* (Holway 1999), this is apparently not the case on Laskey Mesa.

Ant-like spiders, possibly of the genus *Micaria* (Clubionidae) were also present on the stems of SFVS. Other rare to infrequent flower visitors include the European honeybee (*Apis mellifera*), bee-flies (Bombyliidae), a small bumblebee (*Bombus* sp.), and tachinid flies. The jumping spiders and the robber-flies occasionally use the involucral clusters as a perch for hunting small insects.

Additionally, Scott (1986) and Emmel and Emmel (1973) discussed the association of the small blue butterfly (*Philotiella speciosa*) with *Chorizanthe membranacea* and *C. californica* (= *Mucronea californica*). The adult small blue seek nectar from flowers and the larvae feed on pollen and other plant parts. The small blue is sympatric throughout most of the range of SFVS. Also, Moure and Hurd (1987) document visitation of other *Chorizanthe* flowers by halictid bees: *Lasioglossum punctatoventre* on *C. procumbens* and *Halictus farinosus* on *C. douglasii*.

There seem to be many invertebrate visitors to SFVS, some of which could be effective pollinators. Evidence is not currently available to determine which species are effective pollinators. Therefore, additional studies to determine the importance of specific pollinators, as well as the total diversity of invertebrate pollinators of SFVS, is desirable. The possibility that SFVS is a facultative selfer should also be investigated. However, due to the large seed set during the 1999 season, SFVS is apparently not reproductively limited.

J.. Soil Biology

Most plant species support symbiotic (beneficial) fungi that aid in nutrient uptake and a range of other functions. SFVS belongs to a plant family that includes both host and non-host species; thus its mycorrhizal status cannot be assumed without direct examination of root specimens.

The mycorrhizal status of SFVS is of more than academic interest. If it is an obligate mycotroph (requires the symbiosis for survival in field conditions) then an important component of any conservation and management plan and the resulting restoration efforts should include inoculation with mycorrhizal fungi. If, on the other hand, it shares with some other annual plants a tendency to be disadvantaged by mycorrhizal colonization, then inoculation of restoration sites as part of a management plan could be a serious mistake. In other words, it is very important to have the correct answer to this question.

In most circumstances a plant's mycorrhizal status can be determined from examination of field material. Since roots of wild plants become intertwined, good field material requires a series of carefully-collected plants which are then separated from other plants by carefully soaking away the soil while keeping the root system intact and attached to the stem of the identified plant.

As a first approximation, a small amount of soil was collected immediately adjacent to the roots of an isolated SFVS plant. After soaking apart the root mass, it appeared that there was more than one kind of root. Some of the roots may have belonged to nearby annual grasses. After cleaning and staining the roots by the method of Koske and Gemma (1989), it appeared that all roots in the sample were mycorrhizal. There were structures indicating at least two species of fungi from the mycorrhizal genus *Glomus* (one was probably the widespread *C. intraradices* and the other was a soil-borne spore that formed small clusters).

To determine with certainty whether this species is a mycorrhizal host we should inoculate test plants growing in isolation from other plants. Such experiments would also allow us to determine the degree of dependence of SFVS on the symbiosis. From the current information, we can say that the plant we sampled was not inhibited by the presence of abundant mycorrhizal inoculum in its root zone, or at least was not so inhibited that it could not mature and produce flowers.

K. Cryptogamic Crust Associations

A second group of organisms that might bear on the success of SFVS is the group of primitive plants collectively known as "cryptogamic crusts." These plants form a mat on the surface of many soils, and include algae, fungi, mosses, and lichens. The cryptogamic crust is generally considered beneficial (Johansen 1993). In the case of SFVS, the crusts may help to stabilize sandy substrates (Eldridge and Greene 1994) and improve overall moisture (Lange et al. 1992). Examination of the soil surface during the vegetative surveys and in the course of other work has indicated that occurrence of the cryptogamic crust is sporadic on Ahmanson Ranch and is apparently unrelated to distribution of SFVS. Allen (1996) reached a similar conclusion with *D. leptoceras*. Crusts are most abundant on open areas of San Andreas soil and almost completely absent from weedy portions of Zamora soils. While future restoration efforts might include inoculation with cryptogamic crust organisms, the crust does not appear to either favor or inhibit SFVS. The soil crusts on Laskey Mesa are most frequently comprised of ruderal mosses, such as *Bryum argentium* and *Weisia controversa*, cyanobacteria, including *Nostoc* and *Microcoleus*, and rarely lichens, such as *Collema tenax* [Photo 15; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. Rock-loving lichens, mostly common species of *Acarospora*, *Caloplaca*, and *Porpidia*, frequently grow on the siltstones associated with SFVS ridge-and-bench topography. Although SFVS does occasionally grow in shallow soil pockets directly on siltstone, none of these outcrops support pincushion lichens which could act as "seed traps or nurseries" which is observed elsewhere in Ventura County (Riefner and Bowler 1995).

L. Population Trends and Threats

The total range of SFVS is not unusually small when compared to many other *Chorizanthe* species. Based on the plant's ecology and the number of historic collections, it appears that the regional distribution of SFVS may have always been patchy, and its preferred habitat of low-nutrient, open, sandy-colluvial soils were always localized. To date, J.L. Reveal (pers. communication) and other researchers consider habitat destruction to be the predominant explanation why SFVS has been presumed to be extinct. Accordingly, the current isolation of the Laskey Mesa population is largely the result of encroaching urban development, and perhaps, extensive historic grazing and agricultural practices of the San Fernando Valley region.

These combined effects have ultimately contributed to and have produced irreversible changes in the natural pattern of habitat functions within this plant's pre-European distribution in southern California. Especially important is the loss and destruction of CSS and associated mosaics of native grasslands, which was likely the preferred historical habitat of SFVS [Photo 16; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. It has been estimated that roughly 90% of southern California's CSS habitat existing prior to European settlement has been lost, with most of the loss occurring since the 1930's (Atwood 1990). The human impact to valley grasslands over the last hundred years has also been extensive (Heady 1988). The historic, pre-European relationship between native grasslands and CSS, although currently controversial, is important. Keeley (1991) and Hamilton (1997) make the case that many areas currently occupied by exotic annual grasslands formerly supported CSS with smaller mosaics of native grasslands/prairies. Since SFVS apparently prefers these deeper, thin soils of prairies/CSS ecotone habitats, it has likely suffered at least such losses in its range during those periods.

However, since the Laskey Mesa population is the first known record of SFVS for Ventura County, other out-lying unidentified populations may still be found within the historic range of SFVS in areas underlain by sandy and/or marine bedrocks that have not been carefully surveyed. The discovery of additional populations would not be surprising since thirteen taxa also presumed to be extinct in California were rediscovered between 1988 and 1994 (Skinner et al. 1995). Tibor (1999) also discusses several other plants thought to be extinct in California that have been rediscovered in the last few years, including the Ventura marsh milk-vetch (*Astragalus pycnostachyus* var. *lanosissimus*).

Current concerns related to the conservation and recovery of SFVS in southern California include continued small- and large-scale habitat loss and fragmentation of native scrub and native grassland habitats, habitat degradation through continued invasion by exotic vegetation, agriculture and urbanization, and perhaps, unnatural fire regimes such as increased fire rotation periods in the Santa Monica Mountains (Keeley et al. 1999). Additionally, the isolation of Laskey Mesa greatly increases the potential of a renewed threat in the context of general environmental and demographic stochasticity. Interestingly, potential changes to the man-made disturbance regimes that have helped to perpetuate the plant at Ahmanson Ranch may speed the encroachment of the more competitive exotic grasses into open habitats, converting them to dense annual grasslands and thereby, decreasing the annual seed production of SFVS.

There is no imminent threat to SFVS due to project grading at the Ahmanson Ranch development site. The Ahmanson Land Company has notified all the appropriate State and Federal agencies of its discovery, and is in the process of redesigning its project while preparing a detailed onsite conservation and restoration program.

V. CONSERVATION AND RESTORATION PROGRAM

Restoration and preservation have often been cast as philosophically opposite goals within the scope of conservation (Kane 1994). However, when the limitations of these two strategies are reviewed, a unifying theme and their complementary nature emerges which clearly recognizes that neither restoration nor preservation is achievable or complete in an ideal state (Brown 1994; Jordan 1994). During our modern era, and especially in southern California, where natural functions have been altered and degraded by an ever growing onslaught of alien species (Soule 1990), restoration of ecological dynamics is vital. As such, many conservationists believe that restoration can complement preservation by addressing broader conservation goals (Pickart and Sawyer 1998).

At Ahmanson Ranch, the very nature of the open-soil habitats favored by SFVS are continually susceptible to invasion by non-native plants, and therefore, preservation alone of Laskey Mesa can not guarantee protection of SFVS from invasive species or random stochastic events. Importantly, Barbour et al. (1993) warns that passive conservation of existing conditions for the purpose of conservation is often inadequate. For these reasons, preservation alone of the spineflower habitat areas may not be a viable conservation solution, and restoration and management can be an essential part of a conservation program by meeting broader conservation goals. Therefore, restoration and active management should be an essential component of a program to conserve SFVS.

Accordingly, the goal of the Ahmanson Ranch SFVS conservation program is to preserve and restore habitat values equal to, or greater than those that could be unavoidably impacted by the forthcoming Ahmanson Ranch development project. This goal may be accomplished through several means, including: (1) avoidance of impacts, (2) reduction of impacts, (3) habitat replacement and enhancement, (4) implementation of a habitat resource management program for the Ahmanson Ranch open space and surrounding dedication areas; (5) collection and storage of SFVS seed; and (6) long term restoration and enhancement of SFVS through development of a conservation plan that includes offsite locations. These methods will be discussed in greater detail in forthcoming reports.

A. Restoration and Management Strategies

Strategies for the restoration and management of SFVS habitat are summarized here. Use of a range of these methods should result in successful conservation and restoration of SFVS.

As noted previously by McGraw and Levin (1998), the most important consideration is to keep spineflower planting sites open and free from exotic annual grasses. Additionally, initial efforts to recreate the habitat for an endangered annual, *Amsinckia grandiflora* (Pavlik et al. 1998) also demonstrated the importance of reducing competition from non-native grasses. The preliminary findings of Dr. Ted St. John, and the methods used by Pavlik et al. (1998), suggest that a range of methods should be used, including:

<u>Creation of compacted soil</u>. Soil is routinely compacted in construction operations and those methods could be easily adapted for this purpose. Potential restoration areas (e.g., areas with loose soils and a weedy vegetative cover could be wet to an appropriate moisture level and compacted with tire or track vehicles to bulk densities levels indicated by this work to be tolerable to SFVS but too high for growth of exotic grasses. This method could be carried out in a non-destructive manner; that is, it is available for use on sites that may have a SFVS seed bank.

<u>Creation of very thin soils</u>. This would be most suitable over a solid bed of siltstone [Photo 17; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)] where the existing soil could be removed to leave only pockets of soil, with little or none of it deeper than two to four centimeters. This method is destructive and should not be used on sites that may have a SFVS seed bank.

<u>Creation of open areas that are thoroughly permeated by mycorrhizal roots of *Ericameria palmeri*</u> [Photo 18; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)]. This is similar to several other restoration projects carried out by the consulting team (Riefner et al. 1998; St. John 1999). Successful establishment of weed-free areas requires intermediate steps that were described by St. John (1988; 1999). It is not clear that these areas will maintain themselves over the long term, since it is possible that later-successional native species will move into the area. This method might be combined with the others, but in any case should not be the only method. This is a non-destructive method that is suitable for use on areas with a pre-existing SFVS seed bank.

<u>Manipulation of existing habitat to increase the availability of open-soil patches by reducing competition from annual grasses by fire, herbicide application, and clippings</u>. These methods were used by Pavlik et al. (1998) which successfully increased the availability of low-competition habitats for the endangered annual, *Amsinckia grandiflora*. One of these management techniques that may be especially useful at Ahmanson Ranch is the application of a grass-specific herbicide such as fluazifop-p-butyl (trade name: Fusilade, ICI Corporation). Live cover by introduced grasses was effectively eliminated by the use of this herbicide (Pavlik et al. 1998). Mowing and clipping grasses, and the use of fire, may also be incorporated into the restoration and habitat management program at Ahmanson Ranch.

Additional potential management techniques to control exotic grasses, such as manual removal, have been utilized with some success in other sandy soil habitats. On stabilized dunes at Montana de Oro

State Park, San Luis Obispo County, a veldt grass (*Ehrharta calycina*) manual removal project produced open-soil habitats and the conditions necessary for the proliferation of the rare annual *Chorizanthe californica* (=*Mucronea californica* - a CNPS List 4 plant) [Photos 19-21; Exhibit 4, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999)], in dune scrub infested with this exotic grass (Pickart 1999). This first-year success story may be temporary, but this "non-destructive" manual technique could be applied to remove exotic grasses in sparse SFVS patches located within existing spineflower habitat areas at Ahmanson Ranch. Additionally, these plots could also utilize follow-up treatments with a grass-specific herbicide to ensure weed control.

Soil Salvaging. In addition, the preferred thin-soils associated with SFVS habitat can be salvaged and applied elsewhere to re-create SFVS habitat in the dedicated open space areas associated with the Modelo rocks.

B. Potential Habitat Restoration Areas

The habitat replacement program will result in creation/restoration and enhancement of the types of habitats associated with SFVS at Ahmanson Ranch: (1) sparse CSS, (2) native grassland/forbs, and (3) other open-and shallow-soil habitats. Restoration plots can be placed within unoccupied portions of the larger habitat areas (5 and 10), or in dedicated open space areas of the Ahmanson Ranch. Based on current information, initial restoration plots would be most appropriate within areas characterized by loose soils and/or a high weed cover. It is assumed that manipulation of 'suitable but unoccupied habitat' (defined as habitat that resembles occupied habitat in all aspects, except the presence of SFVS) within known stands of SFVS would not occur until the role of these areas in maintaining the population is better understood. For example, these unoccupied habitat areas may support an extant seed bank or function as important colonization sites in maintaining population dynamics. Because this is the only currently known population of SFVS, future conservation sites in maintaining and recovery programs should incorporate efforts to re-establish the species elsewhere within its historic range. Exhibit 6, provided in the Preliminary Report: Biology of the San Fernando Valley Spineflower, Ahmanson Ranch, Ventura County California (GLA 1999), shows the extensive open-soil habitat located in the Community Open Space areas where habitat creation/reseeding can be performed as part of the conservation plan. Enhancement could potentially occur within the exotic grass-dominated portions of the existing Areas 5 and 10, and habitat creation could take place in the dedicated open space areas underlain by the Modelo rocks.

VI. ADDITIONAL - CONTINUING STUDIES DESIRED

The field and laboratory work presented here is not yet complete. It would be desirable to pursue some further research as part of an offsite re-establishment and restoration program. For example, it would be desirable to do some mycorrhizal growth response experiments with SFVS, and to test the response of its seed to removal of nitrate.

The field values of bulk density are a useful guide, but it is also important to observe experimentally the optimum values that can simultaneously suppress weed growth while permitting spineflower growth. Because restoration projects may involve mycorrhizal inoculation, we should identify fungal species that are associated with the spineflower, and contract with an inoculum supplier to produce site-specific mixtures of fungi for eventual use in developing a conservation plan.

SFVS appears to do well in disturbed habitats. The plant presently is not reproductively limited due to the abundance of the non-native Argentine ant onsite. However, additional data are needed to document which insect pollinators are important and if the plant is a facultative selfer.

In order to determine the influence of small mammals on the biology and natural history of SFVS, trapping and photographic survey studies could be undertaken. These studies would be intended to determine if a unique assemblage of small mammal species are associated with SFVS habitat areas, play a role in dispersal of seed, and utilize seed as food resource.

Additional research is also desirable to investigate the potential genetic variability of the plant.

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