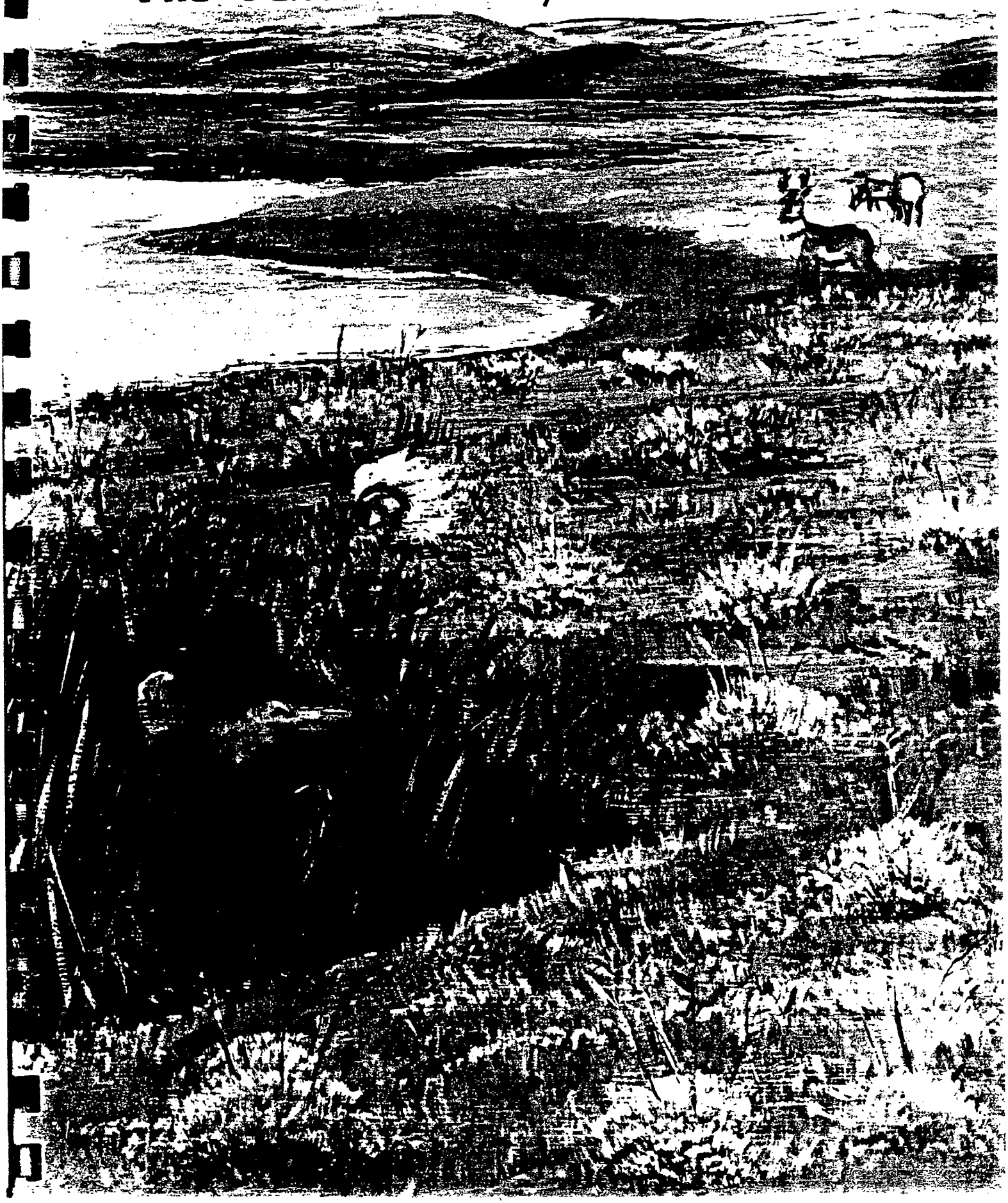
# The Central Valley Prairie



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# THE CENTRAL VALLEY PRAIRIE

## VOLUME I

California Prairie Ecosystem

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The author is very grateful to Director William Penn Mott, Jr., that no deadline was set for this report. Ecological studies, to be meaningful and useful, take a great deal of time and effort, and are never complete. Detailed studies both on ecosystem concepts and on basis of park unit are necessary before concrete management policies can be made.

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## ABSTRACT

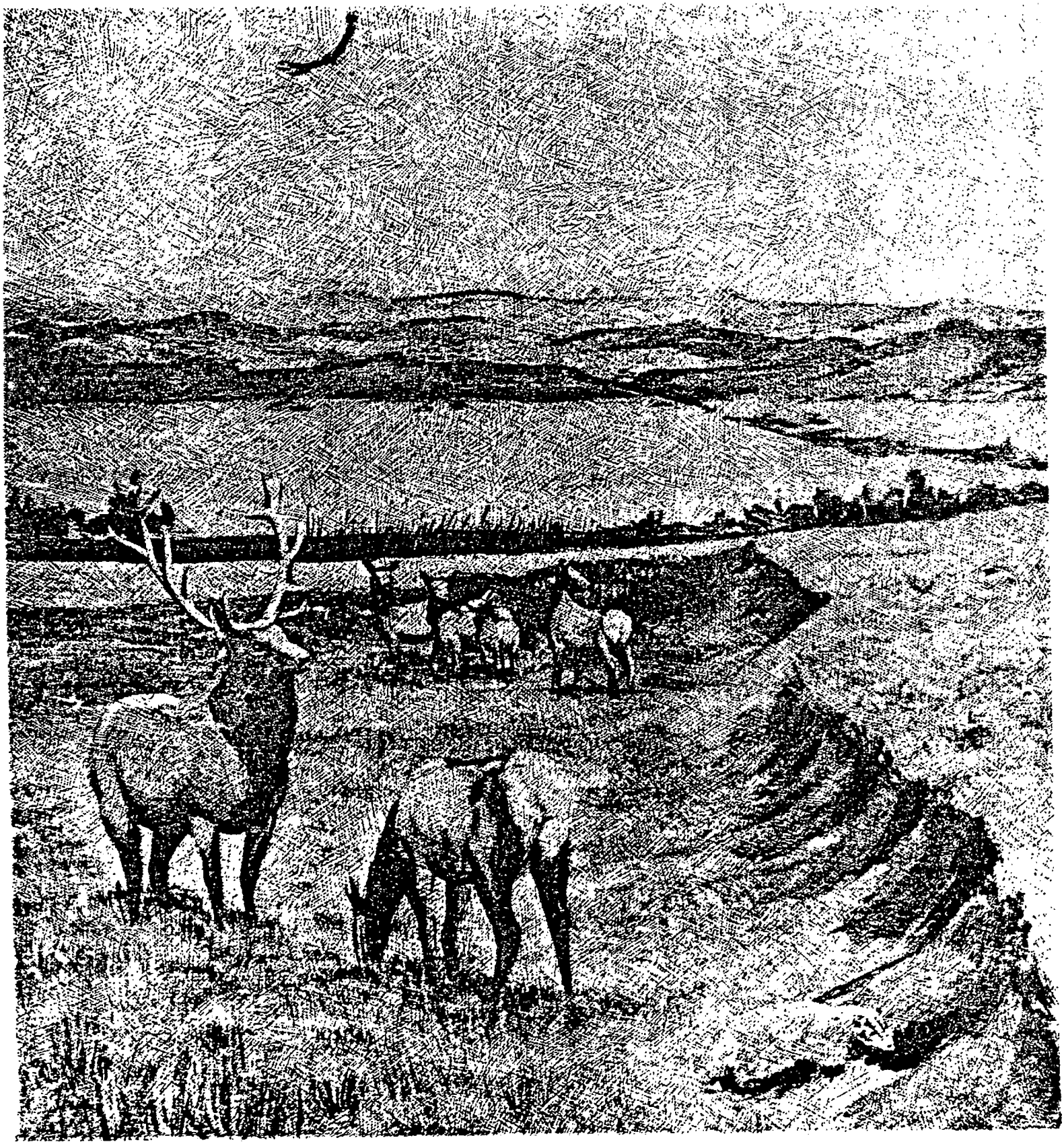
A survey was conducted in order to locate and evaluate remnants of the pre-Spanish Central Valley prairie, which is a division of the California prairie. Special emphasis was placed on the relict stipa community in the La Jolla Valley, Point Mugu State Park.

It was found that the densest stands of pure purple needlegrass (*Stipa pulchra*) occur in the La Jolla Valley; however, other native elements of the stipa community were notably lacking. The best examples of the Central Valley prairie were found in the Dozier area of Solano County which apparently never have been under cultivation. These areas are in need of protection and should be preserved. The largest expanses of the stipa community are located on Camp Pendleton Marine Corps Base, these stands are burned periodically, indicating that the stipa community is a pyric climax in the south coastal mountains. With the Spanish introduction of Mediterranean annual grasses, the Central Valley prairie communities have become edaphic climaxes rather than regional or climatic climaxes.

The current status of Central Valley prairie communities is summarized in Table A.


Table A. The Status of Central Valley Prairie Communities of California as of 1971.

| Community | Location | County | Acreage | Ownership | Use | Rating | Protection Priority |
|---|---|---|---|---|---|---|---|
| Stipa Hog wallows | Dozier | Solano | 1,000 | private | grazing | excellent | 1 |
| Stipa | Cal Poly | San Luis Obispo | 300 | State | arboretum | excellent | — |
| Stipa | La Jolla Valley, Pt. Mugu SP | Ventura | 250 | State | park | excellent | 2 |
| Stipa | Camp Pendleton | San Diego | 2,000-3,000 | U.S. | Marine training | excellent | — |
| Stipa | Mt. Tamalpais SP | Marin | 1,000 | State | park | excellent | 5 |
| Hog wallows | Hog wallows | Solano | 500 | private | grazing | excellent | 4 |
| Alkali flat | San Luis Island | Kern | 1,500 | U.S./private | refuge/grazing | excellent | 3 |
| Stipa | Annadel Farms | Sonoma | 550 | State | park | good | 8 |
| Stipa | Hastings Natural History Reserve | Monterey | 300 | State | scientific | good | — |
| Stipa | Los Laureles Grade | Monterey | ? | private | subdivision | good-fair | — |
| Three-awn | Salt Canyon | Colusa | 200 | private | grazing | good | 10 |
| Stipa | Gaviota SP | Santa Barbara | less than 50 | State | park | good | 9 |
| Stipa | Leutholz Ranch | Solano | 150 | private | grazing | fair | — |
| Stipa | Henry Cowell Redwoods SP | Santa Cruz | less than 50 | State | park | fair | 6 |
| Stipa | Montana de Oro SP | San Luis Obispo | less than 50 | State | park | fair | 7 |
| Stipa | Humboldt Redwoods SP | Humboldt | less than 50 | State | park | poor | — |
| Stipa | Rio Vista Junction | Solano | less than 50 | private | grazing | poor | — |
| Stipa | Point Sal SB | Santa Barbara | less than 50 | State | recreation | poor | — |



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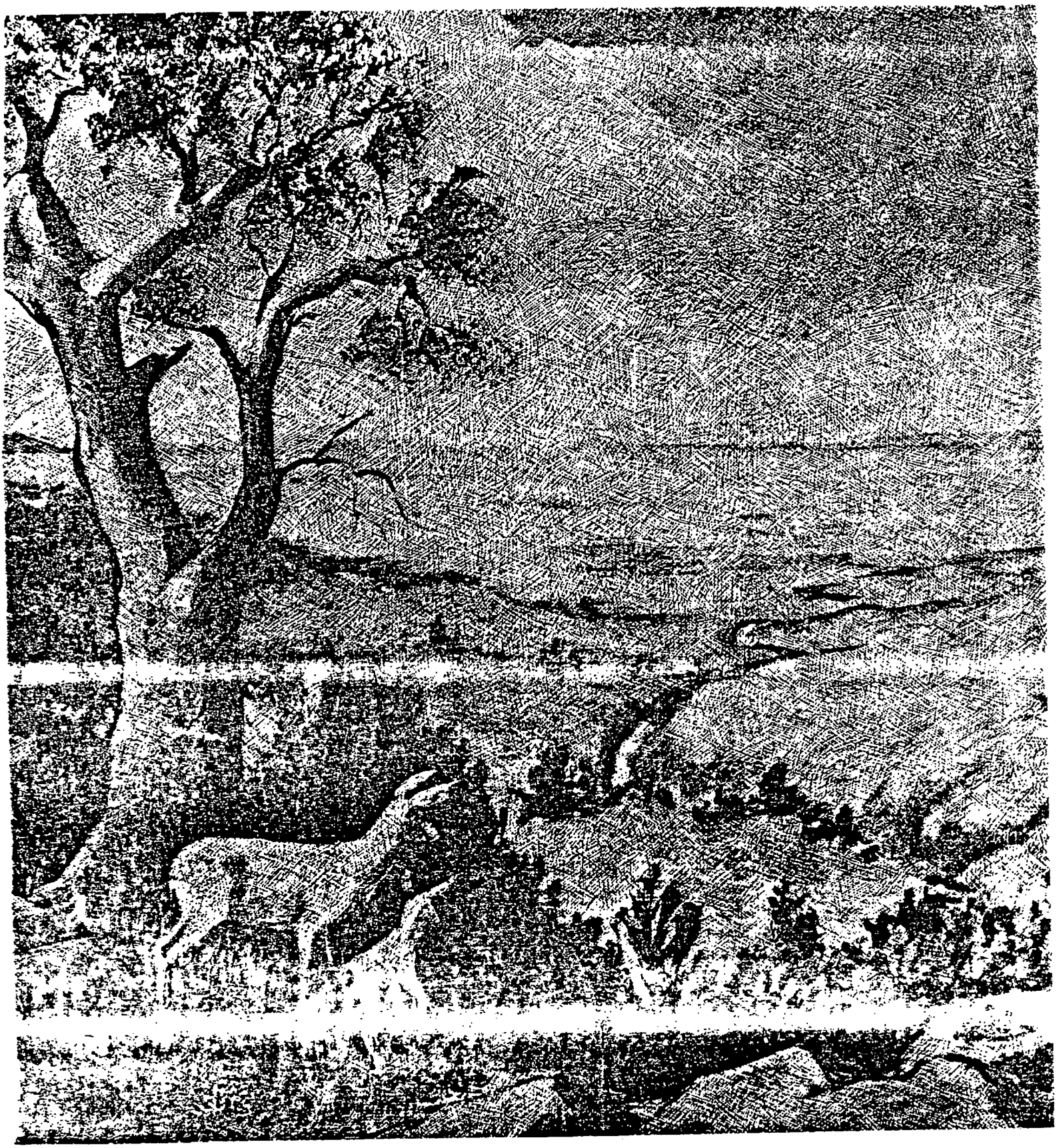
## INTRODUCTION

The grassland biome, which covers about one-fifth of the globe, is the most disturbed and least understood group of ecosystems. Man, having evolved as part of this biome, has greatly modified most, if not all, of the world's grasslands. Man's close association with grasslands is characterized by the evolution of grazing animals and cultivated crops through his manipulation.

The temperate North American grasslands were not manipulated, for the most part, by the Indians. However, crops, such as corn, were grown in some areas and fire was used to herd and trap wild grazing animals. The conquistador's introduction of the horse changed the dynamics of the grassland ecosystems of North America. However, the horse was a relatively late introduction to California and was not well established on grasslands until late in the 18th century. The grasslands were not cultivated by the Indians except for possibly some small areas of tobacco. Therefore, the California grasslands are unique in that manipulation by man was minimal until relatively recently and the last of the temperate grasslands to be cultivated.

The object of this study is to establish the pristine state of the California prairie and to ecologically evaluate remaining relic examples of this prairie ecosystem. In volume 1, special emphasis is placed on relic sites of the Central Valley prairie division of the California prairie. Volume II will consider the north coastal prairie in detail.



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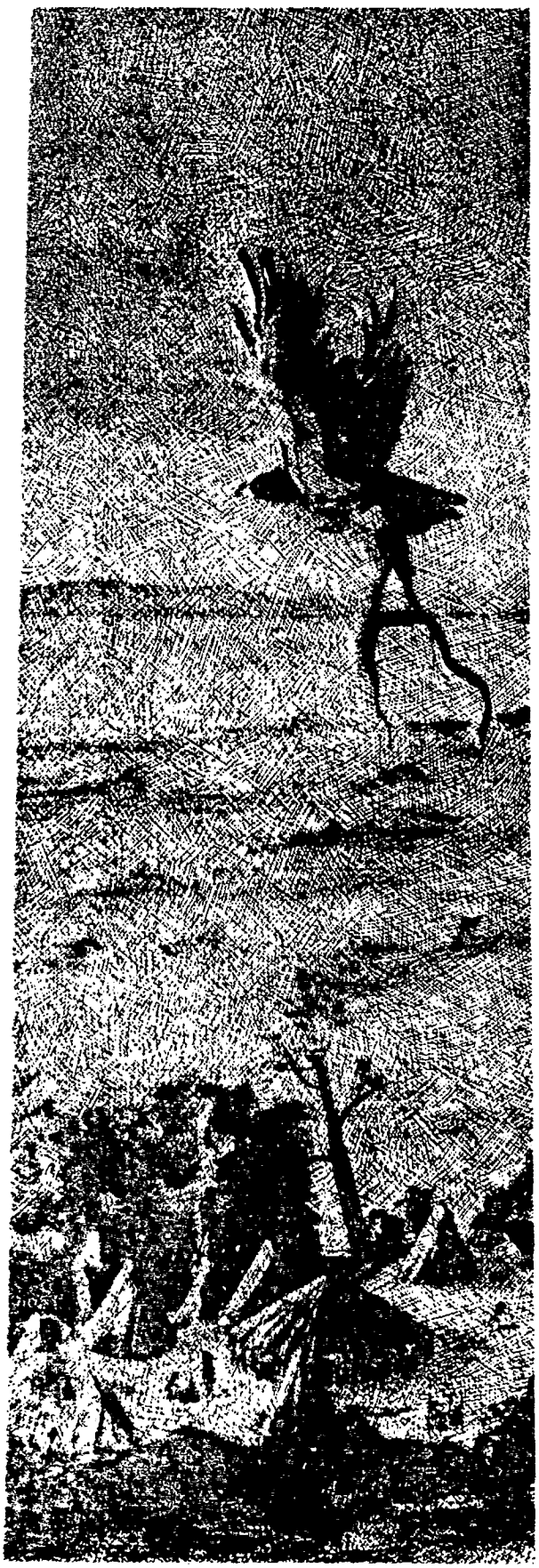


## THE PRISTINE STATE

For 10,000 years, the ecology of the California prairie was in balance. On the prairie, over 100,000 Indians lived in harmony with nature just over 200 years ago. The earliest reference to California grasslands was recorded in July, 1769. A group of Spaniards led by Don Gaspar de Portola rode northward from San Diego through the Coast Ranges in search of the Port of Monterey. This expedition was the first extensive European sojourn into the interior of California (Burcham, 1957). On Tuesday, July 18, 1769, one of the expeditioners, Miguel Costanso, wrote in his diary: "The place where we halted was exceedingly beautiful and pleasant, a valley remarkable for its size, adorned with groves of trees and covered with the finest pasture" (Costanso, 1770). This was the first description of the Great Central Valley of California, and the first appearance of white man in the valley.

One hundred years later, John Muir came to California and crossed the Great Valley on foot. He described what he saw, noting: "So on the first of April, 1868, I set out afoot for Yosemite (from Oakland). It was the bloom time of the year over the lowlands and coast ranges; the landscapes of the Santa Clara Valley were fairly drenched with sunshine, all the air was quivering with the songs of meadowlarks, and the hills were so covered with flowers that they seemed to be painted. Slow indeed was my progress through these glorious gardens, the first of the California flora I had seen. Cattle and cultivation were making few scars as yet, and I wandered enchanted in long wavering curves, knowing by my pocket map that Yosemite Valley lay to the east and that I should surely find it.

Looking eastward from the summit of the Pacheco Pass one shining morning, (I found before me) a landscape . . . that after my wanderings still appears as

the most beautiful I have ever beheld. At my feet lay the Great Central Valley of California, level and flowery, like a lake of pure sunshine, forty or fifty miles wide, five hundred miles long, one rich furred garden of yellow compositae. And from the eastern boundary of this vast golden flowerbed rose the mighty Sierra, miles in height, and so gloriously colored and so radiant, it seemed not clothed with light, but wholly composed of it, like the wall of some celestial city." (Adams and Muir, 1948).

Mountain ranges to the east and the desert in the south isolate this great valley and the California prairie from other grasslands. However, it was connected (until recently) in Northern California with a southern extension of the Palouse prairie (Shelford, 1963), and therefore, the California prairie is related, in character, to the Palouse prairie. This prairie occurred in eastern Oregon, eastern Washington, adjacent Idaho, and western Montana. Together, these communities comprise the Pacific bunchgrass area, as distinguished from the tall grass and short grass prairies of the Great Plains (Beetle, 1947). The Palouse and California prairies are products of winter rains in contrast to the tall and short grass prairies, which are products of spring and summer rains (Oosting, 1956). Genetic and paleobotanical evidence suggests that the endemic species of the California prairie are largely northern, and ultimately palearctic in their affinities (Stebbins and Major, 1965).

Pacific panicum (Panicum pacificum). Spring growth stage.

The California prairie, which covered more than one-fourth of California, is constituted by two grassland prairie biotic communities, which are distinguished by differences in climate and dominant species. These are the Central Valley prairie of Burcham (1957), (California steppe of Kuchler, 1964; or the valley grassland of Munz and Keck, 1959) and the north coastal prairie of Burcham (1957), (Fescue-Oatgrass type of Kuchler, 1964; or the coastal prairie of Munz and Keck, 1959).

This discussion will be limited mainly to the Central Valley prairie vegetation type. This prairie type was the major grassland of California. It dominated the great interior valley and occurred in the low, hot valleys of the southern Coast Ranges from San Francisco (Kuchler, 1964) to as far south as Baja California del Norte. This type occurred in the Great Valley, Sierra foothill and low coastal mountain, and southwest mountain and valley landscape provinces of Mason (1970). Elevational range is mainly between 50 and 500 feet above sea level, but it rises above 1,500 feet in the south end of the San Joaquin Valley, and a small area on the south side of the Tehachapi Mountains and areas in eastern San Diego County, it occurs at about 4,000 feet (Burcham, 1957; Munz and Keck, 1963).

Originally, in the south coastal area, the vegetation of south-facing slopes was often the Central Valley prairie, while the north-facing slopes were dominated by the California chaparral (Shelford, 1963). The Central Valley prairie was characteristically a subtropical treeless grassland, but it was widely transgressed, in the north, by the valley oak (*Quercus lobata*) with a rather indefinite ecotone (transition area) occurring between the Central Valley prairie and the foothill oak woodland. The scattered oaks do impart a woodland aspect to the prairie, but do not otherwise alter the essential character of the ecosystem from that of a normal treeless prairie (Burcham, 1957) or steppe. However, areas where oaks do occur in the prairie ecosystem would be technically considered an oak savanna.

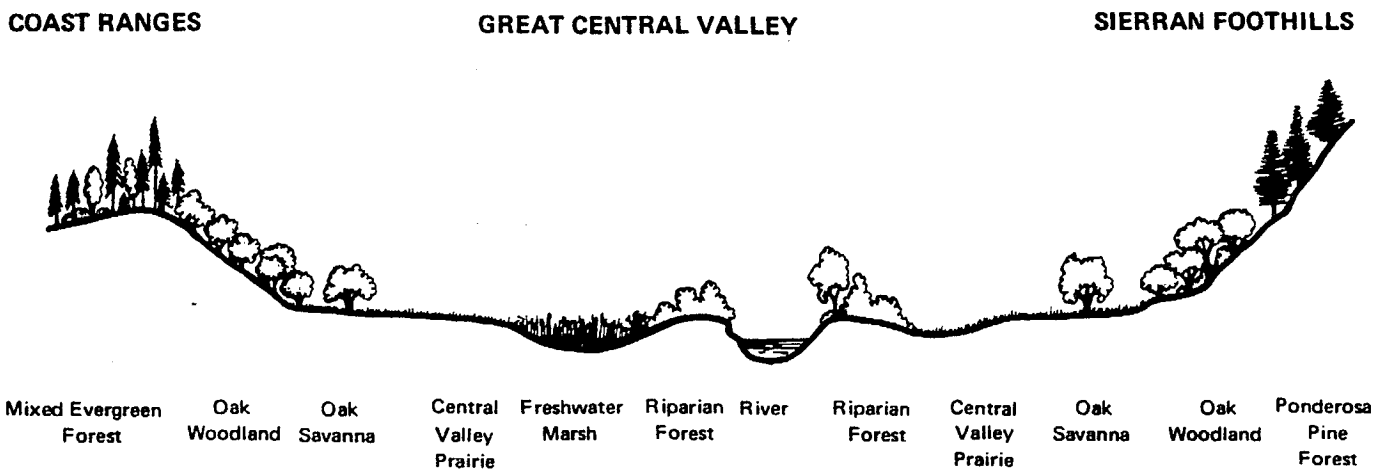
In the Great Valley, broad areas of native bunchgrasses spread inward from the margining foothills toward extensive tule swamps near the water courses;

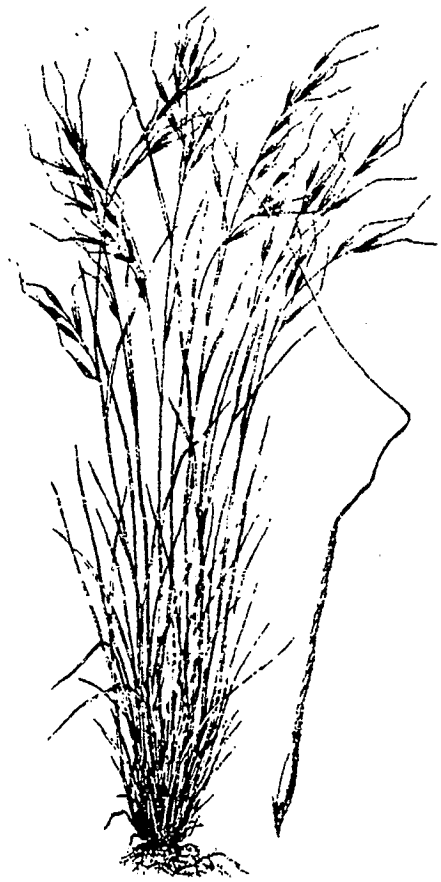
along the water courses were variable but large borders of riparian forest and shrubs. The Great Valley was a large, varied, and productive area with many diverse habitats for birds and mammals. A schematic view of the original vegetation pattern of the Great Central Valley is shown in Figure 1.

The pristine grasslands were occupied by pronghorn antelope (*Antilocapra americana*), tule elk (*Cervus elaphus nannodes*), deer (*Odocoileus hemionus*), Coyote (*Canis latrans*), as well as animals such as grizzly bear (*Ursus horribilis*), jackrabbit (*Lepus* sp.), ground squirrel (*Citellus* spp.), badger (*Taxidea taxus*), pocket gopher (*Thomomys* sp.). and pocket mouse (*Perognathus* spp.). Birds inhabiting the grasslands were western meadowlark (*Sturnella neglecta*), horned lark (*Otocoris alpestris*), Brewer blackbird (*Euphagus cyanocephalus*), desert sparrow hawk (*Falco sparverius phalaena*), and horned owl (*Bubo virginianus*). The Pacific rattlesnake (*Crotalus viridis*) and the gopher snake (*Pituophis melanoleucus*) were numerous. (Heady, 1968; Shelford, 1963; and Storer, 1965).

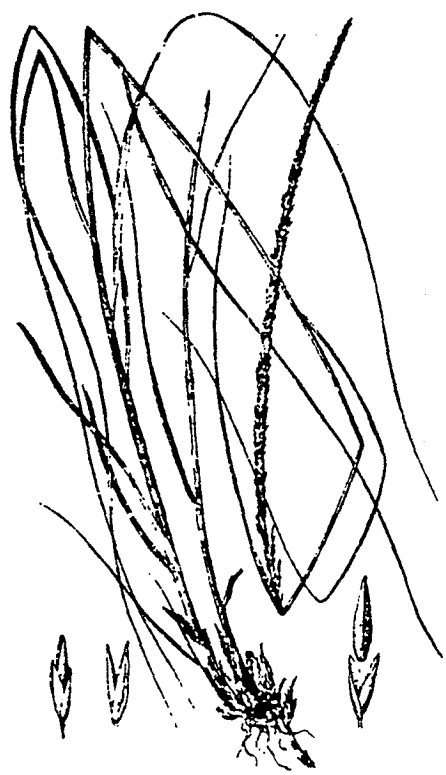
The pronghorn antelope was originally very abundant in the San Joaquin Valley, as in other bunchgrass areas, occurring in herds of two or three thousand. The pronghorns fed largely on grasses, only occasionally on twigs and leaves of shrubs. The coyote preyed largely on jackrabbits, although it also ate grasshoppers, other insects and fruit. The blacktailed jackrabbit (*Lepus californicus*) originally occurred in great numbers. The badger had a California distribution similar to that of the California prairie, and the Beechey ground squirrel (*Citellus beecheyi*) constituted one of the most characteristic species of the Central Valley prairie. The grass seeds and forbs are used by the ground squirrel for food and the grasses for lining nests. The Botta pocket gopher (*Thomomys bottae*) was an important species in the grasslands. The San Joaquin pocket mouse (*Perognathus inornatus*) also was associated with the Central Valley prairie. The tule elk ranged throughout the

Fig. 1. A schematic, east-west cross-section of the original vegetation of the Great Central Valley of California.





Purple needlegrass (Stipa pulchra).



Deergrass (Muhlenbergia rigens).

great Central Valley. The migration of this elk was no more than a seasonal shift from the valley to the adjacent foothills when flooding occurred.

In 1944, remnants of grassland near Dozier, California, were occupied by the pellucid grasshopper and the devastating grasshopper which occur periodically in large numbers and migrate from place to place. The homopteran insect (*Xerophloea viridis*) also fed on native grasses, but little in known about the remainder of the original invertebrate population (Shelford, 1963).

The original appearance of the California prairie is not known; it is not a matter of historical record. Early Spanish accounts refer to the prairie as merely an excellent pasture. It is believed that the native perennial bunchgrasses were far more abundant in pristine times and that they have since tended to disappear under the stress of cultivation, heavy grazing, and competition from introduced species (Beetle, 1947), (especially species from the Mediterranean area).

It is thought that in pristine times the vast expanses of the Central Valley prairie were mainly dominated by two perennial bunchgrasses, purple needlegrass (*Stipa pulchra*) and nodding needlegrass (*Stipa cernua*). These were liberally supplemented by erect perennials and a few stoloniferous perennials which were interspersed with numerous annuals. The Central Valley prairie communities differed from other prairies of the world in both identity of the perennial species and the larger number and the importance of annuals (Beetle, 1947). Needlegrasses are presumed to have evolved from isolated steppe progenitors as the Mediterranean type climate slowly developed over the past million years or so. This evolution did not include tolerance to heavy grazing pressure, characteristic of steppes and prairies in other parts of the world: for at least through the present epoch, grazing animals have not been a numerous component of the California prairie ecosystems (Robinson, 1968).

Apparently, purple needlegrass was the principle species throughout the Great Valley, but was not as abundant along the coast (Oosting, 1956). Blue wild-rye (*Elymus glaucus*), pine bluegrass (*Poa scabrella*), and deergrass (*Muhlenbergia rigens*) were important associates in the stipa community. Only one of the dominant grasses in this community departs from the bunchgrass habit, beardless wild-rye (*Elymus triticoides*), a sod-former. This grass formed an extensive consociation in the central portion of the San Joaquin Valley, as well as in some of the larger coastal valleys (Clements and Shelford, 1939). In the southern coast ranges and southern California, foothill needlegrass (*Stipa lepida*) and large needlegrass (*S. coronata*) share the role of principle dominants with the two interior species. Important associated grasses were Junegrass (*Koeleria cristata*), small-flowered melic (*Melica imperfecta*), deergrass and various three-awn grasses (*Aristida* spp.) (Burcham, 1957). Blue wild-rye was characteristic of the oak savanna while foothill needlegrass and large needlegrass were common on upper slopes along the Central Valley prairie-California chaparral ecotone, the California chaparral, and in the oak savanna (Burcham, 1957; Shelford, 1963).

Great masses of annuals, representing more than 50 genera and several hundred species were present; their densities fluctuated widely with rainfall, temperature, slope (Shelford, 1963), exposure, fire, and soils. According to Harshberger (1911), these annuals had remarkably short life spans. They would germinate, attain full size and mature their seed within a few months

in the spring. During the months of March, April, and May, the Great Valley was a continuous bed of grasses, sedges, and flowering plants. Each species usually dominated a particular ecotope (habitat) often with the grassland communities occurring on hummocks and the hog wallow community in damp swales.

The prairie was covered with masses of wildflowers making solid blotches of bright blue, orange, white, yellow, pink, and cream (Harshberger, 1911). The following plants were conspicuous during the vernal period when they flowered profusely: *Trifolium tridentatum, Gilia tricolor, Orthocarpus erianthus, O. purpurascens, Layia platyglossa, Sisyrinchium bellum,* and various species of the genera *Layia, Brodiaea, Calandrinia, Nemophila, Castilleja,* and *Lupinus.*

Following the spring months subsequent to May, the general brown and purple colors of the vegetation were the most marked characteristics of the Central Valley prairie. In October when the dry spring vegetation had disintegrated, there was a second outburst of floral bloom with the appearance of yellow masses of the tarweed (*Holocarpha virgata*). The tarweed association was often miles in extent; a single plant produced as many as 3,000 flowers. Later, in November, two to three species of *Eriogonum* and tufts of *Grindelia* spp. bloomed and continued to bloom until the spring flowers of January appeared (Jepson, 1893; Muir, 1901).

Junegrass (Koeleria cristata).

According to Beetle (1947), the native bunchgrasses (that is, nonstoloniferous types) whose conspicuous scattered clumps gave the California grassland its characteristic aspect include:

*Agrostis ampla*
*Andropogon virginicus* var. *hirsutior*
*Aristida hamulosa*
*Bromus carinatus*
*Bromus laevipes*
*Danthonia californica*
*Elymus condensatus*
*Elymus glaucus*
*Koeleria cristata*
*Melica californica*
*Melica imperfecta*
*Muhlenbergia rigens*
*Panicum pacificum* (and allies)
*Sitanion hystrix*
*Sitanion jubatum*
*Stipa cernua*
*Stipa lepida*
*Stipa pulchra*

Native annuals of the California grassland were:

*Agrostis exigua*
*Aristida oligantha*
*Bromus trinii*
*Eragrostis hypnoides*
*Eragrostis orcuttiana*
*Festuca megalura*
*Festuca microstachys*
*Festuca octoflora*
*Phalaris angusta*
*Scribneria bolanderi*

Other important species were (Kuchler, 1964):

*Aristida divaricata*
*Eschscholzia californica*
*Gilia* spp.
*Lupinus bicolor*
*Lupinus luteolus*
*Orthocarpus* spp.
*Plagiobothyrus nothofulvus*
*Sisyrinchium bellum*

Prairie threeawn (Aristida oligantha).

There are two important edaphic variants within the Central Valley prairie; the alkaline flat community and the "hog wallow" community. The alkali

flats cover large areas, especially on the west side of the San Joaquin Valley. These areas support dense stands of saltgrass (*Distichlis stricta*) and alkali sacaton (*Sporobolus airoides*), as well as other alkali-tolerant plants such as *Anemopsis californica, Nitrophila occidentalis, Astragalus tener* and *Trifolium fucatum.* The "hog wallows" are small depressions occurring extensively in bench lands underlaid by hardpan along the east side of the Sacramento and San Joaquin valleys from Shasta to Kern counties. During the rainy winter months, the depressions fill with water, and subsequent evaporation from the vernal pools create an unusual ecotope where a rare vernal flora has evolved. The hog wallow community includes such species as *Lepidium latipes, Lythrum hyssopifolia, Navarretia leucocephala, Downingia elegans, Mimulus tricolor,* and *Psilocarphus brevissimus* (Burcham, 1957).

**Blue wild-rye** (Elymus glaucus).

**Creeping lovegrass** (Eragrostis hypnoides).

**Alkali sacaton** (Sporobolus airoides).

**Desert saltgrass** (Distichlis stricta).

**California oatgrass** (Danthonia californica).

## THE DESTRUCTION OF THE CENTRAL VALLEY PRAIRIE

With the European settlement of California came plant introductions from all over the world; some introductions were intentional, some nonintentional. Elements of grassland floras from other regions with Mediterranean climates have been mixed with the pristine vegetation of California. Species from matching environments but with dissimilar floras, (from Southern Europe, Chile, South Australia, and South Africa) have successfully invaded the California prairie. Many introduced species occupy seral or even weedy habitats, but others are in what appears to be a new stable vegetation (Major and Pyott, 1966). Such introductions as annual bluegrass (*Poa annua*), barley (*Hordeum murinum*), and Italian ryegrass (*Lolium multiflorum*) made almost immediate headway as evidenced by adobe-brick studies (Hendry, 1931).

One of the main factors which shifted the competitive advantage from native to non-native grasses appears to be the inability of native grasses to successfully compete under heavy grazing conditions. The use of the grasslands of California for domestic grazing animals dates from the arrival of the first Spanish colonist in 1769. Before that time, the grasslands were subjected only to limited grazing by game animals and use by rodents (Burcham, 1957). Controlled grazing began around 1773 (Mason, 1970), and has continued in many grassland areas to date. The first widespread permanent grazing began in 1824 when land grants for the vast cattle ranchos were made under the Mexican Liberal Colonization Act. Herds of cattle numbering tens of thousands overgrazed the lush California prairie, causing the first major human impact on the rich resources of California. Once domestic grazing animals were introduced, the pristine bunchgrass community quickly disappeared in most of the California prairie (Clark, 1956).

Although little reference was made to grassland changes, some information points to a rapid species change, at least in some areas of the California prairie. In a letter to the Surveyor General of the United States, dated September 20, 1851, a surveyor, Leander Ransom, noted that most of the Pacheco Valley was under cultivation at that time and of the Mount Diablo area he noted: "These valleys and ravines and hills surrounding them are mostly covered with thick-set wild oats, growing from 4 inches to as many feet in height. Even Mount Diablo has a covering of wild oats which affords abundant pasturage to the extensive droves of cattle and horses that are scattered abroad over this magnificent range, and also herds of elk, antelope, and deer that abound here. One herd of elk that we saw on the mountain numbered at least 200". From the passages in the letter, it is evident that trees were scarce, even on Mount Diablo and this area was mainly rolling grasslands. It is obvious that by 1851, wild oats had already replaced perennial bunchgrasses in the coastal hills, but from other accounts, apparently the Great Valley still had vast areas of relatively pure native grasses.

Much of the grassland was plowed under and grainfields were the major crop of the Great Valley until early in this century. The remaining grasslands of the Great Valley are now dominated by soft chess (*Bromus mollis*), ripgut (*B. rigidus*), red brome (*B. rubens*), Fescues (*Festuca* spp.), wild oats (*Avena fatua*), and slender wild oats (*A. barbata*) (Major, 1963). By 1918, wild oats had invaded most of the Great Valley prairie. In 1918, Clements observed and noted: "the obliteration of many hundred miles of nearly continuous consociation of *Stipa pulchra*" . . . and the establishment of "the wild oats, *Avena fatua* as the great dominant throughout" (Beetle, 1947).

**Foxtail fescue (Festuca megalura).**

## DISTRIBUTION, PAST AND PRESENT

The distribution of the pristine Central Valley prairie covered nearly one quarter of California. After two hundred years of environmental disturbances, such as cultivation, grazing and land subdivision, the Central Valley prairie has been reduced to a few relict stands. Present sites are neither made up of purely native vegetation nor are they of any large expanse. Figures 2 and 3 accentuate the striking change in distribution of this prairie ecosystem which has occurred over the past two hundred years. Sites noted in Figure 3 are relict stands dominated by native species, however, all these sites contain some introduced annual grass species.

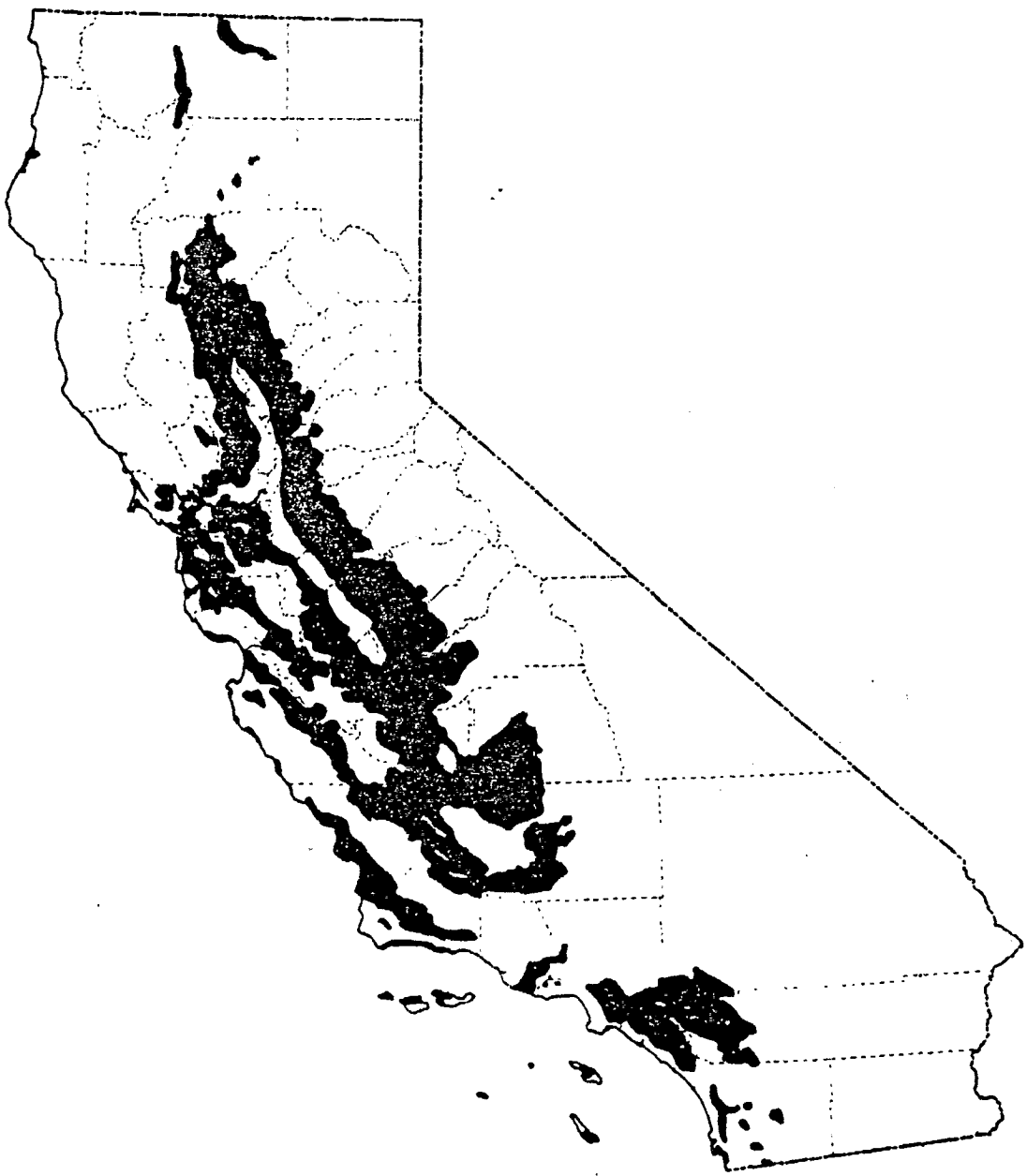
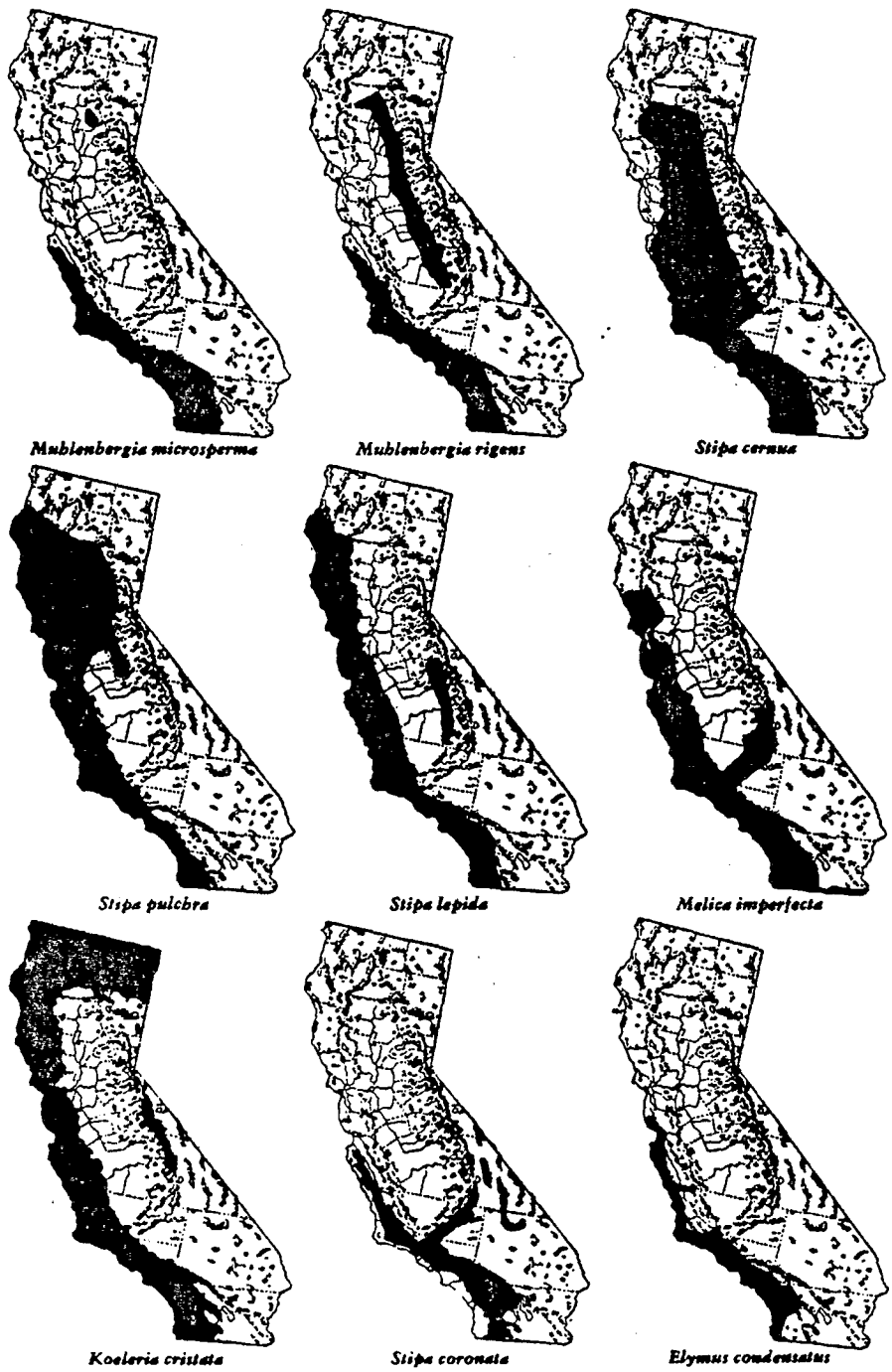


Fig. 2. Pristine distribution of the Central Valley prairie (modified from Kuchler, 1964; Burcham, 1957; and Wieslander, 1945).

The general distribution of important native grasses are delineated in Figures 4 and 5.

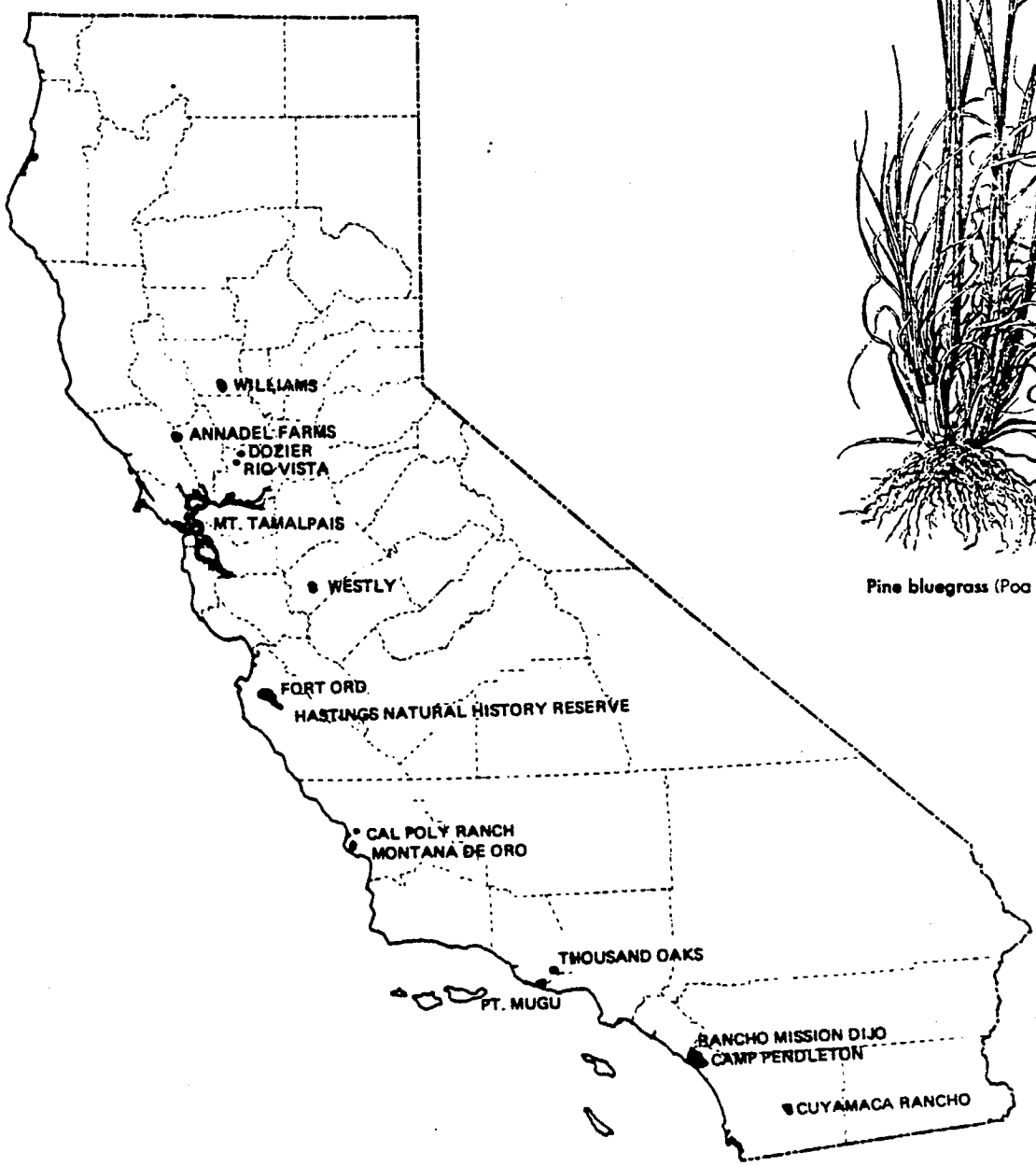
Fig. 4. Distribution of grasses native to the Central Valley prairie which occur both in the south Coast Ranges and in the Central Valley (from Beetle, 1947).




Small-flowered melicgrass (Melica imperfecta).

Pine bluegrass (Poa scabrella).

Fig. 3. Present distribution of the Central Valley prairie (1972).



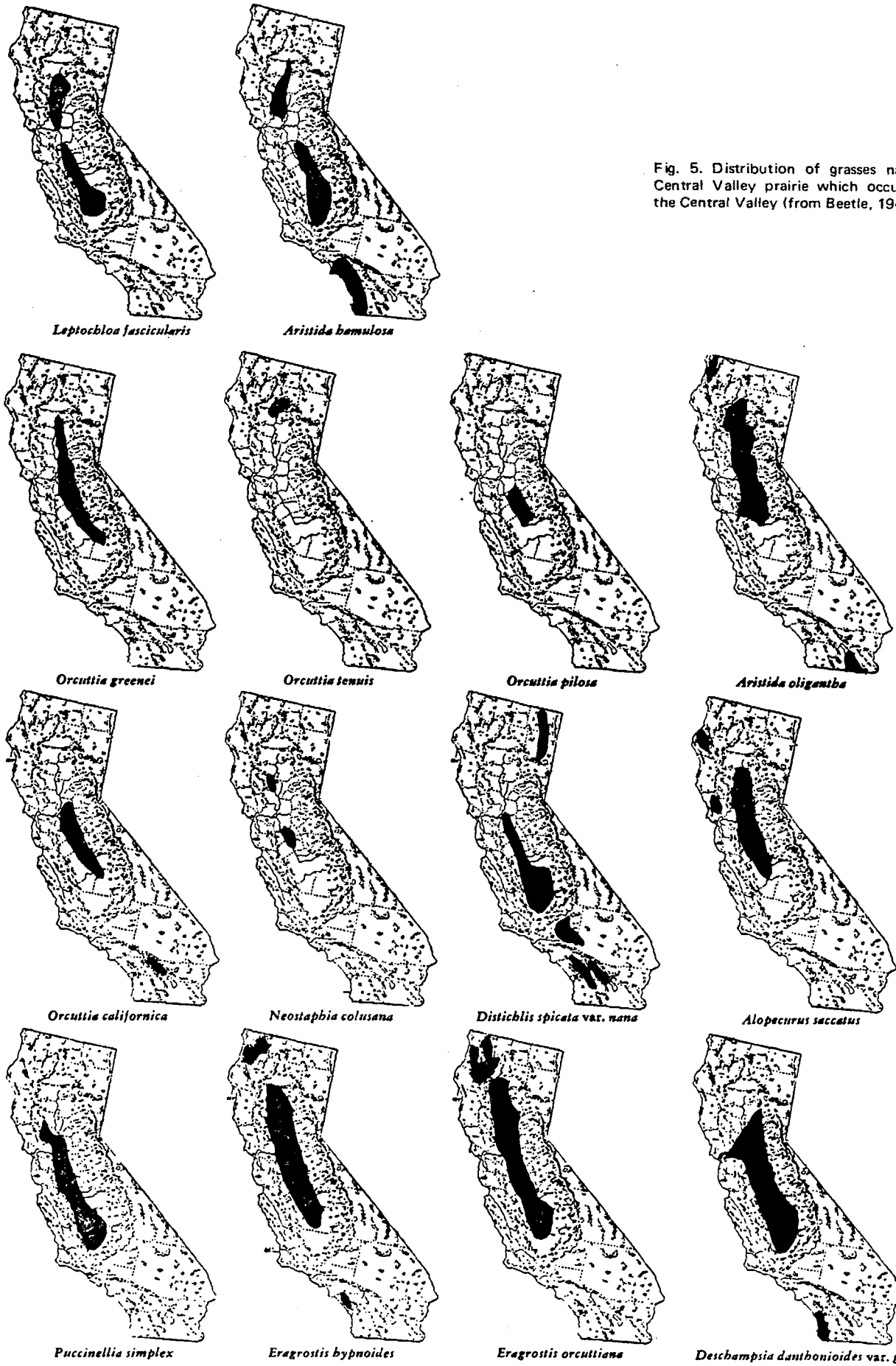



Fig. 5. Distribution of grasses native to the Central Valley prairie which occur mainly in the Central Valley (from Beetle, 1947).

## SOILS

Soils are quite variable under the Central Valley prairie. The zonal soils of the Central Valley prairie are all pedocals except at the grassland-woodland ecotones where pedalfers occur. Intrazonal and azonal soils are also found under this prairie.

Zonal soils occur over large areas or zones which are limited by geographical characteristics Thus, the zonal soils include those groups having well-developed soil characteristics that reflect the influence of the active factors of soil genesis – climate and living organisms. These soils are characteristically best developed on the gently undulating terrace land, with good drainage, from parent material not of extreme texture or chemical composition that has been in place long enough for biological forces to have expressed a great influence. The stipa community dominated, but was not limited to these soils.

Soil orders are broken down into Great Soil Groups. The classification of zonal soils into morphologically similar groups is dependent mainly on vegetation and climatic factors of which precipitation plays the greatest role. All grassland soils are similar mainly due to their high organic matter content, and therefore a dark color. The organic matter content of grassland soils increases with increasing rainfall; therefore, grassland soils formed under humid conditions are darker than those formed under dry conditions. In Table 1, the great soil groups of the zonal soil order, which are formed under the Central Valley prairie, are listed in relative order from mesic to xeric environments.

Table 1. Classification of Zonal Central Valley Prairie Soils With Relation to Precipitation and Organic Matter Content.

| Great Soil Group | Rainfall | Organic Matter |
|---|---|---|
| Pedalfers | High | High |
| Noncalcic Brown | | |
| Degraded Chernozem | | |
| Pedocals | | |
| Prairie | | Medium |
| Reddish Prairie | Medium | |
| Chernozem | | |
| Chestnut | | |
| Reddish Chestnut | | |
| | Low | Low |

Intrazonal soils have more or less well-developed soil characteristics that reflect the dominating influences of some local factor of relief or parent material over the normal effect of climate and vegetation.

The intrazonal soils of the Central Valley prairie are Wiesenböden, planosols and rendzina. Wiesenböden are halomorphic, imperfectly drained meadow soils. The alkaline flat community and hog wallow communities occur on these soils. Planosols have strongly leached surface layers over compact or cemented claypan or hardpan. Some have normal A and B horizons above the claypan or hardpan. Rendzina soils are a dark grayish-brown to glandular soil underlain by gray or yellowish, usually soft, calcereous material. Planosol and Rendzina soils occur in oak savanna areas, and grassland-oak woodland ecotones.

Azonal soils found under the Central Valley prairie consist mainly of alluvial soils but some lithosols are also present. Alluvial soils have little profile development but organic matter has accumulated; these soils are often found in south coastal valleys. Lithosols are thin stony surface soils with little or no illuviation and stony parent materials. These soils occur along grassland-chaparral ecotones.

In the Great Valley landscape province, the Central Valley prairie occurs mainly on the Wiesenböden, chernozem, prairie and alluvial great soil groups. In the Sierra Foothill and Low Coastal Mountain landscape province, grassland soils are mainly on noncalcic brown and rendzina great soil groups, while in the Southwest Mountain and Valley landscape province the Central Valley prairie communities occur on the rendzina and lithosols.

Table 2 gives soil series associated with the Central Valley prairie communities. The majority of these soil series was formed under the Central Valley prairie, however, at the present time, only a few of these series have relict prairie community sites. The better sites occur on the Zamora, Cropley and Olcott series.

Table 2. Soil Series Associated with Central Valley Prairie Communities.

**GREAT VALLEY LANDSCAPE PROVINCE**

**Prairie Alluvial**

1. Farralone
2. Julian
3. Mottsville
4. Corralitos
5. Soquel
6. Ferndale
7. Chualar
8. Gorman
9. Lockwood
10. Arguello
11. Rohnerville
12. Olcott
13. Antioch

**Prairie Planosol**

1. Santa Ynez
2. McClusky
3. Pinto
4. Tierra
5. Watsonville
6. Atascadero
7. Chamise
8. Jalama
9. Sebastopol
10. Wright

**Chernozem**

1. Ducor
2. Planada
3. Poterville
4. Hovey
5. Denverton
6. Los Banos
7. Montezuma

**Chernozem Solonchak**

1. Norman
2. Orestimba
3. Oxalis
4. Pescadero
5. Piper
6. Willows
7. Antone
8. Dunnigan
9. Lindsay
10. Marcuse
11. Solano

**Wiesenböden**

1. Burchell
2. Carson
3. Conejo
4. Edenvale
5. Pit
6. Anita
7. Landlow
8. Stockton
9. Genevra
10. Meyers
11. Agueda
12. Alamitos
13. Bayshore
14. Gastro
15. Clear Lake
16. Cropley
17. Dublin
18. Pacheco
19. Russell
20. Santa Rita
21. Sunnyvale
22. Capay
23. Grimes
24. Freeport
25. Sacramento
26. Temple
27. Tulare
28. Glann
29. Kirkwood
30. Merced

**Noncalcic Brown**

1. Greenfield
2. Hanford
3. Hilman
4. Oakdale
5. Oak Glen
6. Ripperdan
7. Visalia
8. Athlone
9. Gridley
10. Honcut
11. La Braza
12. Modoc
13. Sutter
14. Surprise
15. Vina
16. Wyman
17. Carpenteria
18. Cortina
19. Danville
20. Elder
21. Yolo
22. Zamora
23. Zanga
24. Anderson
25. Ballico
26. Bear
27. Columbia
28. Feather
29. Ramada
30. Arbuckle
31. Chamisal
32. Maywood
33. Tujunga
34. Bonsall
35. Placenta
36. Coombs
37. Keefers
38. Agate
39. Antelope
40. Bieber
41. Gould
42. Hillgate
43. Ohmer
44. Positas
45. Saratoga
46. Ulmar
47. Wasioja
48. Cachuma
49. Cometa
50. Corning
51. Flournoy
52. Hartley
53. Herdlyn
54. Kimball
55. Olcott
56. Las Flores
57. Olivenhain
58. Gaviota
59. Auburn

**Noncalcic Brown Ferrosol**

1. Madera
2. Monserate
3. Yokohl
4. Ysidora
5. Lindo
6. Montaque
7. Seville
8. Gloria
9. Rocklin
10. San Joaquin
11. Redding

TABLE 2 (continued)

SIERRA FOOTHILL AND LOW COASTAL MOUNTAIN LANDSCAPE PROVINCE

**Noncalcic Brown**

1. Fallbrook
2. Vista
3. Auburn
4. Escondido
5. Gleason
6. Konokti
7. Las Posas
8. Los Trancos
9. Pentz
10. Sobrante
11. Underwood
12. Whitney
13. Amador
14. Carrisalitos
15. Contra Costa
16. Forgeus
17. Gaviota
18. Vallecitos
19. Yucaipa

**Rendzina**

1. Calera
2. Caliente
3. Kern
4. Kettleman
5. Nacimiento
6. Montera

**Gray Brown Podzol**

1. Butte

SOUTHWEST MOUNTAIN AND VALLEY LANDSCAPE PROVINCE

**Rendzina**

1. Calleguas
2. Diablo
3. Olympic
4. Millsholm
5. Malibu

**Planosol**

1. Aliso
2. Milpitas
3. Olivenhain
4. Tangair
5. Tierra
6. Watsonville

**Prairie**

1. Arguello
2. Botella
3. Jalama
4. Santa Lucia
5. Lockwood
6. Sheridan
7. Cayucos

**Prairie-Grumusols**

1. Cayucos
2. Los Osos

**Chernozem-Grumusols**

1. Climax
2. Montezuma
3. Sespe

**Noncalcic Brown Soils**

1. Ballard
2. Sobrante
3. Zamora

**Wiesenböden**

1. Clear Lake
2. Cropley

According to Sampson et. al. (1951), a wide variety of soils support the California prairie and typically, soils formed under intermediate precipitation are the best grassland soils.

The best grassland soils are dark in color, medium to heavy in texture and therefore of fairly high water-holding capacity, granular in structure and therefore friable, and have a fair organic matter content. They vary in their reaction from slightly acid to those of the rendzina type which are calcereous throughout. Even in the higher rainfall areas, the soils are typically more basic with increase in depth, in contrast with forest soils which become more acid with depth. Grasses grow better with a good supply of calcium while native perennial grasses compete better with annual grasses on high phosphate soils (Robinson, 1968). California prairie often occurs on much shallower soils than do forest communities, but deeper than chaparral and scrub communities.

Many grassland soils of the state have a depth of only about two feet to bedrock. Also, many good grassland soils have claypan subsoils which are unsuited to woodland or forest.

California chaparral and coastal scrub communities usually occur on soils that are too shallow for grassland; however, under certain edaphic conditions, grasslands may also occur on very shallow soils. For example, in the San Luis Obispo area, a stipa community occurs on very shallow, rocky serpentine soils on northerly exposures. In the Santa Cruz Mountains and the Mount Tamalpais area, stipa stands also occur on shallow serpentine soils. In the Santa Cruz Mountains they are mainly confined to the east side of the main ridge. However, at Mount Tamalpais, the prairie community occurs on the west slopes of the mountain.

On the coastal shelf at Montana de Oro State Park the best relict stand was found on very deep virgin Lockwood soil but other stands occurred on very shallow, eroded soil (Lockwood C horizon). Annual grassland and coastal sage scrub occurred in the profile depths between these extremes. This phenomenon often occurs in nature where ecological amplitudes show two optimum peaks.

Soil Ecology

In pristine times, the Central Valley prairie was a dynamic, but stable community of life, ranging from the grizzly bears down to viruses. The entire economy of this ecosystem was based upon the native perennial bunchgrasses. The soil itself was formed under grasses which were fed upon by tule elk and pronghorn antelope. Nutrients and organic matter were returned to the soil from the droppings of grazing animals and their predators (Indians and coyotes, etc.), as well as the death of these and other organisms. The organic residues were broken down by soil microbes, mainly bacteria, while a vast and complex faunal community – the pocket gophers, pocket mice, earthworms and ants – constantly worked the soil to compensate for the compaction brought about by the hoofs of grazing animals.

Pocket gophers are usually found in grass soils, as tree and shrub roots often act as barriers to their activities. They rarely move above ground to feed, preferring to burrow to reach plant roots. They often feed on roots, with no surface evidence of their activities, cleanly nipping off the roots and causing the death of the plant. The gophers are the most abundant and effective burrowing rodents in California according to Joseph Grinnell and Tracy Storer who estimated that over the past two hundred thousand years gophers gave meadow soil the equivalent of 3,400 plowings to a depth of six inches (Farb, 1959).

Certain bacteria and blue-green algae are important organisms in that they fix atmospheric nitrogen (non-usable to plant and animal metabolism) into nitrogen compounds which are basic to the nutrition of all higher plants and all animals. The most important nitrogen-fixing mechanism at work in the grassland ecosystem is the symbiotic relationship between rhizobial bacteria and legumes.

The rhizobia live in root nodules of leguminous plants and furnish the plants with nitrogen while the plants, in turn, furnish the bacteria with other nutrients. Lupins fix from about 75-175 pounds of nitrogen per acre per year while clover may fix from 150-300 pounds per acre per year.

Free living blue-green algae (Phylum Cyanophyta) are important in damper areas of the California prairie; example, the hog wallow community. In dryer areas, blue-green algae are associated with fungi in a microbial symbiosis known at lichens; however, not all lichen symbiots fix nitrogen.

Some bacteria also fix atmospheric nitrogen. *Azotobacter* is the most common genus; *A. chroaccocum,* and *A. agilis* occur in clay soils with the stipa community while *A. vinelandii* prefers slightly alkaline conditions and would be expected in the alkaline flat community.

Free living organisms fix from 15 to 35 pounds of nitrogen per acre per year. Rain also adds nitrogen to the ecosystem but the amount is small, only about 2-5 pounds per acre per year in the Central Valley prairie.

These additions of nitrogen to the ecosystem build up in the plant biomass as succession progresses and eventually reach a dynamic balance through losses, such as leaching from the soil, bacterial denitrification and reduction to nitrogen gas by *Psendomonas* and *Micrococcus*, and through volatilization by fire (Barry, in preparation).

Nematodes are quite abundant and are ecologically important for the California prairie. Many nematodes prey on bacteria, fungi, protozoa, and other nematodes, while others attach to plants feeding on plant juices; there is also evidence that they feed on decaying organic matter. They inhabit the thin moisture film which surrounds soil particles, or they occur around plant roots. The top inch of a square yard of grassland soil may contain up to twenty million nematodes.

Nematodes are preyed upon by many soil organisms. One of the most interesting relationships in the soil food web is that of the predatory fungi which is able to trap the much larger nematodes using a variety of snares. An example of such a fungi is *Arthrobotrys* spp. When no nematodes are present, these fungi live peacefully in the soil, consuming organic matter; however, when nematodes are present, *Arthrobotrys* becomes a hunter. It sends out sticky spider web-like loops and if a wandering nematode comes in contact with one of the loops, it becomes fastened, struggles, brushing against more loops and, within a few hours, becomes tightly encased, dies and is digested. Many variations occur in the trapping methods. Once the nematode is trapped, the fungi consumes the nematode by sending out thread-like tubes which enter the nematode's body and consume it from the inside out. The threads grow filling the body of the nematode. When feeding is completed the thrifty fungus then efficiently digests the threads. Often more than one nematode at a time is consumed. Predacious fungi also attack small crustaceans, amoebas, and rotifers.

The wireworm, which is the larval stage of the click beetle, is very destructive to plants, as it bores through the outer layers of seeds and roots to get the succulent inner portions. Wireworms respond to chemical stimuli; secretions of amino acids from roots attract wireworms to the succulent roots while secretions of sugar compounds stimulate the physical biting of the root (Farb, 1959).

Plant pathogens inhabit the grass litter layer; as this layer builds up, populations increase and the general health of the plants is endangered by disease outbreaks. Fire acts as a natural cleansing agent destroying the pathogens and their habitat, thus allowing grasses to remain healthy and vigorous.

## CLIMATE

Climate of the Central Valley prairie is typically Mediterranean with cool winters and hot dry summers. According to Sampson et. al. (1951), these unusual climatic conditions have encouraged the growth of introduced Mediterranean annuals on some 20 million acres of California prairie. However, other factors such as heavy grazing were probably more important in the disappearance of the native perennial bunchgrasses.

The climates of the world have been classified by Walter and Lieth (1967). The Central Valley prairie is found in the following climatic types: III (IV), $IV_2$, and IV (III). This classification is based on Thornthwaite's concepts of potential evapotranspiration, soil storage of moisture, and recharge of water, and his graphical approach, which balances water added to the ecosystem by precipitation against outgo through the process of evapotranspiration (Major, 1963). Actual evapotranspiration is dependent on the type of vegetative cover and the temperature regime. An example of the climatic type $IV_3$ is represented in Figure A. This climatic type is basically Mediterranean. The graphs indicate that the Central Valley prairie is characteristicly found in areas of summer drought.

Another method of climatic classification that is useful in ecological investigations is the method perfected by Bailey (1960). His method

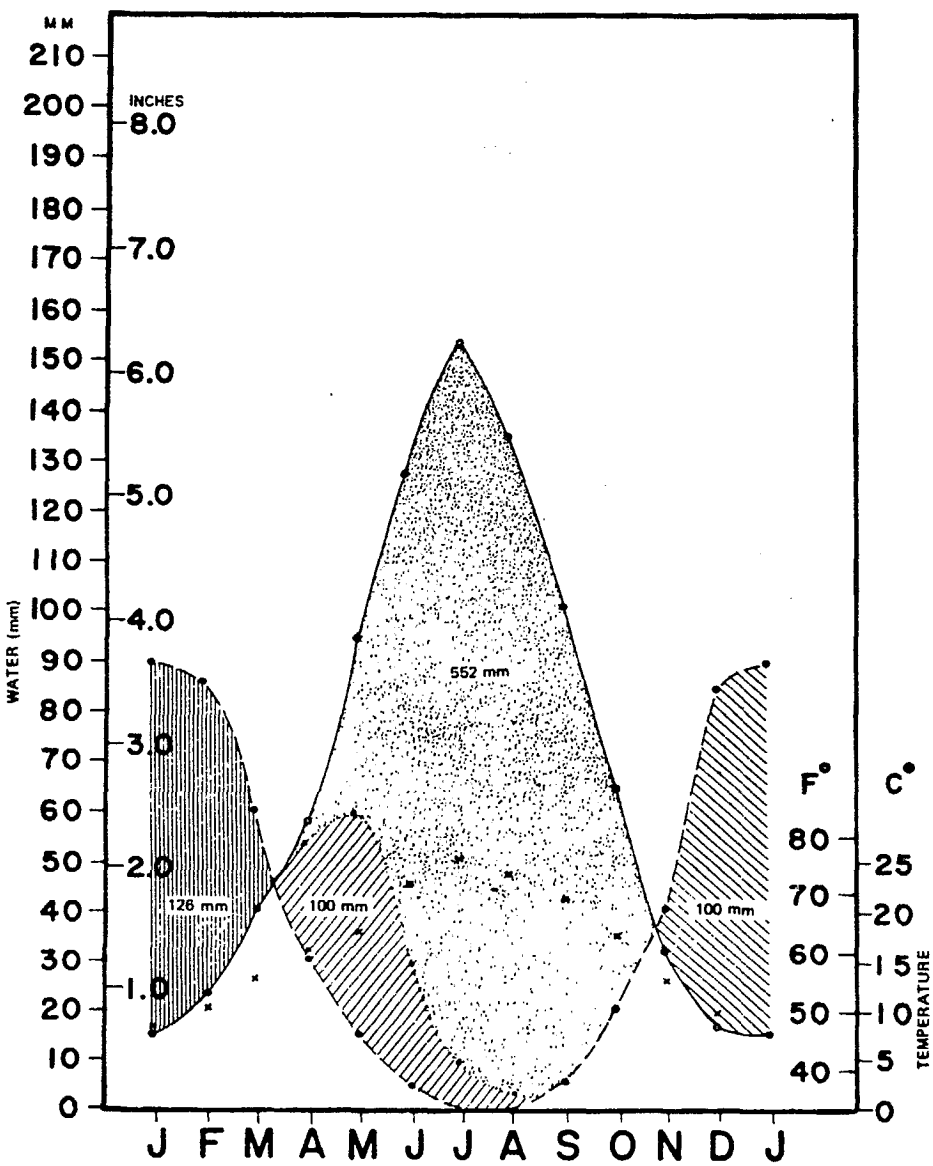



Fig. A. An evapotranspiration diagram of Davis, California representing climatic type $IV_3$ *(from Major, 1967).*

graphically delineates plant communities with relation to the climatic parameters of equability or temperateness (W), and effective temperature (ET).

Equability is a property of climate that applies to warm tropical climates as well as to cold temperate regions; it is one of the two aspects of temperature that affect life. Equability expresses departures from 57.2°F, and so responds mainly to temperature extremes. The centrum (57.2°F) from which departures in equability are computed is midway between polar (ET 50°F) and tropical (ET 64.4°F) climate, and is also approximately the mean temperature of the earth's surface. If monthly temperatures remain uniformly at 57.2°F, then equability has an ideal rating of 100. If mean annual temperature is higher or lower than 57.2°F, or if temperatures fluctuate seasonally, then equability is less than 100.

Effective temperature (or warmth) measures the warmth of a climate in terms of the temperature and duration of the summer period (tropical warm temperate, cold temperate, etc.) (Axelrod and Bailey, 1968). ET measures warmth by a scale that specifies temperature at the beginning and end of a warm period, and the duration of that period. Thus, a principle of seasonal rather than annual warmth is expressed by ET. It is determined from the

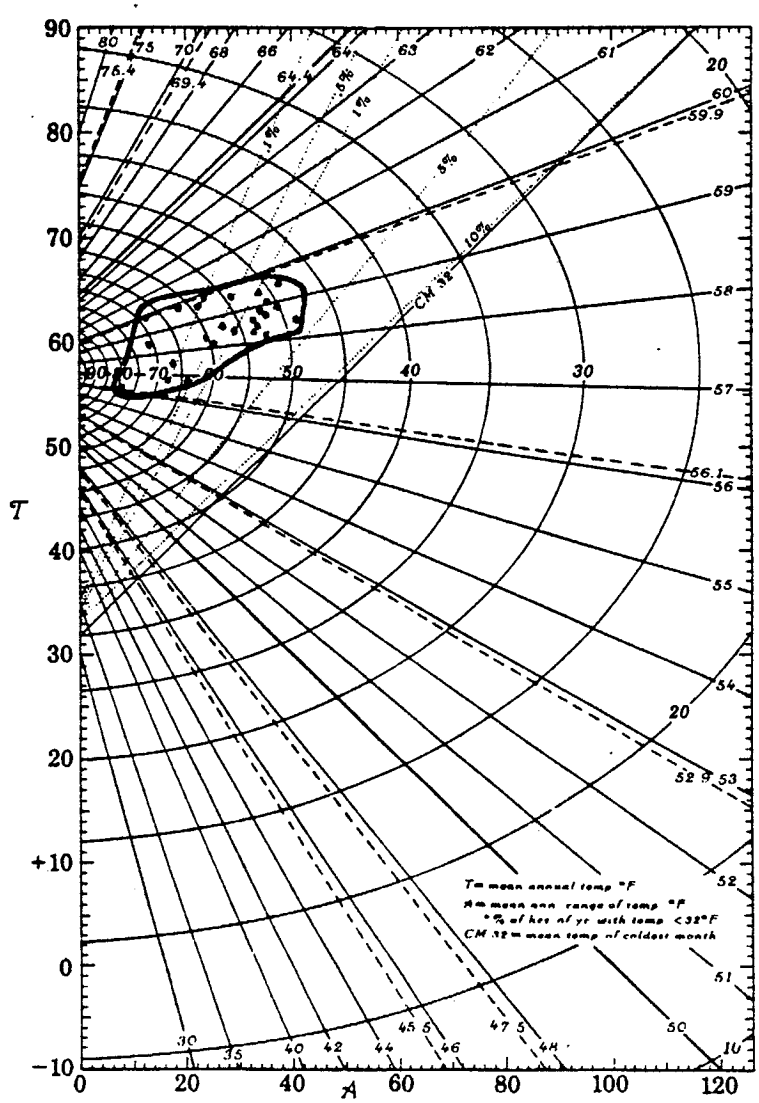



Fig. 6. A nomogram of the ecological position of the Central Valley prairie in relation to the climatic parameters of equability and warmth.

mean temperatures of the warmest (WM) and coldest (CM) months; these factors alternate in their control over ET (Axelrod, 1965).

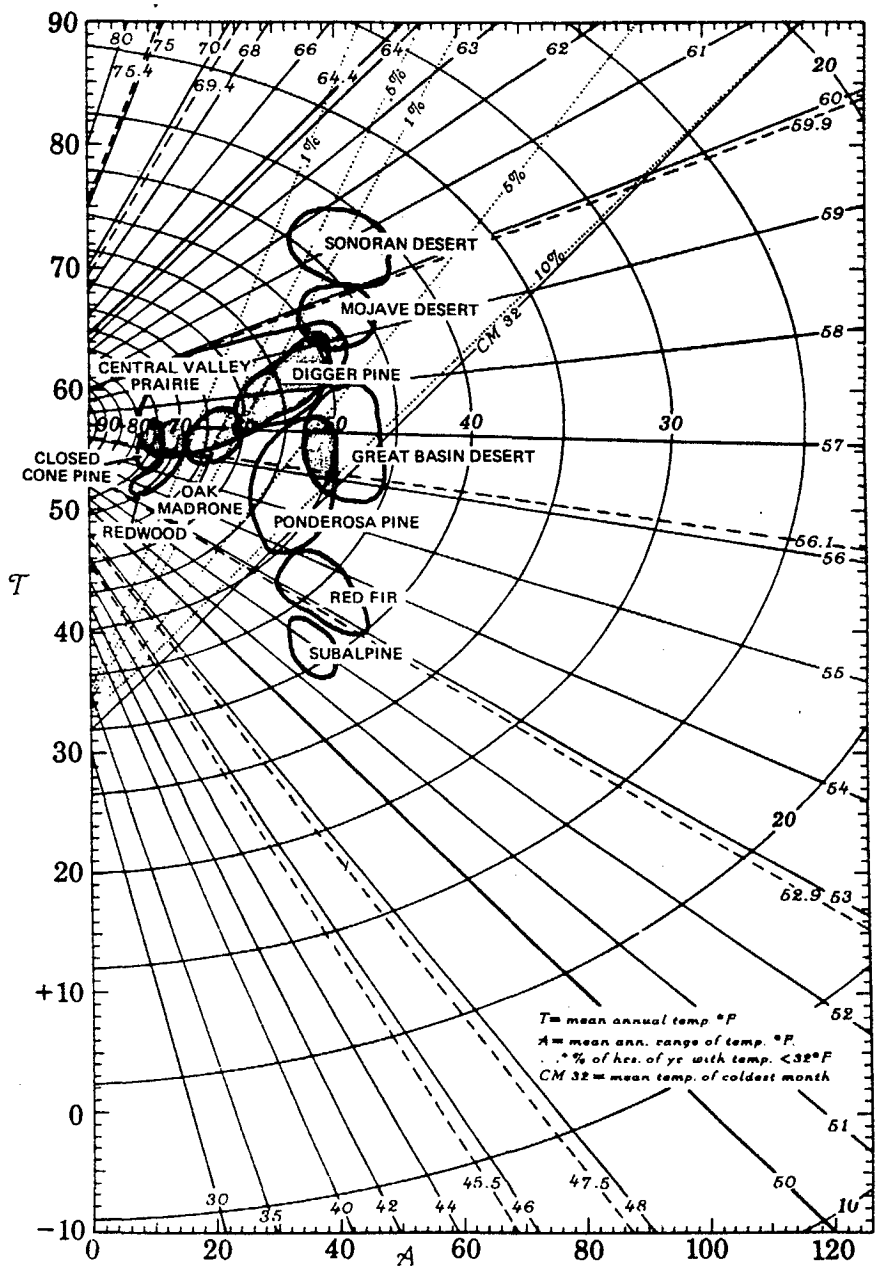
The equability and effective temperature was plotted for the Central Valley prairie using the mean annual (T) and mean annual range (A) of temperatures from 32 stations within the area where the Central Valley prairie was the dominant zonal vegetation during pristine times. Figure 6 illustrates the effective temperature and equability requirements for the Central Valley prairie. The radial lines denote the equability which ranges from 98 to 53 for this vegetation.

From these data one can determine whether or not the pristine state of any area was the Central Valley prairie by plotting the weather station data. If the point falls within the delineated area, and the evapotranspiration graphs fit within one of the determined climatic types [III (IV), $IV_2$, $IV_3$, or IV (III)], then it is safe to assume that the zonal pristine vegetation was the Central Valley prairie. Many plant communities have been plotted with relation to the above climatic factors.

Figure 7 contrasts the Central Valley prairie with other plant communities of California in relation to the climatic parameters of equability and effective temperature.

Average rainfall in the Central Valley prairie varies from 6 to 20 inches. Generally, areas of rainfall lower than 6 inches support desert vegetation while areas of rainfall higher than 20 inches support forest vegetation. Growing season varies from 7 to 11 months with 205 to 325 frost free days. Mean maximum summer temperatures range from 88° to 102° and mean winter minima from 32° to 38°F. The Central Valley prairie occurs in areas of summer drought: the summer dry period lasts for 5 to 6 months. The plants of this community are adapted to high soil and atmospheric moisture stress.

Fig. 7. Nomogram illustrating the ranges of various biotic communities of California with relation to equability and effective temperature.



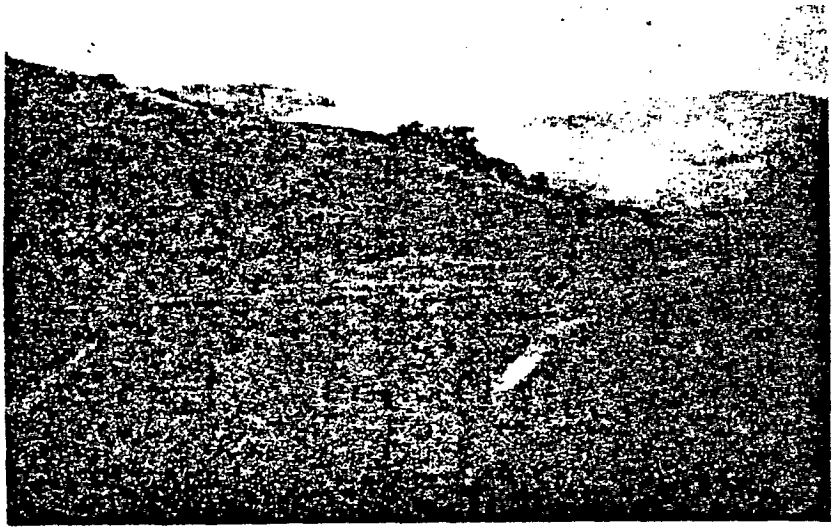


Fig. 8. Control burn at Camp Pendleton Marine Corps Base. Such burns are prescribed annually to prevent wildfires; 25 June 1971.

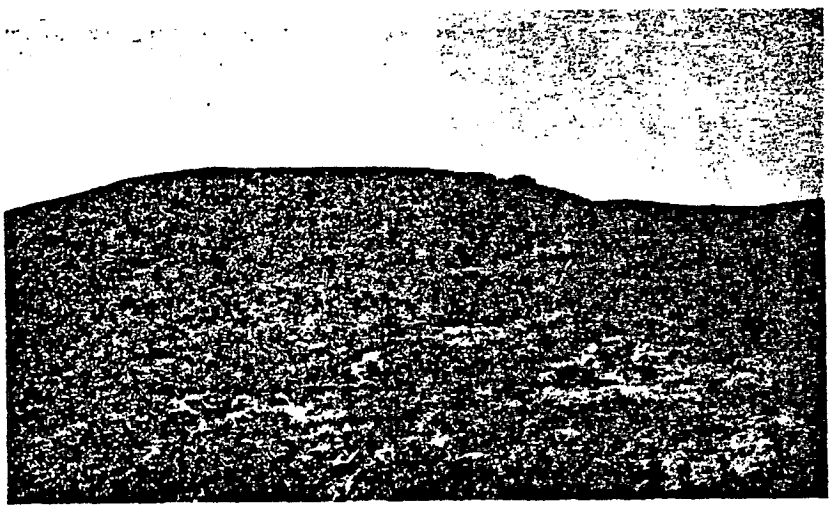


Fig. 9. Burned Central Valley prairie and oak woodland communities on Camp Pendleton Marine Corps Base. Note fire damaged trees, these will survive; 25 June 1971.

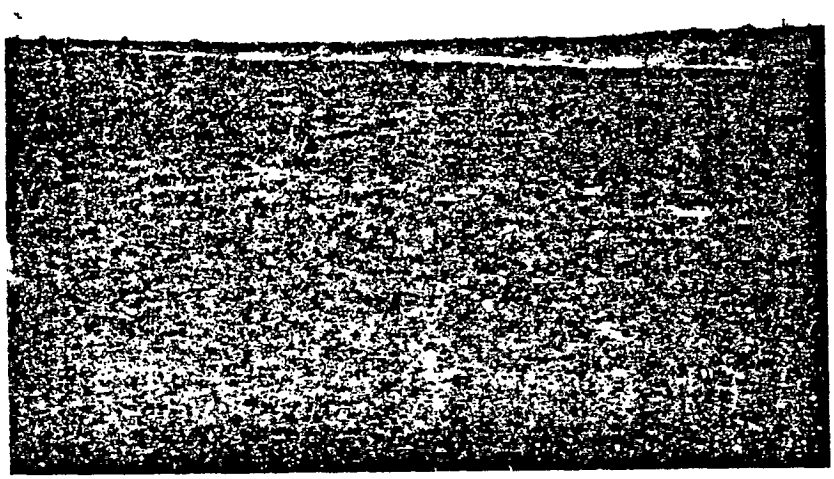


Fig. 10. Purple needlegrass actively growing several weeks after being burned. Exotic annual grasses were destroyed by the fire. Camp Pendleton Marine Corps Base; 25 June 1971.

## FIRE

Fire is a dominant factor in the history and biology of many plant communities; it is one of the basic natural forces that has influenced plant communities over evolutionary periods of time. Certain plant communities require periodic fires to maintain their position in the biosphere.

Plant species have properties that may inhibit or enhance flammability and frequent fires. Prairies and pine forests are examples of plant communities which foster high flammability and frequent fires (Mutch, 1970). Prairie and savanna communities might not even exist without fire (Souer, 1950).

In pristine times, the California prairie ecosystems were burned periodically. It is of interest to note that six cases of wildfire were recorded by the Portola Expedition of 1769 and nearly all burned areas mentioned were in *grassland*. The John Work Expedition of 1832 encountered four wildfires, one was recorded as accidental, having started in an Indian village near Woodland, but other fires were set intentionally by Indians. Evidence of Indian burning was apparent during the Spanish period; in 1797 the Spanish governor issued a proclamation forbidding Indian burning of wildlands (Raymond, 1965). In an area now within the confines of Camp Pendleton Marine Corps Base (Las Pulgas Canyon), Father Juan Crespi noted in July of 1769: "Near the water there is sort of a garden of considerable size, with lush grapevines and countless Rose of Castile (*Rosa californica*) patches among the vines, as if they had been planted there. As the heathens (Indians) had recently burned here, the roses were spoiled, yet the rose bushes were shooting up again handsomely, . . ." (Pourade, 1968).

Periodic burning is still practiced at Camp Pendleton. Control burning has been practiced here since 1942. During 1970, control burning was conducted on 5,410 acres. Some areas have been burned annually for the last 18 years, according

to Mr. W. D. Taylor of the base's Natural Resource Office. Mr. Taylor and Lt. Col. N. Kavakich, Director of Natural Resources, showed the author hundreds of acres of Central Valley prairie which had been burned periodically, and which has been able to compete with exotic grass species as well as chaparral species. These areas contained fine stands of native perennial bunchgrasses (mainly *Stipa pulchra* and *S. lepida*). In areas that had been burned several weeks before my visit (June 25, 1971), the bunchgrasses were green and actively growing, but all exotic annuals were completely burned up (Figures 8 to 12). The great success of native elements of the Central Valley prairie under conditions of periodic burning is good evidence that fire is a very important factor in maintaining Central Valley prairie communities. Control burns should be used to maintain this community in other areas where it still occurs. According to Daubenmire (1968), fire is essential in maintaining the vigor and vitality of grasses in most grasslands. The slow accumulation of litter causes deterioration of the vigor and vitality of grasses. Burning at intervals of 1-15 years, depending on the particular region, is essential for maintaining natural productivity.

Succession

Fire has been established as part of the natural secondary successional pattern in the Central Valley prairie. After fire or other disturbances, seral species such as lupines (Figure 13), and the California poppy (Figure 14) often predominate; these are gradually replaced by the pyric climax perennial bunchgrasses. Soil disturbances, such as the natural cultivation of the soil by pocket gophers, shift the competitive advantage toward the California poppy while fire encourages the introduction of lupine species. Lupines are nitrogen-fixers and replace the nitrogen loss from the biomass due to fire.

Climax species are often fire resistant, such is the case with the climax species of the Central Valley prairie, the needlegrasses, as is illustrated in Figures 10-12.

Fig. 11. Purple needlegrass growing vigorously about one month after control burn at Camp Pendleton Marine Corps Base; 25 June 1971.

Fig. 12. Purple needlegrass, wild oats and sweet fennel in an area burned during the spring at Camp Pendleton Marine Corps Base; 25 June 1971.

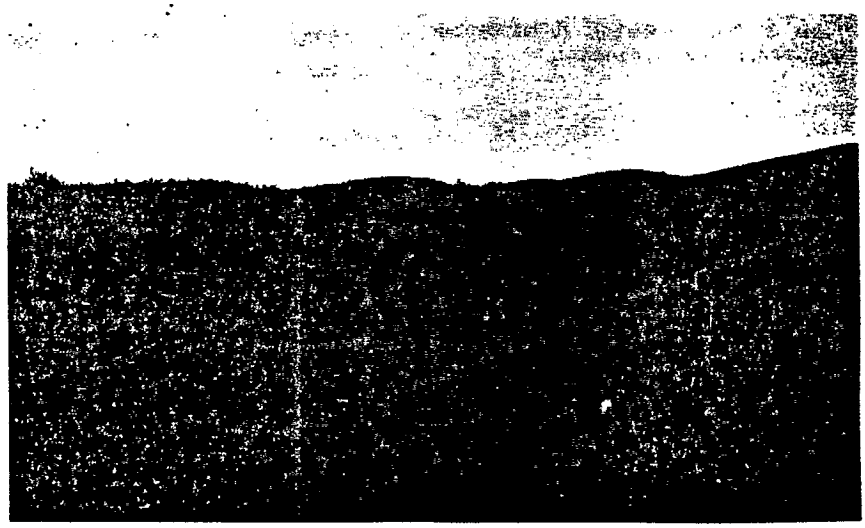


Fig. 13. Early grassland successional stage with nitrogen-fixing lupines, Hastings Natural History Reserve, Carmel Valley; 1 June 1971.

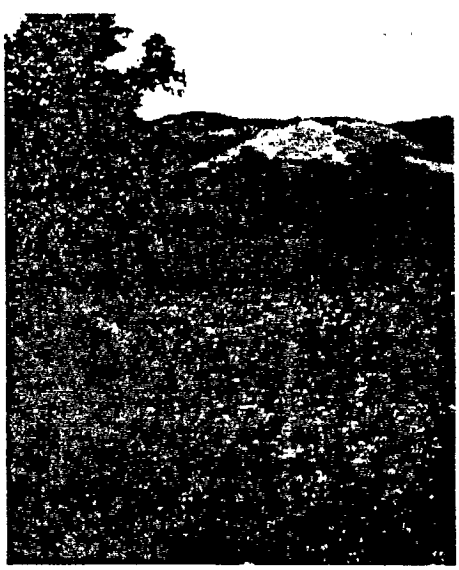
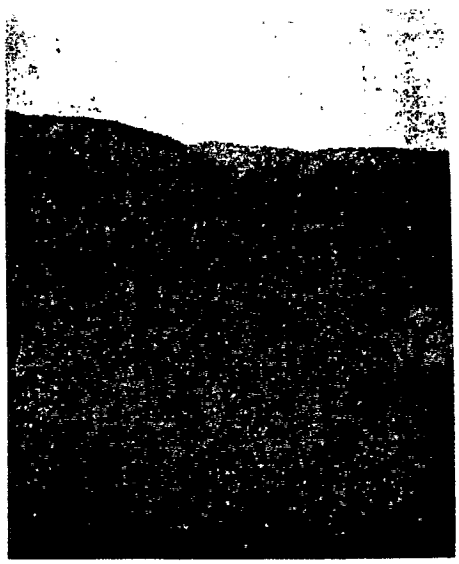


Fig. 14. California poppies dominate grassland areas where the pocket gophers have been very active. Poppies often occur in the Central Valley prairie after a soil disturbance. La Jolla Valley, Point Mugu SP; 30 May 1971



## EVALUATION OF RELICT CENTRAL VALLEY PRAIRIE SITES, 1971

In order to evaluate the remaining Central Valley prairie communities, a great number of contacts were made with specialists in range management, ecology, agronomy, and other fields. The evaluation includes the relative quality and quantity of known sites; only sites visited by the author were rated, all other known sites are noted only.

Quality of sites was determined by the density, and pureness of stands (frequency of non-native species), and by the number of native species present.

Quantity was measured by plotting stands on U.S.G.S. topographical quads; time did not permit accurate delineation of all stands.

Site quality ratings are summarized in Table 3, and quantity ratings are found in Table 4. Sites which have been confirmed by various individuals and publications, but not visited by the author are listed in Table 5.

The ecological values of many of these sites are summarized in the following paragraphs.

Table 3. Quality Ratings of Relict Central Valley Prairie Sites in California.

| Site Location | Rating |
|---|---|
| Dozier (Solano Co.) | Excellent |
| Cal Poly Arboretum (San Luis Obispo Co.) | Excellent |
| La Jolla Valley, Point Mugu SP (Ventura Co.) | Excellent |
| Camp Pendleton Marine Corps Base (San Diego Co.) | Excellent |
| Mount Tamalpais SP (Marin Co.) | Excellent-good |
| Hog Wallows (Solano Co.) | Excellent |
| San Luis National Wildlife Refuge (Kern Co.) | Excellent |
| Annadel Farms (Sonoma Co.) | Good |
| Hastings Natural History Reserve, UC (Monterey Co.) | Good |
| Gaviota SP (Santa Barbara Co.) | Good |
| Los Laureles Grade (Monterey Co.) | Good-fair |
| Salt Canyon (Colusa Co.) | Good |
| Leutholz Ranch (Solano Co.) | Fair |
| Henry Cowell Redwoods SP (Santa Barbara Co.) | Fair |
| Montana de Oro SP (San Luis Obispo Co.) | Fair |
| Humboldt Redwoods SP (Humboldt Co.) | Poor |
| Rio Vista Junction (Solano Co.) | Poor |
| Point Sal SB (Santa Barbara Co.) | Poor |
| Thousand Oaks (Ventura Co.) | Poor |

| Site Location | Approx. Acreage |
|---|---|
| Camp Pendleton Marine Corps Base | 2,000-3,000 |
| San Luis Island | 1,500 |
| Dozier | 1,000 |
| Mount Tamalpais SP | 1,000 |
| Annadel Farms | 550 |
| Hog Wallows | 500 |
| Hastings Natural History Reserve | 300 |
| Cal Poly Arboretum (and adjacent areas) | 300 |
| La Jolla Valley | 250 |
| Salt Canyon | 200 |
| Leutholz Ranch | 150 |
| Henry Cowell SP | less than 50 |
| Gaviota SP | less than 50 |
| Montana de Oro SP | less than 50 |
| Humboldt Redwoods SP | less than 50 |
| Point Sal SB | less than 50 |
| Rio Vista Junction | less than 50 |
| Thousand Oaks | ? ? |
| Los Laureles Grade | ? ? |

Table 4. Site Quantity Ratings of Relict Central Valley Prairie Stands in California

1. Antelope Valley (Los Angeles Co.)
2. Fort Ord Military Reservation (Monterey Co.)
3. Hopland Field Station, U.C. (Mendocino Co.)
4. Luke's Prairie – Humboldt Redwoods SP (Humboldt Co.)
5. Old River Islands (San Joaquin Co.)
6. Proberta (Shasta Co.)
7. Rancho Mission Viejo (San Diego Co.)
8. Salinas Valley (Monterey Co.)
9. San Joaquin River Islands (San Joaquin Co.)
10. Santa Barbara Channel Islands (Santa Barbara Co.)
11. San Benito Valley (San Benito Co.)
12. White Rock Crossing (Sacramento Co.)
13. Camp San Luis Obispo Military Res. (San Luis Obispo Co.)
14. Deer Valley (El Dorado Co.)
15. Putah Creek (Solano/Yolo Cos.)
16. Rancho Rio de Los Putas (Yolo Co.)
17. Salmon Creek, Wright Ranch near Humboldt Redwoods SP (Humboldt Co.)
18. Delta Meadows (Sacramento Co.)
19. San Joaquin River Rookery (San Joaquin Co.)
20. Friant area (Fresno Co.)

Table 5. Relict Central Valley Prairie Sites Confirmed, But not Visited or Rated by the Author

California bromegrass (Bromus carinatus).

*Location:* Great Valley Landscape Province. (U.S.G.S. Dozier and Bird's Landing 7½' quads; T5N, R1E, one mile south of Dozier Station along State Route 113. Portions of sections 13, 14, 23, 24 & 25.)

*Ownership:* Hamilton Brothers; Rio Vista, California

*Present Use:* Sheep and cattle grazing.

*Elevation:* 13-21 feet

*Vegetation:* All of section 24 and the north ½ section of 25 contain excellent examples of the Central Valley prairie and the freshwater marsh community. Both the "hog wallow" and stipa communities of the Central Valley prairie are well represented here. According to Mr. Beecher Crampton, this area has the finest example of the Central Valley prairie in the state; the author agrees with this statement. The area is an excellent miniature example of this prairie ecosystem, with high species diversity and many native species. The vernal lake located at the section corner 14/13 & 23/24 has a rare and endangered native grass species which occurs nowhere else in the world; this is *Orcuttia murcronata*. The dominant vegetation of the intermittent alkaline lake basin is *Frankenia grandifolia, Cressa truxillensis, Sida hederacea,* and *Eryngium aristulatum*, with some patches of *Heleocharis palustris, Distichlus spicata, Lippia nodiflora,* var. *reptans* and *Navarretia bakeri.* The rare and endemic *Orcuttia* and *Neostapfia colusana* grow in association with *Frankenia* and *Eryngium* (Crampton, 1959). Figures 15-18 picture the large, half-mile in diameter vernal lake.

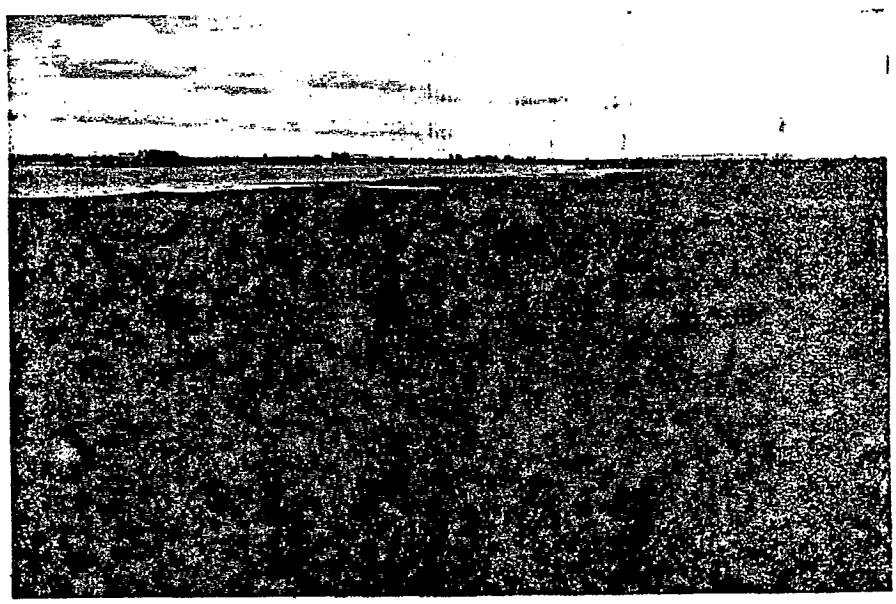


Fig. 15. Large vernal lake in the Central Valley prairie south of Dozier Station, Solano Co. Foreground dominated by soft chess and goldfields; 16 May 1971.

Fig. 16. Another portion of the vernal lake with a eucalyptus grove in the background (looking north). Foreground contains elements of the Central Valley prairie; 16 May 1971.

Fig. 17. This vernal lake is the only habitat in the world where the rare and endangered *Orcuttia murcronata* occurs. Its ecotope is on the edge of the pool as seen in the center of the photo. The foreground is dominated by *Baeria fremontii*; 16 April 1971.

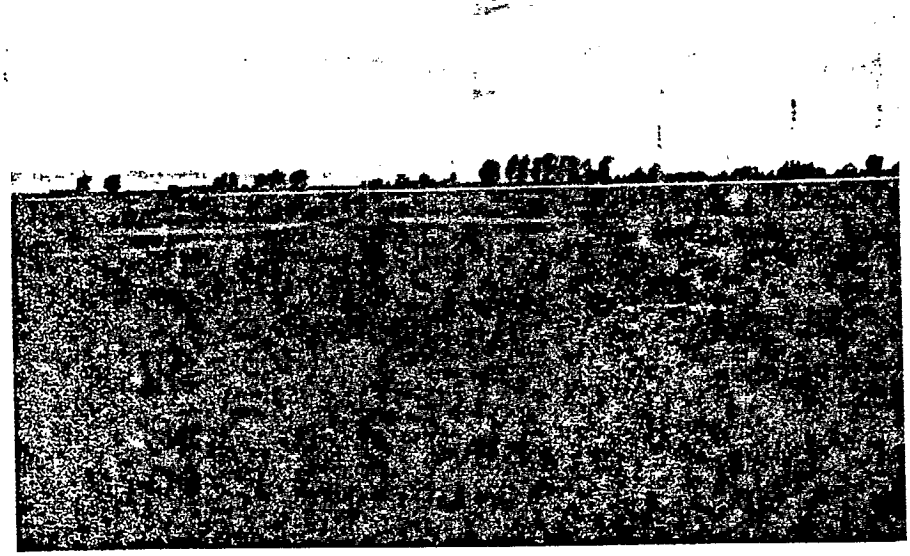


Fig. 18. The vernal lake from a distance and goldfields in center of photo; 16 April 1971.

The stipa community occupies the higher, well drained hummocks on Antioch fine sandy loam in the south end of the grassland and Olcutt fine sandy loam at the north end of the grassland area, and purple needlegrass covers from 5 to 55 percent of the area according to Adams (1964). Soft chess and ripgut are sub-dominant. Other species are wild oats, goldfields, *Erodium obtusiplicatum, Orthocarpus erianthus, Cerastium vercosum, Sidalcea malvaeflora,* blue eyed grass (*Sisyrinchium bellum*), *Ranunculus californica,* and *Hypochaerus glabra*. Figures 19-28 show examples of the physiognomy of this community.

The hog wallow community is dominated by soft chess, goldfields, salt grass (*Distichlus spicata*), annual hairgrass (*Deschampsia danthonoides*), foxtail fescue (*Festuca megalura*), European foxtail fescue (*F. dertonensis*), Johnny jump up (*Viola pedunculata*), *Cerastium viscosum* and *Downingia pulchella*. Figures 19, 20, 21, 22, 23, 24, 27, and 28 show the physiognomy of this community.

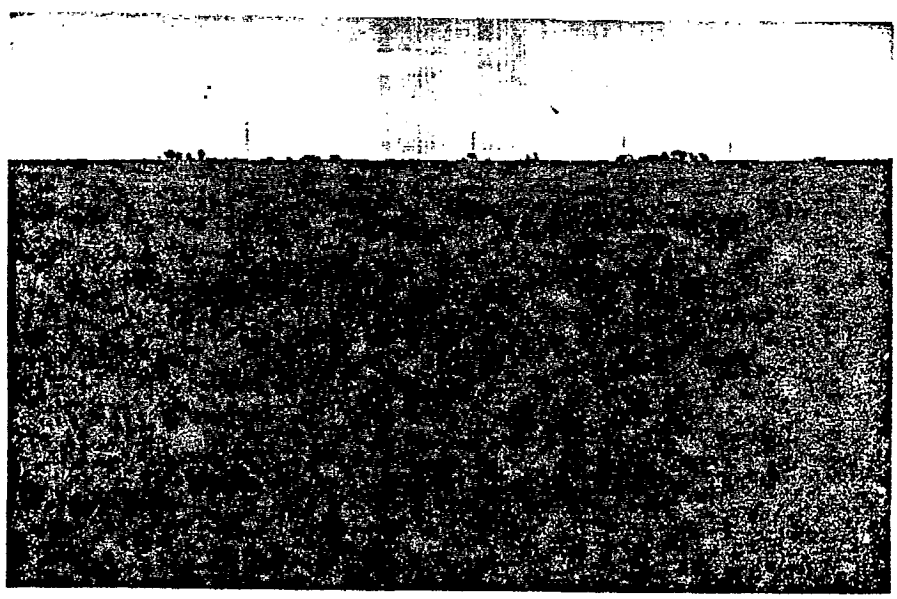


Fig. 19. Bunches of purple needlegrass surrounded by soft chess. This association dominates higher dryer areas on Antioch fine sandy loam; 16 April 1971.

Fig. 20. Depressions in the Central Valley prairie are dominated with goldfields and the high hummocks are dominated by bunches of purple needlegrass, NE ¼ section 25; 16 April 1971.

Fig. 21. Locations of vernal pools are indicated by the yellow-flowered goldfields in the NE ¼ section 25; 16 April 1971.

Fig. 22. Healthy bunches of purple needlegrass are seen throughout section 24, which is an excellent example of the pristine Central Valley prairie, and the best example found in the Dozier area and in the Great Valley landscape province; 16 April 1971.

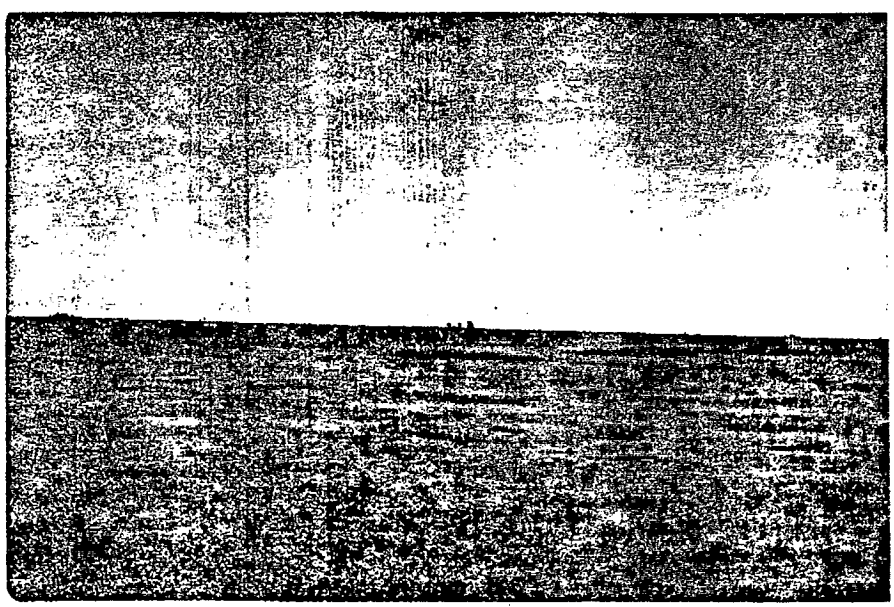


Fig. 23. Masses of goldfields in section 24. Scenes like this were common in the Great Central Valley landscape province during pristine times; 16 April 1971.

Fig. 24. Some dried vernal pools are dominated by *Orthocarpus attenuatus* (white mass in center of photo). Sedges dominate green areas. A portion of section 23; 16 April 1971.

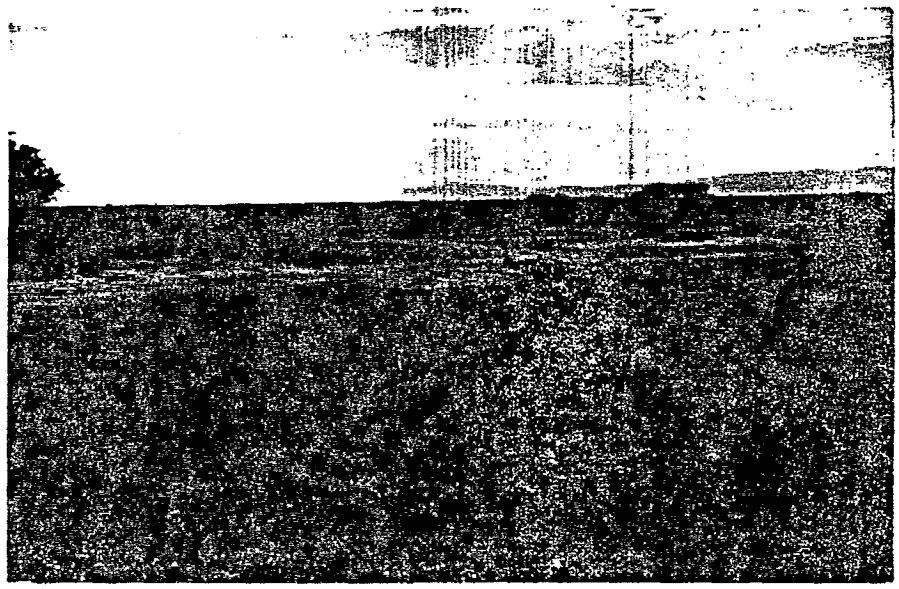
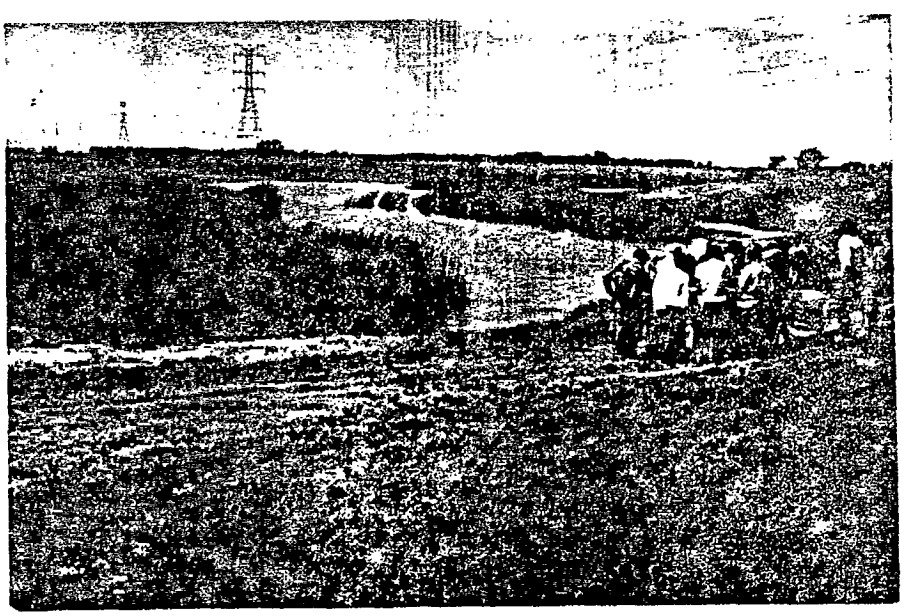


Fig. 25. Stipa community in section 25. UCD ecology class conducted by Dr. Jack Major; 16 April 1971.

Fig. 26. Freshwater marsh with UCD ecology class studying the marshland-grassland ecotone, which is dominated by Johnny tuck. The freshwater marsh is dominated by tule or bulrush and spike rush; 16 April 1971.



The freshwater – or tule – marsh community is dominated by common tule (*Scirpus auctus*), California bulrush (*S. californicus*), spike rush (*Heleocharis palustris*), and Cattail (*Typha domingensis*). Figures 25 and 26 show the physiognomy of the freshwater marsh.

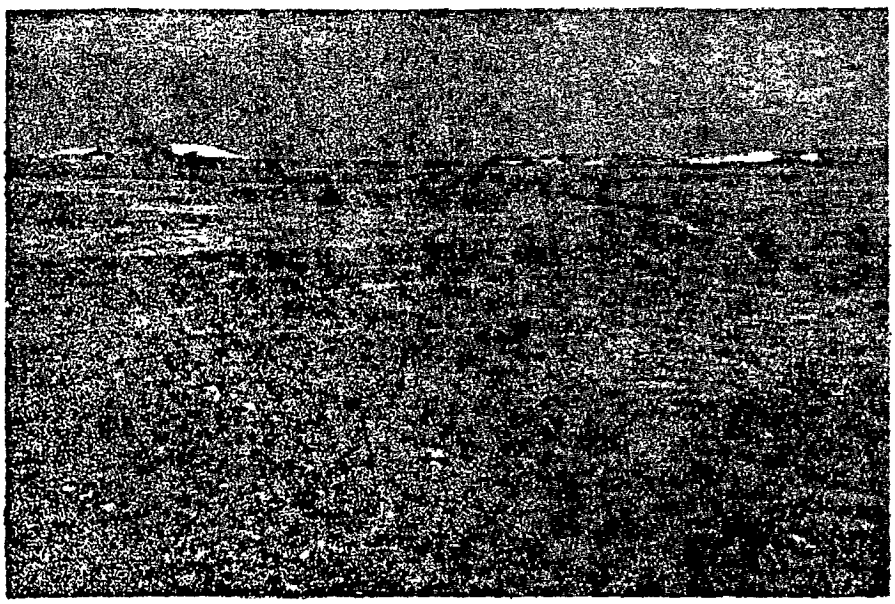


Fig. 27. Field dominated by *Orthocarpus erianthus* near a vernal pool. East ½ section 18, south of Dozier Station; 16 April 1971.

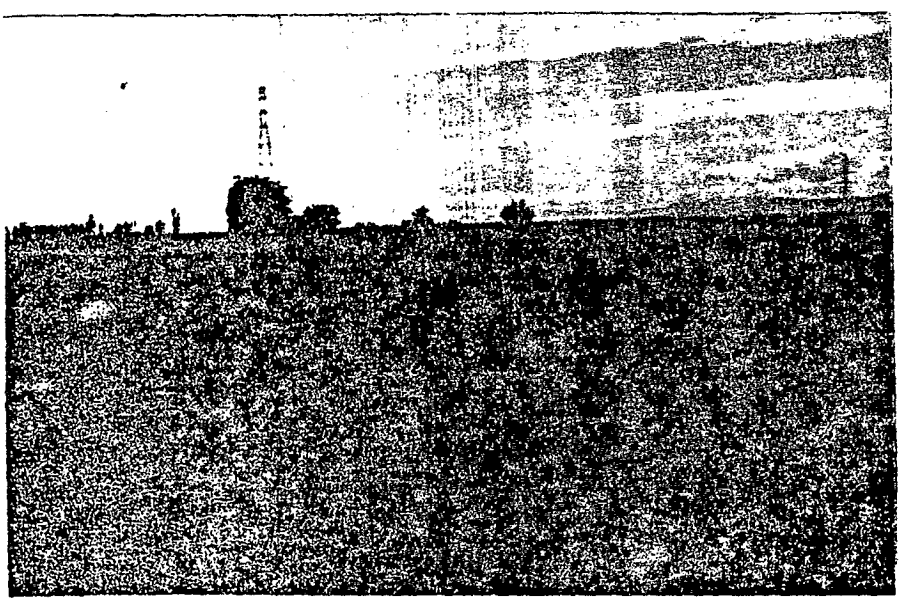


Fig. 28. Goldfields dominate on wet compacted soils in the background while Johnny tuck and wild barley (*Hordeum brachyantherum*) occur in wet, less compacted soil in the foreground, section 14; 16 April 1971.

*Recommendations:* Figure 29 delineates areas of the stipa grassland community within the best remaining example of the Central Valley prairie in the state. The area should be considered for State Reserve status. Portions of sections 14 and 23 east of the railroad; all of sections 13, 24 and 25; the west ½ of sections 18, 19 and 30 should be preserved for representation as part of the natural landscape of the Great Valley landscape province.

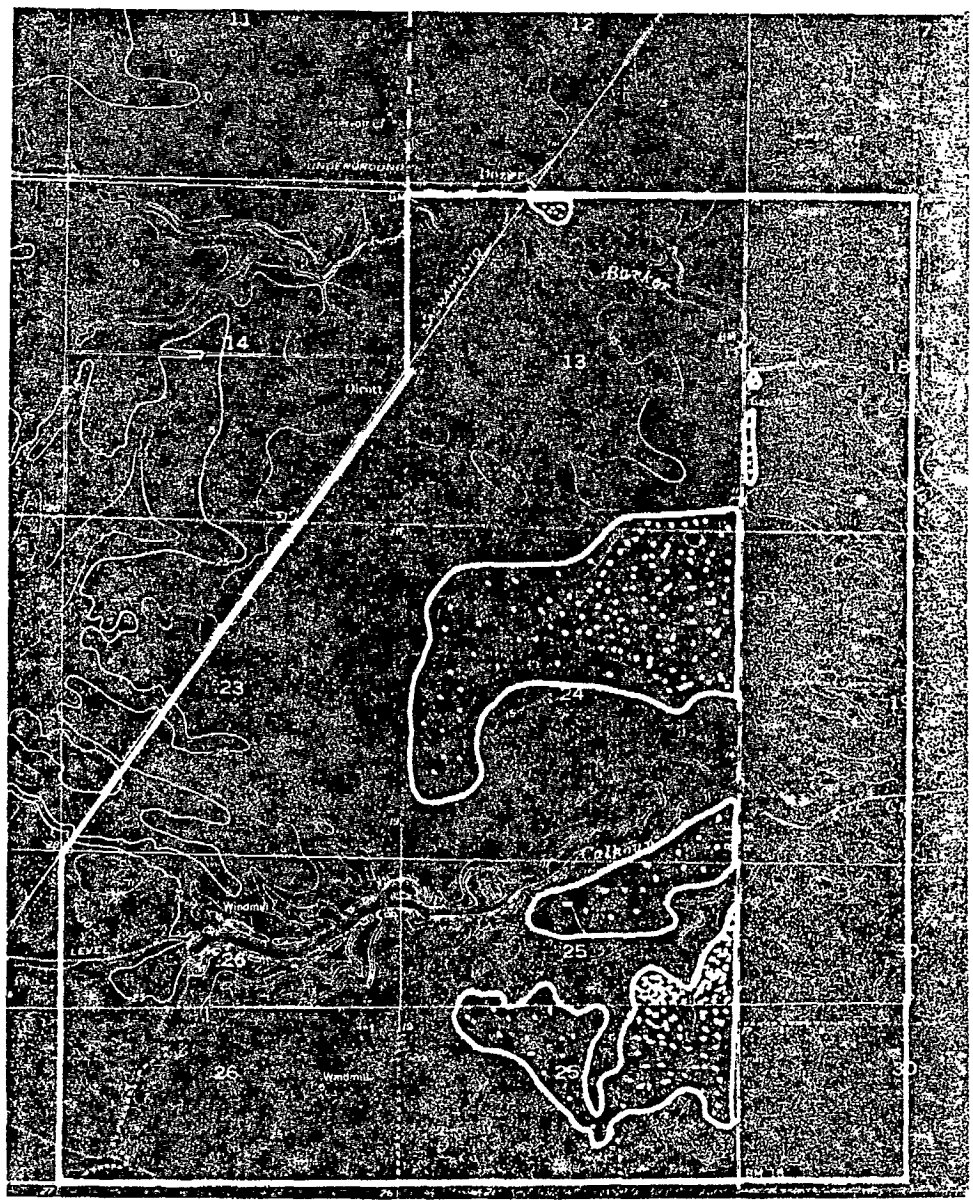



Fig. 29. Proposed State Reserve near Dozier Station, Solano Co. (Dozier and Birds Landing U.S.G.S. 7½' quads). The outer area delineates a unique group of plant communities making up the best example of the pristine-like Central Valley prairie in the state. The irregular outlines contain the *Stipa* association with the dots representing relative density of purple needlegrass. The large vernal lake contains two rare and endangered grasses.

## CALIFORNIA STATE POLYTECHNIC COLLEGE ARBORETUM AND PETERSON RANCH UNIT

*Location:* Sierra Foothill and Low Coastal Mountain Landscape Province (San Luis Obispo 7½' quad; R12E, T30S. Horse Canyon – Brizziolari Creek area northwest of campus; sections 13, 14, 23 & 24.) (See Figs. 33 and 34.)

*Present Use:* Arboretum stands have been used for scientific study with no grazing for at least 20 years. The Peterson Ranch unit is grazed by livestock.

*Elevation:* 400 to 1,185 feet.

*Vegetation:* Purple needlegrass occurs on serpentine outcrops on rolling hills, often below the California chaparral and above the annual grassland community. The soil is classified as Montara rocky clay. Dr. John V. Stechman has mapped and classified the vegetation of the area. He recognizes three associations in the stipa community; these are *Stipa* (Fig. 30), *Stipa-Festuca* (Fig. 31), and *Stipa-Yucca* (Fig. 32).

The dominant species of the stipa association are purple needlegrass, and dwarf plantain (*Plantago erecta*). Other species are hazardia (*Haplopappus squarrosa*), and California melic. The *Stipa-Festuca* association is dominated by purple needlegrass, and foxtail fescue (*Festuca megalura*). Other important native species are pine bluegrass, foothill needlegrass, California melic, Junegrass and Blue-eyed grass.

The *Stipa-Yucca* association is similar to the above native grass associations but it also contains Our Lord's Candle (*Yucca whipplei*).

*Recommendations:* The arboretum is protected and requires no changes. However, the areas that are grazed might be considered for protection or research purposes. The arboretum could be expanded to encompass these areas.

Fig. 30. Stipa association of the Central Valley prairie, west of Horse Canyon on the Peterson Ranch unit, California Polytechnic College, San Luis Obispo. The physiognomy is very similar to an alpine fell field. Note serpentine outcrops; 28 April 1971.

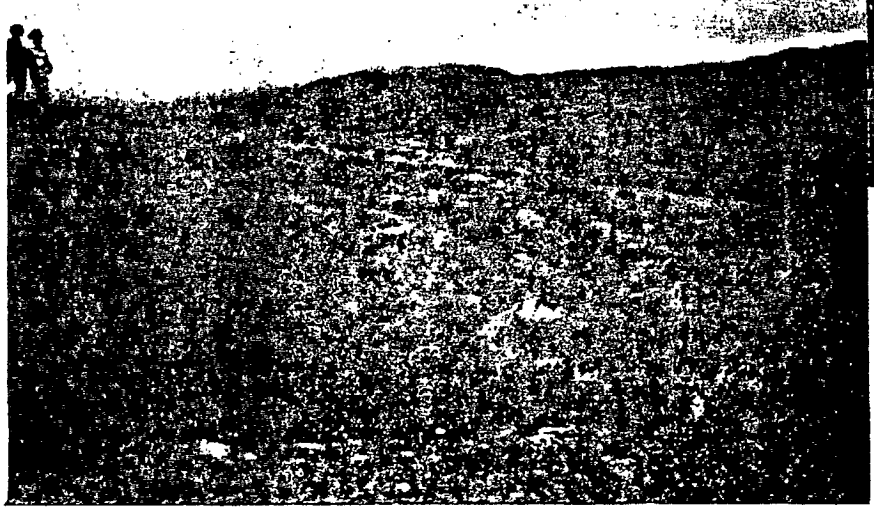
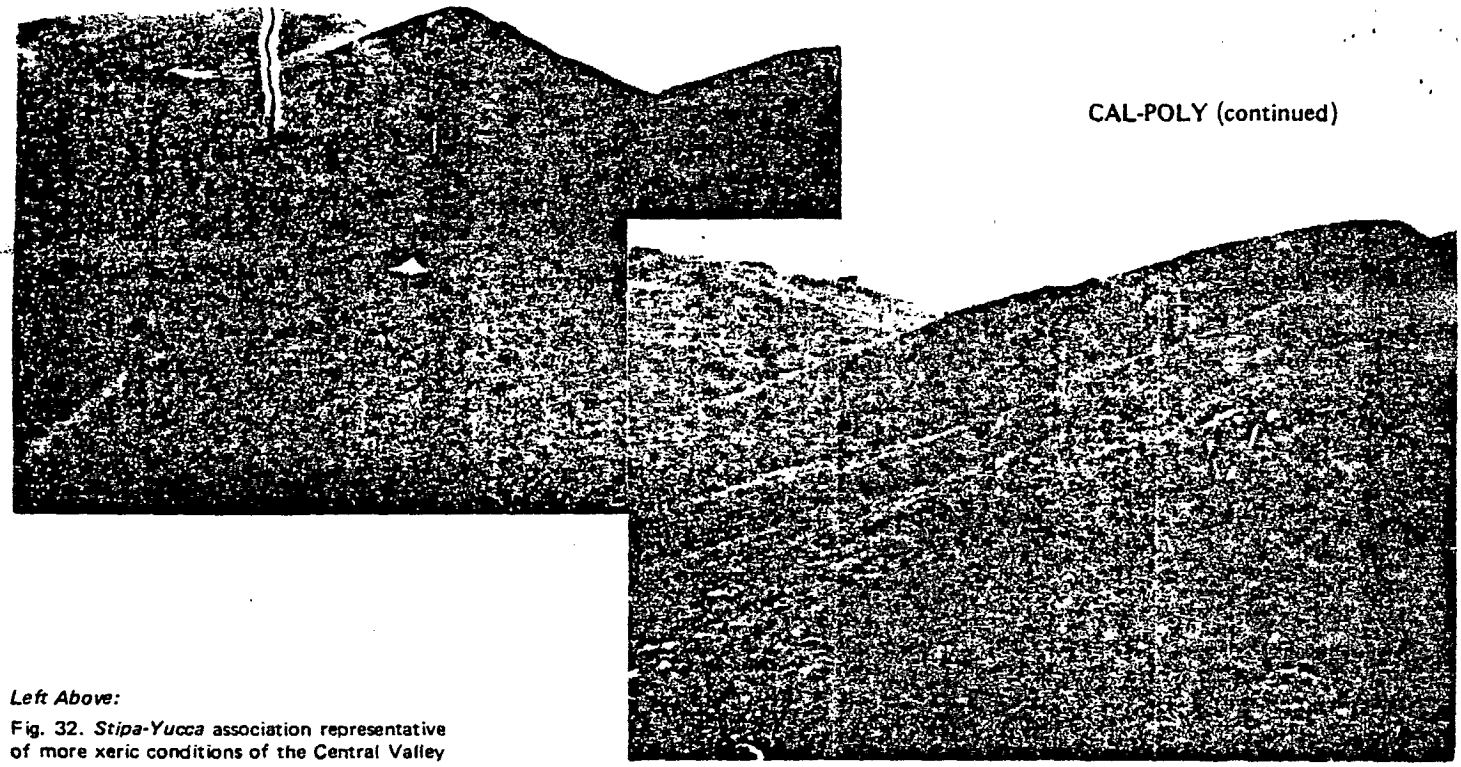


Fig. 31. *Stipa-Festuca* association of the Central Valley prairie east of Horse Canyon on the Peterson Ranch unit, California Polytechnic College, San Luis Obispo; 28 April 1971.



*Left Above:*

Fig. 32. *Stipa-Yucca* association representative of more xeric conditions of the Central Valley prairie. Arboretum is located on the hill in the center of the photo. Peterson Ranch unit, California Polytechnic College, San Luis Obispo; 28 April 1971.

*Right Above:*

Fig. 33. Purple needlegrass occurs associated with *Plantago erecta* and dwarfed coast live oak on serpentine soils. Peterson Ranch unit, California Polytechnic College, San Luis Obispo; 28 April 1971.

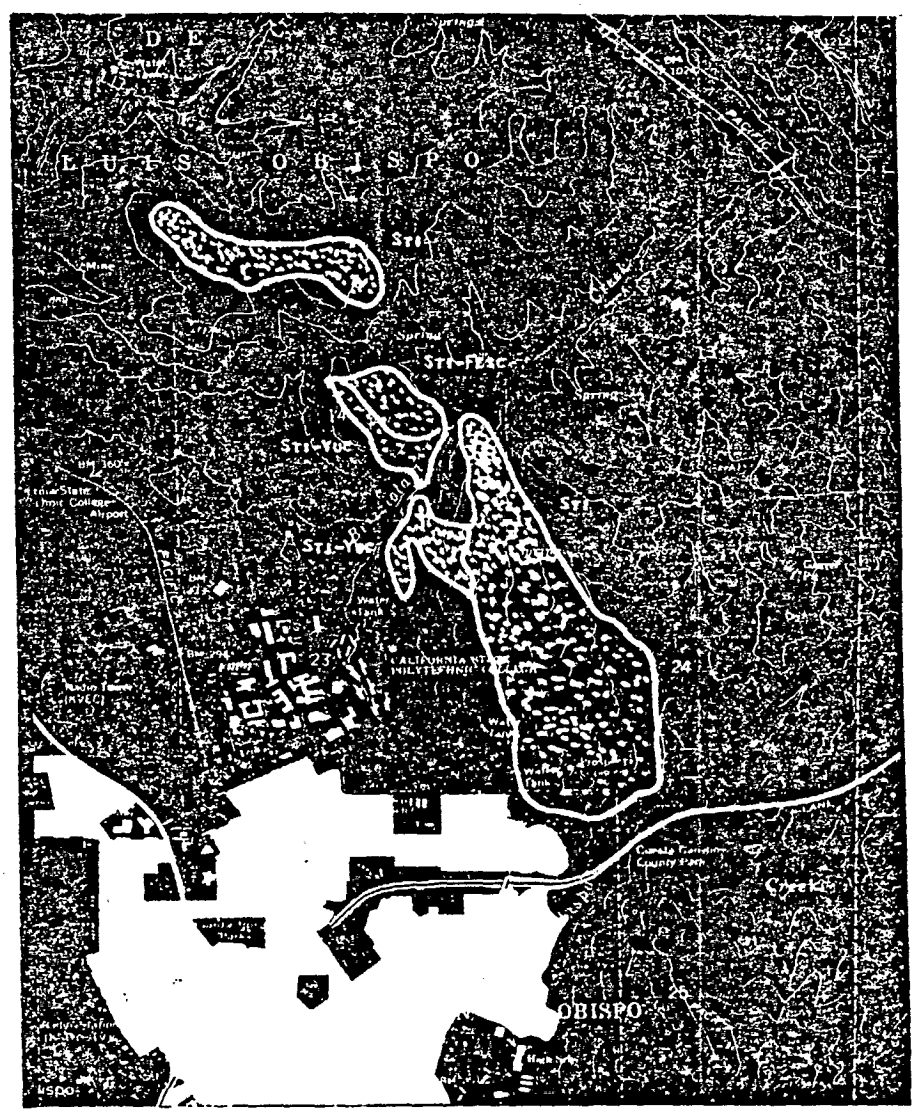



Fig. 34. Distribution of relict Central Valley prairie stands on the California Polytechnic College ranch (San Luis Obispo U.S.G.S. 7½' quad). Sti = *Stipa* association; Sti-Fesc = *Stipa-Festuca* association; and Sti-Yuc = *Stipa-Yucca* association as mapped by Dr. John V. Stechman.

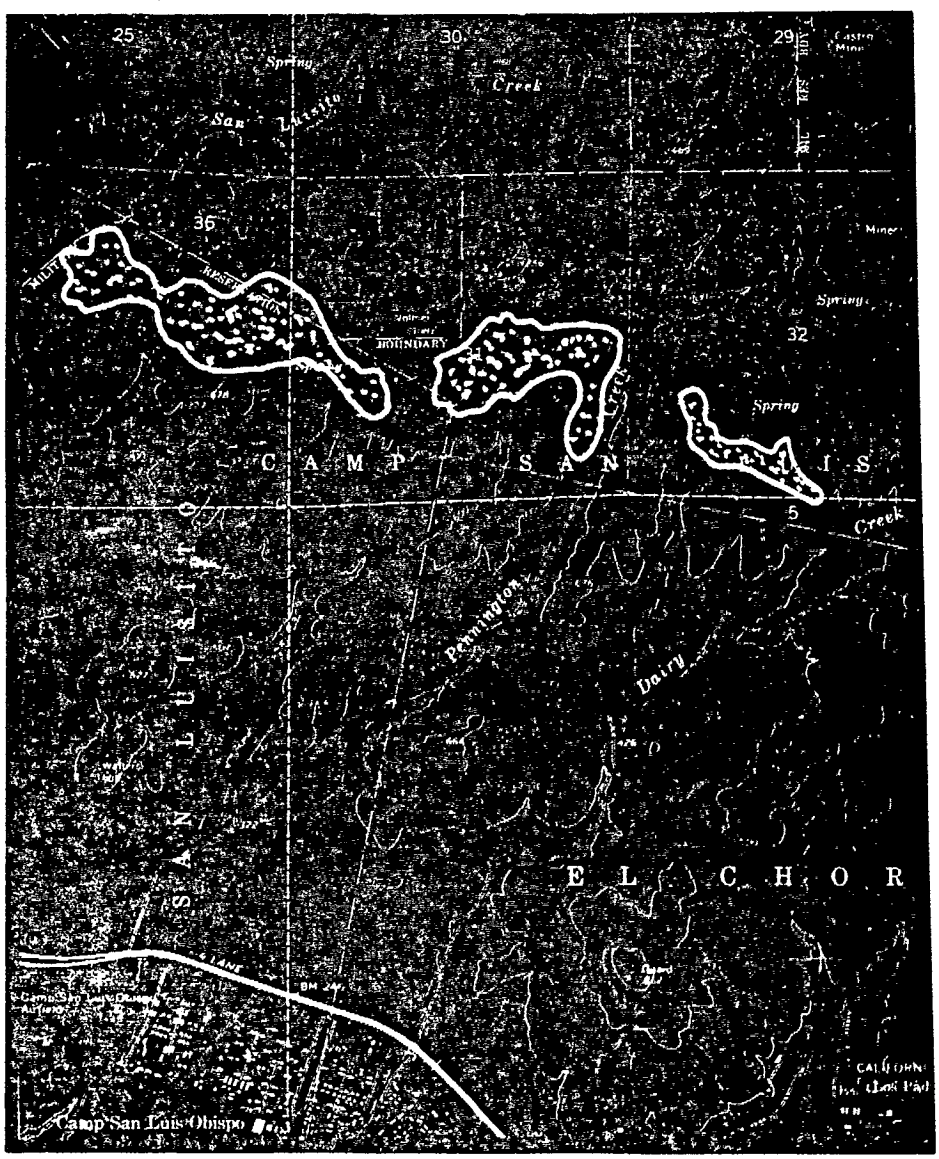



Fig. 35. Distribution of relict Central Valley prairie stands on Camp San Luis Obispo Military Reservation as mapped by Dr. John V. Stechman (San Luis Obispo U.S.G.S. 7½' quad).

## POINT MUGU SP – LA JOLLA VALLEY

*Location:* Southwest Mountain Valley Landscape Province (Point Mugu U.S.G.S. 15' quad).

*Elevation:* 550-875 feet.

*Use:* Past use includes cultivation and grazing, now released from grazing.

*Vegetation:* Elements of the Central Valley prairie have been re-established around the perimeter of La Jolla Valley and in some disturbed areas within the California coastal chaparral and coastal sage scrub communities (Figs. 36-41). One of the dominant species of the Central Valley prairie, purple

Fig. 36. La Jolla Valley from the east rim. Infrared film allows the use of remote sensing techniques to map vegetation, (Kodak Infrared Ektachrome-f22 at 1/60 sec.), silvery white areas are grassland vegetation; 26 April 1971.

Fig. 37. La Jolla Valley from the east rim. Ektachrome X was used for comparison with infrared. Note areas of native tarweed in yellow and silver sage in silver. Comparison shots often bring out different elements of the vegetation; 26 April 1971.

POINT MUGU (continued)

needlegrass, forms solid stands over about 100 acres in the south and western ends of the valley (Figs. 44-49). Here at the edge of the fog belt, on Cropley clay and Garretson loam, purple needlegrass has reached its present ecological optimum.

Dr. Harold F. Heady says this is the finest stand of purple needlegrass he has ever seen. The author has come to the same conclusion; no other stands in the state are as vigorous or as dense (Figs. 45-47). Dr. Heady also noted that the stands had expanded greatly since 1965. Stipa stands in the La Jolla Canyon occur on Zamora loam and are not as vigorous; but the stands contain both purple and foothill needlegrasses as co-dominants (Fig. 50). Foothill needlegrass also occurs on the grassland-chaparral ecotone and as an understory in the California coastal chaparral and coastal sage scrub.

Figs. 38, 39. Kodak Ektachrome (left) and Infrared Ektachrome (right) comparison photos of the La Jolla Valley. Note dark areas in the center of the valley in right photo (upper portion of photo); these areas consist mainly of introduced annual grasses such as Italian ryegrass and wild barley. Red dots are laural sumac in the California coastal chaparral community and black represents the southern oak woodland community; 26 April 1971.

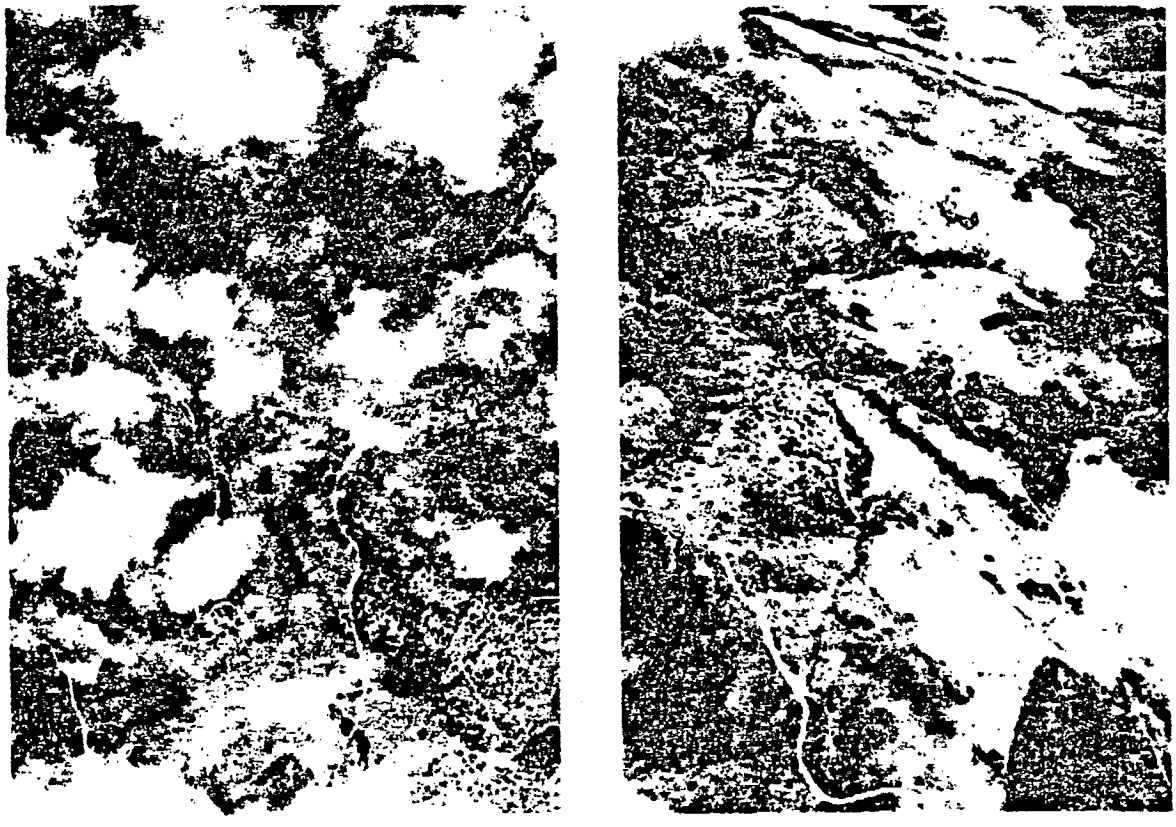


Fig. 40. Infrared Ektachrome photo of the center of La Jolla Valley. Straw-colored areas are purple needlegrass; 26 April 1971.

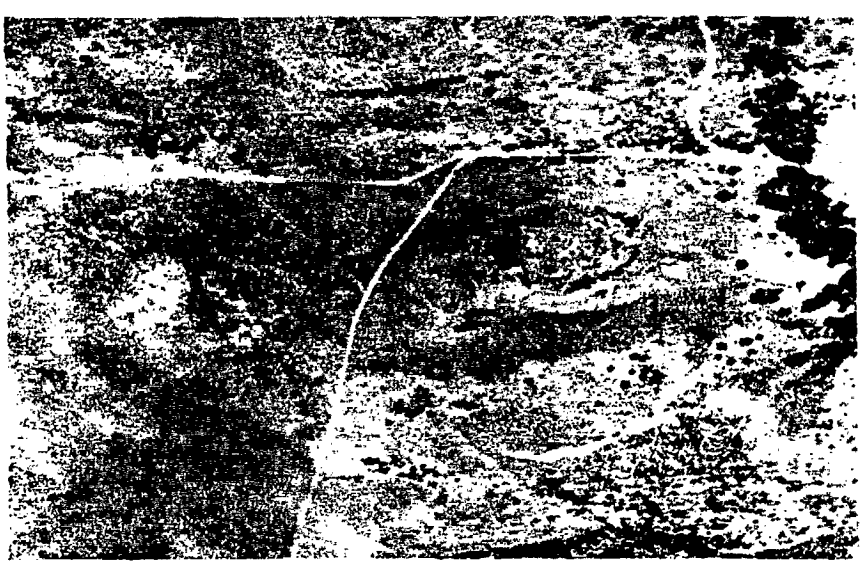


Fig. 41. Ektachrome photo of the center of La Jolla Valley. Silver areas are silver sage, yellow is tarweed, light green is wild barley (left of photo), harding grass (right center). Circular areas are evidence of cultivation; 26 April 1971.

Fig. 42. Infrared Ektachrome of the Danielson Ranch area in upper Big Sycamore Canyon. Cultivated areas shown in white are mainly wild oats; 26 April 1971.

Fig. 43. Ektachrome X of the Danielson Ranch area. Straw-colored areas are under cultivation; 26 April 1971.

Fig. 44. La Jolla Valley looking east from Mugu Peak. Areas of solid purple needlegrass are located between the coastal sage scrub (foreground) and the southern oak woodland (center). Dark green areas in grassland are the introduced harding grass. Light green and straw-brown areas are purple needlegrass; 31 March 1971.

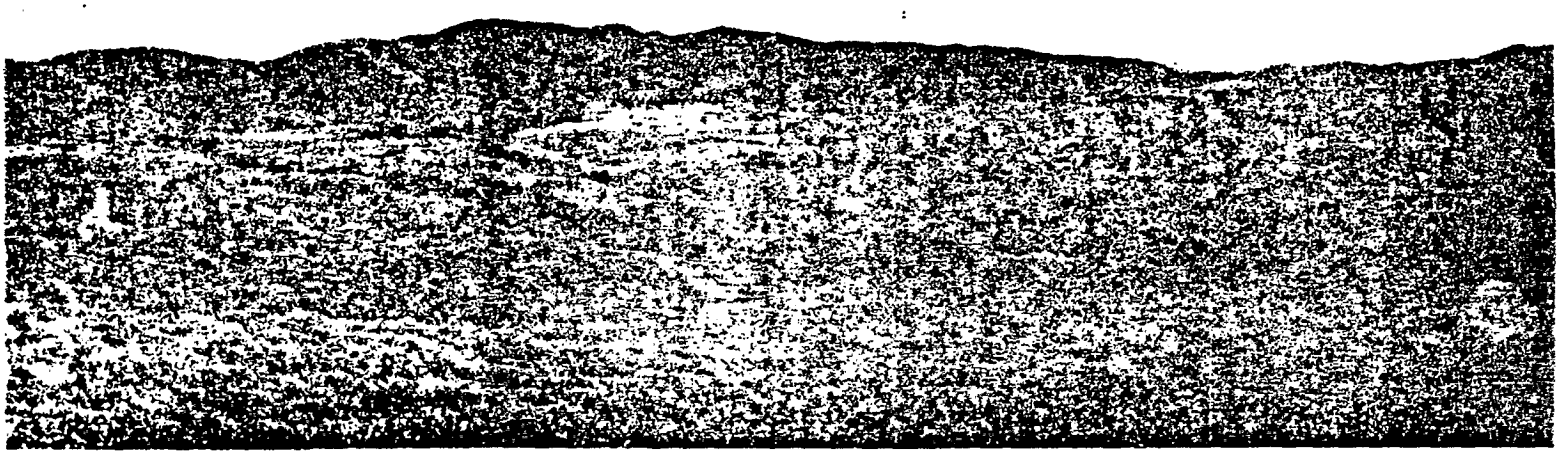


Fig. 45. Solid stands of purple needlegrass in the south end of La Jolla Valley are the finest stands found in the state; 31 March 1971.

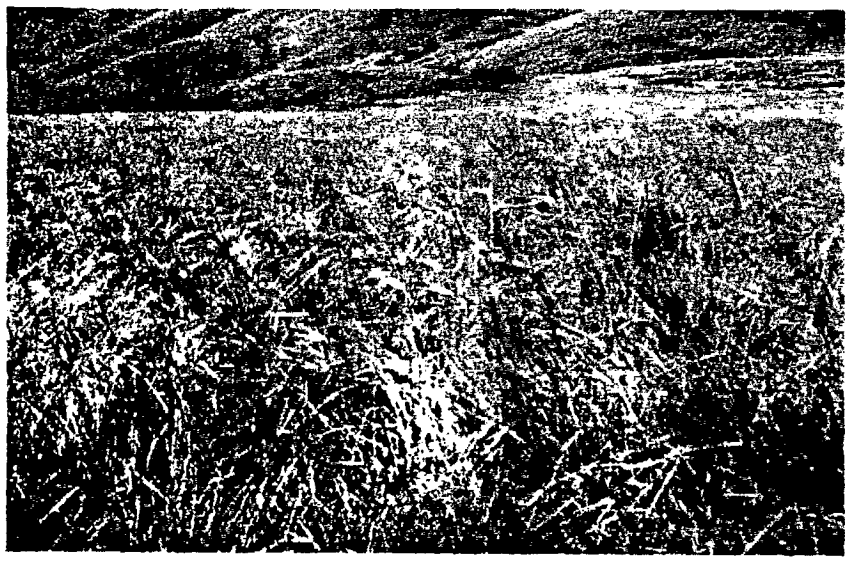


Fig. 46. Solid purple needlegrass stands in the La Jolla Valley reach up to 4 feet tall; 31 March 1971.

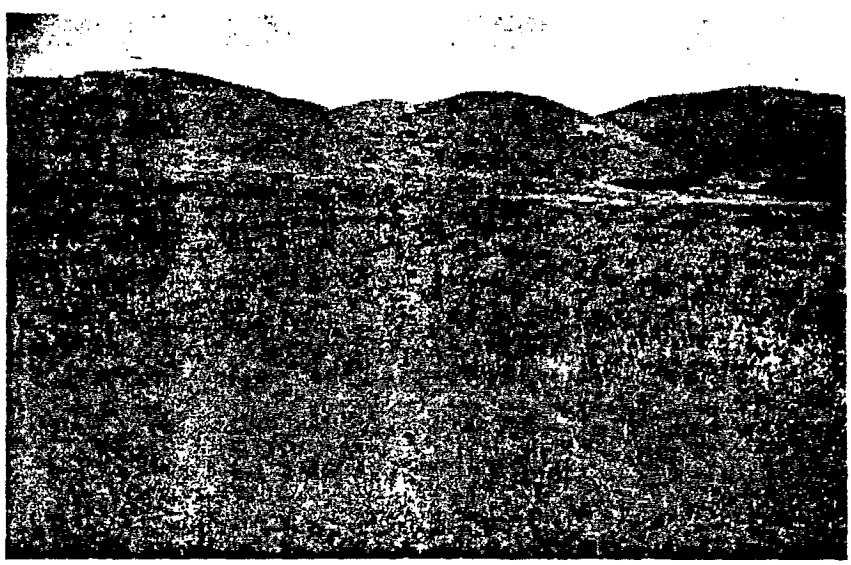


Fig. 47. Enclosure contains harding grass while outside the enclosure is needlegrass. Apparently harding grass is more palatable, thus is less tolerant to grazing than is purple needlegrass; 31 March 1971.

Fig. 48. Southwest end of La Jolla Valley with Mugu Peak in background. Note the straw-colored purple needlegrass in a mozaic of green barley and silver colored sage. Photo by J. Tryner; 27 April 1971.

Fig. 49. West side of the La Jolla Valley with a mozaic of grassland species. Purple needlegrass and wild oats are straw-colored with green wild barley. Gray is Italian ryegrass. Photo by Mr. J. Tryner; 27 April 1971.

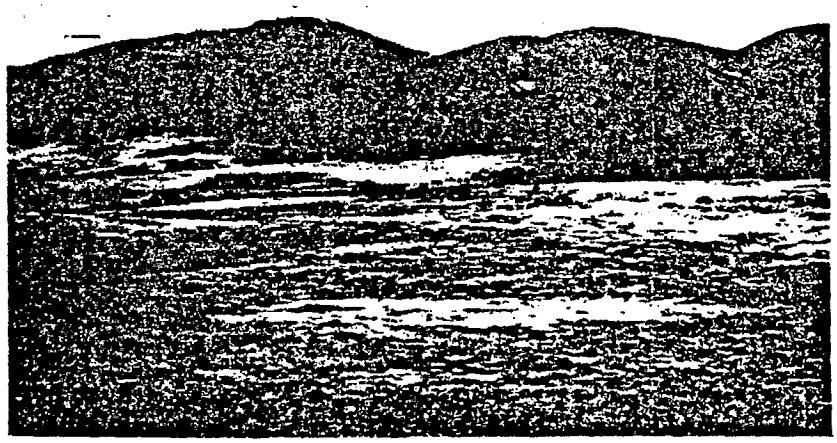


Fig. 50. Native grassland in La Jolla Canyon. Purple needlegrass and foothill needlegrass dominate on Zamora loam. The access road to La Jolla Valley crosses this area. Photo by Mr. J. Tryner; 27 April 1971.

The north end of the valley contains other elements of the Central Valley prairie. Tarweed (*Hemizonia ramosissima*) (Figs. 54-58, & 63) dominates on the heavier more compacted soils, i.e., Los Osos clay loam and Cropley clay. A mixture of native and exotic species occurs on Cropley clay and Malibu loam at the extreme north end of the valley. Purple needlegrass occurs here in an admixture with such natives as tarweed, brodiaea (*Brodiaea jolonensis*), blue-eyed grass (Fig. 62), California melic (*Melica imperfecta*), goldfields (*Baeria chrysostoma*), *Festuca reflexa,* foothill needlegrass, California poppy (Figs. 14, 65) and shooting star (*Dodecantheon clevelandii*) (Fig. 65). Non-native plants include slender wild oats (*Avena barbata*), wild oats (*A. fatua*), red brome (*Bromus rubens*), Soft chess (*B. mollis*), ripgut (*B. rigidus*), Italian ryegrass (*Lolium multiflorum*), and black mustard (*Brassica nigra*) (Figs. 52, 65).

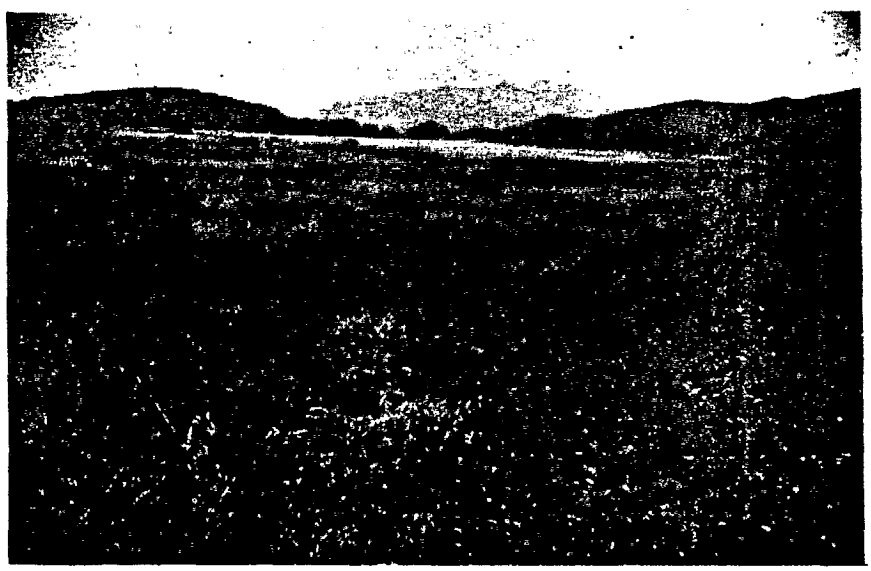


Fig. 51. Central La Jolla Valley with Boney Mountain in the background. Parking area and camper supply center site contains mostly non-native Italian ryegrass and black mustard; 30 February 1971.

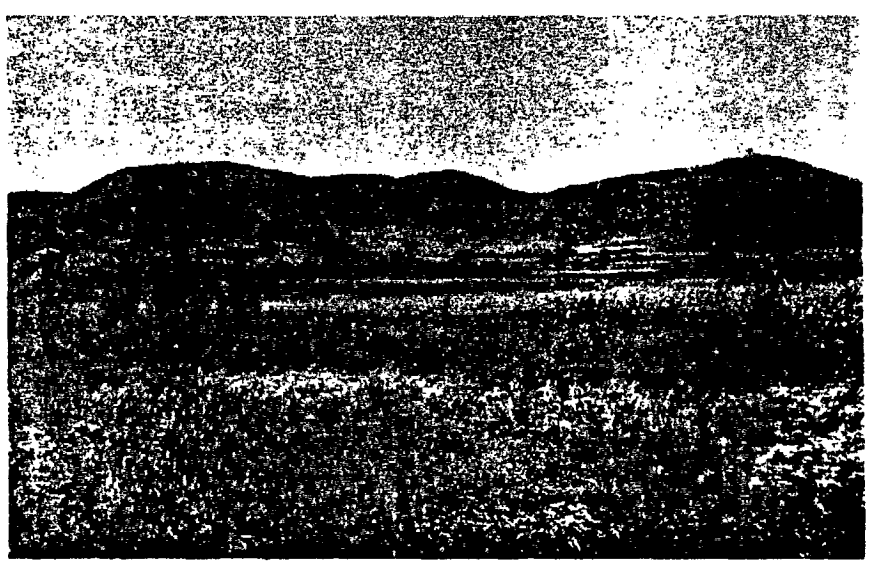


Fig. 52. Central La Jolla Valley. Dr. H. Heady, Mr. F. Meyer, Mr. J. Geary and Mr. J. Tryner standing on the picnic area site. Yellow flower is black mustard. The area contains mostly non-native species; 20 March 1971.

Fig. 53. Dr. Harold F. Heady standing next to a clump of purple needlegrass near the group camping site; 20 March 1971.

Fig. 54. North-central La Jolla Valley showing grassland mozaic with native tarweed (yellow) and purple needlegrass mixed with wild oats (straw-colored). This grassland area is planned for tent and camper camping. Photo by Mr. J. Tryner; 27 April 1971.

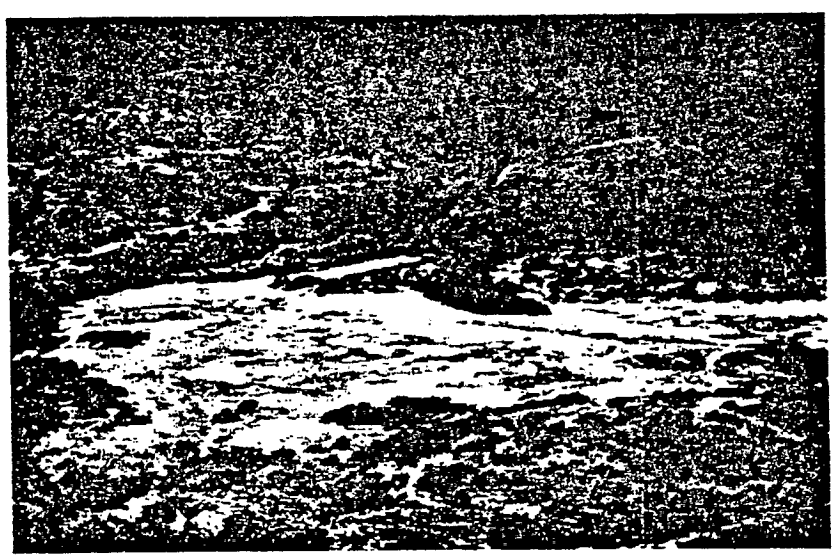


Fig. 55. Northern La Jolla Valley mozaic of native and non-native grasses is planned for tent camping. Photo by Mr. J. Tryner; 27 April 1971.

Fig. 56. Northern La Jolla Valley showing the camper camping area on the mozaic of tarweed, purple needlegrass and other native elements of the Central Valley prairie. Photo by Mr. J. Tryner; 27 April 1971.

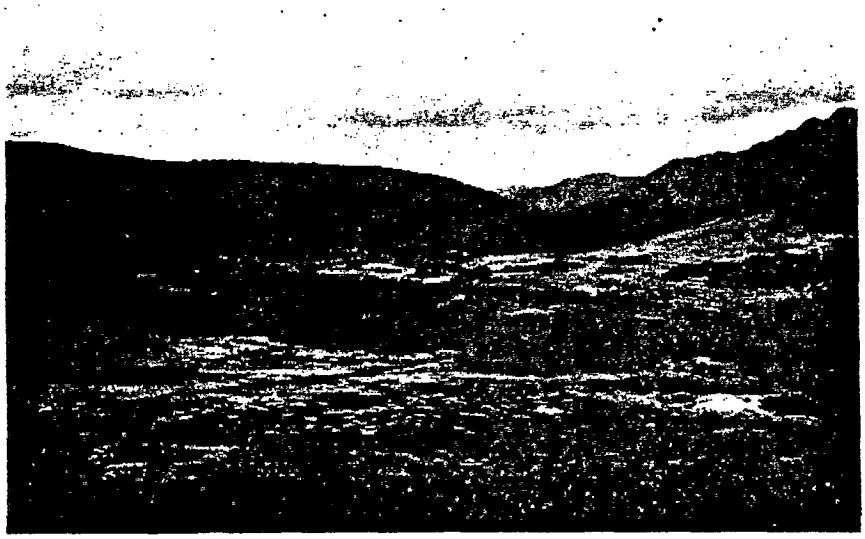


Fig. 57. North end of La Jolla Valley. Planned meadow area in foreground is a mozaic of tarweed (yellow), wild oats (straw-colored), purple needlegrass (straw-colored), and wild barley (green). Proposed camper camping area in the background is highly erodible. Photo by Mr. J. Tryner; 27 April 1971.

Fig. 58. Looking south across La Jolla Valley. Silver sage in foreground. Tarweed (green) occurs on heavier soils, especially Los Osos clay while purple needlegrass (straw) is found on moderately heavy soils, i.e., Cropley clay and Zamora loam; 26 April 1971.

No native species were found in the center of the valley. The main soils of this area are Los Osos clay loam and Cropley clay. This is a much more mesic ecotope than around the perimeter of the valley and the dominant species are Italian ryegrass, wild oats, black mustard, foxtail barley (*Hordeum leporinum*), redstem filaree (*Erodium cicutarium*) and *E. moschatum*. This exotic annual grass community will persist as long as the soil moisture remains high; the native bunchgrasses are rather intolerant of such high soil moisture.

The east side of the valley contains a mixture of native and non-native bunchgrasses and the introduced harding grass (*Phalaris tuberosa* var. *stenoptera*) (Fig. 59). This association occurs on mesic phases of Los Osos clay loam and Cropley clay soils.

The release of grazing pressure on the valley has apparently shifted the competitive position of needlegrasses. Under a no-grazing regime, native perennial needlegrasses are favored over exotic annual grasses in much of the La Jolla Valley.

*Recommendations:* Although the La Jolla Valley does not contain the most expansive or the greatest number of native species, it does have the best stands of purple needlegrass found anywhere. Native species are making a great comeback in this valley. The combination of edaphic, climatic, and biotic factors, which currently prevail in the valley, favor native Central Valley prairie elements over introduced annual grasses.

Figure 70 shows the areas in the valley which contain native elements of the Central Valley prairie. Areas outlined in red circumvent habitats dominated by native species, and the black lines delineate areas dominated by needlegrasses. The red lines indicate areas worthy of preservation without consideration of proposed development plans. The upper portion of Big Sycamore Canyon (Figs. 42, 43) has been highly disturbed and has no ecological significance. Cultivated areas will likely revert to annual grassland.

The areas outlined in red on Figure 70 would make the ideal boundaries for natural preserve status. The areas in solid black would be highest priority, especially the southern end of the valley. The southwest portion of the valley contains the best examples of the Central Valley prairie. Excellent representative examples of the southern oak woodland, the California coastal chaparral, the coastal sage scrub and riparian communities are found between Point Mugu and the La Jolla Valley..

Fig. 59. Clumps of non-native harding grass occurs along the east side of La Jolla Valley. These are often mistaken for native bunchgrasses; 31 April 1971.

Fig. 60. Dr. Michael M. Barbour examining native grassland areas above Big Sycamore Canyon. The area apparently had been disturbed sometime in the past, thus shifting competitive position from the coastal sage scrub to the Central Valley prairie; 30 March 1971.

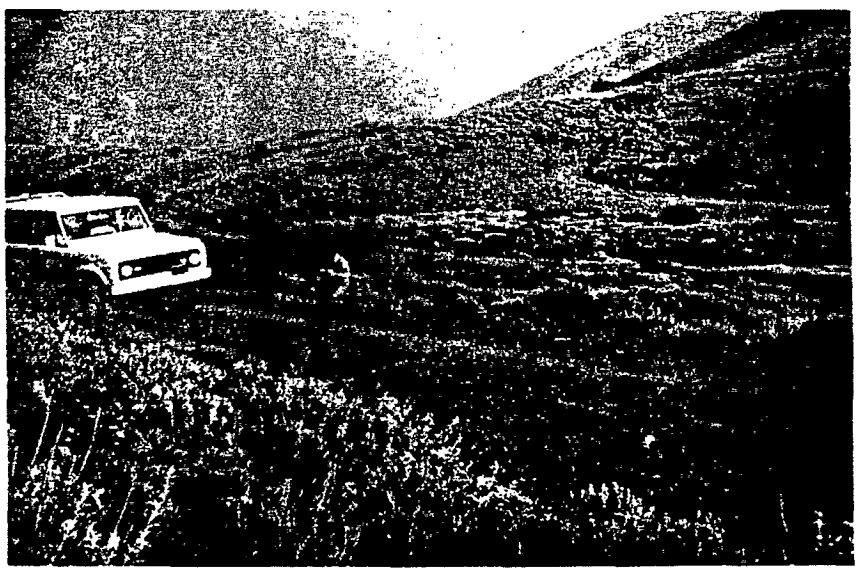


Fig. 61. Grassy swale above Big Sycamore Canyon contains solid stands of purple needlegrass on well drained soils of the Millsholm-Malibu complex; 30 March 1971.

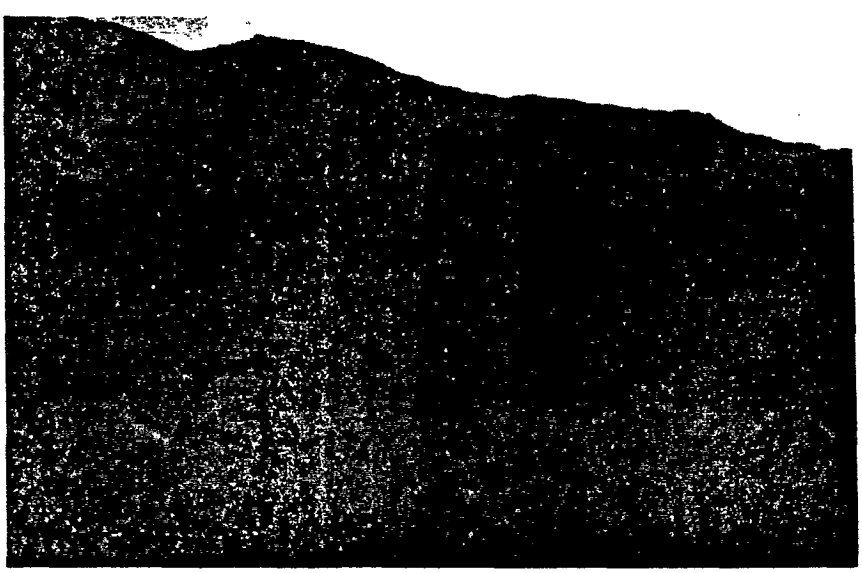


Fig. 62. Blue-eyed grass (*Sisyrinchium bellum*) is common in the Central Valley prairie ecosystem at Point Mugu.

Fig. 63. Grassland with purple needlegrass and tarweed in bloom. Big Sycamore Canyon.

Fig. 64. Purple needlegrass.

Fig. 65. Black mustard.

Fig. 66. California poppy.

Fig. 67. Indian paint brush is common along the chaparral-grassland ecotone.

Fig. 68. Shooting star occurs in the dryer areas of the stipa community.

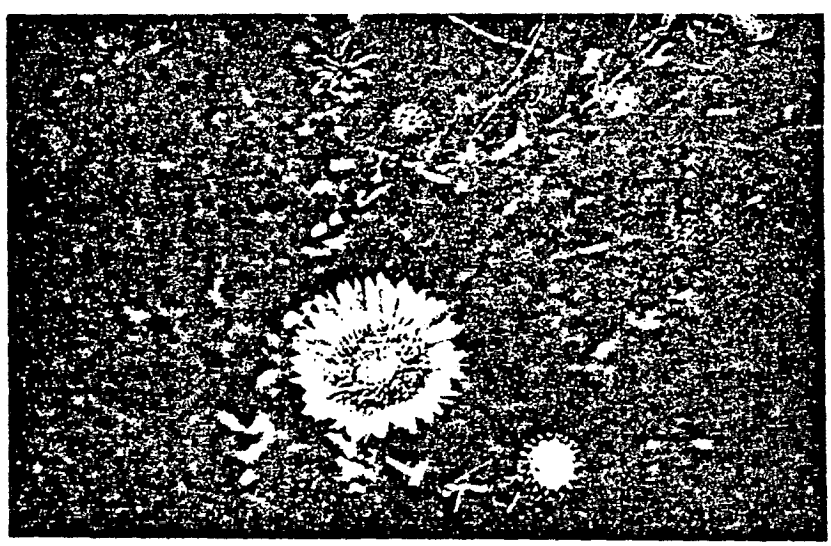


Fig. 69. *Haplopappus squarrosa* is found in more mesic areas of the Central Valley prairie in the La Jolla Valley. Photo by Mr. J. Tryner; 27 April 1971.


Fig. 70. Distribution of relict Central Valley prairie stands in Point Mugu SP. Dots indicate density of purple needlegrass. The solid white are areas containing elements of the Central Valley prairie, and the outside line encompasses areas worth preservation. (Pt. Mugu U.S.G.S. 15' quad).

Fig. 71. Grassy ridges in Mt. Tamalpais SP are dominated by purple needlegrass with some wild oats also present; 30 June 1971.

Fig. 72. Purple needlegrass in foreground on south ridge above Steep Ravine Canyon, Mt. Tamalpais SP; 30 June 1971.

Fig. 73. Central Valley prairie on the ridge surrounding the Lone Tree Creek watershed. Purple needlegrass dominates on the ridges while annual grasses become more prevalent with descending elevation. Mt. Tamalpais SP; 30 June 1971.

## MOUNT TAMALPAIS STATE PARK

*Location:* Sierra Foothill and Low Coastal Mountain Landscape Province (U.S.G.S. San Rafael and Point Bonita 7½' quads).

*Elevation:* 200-1,398 feet.

*Vegetation:* Much of the open grassland along the southern and western portions of the park contain elements of the Central Valley prairie. Purple needlegrass occurs in nearly pure stands on ridges with serpentine parent material. This native bunchgrass is associated with wild oats, ripgut, soft chess, and plantain. In more mesic and shadier redwood-grassland ecotones *Dichondra repens* occurs. Coyote brush (*Baccharis pilularis*) is invading eroded areas (Figs. 74, 75). As one goes down the ridges, species composition changes with wild oats becoming dominant on the coastal bluffs. Sheep sorrel (*Rumex acetosella*), a non-native, occurs occasionally in depressions.

Fig. 74. Coyote brush invading eroded grassland areas in the Lone Tree Creek watershed, Mt. Tamalpais SP; 30 June 1971.

Fig. 75. Following the invasion of Coyote brush, other elements of coastal sage scrub community invade eroded grassland areas as seen in the Steep Ravine Canyon watershed, Mt. Tamalpais SP; 30 June 1971.

*Recommendations:* The native character of these grasslands can be enhanced by periodic spring burning which will help eliminate exotic annuals or they may be left alone. The stipa community appears to be in a stable state at present; burning or other control methods may be necessary if annual grasses become too agressive in the future.

Eventually species composition may change due to litter buildup; under such conditions, the moisture holding capacity of the soils will increase allowing more mesic introduced annuals, such as foxtail barley and Italian ryegrass, to become dominant.

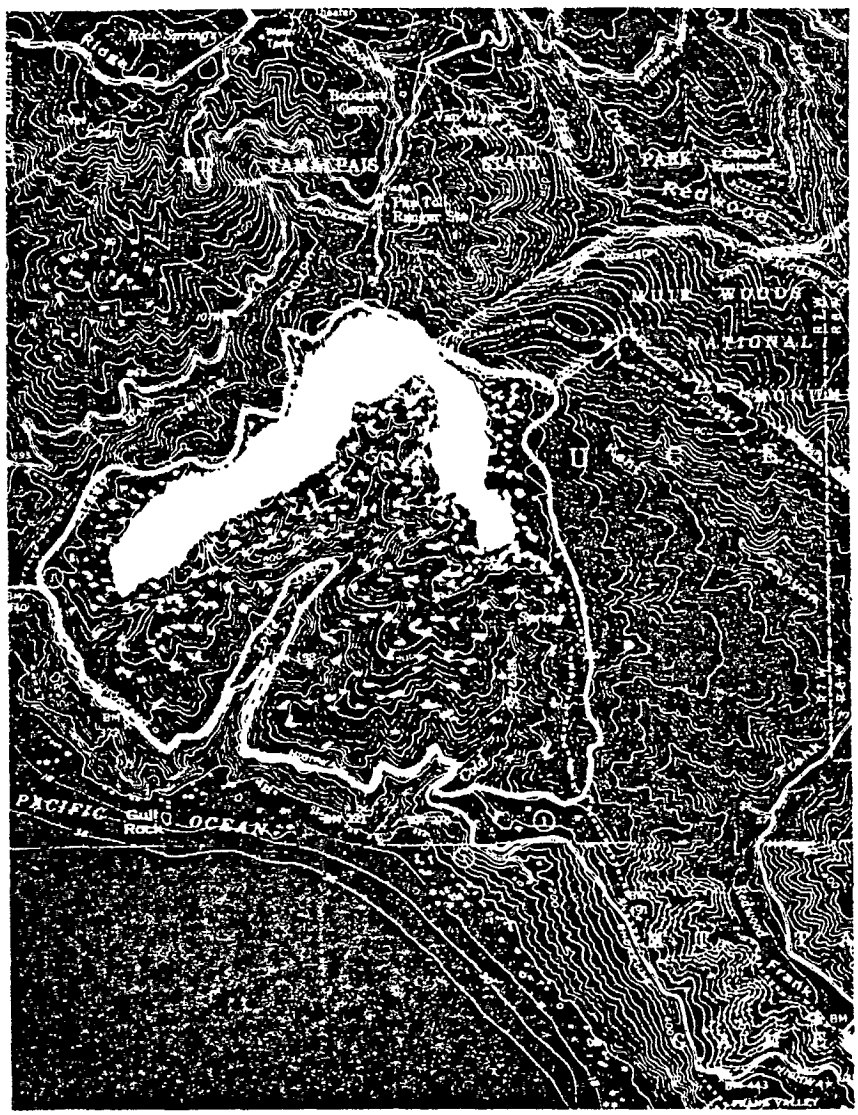



Fig. 76. Approximate distribution of the Central Valley prairie in Mt. Tamalpais SP (U.S.G.S. San Rafael and Point Bonita 7½' quads).

## HOG WALLOWS AND MAC DONALD RANCH

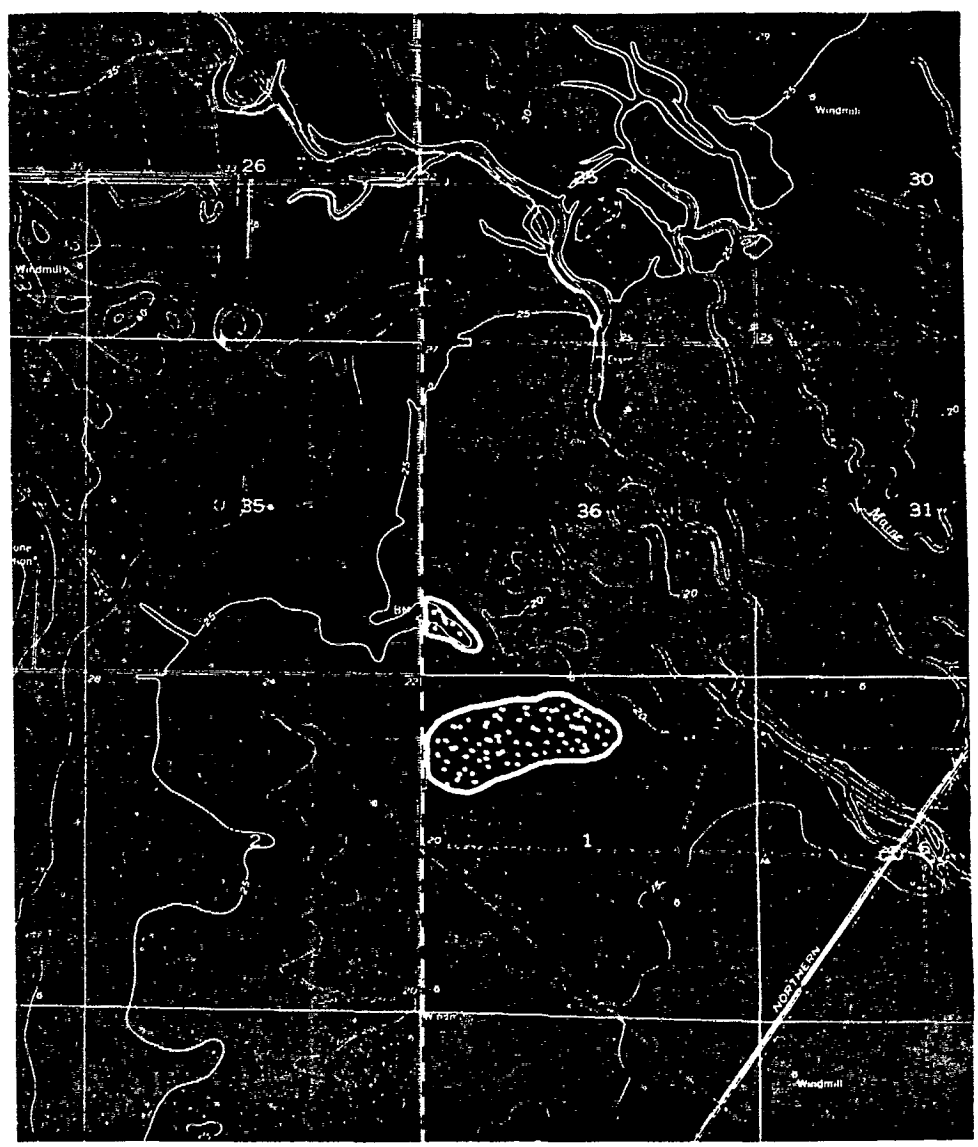
*Location:* Great Valley Landscape Province (U.S.G.S. Dozier 7½' quad: portions of section 16, T6N, R1E.)

*Present Use:* Sheep grazing.

*Vegetation:* This area is the finest example hog wallow community in existence. But purple needlegrass and other dominants of the Central Valley prairie are poorly represented. A great diversity of species occurs in the hummocky area. A checklist for the area has been compiled by Dr. Jack Major. The areas containing purple needlegrass are indicated in Figure 77.

*Recommendations:* This area is high on the acquisition list of the University of California Natural Lands and Water Reserve System. If their program does not materialize, this land should be considered for acquisition by the Park System.

Fig. 77. Distribution of purple needlegrass in the hog wallow-Mac Donald ranch area south of Dixon, Solano Co. (U.S.G.S. Dozier 7½' quad).




Checklist of Vascular Plants in the
Vernal Pool Hog Wallows
South of Dixon, Solano County

(Compiled by Dr. Jack Major)

The order is that of Munz and Keck (1959, 1963).

***Pilularia americana.***
***Myosurus minimus*** ssp. ***apus*** var. ***sessiliflorus.*** Mouse tail
***Sida hederacea.*** Alkali mallow.
***Erodium botrys.*** Broad-leaf filaree.
***E. brachycarpus (obtusiplicatum).*** Broad-leaved filaree.
***Limnanthes douglasii*** var. ***rosea.*** Meadow foam.
***Eremocarpus setigerus.*** Turkey mullein, doveweed.
***Frankenia grandifolia***
***Viola pedunculata.*** Johnny jump up, Wild pansy.
***Lepidium nitidum.*** Peppergrass.
***L. latipes.***
***Tripidocarpum gracile.***
***Stellaria media.*** Common chickweed.
***Cerastium vulgatum (holosteoides).***
***Sagina occidentalis.***
***Arenaria californica.***
***Spergularia media.*** Sand spurrey.
***S. villosa.***
***S. rubra.***
***Montia hallii.***
***Chorizanthe polygonoides***
***Rumex crispus.*** Curly dock.
***Dodecatheon clevelandii*** ssp. ***patulum.*** Shooting star.
***Plantago bigelovii.*** Plantain.
***P. hookeriana.*** Plantain.
***Microcala quadrangularis.***
***Convolvulus arvensis.*** Morning glory (wild), bindweed.

*Navarretia leucocephala.*
*Cressa truxillensis* var. *vallicola.* Alkali weed.
*Linanthus bolanderi.*
*L. bicolor.*
*Plagiobothrys hystriculus.* Popcorn flower (found only in Solano County).
*P. humistratus.*
*P. stipitatus.* Yellow-green.
*P. s.* var. *micranthus.*
*Veronica persica.* Speedwell.
*Orthocarpus erianthus.* Johnny tuck.
*O. attenuatus.*
*Lippia nodiflora* var. *reptans.*
*Pogogyne zizyphoroides.*
*Tillaea erecta.* Pigmy weed.
*Medicago hispida* (= *polymorph*). Bur clover.
*Trifolium bifidum.* Clover.
*T. variegatum.*
*T. tridentatum.* Tomcat clover.
*T. barbigerum.*
*T. fucatum.*
*T. amplectens.*
*T. depauperatum.*
*Astragalus tener?*
*Lythrum?* Loosestrife.
*Callitriche marginata.* Water starwort.
*Lilaeopsis occidentalis.*
*Lomatium utriculatum.*
*L. Caruifolium.*
*Eryngium vaseyi* var. *vallicola.*
*Downingia pulchella.*
*Downingia ornatissima.*
*D. concolor.*
*D. insignis.*
*Achyrachaena mollis.*
*Layia chrysanthemoides.* Tidy tips.
*Hemizonia luzulaefolia* ssp. *rudis.* Tarweed.
*H. pungens?.* Spikeweed.
*Holocarpha virgata.* Tarweed.
*Baeria* (=*Lasthenia*) *chrysostoma.* Goldfields.
*B. platycarpha.* Th.
*B. fremontii.*
*Lasthenia glaberrima.*
*L. glabrata.*
*Blennosperma nanum.*
*Soliva pterosperma.*
*Cotula coronopifolia.* Brass buttons.
*Senecio vulgaris.*
*Psilocarphus brevissimus.*
*P. oregonus.*
*Evax caulescens.*
*Centaurea calcitrapa.* Purple star thistle.
*Lactuca serriola.* Prickly lettuce.
*Microseris douglasii.*
*Hypochoeris glabra.* Cat's ear.
*Machaerocarpus californicus.*
*Lilaea scilloides.* Quillwort.
*Muilla maritima.*
*Calochortus?*
*Brodiaea coronaria.* G.
*B. pulchella.* G. Blue dicks.
*Sisyrinchium bellum.* Blue-eyed grass.
*Juncus* spp.
*J. bufonius.* Toad rush.
*Scirpus.* Bulrush, tule.
*Heleocharis palustris.* Spike rush.
*Carex? tumulicola.* Sedge.
*Bromus mollis.* Soft chess.
*B. rigidus* (= *diandrus*). Ripgut.
*Festuca ? megalura.* Th. Foxtail fescue. (*Vulpia m.*).
*F. microstachys* agg. (*F. reflexa* group).
*Pleuropogon californicus.* Semaphore grass.
*Poa annua.* Annual bluegrass.
*P. bulbosa.* Bulbous bluegrass.
*P. scabrella.*
*Distichlis spicata.* Saltgrass.
*Melica californica.*
*Taeniatherum asperum.* Medusa head.
*Hordeum brachyantherum.* Wild barley.
*H. hystrix.*
*H. leporinum.*
*Deschampsia danthonoides.* Hairgrass.
*Avena fatua.* Wild oats.
*A. barbata.* Slender wild oats.
*Alopecurus howellii.*
*Gastridium ventricosum.* Nit grass.
*Stipa pulchra.* Purple needlegrass.
*Phalaris lemmonii.*
*Panicum hillmanii.*

## SAN LUIS ISLAND

*Location:* Great Valley Landscape Province (U.S.G.S. San Luis Ranch 7½' quad). The island is the largest parcel of uncultivated grassland in the San Joaquin Valley (about 14,000 acres).

*Elevation:* 75 feet.

*Vegetation:* The original grasses of the dryer areas have been replaced with European annual grasses, primarily soft chess, ripgut, and mouse barley. However, excellent examples of the alkali flat community are found in lowland areas where drainage is poor. Both white and black alkali soils occur on the island. On these soils, with a high water table, saltgrass, slender wheatgrass and alkali sacaton dominate (Fig. 78) with *Agropyron trachycaulum*. Other native species are alkali heather (*Frankenia grandifolia*), alkali mallow (*Sida hederacea*), gumweed (*Grindelia camporum*), Jackass-weed (*Wislizenia refracta*), and *Baeria platycarpha* (Fig. 79).

*Recommendations:* The proposed San Luis Island project would preserve vast areas of native bunchgrasses of the alkali flat community. Some areas are currently preserved in the adjacent San Luis National Wildlife Refuge, but are currently being grazed by cattle (to be phased out). The re-introduction of tule elk and pronghorned antelope would be desirable in this area.

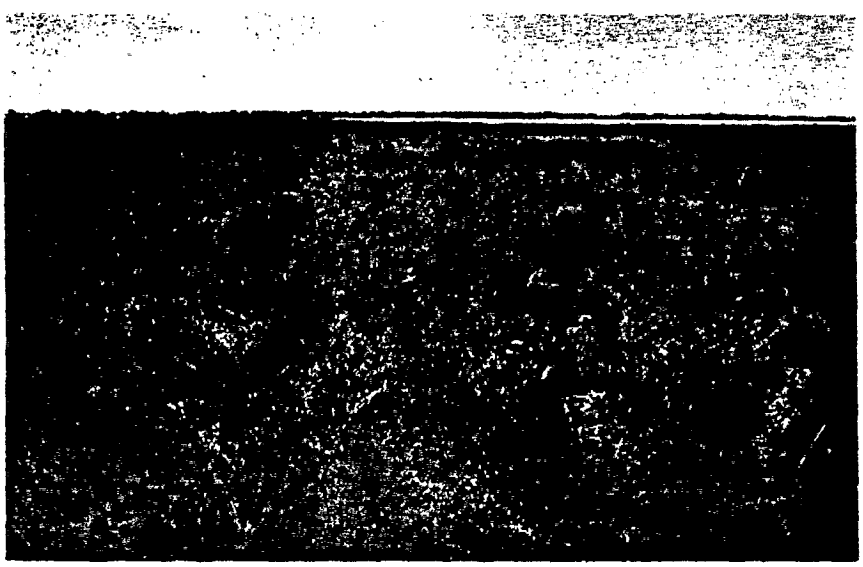


Fig. 78. The alkali flat community of the Central Valley prairie. Alkali sacaton is the dominant bunchgrass in the photo. San Luis Island National Wildlife Refuge; 17 June 1971.

Fig. 79. Lower areas in the alkali flat community dominated by *Baeria platycarpha* and saltgrass. Note alkali sacaton in background. San Luis Island National Wildlife Refuge; 17 June 1971.

## BENNETT MOUNTAIN (Annadel Farms)

*Location:* Foothills and Mountains Landscape Province (U.S.G.S. Santa Rosa 15' quad). Los Quilicos in the Sonoma Mountains.

*Elevation:* 1,000 to 1,359 feet.

*Vegetation:* Peripheral meadow areas are dominated by native bunchgrasses of the Central Valley prairie while lower central areas are dominated by exotic annual grasses. (Figs. 80, 81). Native species include: purple, nodding and foothill needlegrasses, squirreltail (*Sitanion hystrix*), and shooting star (*Dodecantheon hendersonii*) (Fig. 82).

Fig. 80. Mixed native bunchgrass and annual introduced grasses at Bennett Mountain in the Sonoma Mountains. Greener areas are introduced wild barley. Purple needlegrass, nodding needlegrass, and squirreltail occur along the edges of the grassland; 15 June 1971.

Fig. 81. Grasslands southeast of Bennett Mountain, Sonoma Mountains. Green areas are exotic wild barley, straw-colored areas are exotic wild oats and brown areas are native bunchgrasses; 15 June 1971.

Native bunchgrasses also occur in the northern oak woodland community. Western fescue (*Festuca occidentalis*) forms nearly solid stands beneath the Oregon oak (*Quercus garrayana*) on southern exposures (Fig. 83) with occasional clumps of California oatgrass (*Danthonia californica*). The distribution of the Central Valley prairie is presented in Figure 84.

Fig. 82. Peripheral grassland area with native squirreltail, and blue flowered shooting star. Non-native wild oats in background; 15 June 1971.

Fig. 83. Native bunchgrasses covering the floor of the northern oak woodland. The Oregon oak-western fescue association occurs on southern exposures in the Sonoma Mountains; 15 June 1971.

*Recommendations:* Before development in this area is planned, a more detailed ecological study should be made with reference to all natural values present. For esthetic reasons alone, important portions of the grassland and northern oak woodland communities should be given preservation status to protect their scenic and ecologic values.

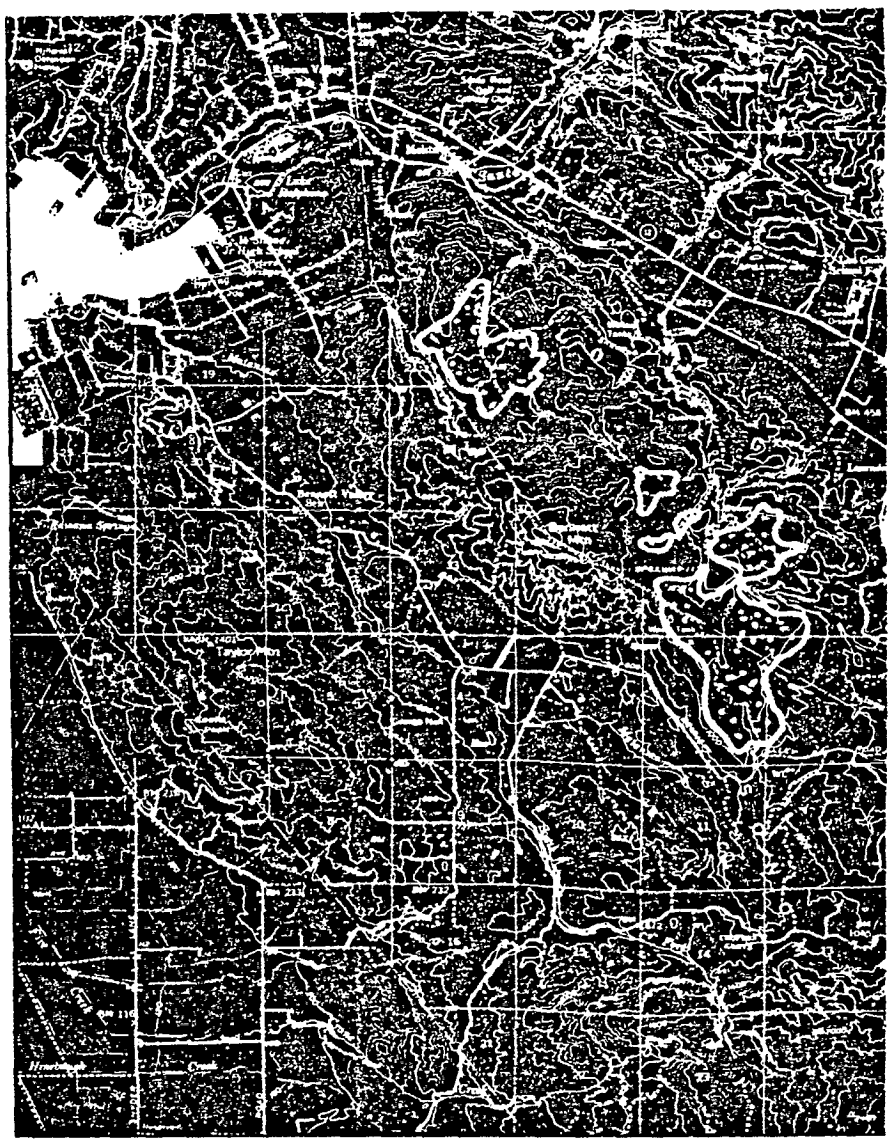


Fig. 84. Distribution of Central Valley prairie elements at Bennett Mountain (Annadel Farms) area (U.S.G.S. Santa Rosa 15' quad).

## MARINE CORPS BASE – CAMP PENDLETON

*Location:* Southwest Mountain and Valley Landscape Province (U.S.G.S. Margarita Peak 7½' quad), Vallecitos.

*Current Use:* Spring grazing and troop training.

*Elevation:* 1,800 to 2,800 feet.

*Vegetation:* A quick reconnaissance of the base showed a number of areas of Central Valley prairie. Purple needlegrass is the dominant grass above about 500 feet, lower grasslands and coastal shelves contain mainly wild oats. The best grasslands occurred in Vallecitos (Fig. 85) on Fallbrook sandy loam. Here purple needlegrass and tarweed make up a mozaic pattern throughout the valley. Contrary to most areas studied, tarweed becomes established where sandy soil is loosened by tank tracks rather than in compacted areas. Areas proposed for park status do not contain native grassland elements.

*Recommendations:* Current burning management practices are adequate, however, firebreaks should not be plowed through grassland areas as they are presently being constructed.

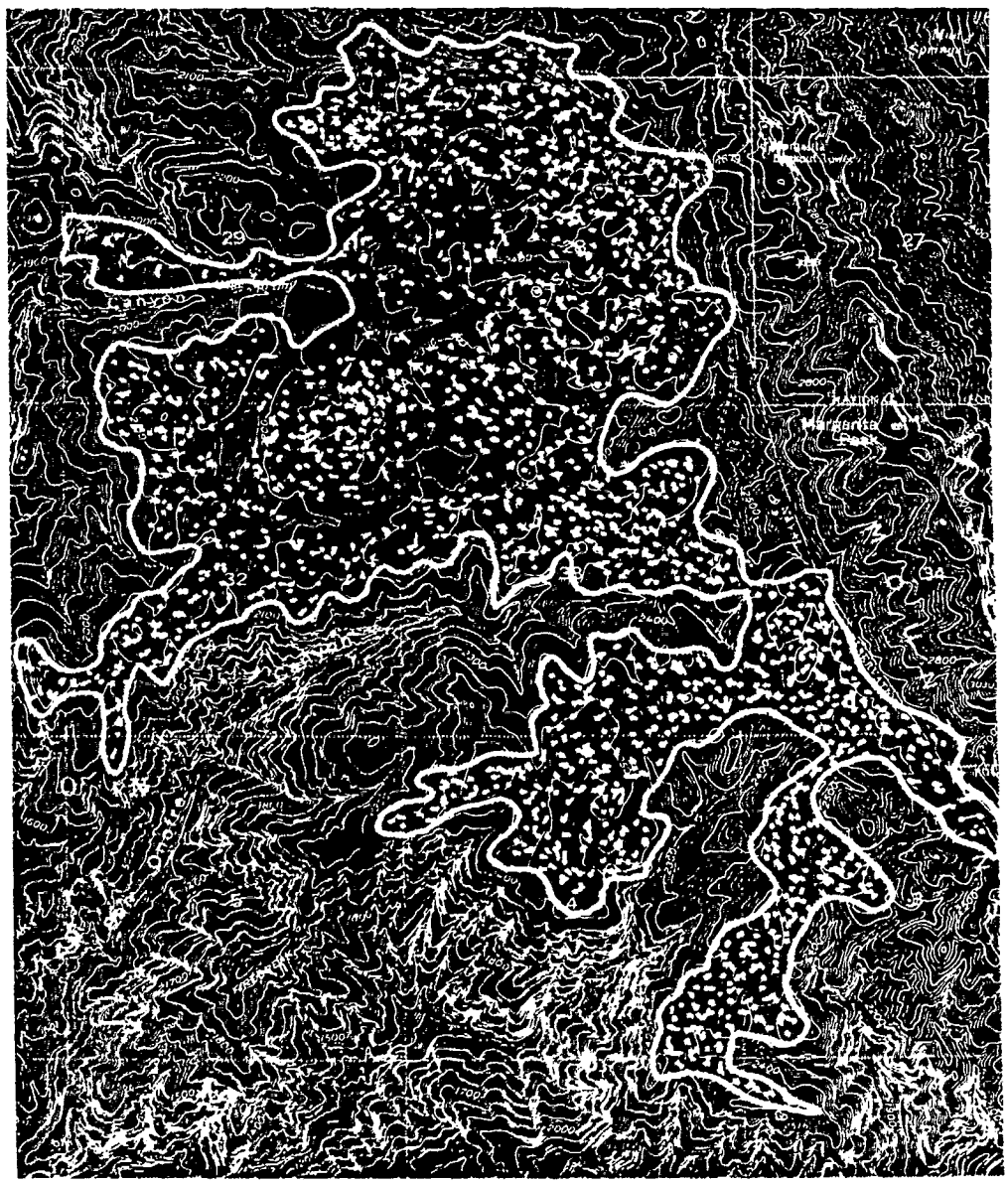



Fig. 85. Partial, estimated distribution of relict Central Valley prairie elements at Camp Pendleton, San Diego Co. (U.S.G.S. Margarita Peak 7½' quad).

## HASTINGS NATURAL HISTORY RESERVE

*Location:* Sierra Foothill and Low Coastal Mountain Landscape Province. Carmel Valley, Monterey County (U.S.G.S. Rana Creek and Chews Ridge 7½' quads).

*Present Use:* Research.

*Elevation:* 1,850 to 2,650 feet.

*Vegetation:* Islands of grassland occur in the foothill woodland. Most of the grassland is dominated by the annual grass type but 15 stands of the stipa community of the Central Valley prairie are present. According to White (1967), the stands occur on 5 different geological substratas and on 7 different soils – Crafton sandy loam, Terra sandy loam, Sobrante stony clay loam, Butte clay, Cayucos clay, and Sobrante stony clay. Most stands have been protected from grazing since 1937. However, two of the stands have been grazed year round by two to five horses (Fig. 86).

Of the native plants present in the grazed stipa community, plantain (*Plantago hookeriana* var. *californica*), is the most common associate followed by: *Clarkia purpurea* ssp. *quadrivulnera*, foxtail fescue (*Festuca megalura*), *Chlorogalum pomeridianum*, and *Brodiaea lutea*. Foxtail fescue is the most common associate with purple needlegrass on ungrazed stands. Other common species are listed in relative abundance as follows: *Clarkia purpurea* ssp. *quadrivulnera*, plantain, *Brodiaea lutea, Chlorogalum pomeridianum, Dodecatheon clevelandii* ssp. *sanctarum, Orthocarpus attenuatus, Sisyrinchium bellum* and *Lomatium utriculatum* (White, 1967). Robinson (1968) lists additional species of the stipa community including the native grasses: *Festuca reflexa* and *Sitanion jubatum*; and native forbs are as follows:

*Athysanus pusillus*
*Bloomeria crocea*
*Brodiaea pulchella*
*Calochortus luteus*
*Caucalis microcarpa*
*Chlorogalum pomeridianum*
*Linanthus bicolor*
*Lotus subpinnatus*
*Lupinus nanus*
*Madia gracilis*
*Navarretia mitracarpa* ssp. *jaredii*
*Ranunculus californicus*
*Sanicula bipinnatifida*
*Sidalcea malvaeflora*
*Trifolium gracilentum*
*Verbena lasiostachys*
*Viola pedunculata*

Fig. 86. Non-grazed enclosure illustrates the performance of purple needlegrass (green colored grass) under grazed and nongrazed regimes. The competitive position is shifted toward wild oats (straw-colored) under heavy horse grazing. Southerly exposure on Red Hill, Hastings N.H.R.; 1 June 1971.

Fig. 87. Clumps of purple needlegrass endure poor, shallow soils and drought conditions on School Hill, Hastings, N.H.R.; 1 June 1971.

About 25% of the biomass on ungrazed stands was purple needlegrass, however, this varies considerably from stand to stand as seen in Figures 87 and 88.

*Recommendations:* No management changes required.

Fig. 88. The best stand of purple needlegrass on Hastings N.H.R. occurs on a knoll above Lambert Flats with a westerly exposure; 1 June 1971.

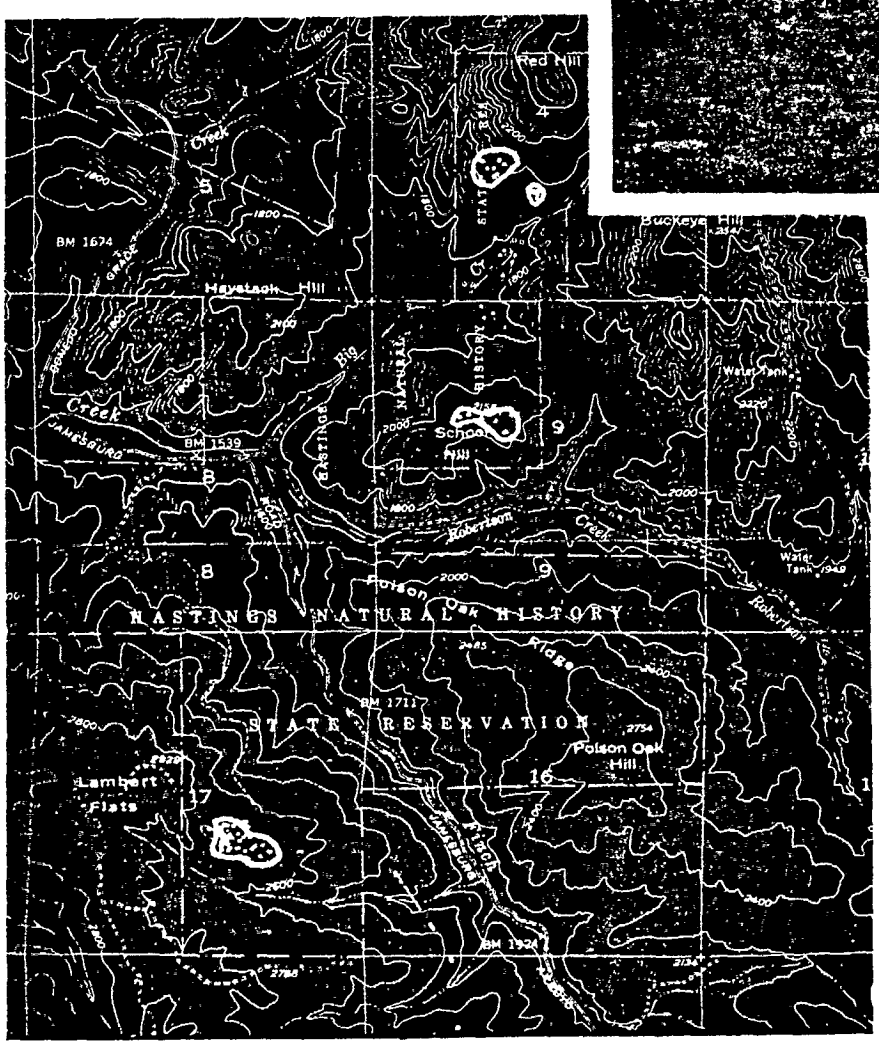



Fig. 89. Distribution of the *Stipa pulchra* community of the Central Valley prairie at Hastings Natural History Reservation, Monterey Co. (U.S.G.S. Rana Creek and Chews Ridge 7½' quads).

## SALT CREEK CANYON

*Location:* Sierra Foothill and Low Coastal Mountains Landscape Province. Salt Creek Canyon, Colusa County. (U.S.G.S. Wilber Springs 15' quad, section 33, T15N, R4W).

*Present Use:* Sheep grazing.

*Ownership:* Three Sisters Ranch

*Elevation:* 400 to 480 feet.

*Vegetation:* Where Salt Canyon meets the Sacramento Valley, a relict stand of the native bunchgrass, Arizona three-awn (*Aristida hamulosa*) is found (Fig. 90). The three-awn community occurs on a steep south-facing hillside. Soils are very shallow and highly eroded with numerous sheep trails traversing the hillside. This community is the most xeric community of the Central Valley prairie. Some purple and foothill needlegrasses occur with this community. Areas between bunches are dominated by plantain (*Plantago heterophylla*). Other common species were red brome, *Erodium cicutarium, E. botrys* and *E. obtusiplicatum*. Wild oats and slender wild oats are occasional in this community.

Fig. 90. Arizona three-awn community on xeric south-facing slope in Salt Creek Canyon. Flat areas at base of hill are dominated by exotic, mesic foxtail (green color); 11 May 1971.

Fig. 91. Clumps of Arizona three-awn with plantain dominating areas between the native bunchgrass. Kodak Ektachrome X; 11 May 1971.

Fig. 92. Arizona three-awn appears violet-colored with Kodak Infrared Ektachrome; 11 May 1971.

Fig. 93. Kodak Infrared Ektachrome showing purple needlegrass (dark purple) and wild oats (white) on knoll above the Arizona three-awn stand, Salt Creek Canyon; 11 May 1971.

*Recommendations:* Three-awn is not relished by grazing animals, in fact the grazing eliminates competition from introduced annual grasses. No change in management, except lightening the grazing load, is recommended at this time. If, in the future, areas to the west are considered for park acquisition (Capay Creek Tule Elk herd), Salt Creek Canyon should be included.

Fig. 94. Purple needlegrass and Arizona three-awn in a plantain matrix. Salt Creek Canyon; 11 May 1971.

Fig. 95. Distribution of the *Aristida hamulosa* community in the Central Valley prairie. Salt Creek Canyon, Colusa Co. (U.S.G.S. Wilbur Springs 15' quad).

## LEUTHOLZ RANCH AND RIO VISTA JUNCTION

*Location:* Great Valley Landscape Province (portions of sections 5, 8 and 9, T4N, R1E, U.S.G.S. Denverton 7½' quad).

*Elevation:* 30 to 112 feet.

*Present Use:* Sheep grazing.

*Vegetation:* According to Adams (1962) purple needlegrass makes up only 15% of the cover in the pasture area on the Leutholz ranch (Figs. 96, 97) and 5% at the Rio Vista Junction site (Fig. 97). Soft chess and ripgut are the most important species associated with purple needlegrass in both stands. At the Leutholz ranch, red brome (*Bromus rubens*) was present indicating a drought condition. The following species are common to both sites: *Avena barbata, Brodiaea pulchella, Lupinus nanus, Orthocarpus erianthus, Erodium botrys, Poa scabrella, Sidalcea malvaeflora,* and *Lomatium utriculatum.* The following species occur only at the Leutholz ranch site: *Avena fatua, Erodium obtusiplicatum, Festuca megalura, F. dertonensis, Lotus subpinnatus, Medicago hispida, Viola pedunculata, Gilia tricolor, Melica californica, Gastridium ventricosum, Filago gallica, Elymus caput-medusae, Convolvulus arvensis, Silene gallica, Brodiaea laxa,* and *Navarretia pubescens.* The following species occur at the Rio Vista Junction site only: *Lupinus bicolor, Trifolium tridentatum, Cerastium viscosum,* and *Sisyrinchium bellum.*

The Leutholtz ranch stand occurs on Olcott fine sandy loam, gray phase. The soil of this phase is higher in humus than the typical Olcott fine sandy loam and is confined to alluvial terraces along the western slopes of the Montezuma Hills. The soil at the Rio Vista Junction stand is probably Gaviota sandy loam.

Fig. 96. Clumps of purple needlegrass in pastureland along Highway 12, Solano County (Leutholz ranch); 23 March 1971.

*Recommendations:* The Nature Conservancy had planned to purchase this area about 10 years ago but has not acted on it to date. Although the area is presently poor to fair in respect to native species, with proper management, including release from grazing pressure, these relict stands of Central Valley prairie could be improved.

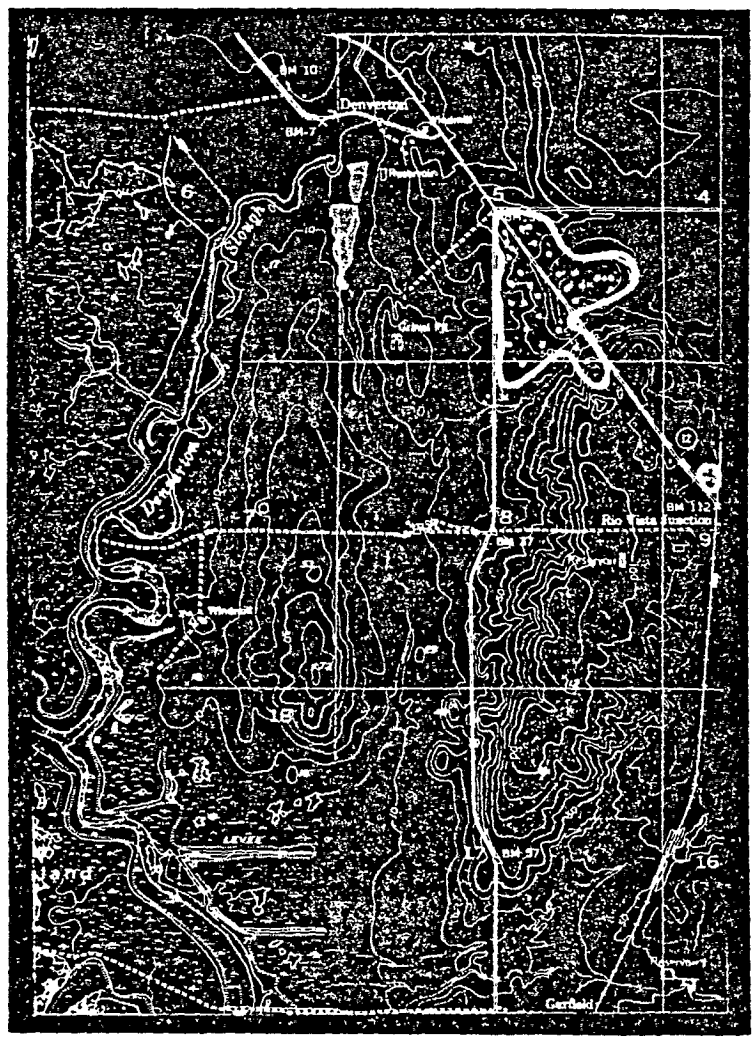
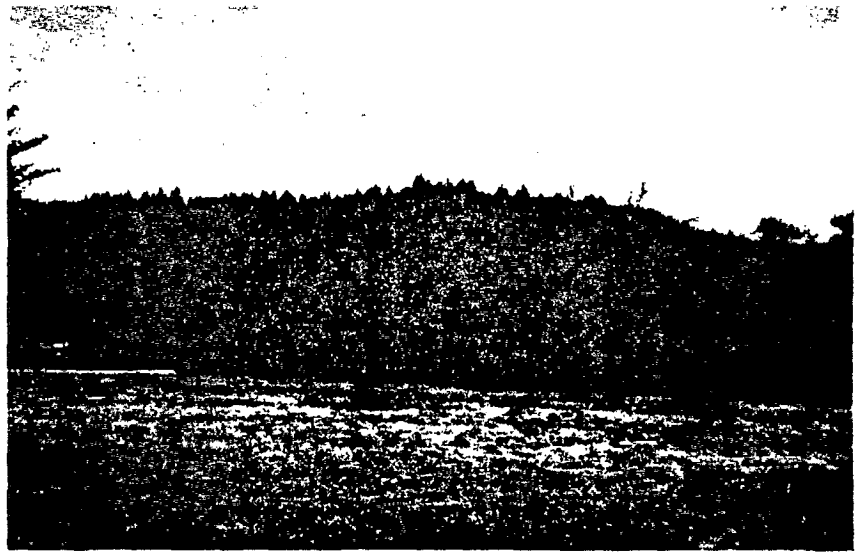



Fig. 97. Distribution of relict stands of the stipa community at the Leutholz ranch (sections 5 and 8) and Rio Vista Junction (section 9) in Solano Co. (U.S.G.S. Denverton 7½' quad).

Fig. 98. Meadow area at Henry Cowell Redwoods SP containing purple needlegrass; 2 June 1971.



## HENRY COWELL REDWOODS STATE PARK

*Location:* Coast Redwood Landscape Province, Santa Cruz County (U.S.G.S. Felton 7½' quad).

*Elevation:* 310 to 340 feet.

*Present Use:* Baseball field.

*Vegetation:* Some purple needlegrass occurs in the proposed parking area expansion (Figs. 98, 99). The soil here has been compacted west of the entry road, but is undisturbed east of the road. This area is dryer than the majority of the meadow area. The main meadow is located north of the *Stipa* stand and is made up of the exotic annual grassland community.

*Recommendations:* Presently the area is mowed because of the high fire danger. The mowing program should be replaced with a judicial spring burning program. Such a program will encourage the stipa community of the Central Valley prairie in dryer areas while some elements of the north coastal prairie may return to dominate moister areas.

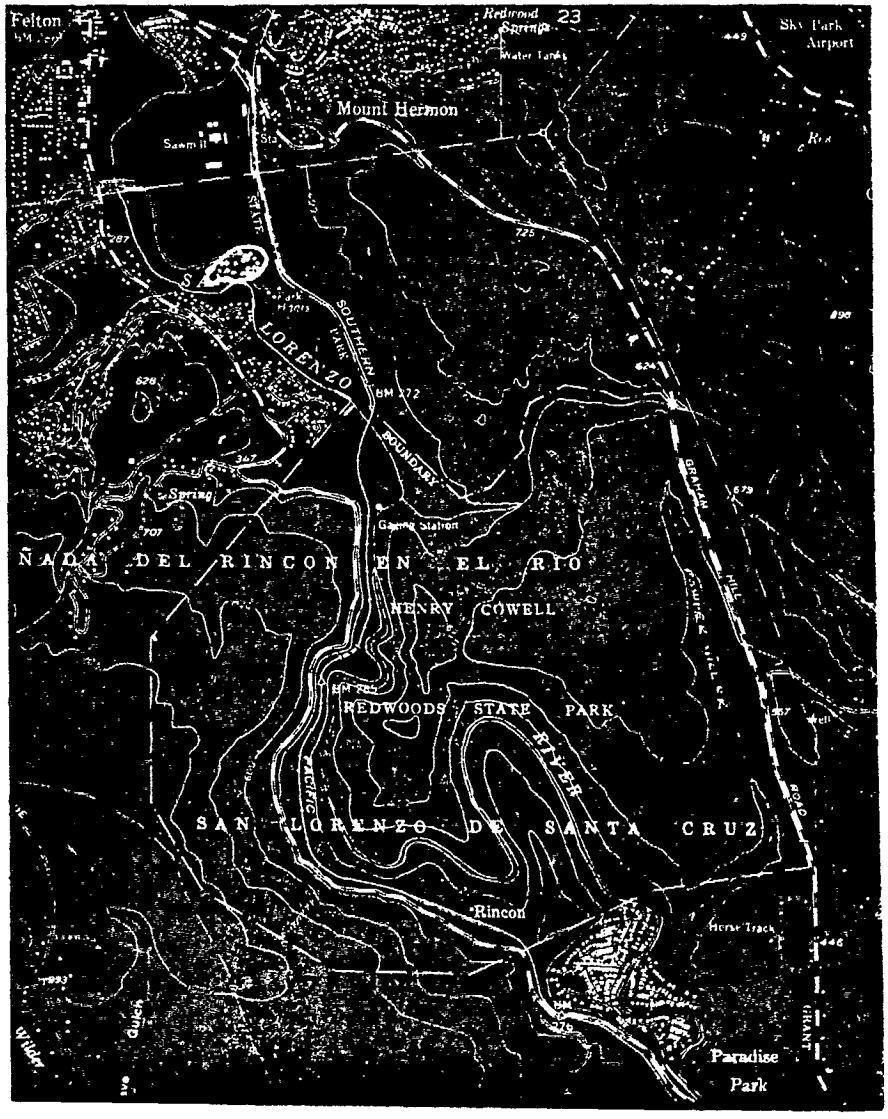



Fig. 99. Distribution of the stipa community at Henry Cowell Redwoods SP (U.S.G.S. Felton 7½' quad).

Fig. 100 Purple needlegrass dominated coastal bench at Montana de Oro SP. Patches of the stipa community often occur in the coastal sage scrub; 21 April 1971.

## MONTANA DE ORO STATE PARK

Some areas of the upper coastal shelf between Islay and Coon Creeks contain the stipa community in mozaic with elements of the northern coastal scrub and the coastal sage scrub (Fig.100). The lower coastal shelf in this area contains the exotic annual grass community. This community has dominated the area since it was released from cultivation. Management recommendations have been made for the restoration of the lower coastal shelf to the original Central Valley prairie (see Management Program for Montana de Oro Coastal Plains – *re-establishment of the California Prairie Ecosystem*).

## GAVIOTA STATE BEACH

Relict *Stipa pulchra* stands occur between the railroad and the coastal bluffs. These areas remain as the result of protection from grazing and cultivation. The coastal bluff areas in the park are covered with coastal sage scrub or the *Stipa* association. Many areas are a mozaic of these vegetation types. The bluffs between the oil tanks and Gaviota Beach should be designated a natural preserve status.

In the rolling hills above Gaviota Canyon, *Stipa lepida* occurs mixed with elements of the annual grassland. Native grasses may return to these areas now that grazing has ceased.

## POINT SAL STATE BEACH

A mozaic of foothill needlegrass and coastal sage scrub (Figs. 101, 102) occurs along the bluffs above the beach. Foothill needlegrass forms a dense understory in most of the coastal sage scrub of this area (Fig. 103). Open grassy areas higher up the ocean-facing slopes are dominated by wild oats, while dryer areas on the hilltops are occupied by purple needlegrass.

The bluff areas are highly erodible and should not be disturbed in any way. Any road construction to the beach would cause serious problems. The vegetation should be left unmanaged.

Fig. 101. Patches of foothill needlegrass in the coastal sage scrub on bluffs above Point Sal SB; 26 April 1971.

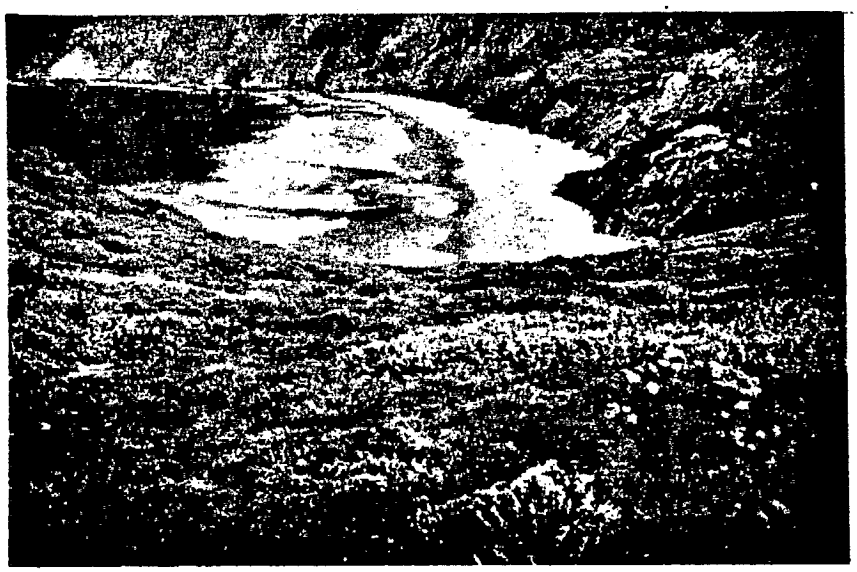


Fig. 102. A mozaic of foothill needlegrass, purple sage (*Salvia leucophylla*), with the yellow flowered *Coreopsis gigantea*. Point Sal SB; 26 April 1971.

Fig. 103. Foothill needlegrass forms an understory in the coastal sage scrub. This association is important in controlling erosion on the coastal bluffs in the Point Sal area; 26 April 1971.

## SUMMARY AND CONCLUSIONS

Representative examples of the original Central Valley prairie were surveyed during the spring, summer and autumn of 1971. The best examples of the stipa community were found at Dozier (Solano County), Cal Poly Arboretum (San Luis Obispo County), La Jolla Valley (Ventura County), and Camp Pendleton (San Diego County).

The best examples of the hog wallow community were found north of Dozier and south of Dixon (Solano County). The only examples of the alkaline flat and three-awn communities were found at San Luis Island (Kern County) and Salt Canyon (Colusa County) respectively.

Over the past 200 years, the area of the Central Valley prairie has declined to a few relatively small stands; a large portion of the prairie has been put under cultivation, while other prairie areas have been subjected to heavy grazing pressure. Under heavy grazing, the introduced annual grassland community has replaced most of the stipa grassland community in the state. Stipa grasslands have persisted as an edaphic climax showing a typical ecologic amplitude to edaphic factors, i.e., occurring only on very good soils or extremely poor soils.

The best examples of the relict Central Valley prairie should be protected.

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