

VEGETATION STUDIES OF ELK PRAIRIE,
PRAIRIE CREEK REDWOODS STATE PARK,
HUMBOLDT COUNTY, CALIFORNIA

by
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Table of Contents

List of Tables.....	ii
List of Maps.....	ii
List of Figures.....	iii
Abstract.....	iv
Acknowledgment.....	v
Introduction.....	1
Description of the Study Area.....	2
History of Elk Prairie.....	6
Methods.....	14
Results and Discussion.....	18
Modification of the Natural Drainage System.....	18
Prairie Invasion by Woody Plants.....	19
Elk Prairie Vegetation Analysis.....	42
Discussion of Elk Prairie Vegetation Results.....	51
Potential Natural Vegetation at Elk Prairie.....	59
Ossagon Prairie.....	60
Lincoln Prairie.....	62
Conclusions.....	64
References.....	65

Appendices

A. Soil pit description at Elk Prairie.....	70
B. Locations of transects.....	72
C. Transect results at Elk Prairie, 1986 and 1987.....	74
D. Miscellaneous notes.....	104
E. Vascular plants found at Elk Prairie, 1986-87.....	106
F. Vascular plants found at Ossagon, 1986-87.....	110
G. Vascular plants found at Lincoln, 1986-87.....	112

List of Tables

Table

1. Mean Monthly Rainfall, 1976-1983.....	4
2. Annual Temperature Data.....	4
3. Summary of Transect Results, Summer, 1986.....	43
4. Summary of Burn Results, September, 1986.....	44
5. Summary of 15 Elk Prairie transects, Summer, 1987.....	45
6. Summary of Transect Results in Grassland Vegetation Type.....	46
7. Summary of Transect Results in Slough Sedge Vegetation Type.....	47
8. Summary of Frequency Changes on Burned Transects, 1986-87.....	48
9. Results of Paired T-test Analysis at Elk Prairie Burned Transects...	49
10. Results of Paired T-test Analysis at Unburned Local Prairies.....	50
11. Comparison of 1986 Cover Values with Bentley (1959).....	58
12. Summary of Transect Results at Ossagon Prairie.....	61
13. Summary of Transect Results at Lincoln Prairie.....	63

List of Maps

MAP 1 Location of Study Area.....	3
MAP 2 Topographic map of Elk Prairie.....	back pocket

List of Figures

Figure

1. View of Boyes Ranch in 1920's.....	12
2. 1986 photograph showing changes in vegetation of Elk Prairie.....	13
3. Aerial view of Civilian Conservation Corps Camp.....	15
4. Aerial view of Elk Prairie.....	16
5. 1920's view from near the southern end of Elk Prairie.....	22
6. 1986 view duplicating that of Figure 5.....	23
7. Western edge of Elk Prairie, 1940's.....	24
8. 1986 view duplicating that of Figure 7.....	25
9. Early 1920's view of the southeast edge of Elk Prairie.....	28
10. 1986 view of the southeastern edge of Elk Prairie.....	29
11. 1920's view of Elk Prairie looking northwest.....	30
12. 1986 view of Elk Prairie looking northwest.....	31
13. A 1940's view of Elk Prairie looking east.....	32
14. 1986 view of Elk Prairie looking east.....	33
15. Looking west across Elk Prairie, about 1940.....	36
16. Looking west across Elk Prairie after September 1986.....	37
17. View northwest across Elk Prairie, 1920's.....	38
18. View northwest across Elk Prairie, 1986.....	39
19. 1950's view of gift shop.....	40
20. 1986 view of former gift shop location.....	41
21. 1920's view northeast toward former Boyes farm house.....	53
22. Boyes Prairie (Elk Prairie) during the period of heavy elk use....	54
23. Elk Prairie in 1986 following recovery from heavy elk use.....	55
24. View east across former Boyes Pasture during period of heavy elk use.....	56
25. 1986 view across former Boyes Pasture after recovery from heavy elk use.....	57

ABSTRACT

Elk Prairie, an important feature of Prairie Creek Redwood State Park, is a natural feature modified directly and indirectly by human use patterns in post-settlement times. The prairie has been drained, but the drainage system is slowly failing, formerly wet areas are becoming wet again and sedge dominated vegetation is increasing.

A permanent line-point transect system was established in the prairie in 1986 and measured in 1986 and in 1987. While intended as a long-term vegetation monitoring tool, the results show that the prairie is dominated by non-native species and that a management fire on the west half of the prairie in September, 1986 resulted in significant increases in cover by some non-native species. None-the-less, native species are well represented in the prairie flora.

The margins of Elk Prairie are being invaded by shrubs and trees, especially along roadside ditches and fence lines where competition from grasses and the effects of browsing by elk are reduced. These features and other man-influenced alterations of the prairie have led to invasion by trees, which will slowly alter the historic appearance of the prairie. Redwood trees along the park roadside ditch are growing rapidly, less than fifty years old, some exceed four feet in diameter and fifty feet in height. While non-native plants dominate the prairie vegetation, many native species are present or available for reintroduction as part of a resource management program designed to maintain the historic appearance of the prairie and enhance the native species components.

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Introduction

The large prairie located in Prairie Creek Redwoods State park, now known as Elk Prairie, is a natural feature which has long been a focus for human use. For the long-term management of such features in natural area parks it is necessary to understand the effects of human use and alterations of the native ecosystem. This information may be used to actively manipulate the system in order to restore and/or maintain natural or near natural conditions. The objectives of the work described here were:

- 1) To describe the present-day vegetation of Elk Prairie.
- 2) To describe changes in the natural drainage patterns at the northeastern end of the prairie and their effects on vegetation.
- 3) To evaluate modern changes in the vegetation of the prairie and the prairie margins.
- 4) To establish a permanent baseline for monitoring the prairie vegetation over time in Elk Prairie, Lincoln Prairie and Ossagon Prairie.
- 5) On the basis of this work, to provide suggestions for park management leading to reduction of modern human impacts on the natural system encompassing the prairie.

In the course of the work, after installation and data collection for a system of permanent transects in the grassland, the west half of the prairie was burned in a prescribed management fire. The burned transects were remeasured after the fire on September 11, 1986 and remeasured in June, 1987.

Description of The Study Area

Prairie Creek Redwoods State Park is located in Humboldt County, in north-western California (Map 1). Established in 1923, and enlarged in subsequent years, the park is managed by the State of California, Department of Parks and Recreation. The park is within the present boundaries of Redwood National Park, established in 1968. Elk Prairie, the principal focus of this study, is located about 6 miles (10 km) north of the town of Orick and is about 3 miles (5 km) inland from the Pacific Ocean (Lat. $41^{\circ} 22' 00''$, Long. $124^{\circ} 01' 30''$). The 125 acre (50 ha) prairie is bisected by U.S. Highway 101. Elk Prairie has been known as Boyes Prairie and Big Prairie in times past. The study area is within the Prairie Creek drainage, a 40 mi² (100 km²) watershed tributary to Redwood Creek which flows to the sea near Orick. The Prairie Creek watershed lies within the youthful river transported deposits of the Gold Bluff Formation, originally derived from the Klamath mountains (Hardin and others, 1981). The prairie itself (elevation 110-180 ft), is an extensive stream terrace of reworked gold bluff formation materials, probably at least 100,000 years of age. (D. Hagans, Pers. comm.) Its physical origins have not been investigated. In the course of the study fossil plant materials, apparently leaves of modern *Corylus* and *Lithocarpus* were found in the bank of Prairie Creek near the headquarters building.

Steep intermittent streams drain onto the prairie during the winter rainy season and have formed small alluvial fans on it's eastern edge. These watersheds range from 1 to 10 acres in size. A weakly developed drainage in the center of the prairie drains south, eventually reaching Prairie Creek near May Creek. Prairie Creek is incised below the Elk Prairie terrace on the west and old meanders occur on the western Prairie Creek margin of the prairie. The terrace slopes gently to the south-southwest with a slope of less than 100 ft/mile (less than 18 m/km). On the east the ridges rise sharply to 500 ft. (150m) and to the west 600 ft (180m).

The climate of the study area is strongly influenced by the nearby Pacific Ocean which moderates temperatures and produces frequent low clouds, especially during the summer months. This fog ameliorates an otherwise rainless summer which is in contrast with the high winter rain-fall. Annual precipitation is about 66 in (170 cm), mostly occurring as rainfall. Snow is rare. Summer fog augments the moisture balance as it collects on vegetation. As much as 16.7 in (42.5 cm) of fog drip has been reported in coastal California forests (Azevedo and Morgan, 1974), but is not reported as part of the annual precipitation total (Table 1).

Map 1. Location Map

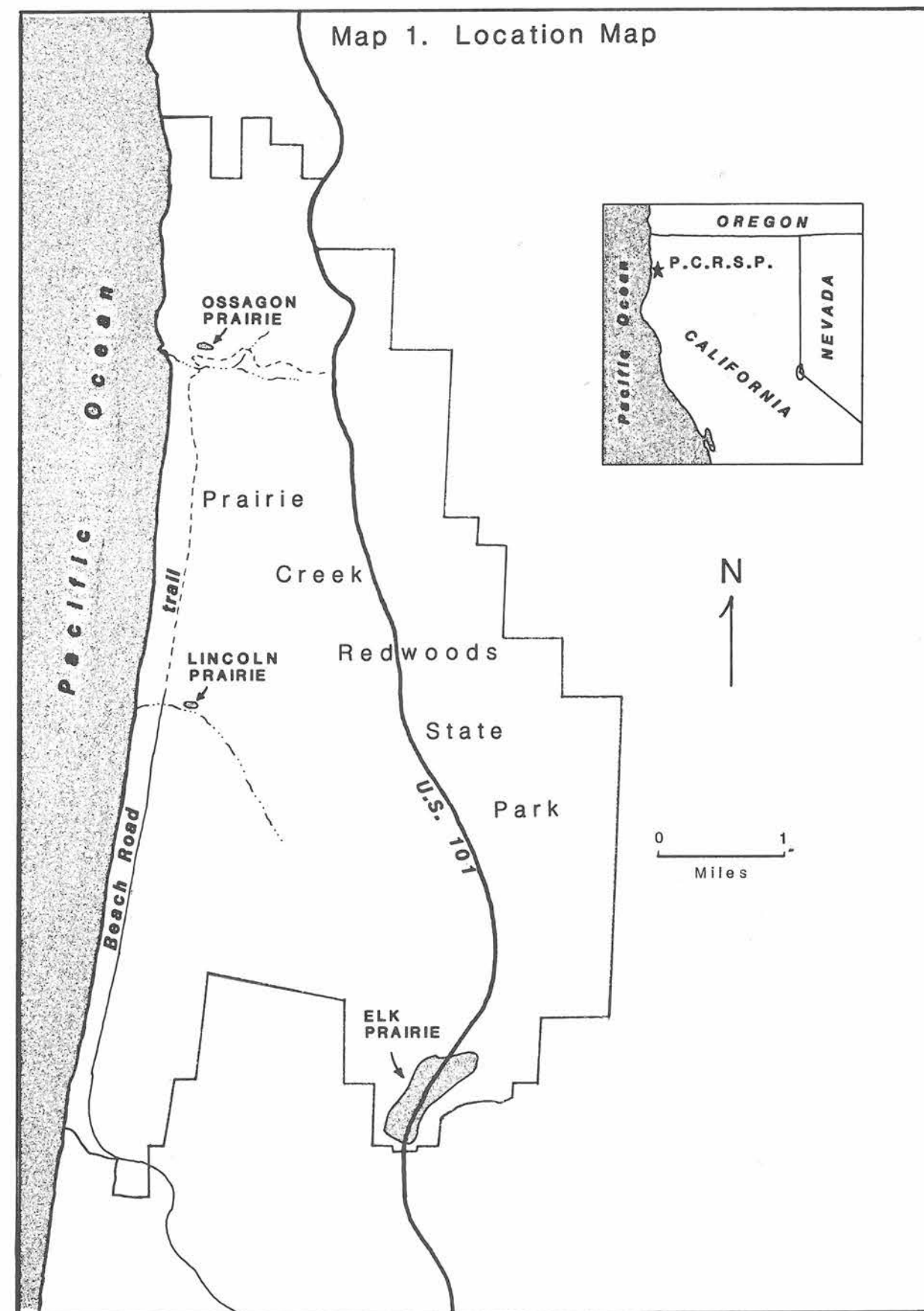


Table 1
MEAN MONTHLY RAINFALL
1976 - 1983
Prairie Creek Redwoods State Park

	inches	cm
October	5.07	12.9
November	6.87	17.4
December	13.06	33.2
January	7.85	19.9
February	10.40	26.4
March	8.59	21.8
April	6.16	15.6
May	2.91	7.4
June	1.20	3.0
July	1.20	3.0
August	0.41	1.0
September	2.55	6.5
	66.27	168.3

The mean length of the freeze free period is 250 days (Elford, 1970) and the mean annual temperature reported at Prairie Creek State Park is 51.9°F (Table 2).

Table 2
Annual Temperature data, Prairie Creek Redwoods State Park

Mean daily maximum, January = 50°F (10°C)
Mean daily minimum, January = 36°F (2.2°C)
Mean daily maximum, July = 68°F (20°C)
Mean daily minimum, July = 50°F (10°C)

Mean Monthly Temperature

	°F	°C		°F	°C
January	43.6	6.4	July	59.3	15.2
February	45.9	7.7	August	59.6	15.3
March	47.4	8.6	September	59.0	15.0
April	50.0	10.0	October	54.5	12.5
May	53.3	11.8	November	48.6	9.2
June	56.7	13.7	December	45.3	7.4
			Annual	51.9	11.1

The forest vegetation of the park is dominated by coast redwood (*Sequoia sempervirens*). Near the coast Sitka spruce (*Picea sitchensis*) increases in importance while Douglas-fir (*Pseudotsuga menziesii*) increases inland and at higher elevations. On the immediate coastal slopes coastal prairie and northern coastal scrub (Munz and Keck, 1973) are predominant.

Elk Prairie is morphologically and floristically similar to coastal prairies near Crescent City, California to the north. Those prairies also appear to have developed on soils derived from older river sediments. Their soils are relatively clay rich and are water saturated in winter, drying to an adobe-like consistency in summer (at least after cultivation). A soil description for a single pit on Elk Prairie is attached as Appendix A. A water well drillers report (California Department of Water Resources, 1973) for the southern extremity of the prairie (on Redwood National Park lands) reported five feet of "over burden" over thirty feet of yellow clay. This in turn overlaid twenty-five feet of cemented gravel over the water bearing gravels suitable for the water supply.

History of Elk Prairie

Prairies existed long before the arrival of Indian people on the North American continent. The great prairies in the rain shadow of the Rocky Mountains are a consequence of the mountain influence on the continental climate. Where prairies are surrounded by forests and winter rainfall is substantial, natural prairies like those in Prairie Creek Redwoods State Park are probably a consequence of soil properties. High clay soils formed on old river deposits tend to be waterlogged in winter and dry out rapidly in early spring and summer with the cessation of rain. A thick grass sod dries out the upper soil levels rapidly and any tree seedlings which may have germinated there have little chance of surviving the rainless summer. Thus the prairies have natural biotic origins based on the responses of plants to their physical environment. They can also be influenced by human activities.

The Indian people who occupied the coastal redwood region used fire in and around coastal prairies. Elk Prairie appears to have been seasonally occupied by the Indian people living in permanent villages along the immediate coast at Espa lagoon, Ossagon Creek and elsewhere north and south. The prairie contains an archeological site described as Yurok, a fishing camp and other scattered evidence of Indian use (Ritter, 1969).

The first written descriptions of the prairies near Elk Prairie are those of the 1828 visit by Jedediah Smith and his party. They reached the coast near Orick and described the Bald Hills prairies where they camped before retreating to the Klamath River (Sullivan, 1934). While a history of Indian use of Elk Prairie is not available, information for similar areas can be used by inference.

Direct, first hand descriptions of Indian uses of coastal prairies, including burning, are rare. George Gibbs (in Hoopes, 1966) kept the journal of the Redick McKee expedition as the Indian agent. McKee traveled from Sonoma up the Eel River and into Humboldt County in late summer, 1851. McKee made several observations of grass recently burned off by the Indians in September ("for the purpose of collecting aniseed with greater ease") (p. 226). Burning was not ubiquitous, as McKee also reported much fine grass. Near the South Fork of the Eel they found "a small prairie of about 80 acres from which the grass was mostly burnt, a bare sufficiency only remaining" (70 men with 140 horses and mules needed grass). At one point (September 6th) McKee mentioned a large redwood tree adjacent to a small burned prairie. The redwood, partly burned out, was still smoking.

Gibbs, speaking of the Indian people living on the Eel River below the Van Duzen provides a considerable description of the natural resources of the region:

"as far as regards their number, we could not ascertain it with any exactness. As usual, it was much overrated in general report and it is probable that those on the Eel river below Van Duzen's fork, and around the bar, fall short of five hundred. Their food consists principally of fish, eels, shell-fish, and various seeds, which,

like those in the southern valleys, they collect after burning the grass. A small species of sun flower furnishes a very abundant supply of these last. The sallal, salmon, and berries, hazel-nuts, &c., also abound. Occasionally the more enterprising snare the elk, which are very numerous."

Describing the hills on the south of the Eel River Valley:

"these mountains run back, in an easterly direction some eighteen miles. They present a fine grazing country on the slopes, and good situations for farms at their base. The bottom land on the river is low and level, and in width averages perhaps five miles. Much of this is, however, covered with thickets of willows, &c., and is subject to floods in the rainy season. Those tracts above the reach of the freshets are generally of fern prairie, rich, but not easily subdued."

and later:

"leaving the Mad River, we ascended a long spur of mountain to the top of the dividing ridge between it and Redwood Creek, through alternate forest and prairie land. The character of the mountains, from this to the Klamath, differs widely from those we have before passed over. Their summits are broader, and the declivities less steep and broken. Prairies of rich grass lie on their southern slopes, and especially on their tops, from whence their name of Bald Hills is derived. This grass was now yellow with ripeness, and the wind, sweeping over its long slender stems, give it a beautiful appearance. The Indians use the stalks in their finer basket work; and, when split, in the braids with which they tie up their hair, and other ornamental fabrics. The timber here becomes much more open, and fir, white and yellow, pre-dominates over the redwood. This last is now chiefly confined to the immediate neighborhood of the coast. Springs of good water occur near almost all these prairies, and camps are therefore selected on their skirts. Late in the season, however, the grass is often burned, and dependence cannot always be placed upon the usual grounds. In winter, snow lies on them for several weeks, and to a considerable depth. Elk are very abundant in these mountains, and the ground was marked everywhere with their footprints.

THURSDAY, SEPT. 25th [1851] Our route today led down to a small branch of Mad River, and thence up another still higher mountain than the last, where we encamped upon another prairie. It had been our intention to go on to Redwood Creek, but a train of packers returning, informed us that the only accessible camps there had been burnt over (but whether a result of autumn burning or hostilities is unclear). Later our march was about twelve miles, and we had the satisfaction of finding that we were only two miles and a half from our next destination, the forks of the Klamath and Trinity. Water and grass were abundant."

Plainly some, but not necessarily all of the prairies were burned in autumn.

Jed Smith traveled through the Klamath and Redwood Creek Country in the spring of 1828. Smith and his clerk, Rogers, both left written descriptions of prairies extant in 1828, which are prairies today. The rich ferns mentioned by McKee must be braken fern (*Pteridium aquilinum*). It is mentioned specifically by Smith in his transcribed journal (Sullivan, 1934) for June 8th, 1828, "the high hills (near Wilson Creek north of the Klamath River) which came in close to the beach of the Ocean present a front nearly destitute of timber with bushes, brakes and grass in some places." On June 17th "the prairie (the Elk Valley, east of Crescent City) was covered with brakes, bushes and grass and had many springs, some of which were miry". Smith, traveling across the Bald Hills and up the coast in May and June makes no mention of Indian burning in the spring. Drucker (1937, p. 232) reported for the Tolowa that "Late spring, when the old fern was quite dry and the new growth just starting, is said to have been the time for burning off the hillsides to improve the hunting grounds."

Notes from the "Overland Expedition" traveling through the Willamette Valley in September, 1841 indicate extensive grass burning there (Dillon, 1975). "All vegetation save trees were destroyed by the fires of the Indians intent on making root digging easier" (p.290). "The [Indian] women toted baskets of seeds and camas roots." The members of the expedition were inclined to believe the burning was done to deprive them of grass for their horses, but on the Siskiyou trail, after leaving the Rogue River, "The [expedition] people saw only one Indian all day, a woman collecting roots and seeds into a funnel shaped basket." She wore a deerskin mantle and a cup shaped cap of tules and she carried a firebrand. She was so intent on setting fire to prairie and mountain ravines that she paid him no heed...(Dillon, 1975 p. 317). Observations of Indian burning continued as the party passed down the Sacramento Valley.

The range of Camas or Quamash (*Camassia* spp.) a lily well known to the Indians of the northwest and the similar *Brodiaea*s overlap in northwestern California (Munz and Keck, 1968). On June 15, 1828, Smith encamped in the coastal prairie south of Crescent City and was visited by several Indians bringing... "some Clams, small fish, Raspberries, and a Root which on the Columbia is called Commass" (Sullivan, 1934 p. 100). *Camassia* and/or *Brodiaea* were apparently gathered in the spring as well as the fall. Waterman (1920 p. 222, 223) notes:

"the Yurok had a great many varieties of vegetable food besides the acorns. They speak of many edible bulbs (mostly lilies, I think) as "Indian potatoes" in Yurok; Hr'lkr and otoi'. Another source of food was grass seed, which they gathered with the seed beater. I think this was important, not from its quantity but from the fact that it introduced variety into a rather monotonous diet. They speak highly of grass seed, mentioning "millet" (legel), wild sunflower (pets'lo), clover (kla'po), and at least four other varieties called tsi'ge, tse'gem, slo'wil, and no'Rpil. People camped on open grass lands or prairies, in brush huts covered with

brakes laid on in courses, shingle fasion. So far as I know, grass lands were not owned by individuals, though each village had its own localities and never went elsewhere."

A Klamath river woman, Lucy Thompson, wrote "when the Indians first reached the Klamath there were large prairies and vast tracts of grassy land which have since grown up in timber and underbrush. Many of the prairies were set on fire and burnt off every year during the dry seasons, which kept the timber from growing up very fast" (Thompson, 1916 p. 66). In southern coastal Humboldt County, Sinkiyone "men fired grassy meadows; women, children gathered roasted grasshoppers in flat baskets. Roasted grasshoppers were a delicacy." (Nomland, 1940). Clearly, the native grasslands were important to the Indian people for food and other materials and apparently it was customary to burn the prairies often, perhaps annually.

Before 1850 European cultural influences along the far north coast of California were limited to scattered landfalls by Mexican, British and American Ships at Trinidad. With the discovery of gold in the Sierra Nevada foothills, then the Trinity River, European Americans arrived on the north coast overland late in 1849 (the Gregg party) and by sea in 1850. On April 11th, 1850, adventurers from the Brig Cameo, sailed up from San Francisco and landed near the mouth of the Klamath River, and discovered gold on the beach at Gold Bluffs. During 1850 and 1851 a number of companies were formed to exploit claims made on the Gold Bluffs and the beach (Bearss, 1969).

It is probable that the miners also established claims to Elk Prairie about the same time. One G.W. Gann claimed a small prairie on the Bald Hills in 1854. He also had an interest in Elk Prairie that he sold to Nathaniel F. Neeley November 15th 1862. (Klamath County Book of Mortgages Book A, p. 364) Ganns mortgage to Neeley (\$1,327 for 6 months), included an "equal undivided half part of...lands situated on the coast...between the mouth of the Klamath River and Redwood Creek known...as the 'Union Gold Bluff Mining claim' and as an equal undivided half part of 34 mules, 3 horses and the mining tools and apparatus belonging or appertaining to said claim. And also an equal undivided one half part of that certain tract of land situated about five miles east from said mining claim now owned and occupied by the said of the first part with others and known and described as the Union Gold Bluff companies farm containing fifty acres more or less..."

Since Gann's claim was 5 or 6 miles from the Gold Bluff Mining claim at Major Creek, it is probably safe to assume that the Elk Prairie lands had been claimed earlier.

Klamath County mortgages, book B, page 364, November 15, 1862, listed the prairie as part of the Gold Bluff Mining Company properties. By 1869 tax roles showed that S.P. Tuley and Chas. Johnson had a ranch on Big Prairie [Elk Prairie] and their taxable possessions included a horse, 5 cows, 10 calves and 55 cattle. At the same time the Union Gold Bluff Mining Company had mules worth \$800 [representing 40 animals?] which were probably fed hay

from the prairie and which may have been pastured in the prairie. In 1885 the Pioneer Mining Company "was possessed" of a claim of 640 acres, including the placer mine and Ganns Prairie and SE 1/4 Sec. 2 [Elk Prairie] while the Union Mining Company "possesses and claimed" 160 acres on Prairie Creek which land was valued at \$150 and improvements at \$150 (this land includes roughly E 1/2 of NW and W 1/2 of NE 1/4 of Section 11). The 1878 survey notes of M.F. Reilly mentions two good prairie farms on sections 2 and 11. In 1897 William Ayers, reporting in the Blue Lake Advocate, spent the night of April 27th at Prairie Creek... "the fine open prairies of A.J. Harris. This is really a fine place, at least 200 acres of clear land, 100 acres in crops, comfortable dwelling house and 2 large barns".

After the public lands had been surveyed under the provisions of the Homestead Act (1862) and later the Timber and Stone Act, they were "thrown open to entry". The land around Elk Prairie and most other forest lands in northern Humboldt County rapidly fell into the hands of timber speculators (Puter, 1908). By 1894 many illegal claims had been set aside, but the American Lumber Company still owned the land around the prairie. The 1902 tax records show most of the timber land around the prairie was owned by the American Lumber Company (except SW 1/4 Section 2 which was owned by C.A. Smith Timber Company). These lands later passed into the hands of the Sage Timber Company and later Hill-Davis Lumber Company.

The Blue Lake Advocate, (September 26, 1908) reported "the prairie was claimed and occupied by the Gold Bluff Mining Company who had taken it up as mineral land. Mr. Harris believing the title held by this company was no good, moved upon the land and took possession. A lawsuit was then instituted to oust Mr. Harris but the courts decided him the lawful owner," (dates of events not reported) (Fountain, N.D.).

A.J. Harris obtained a patent from California for the land in 1900, and title records indicate he sold it in 1905 to George Boyes of Blue Lake. Three hundred and twenty acres, including (improvements) and 160 acres of redwood timber brought the handsome sum of \$15,500. In January 6, 1906, William Boyes and his son Charles were quite busy plowing on their newly acquired ranch. In 1923 Prairie Creek State Park was established by a 160 acre gift of forest land from the Joseph Russ family (about a mile north of the prairie) (Bearss p. 249). In 1932 the Save the Redwoods league bought the tract that included Boyes Prairie (286 acres) and other claims and timberland, and deeded the lands to the State of California (Bearss, 1969 p. 250) as part of Prairie Creek Redwoods State Park.

Besides grazing and plowing, other changes eventually reached the Prairie. The Reilly Survey (1878) mentions a house, barn and corral in the prairie and shows the trail to the Klamath paralleling the south side of Boyes Creek. In 1894 the wagon road from Eureka to Crescent City opened, (McBeth, 1950). In 1900 A.J. Harris sued the Board of Supervisors to restrain Humboldt County from maintaining a public road over his property (and lost) (SBF p. 80).

In an interview (4/22/84) transcribed in the unit history of Prairie Creek Coast Redwoods State Park, Clark Lovin described conditions about 1927, when his father operated an auto court in partnership with Boyes at the north end of the prairie where the park headquarters now stands. Lovin mentioned that Boyes Prairie was "sumped". "He had it all sumped and that was Boyes field" (he raised hay and cattle) "all the field here was fenced... there was a phone line along the highway". (In response to a direct question by the interviewer Lovin professed no knowledge of any irrigation system). Photographs (Fig. 1) taken in the 1920's clearly show some of the drainage ditches in the east side of the Prairie which Lovin is describing when he used the term "sump" (an open drainage system). Figure 2 is a photograph from the same viewpoint, made in 1986.

In 1933, Company 1903 of the Civilian Conservation Corps was established and headquartered at Prairie Creek. The CCC members removed old structures, built the present park headquarters, constructed trails, did planting and "beautification" work. Their work ushered in the beginning of the modern era for many parks, including Prairie Creek Redwoods, but the real increases in park use were delayed by World War II. The CCC camp itself, which consisted of 14 temporary buildings (Fig. 3) were removed when the CCC was disbanded in 1937. For later park history, readers are referred to the unit history on file at park headquarters.

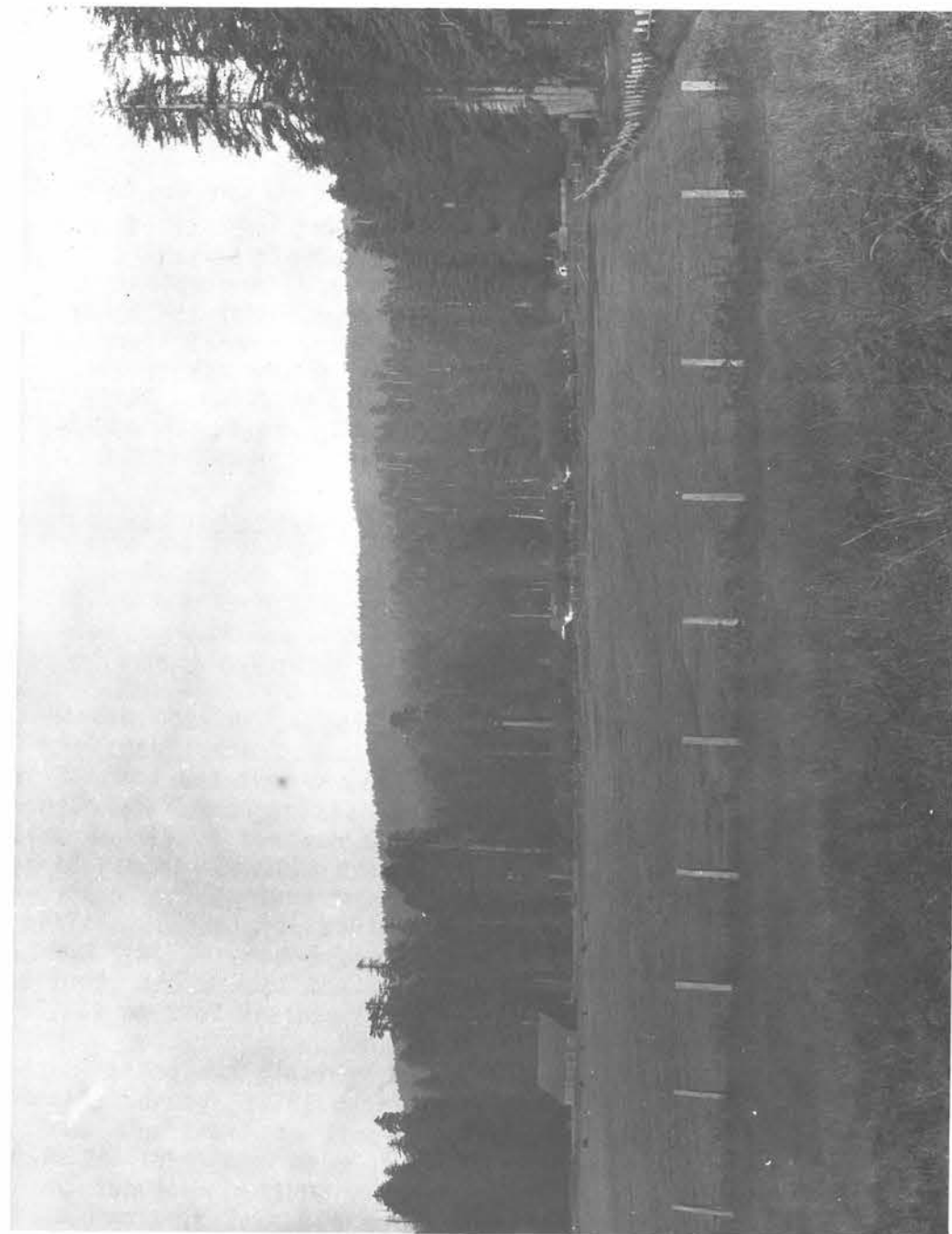


Figure 1. View of Boyes Ranch in 1920's with drainage ditches obscured by fence line vegetation in foreground and paralleling fence on right. Dark lines in center of grazed fields are shallow drainage ditches intended to dewater the pasture.



Figure 2. 1986 photograph showing changes in vegetation of Elk Prairie associated with the presence of the failing drainage system. Compare with Figure 1, a photograph made from the same location in the 1920's.

Methods

Historical accounts, including interviews and records available from Park offices at Prairie Creek were investigated as were title records, maps and land survey notes as they applied to human use history of the Elk Prairie area. Surface photographs made in the 1920's and 30's and part of the collection of the Save-the-Redwoods League and photographs from other sources were examined to evaluate change and human use. Aerial photographs from 1936, 1962, 1966, 1968 and later were also examined. Scenes were identified and rephotographed using similar camera systems and the changes described qualitatively. Woody plants beyond the treeline of the old growth redwoods on the prairie margins were aged using tree corers and located on aerial photographs.

The prairie was surveyed using standard surveying methods, including a theodolite and infra-red distance meter to determine general topography and specific features especially as related to the question of the location of natural channels and artificial drainages. The data were reduced and a map prepared (Map 2.) using a four foot contour interval in conjunction with airphoto interpretation and field inspection.

In order to establish a permanent prairie vegetation monitoring system, a series of fifteen 200 foot permanent line transects were established in two lines paralleling the long axis of Elk Prairie (Figure 4). Elk Prairie was systematically sampled using these fifteen line transects. The initial design to obtain well distributed samples throughout the prairie proper involved establishing two baselines paralleling the long axis of the prairie and laying out the plots at approximately 450 ft (137.2m) intervals, perpendicular to the baseline. The locations of the plots as installed are shown in Fig. 4 and described in Appendix B. Some adjustments were made because of the presence of U.S. Highway 101. Each transect was defined by end points, 201 ft (61.27m) apart consisting of 1½ in galvanized steel pipe driven 3-3½ ft into the soil. (Plot #11 was reduced to a length of 151 ft). With one pipe as zero, the transect was sampled at 1 ft intervals between the end points. At each foot mark a pointed pin (range pole) one inch in diameter was dropped vertically. At each point each plant species touching the pin was reported. The height (in meters) of the uppermost plant was reported where it touched the pin. If the soil surface was obscured by vegetation, no other data were obtained. If exposed soil, rock or litter was visibly touched by the pin, it was recorded, but these were infrequently encountered because the prairie soil generally was obscured by the basal stubble of live grasses and/or thatch. When soil was visible, it was often a result of pocket gopher (*Thomomys bottae*) excavation.

The data for each plot were aggregated and tabulated using a Sperry personal computer and programs written for this work by Dwain Goforth. Species frequency lists for each plot and for aggregations of plots were generated. For each plot a dominant species profile was generated which displayed the identifying code and height for the tallest species encountered at each point along the transect. Similar data were obtained



Figure 3. Aerial view of Civilian Conservation Corps Camp about 1935. Northwestern end of Elk Prairie, Prairie Creek Redwood State Park. Mathew Sautino, Humboldt State Library Collection.



Figure 4. Aerial view of Elk Prairie, Prairie Creek State Park showing distribution of grassland sampling transects. Note central ditch and darker sedge dominated vegetation near transects 10, 11 and 14.

from single line transects (300 feet in length) established in Lincoln Prairie and Ossagon Prairie.

In addition to these data, taxa seen near the plot (but not encountered on the transect) were listed and brief phenological descriptions for the more important species were given. A general list was made of all taxa observed on the prairie and its immediate margins. Voucher specimens were collected and verified at the Humboldt State University Herbarium, as were unknown or problematic specimens. Initial sampling was carried out in June and July, 1986. In September, 11 plots were resampled in order to document the results of a prescribed fire which burned the prairie west of highway 101 on September 11, 1986. In June, 1987 all transects were resampled.

To examine change in the grassland following the September prescribed prairie burn between 1986 and 1987, the 25 most frequent species on the burned transects were tested for significant change using the paired sample T-test (Zar, 1984). While the transects did not represent a random sample, it was assumed that the frequency results are indicative of results that would have been found under a random sampling method.

In addition to the results from the burned Elk Prairie transects, the same test of significant change between 1986 and 1987 frequencies was conducted for the same species from unburned grassland transects from nearby prairies (Lincoln, Ossagon, and Upper Gann in Redwood N.P.). It must be emphasized that this second analysis is for comparative use only, and does not represent an experimental control for the burned Elk Prairie transects.

Lastly, the results from unburned transects at Elk Prairie were also subjected to paired-sample T-tests to identify any statistically significant changes in species frequencies. As these transects are dominated by sedges (wet prairie vegetation) the results are not comparable with the burned grassland transects on Elk Prairie.

The analysis was performed using the paired-sample T-test procedure in the SPSS/PC computer program (SPSS, 1984).

Results and Discussion

Modification of the Natural Drainage System

The eastern margin of Elk Prairie lies at the toe of a slope draining the ridge separating the Prairie Creek and Boyes Creek drainages on the west and north from the May Creek drainage to the southeast. The westward draining slope comprises about 100 acres (40 ha) and is drained by several intermittent streams and one second order perennial stream which emerges from the forest margin upslope of the park maintenance area. The largest stream drains a watershed of 12-15 acres (5-6 ha). Most of the smaller streams have defined channels in their steeper midslope reaches which drain onto alluvial fans at the break in slope above the prairie. The smaller water courses drain watersheds of 1 to 7.5 acres (.4 to 3 ha) and surface flow in each disappears into the alluvial fans throughout most of the year. The discharge from these streams often emerge near the lower edge of the alluvial fan as diffuse springs and wet ground.

The largest stream reaches a low gradient well away from the prairie edge and has a well defined channel and a small flood plain. It flows west to the prairie margin and turns southwest along the left edge of a large gently sloping alluvial fan which underlies the park developed area in the northeastern corner of the prairie. The stream has occupied its present channel for several hundred years or more. This is clear from the size (and age) of the redwood trees on the stream bank and alluvial fan north of the present channel. The basal swell of the redwoods (4-8ft (1.2-25m) dbh) suggest that they grew in place and have not been buried by any substantial flood deposits during their lifetime. About 300 ft (100m) below the trail bridge this stream disappears into a sinkhole. The subsurface flow emerges again 400-500 ft (120-150 m) to the southwest as a broad expanse of wet ground dominated by sedges (especially *Carex obnupta*) with springs and two permanent or near permanent pools (Map 2). Modest efforts to map subsurface flows using sodium chloride and a salinity meter were unsuccessful.

At some time prior to the earliest known photographs a drainage system was developed to divert the flow of surface water from the slopes along the northeastern margin of the prairie and to drain portions of the prairie itself. A ditch was dug along the prairie margin from the largest stream (from point A, map 2) southwest about 1200 ft. (365 m) then turning northwest for about 250 ft. (75m) crossing under the present U.S. Highway 101 and continuing for more than 2500 ft. (750 m) to the south end of the prairie. The lower 2000 ft (600 m) pass through low sedge dominated ground formerly drained by an ephemeral channel heading up an intermittent stream at the south end of the prairie. The drainage ditch flows into the former natural stream channel in the riparian forest vegetation south of the prairie. This stream eventually joins Prairie Creek just above May Creek.

The purpose of the ditch system is clearly for drainage, not irrigation. This is indicated by Clark Lovin, who said in his interview (Unit History, 1984), that Boyes Prairie was "sumped" (by the late 1920's) and not irrigated. A sump is an open drain, even now used in the diked pastures

around Humboldt Bay. An infra-red aerial photograph taken in April, 1984 shows an extensive network of these ditches in the sedge-dominated wet ground in the northeast and southeast portions of the prairie. Some are shown on Map 2. These shallow ditches are difficult to detect on the ground because they have been trampled by livestock, filled by organic material and covered by vegetation. The shallow ditches join the primary system, which is a ditch usually 2-3 ft. (.5-1 m) deep through the middle of the prairie. It is clearly visible and fully functional today. The eastside primary ditch is less functional, its margins are invaded by alder (*Alnus rubra*) and it readily overflows into the sedges. The upper section of the original primary ditch (between points A and C, Map 2) appears to have failed years ago and the largest stream resumed its earlier meandering channel, leaving the ditch through the forest margin dry and non-functional. This dry ditch segment is crossed by the Elk Prairie Trail. A secondary ditch, probably developed later, leads from the sink, where summer surface flow ends (point B) to a point near where flows reemerge (near point C) above the perennial pools. During storm periods when the discharge from the largest stream exceeds an estimated 5 ft³/sec. (0.15 m³/sec) it overflows and flows down the ditch. Infrequently, the capacity of the 18 in. (46 cm) metal culvert carrying the primary ditch under highway 101 is exceeded and the highway flooded. During the peak of a storm in 1972 at least 300 ft. (100 m) of the roadway was covered by flowing water up to 4 in. (10 cm) deep as the surface runoff from the eastside streams sheeted across the prairie. By the end of summer the ditch and prairie west of the highway is dry and only the wettest parts of the east side (around point C) and the areas marked as springs or pools remain wet and mirey.

The open drain and ditch system was developed to dewater the wettest portions of the prairie, presumably to improve the pasturage there for livestock. Over the years the drain fields have filled in and the primary ditch system has become less efficient, especially in the vicinity of point C and along the alder lined reach below point C (Map 2). Sedges have become increasingly abundant, replacing pasture grasses (Figs. 2) in the wet soils and shrubs and trees have invaded the margins of the ditches. As the ditches fail the east slopes have become wetter and the wet period has become extended longer into the summer. This trend is restoring the affected portions of Elk Prairie toward more natural conditions, and reducing the influences of modern alteration of the surface water regime.

Prairie Invasion by Woody Plants

It is reasonably clear that Elk Prairie is a natural prairie. It was present when the first white settlers arrived. The natural origins of coastal prairies as classified by Munz (Munz and Keck, 1973) are much less apparent. I believe the coastal prairies, both in the Bald Hills setting on steep earth flow features and in low slope, old river deposits owe their existence to relatively poorly drained (clay-rich) soils which dry out rapidly with the onset of summer drought. This wet-dry cycle favors dry season dormant grasses and herbs and works against most woody species. Naturally occurring fires and Indian burning might expand a pre-existing

opening, but it is doubtful that the Indians created the openings from otherwise continuous forests. Land surveys of forest and prairie lands in the Crescent City-Smith River area of Del Norte County conducted just three years after settlement in 1850 reveal that the prairie-forest margin has changed little since that time. However, with the cessation of burning and grazing, fallow prairie-agricultural lands are being invaded by shrubs, alder and conifers and some smaller prairies have been strongly invaded by Douglas-fir.

The 1850 margins of the coastal prairies discussed here are relatively well defined by the presence of old growth forest trees, usually redwood or Douglas-fir, several hundred years old or older. While Indian burning may have influenced some forest sites more than others, the evidence for forest fire frequency in the near coastal setting (Veirs, 1982) suggests that Indian burning was not important on a forest wide basis, but was limited to specific sites and practices. Some valley bottom forests of spruce (*Picea sitchensis*), maple (*Acer macrophyllum*), cottonwood (*Populus trichocarpa*) and similar riparian species were converted to agricultural uses following clearing, but riparian redwood stands were only rarely converted, usually with ample evidence left in the form of long lasting stumps.

Within the old growth redwood forest adjacent to the Elk Prairie there are substantial numbers of stumps of trees felled for agricultural, mining and road building purposes, mostly in the late 1800's and early 1900's. Some logs are visible in the west edge of the prairie during the CCC occupancy (Fig. 2). The trees may have been felled to provide redwood fence and building materials. No commercial logging appears to have been conducted on the prairie margins. Young redwood, spruce and Douglas-fir have become reestablished following the scattered disturbances in the forest on the prairie margins. They are typically 30-60 years old, although some may be older. In the forest margin many old growth trees have charred bark which indicates forest fires or deliberate burning associated with Indian or early white uses. No fire scar aging was attempted as a part of this study. No non-native trees or shrubs were found within the old growth forest margins of Elk Prairie.

The earliest photographs available for this study of the Elk Prairie were those of the Save-the-Redwoods League study from the 1920's (SRL, undated). Photos from that period show that the prairie was grazed by cattle, mowed for hay, planted to apples and cultivated for row crops. These patterns of use are probably little different from the days of Gold Bluff mining when "Big" Prairie and Gann's Prairie were used for livestock and gardens. Some row crops, including carrots, beets and cabbage, were grown in the early days as winter feed for livestock (Davison, Pers. comm.). Grazing was not necessarily severe in the 1920's. Photographs (Fig 5) show a substantial standing crop of grasses and bracken fern in the southern half of the prairie. These would have been closely cropped or trampled under heavy grazing pressure. Fig. 6 shows the same view in 1986 with use by elk. Since the elimination of livestock and agricultural burning following establishment of the park, woody plant invasion has become a persistent problem requiring maintenance, especially along roadside ditches

and fence lines. Many woody plants are heavily browsed today by the native Roosevelt elk (*Cervus elaphys roosevelti*), which have recovered from near extirpation due to the protected habitat of Prairie Creek State Park.

Redwood (*Sequoia sempervirens*)

Only a few redwood have become established in the prairie proper and these are associated with ditches and fence lines. A row of redwoods now line the east side of the park service road near the entry kiosk. A dozen trees are 3-5 ft in diameter at breast height. All were established after the CCC camp was removed. The largest are growing at the rate of 1-inch in diameter each year. In time they will form a solid barrier along the roadside and presently represent a major change in the appearance of the prairie margin. One smaller redwood has become established in the fence line along U.S. 101. Without the favorable habitat of the ditch and fence line, these trees probably would not have become established. A similar situation exists at the north end of the Big Tree parking area. About dozen rapidly growing young redwoods established on construction spoil now screen the natural vegetation at the edge of the parking lot.

Elk often severely rub redwood with their antlers, removing cambium and changing the shapes of the stem, but not often killing the trees.

Once well established, rapidly growing redwood of relatively recent origin become relatively permanent landscape features. Figure 7 shows the western edge of the prairie along the park road in the 1940's. Figure 8 is the same scene in 1986 showing a row of large redwood trees established in the ditch line after the removal of the CCC camp.

Sitka Spruce (*Picea sitchensis*)

Sitka spruce have extensively reoccupied areas in the forest margins that had been cleared or logged earlier, especially along the east edge of Highway 101 at the south end of the prairie. These trees invaded an area of grassland that was bladed off during highway construction in the 1920's. Most are now 40-50 years of age. Figures 9 and 10 are views of the southeastern edge of the prairie in 1920 and 1986. Despite the dense canopy of the spruce, some native prairie vegetation has persisted on the now-forest floor, including *Calamagrostis nutkaensis*. Some of these trees were removed from the roadside during the course of the study.

Scattered spruce seedlings have become established in the prairie proper and in ditch lines and cutbanks, especially along the old road on the west side of the prairie. Spruce established in the open prairie grow slowly and are usually damaged by elk, eventually dying due to elk damage. Those protected by enlarging cascara and alder copses may become mature invaders of the prairie margin, progressively closing the prairie as shading provides more favorable growing habitat. Another stand of large spruce, 40-80 years old, dominate the south end of the prairie on Redwood National Park land.



Figure 5. 1920's view from near the southern end of Elk Prairie, looking north. Notice the relatively ungrazed condition and absence of marginal shrubs and trees. Boyes' barn and auto court are visible on right. (S.R.L. Collection)



Figure 6. 1986 view duplicating that of Figure 5. Notice the effects of elk use and the increase in shrubs and young trees on prairie margin.



Figure 7. Western edge of Elk Prairie, 1940's. (S.R.L. Collection)



Figure 8. 1986 view duplicating that of Figure 7. Redwoods 4 to 5 feet in diameter now line the roadside ditch. They were established after the removal of the CCC camp.

Douglas-fir (Pseudotsuga menziesii)

A few Douglas-fir have become established in better drained portions of the prairie. Six or seven about twenty years old are growing above the campground loop on the prairie edge (Figs. 11-12). It may be that the elk use is decreased near the areas of more frequent human use and seedling survival enhanced as a result. Like spruce and redwood, the Douglas-fir may be damaged by male elk rubbing their antlers against the stems. Small Douglas-fir are very sensitive to fire and are easily killed by a prairie fire. Bentley (1959) mentions that fire was used to kill small Douglas-fir trees in the south end of the prairie. One Douglas-fir, possibly planted, near the former Boyes residence is rapidly growing into a major element of the landscape. If these trees once established in the prairie reach their full potential size, they will produce substantial changes in the historic character of the prairie.

Red Alder (Alnus oregona)

Alder can be an aggressive invader of wet coastal prairie, especially following the removal of livestock. Alder stands have developed in the bottoms along Boyes Creek and Prairie Creek where they become established on recent flood deposits. It is possible that alders along these stream courses were cut in early settlement days for firewood or to open additional pasture land. Alder are established also in the former fence line along the ditch and the alluvial fans on the east side of the prairie (Figs. 13-14). The presence of these trees is due to the protection and habitat provided by the ditch and old fence line. Alder is usually confined to wet sites and its distribution, except along the old fence and ditch line, is relatively natural.

Domestic Apple (Malus sylvestris)

The apple trees established in orchards by Mr. Boyes (or earlier) are declining in number slowly with age. They display a prominent browse line and provide food and shade for the elk. The elk do not seem to damage the apple trees by antler rubbing. There are a few domestic apple trees scattered about the prairie, either planted or volunteer. One, at the corner of the drainage ditch east of U.S. 101 may be a cross between the domestic apple and the native crab apple. These scattered apple trees should be considered escaped exotics while the orchards are a historic feature. The number of apple trees in the orchard is declining. Fewer than twenty trees are alive today, less than half the number apparently present in 1930's photographs and considerably fewer than present in the 1920's (Fig. 1).

Oregon Crab Apple (Malus fusca)

Oregon crab apple is found scattered in the coastal prairies of northwestern California and north to Alaska. At Elk Prairie it occurs only as scattered, severely browsed specimens one to two feet tall except for one remnant tree, now fallen, on the edge of the drainage ditch in the

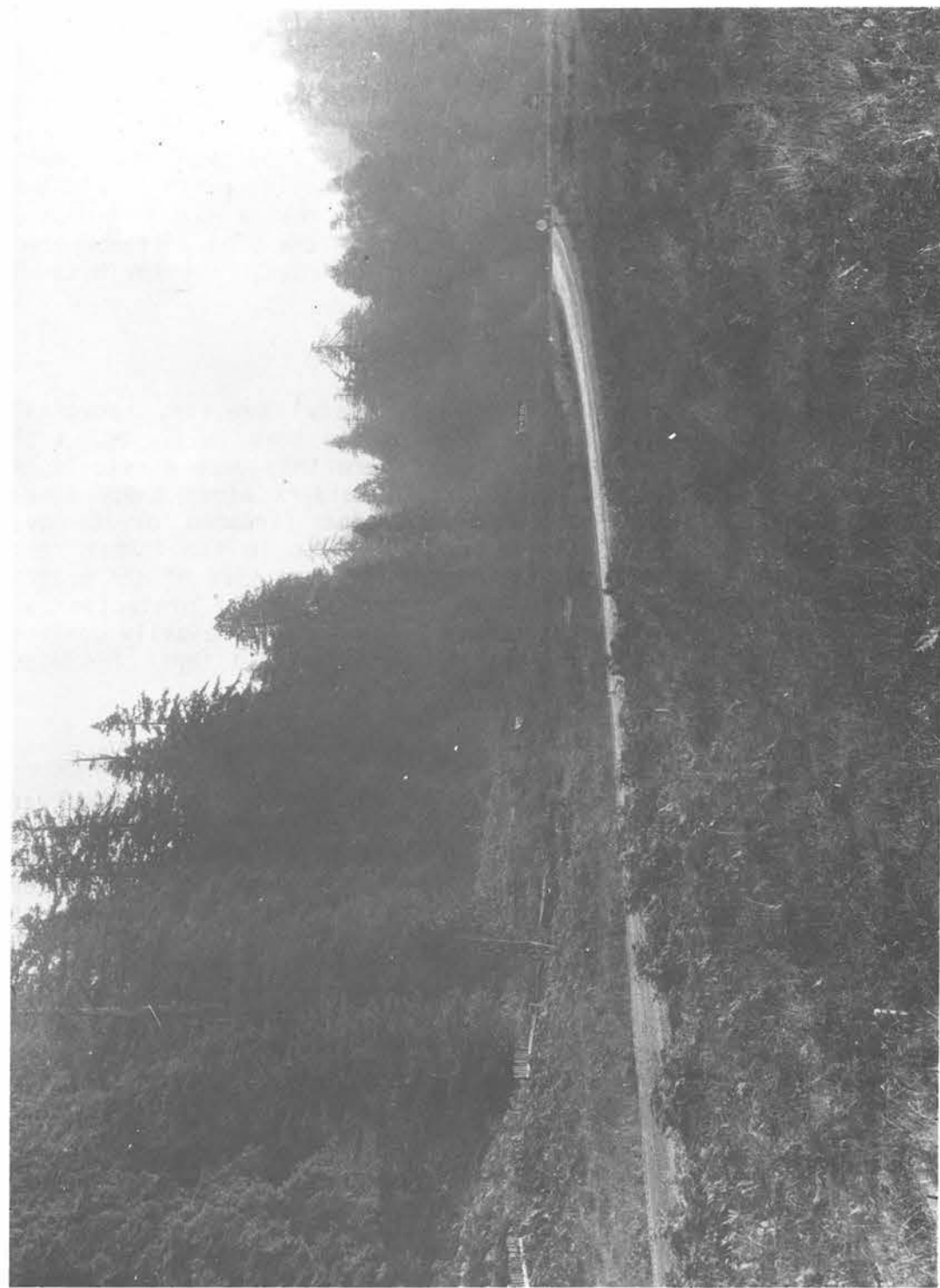


Figure 9. Early 1920's view of the southeastern edge of Elk Prairie.

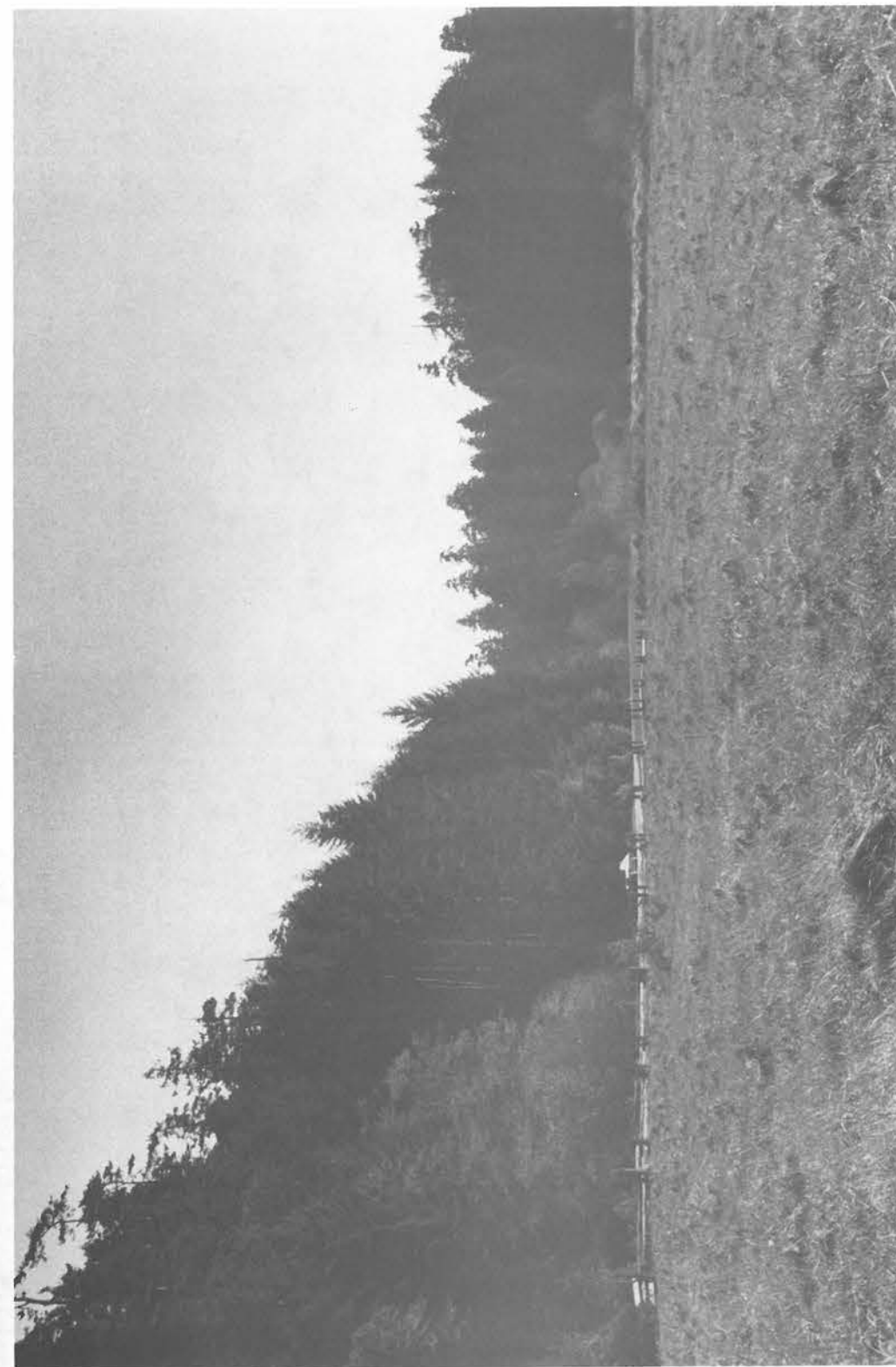


Figure 10. 1986 view of the southeastern edge of Elk Prairie. The Sitka spruce stand on the east side of the road (above parked car) became established on prairie soils scraped bare when the highway was improved in the 1920's.

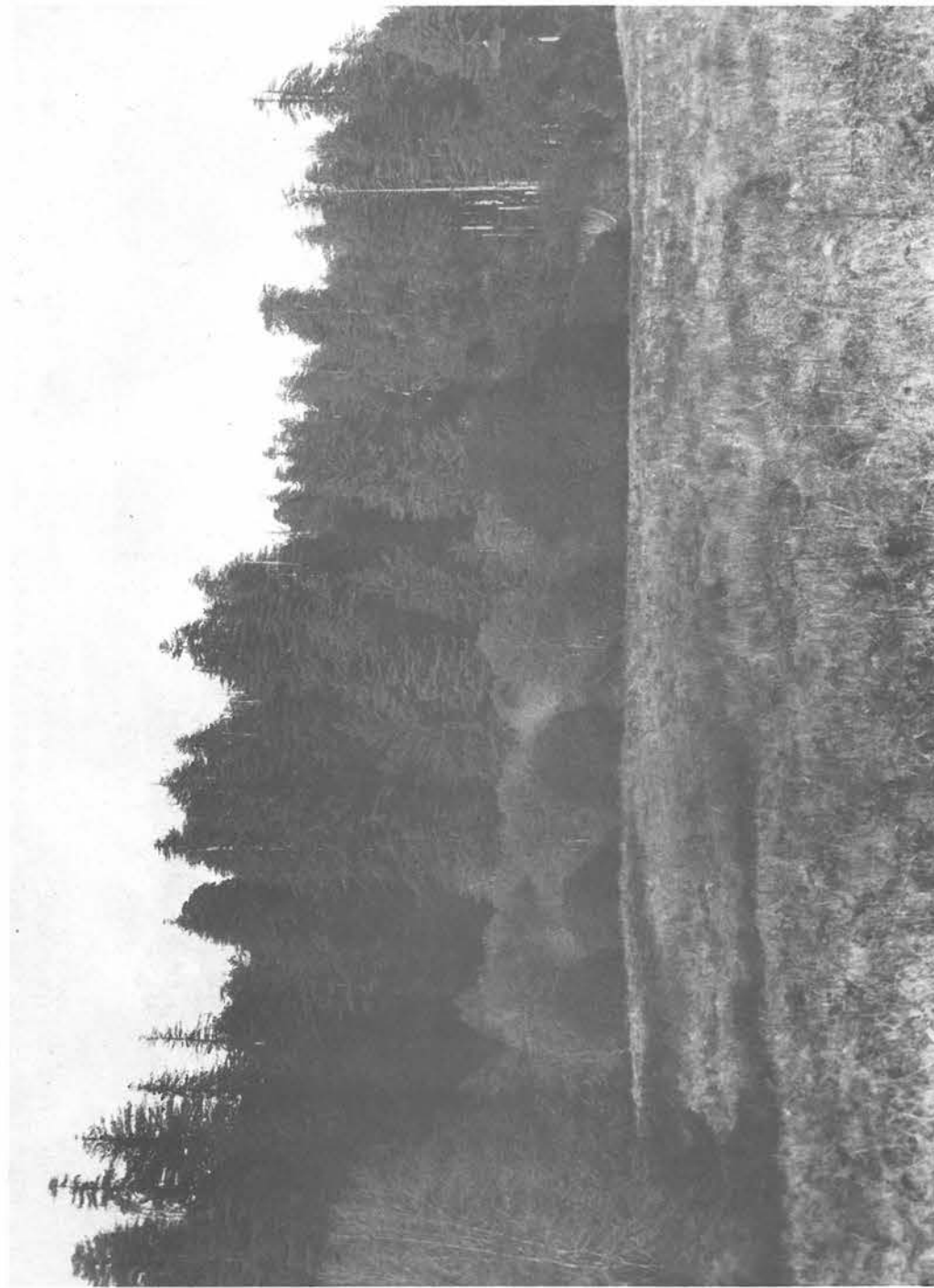


Figure 11. 1920's view of Elk Prairie looking northwest toward the present campground loop.
(S.R.L. Collection)

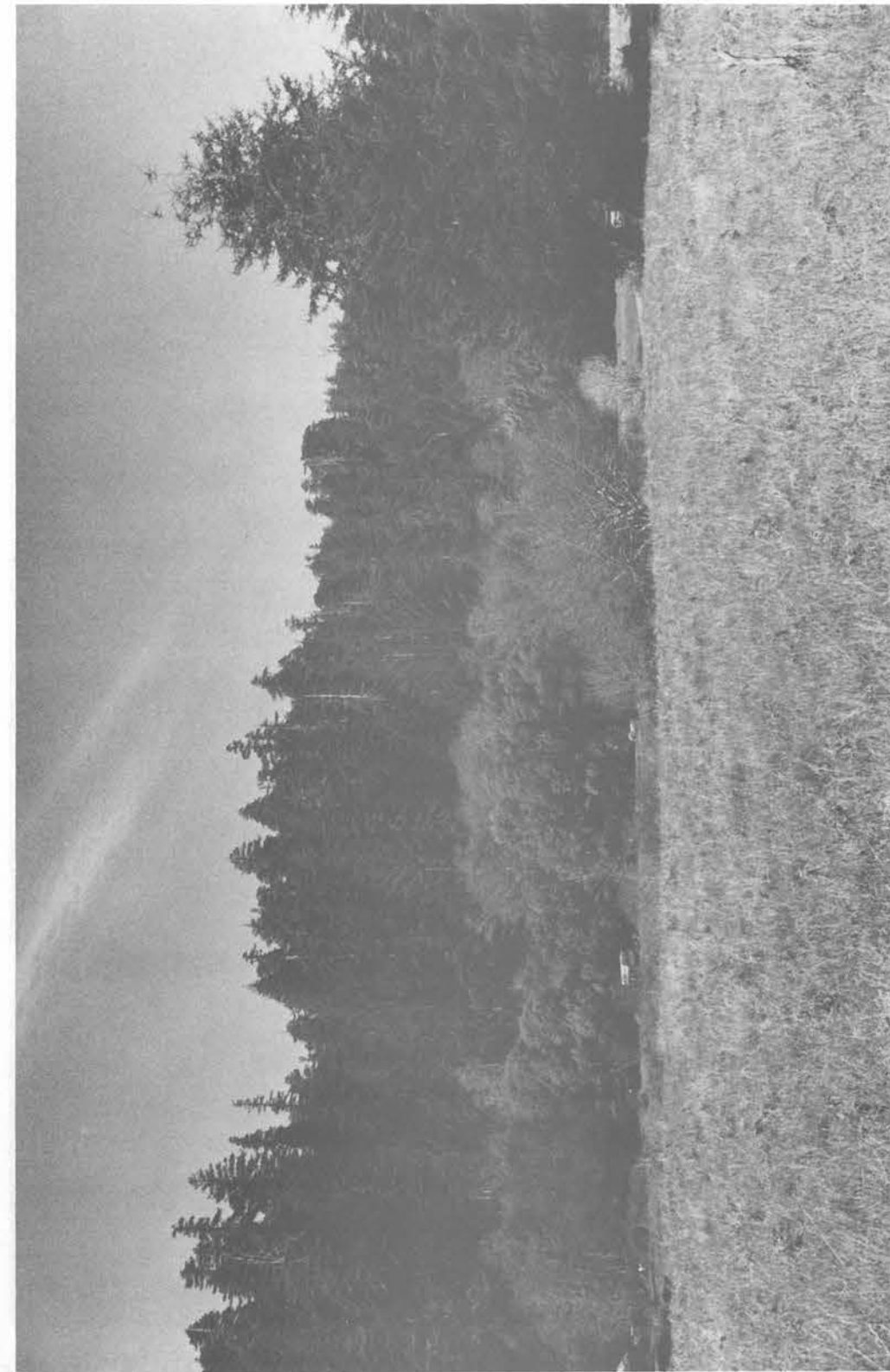


Figure 12. 1986 view of Elk Prairie looking northwest toward the present campground loop. On the right is a young Douglas-fir recently established in the prairie. Notice the increased size of the alder and bay trees at the old growth forest edge. Cascara trees are in the right center of the scene.

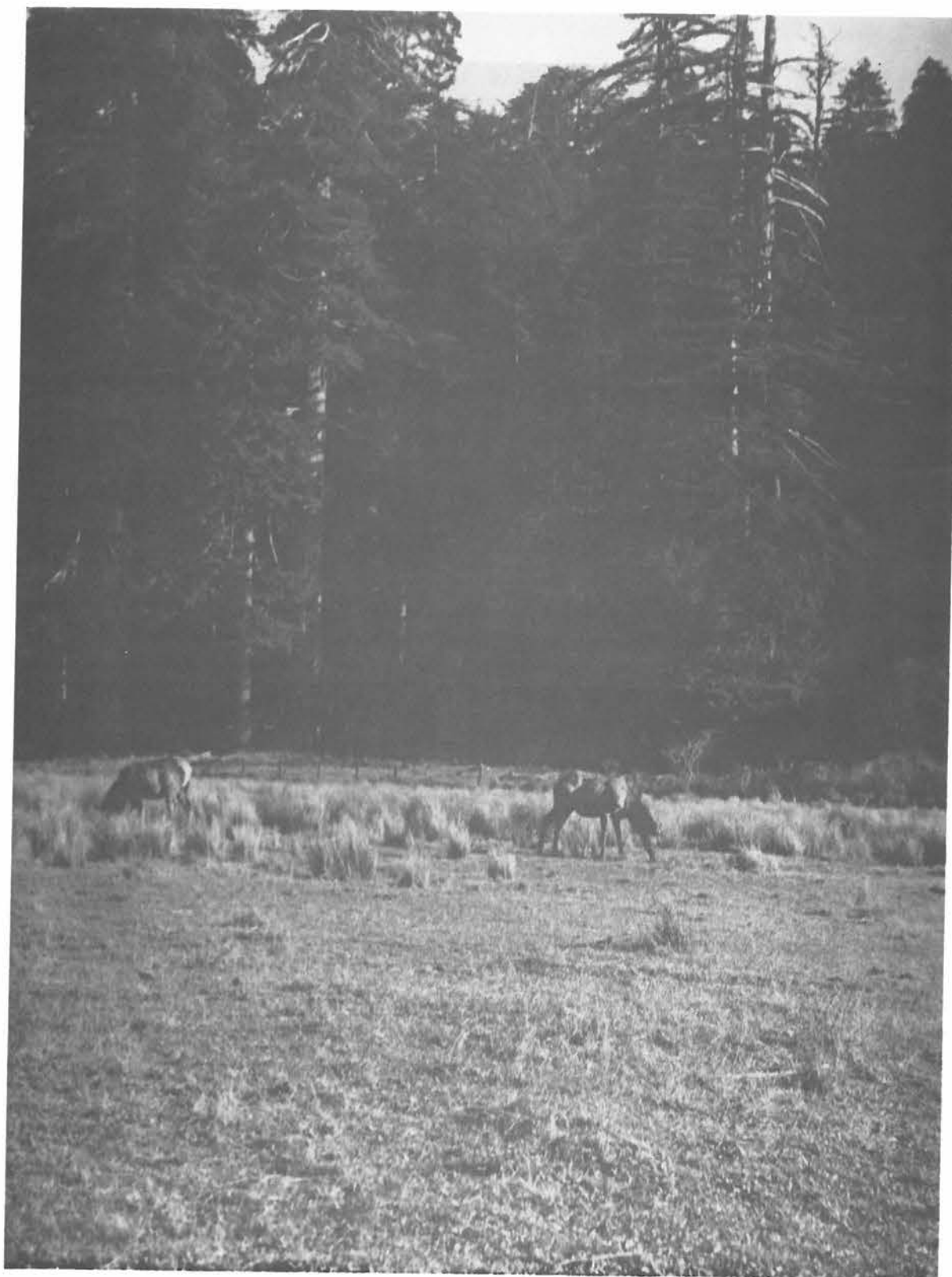


Figure 13. A 1940's view of Elk Prairie looking east during the period of heavy elk use. Notice fence line which is adjacent to drainage ditch. (Savina Barlow Collection)



Figure 14. 1986 view of Elk Prairie looking east duplicating Figure 13. Notice heavy invasion of alder on margin of the ditch and sedges in the middle. This portion of the prairie is becoming dominated by sedges as the drainage system fails.

middle of the prairie. This small tree is native to the prairie habitat, but is being eliminated by heavy elk browsing. Several of these trees occurred along the central prairie ditchline (Fig. 15), established before the return of elk to the prairie, but they have died and have not been replaced (Fig. 16).

Cascara (*Rhamnus purshiana*)

Cascara or buckthorn is a small tree. It is the most widespread invader of the prairie margins, first becoming established in ditch lines, cutbanks, and fence lines, then spreading by seeding into nearby prairie. Cascara is only lightly browsed by the elk and only occasionally damaged by rubbing. Once established, copses of Cascara provide cover for Sitka spruce, alder, huckleberry, salal and other forest understory species. Cascara can be top-killed by burning but resprouts. Most of the Cascara top killed by the September, 1986 controlled burn of the prairie are resprouting.

Tanoak (*Lithocarpus densiflorus*)

A few tanoak are scattered along the northwestern margin of the prairie. A common prairie margin/redwood forest species, it is not an aggressive invader on Elk Prairie where it may be nearing its natural coastal limit.

Bay (*Umbellularia californica*)

Two very large bay trees stand near the perennial stream emerging from the forest behind the Boyes house. These trees were large in the earliest photographs and were probably present before settlement. Other, younger, trees stand in the margin of the prairie/riparian forests west of the first campground loop. Bay is a relatively common forest/prairie margin tree species and is a normal minor component of the forests around the prairie.

Hazel (*Corylus cornuta*)

Hazel is also a prairie margin/forest species, formerly important in Indian basket making and probably regularly burned to maintain the availability of young stems for basket material. It is common around the prairie but is not an aggressive invader. It occurs extensively within the forest margins around the prairie and may indicate that the forest margins were formerly more open.

Himalaya-berry (*Rubus procerus*)

This aggressive exotic is a serious invader of coastal prairie, becoming established following termination of grazing agriculture or in ditches and road cutbanks. It is widespread in the north end of the prairie, and forms extensive closed stands taller than a person. Where elk use is heavy, it persists as pruned, waist-high clumps.

Osoberry (*Osmaronia cerasiformis*)

This native shrub occurs as scattered individuals near the forest margin or with snowberry. It is not an aggressive invader.

Snowberry (*Symphoricarpos albus*) and Rose (*Rosa californica*)

Snowberry forms closed shrub stands along the drainage ditch in the center of the prairie and occasionally along the prairie margin elsewhere. California rose is often associated with the snowberry. Prairie fires tend to limit the distribution of these shrubs, but the snowberry was present in the 1920's Fig. 17 and in 1986 Fig. 18. The snowberry was top-killed by the 1986 fire, but has resprouted.

Blackberry (*Rubus vitifolius*)

This trailing native is widely distributed throughout the prairie and is a natural component. Elk grazing and fire keep blackberry and rose plants from becoming larger, more dominant shrubs.

Rhododendron (*Rhododendron macrophyllum*) and Azalea (*R. occidentale*)

These native shrubs are scattered around the entry roads at the northern end of the prairie. They were probably planted as a part of landscaping efforts following park establishment and should not be considered part of the natural scene. They are not spreading, and those on the prairie proper were top-killed by the September, 1986, controlled burn.

Cotoneaster (*Cotoneaster* sp)

This showy introduced shrub is spreading in northcoastal California prairies, aided by birds which feed on the red fruits. Cotoneaster may be controlled by burning. About twenty individuals were observed in the prairie.

Other non-native shrubs and trees

The grounds of the employee housing area, including the former Boyes house, are extensively planted with ornamental trees, shrubs and other perennial plants and native trees and shrubs. The species composition and status of these ornamental plantings were not evaluated as a part of this study. At the southern end of the prairie ornamental plantings associated with a former gift shop (Figs. 19-20) persist as scattered specimens of English laurel (*Prunus laurocerasus*) and several unidentified ornamental shrubs. They are not spreading.

Regular removal of small trees and shrubs established along the fence lines paralleling U.S. Highway 101 in recent years by hand crews from the CCC has been very effective. Regular removal of shrubs and small trees from the ditches, and fence lines keep the roadside drainage structures, and fences from becoming hedge rows, which would otherwise obscure the natural scene

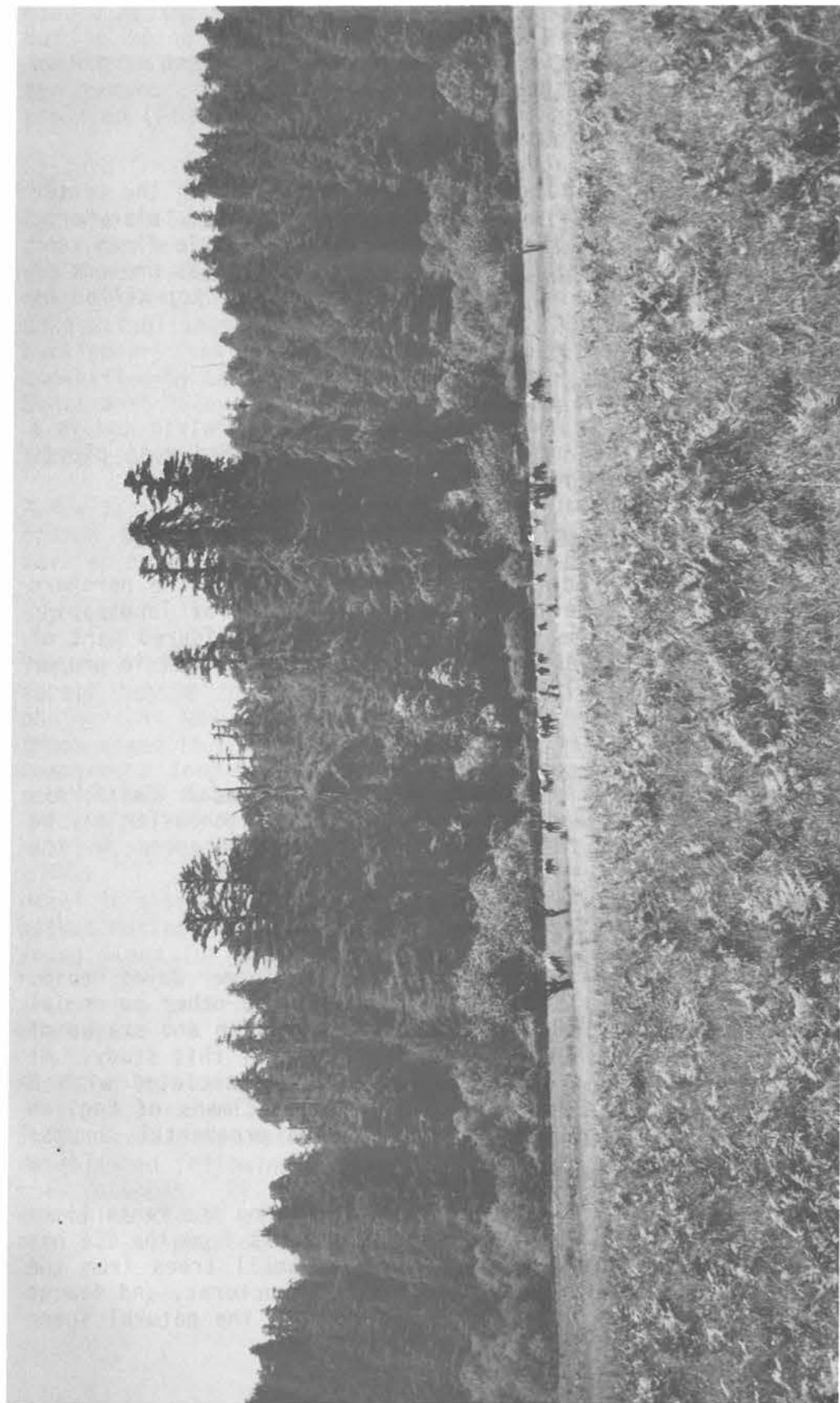


Figure 15. Looking west across Elk Prairie, about 1940. Browsed Oregon crab apple (*Malus fusca*) trees along the ditch line in Elk Prairie after Roosevelt Elk had become reestablished on the prairie (S.R.L. Collection).

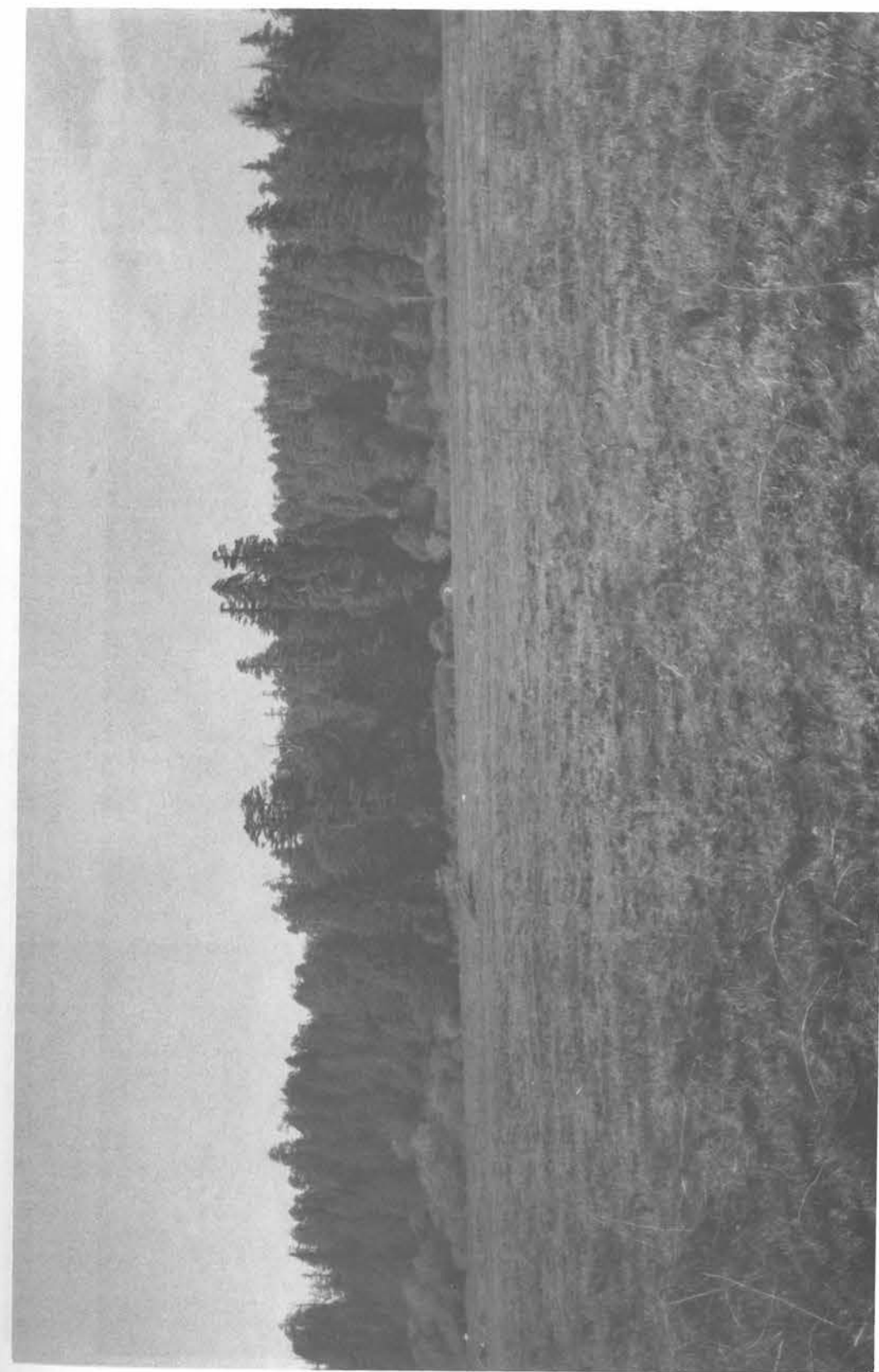


Figure 16. Looking west across Elk Prairie after September 1986 prescribed fire. Notice the remains of a near dead Oregon Crab Apple (*Malus fusca*) tree in the left center of the scene.

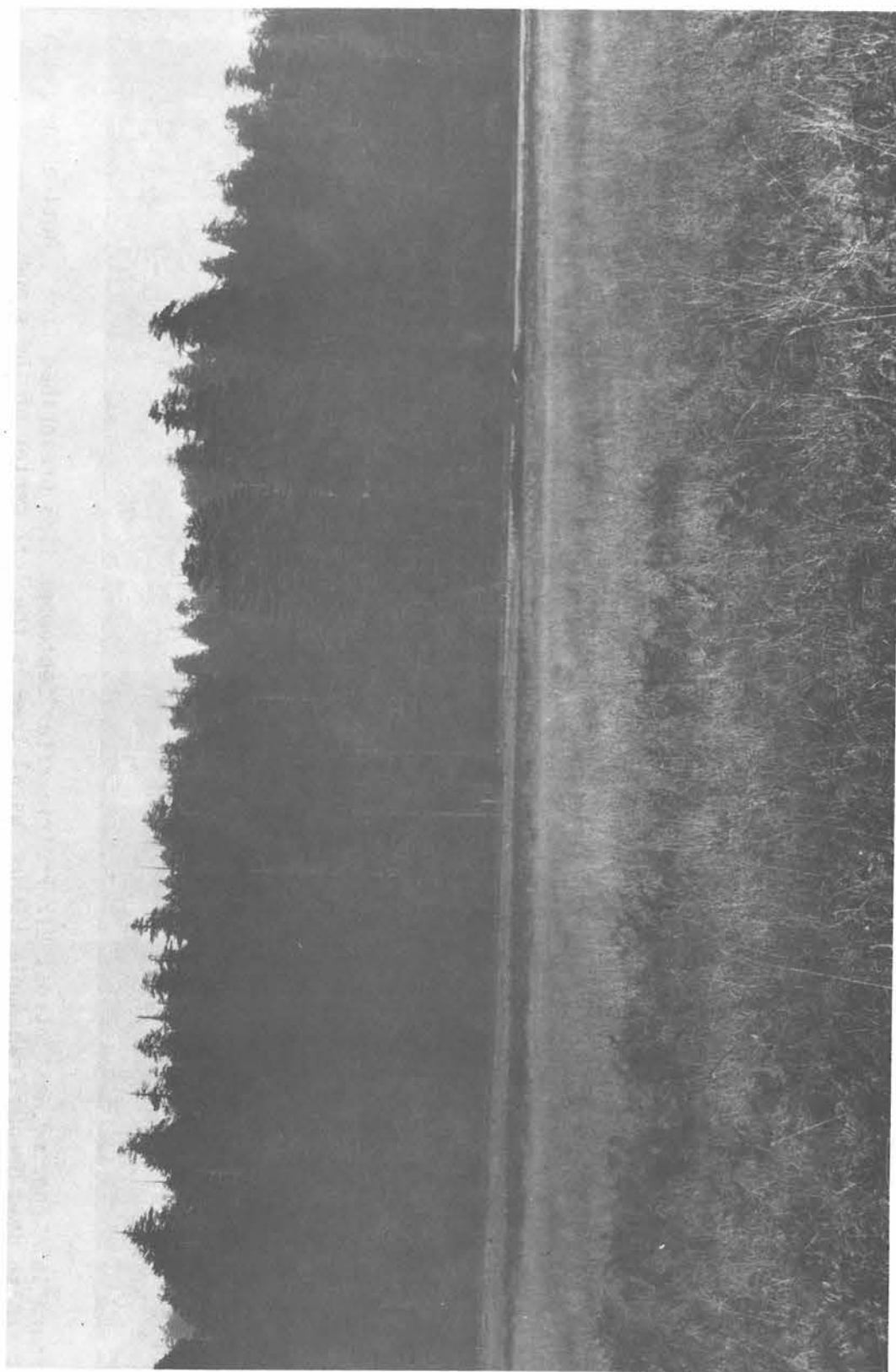


Figure 17. View of northwest across Elk Prairie, 1920's. Grasses and Braken fern are prominent in the foreground, snowberry probably forms the shrubs in the middle distance (S.R.L. Collection).



Figure 18. View northwest across Elk Prairie, 1986. Grasses and bracken fern remain dominant in the foreground. Snowberry forms shrub stands in the middle distance. Well established shrub stands dominated by cascara (Rhamnus purshiana) line the park roadside along the edge of the redwood forest.

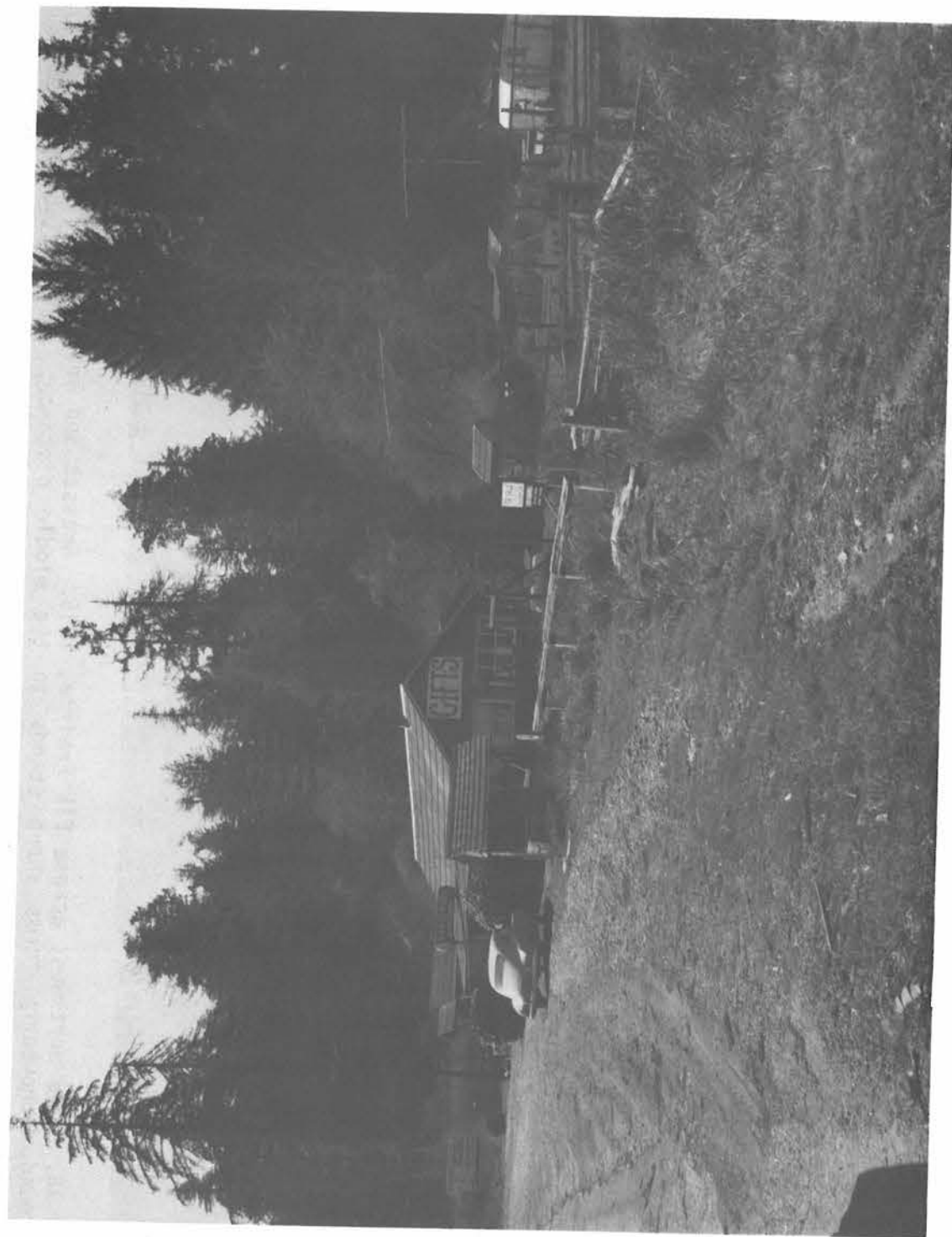


Figure 19. 1950's view of gift shop at south end of Elk Prairie (P.C.R.S.P. Collection)

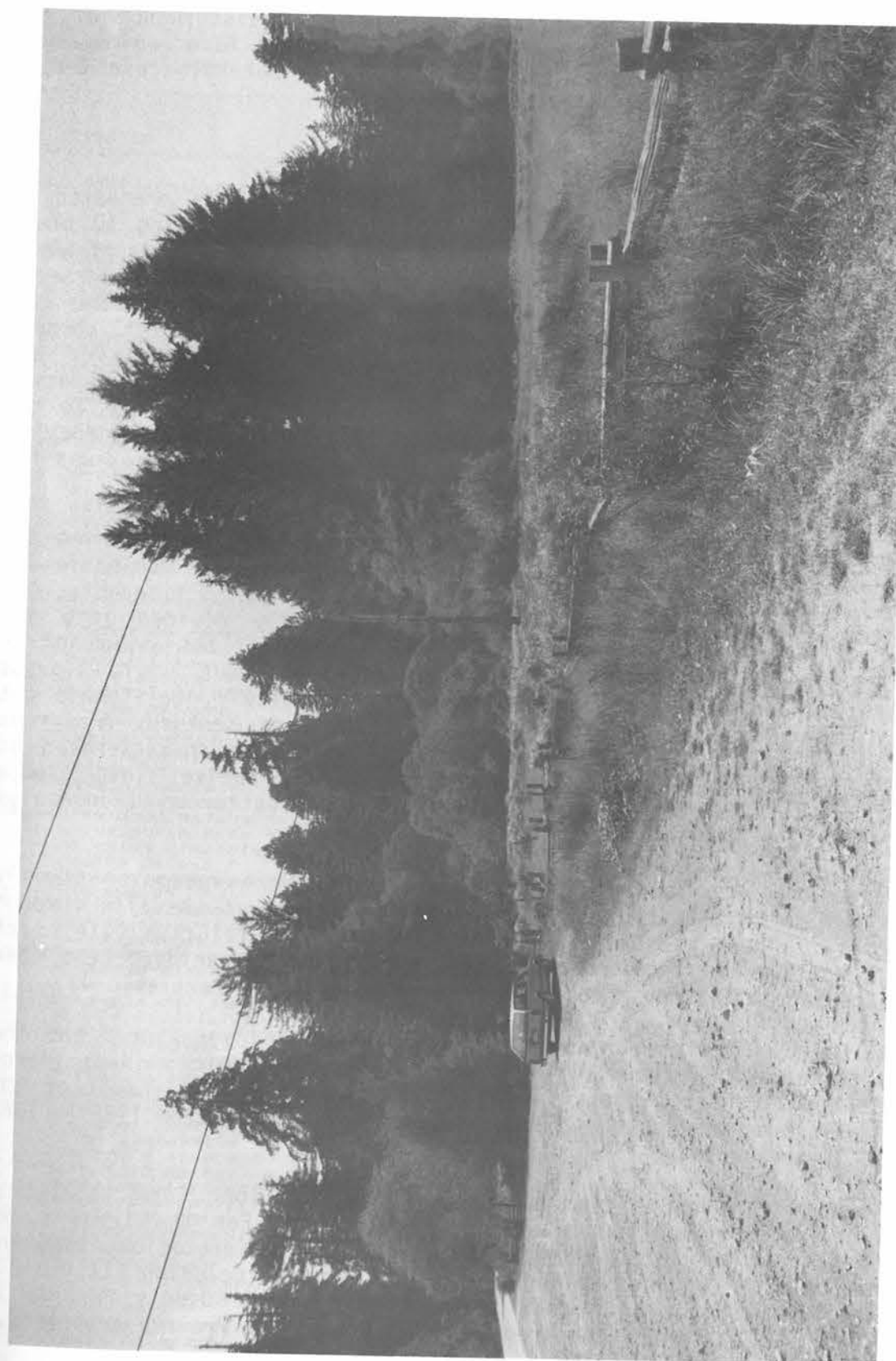


Figure 20. 1986 view of former gift shop location at south end of Elk Prairie.

and alter the natural plant communities. While the succession from prairie to shrubs and trees may be a natural consequence of disturbance of the prairie sod, protection from browsing and changes in the fire regime, such changes should not be permitted to wholly alter the natural scene merely because they are consequences of ditches and fences.

Elk Prairie Vegetation Analysis

A list of species in and on the margins of Elk Prairie is presented as Appendix E. There were 199 species in 145 genera representing 50 plant families (Munz and Keck, 1973). Thirty-four grasses were present, of which twelve are thought to be native. Examples of the individual transects results are presented in Appendix C. The transect data for summer and fall 1986 and summer 1987 are summarized and presented in tables 3 through 5. Native plants are denoted by an asterisk in the tables. For the tables, frequency is defined as the percent value of count of species encounters divided by number of points along transect: dominance is the percent value of a frequency of a species divided by the sum frequency of all species; and % as tallest is the percent frequency that species was the tallest plant at a point (Mueller-Dombois and Ellenberg, 1974)

Seventy-seven plant species were encountered on the transects during the summer, 1986 sampling period. Fourteen species exceeded 1% dominance for all taxa encountered at all 2950 sampling points in the 15 transects. Of these, six were native. The transects were readily divided into two subsets. Eleven transects (Table 6) could be characterized as upland or xeric grassland dominated by the non-natives. Sweet vernal grass (*Anthoxanthum odoratum*)(20%), redtop (*Agrostis alba*)(12%), California oat grass, (*Danthonia californica*), a native, (10%), and Kentucky bluegrass (*Poa pratensis*)(9%). The remaining four transects were characterized as hydric sedge vegetation, and are dominated by the native slough sedge (*Carex obnupta*)(28%) and the non-native creeping buttercup (*Ranunculus repens*)(24%) (Table 7).

The eleven transects burned in September, 1986, were resampled shortly after the fire to measure the effects of the passage of the fire through the prairie. These measurements identified only the relative effects of burning, not the presence or absence of a particular species. Less than 10% of the vegetative cover remained unconsumed by the fire (Table 4).

In 1987 the Elk Prairie transects were revisited and remeasured and the results summarized (Table 5). There were significant changes in dominance in the burned transects (No.s 1-8, 13-15), presumably as a result of the fire. Table 8 summarizes the change in species frequency from 1986 to 1987 on these 11 transects.

The permanent transect system was established for long term vegetation monitoring rather than for experimental purposes. For that reason, no unburned control was established. As an aide to interpretation, 1986 and 1987 results from unburned upland prairie transects, including Elk Prairie #12, Lincoln, Ossagon, and seven transects from upper Gann's Prairie in Redwood National Park were compared with the burned Elk Prairie transects.

Table 3. Summary of Transect Results, Summer, 1986

Total # of points in transect = 2950
Average height of vegetation in meters = 0.49
Average # of species per point = 3.28339

#	SPECIES	FREQUENCY	DOMINANCE	% AS TALLEST
1	<i>Anthoxanthum odoratum</i>	53.76	16.44	29.62
2	<i>Agrostis alba</i>	30.64	9.37	7.91
3	<i>Danthonia californica</i> *	27.56	8.43	9.38
4	<i>Poa pratensis</i>	22.58	6.90	2.07
5	<i>Carex obnupta</i> *	21.42	6.55	17.46
6	<i>Holcus lanatus</i>	21.36	6.53	7.20
7	<i>Ranunculus repens</i>	18.81	5.75	0.34
8	<i>Pteridium aquilinum</i> *	16.54	5.06	10.33
9	<i>Plantago lanceolata</i>	15.29	4.68	1.22
10	<i>Dactylis glomerata</i>	15.22	4.65	4.69
11	<i>Hypochoeris radicata</i>	14.68	4.49	1.15
12	<i>Carex sp.</i> *	9.83	3.01	1.90
13	<i>Bromus carinatus</i> *	9.42	2.88	2.11
14	<i>Rubus vitifolius</i> *	7.76	2.37	0.14
15	<i>Oenanthe sarmentosa</i> *	2.85	0.87	0.14
16	<i>Rosa californica</i> *	2.71	0.83	0.24
17	<i>Prunella vulgaris</i>	2.61	0.80	0.24
18	<i>Vulpia megalura</i> *	2.51	0.77	0.65
19	<i>Rumex acetosella</i>	1.83	0.56	0.07
20	<i>Bromus mollis</i>	1.80	0.55	0.24
21	<i>Festuca rubra</i>	1.69	0.52	0.31
22	<i>Aster chilensis</i> *	1.56	0.48	0.00
23	<i>Hypericum anagalloides</i> *	1.29	0.39	0.00
24	<i>Juncus bolanderi</i> *	1.25	0.38	0.48
25	<i>Ranunculus californicus</i> *	1.22	0.37	0.14
26	<i>Trifolium dubium</i>	1.15	0.35	0.07
27	<i>Lotus formosissimus</i> *	1.12	0.34	0.10
28	<i>Mimulus moschatus longiflorus</i> *	1.12	0.34	0.00
29	<i>Erechtites prenanthoides</i>	0.98	0.30	0.14
30	<i>Trifolium repens</i>	0.98	0.30	0.00
31	<i>Juncus effusus brunneus</i> *	0.95	0.29	0.44
32	<i>Veronica scutellata</i> *	0.95	0.29	0.00
33	<i>Viola adunca</i> *	0.95	0.29	0.00
34	<i>Achillea millefolium</i>	0.88	0.27	0.03
35	<i>Lolium perenne</i>	0.88	0.27	0.17
36	<i>Juncus bufonius</i> *	0.85	0.26	0.03
37	<i>Galium trifidum subbiflorum</i> *	0.81	0.25	0.03
38	<i>Stellaria crispa</i> *	0.81	0.25	0.00
39	<i>Vulpia bromoides</i>	0.78	0.24	0.07
40	<i>Luzula comosa</i> *	0.75	0.23	0.10
41	<i>Aster chilensis</i> *	0.71	0.22	0.00
42	<i>Iris douglasiana</i> *	0.64	0.20	0.24
43	<i>Lotus purshianus</i> *	0.64	0.20	0.00
44	<i>Geranium dissectum</i>	0.54	0.17	0.00
45	<i>Juncus patens</i> *	0.51	0.16	0.20
46	<i>Cirsium arvense</i>	0.37	0.11	0.07
47	<i>Stachys sp.</i> *	0.37	0.11	0.00
48	<i>Epilobium watsonii</i> *	0.31	0.09	0.00
49	<i>Taraxacum officinale</i>	0.31	0.09	0.00
50	<i>Carex praegracilis</i> *	0.20	0.06	0.00
51	<i>Deschampsia cespitosa</i> *	0.20	0.06	0.03
52	<i>Myosotis discolor</i>	0.20	0.06	0.00
53	<i>Aira caryophyllea</i>	0.17	0.05	0.03
54	<i>Fragaria californica</i> *	0.17	0.05	0.00
55	<i>Crepis capillaris</i>	0.14	0.04	0.00
56	<i>Elymus glaucus</i> *	0.10	0.03	0.07
57	<i>Plantago major</i>	0.10	0.03	0.00
58	<i>Rhamnus purshianus</i> *	0.10	0.03	0.10
59	<i>Triteleia hyacinthina</i> *	0.10	0.03	0.00
60	<i>Brodiaea coronaria macropoda</i> *	0.07	0.02	0.00
61	<i>Linum bienne</i>	0.07	0.02	0.00
62	<i>Lotus micranthus</i> *	0.07	0.02	0.00
63	<i>Rubus laciniatus</i>	0.07	0.02	0.00
64	<i>Sherardia arvensis</i>	0.07	0.02	0.00
65	<i>Sisyrinchium bellum</i> *	0.07	0.02	0.00
66	<i>Veronica americana</i> *	0.07	0.02	0.00
67	<i>Veronica serpyllifolia</i>	0.07	0.02	0.00
68	<i>Bellis perennis</i>	0.03	0.01	0.00
69	<i>Cytisus monpezzulanus</i>	0.03	0.01	0.00
70	<i>Digitalis purpurea</i>	0.03	0.01	0.03
71	<i>Galium aparine</i>	0.03	0.01	0.00
72	<i>Heracleum lanatum</i> *	0.03	0.01	0.00
73	<i>Lolium multiflorum</i>	0.03	0.01	0.03
74	<i>Malus fusca</i> *	0.03	0.01	0.00
75	<i>Sanicula crassicaulis</i> *	0.03	0.01	0.00
76	<i>Stellaria media</i>	0.03	0.01	0.00
77	<i>Veronica arvensis</i>	0.03	0.01	0.00
78	<i>Viola glabella</i> *	0.03	0.01	0.00

Table 4. Summary of Burn Results, September, 1986

Total # of points in transect = 100
Average height of vegetation in meters = 0.04
Average # of species per point = 1

#	SPECIES	% FREQUENCY
1	burned vegetation	67.09
2	burned litter (partially consumed)	11.18
3	undisturbed soil (between plants)	9.09
4	singed vegetation	5.18
5	unburned vegetation	3.91
6	disturbed soil (gopher mound)	3.45
7	heavy white ash or cooked soil	0.09

Table 5. Summary of 15 Elk Prairie transects, Summer, 1987.

Total # of points in transect = 2950
Average height of vegetation in meters = 0.37
Average # of species per point = 3.367119

#	SPECIES	% FREQUENCY	% DOMINANCE	% AS TALLEST
1	Anthoxanthum odoratum	46.88	14.10	27.72
2	Agrostis alba	35.69	10.74	11.53
3	Danthonia californica *	28.14	8.46	12.93
4	Carex obnupta *	20.92	6.29	15.44
5	Hypochoeris radicata	20.44	6.15	1.26
6	Holcus lanatus	20.00	6.02	5.20
7	Ranunculus repens	19.32	5.81	0.41
8	Plantago lanceolata	17.08	5.14	1.05
9	Poa pratensis	16.71	5.03	1.60
10	Dactylis glomerata	11.73	3.53	4.69
11	Pteridium aquilinum *	10.51	3.16	7.21
12	Carex sp. *	10.27	3.09	1.26
13	Trifolium dubium	9.66	2.91	0.75
14	Bromus carinatus *	7.42	2.23	0.88
15	Rubus vitifolius *	6.51	1.96	0.37
16	Vulpia megalura *	3.66	1.10	1.67
17	Crepis capillaris	3.08	0.93	0.03
18	Rumex acetosella	2.61	0.79	0.14
19	Vulpia bromoides	2.58	0.78	0.48
20	Geranium dissectum	2.44	0.73	0.03
21	Festuca rubra	2.20	0.66	0.51
22	Prunella vulgaris	2.14	0.64	0.14
23	Rosa californica *	2.10	0.63	0.03
24	Aster chilensis *	2.03	0.61	0.07
25	Oenanthe sarmentosa *	2.03	0.61	0.03
26	Trifolium repens	2.03	0.61	0.03
27	Bromus mollis	2.00	0.60	0.78
28	Ranunculus californicus *	1.73	0.52	0.48
29	Bromus L.f. stamineus	1.69	0.51	0.99
30	Hypericum anagalloides *	1.29	0.39	0.00
31	Galium trifidum subbiflorum *	1.19	0.36	0.07
32	Achillea millefolium	1.08	0.33	0.10
33	Luzula comosa *	1.02	0.31	0.20
34	Lotus formosissimus *	0.88	0.27	0.03
35	Juncus bolanderi *	0.78	0.23	0.44
36	Stachys sp. *	0.71	0.21	0.00
37	Erechtites prenanthoides	0.68	0.20	0.10
38	Lolium perenne	0.68	0.20	0.17
39	Cirsium arvense	0.64	0.19	0.03
40	Juncus effusus brunneus *	0.64	0.19	0.37
41	Mimulus moschatus longiflorus *	0.64	0.19	0.00
42	Sherardia arvensis	0.61	0.18	0.00
43	Veronica scutellata *	0.61	0.18	0.00
44	Iris douglasiana *	0.58	0.17	0.10
45	Lotus purshianus *	0.54	0.16	0.00
46	Viola adunca *	0.51	0.15	0.00
47	Aira caryophyllea	0.47	0.14	0.10
48	Epilobium watsonii *	0.47	0.14	0.00
49	Stellaria crispa *	0.47	0.14	0.00
50	Juncus patens *	0.44	0.13	0.27
51	Juncus bufonius *	0.31	0.09	0.03
52	Lotus micranthus *	0.31	0.09	0.00
53	Myosotis discolor	0.27	0.08	0.00
54	Sisyrinchium bellum *	0.27	0.08	0.00
55	Triteleia hyacinthina *	0.24	0.07	0.03
56	Cirsium vulgare	0.20	0.06	0.00
57	Scirpus setaceus	0.20	0.06	0.00
58	Poa kelloggii *	0.17	0.05	0.00
59	Taraxacum officinale	0.17	0.05	0.00
60	Anagallis arvensis	0.14	0.04	0.00
61	Elymus glaucus *	0.14	0.04	0.00
62	Hordeum brachyantherum *	0.14	0.04	0.00
63	Barbarea orthoceras *	0.10	0.03	0.03
64	Linum bienne	0.10	0.03	0.00
65	Plantago major	0.10	0.03	0.00
66	Veronica americana *	0.10	0.03	0.00
67	Veronica serpyllifolia	0.10	0.03	0.00
68	Fragaria californica *	0.07	0.02	0.00
69	Gastrium ventricosum	0.07	0.02	0.07
70	Ligusticum aplifolium *	0.07	0.02	0.00
71	Rhamnus purshianus *	0.07	0.02	0.07
72	Sagina sp. *	0.07	0.02	0.00
73	Sisymbrium sp.	0.07	0.02	0.00
74	Cardamine oligosperma *	0.03	0.01	0.00
75	Cerastium arvense *	0.03	0.01	0.00
76	Cynosurus cristatus	0.03	0.01	0.00
77	Daucus carota	0.03	0.01	0.00
78	Deschampsia cespitosa *	0.03	0.01	0.03
79	Juncus sp. *	0.03	0.01	0.00
80	Lotus sp.	0.03	0.01	0.00
81	Panicum acuminatum *	0.03	0.01	0.00
82	Stellaria media	0.03	0.01	0.00
83	Trifolium wormskioldii *	0.03	0.01	0.00
84	Viola glabella *	0.03	0.01	0.00

Table 6. Summary of Transect Results in Grassland Vegetation Type

Total # of points in transect = 2200
 Average height of vegetation in meters = 0.45
 Average # of species per point = 3.382727

#	SPECIES	% FREQUENCY	% DOMINANCE	% AS TALLEST
1	<i>Anthoxanthum odoratum</i>	73.14	19.96	36.71
2	<i>Agrostis alba</i>	41.95	11.45	10.17
3	<i>Danthonia californica</i> *	40.95	11.18	13.50
4	<i>Poa pratensis</i> *?	32.55	8.88	2.67
5	<i>Pteridium aquilinum</i> *	24.36	6.65	13.83
6	<i>Hypochoeris radicata</i>	21.68	5.92	1.75
7	<i>Dactylis glomerata</i>	20.59	5.62	5.83
8	<i>Plantago lanceolata</i>	20.41	5.57	1.50
9	<i>Holcus lanatus</i>	18.82	5.14	5.29
10	<i>Carex sp.</i> *	13.64	3.72	2.42
11	<i>Bromus carinatus</i> *	12.82	3.50	2.63
12	<i>Rubus vitifolius</i> *	10.86	2.96	0.17
13	<i>Prunella vulgaris</i> *?	3.64	0.99	0.33
14	<i>Vulpia megalura</i> *	3.59	0.98	0.88
15	<i>Aster chilensis</i> *	3.05	0.83	0.00
16	<i>Rumex acetosella</i>	2.59	0.71	0.13
17	<i>Bromus mollis</i>	2.41	0.66	0.21
18	<i>Festuca rubra</i> *?	2.27	0.62	0.38
19	<i>Ranunculus californicus</i> *	1.64	0.45	0.17
20	<i>Achillea millefolium</i> *?	1.50	0.41	0.04
21	<i>Viola adunca</i> *	1.23	0.33	0.00
22	<i>Vulpia bromoides</i>	1.14	0.31	0.04
23	~ gopher mound	1.09	0.30	0.06
24	<i>Lolium perenne</i>	1.00	0.27	0.08
25	<i>Trifolium dubium</i>	1.00	0.27	0.08
26	<i>Luzula comosa</i> *	0.91	0.25	0.13
27	<i>Iris douglasiana</i> *	0.86	0.24	0.29
28	<i>Lotus purshianus</i> *	0.77	0.21	0.00
29	<i>Rosa californica</i> *	0.64	0.17	0.04
30	<i>Geranium dissectum</i>	0.50	0.14	0.00
31	<i>Trifolium repens</i>	0.50	0.14	0.00
32	~ road surface	0.50	0.14	0.21
33	<i>Cirsium arvense</i>	0.45	0.12	0.08
34	<i>Ranunculus repens</i>	0.36	0.10	0.00
35	<i>Crepis capillaris</i>	0.32	0.09	0.00
36	<i>Taraxacum officinale</i>	0.32	0.09	0.00
37	<i>Carex praegracilis</i> *	0.27	0.07	0.00
38	<i>Aira caryophylla</i>	0.23	0.06	0.04
39	<i>Deschampsia cespitosa</i> *	0.23	0.06	0.08
40	<i>Fragaria californica</i> *	0.23	0.06	0.00
41	<i>Brodiaea coronaria macropoda</i> *	0.18	0.05	0.00
42	<i>Elymus glaucus</i> *	0.14	0.04	0.08
43	<i>Rhamnus purshianus</i> *	0.14	0.04	0.13
44	<i>Rubus laciniatus</i>	0.14	0.04	0.00
45	~ elk dropping	0.14	0.04	0.00
46	<i>Linum bienne</i>	0.09	0.02	0.00
47	<i>Lotus micranthus</i> *	0.09	0.02	0.00
48	<i>Sherardia arvensis</i>	0.09	0.02	0.00
49	<i>Carex obnupta</i> *	0.05	0.01	0.00
50	<i>Cytisus monpeulanus</i>	0.05	0.01	0.00
51	<i>Galium aparine</i>	0.05	0.01	0.00
52	<i>Juncus patens</i> *	0.05	0.01	0.00
53	<i>Lolium multiflorum</i>	0.05	0.01	0.00
54	<i>Malus fusca</i> *	0.05	0.01	0.04
55	<i>Sanicula crassicaulis</i> *	0.05	0.01	0.00
56	<i>Stellaria media</i>	0.05	0.01	0.00
57	<i>Viola glabella</i> *	0.05	0.01	0.00
58	~ soil	0.05	0.01	0.00

Table 7. Summary of Transect Results in Slough Sedge Vegetation Type

(Transects 9 10 11 14)

Total # of points in transect = 750
 Average height of vegetation in meters = 0.62
 Average # of species per point = 2.992

#	SPECIES	% FREQUENCY	% DOMINANCE	% AS TALLEST
1	<i>Carex obnupta</i> *	84.13	28.13	68.53
2	<i>Ranunculus repens</i>	73.07	24.43	1.33
3	<i>Holcus lanatus</i>	28.93	9.67	11.47
4	<i>Anthoxanthum odoratum</i>	14.40	4.81	6.67
5	<i>Oenanthe sarmentosa</i> *	11.20	3.74	0.53
6	<i>Rosa californica</i> *	8.80	2.94	0.80
7	<i>Danthonia californica</i> *	6.40	2.14	2.80
8	<i>Plantago lanceolata</i>	5.33	1.78	0.27
9	<i>Hypericum anagalloides</i> *	5.07	1.69	0.00
10	<i>Juncus bolanderi</i> *	4.93	1.65	1.87
11	<i>Lotus formosissimus</i> *	4.40	1.47	0.40
12	<i>Mimulus moschatus longiflorus</i> *	4.40	1.47	0.00
13	<i>Erechtites prenanthoides</i>	3.87	1.29	0.53
14	<i>Juncus effusus brunneus</i> *	3.73	1.25	1.73
15	<i>Veronica scutellata</i> *	3.73	1.25	0.00
16	<i>Juncus bufonius</i> *	3.33	1.11	0.13
17	<i>Galium trifidum subbiflorum</i> *	3.20	1.07	0.13
18	<i>Stellaria crispa</i> *	3.20	1.07	0.00
19	<i>Agrostis alba</i>	2.67	0.89	0.53
20	<i>Trifolium repens</i>	2.40	0.80	0.00
21	<i>Hypochoeris radicata</i>	2.00	0.67	0.00
22	<i>Poa pratensis</i>	2.00	0.67	0.27
23	<i>Juncus patens</i> *	1.87	0.62	0.80
24	<i>Prunella vulgaris</i> *	1.60	0.53	0.00
25	<i>Trifolium dubium</i>	1.60	0.53	0.00
26	<i>Stachys sp.</i> *	1.47	0.49	0.00
27	<i>Epilobium watsonii</i> *	1.20	0.40	0.00
28	<i>Myosotis discolor</i>	0.80	0.27	0.00
29	<i>Rubus vitifolius</i> *	0.80	0.27	0.00
30	<i>Bromus mollis</i>	0.67	0.22	0.27
31	<i>Geranium dissectum</i>	0.67	0.22	0.00
32	<i>Lolium perenne</i>	0.67	0.22	0.40
33	<i>Carex sp.</i> *	0.53	0.18	0.00
34	<i>Vulpia bromoides</i>	0.53	0.18	0.13
35	<i>Deschampsia cespitosa</i> *	0.40	0.13	0.00
36	<i>Luzula comosa</i> *	0.40	0.13	0.00
37	<i>Plantago major</i>	0.40	0.13	0.00
38	<i>Pteridium aquilinum</i> *	0.40	0.13	0.27
39	<i>Triteleia hyacinthina</i> *	0.40	0.13	0.00
40	<i>Vulpia megalura</i> *	0.40	0.13	0.00
41	<i>Aster chilensis</i> *	0.27	0.09	0.00
42	<i>Dactylis glomerata</i>	0.27	0.09	0.00
43	<i>Lotus purshianus</i> *	0.27	0.09	0.00
44	<i>Rumex acetosella</i>	0.27	0.09	0.00
45	<i>Sisyrinchium bellum</i> *	0.27	0.09	0.00
46	<i>Taraxacum officinale</i>	0.27	0.09	0.00
47	<i>Veronica americana</i> *	0.27	0.09	0.00
48	<i>Veronica serpyllifolia</i>	0.27	0.09	0.00
49	<i>Bellis perennis</i>	0.13	0.04	0.00
50	<i>Bromus carinatus</i> *	0.13	0.04	0.00
51	<i>Cirsium arvense</i>	0.13	0.04	0.00
52	<i>Digitalis purpurea</i>	0.13	0.04	0.13
53	<i>Heracleum lanatum</i> *	0.13	0.04	0.00
54	<i>Veronica arvensis</i>	0.13	0.04	0.00
55	<i>Viola adunca</i> *	0.13	0.04	0.00

Table 8. Summary of Frequency Changes on Burned Transects, 1986-87

SPECIES	1986 Frequency	1987 Frequency	Change	% Change	2-tail Prob.
Taraxacum officinale	0.23	0.00	-0.23	-100.00	n.a.
Juncus patens	0.09	0.00	-0.09	-100.00	n.a.
Brodiaea coronaria macropoda	0.09	0.00	-0.09	-100.00	n.a.
Rubus laciniatus	0.09	0.00	-0.09	-100.00	n.a.
Malus fusca	0.05	0.00	-0.05	-100.00	n.a.
Digitalis purpurea	0.05	0.00	-0.05	-100.00	n.a.
Deschampsia cespitosa	0.27	0.05	-0.22	-81.48	n.a.
Stellaria crispa	0.45	0.09	-0.36	-80.00	n.a.
Lolium perenne	0.55	0.14	-0.41	-74.55	0.135
Fragaria californica	0.23	0.09	-0.14	-60.87	n.a.
Viola adunca	1.18	0.68	-0.50	-42.37	0.597
Pteridium aquilinum	20.59	12.55	-8.04	-39.05	0.006
Rhamnus purshianus	0.14	0.09	-0.05	-35.71	n.a.
Dactylis glomerata	15.09	9.77	-5.32	-35.26	0.015
Oenanthe sarmentosa	0.41	0.27	-0.14	-34.15	n.a.
Poa pratensis	26.82	18.64	-8.18	-30.50	0.023
Rosa californica	2.68	1.95	-0.73	-27.24	0.536
Prunella vulgaris	3.00	2.27	-0.73	-24.33	0.029
Rubus vitifolius	8.91	6.86	-2.05	-23.01	0.069
Rubus vitifolius	0.68	0.55	-0.13	-19.12	0.444
Iris douglasiana	0.86	0.73	-0.13	-15.12	0.667
Lotus purshianus	8.41	7.18	-1.23	-14.63	n.a.
Carex obnupta	64.50	56.36	-8.14	-12.62	0.018
Anthoxanthum odoratum	8.50	7.55	-0.95	-11.18	0.416
Bromus carinatus	3.04	2.73	-0.31	-10.20	0.199
Aster chilensis	0.95	0.86	-0.09	-9.47	0.638
Trifolium repens	20.77	19.59	-1.18	-5.68	0.772
Holcus lanatus	7.59	7.23	-0.36	-4.74	0.558
Carex sp.	31.50	31.05	-0.45	-1.43	0.813
Danthonia californica	5.82	5.77	-0.05	-0.86	0.771
Ranunculus repens	0.32	0.32	0.00	0.00	n.a.
Erechtites prenanthoides	0.14	0.14	0.00	0.00	n.a.
Plantago major	0.36	0.41	0.05	13.89	n.a.
Juncus effusus brunneus	18.14	20.86	2.72	14.99	0.042
Plantago lanceolata	39.59	45.91	6.32	15.96	0.013
Agrostis alba	2.27	2.68	0.41	18.06	0.434
Bromus mollis	0.14	0.18	0.04	28.57	n.a.
Hypericum anagalloides	2.27	2.95	0.68	29.96	0.586
Festuca rubra	18.91	26.50	7.59	40.14	0.000
Hypochoeris radicata	0.86	1.27	0.41	47.67	0.222
Luzula comosa	0.82	1.23	0.41	50.00	0.037
Achillea millefolium	0.09	0.14	0.05	55.56	n.a.
Linum bienne	0.32	0.50	0.18	56.25	n.a.
Lotus formosissimus	1.36	2.14	0.78	57.35	0.363
Ranunculus californicus	4.28	8.18	3.90	91.12	0.008
Vulpia spp.	0.23	0.45	0.22	95.65	n.a.
Veronica scutellata	1.64	3.23	1.59	96.95	0.048
Rumex acetosella	0.27	0.73	0.46	170.37	n.a.
Stachys sp.	0.23	0.64	0.41	178.26	0.358
Aira caryophyllaea	0.05	0.14	0.09	180.00	n.a.
Cirsium arvense	0.32	0.95	0.63	196.88	n.a.
Galium trifidum subbiflorum	0.09	0.41	0.32	355.56	0.074
Lotus micranthus	0.05	0.23	0.18	360.00	n.a.
Sisyrinchium bellum	0.59	3.05	2.46	416.95	0.004
Geranium dissectum	0.09	0.82	0.73	811.11	0.030
Sherardia arvensis	1.09	12.77	11.68	1071.56	0.005
Trifolium dubium	0.18	4.14	3.96	2200.00	0.003
Crepis capillaris	0.00	0.05	0.05	n.a.	n.a.
Cerastium arvense	0.00	0.05	0.05	n.a.	n.a.
Cardamine oligosperma	0.00	0.05	0.05	n.a.	n.a.
Panicum acuminatum	0.00	0.05	0.05	n.a.	n.a.
Veronica americana	0.00	0.05	0.05	n.a.	n.a.
Trifolium wormskioldii	0.00	0.09	0.09	n.a.	n.a.
Ligusticum apiifolium	0.00	0.09	0.09	n.a.	n.a.
Scirpus setaceus	0.00	0.09	0.09	n.a.	n.a.
Sisymbrium sp.	0.00	0.09	0.09	n.a.	n.a.
Barbarea orthoceras	0.00	0.09	0.09	n.a.	n.a.
Epilobium watsonii	0.00	0.14	0.14	n.a.	n.a.
Anagallis arvensis	0.00	0.18	0.18	n.a.	n.a.
Mimulus moschatus longiflorus	0.00	0.18	0.18	n.a.	n.a.
Hordeum brachyantherum	0.00	0.27	0.27	n.a.	n.a.
Cirsium vulgare	0.00	0.32	0.32	n.a.	n.a.
Myosotis discolor	0.00	0.41	0.41	n.a.	n.a.
Juncus bufonius	0.00				

Table 9. Results of Paired T-test Analysis at Elk Prairie Burned Transects

SPECIES	Change in mean count	T-value	Two-tail prob.
* significant decline *			
P<.05			
Pteridium aquilinum	-16.09	-3.44	0.006
Dactylis glomerata	-11.36	-2.92	0.015
Anthoxanthum odoratum	-16.27	-2.84	0.018
Poa pratensis	-16.36	-2.69	0.023
Prunella vulgaris	-1.60	-2.59	0.029
* no sig. change *			
P>.05			
Rubus vitifolius	-4.50	-2.07	0.069
Aster chilensis	-3.22	-1.40	0.199
Iris douglasiana	-0.75	-0.88	0.444
Bromus carinatus	-2.10	-0.85	0.416
Viola adunca	-5.50	-0.73	0.597
Rosa californica	-2.00	-0.65	0.536
Carex sp.	-0.73	-0.61	0.558
Festuca rubra	-3.00	-0.58	0.586
Trifolium repens	-0.33	-0.50	0.638
Lotus purshianus	-0.67	-0.50	0.667
Ranunculus repens	-0.17	-0.31	0.771
Holcus lanatus	-2.36	-0.30	0.772
Danthonia californica	-0.91	-0.24	0.813
Bromus mollis	1.13	0.83	0.434
Ranunculus californicus	2.43	0.98	0.363
Aira caryophyllaea	1.20	1.04	0.358
Luzula comosa	1.29	1.36	0.222
Lotus micranthus	2.00	3.46	0.074
* significant increase *			
P<.05			
Rumex acetosella	3.50	2.29	0.048
Plantago lanceolata	5.45	2.33	0.042
Achillea millefolium	2.25	3.58	0.037
Sherardia arvensis	3.20	3.30	0.030
Agrostis alba	12.64	3.04	0.013
Vulpia spp.	11.56	3.50	0.008
Trifolium dubium	23.36	3.61	0.005
Geranium dissectum	5.40	3.90	0.004
Crepis capillaris	9.67	4.17	0.003
Hypochoeris radicata	15.18	6.15	0.000

Table 10. Results of Paired T-test Analysis for Unburned Transects at Elk and Other Local Prairies. (Data from 1,600 points on 10 transects at four prairies.)

SPECIES	86-87 CHANGE IN MEAN COUNT	T-VALUE	TWO-TAIL PROB.

* decrease *			
Aster chilensis	-3.70	-5.00	0.015
Rubus vitifolius	-19.22	-2.92	0.019
Agrostis alba	-10.60	-2.15	0.098
Pteridium aquilinum pubescens	-3.40	-1.89	0.092
Trifolium dubium	-4.50	-1.32	0.278
Achillea millefolium	-0.86	-0.79	0.457
Plantago lanceolata	-2.00	-0.49	0.633
* increase *			
Rumex acetosella	0.60	0.32	0.759
Geranium dissectum	0.83	0.70	0.517
Holcus lanatus	1.80	0.84	0.425
Dactylis glomerata	2.80	0.87	0.409
Hypochoeris radicata	2.50	1.10	0.307
Danthonia californica	4.67	1.20	0.286
Crepis capillaris	3.00	1.22	0.278
Anthoxanthum odoratum	10.62	1.37	0.212
Bromus carinatus	13.87	3.22	0.015
Poa pratensis	28.10	3.77	0.004

Results of the paired-sample T-tests from the burned transects at Elk Prairie indicate that of the most frequent species, five showed a statistically significant decline in frequency, 18 showed no change, and 10 showed a statistically significant increase in frequency. These results, are summarized in Table 9. Table 10 summarizes paired-sample T-tests from the three local unburned prairies, for comparison purposes.

It should be noted that no native species (with the possible exception of *Vulpia megalura*, which had been combined with *V. bromoides*) showed a significant increase in frequency after the fire. Also, the only native species to decline significantly after the fire was braken fern (*Pteridium aquilinum*).

None of the 11 species tested from unburned Elk Prairie transects changed significantly.

Discussion of Prairie Vegetation Results

Photographs of the Elk Prairie made in the 1920's and early 1930's show that the northern end of the prairie supported a working ranch. Some areas were closely cropped paddocks, especially the fenced areas due south of the Boyes house (Fig. 21). Other portions of the prairie, perhaps not a part of Boyes ownership, show a well developed cover of grass and braken fern. Grazing and other agricultural practices were terminated sometime after park establishment in 1933 and as the C.C.C. operation was concluded.

Park files (Milne, 1949 in Bentley, 1959) report that in 1937 a few elk were "driven into the prairie by a forest fire". From 1937 to 1949, the population grew to 180 head, the range deteriorated and a die off was precipitated. By the end of 1951, the elk numbered 43 animals (Bentley, 1959) and declined further in the years following (Harn, 1958). Subsequently Canada thistle (*Cirsium arvense*) and bull thistle (*C. vulgaris*) became abundant, braken fern reappeared and slough sedge became widespread in the "drainage" area. Orchard grass (*Dactylis glomerata*), practically non-existent in 1950, spread throughout the prairie by 1956. California oat grass (*Danthonia californica*) was planted around 1954. Himalaya-berry (*Rubus procerus*) was not mentioned during observations reported for this period (Bentley, 1959). Photographs made in the 1940's by Mrs. Savina Antonioli Barlow show clearly the heavily used condition of the prairie as the elk population was increasing (Fig. 22). Recovery to present conditions (Fig. 23) followed declines in elk use on the prairie near the Boyes house.

A similar pair of photos (Figs. 24-25) show the recovery of the pasture. Figure 25 also shows the invasion of the drainage ditch and tree line by alders.

By the time of Bentley's study, his summer photographs show a substantial grass and braken fern cover re-established in spite of his statement that the prairie appears like a "well mown golf course" from the middle of

December through March. Cover for Bentley's twelve most abundant species, representing 71% of the total cover were compared with values for the eleven 1986 upland transects using the percent tallest species as equivalent cover values. In this comparison, eleven species have cover values greater than 1%. Eight species are found in both lists (Table 11). Of the three species with the greatest cover (% expressed as dominance) in 1958, *Anthoxanthum odoratum* and *Danthonia californica* remain in the top three in 1986. *Agrostis alba* is increased in 1986, replacing *Holcus lanatus* which declined. *Hypochoeris radicata* also declined, probably in response to greater competition from grasses (due to decreased disturbance). *Poa pratensis* and *Pteridium aquilinum* showed large increases, *Bromus* sp. and *Dactylis glomerata* show little change, while *Vulpia megalura*, *Lolium perenne* and *Trifolium repens* decreased.

With these changes noted, it is surprising how little change in composition has occurred over three decades. The apparent similarity of the prairie composition, however, was not substantiated by a contingency table G-test (Zar, 1984).

Bentley's observations on livestock forage species desirability and elk feeding preferences suggest that elk feeding habits may be important in the successional patterns on the prairie after removal of domestic livestock. *Danthonia californica*, a very desirable forage species for livestock was not noted to be heavily used by the elk at Boyes (Elk) Prairie in 1958. *Agrostis alba*, also regarded as desirable for livestock was not eaten by the elk. *Anthoxanthum odoratum* was considered undesirable or worthless for livestock, but was eaten ("relished") by the elk in Boyes (Elk) Prairie according to Bentley (1959). The desirable *Dactylis glomerata* and *Lolium* spp. were utilized heavily and undesirable forage species, as a group, were also utilized heavily. *Rhamnus purshiana* and *Rosa californica* were heavily used by elk while *Iris douglasiana* and *Alnus rubra* were not (Bentley, 1959).

In spite of differential use, cover values for *Anthoxanthum odoratum*, *Danthonia californica*, *Holcus lanatus*, *Dactylis glomerata* and *Bromus* sp are virtually the same for 1958 and 1986 on the dry prairie. *Vulpia megalura* declined substantially and *Pteridium aquilinum* increased substantially. In 1958, 5% of the sample points were described as litter. In 1986, all points had plant cover represented and no litter was reported following the methods of this study.

Any of these conclusions may be questioned because of the differences in sampling methods, but the most obvious interpretation of the results suggests that no major vegetation changes have occurred in the dry prairie vegetation at Elk Prairie since 1958. Since Bentley avoided the wet, sedge dominated portions of the prairie, no comparable interpretation is possible for that vegetation type.

Harn (1958) also established sixteen line point transects 100 feet long, which were read in the winter of 1956-57. His plots included both wet and dry prairie vegetation, but winter sampling and the absence of a discussion of methods precludes any comparison with current conditions.



Figure 21. 1920's view northeast toward former Boyes farm house. The foreground may be wheat stubble, the middle distance is pasture, and a corn patch is on the right. The house is screened by the apple orchard (S.R.L. Collection).



Figure 22. Boyes Prairie (Elk Prairie) during the period of heavy elk use during the 1940's. (Savina Barlow Collection).

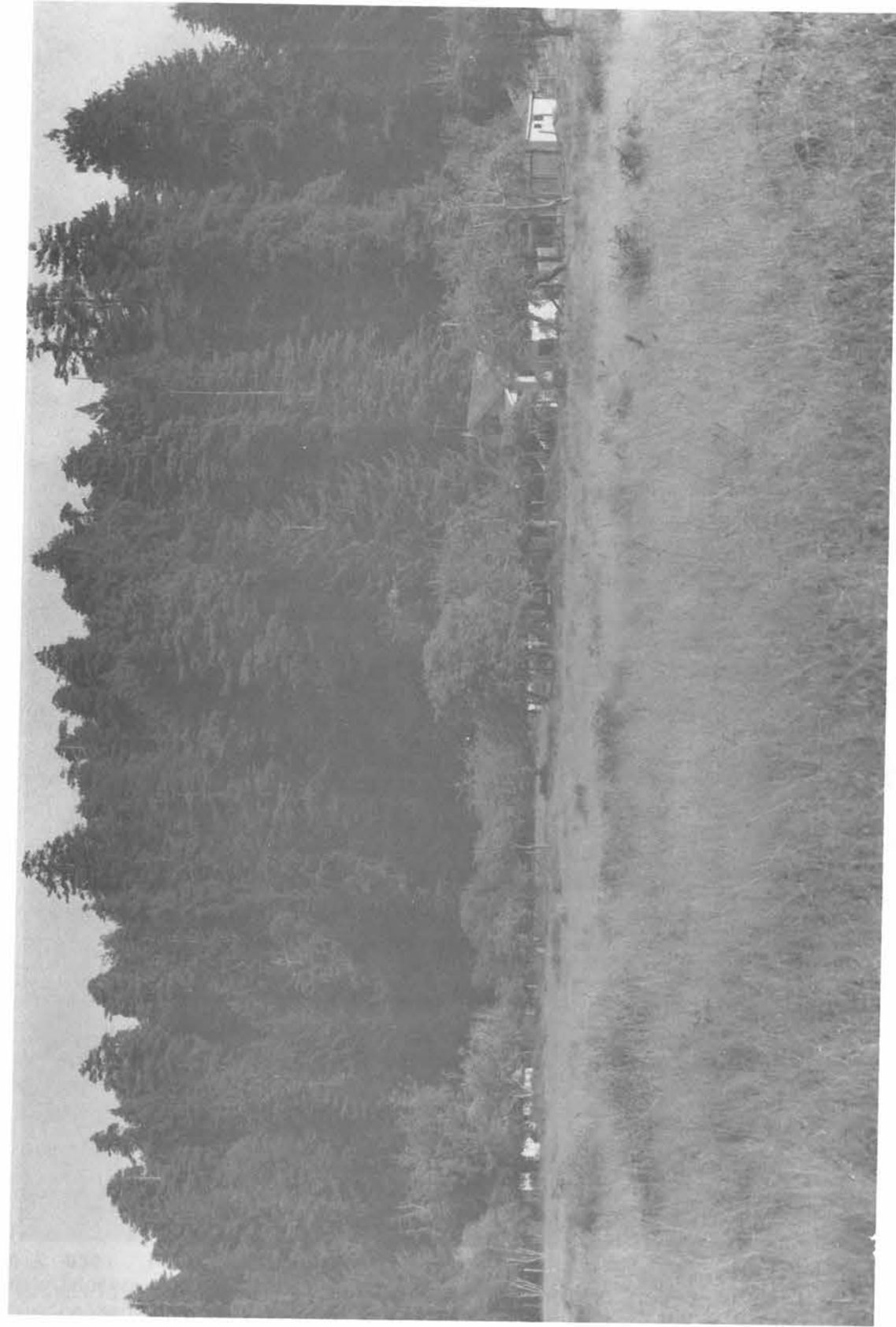


Figure 23. Elk Prairie in 1986 following recovery from heavy elk use (see Figure 11).

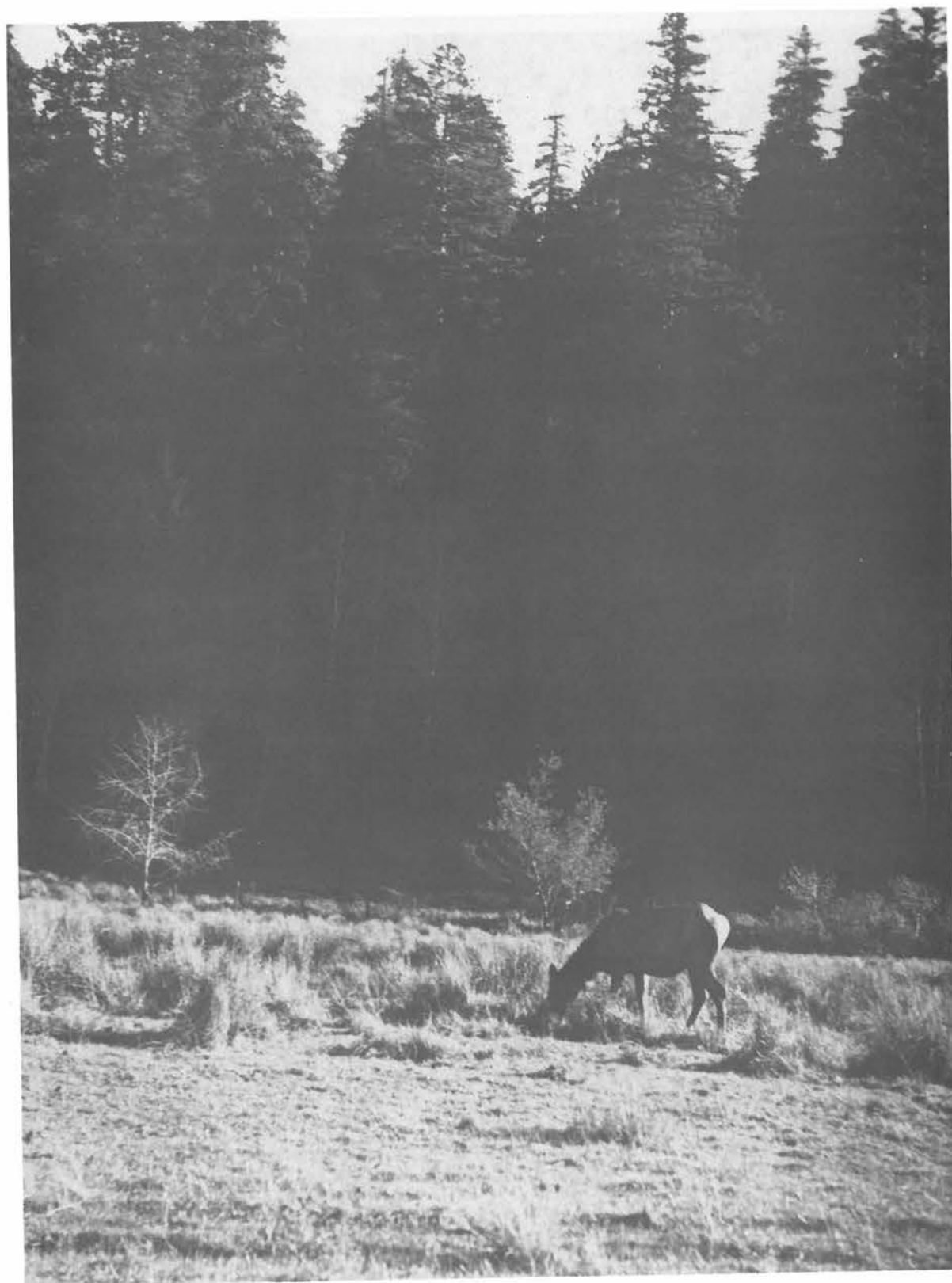


Figure 24. View east across former Boyes Pasture during period of heavy elk use in 1940's. Notice sedges and fence line with parallel drainage ditch (Savina Barlow Photo).



Figure 25. 1986 view across former Boyes Pasture after recovery from heavy elk use. Notice the increase in sedges and the extensive alder stand developing along and behind the former ditch and fence line. Some Australian fireweed is visible among the sedges in the middle distance which was established following a prescribed fire conducted about 1983.

Table 11. Comparison of 1986 Cover Values with Bentley (1959)

SPECIES	% COVER	
	1957	1986
Anthoxanthum odoratum	21.90	20.70
Danthonia californica	13.00	10.28
Hypochoeris radicata	9.70	6.19
Holcus lanatus	6.80	6.08
Vulpia megalura	6.10	1.06
Dactylis glomerata	5.20	4.93
Bromus mollis	4.60	0.70
Agrostis alba	4.50	12.94
Plantago lanceolata	3.90	5.78
Carex sp.	0.90	2.47
Rubus vitifolius	0.70	2.93
Pteridium aquilinum	0.40	6.72
Bromus carinatus	0.30	2.79
Poa pratensis	---	8.76
Aster chilensis	---	0.97
Prunella vulgaris	---	0.97
Festuca rubra	---	0.75

Potential Natural Vegetation at Elk Prairie

No records exist of the natural vegetation and species composition at Elk Prairie at the time of first white settlement. The predominance of non-native species today indicate major changes in species composition.

Previous discussion in this report indicates that the prairie probably had the same general distribution of wet and dry vegetation types, with the exception that the wetter vegetation type areas in the south-central portion of the prairie have become smaller due to the main drainage ditch which now more completely drains the prairie.

While approximately 50% of the species present at Elk Prairie are considered native, most of these are either forest margin species or are localized or thinly distributed. It is likely that numerous native Elk Prairie species are now extirpated.

Post-settlement influences have reduced mesic and hydric habitat and converted the prairie into a more homogeneous pattern of a few vegetation types often dominated by exotic pasture grasses and weeds.

Determination of native species composition is speculative. However, early descriptions the presence and distribution of known natives at Elk Prairie and comparisons with the flora of other local prairies (mostly in the Bald Hills area of Redwood National Park) can help in this speculative process.

Many of the localized native species were once more widespread or dominants on the prairie. These include *Calamagrostis nutkaensis*, *Elymus glaucus*, *Heracleum lanatum* (cow-parsnip), *Angelica tomentosa hendersonii*, *Solidago canadensis elongata* (golden rod), *Deschampsia cespitosa*, *Satureja douglasii*, *Lupinus latifolius*, *Trifolium wormskioldii*, *Dichelostemma congesta*, *Triteleia hyacinthina*, *Malus fusca* (Oregon crab-apple), and *Ligusticum apiifolium*.

Dichelostemma ida-maia and *Anaphalis margaritacea* were reported by Bentley (1959) but are now absent. Several other species including *Ceanothus thyrsiflorus* and *C. velutinus* and *Epilobium angustifolium* (fireweed) also were missing from the prairie flora, perhaps as a result of reduced fire frequency in and adjacent to the prairie.

Common native grasses from similar habitats nearby are likely candidates for consideration as native also to Elk Prairie. These include *Agrostis hallii*, *Festuca californica*, *F. idahoensis*, *F. occidentalis*, *Glyceria elata*, and *Melica subulata*. The majority of the species considered more widespread in pre-historic times are larger and more robust than the species now dominating Elk Prairie. Thus, it is likely that the present vegetation is lower and more uniform in height than the pre-settlement vegetation.

Ossagon Prairie

Ossagon Prairie lies on a hillslope northeast of the mouth of Ossagon Creek in Section 9, T13N, R1E. The elevation of the prairie is approximately 150 feet with an aspect predominately s.s.w. (200 degrees) on a slope of approximately 20-30 degrees. The prairie is approximately 425 feet long (southeast to northwest) and varies between 50 and 150 feet wide. It appears to be a remnant of a much more extensive prairie on the south facing slopes north of Ossagon Creek.

Ossagon Prairie is surrounded by red alder forest, and is being encroached upon by this species. The alder forests away from the prairie have a dominant understory of *Polystichum munitum* (sword fern), while the alder forest near to the prairie (especially to the west in the Helen Chandler Garland Grove) have a dominant understory of *Holcus lanatus* (velvet grass).

Like Boyes and Lincoln Prairies, Ossagon Prairie is composed of predominantly non-native species. However, of the three, Ossagon seems to have been less disturbed and thus more natural in character. Also, of the two coastal prairies, Ossagon Prairie is less uniform than Lincoln Prairie, having more distinct vegetation patterns.

The east half of the prairie seems most natural and is dominated by *Festuca occidentalis*. Other natives more common on the east half of Ossagon Prairie include *Spiranthes romanzoffiana*, *Fragaria californica*, and *Viola adunca*. *Poa kelloggii* was seen in scattered locations on the prairie.

Sixty-seven species of vascular plants were found at Ossagon Prairie in 1986. Approximately one-half of these species are native (Appendix F).

One 300-foot permanent transect was established in the prairie. Thirty-three species were encountered on the transect, 8 of which are considered native. Table 12 summarizes the results from the 1986 and 1987 surveys.

Many of the 37 species listed for the prairie but not encountered on the transect are primarily forest species. The following native prairie species present at Ossagon were not encountered along the transect: *Aster chilensis*, *Calamagrostis nutkaensis*, *Elymus glaucus*, *Satureja douglasii*, *Fragaria californica*, *Heracleum lanatum* and *Sanicula crassicaulis*.

Compared with Elk and Lincoln Prairies, Ossagon Prairie has a greater diversity of species at any one point (average 3.3, 3.4 and 4.9 plants per point, respectively). As many as ten species were recorded for a single point along the Ossagon Prairie transect.

Results of the transect indicate that Ossagon Prairie is dominated by eight species. While *Festuca occidentalis* is the only native among these, it is the single most frequent species in the transect (although *Anthoxanthum odoratum* is probably more common on the prairie as a whole).

The determination of *Danthonia pilosa* (a non-native from Australia) is based on keys without specimens for comparison. At Ossagon Prairie, this

Table 12. Summary of Transect Results at Ossagon Prairie

Ossagon Prairie
300 points

SPECIES	PERCENT		ABSOLUTE		FREQUENCY	
	7/15/86	6/30/87	CHANGE	AVERAGE		
<i>Festuca occidentalis</i> *	67.0	75.7	8.7	71.3		
<i>Anthoxanthum odoratum</i>	60.0	66.7	6.7	63.3		
<i>Plantago lanceolata</i>	57.7	53.7	-4.0	55.7		
<i>Holcus lanatus</i>	50.0	52.0	2.0	51.0		
<i>Hypochoeris radicata</i>	44.3	46.3	2.0	45.3		
<i>Danthonia pilosa</i>	35.3	30.7	-4.7	33.0		
<i>Agrostis alba</i>	34.7	36.7	2.0	35.7		
<i>Lolium perenne</i>	31.0	46.0	15.0	38.5		
<i>Poa pratensis</i>	16.0	21.7	5.7	18.8		
<i>Trifolium repens</i>	15.0	12.3	-2.7	13.7		
<i>Pteridium aquilinum</i> *	12.7	12.0	-0.7	12.3		
<i>Juncus effusus brunneus</i> *	11.0	12.0	1.0	11.5		
<i>Ranunculus repens</i>	8.7	7.3	-1.3	8.0		
<i>Dactylis glomerata</i>	7.7	11.0	3.3	9.3		
<i>Prunella vulgaris</i>	7.7	5.0	-2.7	6.3		
<i>Trifolium dubium</i>	6.3	4.0	-2.3	5.2		
<i>Cerastium arvense</i> *	3.3	2.0	-1.3	2.7		
<i>Rumex acetosella</i>	3.3	2.0	-1.3	2.7		
<i>Anagallis arvensis</i>	3.0	1.7	-1.3	2.3		
<i>Achillea millefolium</i>	2.7	1.7	-1.0	2.2		
<i>Geranium dissectum</i>	2.7	1.7	-1.0	2.2		
<i>Agropyron repens</i>	1.7	0	-1.7	0.8		
<i>Linum bienne</i>	1.7	3.7	2.0	2.7		
<i>Chrysanthemum leucanthemum</i>	1.3	0.3	-1.0	0.8		
<i>Cirsium vulgare</i>	0.7	1.3	0.7	1.0		
<i>Crepis capillaris</i>	0.7	0.7	0.0	0.7		
<i>Gallium aparine</i>	0.3	0	-0.3	0.2		
<i>Spiranthes romanzoffiana</i> *	0.3	0.3	0.0	0.3		
<i>Vicia sp.</i>	0.3	0	-0.3	0.2		
<i>Viola adunca</i> *	0.3	0.3	0.0	0.3		
<i>Iris douglasiana</i> *	0	1.7	1.7	0.8		
<i>Bellis perennis</i>	0	0.3	0.3	0.2		
<i>Poa kelloggii</i> *	0	0.3	0.3	0.2		
NUMBER OF SPECIES	30	30	0	30.0		
SUM OF FREQUENCIES	487.3	511.0	23.7	499.2		

Danthonia is abundant on the east half of the prairie which seems less disturbed and more natural while nearly absent from the more disturbed west half of the prairie. The species also occurs on the perimeter of Lincoln Prairie and at one location at Boyes Prairie in an isolated location growing sympatrically with *Danthonia californica*. Because it seems unusual for this species - if it is a weed - to grow in more natural sites while avoiding more disturbed sites, it is possible that it is a native species. Specimens will be sent to experts for a more definitive determination.

Subjectively, Ossagon Prairie contains four vegetation types. The first is the eastern half of the prairie dominated by *Festuca occidentalis* and *Danthonia pilosa* (with *Spiranthes romanzoffiana* and *Fragaria californica*), the second is a small wet area in the north-west central part of the prairie dominated by *Juncus effusus* and *Carex obnupta* (with *Calamagrostis nutkaensis* and *Stellaria crispa*) the third is the majority of the remainder of the prairie dominated by *Anthoxanthum odoratum* (with *Plantago lanceolata* and *Hypochoeris radicata* as co-dominants); and the fourth includes the shadier prairie margins dominated by *Holcus lanatus* and *Alnus oregana*.

Presumably this prairie remnant will soon be completely lost to forest encroachment unless restorative measure are undertaken.

Lincoln Prairie

Lincoln Prairie lies on a flat terrace directly above and north of Fern Canyon, in the NE 1/4, Section 28, T12N, R1E. It is approximately 400 feet long and 250 feet wide.

Lincoln Prairie has a long history of use and disturbance. The prairie was used as a mining camp as early as 1851 and may have been artificially enlarged or may be wholly artificial. Logging occurred upslope and a stream was diverted across the prairie by ditching in order to provide water for processing gold bearing sand from the beach. Lincoln Prairie is dominated by non-native species, and is surrounded by a young forest of Sitka spruce. Invasion of the prairie by spruce and red alder is less pronounced than at Ossagon Prairie.

In 1986, fifty-eight species of vascular plants were found growing in Lincoln Prairie, of which approximately 33 (or 57%) are native (Appendix H). The following 22 species found at Lincoln Prairie are considered native prairie species: *Cerastium arvense*, *Stellaria crispa*, *Carex obnupta*, *Carex sp.*, *Bromus carinatus*, *Calamagrostis nutkaensis*, *Danthonia californica* (rare at Lincoln), *Festuca occidentalis*, *Poa kelloggii*, *Iris douglasiana*, *Juncus bufonius*, *Juncus effusus*, *Juncus patens*, *Luzula comosa*, *Stachys mexicana*, *Trifolium wormskioldii*, *Pteridium aquilinum*, *Ranunculus californicus* (rare at Lincoln), *Rubus vitifolius*, *Galium trifidum subbiflorum*, *Ligusticum apiifolium* and *Viola adunca* (rare at Lincoln).

One 300-foot permanent transect was installed in the Prairie. Twenty-nine species were encountered on this transect. Results from the transect (Table 13) indicate that Lincoln Prairie is dominated by five species, none of which are native. In fact, of the 17 most common species in the transect, only three (*Festuca occidentalis*, *Iris douglasiana*, and *Carex sp.*) are native and none have a frequency of over 11%.

Table 13. Summary of Transect Results at Lincoln Prairie

SPECIES	PERCENT		ABSOLUTE FREQUENCY	
	7/21/86	6/18/87	CHANGE	AVERAGE
<i>Agrostis alba</i>	86.0	79.0	-7.0	82.5
<i>Plantago lanceolata</i>	41.3	51.7	10.3	46.5
<i>Holcus lanatus</i>	34.3	37.7	3.3	36.0
<i>Hypochoeris radicata</i>	33.3	38.7	5.3	36.0
<i>Anthoxanthum odoratum</i>	33.0	49.0	16.0	41.0
<i>Ranunculus repens</i>	13.7	11.7	-2.0	12.7
<i>Festuca occidentalis</i> *	11.0	15.3	4.3	13.2
<i>Iris douglasiana</i> *	10.0	10.0	0.0	10.0
<i>Rumex acetosella</i>	10.0	9.7	-0.3	9.8
<i>Dactylis glomerata</i>	9.7	8.0	-1.7	8.8
<i>Poa pratensis</i>	9.7	21.7	12.0	15.7
<i>Lolium perenne</i>	7.0	18.7	11.7	12.8
<i>Prunella vulgaris</i>	6.3	8.7	2.3	7.5
<i>Crepis capillaris</i>	6.0	11.0	5.0	8.5
<i>Trifolium dubium</i>	5.7	1.3	-4.3	3.5
<i>Carex sp.</i> *	5.3	8.0	2.7	6.7
<i>Trifolium repens</i>	4.3	6.0	1.7	5.2
<i>Trifolium wormskioldii</i> *	2.3	6.0	3.7	4.2
<i>Cerastium arvense</i> *	1.3	4.0	2.7	2.7
<i>Bromus carinatus</i> *	1.0	2.0	1.0	1.5
<i>Galium aparine</i>	1.0	3.0	2.0	2.0
<i>Bellis perennis</i>	0.3	0	-0.3	0.2
<i>Claytonia siberica</i> *	0.3	1.7	1.3	1.0
<i>Pteridium aquilinum</i> *	0.3	0.7	0.3	0.5
<i>Ranunculus californicus</i> *	0.3	3.0	2.7	1.7
<i>Rubus vitifolius</i> *	0.3	0.7	0.3	0.5
<i>Stellaria crispa</i> *	0	1.7	1.7	0.8
<i>Danthonia pilosa</i>	0	1.3	1.3	0.7
<i>Poa kelloggii</i> *	0	0.7	0.7	0.3
NUMBER OF SPECIES	26	28	2	27.0
SUM OF FREQUENCIES	334.0	410.7	76.7	372.3

1986 adjacent species:

Danthonia pilosa
Poa kelloggii

1987 adjacent species:

Galium trifidum subbiflorum
Bellis perennis

Conclusions

Elk Prairie is a natural prairie which, like other large coastal prairies probably predates the arrival of humans in northwestern California. The Yurok Indian people living along the coast doubtless used the resources of the prairie, the forest margins, and prairie creek. Fishing, hunting, collection of seeds and roots for food and plant materials for basketry, cordage and other uses resulted in some modification of the native vegetation. Indian use of fire for various purposes in and around this and similar prairies is well known and may have reinforced the natural resistance of the prairie vegetation to invasion by trees and shrubs. In this near coastal, cool, moist setting, fires in the forest itself were relatively infrequent as compared with hotter drier inland settings and we have no evidence that the Indians broadcast burned the forests. When Euroamericans arrived and settled in Elk Prairie, about 1850, the Indian and native wildlife influences in the prairie vegetation were changed.

The miners and homesteaders who took up the prairie and claimed it as their own introduced European livestock, weeds and agricultural practices. They felled trees around the prairie for building materials, planted fruit trees, tilled the soil and developed drainage systems to dewater the heavy soil of wet parts of the prairie. Roads and roadside ditches, motor camps, and gift shops eventually came along. All of these changes are reflected in the vegetation of the prairie, now protected by park status, but the actual appearance of the prairie has not greatly changed. It's boundaries appear relatively stable. Repeated measurements of the permanent transects will help define the grassland changes which may occur too slowly for any single individual to determine.

Prescribed burning is an inexpensive tool for controlling the invasion of the prairie by shrubs and trees, but fire may benefit more aggressive introduced weeds and pasture grasses more than native plants. Experimental work to define the response of the vegetation to various fire regimes is needed to avoid additional damage to the native components of the vegetation. Similarly, experimental introductions of native species from nearby prairies may be appropriate as a management tool for the perpetuation of these native plants.

Direct removal of established trees and shrubs in roadside ditches, fencelines and on other altered sites may continue to be a necessary part of maintenance of the natural or near natural conditions and appearance of the prairie and its margins under present day human use patterns. Protected coastal grasslands with a substantial native component are limited and rarely protected from development. Protection of the natural values of this excellent example of coastal prairie, should continue to be an important objective of the management of the park. Elk Prairie is not pristine, but it is a vignette of pristine America even as traffic flows through it on U.S. Highway 101. Its biological, cultural and scientific values should be carefully guarded and nurtured.

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APPENDICES

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Parent Material	Alluvium
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Physiography Alluvial fan into Prairie Creek Valley

Drainage somewhat poorly drained Permeability moderate Runoff medium Erosion unroded

- (1) Layer from 33-50cm has much more medium and coarse sand, and less silt, than layers above it.
- (2) Layer from 50-70cm contains concretions 1-3cm in diam., weakly cemented by iron and manganese, slightly brittle, moist.
- (3) Layer from 70-110cm contains less sand and fine gravel and more silt than above.

by Jim Popenoe

[illegible]

Temperature regime: ... is not diagnostic for soil taxonomy.

_____ assume mesic (prairie, Pacific coastal)

Therefore, not Aquic. Assume xeric (braving summer drought)

stratification: Assume organic matter is somewhat stratified, along with inorganic deposition, therefore decreases irregularly from surface downward. Therefore, Fluventic subgroup.

Appendix B Locations of Transects

Note: all compass references include 19° declination. The 15 transects lie perpendicular to two reference lines running the length of the prairie. Both lines run true SW 225°. One and one-half inch galvanized steel pipes mark end points of both reference lines and transects. Each pipe is driven 2-3 feet into the ground and stands 12-18 inches above the surface. Each transect marker has a numbered aluminum tag which is also stamped PC VEG to identify this study. Thus a tag stamped PC VEG 10W marks the westernmost end of transect #10.

The zero point (a 2 inch pipe) of the west reference line lies directly south of (behind) the south entrance sign at the junction of Highway 101 and the public entrance road. Bearings from the zero (north) end of the west reference line to prominent landmarks are: 48° to U.S.G.S. benchmark on southeast corner of the Highway 101 bridge over Boyes Creek; 270° to the flagpole near the entrance kiosk; and 236° to the large redwood at the main picnic area along the park road.

Transects 1 through 8 are spaced 450 feet apart (Transect #1 is 450' SW (225°) of the west zero point; Transect #8 is 3600' SW of the west zero point). Transects #2-8 along the west reference line run southeast (135°). Transect #1 runs northwest (315°). Pipes along the reference line are zero points for the transects. Each transect is 200' long (pipes are set 201' apart).

The southern end of the west reference line (which is also the zero point of Transect #8) lies on the perimeter of the prairie southwest of the metal gate ending the public access road (the turn-around past the bicycle camping) on the south west side (forest side) of the old paved road (now trail). Bearings from the south end of the west reference line to prominent landmarks are: 22° (and 120 feet) to the east side of the metal gate at the end of the public access road; 35° to the large redwood in the picnic area; and 70° to the telephone pole on the small knoll on the east margin of the prairie.

The zero point of the east reference line lies just outside (south) of the garden fence at the southeastern-most residence in the residence/corporation yard area. Bearings from this location are: 175° (and 86.5 feet) to the first telephone pole in the prairie south of the maintenance yard (in orchard area); 304° to flagpole at entrance kiosk (and door to visitor center); 140° to the largest bay tree at the head of the alluvial fan; and 256° to the large redwood at the main picnic area. The east reference line runs at 225°, crosses the middle slope of the prairie knoll and ends at the southwestern most telephone pole that lies on the forest side (SW side) of the old west side road. From this telephone pole, bearings are 30° to the flagpole at the entrance kiosk; and 22° to the large redwood at the main picnic area.

Transects 9 through 15 are spaced 459 feet apart along the east reference line (zero point of Transect #9 lies 459 feet SW (225°) of the zero point of the east reference point).

The distance between transect #12 and #13 is 918 feet (due to the midpoint being too near Highway 101), thus transect #12 is 1836 feet SW of the zero point of the east reference line; transect #13 is 2754 feet (#14 is 3213 feet and #15 is 3672 feet SW of the zero end of the east reference line).

All east-line transects are 200 feet long except transect #11 which is 150 feet long. All east-line transects run northwest (315°) and have their zero points on the east reference line except transect #12 which runs northeast (45°) and has all points on the east reference line.

Appendix D. Miscellaneous notes.

Because this study is considered a baseline study, it is important for any future comparative studies to attempt to match the vegetative phenology of this study.

The transects were taken between June 6 and July 1 in 1986 and between May 11 and June 15 in 1987. The spring of 1986 was warmer and wetter than average leading to more luxuriant growth of the herbaceous vegetation. The spring of 1987 was drier than average.

The following table lists some of the more valuable indicator species and their phenological stage at the beginning and end of transect surveys.

Species	Beginning	End
<u>Anthoxanthum odoratum</u>	prime flower	fruit
<u>Pteridium aquilinum</u>	reaching maximum height	max. height
<u>Agrostis alba</u>	early bud	mid-bloom
<u>Bromus carinatus</u>	early prime	fruit
<u>Danthonia californica</u>	early bloom	early fruit
<u>Ranunculus californicus</u>	prime flower	desiccated
<u>Holcus lanatus</u>	early flower	early fruit
<u>Aster chilensis</u>	no flower buds	still no buds

The grass Lophoclaena refractus (= Pleuropogon r.) is listed by the California Native Plant Society in their Inventory of Rare and Endangered Vascular Plants of California (2nd edition). It is considered rare, but not endangered. It was found growing in the alder grove east of the Highway 101 bridge over Boyes Creek.

Legend for Species List Tables.

VER. = Verification

S = seen

C = collected (voucher deposited in R.N.P. herbarium)

HAB. = Habitat

G = grassland (includes disturbed areas)

F = forest/grassland ecotone (prairie edge)

C = Carex obnupta wet areas (includes riparian)

ABUN. = Abundance

1 = abundant

2 = common

3 = occasional (diffuse or in scattered clumps)

4 = rare