RANGE-Brush Control
CP199-50-8/69

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CONVERSION OF BRUSHLAND TO GRASSLAND AT THE TULE SPRINGS RANGE IN SAN DIEGO COUNTY, CALIFORNIA 1/

by

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1/ A cooperative range demonstration project of the University of California, Cleveland National Forest, U. S. Forest Service, and Curt Massey, rancher permittee.

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A ravaging wildfire in 1950 burned 63,000 acres of brushland in southeastern San Diego County. The "out-of-pocket" cost to suppress the fire by the Forest Service alone was approximately $180,000. Considerable concern was expressed by ranchers and other local citizens as to the possibility of reducing reoccurrences of extensive wildfires. Could forage species replace the heavy brush accumulations here and in other parts of the state (Love et al, 1952). Were some perennial grass species adapted to grow in such arid conditions? Many questions were posed at various meetings of cattlemen, urbanites, and interested public agencies. As a result, the Tule Springs Demonstration Range Project was initiated with cooperative efforts involving the University of California; U. S. Forest Service; and the rancher permittee; 3/ plus valuable assistance from the California Division of Forestry. The purpose of the project was to develop and demonstrate chaparral conversion techniques, test on-site adaptation of forage species, and study the persistence of the newly established species.

3/ The project was originally set up under Field Stations Administration of the University with Mr. B. H. Kern, who subsequently sold out to Mr. Curt Massey. Mr. Fred Dorman was Farm Advisor, San Diego County, at the time and rendered valuable assistance.

Description of Area: The Tule Springs range is located approximately 13 miles north of Alpine, California, within the Cleveland National Forest at an elevation of 2500 feet. The average annual rainfall for the past 12 years is 16 inches, which occurs generally during the months of November to May (Table 1). The great amount of variation in rainfall within each year and from year to year poses a problem in seedling establishment and stand persistence. Note particularly the dry years of 1958-59 and 1960-61. Soils of the area are typically residuals developed on granitic parent materials and have been described as various phases of the Fallbrook series. Organic matter and moisture retention capability are low. The pH ranges from 6.0 to 7.0. Soil depth varies from a few inches to five feet. Frost heaving is not a problem, although occasional snowfall may occur. The area is subject to severe desiccating east winds from the desert, locally known as "Santanas," yet the Pacific Ocean is 40 air miles to the west. Chamise (Adenostoma fasciculatum) with interspersed manzanita (Arctostaphylos spp.), buckwheat (Eriogonum spp.), buck brush (Ceanothus cuneatus), scrub oak (Quercus dumosa), sage (Salvia Clevelandii), sugar bush (Rhus ovata), deer vetch (Lotus scoparius), rush rose (Helianthemum aldersonii), and California snakeweed (Gutierrezia californica) were brush species common to the area prior to conversion. Some of the common herbaceous species were: Filaree (Erodium botrys and E. cicutarium), red brome (Bromus rubens), needlegrass (Stipa spp.), wild oats (Avena barbata), and Lotus species.

Pasture Development: The range was developed as a series of progressive brushland manipulation projects. For convenience, the four pastures are referred to as A, B, C, and D (Fig. 1).

Pasture A, the proving ground for further development, was within the wildfire of 1950 and contains 150 acres of tillable land. A "shotgun" mixture of perennial and annual species was broadcast following the fire. The south half of the pasture was railed to effect seed coverage which resulted in a much superior stand.

Pasture B was started in 1952 when 40 acres of standing brush were disked and seeded but were not burned. The balance of Pasture B, 140 acres, and all of C were control burned by Forest Service personnel in August, 1953. After the control burn the burned portion of Pasture B was disked, seeded to selected forage species, and disked again for seed coverage.

Pasture C, containing 86 acres of tillable land and lying within the control burn, was disked and seeded to cereal oats in the fall of 1953. During the fall of 1954, the pasture was disked again, and band-seeded with a commercial grain drill adapted for the drilling operation (Walker and Kay, 1955).

Pasture D was on the perimeter of the Inaja wildfire of 43,000 acres that burned to the northern edge of the demonstration range in 1956. Direct seeding into the chaparral with no seedbed preparation was accomplished in January 1957, using a heavy-duty range drill (Street et al., 1958, and Cornelius, 1959) which was designed by the Arcadia Equipment Development Center of the U. S. Forest Service. No experimental data were collected.

Species Adaptation: Jones and Love (1945), Love et al. (1952), and Love (1956) reported the results of extensive species adaptation tests conducted since 1937 by the University of California in all counties of the state. The Agricultural Extension Service of San Diego had participated in these trials from the start. As a result, it was known that a few species were likely to be well adapted to such arid

sites. Heading the list of perennial grasses were hardinggrass (Phalaris tuberosa var. stenoptera) on deeper soils, and smilo (Oryzopsis millacea) and veldtgrass (Ehrharta calycina) on the less favorable soils. Soft chess (Bromus hollis) was the obvious choice among annual grasses, and rose clover (Trifolium hirtum) the favored legume.

On-site tests of 25 grass and 35 legume species and varieties (Table 2) confirmed the conclusions reached after 25 years of testing under somewhat similar conditions. Several orchardgrass species proved very drought resistant, but their limited growth precluded selection. Occasional alfalfa plants can be found in the pastures, but the original stand has been almost eliminated by gophers and continuous grazing by wildlife.

Hardinggrass appears to be long-lived, palatable, and dependable perennial species on the Tule Springs Range where it does best on the deeper soils. Hardinggrass has low seedling vigor and, therefore, reseeds well only under favorable circumstances. The initial stand thins out until the density of plant populations appears to be balanced. Hardinggrass has persisted well under close grazing which appears to encourage crown spread. It is the principal species in Pasture C.

Smilo has a stem characteristic that renders it lower in palatability than hardinggrass or veldt. The older stems become quite fiberous, and the plants need to be heavily grazed to remain attractive to livestock. However, the stems remain green near the base and new leaves are often produced on old stems. Smilo persists on the poorer soils found on the range, and it is the principal species found in Pasture B where the seeding technique involved broadcasting and disking for seed coverage. Smilo produces abundant seed and has become part of the "landscape" in some areas of Santa Barbara, Ventura, Orange, and San Diego counties.

Veldtgrass is the most palatable of the perennial bunch grasses seeded. It is also a prolific seed producer and reseeds quite readily. However, its high degree of palatability may present problems in grazing management when sown in combination with other species because it is grazed more intensively than the other species. Crowns of veldtgrass reach a maximum diameter of 10-12 inches before their death, usually 3-5 years after establishment. Veldtgrass is found growing on the steep banks of the barrancas and beyond the fences around the pastures.

Soft chess is common in the area. However, it was included at a light seeding rate in Pasture B to occupy the interspaces between perennials. This annual is quite palatable in all stages of maturity. It was not included in the general seeding in Pasture C, and most of the interspaces there now support the less desirable red brome (Bromus rubens) and ripgut (Bromus rigidus), both unpalatable to grazing animals when mature due to stiff, scabrous awns on the lemmas.

Rose clover (Williams, Love, and Berry, 1956) has persisted in Pasture C where phosphate was applied during initial seeding and again in 1957. Colonies are forming in Pastures C and D but rose clover as yet is not a major forage producer. Soil-moisture stress is a serious factor in limiting the success of this late maturing accession at the Tule Springs Range.

Forage Inventory: A forage inventory using the step-point method (Evans and Love, 1957) was carried out each year for 8 years, thus providing a record of the increase or decrease in seeded and non-seeded species in terms of herbaceous ground

cover. In Pasture B hardinggrass, smilo, and veldtgrass increased for the first four years, and in the following three years only smilo continued to increase (Table 3). In 1962 perennial grasses suffered a loss in ground cover which was taken up primarily by soft chess. Over the eight-year period weedy annual grasses have shown a continued increase.

In Pasture C hardinggrass predominates more than smilo. After the sixth year veldtgrass failed to show up in the forage inventory (Table 4). The 1962 perennial grass cover was about half that of the previous year. As in Pasture B there has been a steady increase in weedy annual grasses. Legumes, particularly rose clover, appear to persist in Pasture C.

Differences noted in the forage inventory of the two pastures may be attributed to several causes. Hardinggrass and smilo are the predominant perennial species in the two seeded pastures. While both were planted, smilo is more abundant in Pasture B where the seed was broadcast and disked. Hardinggrass predominates where the seed was drilled and fertilized. The banding of legume seed over phosphate fertilizer (11-48-0) may have been responsible for the retention of rose clover in Pasture C. Although only one-quarter pound per acre of soft chess was seeded originally, the high incidence of this species in Pasture B indicates its great reproductive and competitive abilities. It is of interest to note that red brome is the dominant weedy annual grass in both pastures and that after 11 years annual ryegrass is a very minor component of both.

Considerable variation is evident in the amount of vegetative ground cover from year to year. Perennial grasses show a much higher degree of stability over a period of average and dry years than the annual grasses. A combination of perennial grasses for stability and prolonged green feed production and annual grasses for opportune use of extra moisture and fertility provides a good combination for maximum ground cover and forage production.

The recent growing seasons of 1958-59 and 1960-61 were well below average precipitation and during the summer of 1962 estimates were made of plant mortality and plant site of the sown perennial grass species using a modification of the step-point method of analysis. At each step-point, the total basal area in square feet and basal area consisting of dead area (if any) of the nearest plant of the species under consideration was recorded. Totally dead plants were also noted. A one square foot frame was used by each operator to assist in these estimations. The results are presented in Table 5.

It is estimated that dead crowns of these perennial species would remain recognizable for at least two or possibly three years. Thus, this analysis records the plant mortality which occurred after the low rainfall years, 1958-59, 1960-61, and 1961-62 (See Table 1).

Large differences are apparent between pastures in both the total plant mortality and the proportion of dead area in living plants. In general, plant mortality has been the highest in Pasture A and lowest in Pasture D. In particular, hardinggrass mortality on the north slope of Pasture A has been high in both plant numbers and in the proportion of dead area in living plants.

Large differences are also apparent in the mean basal area of plants. In Pasture B where smilo is dominant over hardinggrass, the mean basal area of smilo is nearly

twice that of hardinggrass. In Pasture C where hardinggrass is more abundant, the mean basal area of each species is more nearly equal. The mean basal area of all species in Pasture A, the oldest pasture, is large in contrast with the small mean basal area in Pasture D.

It appears that each species has survived the three drought years very well on most sites. Only in Pasture A is there high rate of plant mortality. Several possible causes for this are being investigated.

Chemical Brush Control: With the help of Dr. Oliver Leonard of the Botany Department, University of California, Davis, several plots in Pasture A were sprayed to control the resprouting of brush in the spring of 1952, the second growing season following the wildfire. Various rates of the low volatile esters of 2,4-D and 2,4,5-T were applied by aircraft. Seedling control was effective, but only a 50 percent kill was achieved on the brush sprouts. Several type acre plots were sprayed with ground-applied herbicides during the months from February through August. Nearly complete brush control was obtained. A two percent solution of low volatile ester of 2,4-D and diesel oil in equal concentrations sprayed to wet the plants was most effective. Invert emulsions of 2,4-D applied by aircraft gave only a 50 percent kill. Results from these and many other trials provided some information for recommendations on brush control (Leonard and Harvey, 1956).

Two hundred acres of the sprouting brush in Pastures B and C were sprayed with a ground rig. The equipment included a four-wheel drive vehicle that transported a 100-gallon spray tank with two long hoses which allowed the operators to cover a wide swath and spray each plant completely. The spray solution used contained one percent 2,4-D low volatile ester and one percent diesel oil. Total cost of control averaged ten dollars per acre.

Pasture D was sprayed with a fixed-boom sprayer using a one percent and two percent 2,4-D solution. Only the taller sprouts that flipped past the spray-boom were not controlled. Sixty-six gallons of solution were used per acre. Excellent control of various herbaceous weeds was also obtained. Alfalfa was thinned out, but a few plants survived the spraying of June 5. Rose clover had matured seed, and was not severely affected. This method of application has good potential on rolling topography as the only labor required is one equipment operator.

Several plots were also established with pelleted and granular herbicides in cooperation with Dr. O. A. Leonard. Monuron and fenuron were most effective in killing chamise. However, granular 2,4-D has also proven effective at rates higher than commonly applied as a spray. Two growing seasons were required for chamise plants to die from the monuron treatments. Manzanita and scrub-oak showed chlorotic symptoms but subsequently recovered. Fenuron and monuron appeared to be about equal in their effect on the brush, but fenuron was considerably less injurious on annual grass (Table 6). Hardinggrass did not appear to be injured by 16 lbs./A of monuron but was killed at the 64 lbs./A rate. Considerable chlorosis of chamise was noted from the eight-pound rate of fenuron, but plant kill was not effected. Mature chamise plants were killed with 16, 32, and 64 lbs./A rates of fenuron.

Where successful forage stands have been established, there has been very little brush seedling encroachment.

Fertilization: The soils of the experimental range are deficient in both

nitrogen and phosphorus. No minor element deficiencies have been discovered. Although a greenhouse study of the soil suggested a possible molybdenum response, no response was obtained in the field.

A field-scale fertilizer and grazing trial was established in Pastures B and C in 1958--a low-rainfall year. In November, 90 acres of Pasture C were broadcast fertilized at the rate of 54 pounds of nitrogen plus 53 pounds of phosphorus (P_2O_5) per acre. Young steers and heifers averaging 363 pounds were turned into the pastures on January 14, 1958; and at the end of the trial on June 6, their average weight was 611 pounds. Weighing was preceded by standing the cattle overnight without feed or water. The fertilized pasture provided twice the number of animal units per month, nearly three times the production of beef per acre, and two and one-half times the forage per acre as did the unfertilized pasture (Table 7). The net profit per acre over the check pasture was $1.29.

Concurrent with the grazing trial, a fertilizer trial was conducted within an enclosure on a typical site in Pasture C. The following treatments were replicated three times; unfertilized, 54 pounds of nitrogen plus 53 pounds of phosphorus per acre; and 108 pounds of nitrogen plus 106 pounds of phosphorus per acre. Fifteen-foot strips were mowed from each plot during January, April, and May. Perennial and annual grasses of the April clipping were hand-separated.

Fertilization significantly increased the total yield over the unfertilized plots, but the yield from the 108-pound rate of nitrogen was not significantly better than from the 54-pound rate (Table 8). Most of the yield increase could be attributed to the response of the annual grasses rather than the perennial grasses. Annual grasses appeared to respond to fertilization in February and March early in the growing season. In contrast, the perennials provided green feed over a longer period since they reached their greatest response near the end of spring at the peak of their growth.

In the original brush-covered condition, grazing capacities were near zero. After pasture development, carrying capacities approached one animal unit month per acre. Fertilization doubled this capacity during the one-year trial.

Brush conversion costs at the Tule Springs Range were recorded as the project developed. However, much of the work done was developmental or experimental and the figures should be used mainly as a guide. Small plot expenses were not calculated. The average costs range from $6.40 per acre in Pasture A to $24.55 per acre in Pasture C (Table 9). Brush in a large portion of Pasture A, which was not controlled chemically, has regrown and is canceling out the original advantages of fuel reduction and reseeding. Additional expense may be necessary to spot-spray some brush regrowth and seedlings in the entire range area.

Demonstration Value of Tule Springs Range: The Tule Springs Range has been of great value in demonstrating possibilities, difficulties, and care necessary in the conversion of chaparral to a perennial-annual grassland. Field days were held each year from 1953 to 1960 to demonstrate new techniques, discuss wildland management problems and bring results of forage production, chemical control, grazing returns and range fertilization to interested ranchers, public agency personnel, students, and others. The area has been visited annually by range management classes and by wildlife and conservation groups. Approximately 250 people attended the wildland development tour in 1960 which featured a symposium on wildland development using

the Tule Springs Range, in many cases, as an example.

A very practical demonstration of the value of brushland conversion occurred in 1956 when the perennial grass areas of Pasture C served as a safety zone for firefighters and as a line of defense in stopping the 43,000 acre Inaja fire. The permanent conversion of brushland to grassland at Tule Springs Range has demonstrated to many people that such a conversion is possible and that it provides greater forage production and decreases the fire hazard. The area also demonstrates how public and private moneys can be saved by taking advantage of wildfire by "follow up" seeding, chemical control, and management. Additional benefits include improved wildlife habitat and greater watershed yield.

Summary

Following the 63,000 acre Conejos wildfire in 1950, the Tule Springs Range Project in San Diego was established. The main objectives of the project were to investigate replacement of chaparral with perennial and annual grasses and legumes, test the adaptation of species of plants to grow in the arid brushlands, demonstrate chemical control of brush regrowth and study management of brushlands converted to grasslands.

The Tule Springs Range was developed as a series of brushland conversion projects. All of the tillable land in each pasture area was treated according to various available methods for stand establishment. Brush-filled draws and rocky areas remain for wildlife cover.

Out of a large number of species tried initially, the most successful perennial grasses were hardinggrass, smilo, and veldtgrass. Rose clover was a successful component of the forage stand when phosphorous fertilizer was applied. Each year a species inventory has been made. For the past ten years the total percent species cover of perennial grasses has slowly declined although still existing in significant amounts. In contrast, large fluctuations in species cover of annual grasses and forbs have occurred.

Chemical control of brush regrowth and brush seedlings appeared to be most effective using a ground rig to apply a two percent solution of low volatile ester of 2,4-D and diesel oil in equal concentrations. Invert emulsions of 2,4-D, aircraft applied, were tried but did not prove effective. An extensive trial using various rates of monuron, fenuron, and other granular herbicides was also established, but results were not significant.

A range fertilization and grazing trial was carried out in 1958. Forage production and grazing returns were substantially increased by the application of 54 pounds of nitrogen and 53 pounds of P_2O_5 per acre.

One of the greatest values of the Tule Springs Range is its use as a demonstration area for brushland conversion. The general public has seen the introduction of herbaceous species with a lower fuel density than chaparral. Such species have the ability to persist under the arid conditions of the former brushlands with proper management.

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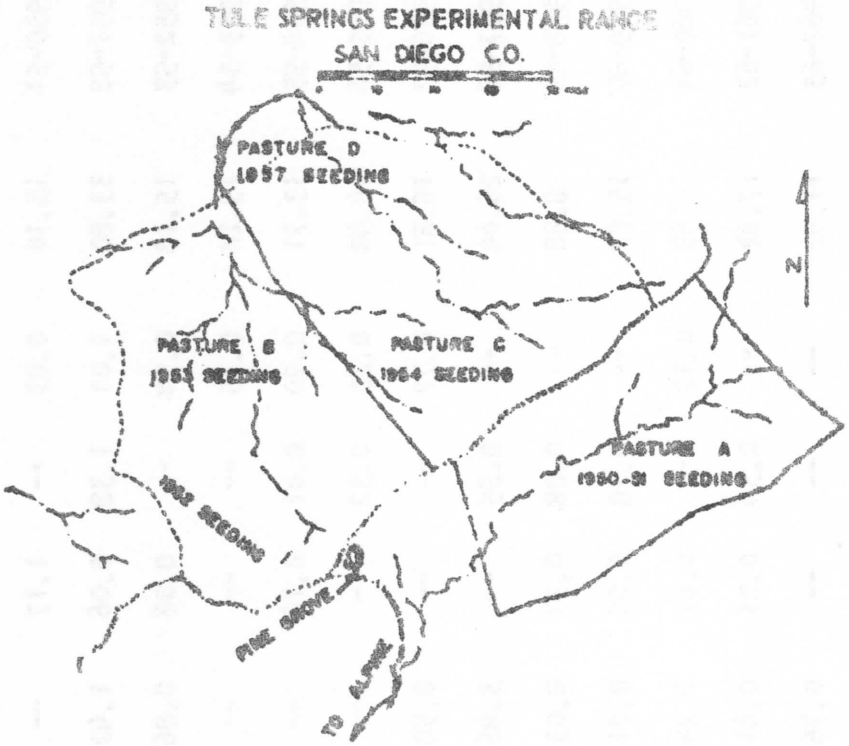
TABLE 1. Thirteen-year summary of rainfall at Tule Springs Experimental Range, San Diego County, California.

	Total Year	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
1950-51	15.10	0.03	--	1.17	--	1.46	0.36	4.75	2.05	1.58	3.40	0.30	--
1951-52	33.80	1.01	1.38	0.06	1.42	1.24	8.73	6.51	1.45	8.86	3.14	--	--
1952-53	15.18	0.94	--	0.08	0.86	4.15	3.15	0.80	1.00	2.15	1.45	0.60	--
1953-54	19.20	0.15	--	--	--	0.60	0.10	6.65	2.20	8.90	0.35	0.15	0.10
1954-55	13.71	0.70	0.01	0.14	--	0.66	1.13	4.52	2.10	0.93	0.68	2.79	0.05
1955-56	14.40	0.83	0.32	--	--	1.41	2.10	4.04	1.61	--	3.33	0.76	--
1956-57	18.81	0.72	--	--	0.50	--	0.69	8.66	1.09	2.74	1.81	2.60	--
1957-58	26.44	--	0.55	--	3.46	1.56	1.92	1.39	4.42	8.05	4.45	0.64	--
1958-59	8.88	--	0.08	0.37	0.03	1.00	0.09	0.64	6.46	0.02	0.06	0.13	--
1959-60	15.87	--	0.28	0.05	0.21	0.30	3.20	3.13	4.78	1.01	2.05	0.86	--
1960-61	5.63	0.12	--	0.67	0.24	1.56	0.13	--	0.11	2.78	0.02	--	--
1961-62	17.62	--	0.34	0.01	0.41	0.81	2.42	3.39	5.89	2.59	--	1.76	--
1962-63	11.92	--	--	--	0.76	--	0.65	0.99	4.62	2.24	2.42	--	0.24
1950-63 Av.	16.66												
13-year Av. Monthly		0.35	0.23	0.20	0.61	1.13	1.90	3.50	2.91	3.22	1.78	0.81	0.03



PASTURE A

Burned summer of 1950.
Seed and rail December 1950.
Airplane sprayed spring 1952 and spring 1953.

PASTURE B West End

Mechanically cleared winter of 1951-52. Broadcast seeded and disced fall of 1952. Brush sprayed using ground rig 1956.

PASTURE B East End

Burned summer of 1953
Broadcast seeded and disced fall of 1952. Brush sprayed using ground rig 1956.

PASTURE C

Burned summer of 1953.
Cropped to oats 1953-54.
Band seeded fall of 1954.
Brush sprayed using ground rig 1956.

PASTURE D

Burned fall of 1956.
Drilled in January, 1957.
Sprayed in May, 1960, ground rig.

FIGURE 1. A view of Tule Springs Range showing areas of perennial grassland converted from chaparral.

TABLE 2. List of species planted at Tule Springs Demonstration Range.

Legumes		Grasses	
Common Name	Scientific Name	Common Name	Scientific Name
Alfalfa		Hardinggrass....	Phalaris tuberosa var. stenoptera
Calif. Common.....	Medicago sativa		
Ranger.....	M. sativa var. ladak	Smilo.....	Oryzopsis miliacea
Nomad.....	M. sativa var. nomad		
Caliverde.....	M. sativa var. caliverde	Veldtgrass.....	Ehrharta calycina
		Softchess.....	Bromus mollis
Clover		Bromegrass	
Rose.....	Trifolium hirtum		
Crimson.....	T. incarnatum	Mountain.....	Bromus marginatus
Autauga Crimson...	T. incarnatum	Prairie.....	B. catharticus
Tomcat.....	T. tridentatum	Harlan.....	B. stamineus
Subclover.....	Trifolium subterraneum	Ryegrass	
Bacchus Marsh.....		Annual.....	Lolium multiflorum
Hills Small.....		Perennial....	L. perenne
Mt. Barker.....			
Nangeela.....		Wild Oats.....	Avena fatua
Tallarook.....			
Rouen.....		Lomasgrass.....	Elymus glaucus
Bur clover		Intermediate Wheatgrass....	Agropyron intermedium
Toothed.....	Medicago hispida		
Spotted.....	M. arabica	Nodding Stipa...	Stipa cernua
Black Medic.....	M. lupulina		
Button.....	M. orbicularis	Sunolgrass.....	Phalaris coerulescens

1/ Three hundred step-points plus 20 square-foot cover estimates in each pasture per year. Numbers in table represent percentage of each species of total herbaceous ground cover.

2/ Species that were broadcast seeded during the fall of 1953.

TABLE 3. Forage inventory [1] of Pasture 3 from 1955 to 1962 based on changes in percent species cover.

	4/24 1955	4/29 1956	5/31 1957	4/12 1958	5/14 1959	5/2 1960	5/4 1961	5/2 1962	5/21 1963
PERENNIALS:									
Harding [2]	1.7	2.5	4.0	6.3	2.7	5.6	3.0	0.7	1.4
Veldt [2]	1.3	1.4	2.1	2.3	0.5	1.0	0.4		0.5
Smilo [2]	1.2	2.4	4.7	7.5	9.1	10.9	16.3	6.3	17.3
Orchard [2]	0.1								
Brome 25 [2]	0.5								
Tall Fescue [2]	0.1		0.1	0.3					
Stipa									
ANNUALS:									
Soft Chess [2]	3.3	3.9	4.0	20.0	7.4	14.6	7.8	14.1	2.9
Annual Ryegrass [2]	2.8	8.3	6.8	7.3	0.2	1.0	0.1		
Cereal Oats									
Wild Oats	0.2								0.3
Red Brome	0.1	0.1	0.6	4.4	4.3	7.7	13.0	14.9	16.6
Ripgut	0.1			1.6	0.1				
Annual Fescue				0.3	0.1	0.5	0.4	0.3	0.6
Filaree					0.2	0.1	0.2	0.8	2.7
Downy Chess					0.7	0.1	0.4	0.1	0.4
LEGUMES:									
Rose Clover [2]		0.1							
Alfalfa [2]								0.1	
Lotus spp.									
Bur Clover									

TABLE 4. Forage inventory [1] of Pasture C from 1955 to 1962 based on changes in percent species cover.

	4/24 1955	4/29 1956	5/31 1957	4/21 1958	5/14 1959	5/2 1960	5/4 1961	5/2 1962	5/21 1963
PERENNIALS:									
Harding [2]	2.9	4.3	11.7	11.7	8.3	9.6	11.8	5.1	6.0
Veldt [2]	1.5	2.5	0.8	1.2	0.2	0.3			0.2
Smilo [2]	0.3	1.0	0.8	1.2	1.4	0.6	1.6	1.0	1.3
Orchard									
Brome 25									
Tall Fescue									
Stipa								0.2	
ANNUALS:									
Soft Chess	0.1	0.3	1.3	2.9	1.4	2.0	0.8	4.4	3.0
Annual Ryegrass	0.4	4.0	8.9	13.1	0.8	0.4	0.7	0.1	
Cereal Oats [3]	2.1	3.3	5.6	0.4	0.6				
Wild Oats						1.0	0.3	0.7	1.1
Red Brome	0.1	1.2	2.5	2.5	3.4	5.1	10.9	11.6	19.8
Ripgut			1.7	12.2	6.1	2.9	4.2	3.2	3.2

TABLE 6. Results of monuron and fenuron applications on chamise. Observations made April 24, 1958.

Treatment (lbs./A)	Date of Application	Grass Cover (%)	Chamise Kill (%)
8 Fenuron	November 7, 1956	80	10
16 "	"	70	95
32 "	"	85	100
64 "	"	75	100
8 Monuron	November 7, 1956	70	50
16 "	"	35	70
32 "	"	5	100
64 "	"	3	100
8 Monuron	March 14, 1957	70	Yellowing of leaves
16 "	"	60	"
32 "	"	30	"
8 Fenuron	February 26, 1958	--	Yellowing of leaves
16 "	"	--	"
32 "	"	--	"

TABLE 7. A grazing trial comparing fertilized and unfertilized range. Tule Springs Range, January 14 to June 4, 1958.

	Fertilized	Unfertilized
1. TREATMENT		
Acres	90	150
Materials per acre	100 lbs./acre 21-53 100 lbs./acre ammonium nitrate	-- --
Nutrients per acre	54 lbs. N; 53 lbs. P_2O_5	--
Costs per acre	$13.87	--
2. STOCKING AND GRAZING		
Animal unit months per acre	2.05	1.08
3. EVALUATION		
Beef produced/acre	117.60 lbs.	41.77 lbs.
Forage produced/acre	5033 lbs. dry matter */	1833 lbs. dry matter */
Extra beef from fertilizer/ acre	75.83 lbs.	--
TOTAL BEEF INCREASE/ACRE (Beef at 20¢/lb.)	$15.16	--
LESS FERTILIZER COST/ACRE	$13.87	--
NET PROFIT/ACRE	$ 1.29	--

*/ Forage yields recorded from clipping study reported in Table 8.

TABLE 8. Yield and crude protein content of annual and perennial grasses harvested April 1958 at Tule Springs Experiment Range.

Fertilizer Treatment (lbs./A)	Annual Grasses Yield (lbs./A)	Annual Grasses Protein (%)	Perennial Grasses Yield (lbs./A)	Perennial Grasses Protein (%)	Total Yield (lbs./A)
Not fertilized	1150	6.37	683	8.56	1833
N_{54} P_{53}	4060	5.78	970	8.45	5033
N_{108} P_{106}	4590	6.21	1230	9.27	5815
LSD, .05% level	2627		781		2786

TABLE 9. A summary of costs in the initial establishment of Pastures A, B, and C, Tule Springs Range.

	Brush Removal 1/	Seeding	Seedbed Preparation and Seed Coverage	Chemical Brush Control	Total Cost Per Acre 2/
Pasture A:					
180 acres (150 acres tillable)	Wildfire	$ 4.40	$2.00	$ --	$ 6.40
Pasture B:					
240 acres (180 acres tillable)	Mechanical and control burn	8.07	2.99	10.00	21.06
Pasture C:					
271 acres (86 acres tillable)	Control burn	4.03 (Cereal oats)	3.53	--	7.56
		10.05 (Perennial seed and fertilizer)	4.50	10.00	24.55

1/ Costs of the initial removal of brush are not included. There was no direct cost in the case of the wildfire. The rancher, U. S. Forest Service, and the California Division of Forestry shared in the clearing of Pastures B and C.

2/ Costs were recorded using the prevailing costs of materials and labor at the time the work was done. A recent communication from Mr. Stanley Stevenson, Supervisor of Cleveland National Forest, indicates a cost of about $60.00 per acre for mechanical clearing, seeding, and chemically treating approximately 200 acres per year for the past three years.