

**STRIPED ADOBE LILY SPECIES MANAGEMENT PLAN**  
*Fritillaria striata* Eastw.

By

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## EXECUTIVE SUMMARY

The striped adobe lily (Fritillaria striata Eastw.) is a State of California threatened plant species. It is so designated because it is known to occur at only about 12 sites in Kern and Tulare Counties. Most of the sites are threatened by agricultural development, livestock grazing and trampling, urbanization, or ORV use.

This bulbous perennial species appears to be restricted to some of the heavy clay (adobe) soils that are found along the eastern side of the San Joaquin Valley and in the foothills of the southern Sierra Nevada and the Tejon Mountains.

It is recognized by the California Department of Fish and Game, Endangered Plant Project that a species management plan is necessary to guide those individuals and agencies concerned with the long-term survival of the striped adobe lily.

This report describes the completed management plan and incorporates the following major recommendations necessary to improve the status of the species:

1. The establishment of a preserve to protect one or more Fritillaria striata populations.
2. Comprehensive field surveys to assess the remaining populations present within the species range. Initial emphasis of surveys should include United States Forest Service lands.
3. A study to evaluate the positive and negative effects of livestock grazing on the species viability at selected populations.

4. A study to investigate the species restriction to specific adobe clay soils and slope aspect/topographic site preference.
5. A study to evaluate the effects of competition from associated nonnative species.
6. A study to correlate rainfall amounts and patterns on the growth and reproductive ecology of the species.
7. The establishment of a comprehensive stewardship program to guide public agencies, landowners and preserve managers in maintaining the viability of the species at known locations.



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## INTRODUCTION

The striped adobe lily (Fritillaria striata Eastw.) is officially designated by the State of California as a threatened plant species (York, 1985). The species is currently a mostly localized endemic of the southern Sierra Nevada and Tehachapi range foothills. Historically, the striped adobe lily was known from several locations in the San Joaquin Valley in Kern and Tulare Counties. Most of these historic valley populations have been extirpated by urbanization and agricultural development. Approximately 12 extant populations are currently known.

The species, which also has been called the Greenhorn adobe lily by Twisselman (1967), is a category 2 candidate for listing as a federal endangered species (USFWS, 1985). It is classified as a list 1B species (rare and endangered) by the California Native Plant Society (Smith and Berg, 1988).

Although the species apparently was never common, based upon the available herbaria records, it was much more widespread than it currently is. Most of the existing populations are only mere fragments of much larger historic occurrences.

From all available data, this species appears to be restricted to some of the heavy clay (adobe) soils that are found along the eastern side of the San Joaquin Valley and in some of the foothills. Most of the existing known populations are threatened by agriculture, grazing, competition, urbanization, ORV use, or other impacts. The California Department of Fish and Game, Endangered Plant Project has contracted to develop a species management plan for the striped adobe lily. This

management plan contains recommendations that are designed to improve the status of the species and ultimately help its recovery.

#### Taxonomic History

Fritillaria striata (Figures 1-1 and 1-2) was first described as a distinct species by Alice Eastwood (1931). The description was based upon the type specimens that were collected by E. Roy Weston, May 1927, On Rattlesnake Grade in the Greenhorn Mountains of Kern County and deposited in the California Academy of Sciences Herbarium (CAS #145549). The species was also represented by collections made in 1928 near Lindsay and 1929 from Frazier Valley, both in Tulare County. In the description, Eastwood noted that the species was related to the adobe lily (Fritillaria pluriflora Torr.) which occurs in the northern Sacramento Valley foothills. F. striata differed, however, in the shape, size, and coloring of the flowers, the conspicuous nectaries, and the connivent stigmas.

#### Technical Description

Fritillaria is a genus of slender, herbaceous perennials with simple leaves, an unbranched stem developing from an underground bulb, a terminal inflorescence, six tepals (three sepals and three petals that are not significantly different), six stamens, a noncapitate style, and usually a prominent nectary. All North American species have a single leafy bract subtending each flower. Worldwide, there are about 100 species included in the genus, some of them prized for their horticultural value.



Figure 1-1  
Line drawing of  
striped adobe lily  
(Fritillaria striata)

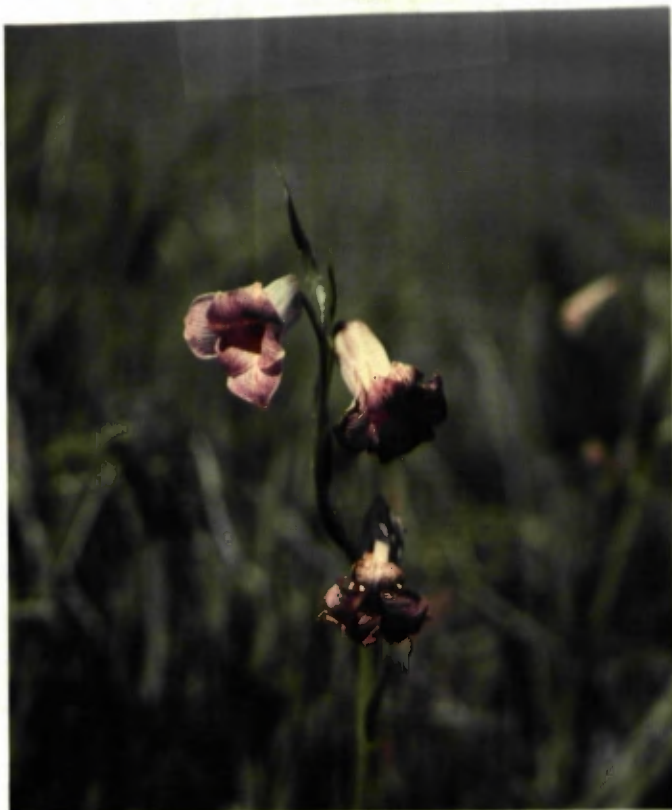
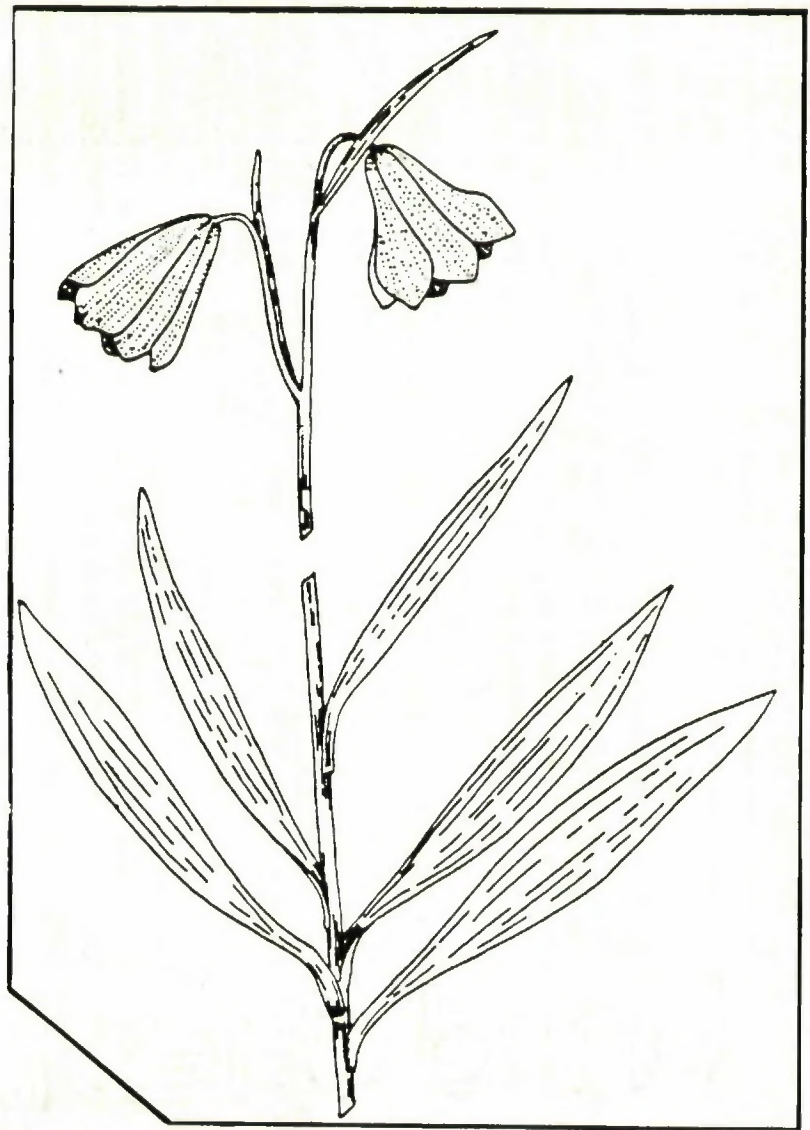


Figure 1-2  
Fritillaria striata, Lewis  
Hill, Tulare Co. (photo by  
R. Hansen)

Fritillaria striata has a deep-seated (ca. 20-35 cm underground), approximately spherical bulb 15-20 mm in diameter of three thick ovoid scales; stems 5-10 cm tall above ground; leaves predominantly basal, ascending, the lowest oblong-lanceolate, 1-2 cm wide, 6-10 cm long, glabrous, opposite to alternate; the upper narrower and somewhat undulate, alternate; flowers, 1-4(9), campanulate, nodding on abruptly recurving pedicels, pink or sometimes white or burgundy, fragrant; tepals 6-10 mm wide, 2-3 cm long, recurved at tips, inside of tepals with prominent red striations usually in pairs 0.2-0.5 mm apart; nectary elliptical to ovate, ca 3 mm x 2 mm, green, concave, at base of tepals; stamens approximating or exceeding the pistil; style linear, 9-15 mm long, barely triparted at the apex. Capsule quadrate, 2 cm long, not winged. Chromosome number = 12 (Cave, 1970).

Habitat, Life History, and Ecological Relationships

The striped adobe lily is apparently an edaphically restricted species. All of the known extinct and extant population sites occur on adobe clay soils. At lower elevations in the valley floor the species has been found on Porterville Clay, Mt. Olive Clay, and Cibo Clay. It has also been found on various other minor series clay-rich soils in the foothills bordering the valley. The physiological-ecological basis for this restriction to heavy clay soils is not known. It is known that the largest historical populations occurred on the more level ground where the deepest clays are found and more soil moisture obviously would be available. Most of these historic population sites have been converted to orchards and the remnant populations left

occur on what may originally have been marginal habitat for the species. It has been noted that the remaining populations generally occur on the lower portions of north-facing slopes (Hansen, 1988; Taylor and Stebbins, 1988). The seeming partiality of north-facing slopes is probably a result of its preference for the more desirable soil moisture and the cooler, more mesic conditions present there. The presence of extremely deep rooted bulbs (to 35 cm) lends support to this theory. It is not known if the species can be cultivated artificially on nonclay soils but the author strongly suspects that it could be, if all of the basic environmental and nutritional needs were met under controlled conditions.

Fritillaria striata is known to occur in both nonnative grassland and blue oak woodland (Holland, 1986). The first collections used to describe the species were made in the nonnative grassland that had become well established in Tulare approximately fifty years earlier. This vegetation rapidly replaced the previously existing native bunchgrass communities in the late 1800s. The common species found associated with F. striata in this community include wild oat (Avena fatua), purple brodiaea (Dichelostemma pulchellum), fiddleneck (Amsinckia intermedia), and blow wifes (Achyrachaena mollis). In those grassland sites where the habitat quality has been substantially degraded the species is often associated with "weedy" nonnatives such as groundsel (Senecio vulgaris), filaree (Erodium botrys), and chickweed (Stellaria media). In the higher elevation occurrences in the foothills the species is associated with widely scattered blue oak trees (Quercus douglasii). Common herbaceous associates in this setting include popcorn flower (Plagiobothrys nothofulvus), soap plant (Chlorogalum



pomeridianum), lomatium (L. utriculatum), and red brome (Bromus rubens).

It is significant to note that Fritillaria striata has been observed growing sympatrically with the Tulare pseudobahia (P. peirsonii), a state-listed endangered plant species. The two species occur together at two locations: Lewis Hill in Tulare County and Pyramid Hill in Kern County (J. Zaninovich, pers. comm., 1988).

Although published reproductive and developmental data are not available, seed set in nature has been observed (J. Shevock, pers. comm., 1988, and R. Hansen, pers. comm., 1988). The author has seen mature dehiscent capsules with apparently viable seeds on plants in Adobe Canyon in Kern County.

It has been observed that vegetative and reproductive phenology appear to be closely correlated with rainfall patterns. The amount and timing of winter rainfall appears to greatly affect the size of the plant and the total number of flowers produced per plant. This developmental pattern is similar to many other bulbous taxa in the Liliaceae.

The species apparently grows in a fairly slow vegetative state over the cold wet winter months of November to January. The plants are known to flower between mid-February and early April and flowering is positively correlated with elevation, exposure, and soil moisture levels. Sufficient spring rains can extend the flowering period a few weeks in some years. Pollination mechanisms are not known but are probably similar to those of other members of the Liliaceae and Amaryllidaceae that occur in the region. Seed production and dispersal have been observed from mid-April through late May at several populations (J. Shevock, pers. comm., 1988).



### Population Numbers and Distribution

In an effort to document all historic and current population occurrences for Fritillaria striata, the following methodology was employed:

1. The most recent element occurrence records of the California Natural Diversity Data Base (CNDDDB) for the species were obtained and analyzed.

2. Research visits were made to the following herbaria: California Academy of Sciences (CAS), University of California, Berkeley (UC), Jepson Herbarium, Berkeley (JEPS), California State University, Fresno (FSC), and California Polytechnic University San Luis Obispo (OBI). The intent of these visits was to obtain any recent or supplemental data available on the species that had not been reported to the Natural Diversity Data Base. It was determined that these herbaria were the most likely repositories for recent collections made for the species.

3. A letter questionnaire was sent to those botanists/biologists/field researchers known to have observed one or more of the populations of Fritillaria striata within the past 3 years.

To date, approximately twenty populations of F. striata have been reported, and most have been inventoried at least once within the past six years by the author of this report. The exact number of historic populations is difficult to ascertain due to the nonspecific location data available on many of the earliest collections present in the California herbaria. Of these twenty populations, four are known or strongly suspected to be extirpated due to a variety of land use impacts. Of the remaining populations, it is roughly estimated that approximately 16,000 individuals existed as of April 1988. Certainly

this is a very low number for a species that exists nowhere else in the world. Obviously, however, an accurate estimate of actual population numbers can only be made after a series of inventories performed over several seasons.

Occurrence elevations range from a low of 500 ft (152 m) near Lindsay in Tulare County to 4700 ft (1433 m) north of Canary Springs along Rancheria Road in Kern County. For a detailed summary of currently available population and distribution data, refer to Table 1 and Figures 2 and 3.

#### Endangerment Factors

Although the size and site quality characteristics of currently known Fritillaria striata populations vary throughout its range, it is clear that the species has been negatively impacted since its original description fifty-seven years ago. The available evidence clearly supports threatened status assigned to it by the Department of Fish and Game and the R-E-D status code of 3-3-3<sup>1</sup> given to the species by the California Native Plant Society (Smith and Berg, 1988).

The striped adobe lily is threatened regionally by many cumulative impacts occurring throughout its range. It is threatened locally by various impacts that directly or indirectly favor the growth of other species at the expense of F. striata.

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<sup>1</sup>CNPS Status Code Translation

R-3 = Occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported.

E-3 = Endangered throughout its range.

D-3 = Endemic to California.



Table 1. Summary of Population and Distribution Data for Striped Adobe Lily (*Fritillaria striata*)

Location/Site	CNDDB Occ. No.	County	T. R. S.	Elev. ft. (m)	No. of Individuals	Last Field Visit	Site Quality	Viability/Defensibility	Ownership	Current Status/Use	Comments
Rancheria Rd., 7.9 Mi. NE of Hwy. 178	1	Kern	28S,30E,18	2,000 (610)	50	1983	Good	Good	Private	Owner Rec. grazing	Prob. hist. Type loc.
Rancheria Rd., 1 Mi. NE of Canary Spring	2	Kern	27N,31E,19	4,700 (1432)	100	1985	Fair/Good	Good	Private	Unprotected, grazing	Upper elev. limit.
Rancheria Rd. at Rattlesnake Grade	3	Kern	28S,30E,3	3,500 (1085)	0	1983	Poor	N/A	Private	N/A	Erroneous
1 air Mi. N of Long Tom Mine	4	Kern	27S,29E,24	2,720 (829)	200	1983	Good	Good	Private	Unprotected, ranching	
Shirley Mdw. Foothills	5	Kern	25S,32E,32	4,560 (1390)	50	1983	Good	Good	Private	Unprotected, ranching	Lumped w/ occ. 16
Wiseman Field in Monotti Cr. area	6	Kern	27S,29E,10	2,120 (646)	400	1983	Good	Good	Private	Owner prot./ranching	Lumped w/ occ. 17
Horseshoe Ranch, 5-Dog Cr.	7	Kern	26S,29E,30	1,000 (305)	?	1974	?	?	Private	Unprotected, ranching	No recent data ev.
Porterville	8	Tul	21S,27E,26	459 (140)	?	1922	Poor	N/A	Private	Extirpated, agriculture	Historic loc.
Frazier Valley	9	Tul	21S,28E,5	560 (171)	?	1983	Poor	N/A	Private	Extirpated, agriculture	Historic loc.
Greenhorn Mtn. Rd.	10	Kern	28S,29E,36	1,000 (305)	?	1983	Poor	N/A	Private	Extirpated, agriculture	Historic loc.
5 Mi. E of Lindsay	11	Tul	20S,27E,13	520 (159)	?	1983	Poor	N/A	Private	Extirpated, agriculture	Historic loc.
Rancheria Rd. 7.8 Mi. NE of Hwy. 178	12	Kern	28S,30E,18	1,080 (634)	50	1985	Fair	Good	Private	Unprotected, ranching	Small pop.
Rancheria Rd., 6.7 Mi. NE of Hwy. 178	13	Kern	28S,29E,13	1,960 (597)	3,000	1985	Good	Good	Private	Unprotected, ranching	Good site
Rancheria Rd., 0.5 Mi. E of Pyramid Hill	14	Kern	28S,29E,13	1,760 (536)	45	1983	Fair	Fair	Private	Unprotected, ranching	Degraded
Rancheria Rd., S face of Pyramid Hill	15	Kern	28S,29E,14	1,760 (536)	2-5,000	1985	Excellent	Good	Private	Unprotected, ranching	Ensemble w/ <u>Pseudobahia</u>
Rancheria Rd., 7.9 Mi. NE of Hwy. 178	16	Kern	28S,30E,18	2,100 (640)	800	1985	Good	Good	Private	Owner rec./ranching	Lumped w/ occ. 1
Granite Stn.	17	Kern	27S,29E,4	1,700 (518)	2,000	1983	Good	Good	Private	Owner prot./ranching	Lumped w/ occ. 6
Eastern Summit Tejon Hills	--	Kern	12N,30E,31,32,33	2,500 (762)	5,000	1987	Good	Good	Private	Unprotected/ranching, T/L	Tejon Ranch
North slope of Lewis Hill	--	Tul	21S,27E,12,13	800 (244)	1,200	1988	Fair	Good	Private	Unprotected, grazing	Owner aware
NW slope Lewis Hill, E of Plano Rd	--	Tul	21S,28E,8	900 (274)	85	1988	Fair	Good	Private	Unprotected, excess grazing	Ensemble w/ <u>Pseudobahia</u>



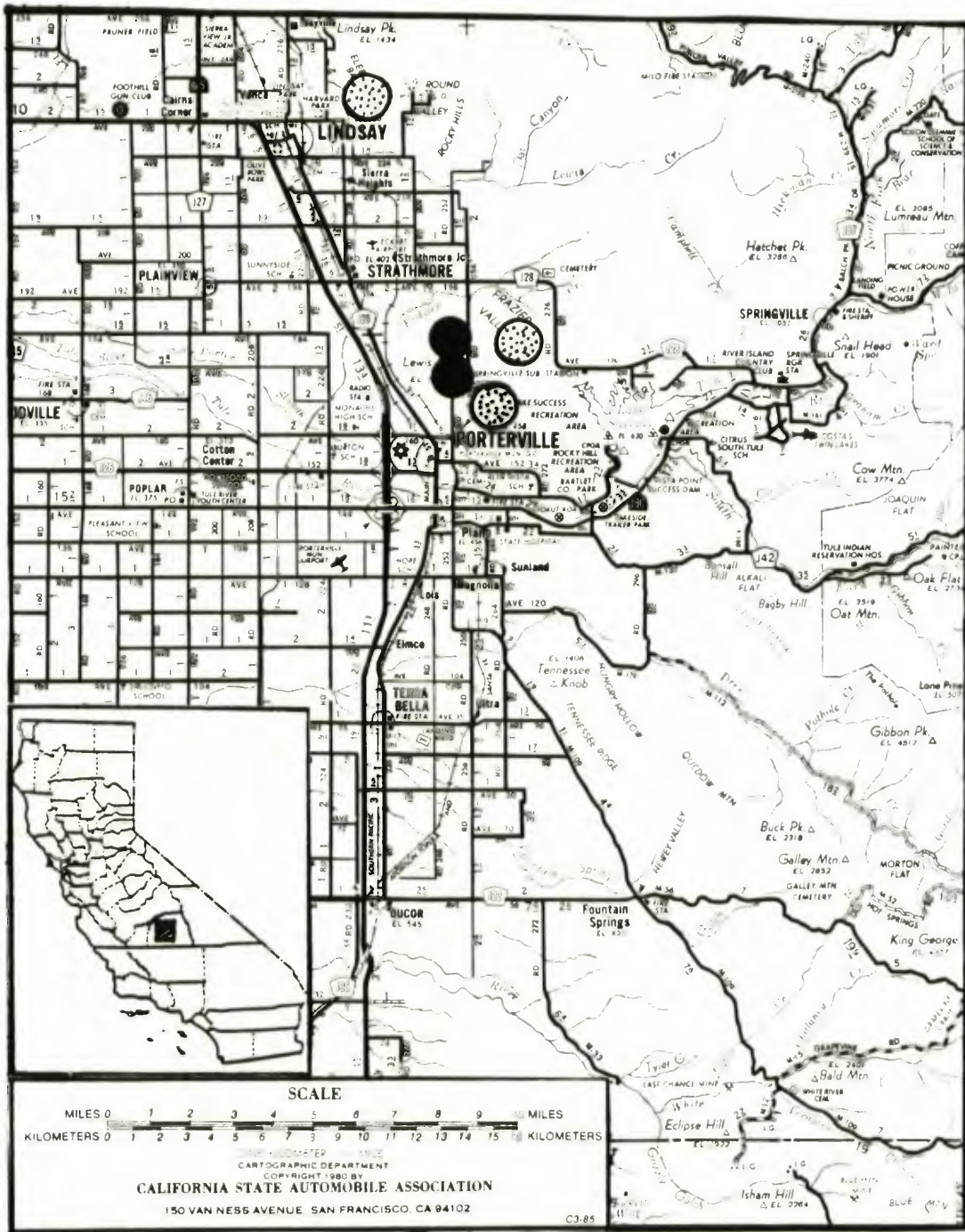


Figure 2. Known Population Sites of Striped Adobe Lily (*Fritillaria striata*) in Tulare County  
Extant Populations as of 4/88 ●  
Extirpated Populations ●



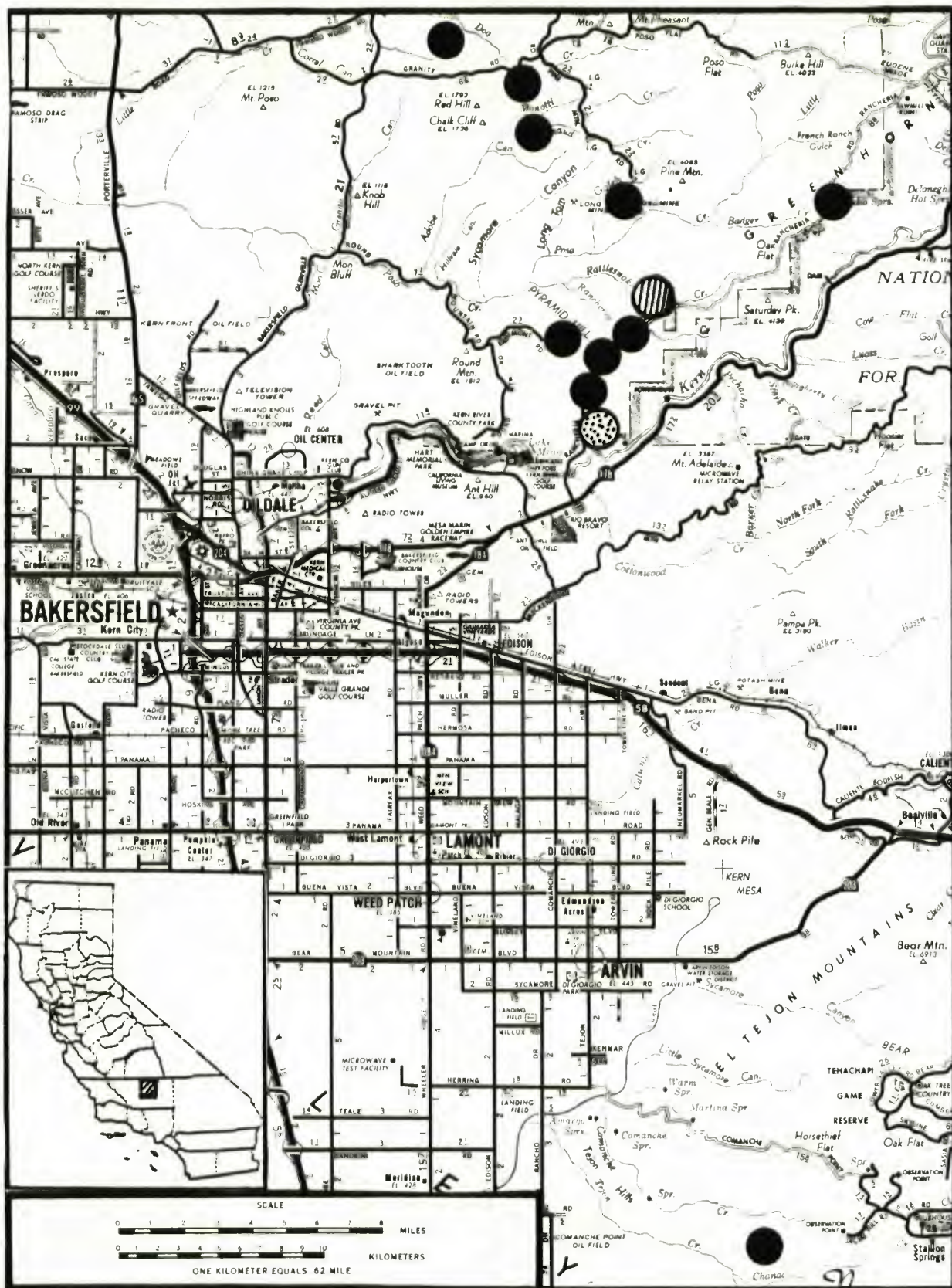


Figure 3. Known Population Sites of Striped Adobe Lily (*Fritillaria striata*) in Kern County  
 Extant Populations as of 4/88 ●  
 Extirpated Populations ●  
 Erroneous Population Location ●

Several factors are known to threaten the species' existence at many of the existing populations.

The most obvious cause of adverse impacts, agricultural land conversion, has resulted in direct and irreversible extirpation of four populations, including all of the collection sites, except the type, referred to by Eastwood (1931) in her species' description. Many of the historic collections were made in the lower elevation valleys of Tulare County and these were the first lands put into agricultural production. The numerous collection sites from the Lindsay area and Frazier Valley were first affected by early grain farms and later by irrigated agriculture, primarily citrus orchards. The few remnant populations still existing at the lower elevations on the slopes of Lewis Hill near Frazier Valley are threatened by the spread of citrus orchards (see Figure 4). With the advent of drip irrigation, orchards can be planted more successfully on much steeper slopes and the potential therefore exists for the complete extirpation of all remaining Tulare County populations.

Virtually all of the known extant populations of Fritillaria striata are being subjected to various degrees of livestock grazing. It is common practice in the region to graze virtually all accessible rangeland that is not agriculturally developed. Most of the grazing is by cattle, although horses have been observed at some of the known population sites by Shevock (pers. comm., 1988). Deer were observed to have eaten most of the mature inflorescences of the Tejon Hills population (5,000 plants) in the span of just one week in 1987 (D. Taylor, pers. comm., 1988).



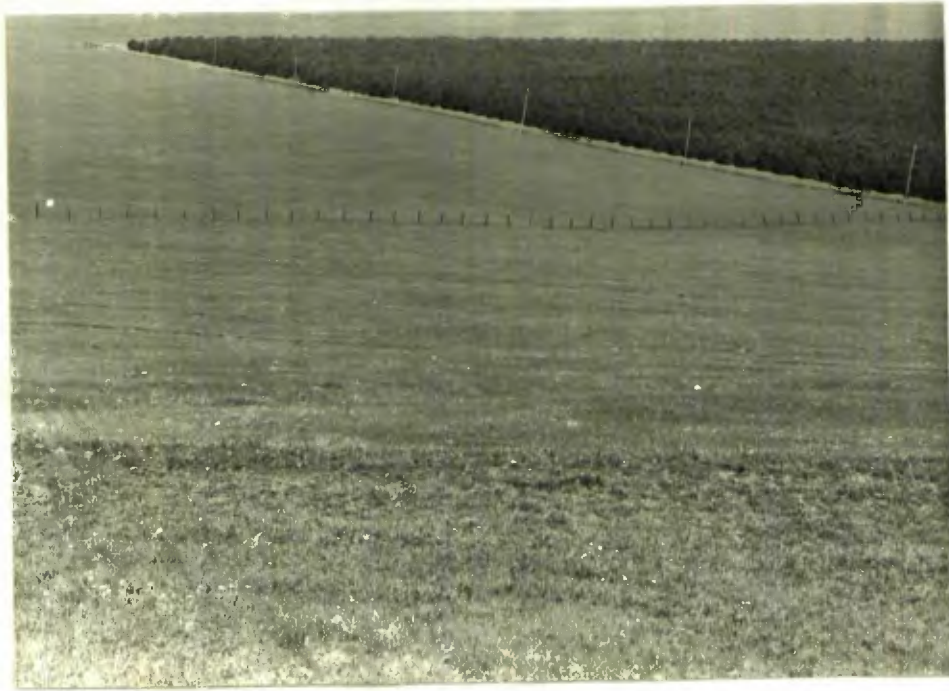


Figure 4. Example of Agricultural (Citrus) Land Conversion in Fritillaria striata habitat. Lewis Hill, Tulare Co. (photo by R. Hansen)



Figure 5. Fenceline Contrast on Right Side of Distant Slope Illustrates Differences in Grazing Regimes. A regime that allows Fritillaria striata plants to flower and seed is beneficial. Lewis Hill, Tulare Co. (photo by R. Hansen)

The degree of impact that grazing has on the species is not well documented. Apparently conflicting statements made by various botanists regarding potential impacts are probably the result of observations made during single visits at different populations in different years. Shevock (n.d.) and Twisselman (1967) have stated that since nearly all remaining populations of Fritillaria striata in Kern County occur on lands for which grazing practices have remained relatively constant for many years, grazing probably has had a relatively minor impact on the species. Other observations made by Taylor (pers. comm., 1988) and Hansen (1988) have documented that the greatest population densities do indeed occur in areas of fairly light grazing (see Figure 5). Observations made by the author indicate that both grazing intensities and timing indeed appear to be significant. Grazing regimes that allow the plants to flower and produce seed are undoubtedly beneficial to the long-term survival of the species. Grazing impacts during the vegetative growth period prior to flowering are harder to assess. Since competing nonnative annual grasses grow faster in the cold foggy months (November to February), this species would probably benefit from light to moderate levels of grazing until early to mid-February (see Figure 5).

Heavily grazed land in the species range often supports large populations of California ground squirrels (Spermophilus beecheyi). A favorite food of these burrowing rodents is the bulbs of perennials like Brodiaea, Chlorogalum, Calochortus, and presumably Fritillaria. They are also known to very effectively "graze" favored herbaceous perennials to ground level. Therefore, excessive numbers of squirrels, an indirect result of heavy grazing, may cause serious negative impacts on the vegetative and reproductive potential of some F. striata populations.



In addition to grazing, it has been noted by Shevock (pers. comm., 1988) that trampling of individual plants in certain populations along Rancheria Road and Pyramid Hill in Kern County is a problem. The congregation of cattle at the densest population sites, especially during the flowering period, has a documented negative impact.

The impact of competition from associated species is another factor that obviously is correlated with the grazing regimes at the existing Fritillaria striata populations. As mentioned, grazing is probably beneficial during the growth period prior to flowering. Although definitive data are not available, it is reasonable to assume that completely ungrazed Avena and Bromus stands would provide formidable competition. Likewise, other nonnative herbs such as Brassica, Sisymbrium, and Raphanus are known to occur at some of the population sites. They too are likely competitors with F. striata for light and nutrients, particularly if the habitat is somewhat degraded. It is significant to note that the largest population known (+5,000 plants) exists in an area of the Tejon Hills of Kern County where grazing pressures are light and the associated species present are dominated by native annuals and Dichelostemma pulchellum, a species with a growth habitat very similar to F. striata (D. Taylor, pers. comm., 1988).

Another threat to the species includes potential road widening, especially along Rancheria Road in Kern County, where several populations occur. Because of the species' affinity for clay soils that are known to be very unstable during the wet months, emergency slope stabilization activities by road maintenance crews could potentially impact these populations.

Potential plans to enlarge Lake Success in Tulare County could pose a threat to any undescribed populations that still may be present in the historic range of the species. Current projections are for an additional 704 acres to be inundated if the project is completed (J. Lacey, pers. comm., 1988).

#### Conservation Efforts

Presently, there are no organized conservation management activities or programs in place to either preserve specific populations or improve the existing habitat of the striped adobe lily. Two of the Kern County populations (CNDDDB #'s 6 and 17) were reportedly being "protected" by the landowner ranchers (refer to Table 1). These ranchers have informally told Jim Shevock (pers. comm., 1988) that they will not alter their current land use patterns for the population sites. They are currently being actively managed for grazing and ranching activities that may or may not prove beneficial to the populations of Fritillaria striata present, depending on time and duration of the grazing.

At least two other landowners in Kern County and one in Tulare County have indicated a general receptiveness to protecting the F. striata populations present on their properties if they are given "guidelines" that will help the species and not significantly detract from the current ranching activities. In particular, Mr. Cole Hawkins, owner of the large population (+1,200 plants) present on Lewis Hill in Tulare County, has expressed interest in altering his grazing regime to benefit the species (R. Hansen, pers. comm., 1988).

It is significant to note that currently no populations of F. striata are known to occur on any state or federal lands. The author



believes that the occurrence potential of new undiscovered populations present on some of the lower elevation portions of the Sequoia National Forest is very high. Any such populations, once documented, would then be afforded the protection of the U.S. Forest Service sensitive species management act.

Some of the populations are currently somewhat "unofficially protected" by either their remote foothill location or fortuitous parcel fencing that lessen some of the previously described deleterious impacts. These sites are obviously prime candidates for further official conservation or protective efforts.

#### Research and Information Needs

Several research and informational needs exist, the lack of which will hinder any future long-term management efforts to protect the striped adobe lily.

First is a need to completely survey and inventory the remaining areas of suitable habitat within the historic range of the species. In particular, foothill woodland in Tulare and Kern counties that contains the topographic and edaphic conditions capable of supporting the species should be surveyed during the early spring months by competent botanical personnel to determine the locations of remaining population occurrences and data on their site quality. The author feels strongly that such a focused survey effort will result in the discovery of some significant new populations of Fritillaria striata. As previously mentioned, it is likely that some populations may exist on lands administered by the Sequoia National Forest and thus would immediately be afforded a definite degree of protection. In addition,



because of the remote locations and access problems inherent with surveying private lands, it is felt that other significant populations await discovery within the range of the species. Of particular interest in a survey effort should be the lands owned by the Tejon Ranch Corporation. One extensive and significant population is known to occur on their property and the appropriate soil conditions are found at other ranch locations. This, and the fact that the Tejon ranchlands are generally less heavily grazed than many of the surrounding areas, increases the likelihood of striped adobe lily population occurrences.

It is also necessary to monitor and evaluate the effects of livestock grazing and trampling at one or more of the known populations. The timing, duration, and intensity of grazing must be evaluated for both positive and negative impacts by using fencing enclosures. The emphasis of this type of data analysis should be on the factors that directly or indirectly affect growth, reproduction, and long-term survival. Obviously, a multi-year research effort with controls is required for this type of study to provide reliable data for use in a species management plan.

Research is also necessary to analyze the apparent restriction of Fritillaria striata to certain soil types. Preliminary speculation based upon field observations by several botanists indicates that the water retention abilities of the adobe clay soils associated with the species may be an important factor. In addition, the apparent relationship between soil, slope, and exposure should be investigated at the same time. It is quite possible that all of these factors cumulatively provide a unique habitat related to moisture availability

that is favored by the species (R. Hansen, 1988, and D. Taylor, pers. comm., 1988).

Another need in understanding the requirements of the species is an investigation into the reproductive ecology of the plant. It is known that the species appears to produce more flowers per plant and more seeds per capsule during years of normal or above normal rainfall. It is not known, however, to what degree the species is reproducing sexually as no seedlings have ever been reported. Reproduction may in fact be mostly vegetative, which may explain the rather limited distribution of the species.

It is also necessary to evaluate the effects of competition on the striped adobe lily, most importantly, the effects of competition from nonnative introduced species. This information must be evaluated and analyzed in conjunction with the data resulting from the grazing and trampling studies to determine if there are ecological relationships between these two factors.

Finally, it is necessary to encourage individuals that have observed the species to contribute these data to a central repository. Several ranchers and local inhabitants that have observed the striped adobe lily and are at least somewhat aware of the species' significance have not reported this information. The information is literally "gleaned" by some individuals such as the author and a few other botanists who also have a keen interest in the species. Any and all information concerning this and similar species should be diligently reported to the California Natural Diversity Data Base as soon as it becomes available.

## MANAGEMENT PLAN

### Management Plan Mission and Needs

The prime mission of the management plan is to evaluate, determine, and implement management activities which will stabilize and improve the biological condition of at least some of the striped adobe lily populations and help in the ultimate recovery of the species. Data presented in the introduction show that the species has been extirpated from four historic locations and some of the remaining extant populations are declining due to a variety of reasons. A management plan tailored to insure the long-term survival and viability of Fritillaria striata is needed to guide the agencies, organizations, and individuals concerned with the species.

As mentioned previously, relatively few living individuals with professional botanical expertise have observed or evaluated the species in nature. Nevertheless, extensive input was solicited from four individuals whose current or historic species observations and whose reputations for botanical expertise were recognized by the author. These individuals are Rob Hansen, Nature Conservancy Preserve Manager, Jim Shevock, U.S. Forest Service Botanist, Dean Taylor, Botanical Consultant, and Jack Zaninovich, Tulare County farmer and botanist. Based upon these consultations and the information obtained from the described sources, seven primary goals were developed and integrated into a management plan. The goals are:

1. To immediately preserve the habitat of one or more populations of F. striata either through direct acquisition or other permanent protection measures.



2. To survey and inventory (quantitatively and qualitatively) all remaining areas of suitable habitat for populations of Fritillaria striata.

3. To conduct a study to learn the effects of livestock grazing and trampling on populations of F. striata.

4. To conduct a study to obtain data concerning the species' apparent ecological-physiological restriction related to moisture availability on certain adobe clay soils and north-facing slopes.

5. To conduct a study to learn the effects of competition on the species' long-term survival and reproductive requirements.

6. To conduct a study to learn the effects of annual rainfall amount and timing on the species' reproductive ecology and vegetative growth.

7. To utilize the information obtained from the previously mentioned studies to establish a cooperative stewardship and management program that will enable the species to recover.

#### Outline of Management Plan

1.0 To establish a preserve of one or more F. striata populations.

##### 1.1 Assessment Objectives

- 1.11 Inventory existing population data and select preferred sites.
- 1.12 Determine ownership boundaries.
- 1.13 Contact landowner(s), public and private.
- 1.14 Estimate acquisition or conservation agreement costs, secure funding.

##### 1.2 Protection Objectives

- 1.21 Owner education and outreach.
- 1.22 Preliminary guidelines for species management.
- 1.23 Notification of public land manager, if applicable.
- 1.24 Removal of obvious direct threats from established preserve(s).
- 1.25 Establish preserve through easement or purchase.

- 1.3 Manipulation Objectives
  - 1.31 Insure defensibility of portions of established preserve(s) to allow controlled studies.
  - 1.32 Proceed with manipulative studies involved in subsequent goal objectives.
- 2.0 Complete inventory of remaining areas of suitable habitat of *Fritillaria striata*
  - 2.1 Assessment Objectives
    - 2.11 Contract field searches of remaining areas of suitable habitat by competent botanical personnel at appropriate season, emphasize USFS personnel and resources.
    - 2.12 Assess newly discovered populations quantitatively and qualitatively.
    - 2.13 Obtain prior cooperation and assistance of private landowners in the survey areas. Utilize J. Zaninovich and J. Shevock and the Nature Conservancy to facilitate cooperation.
  - 2.2 Protection Objectives
    - 2.21 Use data for additional preserve acquisition or protection.
- 3.0 Conduct study of livestock grazing and trampling on some known populations
  - 3.1 Assessment Objectives
    - 3.11 Contract with a competent researcher for annual monitoring of at least four populations under different grazing regimes, setting up a control section in each population.
    - 3.12 Obtain cooperation from private landowners and public land managers, if applicable.
  - 3.2 Manipulation Objectives
    - 3.21 Vary timing and duration of grazing.
    - 3.22 Vary intensity of grazing.
  - 3.3 Protection Objectives
    - 3.31 Use data for preserve management.
- 4.0 Conduct a study of species restriction to certain adobe clay soils and north-facing slopes related to moisture availability
  - 4.1 Assessment Objectives
    - 4.11 Investigate the water holding capacity of clay soils at known populations compared to other soils within geographic range. Investigate the relationship between moisture availability at known populations compared to other soils within geographic range.
    - 4.12 Investigate the relationship between the topographic site and slope aspect characteristics at known populations compared to other sites within the geographic range.



- 5.0 Conduct a study of the effects of competition on the species
  - 5.1 Assessment Objectives
    - 5.11 Inventory of competing annual species.
    - 5.12 Determine relative threats posed by competing species.
    - 5.13 Determine competitive effects on vegetative growth and reproductive ecology of striped adobe lily.
  - 5.2 Manipulation Objectives
    - 5.21 Investigate and coordinate the use of grazing as a management tool to reduce threat of competition.
  - 5.3 Protection Objectives
    - 5.31 Use data for preserve management.
- 6.0 Conduct a study of the effects of rainfall amount and patterns on the vegetative growth and reproductive ecology of the species
  - 6.1 Assessment Objectives
    - 6.11 Monitor available rainfall records for some of known populations over a period of three seasons. Compare with field inventory data, soil occurrence data, and reproductive output data.
- 7.0 Stewardship and management cooperation
  - 7.1 Assessment Objective
    - 7.11 Identify and contact landowners and public agencies
  - 7.2 Protection Objective
    - 7.21 Product educational pamphlet describing species management guidelines.

#### Narrative

- 1.0 Establish a preserve of one or more *Fritillaria striata* populations.

Because of the overall status of the species and the potential for extirpation at several of the known population sites, it is important that at least one population be protected to allow the long-term manipulative studies necessary to further understand the species requirements. Most of the known populations on private lands are vulnerable to varying degrees of habitat degradation and miscellaneous ranching activities that could interfere with the controlled types of studies required. Enough information currently exists to recommend



that efforts be made to directly acquire or otherwise protect at least one and preferably two separate populations to implement the studies. Pyramid Hill in Kern County and the northwest slope of Lewis Hill in Tulare County are recommended sites based upon current data and prospective owner cooperation (refer to Table 1 for specific site quality comparisons). Both sites are particularly significant because they also contain the state-listed Endangered species Pseudobahia peirsonii.

### 1.1 Assessment Objectives

#### 1.11 Inventory existing population data.

Existing population data should be used to prioritize acquisition/protection sites should the recommended population(s) not prove feasible. Priority should be given to two separate populations from different portions of the species range to insure genetic diversity. Also, priority should be given to at least one site occurring in the San Joaquin Valley grassland. Although obviously a large preserve is preferable, the available evidence indicates that small preserves for plants can indeed be viable stable entities if managed properly (Reznicek, 1987; Jarvinen, 1982). This recommendation may be altered if one or more new populations are found to occur on the Sequoia National Forest where they would be provided immediate protective status.

#### 1.12 Determine ownership boundaries.

This task can easily be accomplished by checking the ownership records available in each of the three counties. The resources of the Nature Conservancy staff office could facilitate this objective.

#### 1.13 Contact landowners of preferred sites.

This task can probably be accomplished more successfully by nongovernment personnel such as the Nature Conservancy staff. Many

of the known populations occur on ranches that are often owned and operated by individuals who are not too receptive to government "interference." Jim Shevock of the U.S. Forest Service is also a possible contact person with many of the foothill landowners that own property near the Sequoia National Forest boundary in Tulare and Kern Counties. Mr. Cole Hawkins, owner of the large population on the north slope of Lewis Hill, is reportedly somewhat receptive to protecting the species (R. Hansen, pers. comm., 1988).

#### 1.14 Estimate acquisition or conservation agreement costs.

This task should also probably be performed by the Nature Conservancy staff and the results transmitted to the endangered plant project. The information could then be used to determine funding sources. If additional field survey work results in the identification of new populations on U.S.F.S. lands, conservation costs might be shouldered, at least in part, by the Forest Service.

### 1.2 Protection Objectives

- 1.21 } Owner education and outreach, preliminary
- 1.22 } guidelines

If a conservation agreement is utilized to establish the initial preserve(s), it is important that the landowner be adequately informed of the current known requirements of the species. An outline should be prepared describing the potential negative impacts that could occur and procedures to follow when travel in or near the population is planned.

#### 1.23 Public land manager notification, if applicable.

The managers of any public lands that may be found in the future that contain known populations of striped adobe lily should be notified



of their legal responsibilities under the California Endangered Species Act. A copy of the notification should be sent to the U.S. Fish and Wildlife Service.

1.24 Removal of obvious direct threats from established preserve(s).

At any established preserve "obvious" livestock overgrazing and trampling should be curtailed. No grazing should occur during the flowering period of the species (March, April). In addition, other threats such as herbicide drift and access through the preserve for adjoining land uses should be avoided.

1.25 Establish preserve through easement or purchase.

Once ownership or a permanent conservation agreement has been obtained, the preserve(s) can be established. Notification of appropriate resource management personnel can take place at this time.

1.3 Manipulation Objectives

1.31 Insure defensibility of portions of the established preserve(s) to allow controlled studies.

Various selected portions of the established preserve should be designated for research purposes and adequately fenced to prevent any outside impacts to the test sites.

1.32 Proceed with manipulative studies.

Initial manipulative studies involving grazing, soils, competition, slope aspect, and hydrology can begin by using data obtained from the research sites established at the preserve(s). These data can be gathered either prior to or concurrently with the data obtained from the recommended additional field studies.

2.0 Complete inventory of remaining areas of suitable habitat of *Fritillaria striata*

### 2.1 Assessment Objectives (2.11, 2.12, 2.13)

It is very important that field searches occur in the near future to discover any unknown populations of F. striata that exist. These field searches should be performed by competent botanical personnel who have been trained to recognize the potential habitat and the species itself. The search areas for such survey should be targeted by reviewing all available published soil distribution and topographic data, thereby concentrating the field searches in those areas of natural habitat within the range with the proper adobe clay soils. Because of the similarity in habitat requirements and range overlap, these surveys should be performed concurrent with the recommended surveys for Pseudobahia peirsonii.

Any newly discovered populations should be assessed in terms of habitat quality and defensibility by completing CNDDDB field survey forms.

Since these surveys must be performed within a relatively short time span between approximately March 1 and April 15, it will be necessary to attempt to obtain prior approval of the respective landowners. Jack Zaninovich of Delano and Jim Shevock of San Francisco are likely contacts to facilitate this activity. In addition, contact by Nature Conservancy land stewards might also prove to be advantageous in this effort.

### 2.2 Protection Objectives (2.21)

The additional data obtained from the surveys could be used for subsequent preserve acquisition or species protection. If new populations were discovered on U.S.F.S lands, the regional director could be notified of the forest service's obligations under the sensitive species



management act. If they were on private lands, conservation agreements with the owners should be pursued.

3.0 Conduct study of livestock grazing on some known populations  
(3.1, 3.2)

Because numerous observations by botanists have documented potential negative impacts to the species from excessive livestock grazing, it is necessary to evaluate this practice in terms of long-term management objectives. The seasonal monitoring of at least eight different populations or subpopulations should be carried out for at least two successive seasons.

Realizing that such a study may not be feasible in its entirety on any established preserve, it is advisable that some of the Tulare and Kern County ranchers who have appeared "sympathetic" to the species' plight be contacted. It is likely that the effort would meet with approval since small areas of rangeland are needed for such a study. The managers of the Tejon Ranch would likely be helpful in this effort.

Once the areas for such a study were obtained, manipulative research involving exclosures should be conducted over at least two (preferably four) successive seasons. During this time, the timing and duration of grazing as well as grazing intensity should be varied on the eight areas with a control set up at each area. After evaluating the vegetative and reproductive responses at each site and relating these responses to uncontrollable environmental conditions (such as rainfall), a general set of guidelines related to grazing practices could be produced for use on the existing preserves and at other known populations through the species range.

4.0 Conduct study of species restriction to certain adobe clay soils and north-facing slopes related to moisture availability  
(4.11, 4.12, 4.13, 4.14)

Although numerous observations by botanists have established that striped adobe lily appears restricted to certain adobe clay soil types and slope aspects, no comprehensive study has yet been performed to attempt to explain this relationship.

Although an understanding of the species restriction to certain soil types and slope aspects is not critical to initial preserve established and preliminary management guidelines, it is important in the long-term species management process. An understanding of the ecological-physiological relationship will allow for potential reintroduction of the species on sites containing suitable habitat characteristics.

Therefore, it is recommended that the soil studies concentrate on the following areas:

1. The water-holding capacity of the clay soils should be investigated and compared with other clay soils within the geographic range of the species. The physical structure of the clay soils present in the bulb and root zone region of the species should be investigated. This can be accomplished by taking intact core samples from the substrates at known populations at the appropriate depth for analysis.

2. The relationship between topographic site, slope aspect, and soil moisture levels needs to be investigated. This investigation should focus on both the vegetative growth of the plants from the existing bulbs and seed germination and seedling establishment at the different sites.



5.0 Conduct a study of effects of competition on the species  
(5.1, 5.2, 5.3)

One of the threats to many of the known populations of striped adobe lily appears to be competition, primarily from nonnative annual "weedy" species. Although observations by botanists, and information available from CNDDDB and herbaria records, indicate the threat posed by this phenomenon, no quantifiable data exist to adequately assess the threat.

It is recommended that studies be performed at a minimum of four sites from different populations. These studies should first focus on an inventory of the dominant competitive species and the relative abundance and density at each site. After a species inventory is available, controlled experiments should take place to study the effects of the competing species on fecundity, seed germination, seedling establishment, vegetative growth and floral production of striped adobe lily. This could be accomplished by the physical removal of the various competing species on a series of small test plots within the various populations under controlled conditions.

The study should also focus on the uses of timed livestock grazing for removal or suppression of at least some of the competing species at some of the populations. Arrangements with the ranchers involved in the grazing study could incorporate aspects of the competition study also.

The integrated results from this study could provide critical data useful for the long-term management of any established preserves and the future evaluation of habitat quality at the other existing populations.

6.0 Conduct a study of the effects of rainfall amount and patterns on the vegetative growth and reproductive ecology of the species  
(6.1)

In order to correctly interpret the data produced by some of the recommended soil studies, it is important to also study the effect of natural rainfall patterns on the overall vegetative growth and reproduction of striped adobe lily. The nearest available public rainfall records for at least four populations over a period of three seasons should be compared with the data obtained from field inventory analyses of species abundance, density, and reproductive output (fecundity) at the sites. The results should be analyzed for any obvious patterns between rainfall timing and amount over the growing season with increased or decreased growth and reproduction of striped adobe lily. These data will be useful in the management of the established preserves and the analysis of future field observation data from other existing populations on an annual basis. The data obtained from this study should be incorporated with the data obtained from the grazing studies and soil analysis to arrive at a definitive assessment of the overall threat posed by competitive species. Management guidelines may have to be modified in excessively dry years similar to 1987 and 1988.

7.0 Stewardship and management cooperation (7.1 and 7.2)

If all or even some of the recommended studies are performed in the prioritized sequence, a more definitive understanding of the overall habitat requirements of striped adobe lily will be available. By utilizing the data obtained from the studies, the Endangered Plant Project will be able to produce a simplified summary of the management



practices that are known to be favorable to maintaining viable populations of striped adobe lily within its natural range.

An educational pamphlet describing these species management guidelines could be distributed to preserve managers, public agencies, and private landowners concerned with the long-term survival and management of the species.

IMPLEMENTATION SCHEDULE

Table 2. Implementation Schedule for Management Plan (Fritillaria striata)

Goal	Objective	Priority <sup>1</sup>	Time Period	Responsible Party	Estimated Cost
1.0	1.11 Population Inventory Analysis	2	1 week	Contractor	\$2,000
	1.12 Determine Ownership	1	2 days	Contractor	Incl. in above
	1.13 Owner Contact	1	1 week	DFG, TNC	None
	1.14 Estimate Preserve Cost	1	1 week	DFG, TNC	?
	1.15 Establish Preserve	1	None	DFG, TNC	?
	1.21 Owner Outreach	2	None	DFG, TNC	None
	1.22 Preliminary Guidelines	1	None	DFG, TNC	None
	1.23 Notify Public Land Mgrs. (if applic.)	2	None	DFG, TNC	None
	1.24 Remove Immed. Threats	1	None	DFG, TNC	?
	1.31 Preserve(s) Defensibility	1	None	DFG, TNC	?
2.0	2.11 Field Inventories	1	3 weeks	Contractor	\$5,000 <sup>a</sup>
	2.12 Assess New Populations	1	Incl. in above	Contractor	Incl. in above
	2.13 Landowner Permission	1	Incl. in above	Contractor	Incl. in above
3.0	3.11 Grazing, Trampling, Monitoring Study	2	2 weeks for 2 years	Contractor	\$10,000
	3.12 Landowner Cooperation	2	Incl. in above	Contractor	Incl. in above
	3.21 Vary Grazing Duration	2	Incl. in above	Contractor	Incl. in above
	3.22 Vary Grazing Intensity	2	Incl. in above	Contractor	Incl. in above

<sup>a</sup>If performed at same time as field studies recommended for Tulare Pseudobahia.



Table 2 (cont.)

Goal	Objective	Priority <sup>1</sup>	Time Period	Responsible Party	Estimated Cost
4.0	4.11 Soil Water Studies	3	4 weeks	Contractor	\$3,500
	4.12 Site, Slope Aspect Studies	3	2 weeks	Contractor	\$1,500
5.0	5.11 Competition Inventory	2	4 weeks	Contractor	\$8,000
	5.12 Relative Threat Study	2	Incl. in above	Contractor	Incl. in above
	5.13 Reproductive Threat Study	2	Incl. in above	Contractor	Incl. in above
	5.21 Grazing Mgt. Tools	2	1 week	Contractor	\$2,000
6.0	6.11 Rainfall Monitoring	3	1 week for 3 years	Contractor	\$4,000
7.0	7.1 Landowner Stewardship	3	None	DFG	None
	7.2 Educational Pamphlet	3	1	DFG	None

<sup>1</sup>Priority Rating System Explanation

- 1 = An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.
- 2 = An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.
- 3 = All other actions necessary to provide for full recovery of the species.

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