ORIG W/ PHOTOS

TULARE PSEUDOBAHIA SPECIES MANAGEMENT PLAN

Pseudobahia peirsonii Munz.

By

John C. Stebbins
Herbarium Curator
Department of Biology
California State University, Fresno
Fresno, CA 93740

For

Endangered Plant Project
California Department of Fish and Game
1416 Ninth Street
Sacramento, CA 95814

Funded By

California Endangered Species Tax Check - off Program
Contract No. FG - 7573

January 31, 1989

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Tulare pseudobahia (Pseudobahia peirsonii Munz) is a State of California endangered plant species. It is so designated because it is known to exist in only about 20 disjunct population locations in Fresno, Kern, and Tulare Counties. Many of the populations are small fragments of historic occurrences along the eastern side of the southern San Joaquin Valley.

The annual species appears to be restricted to some of the heavy clay (adobe) soils that have been extensively utilized for agricultural development, urbanization, and livestock grazing. Very few "high quality" population sites remain and most are threatened by one or more potential impacts.

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 Tulare pseudobahia.

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 Pseudobahia peirsonii populations.

2. Comprehensive field surveys to assess the remaining populations present within the species range.

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.

5. A study to evaluate the effects of competition from associated nonnative annual 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.

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Tulare pseudobahia (Pseudobahia peirsonii Munz) is officially designated by the State of California as an endangered plant species (York, 1985). It is found in the San Joaquin Valley from northern Kern County to Tulare and southern Fresno counties. The species 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 never common, Pseudobahia peirsonii was once much more widespread than the currently known approximately 20 disjunct populations, many of which are very small and merely fragments of historic occurrences. This plant seems from all available data to be restricted to some of the heavy clay (adobe) soils that are found along the immediate eastern side of the San Joaquin Valley (Twisselman, 1967). Its current extremely restricted distribution is the result of the combined effects of agricultural development, urbanization, competition from nonnative plant species, and heavy grazing. Very few "high quality" population sites remain and most are threatened. The California Department of Fish and Game, Endangered Plant Project has contracted to develop a species management plan for the Tulare pseudobahia. This report summarizes the necessity for and description of a management plan which is designed to improve the general status of the species and ultimately help its recovery.

Taxonomy

Pseudobahia peirsonii (Figure 1) was first described as a species by Dr. P. A. Munz in 1949. The type (Munz #9038, RSA) specimens were collected in March 1925 from "a grassy flat, Ducor, Tulare county" in the company of Frank W. Peirson (Munz, 1949). Prior to this, specimens of the species were included in *P. heermannii* (Durand) Rydb. or *Monolopia heermannii* (Durand) or *Eriophyllum heermannii* (Durand) Green (Asteraceae), depending on the generic position given that species.

Within the genus, *Pseudobahia peirsonii* is relatively distinct on a morphological basis (see Table 1). *P. heermannii* is a fairly common inhabitant of the Sierran foothills from Butte to Kern County and the Santa Lucia Mountains in Monterey County (Johnson, 1978). *P. bahiaefolia* is a very rare species restricted to the natural low terraces on the eastern side of the central valley from southern Stanislaus County to northern Fresno County. The only known species range overlapping occurs at one site in Tulare County where populations of *P. peirsonii* and *P. heermannii* are sympatric (R. Hansen, pers. comm., 1988).

Table 1. Key to the Species of the Genus *Pseudobahia* (Asteraceae) (Adapted from Munz, 1968, and Abrams, 1951).

Three spp., all in California (Pseudo "False" and Bahia "another genus in the Helenieae Tribe")

Leaves entire (in small plants) or 3-lobed . . *P. bahiaefolia*
Leaves 1-2 pinnatifid.
  Involucres 4-5 mm high; phyllaries united half their length, often with callous processes at their sinuses; leaves 1-2 cm long, mostly pinnatifid . . . . . *P. heermannii*
  Involucres 6-9 mm high; phyllaries free to base, without callous processes; leaves 2-6 cm long, mostly bipinnatifid . . . . . *P. peirsonii*

Figure 1-1. Tulare Pseudobahia (Pseudobahia peirsonii). Photo taken at Highway 180 population, Fresno County.

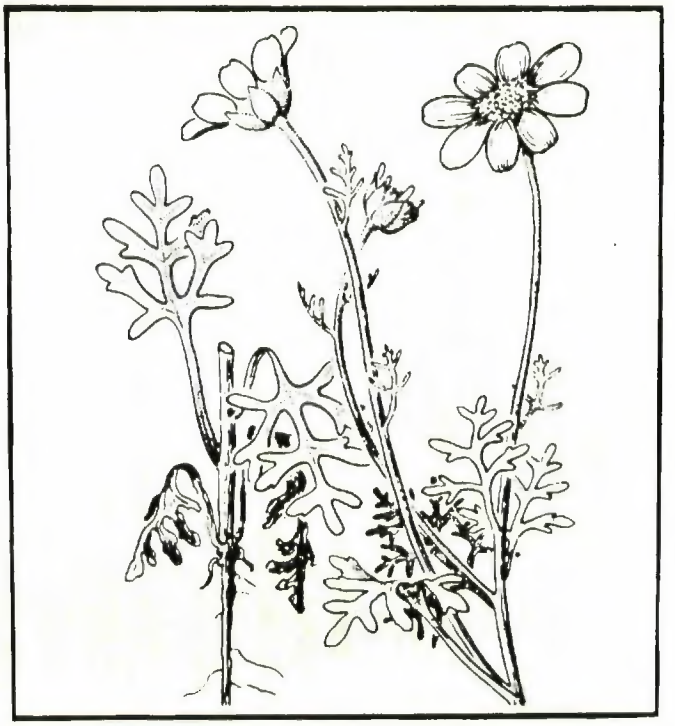

Figure 1-2. Tulare pseudobahia (Pseudobahia peirsonii) (From Abrams, 1951)

Technical Description

Tulare pseudobahia is an erect, somewhat woolly annual 1-6 dm (7.5) high when flowering. The stems are 1.5-4.0 mm thick, mostly divaricately branched above the base, the branches green to somewhat reddish. The internodes are 1-4 cm long; leaves alternate, triangular ovate in outline, gradually reduced up the stem. The petioles are 0.5-4.0 cm long and somewhat flattened. The blades are mostly 1.0-3.5 cm long and almost as wide, grayish-tomentose or floccose, although sometimes glabrate above. Although sometimes pinnatifid in depauperate specimens, the blades are usually bipinnatifid into linear-oblong obtuse segments 1-5 mm wide. The peduncles, which are solitary at the ends of the branches, are tomentose and 2-10 cm long. The hemispheric involucres are 6-9 mm high, tomentose and without narrow callosities on the back of the phyllaries. Phyllaries about 8 in 1 series, lance-ovate and free essentially to the base. Ray-flowers pistillate, fertile generally 8, the tube about 2 mm long, somewhat glandular puberulent, the ligules 5-12 mm long, almost as wide, yellow, broadly ovate, margin entire or with notch at tip. The many disk-flowers are orange-yellow, about 3 mm long, perfect, with a prominently hairy slender corolla tube. The achenes are black, about 3 mm long, glabrous or with a few appressed hairs, oblanceolate in outline, somewhat obcompressed. The pappus none or sometimes corona-like on the disk achenes. Flowering period: March-April.

Habitat, Life History, and Ecological Relationships

Tulare pseudobahia is apparently an edaphically restricted forb. Virtually all of the known extinct and extant populations occur on

heavy adobe clay soils. The species is most often associated with Porterville clay but it has also been found on Academy clay, Centerville clay, Cibo clay, Mt. Olive clay, and other minor clay soil series (Taylor and Stebbins, 1988). The physiological-ecological basis for this natural restriction to heavy clay soils is not known. It is known that the species can be cultivated successfully on nonclay soils in the artificial growing regime of a greenhouse as long as basic nutritional needs are met (Johnson, 1978). This information leads the author of this report in collaboration with Shevock (pers. comm., 1988) and Taylor (pers. comm., 1988) to speculate that the edaphic restriction is possibly at least partially related to the water penetration and retention properties associated with these heavy clay soils (refer to Appendix A). Perhaps seed germination in nature can occur only above a certain moisture threshold and these unique soils retain this moisture level longer in an area where the average annual precipitation is less than 10 inches.

Tulare pseudobahia occurs on the gentle slopes and flats that are found on the "saddles" between the low hills within its range in the San Joaquin Valley. The vegetation community associated with the species is best described as nonnative grassland (Holland, 1986). This species does occur near the edge of the foothill woodland in the southern portion of its range in Kern County where the heavy clay soils are present. The species found in association with Pseudobahia peirsonii vary from a sparse cover of annual grasses (Avena spp., Bromus spp., Vulpia spp.) and showy "wildflower" forbs like owls clover (Orthocarpus purpurascens) and blow-wives (Achyrachaena mollis) on the highest quality sites to the extremely competitive "weedy" species such as star

thistle (Centaurea spp.), mustard (Brassica spp.), and milk thistle (Silybum marianum) on the highly disturbed, overgrazed poorest quality sites.

Although detailed reproductive and developmental studies are needed for accurate documentation, observations made by the author and the relatively few other botanists familiar with the species (D. Johnson, D. Taylor, J. Shevock, D. Martin, pers. comm., 1988) have verified the presence of young seedlings in the late fall (November), usually about 2 weeks after a significant rainfall. These observations also have documented the extreme cyclical growth fluctuations both in population numbers and plant size from season to season. These cyclical growth fluctuations appear to be closely correlated both with rainfall and competition from nonnative plant associates.

The species slowly grows in a vegetative state over the cold wet winter months of December, January, and February. The growth pattern then changes to a reproductive effort in late February and early March with the full spring flowering period occurring from approximately mid-March through late April. The timing of the flowering period can vary significantly with the annual rainfall. In particular, the end of the flowering period is greatly accelerated in excessively dry years.

Population Numbers and Distribution

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

1. The most recent element occurrence records of the California Natural Diversity Data Base (CNDDB) 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 Pseudobahia peirsonii within the past 3 years.

To date, 28 populations of P. peirsonii have been reported, and most have been inventoried by the author of this report. Occurrence elevations range from a low of 300 ft (91 m) at Tulare in Tulare County to 2600 ft (792 m) at Long Tom Gulch in Kern County. Of these 28 populations, 10 are known or assumed to be extirpated, due to a variety of impacts. Of the 18 remaining populations (including two whose exact locations are unknown), it is roughly estimated that approximately 12,000 individual plants existed as of April 1988. Certainly this is a very low number for an annual species that exists nowhere else in the world. Obviously, however, an accurate estimate of the numbers of individuals can only be made after a series of inventories over several years. For a detailed summary of the known population and distribution data currently available, refer to Table 2 and Figures 2, 3, 4, and 5.

Table 2. Summary of Population and Distribution Data for Tulare pseudobahia (Pseudobahia peirsonii)

Location/Site	CNDDB Occ. No.	County of Occ.	T.R.S.	Elevation ft (m)	No. of Individuals[1]	Last Field Visit	Site Quality[2]	Viability/ Defensibility	Ownership	Status/Use	Comments
Adobe Cnyn., 3.5 Mi. SSE of granite Stn.	1	Kern	T27S,R29E,S22	1800 (549)	50	1981	Good	Excellent	Private	Unprotected, ranching	High quality habitat
0.25 Mi. N of Long Tom Gulch	2	Kern	T27S,R29E,S24	2400 (731)	40	1963	Good	Good	Private	Unprotected, ranching	Not seen recently
Near Woody	3	Kern	T25S,R29E,S34	1700 (518)	?	1974	?	?	Private	Unprotected, agriculture	Exact location unknown
9.5 Mi. W of woody on Hwy 155	4	Kern	T25S,R28E,S21	720 (219)	300	1982	Poor	Poor	Private	Unprotected, agriculture	Probably extirpated
0.8 Mi. N of Kern Co. line on Hwy 65	5	Tul	T24S,R27E,S34	550 (167)	?	1974	Poor	Poor	Private	Agriculture, citrus	Extirpated
Vestal Substation, 3 Mi. NE of Richgrove	6	Tul	T24S,R27E,S17	500 (152)	?	1980	Poor	Poor	Private	Agriculture, citrus	2 pops. Extirpated
Ducor, along Rd. to Terra Bella	7	Tul	T23S,R27E,S15	525 (160)	?	1974	Poor	Poor	Private	Agriculture	Type locality, Extirpated
4 Mi. SE of Porterville	8	Tul	T23S,R28E,S21	540 (164)	?	1985	Poor	Poor	Private	Agriculture	Extirpated
6 Mi. E of Porterville	9	Tul	T21S,R28E,S26	600 (183)	?	1952	Poor	Poor	Army Corps?	Reservoir	Extirpated
L. Success Dam, 0.35 Mi. below spillway	10	Tul	T21S,R28E,S34	700 (213)	100	1985	Fair	Fair	Private	Unprotected, grazing	Marginal population
Tulare	11	Tul	T20S,R24E,S11	300 (91)	?	1897	Poor	Poor	Private	Urban agriculture	Extirpated
Exeter	12	Tul	T27S,R27E,S7	1200 (366)	?	1986	Fair?	Fair?	Private	Agriculture, ranching	Exact location unknown
Dinuba	13	Tul	T16S,R24E,S17	330 (106)	?	1927	Poor	Poor	Private	Agriculture, urban	Extirpated
Hwy. 180 between J. Morrow & Campbell Mtn.	14	Fre	T14S,R23E,S14	440 (134)	500	1988	Fair/ Good	Good (in pt.)	Private	Unprotected, grazing	Uncooperative landowner
Academy, 0.5 Mi. S of Jct Shepherd Ave.	15	Fre	T12S,R22E,S27	475 (145)	300	1985	Poor	Poor	Private	Unprotected, agriculture	Probably extirpated
Round Mtn. 0.5 Mi. E of Friant-Kern Canal	16	Fre	T13S,R22E,S12	475 (145)	1200	1988	Excellent	Excellent	Private	Unprotected, grazing	High quality habitat

[1] Based upon CNDDB records, herbaria records, field survey forms, and personal communication.

[2] Based upon site visits by the author and others and CNDDB records.

Table 2 (cont.)

Location/Site	CNDDB Occ. No.	County of Occ.	T.R.S.	Elevation ft (m)	No. of Individuals[1]	Last Field Visit	Site Quality[2]	Viability/ Defensibility	Ownership	Status/Use	Comments
5 Mi. E of Ducor	17	Tul	T23S,R28E,S28	700 (213)	?	1986	Fair/Poor	Fair	Private	Unprotected, part. agric.	Mostly agriculture
Pyramid Hill, .25 Mi. W Rancheria Rd.	18	Kern	T28S,R29E,S14	1960 (597)	1000	1986	Excellent	Excellent	Private	Unprotected, ranching	Ensemble, *F. striata*
0.9 Mi. N of L. Success spillway	19	Tul	T21S,R28E,S26	700 (213)	30	1986	Fair	Fair	Private	Unprotected, overgrazing	Near occ. #10
Base of Rocky Hill, N. of L. Success	20	Tul	T21S,R28E,S26	720 (219)	200	1988	Fair	Fair	Army Corps	Unprotected, recreation	Near occ. #19
L. Success, S. Fk. Arm Tule River	21	Tul	T21S,R29E,S30	700 (213)	30	1988	Fair/Poor	Poor	Army Corps	Unprotected, recreation	Extirpated
Rancheria Rd., 6.2 Mi. N of Hwy 178	22	Kern	T28S,R29E,S23	1600 (488)	40	1986	Good	Excellent	Private	Unprotected, ranching	Near occ. #18
Edison T/L, 0.7 Mi. S of Fountain Springs	23	Tul	T23S,R28E,S35	860 (262)	3000	1986	Good	Good	Private	Unprotected, grazing	Near occ. #24, 17
Edison T/L, 0.4 Mi. N of Fountain Springs	24	Tul	T23S,R28E,S26	830 (253)	500	1986	Good	Good	Private	Unprotected, grazing	Near occ. #23,17
Rag Gulch, NW of Hwy 155	25	Kern	T25S,R28E,S36	900 (275)	200	1986	Good	Good	Private	Unprotected, grazing	New loc. in 86
NE of Round Mtn.	--	Fre	T13S,R23E,S6	520 (158)	50	1987	Good	Good	Private	Unprotected, grazing	Near occ. #16
NE of Porterville, W of Rd. 226	--	Tul	T21S,R28E,S8, 17	800 (244)	5000	1988	Good	Good	Private	Unprotected, grazing	New loc. in 88
Lewis Hill, NE of Porterville	--	Tul	T21S,R27E,S12, 13	650 (198)	370	1988	Fair	Good	Private	Unprotected, grazing	New loc. in 88

[1]Based upon CNDDB records, herbaria records, field survey forms and personal communication.

[2]Based upon site visits by the author and others and CNDDB records.

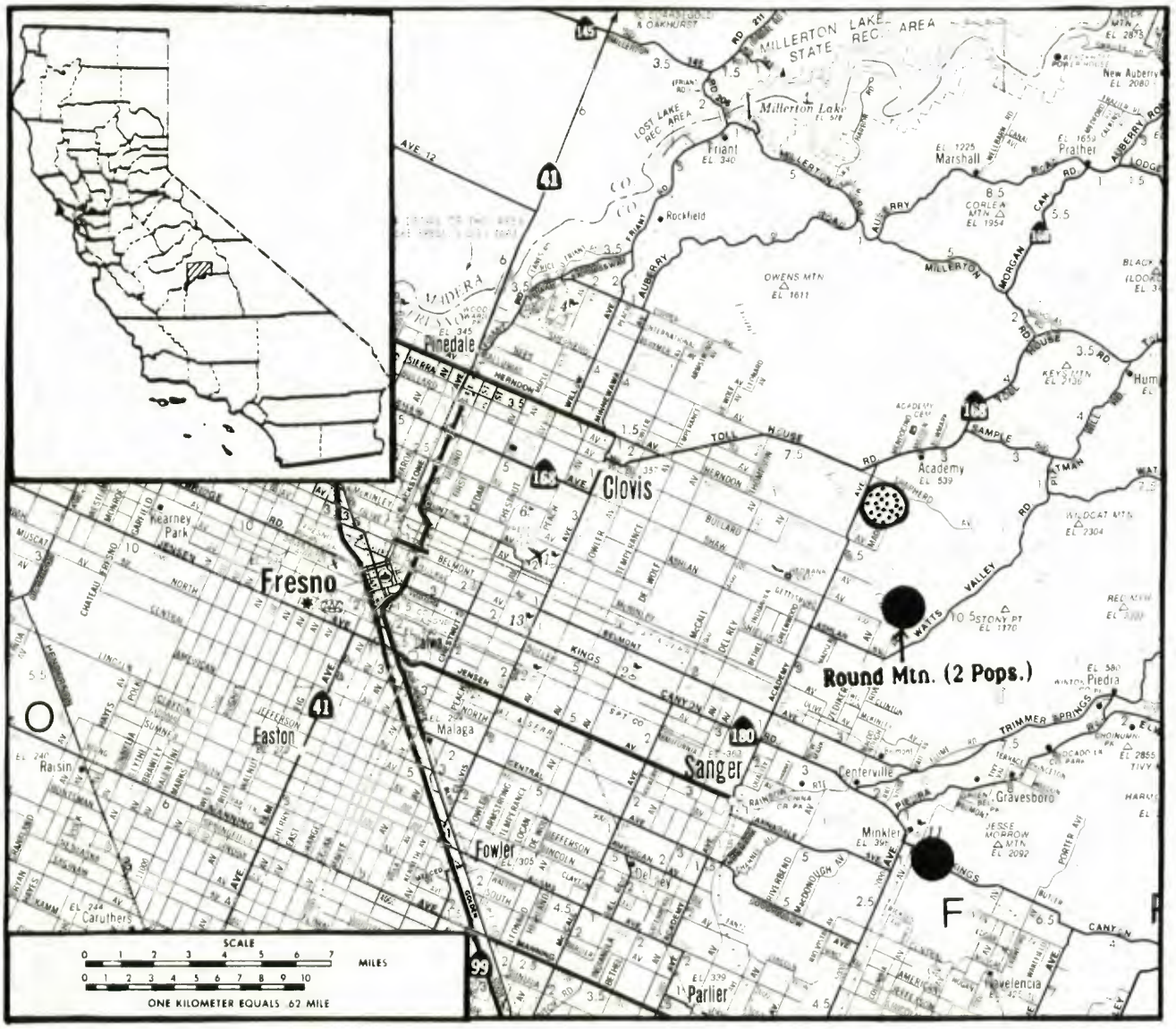

Figure 2. Known Population Sites of Tulare pseudobahia (Pseudobahia peirsonii) in Fresno County
Extant Population as of 4-88
Extirpated Population

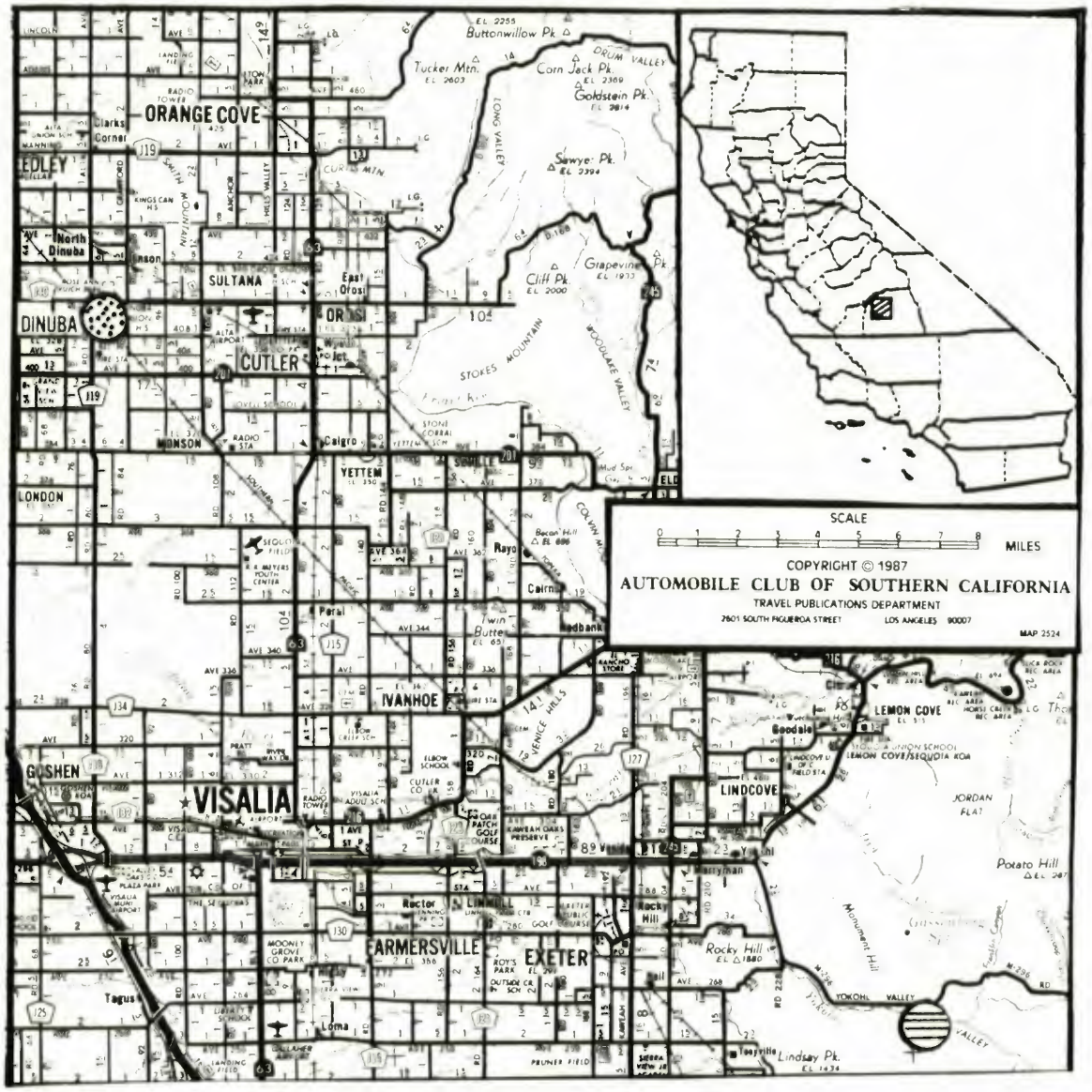

Figure 3. Known Population Sites of Tulare pseudobahia (Pseudobahia peirsonii) in northern Tulare County

Extirpated Population

Exact population location unknown

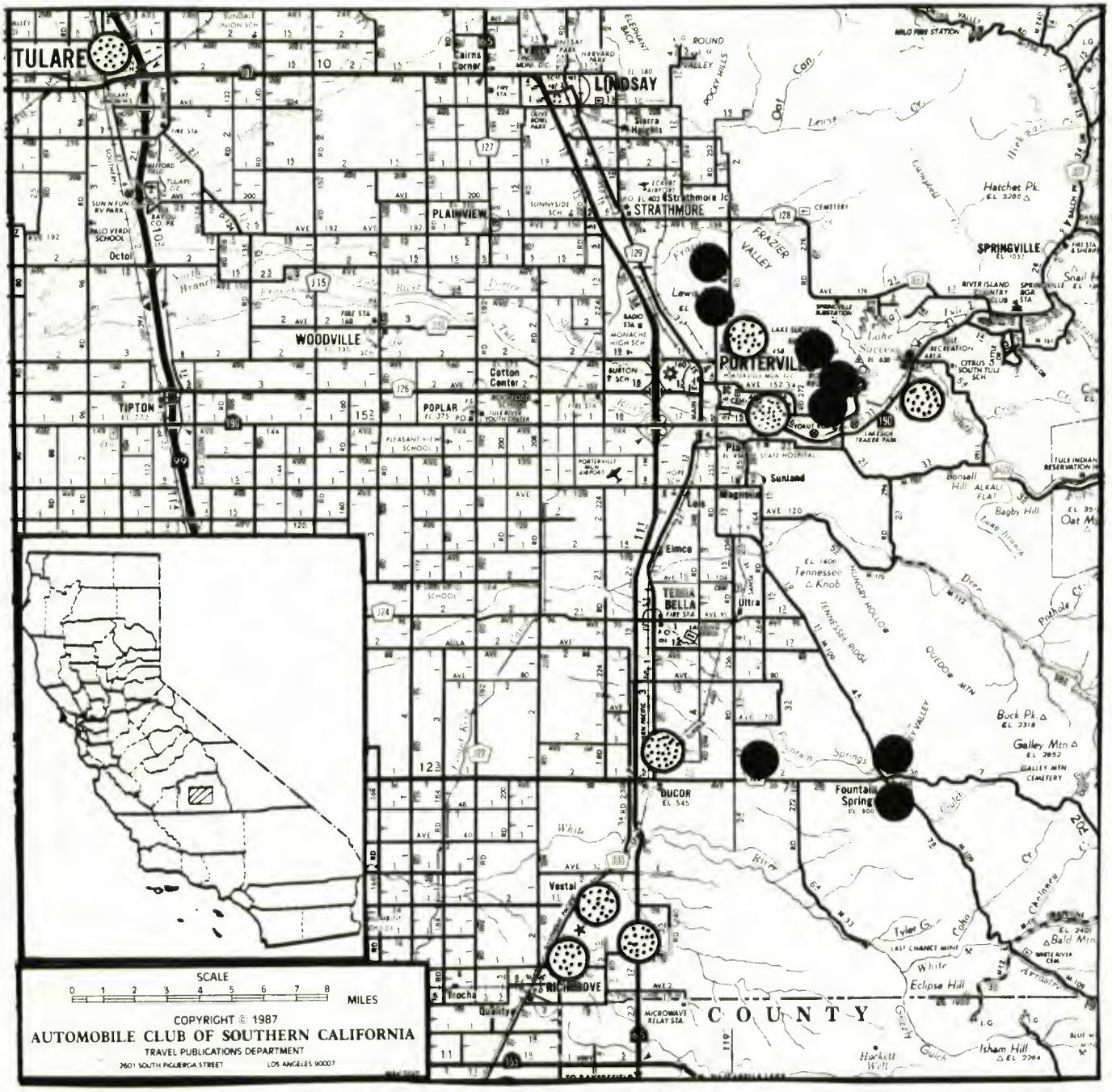

Figure 4. Known Population Sites of Tulare pseudobahia (Pseudobahia peirsonii) in southern Tulare County

Extant Population as of 4-88 ●

Extirpated Population ◉

Two nearby extirpated populations (CNDDB #6) ★

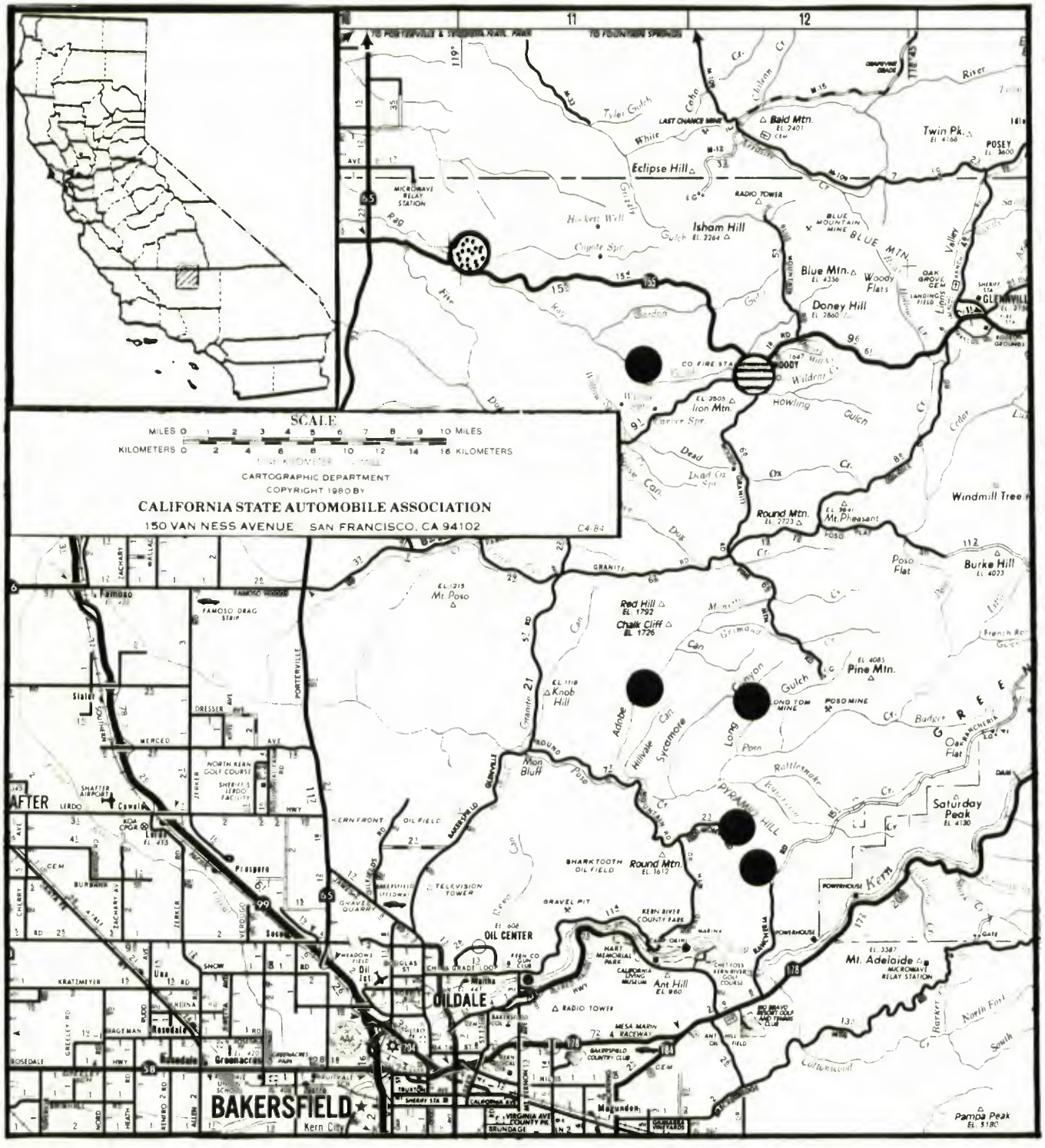

Figure 5. Known Population Sites of Tulare pseudobahia (Pseudobahia peirsonii) in Kern County

Extant Population as of 4-88 ●

Extirpated Populations ◌

Exact population location unknown ▨

Endangerment Factors

Although the size and habitat quality characteristics of known Pseudobahia peirsonii populations vary considerably throughout its range, the actual status of the species has gradually changed from rare to endangered since its original description 39 years ago. All available evidence supports the R-E-D status code of 2-3-3 given to the species by the California Native Plant Society (Smith and Berg, 1988).[1]

The species is endangered in a regional sense by many cumulative impacts, and, in a local sense, when it is compared to most other associated species, it is either threatened or being adversely impacted in some way in every known population.

The most obvious impact that has resulted in direct and irreversible population extirpation is agricultural land conversions (Figure 6). At least eight of the historic population occurrences including the type locality have been lost due to agriculture. The heavy clay soils preferred by the species are often found in the small valleys and flats between the lowest foothills on the east side of the southern San Joaquin Valley. These areas also are considered excellent sites for growing citrus, grapes, and other crops. Many of the known extant populations are currently threatened by adjacent agricultural operations, either directly or indirectly.

---

[1]CNPS status code translation
R-2 = Occurrence limited to one extended population or confined to several populations.
E-3 = Endangered throughout its range.
D-3 = Endemic to California.

Virtually all of the known extant populations of Tulare pseudobahia are being impacted by various degrees of livestock grazing. It is common practice to graze virtually all accessible rangeland that is not agriculturally developed within the region occupied by the species. As a result, some population sites are essentially "cattle pastures" (Figure 7). Here the grazing pressures are so severe that many native species (including Tulare pseudobahia) have been substantially reduced and replaced by nonnative species.

It is, however, significant to note that several botanists (including the author of this report) that are familiar with the species feel that a moderate grazing regime during the growing season is probably beneficial and indeed necessary to reduce the competing nonnative annual flora. Observations made at some of the highest quality populations including the Round Mountain population in Fresno County and the Adobe Canyon population in Kern County support this hypothesis. Unfortunately, most of the known extant populations are so excessively overgrazed that further comparative data are not available.

The threat of competition from nonnative "weedy" species is very real and it is accelerated by a myriad of activities. Periodic discing or plowing, herbicide use, off-road and ranch vehicle use, fire and soil extraction for clay sealants all contribute to land surface disturbance that greatly increases the establishment of nonnative flora. Indeed, the nonnative floristic component is virtually ubiquitous in the valley grassland habitat. Some of the most common nonnative taxa such as Bromus rubens, B. mollis, Erodium spp., and Hordeum spp. are not particularly a threat, especially if light to moderate grazing is present. The major threat to the species from competition appears

Figure 6. Example of agricultural land conversion of Tulare pseudobahia habitat. Photograph taken on slopes of Lewis Hill northeast of Porterville, Tulare county.

Figure 7. Example of excessive livestock grazing of Tulare pseudobahia habitat at Highway 180, Fresno County population

to be the exceedingly aggressive weedy taxa like Avena spp., Brassica spp., Sisymbrium spp., Silybum marianum, Melilotus spp., and Rumex crispus (Figure 8). All of these taxa prefer highly disturbed sites and have rapid vegetative growth habits. These taller plants invade a disturbed site and create an extremely dense patch, thus outcompeting the Pseudobahia peirsonii plants that previously occurred in the same areas. It has been observed that the few plants that do survive under these adverse conditions produce significantly fewer flowers and exhibit somewhat etiolated, weak growth forms. Obviously, a significant decline in population size and numbers has occurred from this described scenario at the Highway 180 population in Fresno County and the Lake Success population in Tulare County.

Other factors that pose threats to the species include the rapid urban expansion of the Porterville, Delano, and Exeter environs in Tulare county. Much of this urban expansion is actually in the form of "mini-ranchettes" or "weekend farms" but the cumulative threat to the remaining habitat is nevertheless similar to the larger scale threats previously mentioned. Many of the San Joaquin Valley cities are actively encouraging residential development on the east edge of the valley in an attempt to keep the "prime flatlands" in agriculture.

In addition, other threats include potential road widening and stabilization projects at several population sites. The clay soils at these sites become very unstable during the wet months and the California Department of Transportation is directly involved in evaluating various stabilization alternatives (D. Martin, pers. comm., 1988). Furthermore, recreational activities associated with the use of Lake Success in Tulare County threaten the remaining

Figure 8. Examples of aggressive competition from nonnative species. Tulare pseudobahia (lower photo) at Highway 180 population. Note competing milk thistle (Silybum marianum) and mustard (Brassica kaber). Also note encroaching agriculture in background of upper photo.

populations present. The Army Corps of Engineers and the California Department of Water Resources are currently studying a plan to raise the level of Lake Success (J. Lacey, pers. comm., 1988). If this action were taken, these remaining populations could be further impacted or even extirpated.

Conservation Efforts

Up to the present time, there have been no organized conservation management activities or programs to either preserve specific populations or improve the existing habitat of the Tulare pseudobahia. All of the current known populations except two are on unprotected private lands. Although a few landowners in Tulare County are somewhat sympathetic to the plight of the species, they have not yet entered into any agreements with any conservation groups or government agencies to actually protect the existing populations and habitat present on their land (R. Hansen, 1988). The Nature Conservancy is actively pursuing the potential of a conservation agreement to protect the high quality habitat and existing population present at Round Mountain in Fresno County but no response from the owner has been obtained yet (L. Lozier, pers. comm., 1988).

Further impacts to the Highway 180 population in Fresno County from a proposed clay extraction project were thwarted in 1988 through the intervention of Caltrans biologists in cooperation with environmental services personnel from Region 4 of the California Department of Fish and Game. This was accomplished in spite of the landowners' threat to bulldoze the population in an effort to allow the extraction project to proceed!

The only populations of Tulare pseudobahia known to be present on public land are those near Lake Success in Tulare County. In spite of easily obtainable species information (York, 1985) and the public records compiled by the CNDDB, the Army Corps of Engineers personnel at Lake Success stated to visiting field biologists recently that "no rare plants occur on their lands" (J. Lacey, pers. comm., 1988). These populations thus are obviously not being managed and are, in fact, subject to severe impacts associated with the recreational use of the lake.

Some of the populations are currently somewhat "unofficially protected" by either their remote 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 (refer to Table 2 for specific sites).

Research and Information Needs

Several research and information needs exist, the lack of which will hinder any future long-term management efforts to proect the Tulare pseudobahia. First and foremost is a research need to completely survey and inventory the remaining areas of potential natural habitat that still exist within the historic range of the species. In particular, the portion of the range in southern Tulare and northern Kern Counties must be surveyed by competent botanical personnel to determine the total population occurrences and associated habitat quality that exists for the species (refer to Figures 4 and 5 for range data). It is speculated by the author, and those few individuals familiar with the species, that at least some significant populations

of the Tulare psuedobahia await discovery. These populations have yet to be documented for a variety of reasons, mainly due to inadequate financial support for travel and research efforts and due to the difficulties involved in performing field surveys on private lands. It is imperative to have fairly complete population occurrence and habitat quality data to prioritize any future habitat acquisition or species conservation efforts.

Secondly, it is necessary to monitor and evaluate the effects of livestock grazing at one or more of the known populations. The timing, duration, and intensity of grazing has to be evaluated for both positive and negative impacts to the species. Obviously, this type of research requires a multi-year approach and an adequate control group to generate reliable data that can be utilized in a long-term management plan.

Thirdly, the apparent restriction of Pseudobahia peirsonii to specific adobe clay soils requires research. Preliminary speculation based upon field observations and initial soil analyses (Appendix A) indicate that the water retention abilities of these rather uncommon soil types may be a critical factor. Nutrient availability may also be a factor. This potential edaphic/biotic relationship requires further investigation and comparison with data from the other soil types that exist within the range of the species.

Fourthly, it is necessary to study and evaluate the effects of competition. Most importantly, the effects of competition from nonnative introduced annuals on the ability of Pseudobahia peirsonii to survive at known localities. This information needs to be developed in conjunction with the data obtained from an analysis

of the effects of livestock grazing. Obviously, the fundamental ecological interrelationship that exists between these two impacts needs to be jointly evaluated.

The last research need is the need to understand the effect of rainfall amount and pattern on the species reproductive ecology. It has been observed that the timing and duration of rainfall appears to be a critical factor in determining the floral production and seed set for a particular season. Information from this level of research could then be analyzed in the context of the known edaphic properties present at a given population and tentative conclusions reached. Long-term monitoring of several populations would be necessary to reinforce or alter the conclusions.

Finally, it is necessary to somehow encourage those individuals who have observed the species to contribute their data to a central repository. Several ranchers and local inhabitants that have observed the Tulare pseudobahia 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 Tulare pseudobahia populations and help in the ultimate recovery of the species. It is obvious from the data presented in the introduction that the species has been extirpated at many historic locations and most of the known remaining extant populations are declining. A management plan tailored to insure the long-term survival and viability of Tulare pseudobahia is needed to guide the agencies and organizations 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 were 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 were:

1. To immediately preserve the habitat of one or more populations of Pseudobahia peirsonii 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 Pseudobahia peirsonii.

3. To conduct a study to learn the effects of livestock grazing on populations of P. peirsonii.

4. To conduct a study to obtain data related to the species' apparent ecological-physiological restriction to certain adobe clay soils.

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 Pseudobahia peirsonii populations.

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

1.2 Protection Objectives
- 1.21 Establish preserve through easement or purchase.
- 1.22 Owner education and outreach.
- 1.23 Preliminary guidelines for species management.
- 1.24 Notification of public land managers.
- 1.25 Removal of obvious direct threats from established preserve.

1.3 Manipulation Objectives
- 1.31 Insure defensability 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 Pseudobahia peirsonii

2.1 Assessment Objectives
- 2.11 Contract field searches of remaining areas of suitable habitat by competent botanical personnel at appropriate season.
- 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 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 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 lang managers.

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

4.1 Assessment Objectives
- 4.11 Investigate the water holding capacity and related nutrient availability levels of clay soils at known populations compared to other soils within geographic range.
- 4.12 Investigate the relationship between pH and nutrient availability at known populations compared to other clay soils within geographic range.
- 4.13 Investigate the relationship between the physical structural characteristics at known populations compared to other soils within the geographic range.

4.14 Investigate the friability of the surface soil layer at known populations as it relates to seed germination. Compare this to similar data obtained from other soils within the geographic range.

4.2 Manipulation Objectives

4.21 Attempt controlled seed germination lab tests on varied clay soil types. Relate to field data.

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 reproductive ecology of Tulare pseudobahia.

5.2 Manipulation Objectives

5.21 Investigate the use of mechanical removal of extremely aggressive competing species. Obtain Caltrans assistance on roadside populations.

5.22 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 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.

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 Produce educational pamphlet describing species management guidelines.

Narrative

1.0 Establish a preserve of one or more Pseudobahia peirsonii populations.

Because of the overall status of the species and the imminent threat of extirpation at several known population sites, it is

important that at least one population be protected immediately. Virtually all known populations on private lands and the two subpopulations on public lands are vulnerable to varying degrees of habitat degradation. Enough information currently exists to recommend that serious efforts be made to directly acquire or otherwise protect at least one and preferably two separate populations. The Round Mountain population (CNDDB #16) in Fresno County and the Pyramid Hill population (CNDDB #18) are the recommended sites based upon current data (refer to Table 2 for specific site quality comparisons).

1.1 Assessment Objectives

1.11 Use existing population data.

Existing population data should be used should the protection of 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. 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).

1.12 Determine ownership boundaries.

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

1.13 Contact landowners of preferred parcels containing desired populations.

This task can probably be accomplished more successfully by nongovernment personnel such as the Nature Conservancy staff which have already expressed interest in the effort (L. Lozier, pers. comm., 1988).

Many of the known populations occur on ranches that are often owned and operated by individuals who are not too receptive to government "interference."

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 explore funding sources, both public and private.

1.2 Protection Objectives

1.21 Establish preserve.

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.

1.22, 1.23 Owner education and outreach, preliminary 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.

124. Public land manager notification.

The managers of any public lands that contain known populations of Tulare pseudobahia 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.

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

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

1.3 Manipulation Objectives

1.31 Insure defensability 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 soils, competition, 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 Pseudobahia peirsonii

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 P. peirsonii 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 surveys should be targeted by reviewing all available published soil distribution data and

concentrating the field searches in those areas of natural habitat within the range with the proper adobe clay soils.

Any newly discovered populations should be assessed in terms of habitat quality and defensability by completing CNDDB field survey forms and transmitted to CDF&G.

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

2.2 Protection Objectives

The additional data obtained from the surveys could be used for subsequent preserve acquisition or species protection. If new populations were discovered on government lands, the appropriate agencies administering such lands could be notified of their obligations under the endangered species 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, 3.3)

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

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.

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, a general set of guidelines related to grazing practices could be produced for use on the existing preserves and at other known populations.

The data obtained could be used in managing the established preserves to further protect the species.

4.0 Conduct study of species restriction to certain adobe clay soils (4.11, 4.12, 4.13, 4.14)

Although numerous observations by botanists have established that the Tulare pseudobahia appears restricted to certain adobe clay soil types in nature, no comprehensive study has yet been performed to attempt to explain this relationship. Preliminary research performed at the California State University Soil Sciences laboratory indicates that the species restriction to particular substrate types is possibly a combination of a narrow pH range and water holding capacity (refer to Appendix A).

Although an understanding of the species restriction to certain soil types is not critical to initial preserve establishment 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 potential relationship between the relatively low pH readings of 5.1 to 5.8 and nutrient availability and/or toxicity should be investigated.

2. The water holding capacity of the clay soils should be investigated.

3. The physical structure of the clay soils present in the 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.

4. The potential relationship between the surface friability of these soils and seed germination should be investigated. This should be performed in a laboratory under controlled conditions.

All of these areas should be investigated on a comparative basis with other clay soils from the immediate vicinities of known species populations. By doing this, an optimal soil habitat index can be prepared that will at least partially explain the species distribution related to certain soil types (D. Bacon, pers. comm., 1988).

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

One of the major threats to many of the known populations of the Tulare pseudobahia appears to be competition, primarily from nonnative annual "weedy" species. Although observations by botanists and information available from CNDDB 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 seed germination, seeding establishment, vegetative growth and floral production of the Tulare pseudobahia. This could be accomplished by the physical removal of the various competing species on a series of small test plots within the various populations and augmented by laboratory plantings under controlled conditions. The resulting data could be used in effectively managing any established preserves or private lands protected through conservation easements.

The study should also focus on the uses of grazing and mechanical removal 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. Caltrans would likely assist in the study of the effects of mechanical "mowing" or biological control of milk thistle on a portion of the Highway 180 population in Fresno County.

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 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 growth and reproduction of the Tulare pseudobahia. 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 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 Tulare pseudobahia. 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 to arrive at a definitive assessment of the overall threat posed by competitive species.

7.0 Stewardship and management cooperation (7.1 and 7.2)

If all or even some of the recommended studies are performed, a more definitive understanding of the overall habitat requirements of Tulare psuedobahia 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 favorable to maintaining viable populations of Tulare pseudobahia.

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 3. Implementation Schedule for Management Plan

Goal	Objective	Priority[1]	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.	2	None	DFG, TNC	None
	1.24 Remove Immed. Threats	1	None	DFG, TNC	?
	1.31 Preserve(s) Defensability	1	None	DFG, TNC	?
2.0	2.11 Field Inventories	1	3 weeks	Contractor	$8,500
	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 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

Table 3 (cont.)

Goal	Objective	Priority[1]	Time Period	Responsible Party	Estimated Cost
4.0	4.11 Soil Water Studies	3	6 weeks	Contractor	$5,000
	4.12 Soil pH Studies	3	Incl. in above	Contractor	Incl. in above
	4.13 Soil Structure Studies	3	Incl. in above	Contractor	Incl. in above
	4.14 Soil Friability Studies	3	Incl. in above	Contractor	Incl. in above
	4.21 Germination Tests	3	Incl. in above	Contractor	Incl. in above
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 Mechanical Removal	3	2 days	Cal-Trans	None
	5.22 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

[1]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.

REFERENCES CITED

Abrams, L. 1951. Illustratred Flora of the Pacific States. Vols. 1-4. Stanford University Press, Stanford, California.

Bacon, D. F. 1988. Personal communication, 9/6/88. Soils Technician, Department of Plant Science. California State University, Fresno. Fresno, California.

Hansen, R. 1988. Native Species Field Survey Form, submitted to California Natural Diversity Data Base for field work performed on 4/9/88.

Hansen, R. 1988. Personal communication, 8/28/88 and 9/5/88. Nature Conservancy Preserve Manager. Visalia, California.

Holland, R. F. 1986. Preliminary descriptions of the terrestrial natural communities of California. California Department of Fish and Game, Nongame Heritage Program. Sacramento, California.

Jarvinen, O. 1982. Conservation of endangered plant populations. Oikos 38:301-307.

Johnson, D. 1978. Systematics of the Eriophyllinae. Unpublished PhD dissertation. Department of Botany, University of California at Berkeley. Berkeley, California.

Lacey, J. 1988. Personal communication, telephone conversation, 9/9/88. Biologist, Department of Water Resources. Red Bluff, California.

Lozier, L. 1988. Personal communication, telephone conversation, 8/26/88. Landowner contact coordinator, The Nature Conservancy. San Francisco, California.

Martin, D. 1988. Personal communication, 8/4/88. Biologist, Cal-Trans. Fresno, California.

Munz, P. A. 1949. California Miscellany. Aliso 2:84. (orig. descrip.)

Munz, P. A., & D. D. Keck. 1968. A California Flora and Supplement. U.C. Press, Berkeley, California.

Reznicek, A. A. 1987. Are Small Reserves Worthwhile for Plants? Endangered Species Update, Vol.5, No. 2. School of Natural Resources, University of Michigan, Ann Arbor, Michigan.

Shevock, J. R. 1988. Personal communication, letter questionnaire dated 6/3/88 and telephone conversation 6/10/88. Botanist, U.S. Forest Service. San Francisco, California.

Smith, J. P., & K. Berg. 1988. Inventory of rare and endangered vascular plants of California. CNPS Spec. Pub. #1, 4th edition. California Native Plant Society, Berkeley, CA.

Taylor, D. W. 1988. Personal communication, telephone conversation, 9/9/88. Botanist, Biosystems Analysis, Inc. Santz Cruz, California.

Taylor, D. W., & J. Stebbins. 1988. Flora of the San Joaquin Valley: Endemism and Endangerment Status. Proceedings of the Conference on Endangered and Sensitive Species of the San Joaquin Valley, Bakersfield, California, 12/10/87 (in press).

Twisselman, E. C. 1967. A Flora of Kern County, California. University of San Francisco, San Francisco, California.

U.S. Fish and Wildlife Service. 1985. Endangered and threatened wildlife and plants: Status review of plant taxa for listing. Federal Register 50:188 39526-7.

York, R. 1985. California Native Plant Status Report: Pseudobahia peirsonii. Unpubl. document prepared by the California Native Plant Society. Sacramento, California.

Zaninovich, J. 1988. Personal communication, telephone conversation, 8/22/88. Rancher, botanist, Tulare County, California.

APPENDIX A

Appendix A - Soil Analysis Data

Percentage Moisture of selected soil types
from Pseudobahia peirsonii population sites

Moisture release at 0.45 atmospheres of pressure as
applied on a pressure plate

Soil Type	Population Site	% Moisture by Weight* Sample 1	Sample 2
Porterville Clay	L. Success,Tul.Co.	36.8	31.4
Academy Clay	Academy,Fre.Co.	37.1	34.3
Cibo Rock Clay	Lewis Hill,Tul.Co.	32.2	36.9
Cibo Clay	Lewis Hill,Tul.Co	28.9	29.2
Mt.Olive Clay	Adobe Cnyn.,Krn.Co.	30.7	30.9

* $\frac{\text{wet wt. - dry wt}}{\text{dry. wt.}} \times 100 = \%$ Moisture by Weight

PH readings of selected soil types
from Pseudobahia peirsonii population sites

Soil Type	Population Site	PH Readings Sample 1	Sample 2
Porterville Clay	L. Success,Tul.Co.	5.2	5.2
Academy Clay	Academy,Fre.Co.	5.6	5.4
Cibo Rock Clay	Lewis Hill,Tul.Co.	5.7	5.8
Cibo Clay	Lewis Hill,Tul.Co	5.1	5.6
Mt.Olive Clay	Adobe Cnyn.,Krn.Co.	5.3	5.3

Soil analysis performed by D. Bacon. Department of Plant Sciences,
California State University, Fresno.