

THE ROOSEVELT ELK, CERVUS CANADENSIS ROOSEVELTI
(MERRIAM), AT PRAIRIE CREEK REDWOODS STATE PARK,
HUMBOLDT COUNTY, CALIFORNIA

by

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INTRODUCTION

This study is concerned with the population dynamics and social behavior of the elk inhabiting northwestern California. Particular attention has been given to mortality, movement, and reproduction.

The elk population studied inhabits two main cover types; logged-over areas, and undisturbed coniferous forests interspersed with small openings. The main area of intensive study consists of approximately 810 acres in and around Prairie Creek Redwoods State Park. More extensive investigations have been carried on over a much larger area (fig. 1). The study area is interspersed with areas used for timber production, agriculture, recreation, and human residence. The elk are subject to disturbance by man and his domestic animals. Mobility and behavior of the elk are somewhat governed by these disturbances.

The field work for this study was carried on from May, 1956 to February, 1958 in Humboldt and Del Norte counties, California. Studies on the elk in this area



Fig. 1, Vicinity map of the study area.

have been carried on in the past (Orr, 1937; Murie, 1945; Russell and Feathers, 1935).

Cooperation and assistance in carrying out this study were received from Howard Leach, Oscar Brunetti, Stanley Thompson, Robert Lassen, Leo Pyshora, Jack Slossen, Ralph Schlifkus, and Victor Simpson of the California Department of Fish and Game. Kenneth Legg, Glen Jones, Milton Frincke, and Elmer Aldrich of the California Division of Beaches and Parks assisted in gathering data. The California Division of Beaches and Parks provided the writer with living quarters and permitted the use of their land and equipment for part of the study. James Yoakum allowed the use of data gathered in this area in the past and provided some photographs of the area. Valuable advice and assistance have been received in particular from Raymond F. Dasmann, Division of Natural Resources, Humboldt State College.

PAST DISTRIBUTION AND ABUNDANCE OF

THE ROOSEVELT ELK IN CALIFORNIA

The Roosevelt elk originally ranged in California from the San Francisco bay region, northward throughout the coast range to the Oregon border (Murie, 1951; Graf, 1955). The species ranged eastward to the vicinity of Mount Shasta (Merriam, 1899; Murie, 1951; Graf, 1955).

Large herds, numbering as many as four hundred animals were reported for Marin and Sonoma counties during the 1840's (Revere, 1922; Toumey, 1926; Finley, 1937). Many landmarks bearing the name "Elk" bespeak the species once wide distribution in Mendocino County. The Jedediah Smith party encountered elk in 1852 in Humboldt, Del Norte, and Trinity counties (Anon., 1943). The Marble Mountains area, west of Scott Valley, Siskiyou County, was inhabited by large herds in the 1870's (Doney, Klink, and Russell, 1916).

Elk were hunted heavily during the Gold Rush for their meat and hides (Finley, 1937; Ellsworth, 1930). This factor, with man and his domestic animals inhabiting suitable elk habitat, led to the complete annihilation of elk in some areas. Siskiyou, Marin and Sonoma counties had lost their last elk in the 1870's (Finley, 1937; Doney, Klink, and Russell, 1916).

By 1925 the once large elk range had been reduced to a small area in Humboldt and Del Norte counties (Barnes, 1925a, 1925b). Graf (1955) states that Donald McLean of the California Department of Fish and Game estimated the total number of Roosevelt elk in California in 1925 to number 15 animals. Elk were scarce on the Prairie Creek study area until 1936 (Milne, 1949).

PRESENT DISTRIBUTION OF
ROOSEVELT ELK IN CALIFORNIA

The largest numbers of Roosevelt elk in California occupy two main areas; the Big Lagoon-Maple Creek area and the Prairie Creek-Gold Bluffs area, both in Humboldt County. Smaller numbers are found in Del Norte County, in the vicinity of Goose Creek, Wilson Creek, and Red Mountain Meadow. Elk have been reported in recent years in the vicinity of Kneeland, Bald Hills, Fresh Water Creek, and Elk River in Humboldt County (Pyshora, personal communication; White, personal communication). A report of elk being seen near Caribou Lake, Trinity County is cited by Graf (1955). During 1957 a mature male was illegally killed near Port Hanford on the Eel River (fig. 2). A lone bull was observed in 1957 in Elk Valley, Siskiyou County (Spinney, personal communication).

In recent years a number of elk from Prairie Creek State Park have been trapped and released in the vicinity of Bear Basin in Del Norte County (table 1). Recent investigations show that elk now occupy this area in small numbers (Spinney, personal communication).

DESCRIPTION OF THE PRAIRIE CREEK STUDY AREA

The main region of study lies north of Orick, Humboldt County, California, in the redwood belt. The vegetation of this region consists of pasture lands along

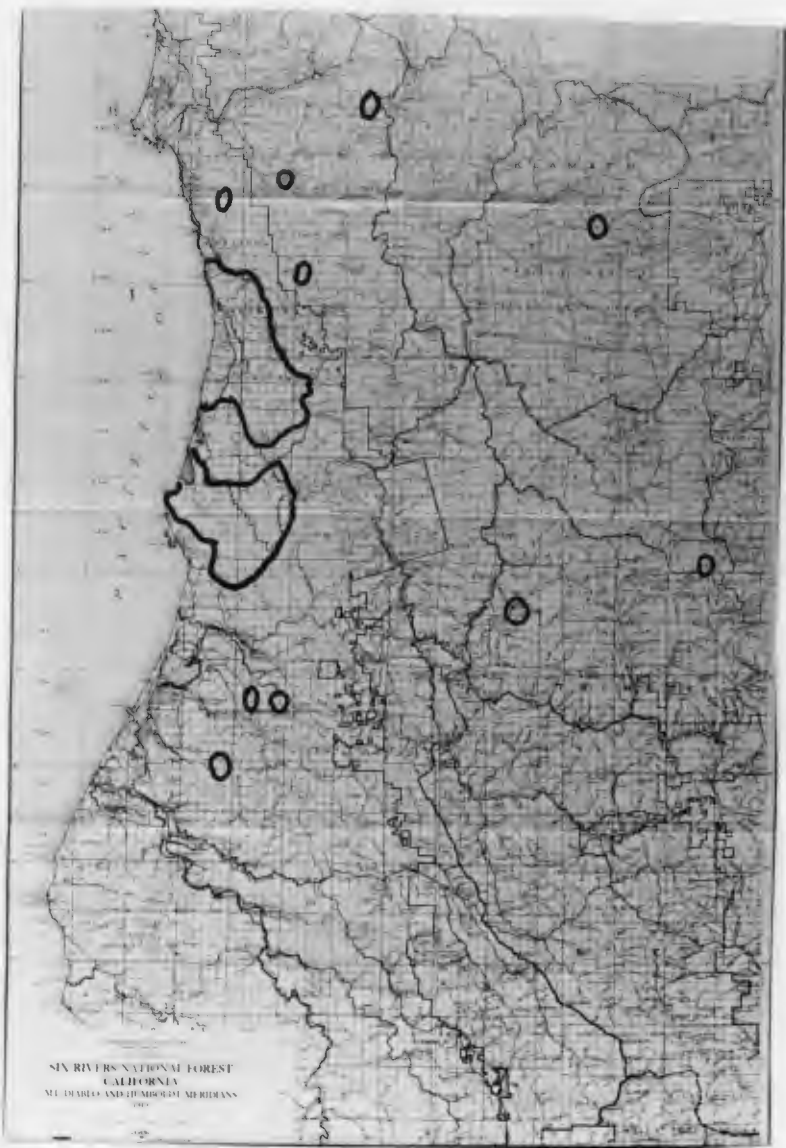


Fig. 2. Distribution map showing location of known elk populations.
Scale-one inch equals twenty-eight miles.

Table 1

Elk captured at Prairie Creek State Park and released at Bear Basin,
Del Norte County*

<u>Year</u>	<u>Males</u>	<u>Females</u>	<u>Total</u>
1947	3	14	17
1951	2	10	12
<hr/>			
Total	5	24	29
<hr/>			

* Data from California Department of Fish and Game files.

the larger stream bottoms, giving way to redwood forests. Spruce forests, shrub-covered hills, marshes, and sand dunes dominate the extreme coastal area. To the east on drier hills, stands of Douglas fir and open range lands are dominant.

Within this region, studies were conducted on an area of approximately 70 square miles. A smaller area of approximately 810 acres, which included grassland, old-growth redwood forests, and logged-over lands was used for more intensive studies.

Physiography

Most of the study area is derived from mixed marine and river deposits. The river deposits were probably laid down by the ancient Klamath River (MacGinitie, personal communication). Soils are primarily of the Grey-Brown podzolic group.

The area lies in the drainage of Prairie Creek which empties into a larger stream, Redwood Creek. Prairie Creek drains approximately 30 square miles and flows a distance of 12 miles through the area. There is a great fluctuation in the seasonal run-off of Prairie Creek. During the summer the stream is low and clear. In the winter following heavy rains the stream may reach flood stage.

The study area is traversed by U.S. Highway 101 and a

network of secondary and logging roads. During the winter months many of the roads are impassable because of land slides and wind-fall trees. On many roads it is necessary to use a four-wheel drive vehicle regardless of the season. Foot trails are numerous throughout the area. These allow for travel over much of the more rugged terrain.

The terrain of the study area ranges in elevation from sea level to 1,250 feet. Slopes are steep, and there are cliffs in the coastal area. Small streams flow the year around in the heavily-vegetated canyons.

Weather

The climate is of the marine-west coast type, with mild summers and wet winters. The average annual rainfall at Prairie Creek State Park is approximately 75 inches, most of which falls between November and March. Snow fall is not common, however, light snows occurred during February of 1957. Fog is prevalent throughout the coastal area during the summer months. Winter temperatures seldom drop below freezing; whereas summer temperatures rarely reach 80°F.

Vegetation

The western part of the study area is covered by communities of shrubs and trees interspersed with small grassy openings. Marshes and swamps also occur. The shrubs are tall and form almost impassable barriers. Dense thickets of salal, blue blossom, black huckleberry

and coyote bush are prevalent. Along the many small streams and on moist, shaded, hillsides red alder forms dense stands. Grassy openings are covered with numerous species of herbs including hair grass, wild iris, lawn daisy, red clover, sweet vernal grass, and hairy cat's ear. Sitka spruce is the dominant conifer in this area.

Inland the area is covered by communities of coniferous trees. Coast redwood is the most abundant species, while Douglas fir, coast hemlock, Sitka spruce, and Port Orford cedar are found in smaller numbers. An understory of California laurel, wax myrtle, California hazel, vine maple, red and black huckleberries, sword fern, deer fern, redwood sorrel, and numerous other shrubs and herbs form dense tangles of vegetation.

Logged-over areas and drier ridges have dense shrub stands, consisting mainly of the aforementioned, shrubs and herbs.

Boyes Prairie, the center of the area of intensive study, is surrounded by heavy stands of coast redwoods. Along the streams red alder, salmon berry, thimble berry and big-leaf maple may form pure stands of hardwoods. The remainder of the study area consists of recently logged-over lands (fig. 3).

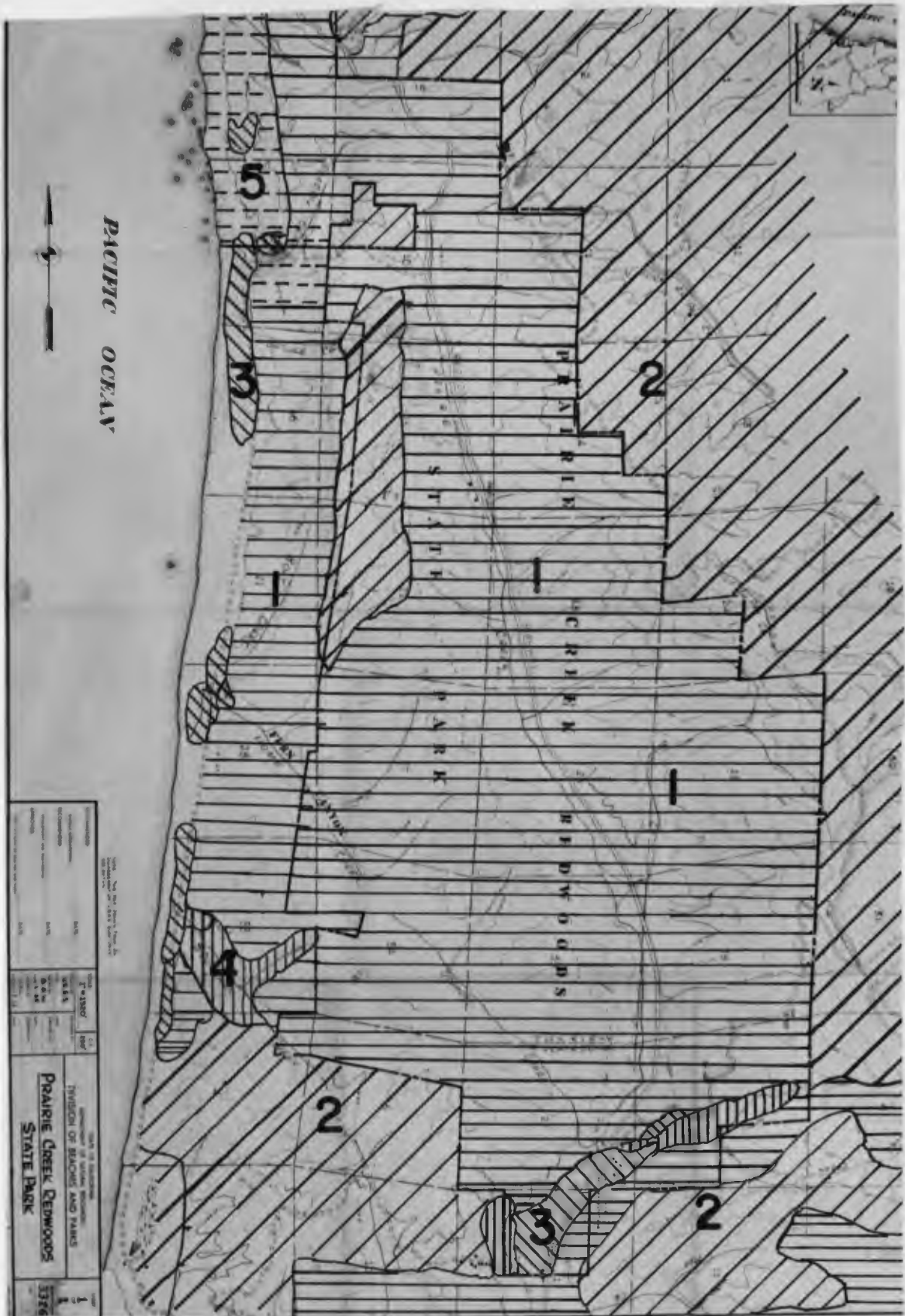


Fig. 3, Vegetation type map of the Prairie study area.
 1. - old-growth timber 2. - logged-over land
 3. - grass lands 4. - hardwoods 5. - shrubs
 Scale: one inch equals one mile.

THE ELK POPULATION

Most studies concerning big game animals have employed indirect methods. The effects of big game on vegetation are studied and population trends are deduced from the changes in vegetation. Few researchers have used direct observation methods on living animals. Notable exceptions include the work of Darling (1937) and Evans as reported by Cameron (1923) on the red deer, Cervus elaphus, in Europe. Recently, Linsdale and Tomich (1953), and Dasmann (1954), have utilized direct-observation methods while studying mule deer. Altmann (1953) and Graf (1943, 1955), have used this method for studying the behavior of elk.

In the present study direct-observation was used to obtain detailed information on the elk population. This method is the most practical where only one man is available for the work of the study. When man power and equipment were available additional techniques were employed.

The success of the study was dependent to an extent on the ability to distinguish the resident elk in the study area from animals that were not normally resident. From the beginning of the study emphasis was placed on learning field marks and morphological differences useful in recognition of individuals and the resident groups. It was found to be possible, with few exceptions,

to distinguish the study group animals from animals that were not resident to the study area. This made the study of population changes relatively easy to follow.

Physical characteristics of elk

Weights: The elk on the study area are of the Roosevelt subspecies, Cervus canadensis roosevelti (MERRIAM) as described by Bailey (1936). The Roosevelt elk has been characterized as being a larger subspecies than the Rocky Mountain elk, C. c. nelsoni (BAILEY) (Murie, 1951). Schwartz (1943) states "a mature bull in prime condition is usually thought to weigh between 700 and 1,000 pounds--." Weights of collected animals from the study area do not bear out this assumption. The only weights available from the study area are those of animals collected during the herd reductions of the past few years. Weights of mature males, ranging in age from 2+ years to 7+ years, ranged from 392 to 717 pounds. The weights of mature females ranged from 376 to 643 pounds (table 2). It should be pointed out that the animals collected were considered to be undesirable. Animals of larger size were seen during field observations. Their weights are not known, but some bulls observed may have weighed over 900 pounds. The average weights for the elk from this area are less than those given by Quimby and Johnson (1951), for the Rocky Mountain elk.

Table 2

Weights of Roosevelt elk collected at Prairie Creek State Park*

<u>Adult Females</u> (pounds)	<u>Live weight</u>	<u>Hog dress</u>	<u>Dressed</u>
	376	---	213
	395	---	221
	395	281	232
	430	---	240
	448	342	273
	467	320	266
	485	---	---
	627	405	339
	643	---	364
Average	<u>474</u>	<u>337</u>	<u>269</u>
<hr/>			
<u>Immature Females**</u>			
	283	212	178
	308	223	181
Average	<u>295.5</u>	<u>217.5</u>	<u>179.5</u>
<hr/>			
<u>Adult Males</u>			
	392	287	225
	414	304	254
	442	324	261
	574	410	340
	594	422	348
	618	426	345
	626	422	392
	664	449	375
	717	493	402
Average	<u>560</u>	<u>393</u>	<u>327</u>
<hr/>			
<u>Immature Male**</u>			
	267	193	156
<hr/>			

* Data gathered during annual herd reduction.

** Less than two years of age.

Antlers: Antlers collected in and around the study area show much variation in size (table 3). Comparison with weights and measurements given by Schwartz (1938) and Graf (1955) indicate a smaller antler size than those found in other Roosevelt elk populations.

Males attain their first set of antlers shortly after they have reached one year of age. These are narrow, straight, unbranched antlers of about 11 inches in length. The antlers of 2-year-old males usually have four or five points to a side. As few as three points and as many as six were observed on the study area for this age class. These antlers are smaller and much more slender than those of more mature animals. Antlers of 3+ and older males are large and thick. As many as seven points and as few as four to a side were observed on large mature animals. The bulk of antlers rather than number of points is the best indicator of age.

Antler abnormalities are not common on the study area. However, a large mature bull visiting the study area during the two rutting seasons covered by this study had an abnormal set of antlers. His left antler was a typical seven point type while the right side consisted of a single large spike. Yoakum (personal correspondence) photographed an animal with similar abnormality during 1952 (fig. 4).

Table 3

Measurement of Roosevelt elk antlers collected
at the Prairie Creek Study Area

No. of Points (one side)	Greatest Spread	Girth at Base	Length of Curved Beam	Ht. at Top Fork
1	10	4.50	9	--
1	12	4.00	12	--
1	13	5.00	13	--
1	12	4.75	14	--
3	20	6.00	26	15
3*	--	6.75	27	--
4*	--	6.25	24	--
4*	--	5.25	25	--
5*	--	6.50	29	--
5*	--	9.00	37	--
5*	--	8.75	39	--
6	34	7.50	40	27
6	37	8.25	41	29
6	39	8.75	45	26
7	43	9.25	47	28
8	43	9.25	41	29

Measurement in inches.

* Cast antlers.



Fig. 4, Bull with malformed antlers
Photo courtesy of James Yoakum

Antlers were measured on all carcasses found throughout the area. The size and description of antlers were recorded for all bulls observed and cast antlers were collected and measured. A general relationship between the size and form of antlers and the maturity of the males was observed.

Pelage: Coat color was found to be the best method for distinguishing the elk of the Prairie Creek "herd" from animals that are not normally resident to the area. The Prairie Creek elk have a coat color that is much lighter than that of elk from surrounding areas. Their coats are of a buff color while the coats of "outsiders" approach the darker color described by Skinner (1936).

The resident males of 1 year or older are much lighter in appearance than the resident females. The colors of the back and "rump patch" lack the contrast that is found in the females. This was found to help in identification of sexes at great distances or in wooded areas where it was impossible to observe the heads of the animals, or during the period when males are without antlers.

"Outsiders" that join the resident herd were easily distinguished by their darker coats. Their manes are much darker and "rump patch" more conspicuous in contrast with their darker coloration.

Winter coats begin to be conspicuous near the end of October. The hair is long and is a lighter color than the summer coat. The coat is quite ragged in appearance. In April the animals begin to shed their winter coats. The animals are more sleek when they are in full summer coat.

The manes of mature females are much longer than those of immature females. The mature animals have a long wispy patch of hair in the gular region. This is lacking or poorly developed in younger animals.

No animals with abnormal coloration were observed during the study. However, Graf (1955) described an adult cow with white patches on her head that he observed at Prairie Creek in 1947.

Age Characteristics: Aging of carcasses was accomplished by using the tooth characteristics described by Quimby and Gaab (1957) and Swanson (1951). Examination of a small number of known-age carcasses indicates a close correlation between Quimby and Gaab's age classes and those of the Prairie Creek elk. Pelage, head shape, and size were used to estimate the ages of antlerless elk (table 4).

Recognition of Individuals

Since marking the elk was not feasible it was necessary for the observer to find differences in

Table 4

Characteristics for distinguishing age and sex classes of Roosevelt elk at Prairie Creek Study Area

Character	Mature Males	Immature Males	Mature Females	Immature Females	Calves
Antlers	Usually 4 or more points on each side. Heavy beam.	Unbranched or 3 to 5 points on each side. Narrow beam.	None	None	"Bumps" visible on males in late spring.
Body: size and shape	Heavy. Short-legged in appearance.	Long-legged in appearance.	Heavy. Short-legged in appearance.	Long-legged in appearance.	Smaller than other classes.
Body: color.	Very light. Little contrast between "rump patch" and back.	Similar to mature males.	Darker than males. Good contrast between "rump patch" and body.	Similar to mature females.	Spotted in late May and early June. Other months similar to adults.
Head and neck region.	Long-muzzle. Heavy mane. Light color.	Shorter head than mature males. Heavy mane. Light.	Long head. Dark, long-haired mane.	Shorter head than mature females. More sparsely haired mane. Dark.	Very short-head.
Behavior	Solitary or with 1 or 2 other mature males, except during the rut.	Usually in groups of similar age and sex class. Spikes usually with family group.	Usually with family group, and in close proximity to other family groups.	With family group. Playful.	Remains close to cow. Playful. More easily disturbed than other age classes.

markings or behavior of the various animals that occupied the study area. Originally, observations were limited to an area of approximately 170 acres of open grassland. However, it soon became evident that the resident "herd" utilized a larger area of some 810 acres. This extended area included dense redwood forest, logged-over land, and hardwood stands.

To study the behavior and movements of the elk of this area are relatively easy because the elk are familiar with man. Each year many tourists approach the animals to observe and photograph them. This familiarity with man makes it easy to approach the elk to make observations. Most observations were made at a distance of 100 feet or less. Occasionally observations at several hundred feet became necessary because of the terrain. A pair of BX30 binoculars and a 15X spotting scope were useful in these instances.

Antlered males: From May through March bulls were identified by antler characteristics. By recording the various antler types at the beginning of the study and recording the sequence in which antlers were cast, the antler type peculiar to individuals could be recognized. When males that were not normally resident to the study area were present a sketch was made of the "newcomer's" antlers. This proved of value as some remained in the area to become part of the resident "herd."

Yearling males showed less variation in antler type. They were more difficult to distinguish from one another. However, by careful observations to find which cow the spike followed, it was possible in most instances to tell them apart.

Females: Because of the "herding" tendency of the species, family groups were not always easy to distinguish from one another. However, it was found that the undisturbed animals tend to move about in family groups within the herd. These family groups usually consisted of a mature female and her offspring of various ages. Most groups differed somewhat in composition on the study area, which helped in identification.

Other differences were noted that helped in identification. Markings about the head differed in some animals. One cow had an ear tag. Two cows limped. The gaunt appearance and body conformation of older animals allowed for easy identification of this age group.

Population Density

Census methods: The elk population of the study area includes those animals that spend the greater part of the year within the boundaries of the study area. Elk that are not resident to the study area sometimes utilize the area. Some of these animals remain to become part of the resident elk group. Others, will wander into the

area for a few days and leave. Most of these animals were from the Boyes Creek and Wolf Creek areas.

The principal method used in censusing the elk was direct-observation. Whenever possible, herd composition counts were taken. Through the use of the above characteristics of the resident elk, the observer could distinguish any strange animals that had wandered into the study area. The daily composition counts were totaled for each month and the average number of elk occupying the area for each month was computed (table 5a).

Other areas in Humboldt and Del Norte counties were censused (fig. 5). Composition counts were taken on each area at least twice during the duration of the study. The approximate number of elk for each area was computed.

Numbers: The population density of the study area shows much variation during certain months (table 5). This was caused by movement of elk into and out of the study area. Mature males have a tendency to leave the study area during the winter months. On three occasions non-resident females and their offspring joined the resident cow group and remained in the area. During the winter of 1957-1958 a number of non-resident females remained in the study area. The population density varied from 24 animals per square mile during January of 1957 to 32 animals per square mile during February of 1958.

Table 5

The elk population at Prairie Creek Study Area
for the years 1951-1954*

Period	Males	Females	Calves	Total
1951				
January	15	38	5	58
February	13	37	5	55
March	16	34	5	55
April	5	32	5	42
May	16	32	5	53
June	17	32	3	52
August	12	22	8	42
September	14	18	3	35
October	14	16	4	34
December	11	25	4	40
1952				
January	11	13	3	27
February	9	18	2	29
March	14	20	5	39
May	17	22	4	43
1953				
December	11	27	4	42
1954				
August	12	17	7	36
September	12	19	9	40
December	10	17	9	36

* Data gathered from Calif. Fish and Game files
and James Yoakum.

Table 5a

The elk population at the Prairie Creek Study Area from 1956-1958.

Period	Mature Males	Two-Year Old Males	Spikes	Mature Females	Immature Females	Calves	Total	Density per sq. mi.
1956								
May	1	5	3		14 (combined)	9	32	26
September	3	5	4		16 "	5	33	26
October	2	5	4		17 "	5	34	27
November	1	5	5		20 "	7	38	30
December	1	5	6	13	4	7	36	28
1957								
January	0	1	5	12	5	7	30	24
February	0	5	5	11	6	7	34	27
March	0	0	6	12	6	7	31	25
April	3	5	5	11	5	7	36	28
May	0	0	5	13	6	7	31	25
June	5	4	2	11	7	4	33	26
July	5	5	4	12	7	5	38	31
August	7	5	3	11	7	5	38	31
September	3	6	2	11	8	5	35	28
October	3	5	4	11	7	5	35	28
November	2	5	3	14	6	5	35	28
December	2	5	2	17	6	5	37	30
1958								
January	2	5	2	16	6	5	36	28
February	3	5	3	14	7	7	39	32

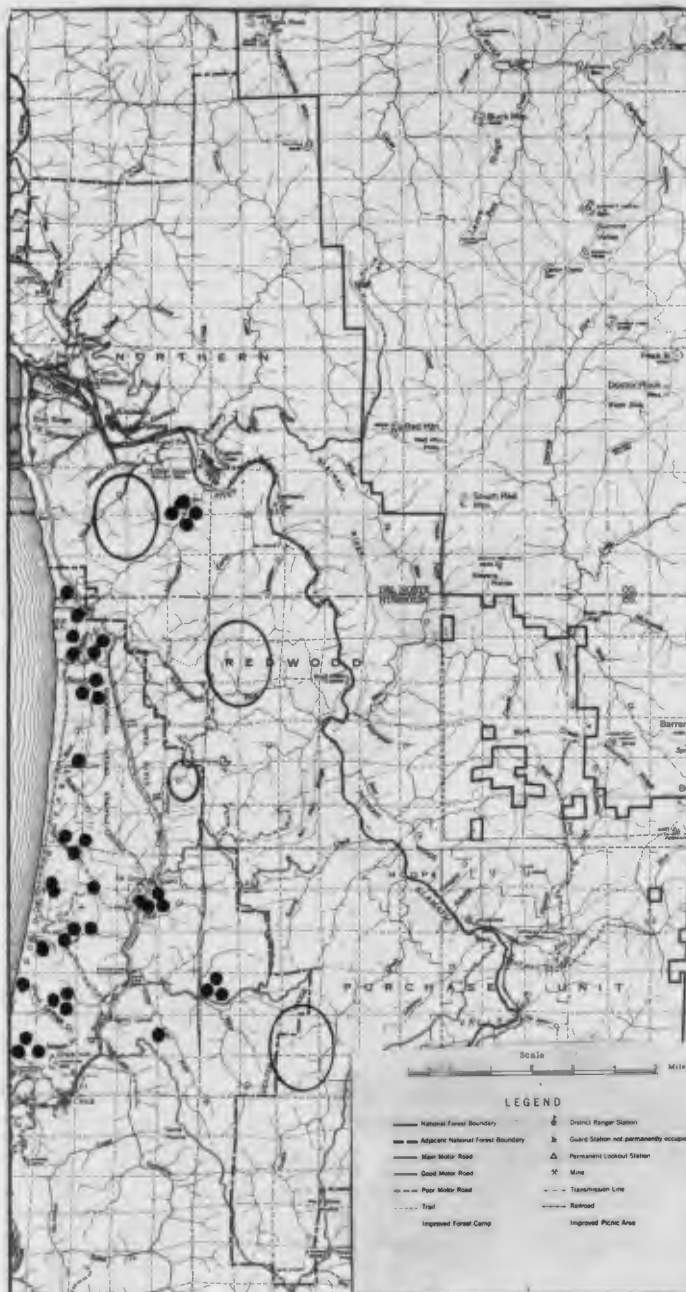


Fig. 5, Map showing location of elk population. Each dot represents 10 animals. White areas represent areas showing elk use, but not censused. Scale- one inch equals 5 miles.

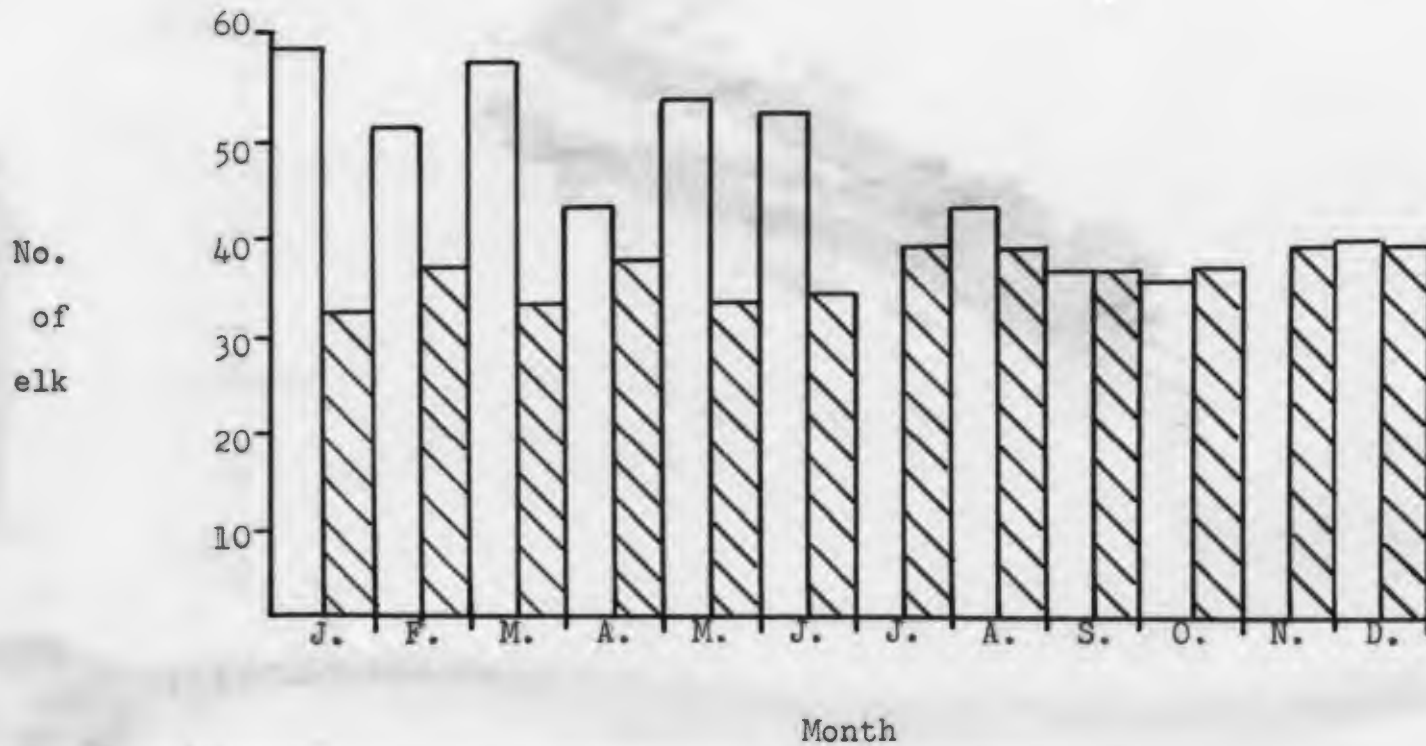


Fig.5b, Comparison of the monthly populations changes in the Prairie Creek elk population for the years 1951 and 1957. Black areas-1951. Lined areas-1957.

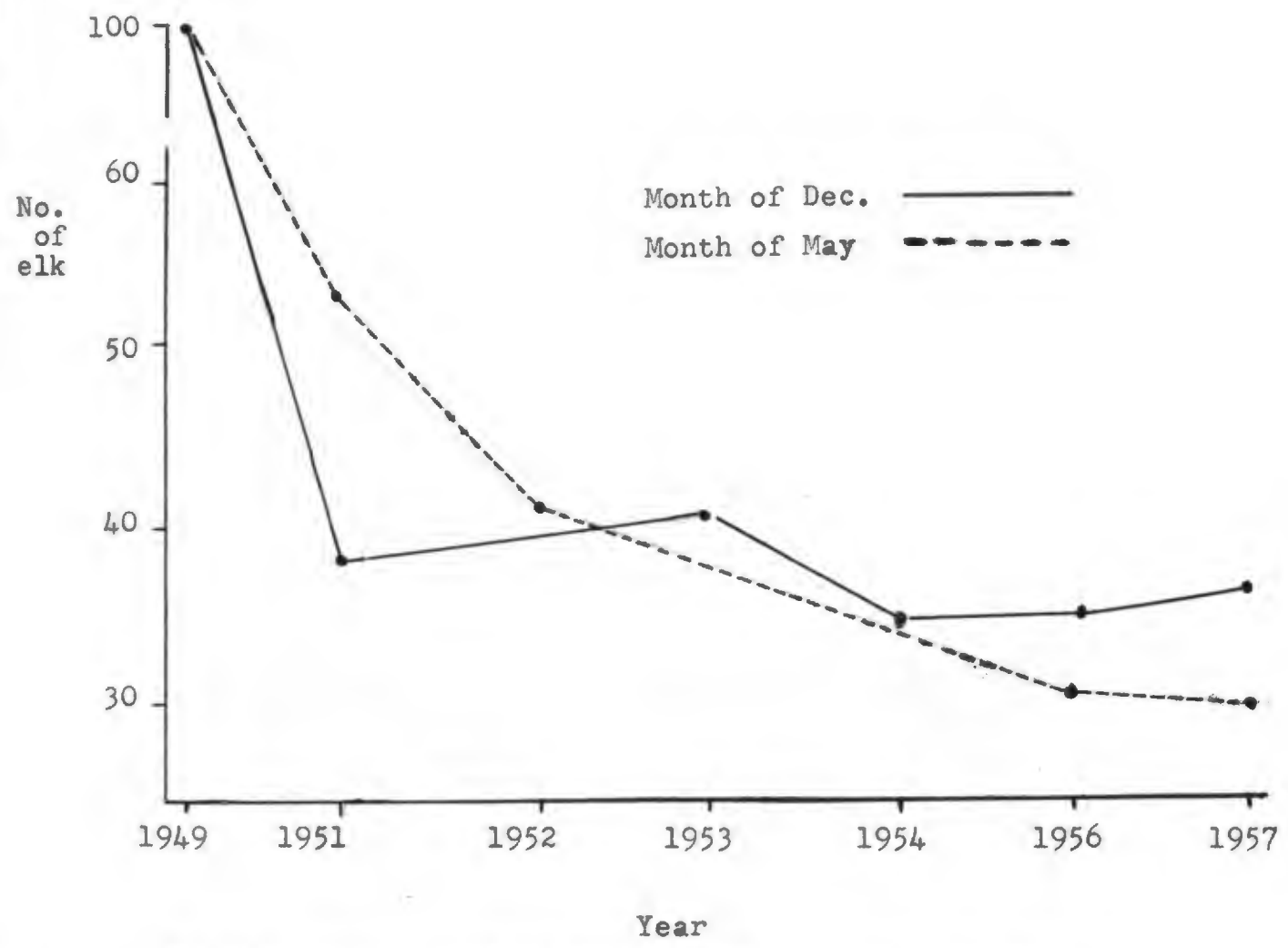


Fig. 5a, Comparison of the Prairie Creek elk numbers for two months for seven years.

Beer's (California Fish and Game files) counts for 1951 show higher population densities than those recorded during the study. A density of 46 animals per square mile was recorded during January and March of 1951. Milne's (1949) figures give a density of approximately 80 elk per square mile during 1948-1949. If Milne's, Beer's and Yoakum's figures are used the population density can be traced back to 1948. These figures show a decline in elk numbers. This is a result of past die-offs and annual herd reduction.

Areas adjacent to the study area are inhabited by many elk. Investigators in the past, (Graf, 1955; Barnes, 1925; Russell and Feathers, 1935; Beer, 1951) estimated the total of Roosevelt elk in California to be between 25 and 200 animals. In this study a total of 394 elk were observed in the area between Redwood Creek and the Klamath River. These were observed on an area of approximately 60 square miles, which gives a density figure of 6.6 elk per square mile. This figure is undoubtedly low. The composition counts for the various areas show a dearth of mature males. This is probably caused by the solitary habits of elk males. Many areas that were observed contained much evidence of elk activity but no elk were seen. The actual number of elk in Humboldt and Del Norte counties probably approaches a

figure of 1000 to 1500 animals. The Big Lagoon-Maple Creek region contains many elk, however, no accurate figures for that area can be given at this time.

Population Structure

Techniques: The sex and age structure of the population was derived by using the methods described under census methods. The population on the study area was followed from month to month and gains from natality and losses due to mortality were recorded upon occurrence. Because of "herd" reduction and the influence of new animals moving into the study area, the sex and age ratios of the population were variable (table 6).

Sex and age ratios: On adjacent areas more females were observed than males because of the difficulty in observing the old, solitary bulls. Males show a tendency to leave the study area for long periods of time, and during the rutting season there is an influx of males.

Composition counts in the Prairie Creek area show a wide range in sex ratios. A ratio approaching the 1::1 condition was recorded during August of 1957 when a ratio of 108 mature males to 100 mature females was recorded. During three months of the study, mature males were absent from the Prairie Creek study area.

The sex ratio of yearling elk recorded during 1955 approached 1::1 (Park files). Five males and four females were

TABLE 6

Number of mature males* and calves per 100 cows
at Prairie Creek study area 1956-'58

* 2 years and older

Period	Mature Males	Calves
1956		
May	63	63
September	56	31
October	42	30
November	30	42
December	46	54
1957		
January	1	58
February	45	63
March	00	58
April	72	63
May	00	54
June	81	36
July	83	41
August	108	45
September	81	45
October	72	45
November	49	35
December	42	30
1958		
January	44	31
February	57	50

observed. The 1956 calf crop shows a ratio of 4 males to 3 females. The sex ratio of the 1957 calf crop was difficult to compute. Many of the calves succumbed during their first few days of life. The carcasses were recovered, but were usually so badly decomposed that identification of sex was impossible. The ratio for calves that survived was 3 females to 2 males.

Schwartz and Mitchell (1945) identified over seven thousand elk to sex and age. Adult cows constituted 70 per cent of the total, adult bulls 6 per cent, spike bulls 4 per cent, and calves 20 per cent.

Of 394 elk identified to sex and age in and around the study area there were 29 per cent bulls, 57 per cent cows and 14 per cent calves. The local elk are not subject to legal hunting pressures which might account for the differences in the percentage of bulls between the study areas.

The age structure of the Prairie Creek population for February 1958 has been estimated as follows:

<u>Age</u>	<u>Number of elk</u>	<u>Percentage</u>
0-1	7	18
1-2	10	25
2-3	8	20
3-6	7	18
6 plus	7	18
Total	<u>39</u>	<u>100</u>

Natality

Prior to this investigation, little data were gathered on the productivity of elk in this area. Annual calf production records were kept for the periods 1953 through 1956 by Beer. Cows were not classified to age classes. Therefore, any figure of average calf production would not necessarily be a true one. Other studies, (Buechner and Swanson, 1955; Coffin and Remington, 1953), have indicated yearling females take part of the rut. Cows of the study group were at least 2 years old during their first rutting season.

The calving season of 1956 was highly successful. Fourteen cows of all ages produced an average of 0.64 calves each. However, of four mature cows collected by California Department of Fish and Game just prior to the calving season, only one contained a fetus. Combining the two figures gives a corrected average of 0.55 calves per female. This is a somewhat lower average than indicated for Roosevelt elk by Schwartz and Mitchell (1945).

The calving season of 1957 indicated that a high percentage of the mature cows produced calves. Four carcasses of mature cows were examined. Two were pregnant. The twelve remaining mature cows produced 13 calves including a set of twins. These combined figures indicate an average of 0.93 calves per mature cow.

The circumstances behind the increase in calves need to be examined. In the past it had been assumed that the productivity of the herd had been suppressed by the overstocked condition of the range. Many cows produced few calves. With a lowered population from herd reduction the ratio of calves to cows improved. However, the ratio still did not approach a 1::1 ratio that might be expected under optimum conditions. This may be because of the heavy mortality of new-born calves. Of the 13 calves born at Prairie Creek in 1957, eight succumbed to causes unknown. The ratio of calves to cows may have been as high as 1::1 in the past, if early calf mortality had been taken into consideration.

Mortality

Past investigations of the elk at Prairie Creek and vicinity have dealt with some mortality factors, but did not delve deeply into the causes. Murie (1945) and Russell and Feathers (1935) mention poaching, and Orr (1937) indicates lung worms as a mortality factor. This meager information and a small amount of a similar nature gleaned from the files of the California Department of Fish and Game was all that was available when this study commenced.

In the past the Prairie Creek herd was much larger than the present population. Beer estimated "well over 100 elk" utilized the grasslands near the park head-

quarters. Dasmann (personal interview) in November 1949 estimated the number of elk in the prairie at over 100. During the winter of 1949-1950 over 40 animals succumbed to malnutrition. Nineteen animals were found dead during 1950-1951. Two fell prey to poachers; the balance to "natural causes" (Beer, 1952).

In 1950, herd reduction was instituted to alleviate the overstocked condition of the grassland. A corral-type trap was constructed and elk were trapped and removed from the area. Herd reduction in the form of killing weakened and senile animals also began in 1950. More than 30 elk have been removed from the area by these methods to the present time.

During this study mortality in the area was checked by regularly searching the study area and surrounding areas for dead elk. The location of dead elk observed in and around the study area is shown in figure 6.

In 1957 mortality was high with 41 known elk deaths discovered in Humboldt County. Calves were most severely affected, followed closely by mature cows. Mature males were affected only slightly less than the above groups. Immature males were the least affected.

The precise cause of death for the 41 animals could not always be determined. Twelve elk succumbed to poaching, six to accidents, seven were collected by the California

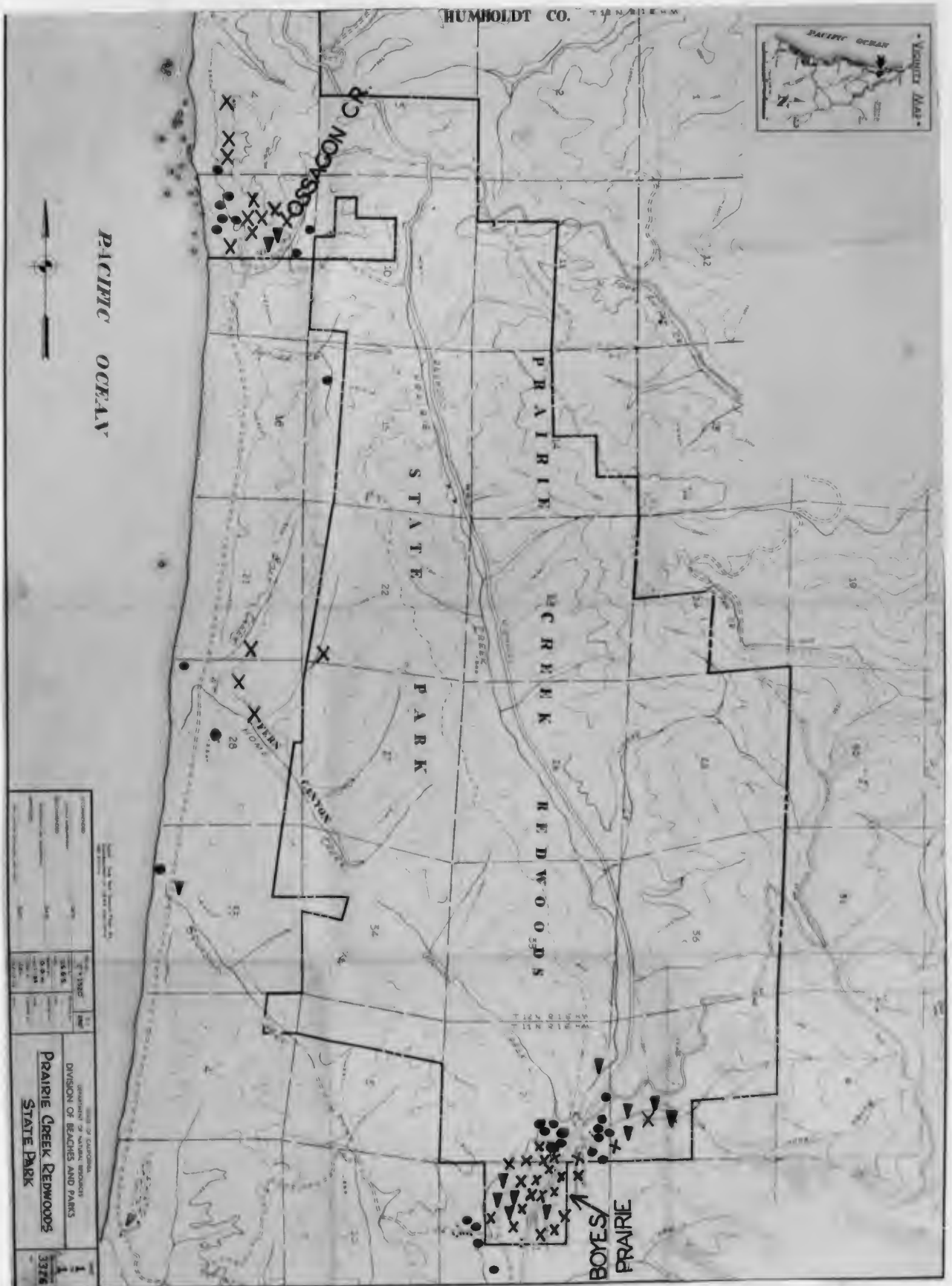


Fig. 6, Map showing location of elk carcasses. Black dots-males. Crosses-females. Triangles-calves.

Department of Fish and Game, and a single calf was malformed at birth. Eight calves died within the first two weeks of life, and the remaining animals succumbed to cause or causes unknown.

In the past, poaching and malnutrition have taken heavy toll on elk in and around the study area. More recently, herd reduction has practically eliminated death from malnutrition in the Prairie Creek area. However, adjacent areas show extreme over-use by both wildlife and livestock. It seems safe to assume that many of the dead elk found in these areas have succumbed to malnutrition.

Consideration of the season of loss for calves shows, in 1957, that the first few weeks of life are the most critical. After the second month the loss of calves is negligible. Calves reaching six months of age tend to survive to maturity unless killed by poachers or accidents.

Differential mortality was noted during the study. Of sixty-eight carcasses positively identified to sex, thirty-eight were females and thirty males. The remaining carcasses could not be identified. These were the carcasses of calves, and when discovered were too badly decomposed to allow positive identification. Fifty-six per cent of the sexed carcasses were females.

Factors: Of the known causes of mortality, other than animals killed during the annual herd reductions, poaching is the major factor. Illegal kill accounts for approximately twenty-five per cent of the total (table 7). Mature males are most severely affected by illegal kill.

Accidents caused the death of approximately twelve per cent of the dead elk discovered. Factors involved included falls, rutting battles, and road-kills by motor vehicles. Elk of all age classes and of both sexes were affected.

Death from predation was unknown as a mortality factor on the study area. Bear droppings were discovered that contained elk hair. However, this could indicate the eating of carcasses by bear. A large black bear was noted harassing the elk at Prairie Creek during the calving season of 1957. However, none of the carcasses of calves discovered during the next few weeks showed any signs of predator activity.

Of elk dying from other causes, some were found soon enough after death to permit autopsy. A few, because of their gaunt appearance and absence of body fat, were believed to have succumbed to malnutrition.

Another possible mortality cause is the aggressive behavior by males toward younger animals. During June of 1957 a 2 year old bull trampled a young calf. The calf did not die, but was injured severely.

Table 7

Mortality factors affecting elk in Humboldt and Del Norte counties, California

for the years 1955 through February, 1958

Factor	Mature Males	2-year old Males	Spikes	Mature Females	Immature Females	Calves	Total	%
Accidents	1		1	4	1	2	9	11.8
Collected	6	1	1	10	1		19	24.7
Disease and parasites	2						2	2.6
Illegal kill	8	1	1	4	2	3	19	24.7
Unknown	3	3		13		8	28	36.3
Total	20	5	3	31	4	13	77	100.

Examinations of collected elk from the Prairie Creek study area by the California Department of Fish and Game have shown a number of diseases and parasites. The following have been discovered on animals collected at the Prairie Creek study area.

Bacterial infections:

Hoof rot, Spherophorus necrophorus

Two adult males were collected at Prairie Creek in November of 1955 that were infected with this disease. Other elk in the area were suspected of having the disease but they recovered. The disease was believed to have been brought into the area by a stray sheep.

Other bacterial infections:

An adult male was collected at Prairie Creek in 1957 that had a large localized pelvic abscess. Cultures showed presence of a variety of bacteria. Cause of abscess was presumed to be by penetration of numerous bird shot found embedded under the skin on the rump.

Parasitic worms:

Lung worm, Dictyocaulus viviparus

Elk collected from 1950 to 1954 were heavily infested with lung worms.

Stomach worms, Oesophagostomum sp., Trichostrongylus sp., Trichuris sp.

Infestation with stomach worms was heavy from 1950 to 1954.

Arthropod pests:

Ticks, Ixodes pacificus, Dermacentor occidentalis

These parasites have periods of abundance and decline. Carcasses discovered during the winter months have shown heavy infestation.

Other pests: One occurrence of larval chiggers was discovered in 1955. The species was not identified.

It is interesting to note that since herd reduction measures have relieved the overcrowded condition of the Prairie Creek area, there has been a decline in the number of parasites found on collected animals.

The population data presented in the preceeding sections provide a background for interpreting the behavior of the elk that will be described in the following pages, and a basis for certain management recommendations.

SOCIAL BEHAVIOR

Annual cycle of activity

Summer: The elk year begins in late May and early June, the time when most calves are born. During this time, in 1957, the calving process was closely followed. Calving began on the 18th of May. The last calf was born on the second of June. The peak of calving took place the first three days of this period. Three cows gave birth to calves on the 18th, two on the 19th, and four more on the 20th of May. The three remaining cows gave

birth to four calves during the remaining period. The cows that calved earliest did not take to cover prior to parturition. The first eight calves were born in the meadow area. The remaining calves were born in dense stands of hardwoods along Boyes Creek.

The cows, soon after dropping their calves, rejoined the herd and only returned to the calves to feed them or when the calves were being searched for by the writer. The calves are difficult to find even in an open area. When the young were a few days old the cow would move them short distances after nursing them. Calves were hidden in brake fern, or tall grasses. Two calves were moved to a thicket of alders. The locations of the calves were best observed when they were being nursed by their mothers. The weather was extremely wet during the first three days of the calf drop. However, the calves remained in close proximity to the place where they were born.

During this period antler growth is conspicuous on males above the two year old class. Bulls spend much time feeding in the open areas and are more conspicuous than later in the year. They are usually found in groups. Females and young animals spend most of their time in the open areas feeding on the plentiful grasses and forbs. At three to four weeks of age, calves follow their mothers

about. They begin to feed on plant material at this age.

By late July bulls begin to concentrate in the vicinity of the cow herds. The sex ratio is much closer to 1::1. Antler growth is complete on the larger, more vigorous males. All sex and age classes are equally visible at this time. The calves have lost their spots and may be seen some distance away from their mothers. Much time is spent loafing and playing. Loafing takes place in mid-day. Playing in the form of a game of tag similar to that described by Darling (1937), takes place in the cool of the mornings and evenings. Much feeding by the herd takes place in the early mornings and late evenings. During the day some feeding by individuals or small family groups takes place but is not a herd activity.

Rutting season: During early August, mature bulls have polished their antlers and some bugling is heard. August 15th was the earliest date Murie (1951) observed any rutting activity. However, he reports bugling is general by September 1st.

The rutting season commenced at different dates during the two years of the study period. In 1956 the rut began in early September and reached a peak in late September. In 1957 the rut began in early August and was at the peak during early September. No explanation for this difference in the starting date can be given.

Prior to the rut, bulls that are not year-around residents to the study area join the resident bulls. By the start of the rut, all the bulls of 2 years of age and older have polished their antlers on the maple and alder trees that are found throughout the area.

The cow group feeds extensively on the ferns and skunk cabbage that is found along the creeks. More feeding during mid-day by all sex and age groups takes place.

During the main period of the rut bugling by males begins in earnest with much activity by the bulls in early morning and late evenings. Bulls without harems are gregarious and usually found in close proximity to harems. Harem bulls are in a constant frenzy guarding against the occasional attempt by "bachelor" bulls to breed with the cows. At this time light rains may fall and the mornings and evenings are cool.

Winter: Following the rut, most of the bulls that are not normal residents of the area leave. Some of the resident bulls may also leave the area for a period of a month or two.

During November and December most of the elk's activity is restricted to feeding. Feeding periods are of much longer duration than in summer and during the rut. Much time is spent by the Prairie Creek herd in an

orchard near the park residences where they feed extensively on the fruit that falls from the apple trees. Dried brake fern and sedge is eaten more readily than at other times. Browsing of blackberry plants is noticeable. Spike bulls may leave the cow group to join older bulls that are present. There is a marked increase in the number of "outsiders" that utilize the area for a few days at a time.

Heavy rains fall at intervals and the temperature may drop to freezing. The streams in the area may reach flood stage.

Spring: Elk are often active throughout the day in early spring. Much of the time is spent feeding on the lush grasses and forbs. The majority of the mature males have lost their antlers. Mature males move about a great deal, sometimes leaving the study area. Pregnant cows are heavy with calf by April.

The mature animals begin to lose their winter coats in March and the animals take on a darker color. The calves approach yearling size and some difficulty may be encountered in identification at distances.

Heavy rains continue to fall at intervals. Occasional heavy frosts appear. Warm afternoons may be expected on clear days.

In March the apple trees, oso berry, skunk cabbage

and salmon berry bloom. Alder, azalea, and the huckleberries put on noticeable growth. Young sedge plants and many forbs make their appearance and are readily eaten by the elk. Many plants; trillium, milk maids, redwood violet, wild ginger and others bloom in late March and early April. The grasses begin to head out in late April and early May. Figure 7 is a graphic presentation of the annual elk activity at Prairie Creek.

Weather and Elk Activity

It is apparent that weather has an important influence on elk activity. Darling (1937) discusses rather thoroughly the effects of weather on the red deer. Webster (1921), has discussed the effects of storms on elk in the Olympic Mountains. It was noted on the study area that weather influenced the movements and other activities of the elk. Bugling and rutting battles took place to the greatest extent during the cold evenings. Strong winds in some instances excluded elk from wooded areas because of branches and foliage falling from trees. Cold rains during the calf drop of 1957 may have been responsible for the high mortality of young calves.

The effects of weather on the elk are not thoroughly understood. Further investigations on this subject may prove to be beneficial to the biologist and game manager.

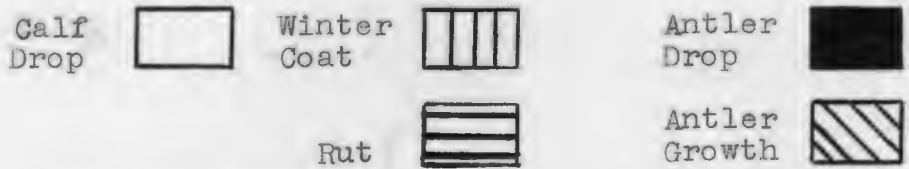
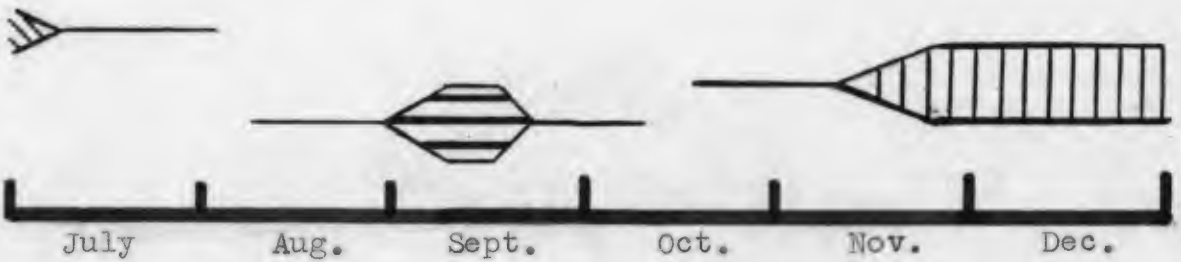
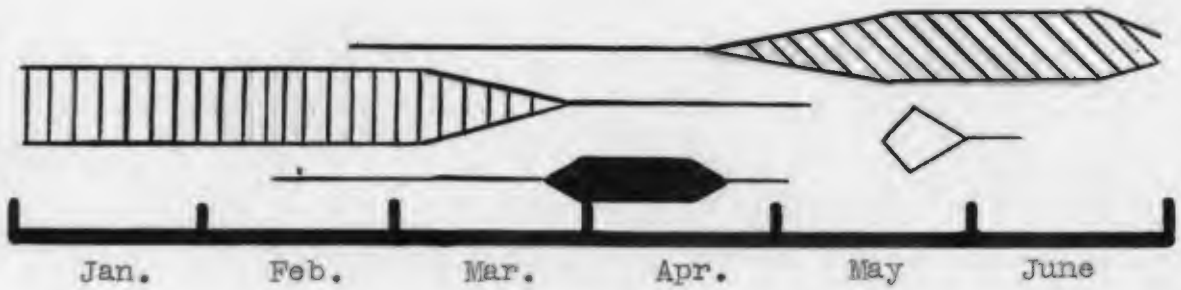


Fig.7, Graphic presentation of annual elk activity at Prairie Creek.

Movements

At the beginning of the study little was known of the movements of elk in this area. Local opinion indicated that some elk groups moved great distances during their annual activities. It seemed to be common belief that elk wander quite freely about the county. It was the opinion of some people that "logging-pressure" caused elk to move completely out of an area. Local ranchers believed that the elk from Prairie Creek State Park traveled great distances to feed in their gardens and fields. This latter point in particular needed investigation. It is of great importance to the California Division of Beaches and Parks to know if the elk that inhabit park lands are destructive to local crops, both agriculture and timber.

The method used for investigating elk movements was direct-observation of known elk groups. This was carried out on both the 810 acre area of intensive study and adjacent areas. The regular practice was to closely follow the elk during active periods. During each season a few days were spent on various areas following the elk activity during daylight hours. Most days were spent at the Prairie Creek study area. Occasionally activities were followed during the night and early morning. Some

time was spent on the various areas at all times of the day and under varying weather conditions.

Daily movements: The daily movements of the elk are directly tied in with the abundance of forage. Movements of various groups are shorter when food is plentiful. During the rut the movements of both cow groups and bulls are somewhat governed by the harem bull.

Cow group: Day usually begins for the cow group at Prairie Creek in one of three "bedding-areas". All three areas are in stands of hardwoods along streams (fig. 8). First activity is noted just prior to sun-up. This usually consists of a few animals rising, stretching, and relieving themselves of waste materials. Usually the younger animals, yearling cows and spike bulls are the first to show signs of activity. Soon the rest of the group arises and all proceed to feed. In spring and summer, play in the form of a game of tag, or splashing in the nearby stream, follows a brief feeding period. If the food supply is plentiful, feeding is limited to three or four hours during the morning. During this feeding period the group will move from the hardwoods to the grassland. From mid-morning until mid-afternoon the group spends the time resting and ruminating. A few animals will rise to graze for a few minutes and then bed down again. At mid-afternoon the group rises and

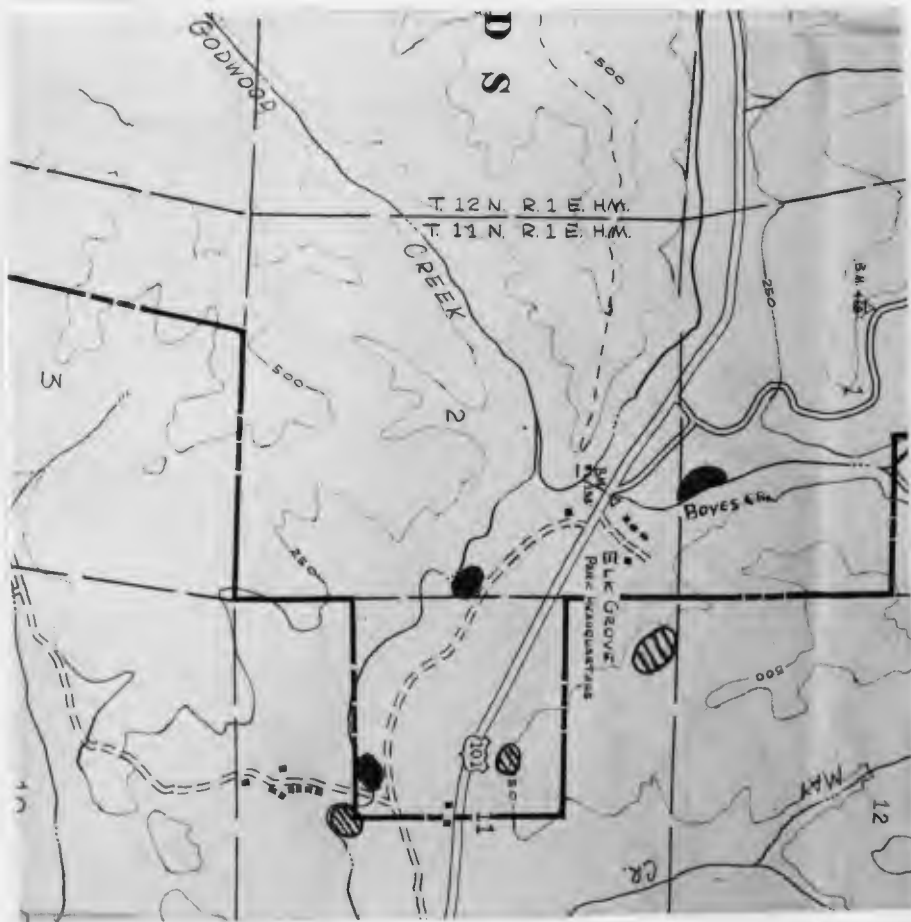


Fig. 8, Bedding-areas of the Prairie Creek elk herd.
 Black areas-cow group Lined areas-bull group

again feeds in earnest, usually moving slowly toward one of the favored bedding areas. In the evening the animals will continue to feed at a slow rate near the bedding area. Finally the group will move into the favored bedding area and bed down three to four hours before midnight. The total days movement will usually traverse not more than 30 to 40 acres, during the favorable seasons, or a linear distance of 0.4 of a mile.

During the rut the movements of cow groups are somewhat governed by the "harem" bull. The bull does not allow the cow group to move about as freely as they would during other seasons. An area that allows the harem bull a full field of vision is usually utilized. Activities are carried on much later into the night and early mornings. Bugling and feeding activities were observed at the hours from twelve, midnight, to two a.m. during the rut.

During the late fall, winter and early spring when the food supply is not abundant, the movement of the herd shows a different pattern than at other times of the year. Much more time is spent feeding and a greater area is covered during the days activities. Feeding activities are obvious during the mid-day. Movements of greater length are usual. Movements of 1.2 miles were recorded

during daylight hours. Average linear movement is approximately 0.6 of a mile.

Bull group: Bull groups are more mobile than cow groups. It was found that the bulls covered a greater area in both seasonal and daily activities. The bulls also show a preference for certain "bedding-areas."

During the months that they occupied the area of the grassland at Prairie Creek, the bulls usually bedded down in one of three areas (fig. 8). During the bulls' occupation of the May Creek drainage a similar situation was found to exist. Bulls on the Butler Creek area were found to occupy specific areas during most of the year as were bulls in the area of the Gold Bluffs road.

Daily activity of the bull group is similar to that of the cows. However, more time may be spent in long movements not related to feeding. Often the bulls will walk over a large area for no apparent reason. During the rut, movements vary with the individual. Bulls that collect "harems" are influenced somewhat by the movements of the cows. The younger bachelor bulls usually remain in close proximity to a "harem". More mature bachelor bulls will move great distances trying to secure a harem. On one occasion during the rutting season of 1957 an easily recognizable bull was observed to move 2.4 straight line miles in three hours in search of cows. This was

the longest movement observed during the study.

Seasonal movements: Seasonal movements were found to differ between the bull and cow groups. The cow group at Prairie Creek occupied and utilized an area of approximately 540 acres during a full year. The resident bulls would leave the study area for a period of a few weeks. During the late winter of 1957 the mature bulls were absent from the study area. A thorough search was made but the bulls could not be found. In 1958 no such movement took place.

Movements of great distance by a single cow elk have been recorded by park personnel. A cow that was trapped and tagged at Prairie Creek and released at Bear Basin, Del Norte County during October of 1951, returned to Prairie Creek the following spring. This represents a movement of 42 straight-line miles (fig. 9).

Interchange with adjacent groups: During the course of the study animals not normally resident to the study area at Prairie Creek joined the resident herd. Some "outsiders" remained in the area to become residents. Others would remain for a few days and then leave.

On three occasions during the investigation the process of foreign animals joining the resident herd was observed. During February of 1957 four "outsiders" entered the meadow from the Boyes Creek drainage. The



Fig. 9, Movement of cow elk released at Bear Basin in 1951. one inch equals 28 miles.

group consisted of two mature cows, an immature cow and a spike bull. This group moved into the resident herd without any reaction of the herd. Two of these animals, the spike bull and one of the mature cows have remained with the resident herd. The others have moved on. On other occasions animals have been observed joining the residents. There is no indication of aggressive behavior by the residents toward the "outsiders". They are readily accepted.

Movement out of the study area was observed when a mature cow and calf that were normally part of the Prairie Creek herd left the area and joined a small band in the Wolf Creek area.

It was also noted that some animals did not attempt to join the herd when utilizing the same area. During January and February of 1958, and August of 1957 small groups of elk would feed in the area of Boyes Creek. Although the resident herd was no farther away than 150 yards at times the animals did not attempt to join them. The outsiders would "bed-down" within 250 yards of the residents on most evenings. After spending a few days in the area the animals moved on to other areas.

Factors influencing movements: The two main factors influencing elk movement on the study area are; the availability of food, and physiological urges, such as

the rut.

Movements of elk into agricultural lands occur during times of food shortages. Elk were found to move over a mile from the boundaries of their normal range to farm lands. Animals at Prairie Creek were not observed to move into the farm lands. However, the bull group moved into logged-over lands during the winter of 1956-1957.

During the rutting season some mature males are found to move great distances in search of cow groups.

Poaching and herd reduction does not cause elk to move out of their normal activity area. Animals disturbed by poachers or collectors were found to take to heavy cover and return to normal activities within a few days or hours.

Other disturbances by man, such as logging-operations do not cause the animals to move. Herds were observed to occupy areas in close proximity to logging activity. No change in their normal daily activity was observed. The normal daily and seasonal movements are shown on figure 9.

Social Aggregations

The elk is essentially a "herd" animal (Murie, 1951; Graf, 1955). The elk herds in and around the study area consist of a number of family groups, probably held together by maternal attachment (Graf, 1955). Herds usually consist in size from 3 to 35 animals. In some instances herds may consist of 40 or more animals (Graf,

1955). In the Ossagon Creek area as high as 61 animals were observed feeding in a single group. In the past herds of several hundred animals have been encountered (Finley, 1937; Revere, 1922).

Family group: The family group is the smallest social unit of the elk herd. This consists of a mature female and her offspring of various ages. A typical family group might consist of a mature female, a two year old female, a spike bull or yearling cow, and calf-of-the year. At the minimum a family group consists of a cow and a calf. At the maximum it may consist of an old female, her offspring, and their young.

The family group remains together most of the year. During the calving period the females may leave the group for a few hours at a time but usually return to their respective groups when possible. During the rutting season yearling males may be driven from their family group by aggressive "harem" bulls. Yearling males are somewhat independent and show a tendency to leave the family group and join more mature bull groups.

In late July and August there is a change in the family group. Young bulls attaining their second set of antlers separate themselves from the family group and join the bull groups. The break with the family group is not complete at this time. The two year old males

continue to return to the family group for a few days at a time. On one occasion a 2^{1/2} bull was observed trying to nurse. With the beginning of the rut the break is completed. Mature bulls vying for the cow groups do not tolerate any antlered males. The two year old bulls are driven away from their family groups and become part of the "bachelor" bull group.

Cow group: The cow group is the largest social unit of elk that has been encountered. This consists of a number of family groups that occupy a given area and have a similar activity pattern. The cow group generally consists of cows, calves and yearling bulls. The cow group has a true social structure. There is a form of leadership within the unit. The leader is a mature cow that, for reasons unknown, the remainder of the herd follows during group activity. In some cow groups a "second-in-command" is present.

Many movements such as crossing a road, walking narrow trails, or fording streams, show definite decision on the part of the head cow. An example of the remainder of the group following the leader's movement can best be illustrated by watching the group cross the highway. Once the leader has crossed the road the remaining animals will follow, oblivious to vehicles that might cause them

injury. On narrow paths, the leader will again be first in line.

Altmann (1952) states that "serious disturbance.... may cause the herd to divide into a number of sub-groups." During the herd reduction of 1957 the cow group at Prairie Creek was disturbed by the report of fire arms. The group divided into two smaller units and took cover in a nearby hardwood stand. Within two hours the herd had reassembled on the meadow.

Vocal communications: The actions of the cow group are sometimes marked with lively vocal communications. Cows were heard to "bark" when disturbed by the investigator. On two occasions when the herd was divided by man's disturbance, cows were heard to "blat" as if calling to other members of the group. Calves were called to the side of cows by a shrill, nasal sound.

Bull group: Bulls may be seen alone or in groups. There seems to be a close relationship between the age of the male and the degree of sociability. The older males are much more solitary in nature than the younger males. Two and three year old males are usually found in a group on the study area. Older animals may be found with another of similar age or solitary.

At any season bulls may join the cow group for a few days, and travel with it. This seems to be a random association, the animals merely brought together by a

common feeding area.

Leadership among bulls is not as definite as in the cow group. On occasions when males were traveling through narrow openings it was noted that no one animal consistently led the group. When disturbed the males show less organized flight than the cow groups. When disturbed in heavily wooded areas males would disperse in a wild manner, in contrast to the cow group which attempts to maintain contact when possible. Much time is spent by the bulls "fencing" with their antlers. With the approach of the rutting season this activity is accelerated.

Occasionally a spike bull will join the mature animals and remain as part of the bull group.

The Harem: The rutting season brings together the bulls and the cow groups. Old males that are normally solitary join the bull group. Males that are successful in gathering a harem are in a constant state of movement trying to protect it from other males.

The harem is much less mobile than the cow or bull groups. All animals are not to be found with their family groups. Yearling males are subject to expulsion from the cow group by the aggressive harem bull at the peak of the rut, but again as the rutting season approaches termination they are tolerated. Most bachelor bulls remain in close proximity to the harem.

Dominance and Aggression

Three types of aggressive behavior were noted; one between the members of the family groups, another between the family groups, and still another among the bull group. In the family group in its usual form it occurs as aggression of the mature cow towards her offspring. Other types of aggressive behavior within the family group are aggression of older offspring toward younger animals. Actual conflict is rare. The larger, older animals assume an "attitude" of aggression that usually causes the younger animals to retreat. The older animals lay their ears back, flare their nostrils, and advance toward the younger animal with teeth bared, much in the manner of an angry horse. Occasionally, when the younger animal is slow to retreat it is bitten or struck with a fore foot. Altmann (1952) states that yearlings were tolerated only at a distance after a new calf was born. No indication of this was found on the study area. Other elk were tolerated by cows in close proximity to their calves. However, aggressive behavior toward other animals was noted during the calving period. A cow that had dropped a calf in the grassland chased this investigator some 250 feet when a search was made for the calf. Initially the cow attempted to dishearten the investigator by barking and gnashing her teeth. When this did not bring results

she approached at a trot causing the investigator to leave the vicinity. The cow could have easily overtaken the intruder but remained a few yards to his rear. Upon reaching the safety of a fence the intruder turned to look back at the cow. She stopped, stamped her feet and barked at him. After a few minutes she returned to move her calf from the immediate area.

Dominance and aggression occur within the cow group. Dominance of mature cows toward other mature cows was observed. Occasionally when an animal from another group grazed too close to a mature cow or another member of a family group, the animal would drive the intruder off. Sometimes a distance of a few feet was sufficient to halt the aggressive behavior. During other instances animals were driven off as far as 20 yards.

Group leadership by an adult female is obvious. Subordinate animals show readiness to follow the dominant cow. Movements of distance are instigated by the "lead-cow." Curiosity of the lead-cow will cause the group to follow her investigation. On one occasion a feral house-cat was hiding in a thicket of berry vines. The lead-cow became aware of his presence and walked a distance of approximately two hundred feet to his hiding place. The remainder of the group followed readily.

In the bull group dominance conflicts are common. They are often seen during late spring and late summer prior to rutting activities. Usually the dominant position is taken by a large, mature male. On two occasions this dominance was clearly observed. The first incident took place during the fall of 1956. The bull group was occupying an abandoned orchard feeding on fallen apples. As apples fell the dominant bull, a large 6 point animal, would drive the other bulls away and devour the apples. This dominant behavior took place four times in a 40 minute period. A second such incident was noted during March of 1957. A large bull in velvet dominated other bulls both in velvet and with hard antlers. The fact that his antlers were soft did not seem to give his better-armed cohorts any advantage.

In temporary feeding groups, mature males were dominant over the cows. This was also true during the rut. Early in the rutting season spike bulls are not tolerated by the harem bull. Repeated efforts to drive them from the cow group usually fail and near the end of the rut the spikes have rejoined their family groups. On one occasion a harem bull struck a calf that was nursing. Although other calves were observed nursing in the herd this behavior was not repeated.

Active fights between males were witnessed. In late August of 1957 the harem bull was defeated and replaced by a large, malformed bull that had been successful in obtaining the harem the year before. On September 1, 1957, the "defeated" bull was successful in recapturing the harem. This fight took place during mid-day. The originally "defeated" bull approached the harem, tossing turf with his antlers, bugling and urinating. He had recently visited a wallow and was covered with mud. The malformed bull was bugling, and running back and forth between his harem and his challenger. The cows were indifferent to the activities. When the challenger had approached to within a distance of 250 feet the malformed bull walked slowly toward him, his neck stretched, and antlers held back, all the while bugling. The challenger was bugling and tossing turf. When they were approximately one hundred feet apart they began circling one another. Each complete circle brought them closer together. Finally the malformed bull charged and the challenger held his ground. Active contact took place for approximately one and one half minutes with neither bull gaining an advantage. Twice more this took place. On the third clash the malformed bull was driven to his haunches. The challenger continued with his advantage and drove and chased the

defeated bull some 200 yards from the immediate area. The defeated bull ran off at a brisk pace and did not stop until he had reached a wooded area. The new champion gave vent to much bugling. Neither animal was injured.

A similar battle was witnessed at Butler Creek during the rutting season of 1957. However, neither bull showed an advantage. The cow group was dispersed and within a few days there was a number of small harems scattered throughout the area. Battles were heard frequently at night. It may be that rutting battles are stimulated by the reduced temperatures during the night, a condition Darling (1937) found with the red deer.

Injuries may occur in the rutting battles that may cause death. A mature bull was killed during a rutting battle in the fall of 1955. In 1956 a bull that had been defeated in a rutting battle was found dead two months later, one mile from the scene of the conflict. Decomposition did not allow for conclusive evidence to the cause of death.

Copulation was observed on one occasion. During the rutting season of 1957 the harem bull was observed in a typical courtship display with a mature cow. This consists of the bull following the cow at a brisk pace, a grimace similar to that seen in domestic cattle on his face. He followed the cow approximately two hours,

occasionally stopping to bugle, urinate, or rattle his antlers on low hanging limbs of trees. Finally, for no apparent reason, the cow stopped and the bull mounted her. This he repeated once more.

Late in the rut of 1957 unusual activity was noted at Prairie Creek. For two days in early October the rut had apparently ended. Bulls of all ages were among the cow group. The harem bull was not disturbed by their presence. Three days later the harem bull had ejected all other bulls and was bugling. No explanation for this behavior can be given.

Immediately after the rut the older, mature males leave the vicinity of the cow group. They become solitary once more and are difficult to observe. Bulls that are not resident to the study area disappear.

Yearling males in the study area are confused by the rutting behavior of the harem bull. Early in the rut they are continually driven from the cow group. As the rutting season nears an end they are admitted back into their family group. No behavior related to sexual interest in females by yearlings was observed during the rut, although such was reported by Graf (1955) and Murie (1951).

During the rut no obvious change in cow behavior

is apparent. The cow remains with her family group. Her mobility may be decreased by the tendency of the harem bull to attempt to keep his harem intact. Some anxiety on the cow's part was noted when yearling males were ejected from the harem. Females of less than two years of age were not observed to take part in the rut although such observations have been reported by others (Buechner and Swanson, 1955).

Vegetation and the elk

The behavior of elk is strongly influenced by the nature and condition of the vegetative cover. Preference is shown by the elk for specific cover types for feeding and shelter. The inter-relationships between elk and vegetation have not been a major part of this study. Results reported here are based on data obtained incidentally during the course of the study.

Vegetation as food: Data on the food habits of elk in and around the study area have been obtained by three methods: (1) direct observation, (2) indirect observation, (3) stomach content analysis.

Direct observation was found useful when the elk were feeding on larger plants. Little data can be gathered by this method when the animals are feeding on small herbaceous plants.

Indirect observations were made by walking well-

used trails, and by determining use through the line-point plot method. This method proved to be of some value where the area is utilized mainly by elk. However, where elk and other herbivorous mammals occur together this method is of little value.

An analysis of stomach contents yielded information of the frequency of plants taken (table 8a). Stomach samples were obtained from animals killed during the annual herd reductions and elk that had succumbed to other causes.

The more important browse plants found in and around the study area are listed in table 8b. Other species were found to be utilized but not to the extent of those listed.

Grasses, forbs and specific ferns constitute the main portion of the elk's diet when they are available. This can readily be seen by visiting areas where these plants form the main cover type. Grasslands will show signs of heavy use, while adjacent areas containing many shrubs and trees will show moderate to light use. Analysis of stomach samples collected in spring and summer confirm this (table 8c). A list of important grasses, herbs, and ferns utilized by elk appear in table 8d.

Table 8a

Analyses of elk stomach samples collected* in and
around the Prairie Creek Study Area

<u>Species</u>	<u>% of Frequency</u>	<u>% of Total Volume</u>
Grasses	100	89
<u>Lolium perenne</u>	78	Trace
<u>Anthoxanthum</u> <u>odoratum</u>	72	Trace
<u>Festuca</u> sp.	39	Trace
<u>Bromus</u> sp.	33	Trace
<u>Poa</u> sp.	33	Trace
Sedges		
<u>Carex</u> spp.	17	Trace
Ferns		
<u>Polystichum munitum</u>	61	5.5
Unident. fern	22	.2
Forbs		
Unident. forbs	78	3.7
<u>Ranunculus repens</u>	61	.5
<u>Trifolium</u> sp.	56	Trace
<u>Plantago</u> spp.	39	Trace
<u>Hypochoeris radicata</u>	22	.2
Trees and Shrubs		
<u>Rubus spectabilis</u>	44	.5
<u>Sequoia sempervirens</u>	28	Trace
<u>Rubus parviflorus</u>	17	.4

Spring, winter and summer only.

Table 8b

Important browse plants found in and around the
Prairie Creek Study Area

<u>Species</u>	<u>Season of Use</u>	<u>Abundance</u>	<u>Remarks</u>
<u>Baccharis pilularis</u>	F,W.	Abundant	Coastal area and Maple Cr.
<u>Ceanothus thyrsiflorus</u>	F,W.	Abundant	Coastal areas and logged- over lands.
<u>Gaultheria shallon</u>	All.	Abundant	Wide spread.
<u>Rhamnus purshiana</u>	F,W.	Abundant	Young plants.
<u>Rubus leucodermis</u>	All.	Abundant	Logged-over areas.
R. <u>parviflorus</u>	All.	Abundant	Along streams.
R. <u>spectabilis</u>	All.	Abundant	Along streams.
R. <u>thyrsoanthus</u>	W,S.	Abundant	Openings and logged-over areas.
<u>Vaccinium parviflorum</u>	All.	Abundant	Heavily used.
<u>Whipplea modesta</u>	Su, W, S.	Abundant	Dry ridges and logged- over areas.

S, Spring; Su, Summer; F, Fall; W, Winter.

Table 8c

*
Plants identified from elk stomach samples from the

Prairie Creek Study Area

<u>Plant</u>	<u>Common name</u>
Ferns	
<u>Lomaria spicant</u>	Deer fern
<u>Polystichum munitum</u>	Sword fern
Grasses	
<u>Aira caryophyllea</u>	Silver hair grass
<u>Anthoxanthum odoratum</u>	Sweet vernal grass
<u>Bromus sp.</u>	Brome
<u>Danthonia californica</u>	Calif. oat grass
<u>Festuca sp.</u>	Fescue
<u>Holcus lanatus</u>	Velvet grass
<u>Lolium perenne</u>	Perennial rye grass
<u>Poa sp.</u>	Blue grass
Sedges and rushes	
<u>Carex sp.</u>	
<u>Eleocharis sp.</u>	
<u>Juncus sp.</u>	
Trees and shrubs	
<u>Pseudotsuga taxifolia</u>	Douglas fir
<u>Rubus parviflorus</u>	Thimble berry
<u>R. spectabilis</u>	Salmon berry
<u>Sequoia sempervirens</u>	Redwood
Forbs	
<u>Calandrinia sp.</u>	
<u>Geranium dissectum</u>	
<u>Hypochoeris radicata</u>	Hairy cat's ear
<u>Montia perfoliata</u>	Miner's lettuce
<u>Plantago sp.</u>	Plantain
<u>Polygonum sp.</u>	
<u>Potentilla sp.</u>	
<u>Ranunculus repens</u>	Creeping crow's foot
<u>Trifolium sp.</u>	Clover

* Identified from stomach samples without reference to volume or frequency.

Table 8d

Grasses, ferns and forbs heavily used by elk
in and around the Prairie Creek Study Area

<u>Species</u>	<u>Season of Use</u>	<u>Abundance</u>
Ferns		
<u>Lomaria spicant</u>	All.	Abundant
<u>Polystichum munitum</u>	All.	Abundant
<u>Pteris aquilina</u>	F,W.	Abundant
Grasses		
<u>Anthoxanthum odoratum</u>	S, Su, F.	Abundant
<u>Dactylis glomerata</u>	S, Su.	Not abundant
<u>Deschampsia caespitosa</u>	S, Su.	Not abundant
<u>Lolium perenne</u>	S, Su.	Abundant
<u>Poa spp.</u>	S, Su.	Abundant
Rushes and sedges		
<u>Carex obnupta</u>	F, W.	Abundant
<u>Carex sp.</u>	S, W.	Abundant
Forbs		
<u>Bellis perennis</u>	S, Su.	Abundant
<u>Lysichiton</u> <u>kamtschaticense</u>	F.	Abundant
<u>Stachys chamissonis</u>	W, S.	Abundant
<u>Ranunculus repens</u>	S, Su, F.	Abundant
<u>Trifolium pratense</u>	S, Su.	Not abundant

S-spring. Su,-summer. F-fall. W-winter.

All stomach samples, with the exception of one, were collected during spring and summer months. The single sample collected during the winter contained a high percentage of sword fern (73%).

Although a great variety of plants is available throughout the study area, elk use of these plants is not equally distributed. Areas east of the main study area support good stands of blue blossom and whipplea. These areas show little elk use, although deer use is quite heavy. Forested areas containing a carpet of sword fern and deer fern are little used except along well-used elk trails. Reasons for the lack of elk use of these areas are not known.

Vegetation as cover: Bedding: Vegetation is important to the elk for reasons other than feeding. Elk regularly make use of specific vegetation types for evening bedding. Hardwood stands along creeks were found to be preferred as bedding areas. Day bedding areas are not selected for any specific vegetation type. Elk were observed bedding down during the day in all types of cover.

Escape: Escape cover is of great importance to the elk. In times of disturbance elk will not necessarily move into heavily forested areas. Flight seems to be the primary reaction. However, if dense brush or forest is

is nearby it will be utilized.

The elk, unlike the deer, does not show preference for particular cover areas. When disturbed, the nearest area that provides cover is used.

Calving: Elk on the study area showed no preference for specific cover types during the calving period. Calves were dropped at the location where the cow happened to be when "labor" began. The highest number of calves born at Prairie Creek during 1957 was born on the grassland. However, when a calf had sufficient strength to follow his mother, he was led to areas providing better cover. Calves were observed being moved into hardwood stands during the calving season of 1957, as early as their third day of life. Calves were also noted in thick stands of fern.

INTERSPECIFIC RELATIONSHIPS

Relations of elk to other herbivorous mammals

Among the herbivorous mammals in the study area the elk is probably the most abundant, with the possible exception of the black-tailed deer. If we consider animal units, the elk is the dominant species.

Its effect on the environment is of major importance.

Interactions between elk and other herbivores is not obvious. Elk and deer come into contact during feeding activities with no obvious behavior change on the part of either. Deer are more easily disturbed than the elk. Disturbances that will effect the deer cause little or no reaction among the elk. Forage competition between elk and deer exists, but its importance in this area is not known.

Domestic cattle utilize some of the open areas that are used by elk. There seems to be intense competition for the grasses in some areas between the two species. Often both species will occupy the same feeding area in close contact. Mutual tolerance was usual. On several occasions a dairy cow wandered into the Prairie Creek area. She traveled with the bull group for a few days. Bulls were observed trying to copulate with her, but they were unsuccessful. Murie (1951) recorded similar incidences of this type of behavior.

Relationship of elk to carnivorous mammals: The list of possible mammalian predators in the study area includes the black bear, mountain lion, bobcat, and domestic dog. The black bear are numerous in Humboldt County. Mountain lions are reported from this region. One was observed at Prairie Creek in early 1956 by park personnel. Bobcats are numerous throughout the study area. Domestic dogs are found on areas adjacent to the study area.

Bear have been reported to prey upon elk calves (Schwartz, 1943; Murie, 1951). During the years of the study there was much evidence that bear frequent the area. During the calving season of 1957 a large black bear was observed harassing the cow group. The elk were chased from their bedding place on Boyes Creek. No evidence of bear predation was found on the study area. However, bear scats containing elk hair were collected adjacent to the study area. This could be due to the bear's habit of consuming carrion.

Mountain lions are not abundant in this area.

They are hunted and harassed by local sheep and cattlemen. No mountain lions were observed by the writer during the years of the study, but there were reports of lions in the area east of the study area. Lion tracks were observed on Brown Creek, and the carcass of a female deer was found covered with debris in a typical lion fashion. It is doubtful if the mountain lion is an important decimating factor on the local elk population.

Dogs have been known to kill elk (Murie, 1951). Most residents in the area have one or more dogs, some of which are allowed to run free. Occasionally a dog will harass the elk, but soon the dog will tire of this. A lone dog is no match for a mature elk. A dog was killed by a large bull in the Wolf Creek area in 1957. Dogs probably do not affect the elk population in this area.

Predators do not seem to be a limiting factor on the study area. No evidence of elk predation was found during the study.

Relations of elk to birds: One bird species was known to feed on elk carcasses - the raven. A number of carcasses was found that were fed upon by this bird. A raven was observed during the calving season of 1957 feeding upon a three-day-old male calf carcass. The day

before the calf had been alive. However, it had been born with a deformed foreleg and was in a weakened condition when observed. It probably died from starvation as it could not stand to nurse. It is a remote possibility that this calf was killed by the ravens of this area.

A close relationship was noted between elk and some birds. The barn swallow which nests in the study area, was observed feeding on insects that were disturbed by the movements of the elk. Swallows were also observed gathering mud at an old elk wallow.

Cowbirds and red-winged blackbirds were observed perching on the backs of elk where they seemed to be feeding upon ticks. The greatest number of observations of birds on elk occur in the period from May through September.

An unidentified bird's nest was found that was made up primarily of elk hair.

Evaluation of Inter-relationships

There is a lack of close inter-specific relationship between elk and birds or mammals, such as was described by Linsdale and Tomich (1953) for the deer. Black bear, mountain lion and bobcat are all present on the study area, but there is little evidence that they are actively preying on the elk.

Relations with herbivores competing for feed may be important. Cattle may utilize areas that are best suited for elk. In the Gold Bluff area overgrazing by both cattle and elk is evident. However, over most of the study area the grazing of other herbivores is small when compared with those exercised by the elk population.

Relationship with man

As stated earlier, the elk in this area are subject to disturbance by man. Fences built by man may inhibit elk movement. Poachers and irate landowners kill elk. Man has logged and burned elk habitat and turned his cattle to graze lands that were once primarily elk range. The elk have benefited from some of this disturbance. Old growth timber stands are inhabited by few elk. Logged-over areas have offered the elk a greater food supply. Man-caused fires may have created more favorable elk habitat.

Many people visit the study area every year. Prairie Creek Redwoods State Park attracts many tourists from June through September. During this period the elk are approached by countless photographers. Areas that are normally used by elk are taken over by human inhabitants. The elk's movements are restricted by these disturbances.

Areas outside the state park are frequently visited

by timber operators. Logging activities may disrupt elk activities for a short time.

From October to May human disturbances are less frequent. Movements and activities of the elk are not subject to as much interference as the summer and fall months, however, poachers are active during the winter months in isolated areas.

Reactions of elk to human disturbance: Elk readily become accustomed to the presence of people. During the study people were observed within a few hundred feet of elk groups. Little or no behavior modifications were observed. Elk were observed feeding near buildings on numerous occasions. On two occasions groups entered the writer's yard during feeding activities. During the annual herd reduction of 1956 firearm reports and the sight of fallen animals among the group caused little change in the behavior of either cows or bulls.

Crop destruction by elk: Elk are destructive to crops. Hinkley (1937) and McLean (1929) have reported crop depredation by Roosevelt elk. Local farmers have filed complaints with the California Department of Fish and Game, that elk eat much of their pasturage. Residents of the Wolf Creek area have complained of elk destroying gardens, and local timber interests have requested a hunt of local elk because of seedling damage.

SUGGESTIONS FOR ELK MANAGEMENT

This study was undertaken to determine certain ecological facts about elk. Some of the findings have application to elk management. This information is here reviewed.

Proper utilization of elk

Elk are more numerous in Humboldt and Del Norte counties than was formerly believed. Many areas have signs of elk use. Some areas are badly overstocked with elk and livestock.

Hunting of elk has been illegal in California since 1854 (Annon., 1928). Most elk live out their lives on a small area. Poachers utilize a few elk but not from all areas. It is this writer's opinion that areas outside the state park lands can support a limited yearly harvest of elk. This would alleviate the overstocked condition on some ranges and pacify land owners that complain about crop depredations. Elk hunts would have to be under strict supervision by the California Department of Fish and Game.

Preservation of elk range

Little has been done in the past to investigate the condition of elk range. Many areas show signs of extreme overuse. Intense range survey methods should be used to decide what improvements should be made to present elk

habitat. In the past heavy die-offs have occurred as a result of range depletion. It is this writer's opinion that further die-offs will occur unless steps are taken to improve the range on the study area.

Management of the Prairie Creek herd

In the past the only management practice utilized on the Prairie Creek herd has been herd reduction. Little was known about movements of the elk, range condition, and productivity. This study has covered some of these problems. However, more information is necessary before a sound management program can be instituted. This writer believes the following suggestions should be carried out as steps toward achieving better elk management:

1. Tagging of the elk that constitute the Prairie Creek herd in order to more precisely determine movements of individuals.
2. Permanent plots installed on the area to determine range trends.
3. An intensive study of elk feeding habits to better determine the plant types preferred by the local herd.
4. Herd reduction should be continued. The area shows signs of overuse and some of the animals are still in poor condition.

A committee has been formed to recommend management practices that will insure the perpetuation of the Prairie

Creek elk herd. The California Division of Beaches and Parks, California Department of Fish and Game, and Humboldt State College will all take part in future herd management.

SUMMARY

The ecology, social behavior, distribution and abundance of the Roosevelt elk was investigated in Humboldt and Del Norte counties, California during the years 1956 through 1958. The main study area is located north of Orick in old growth timber, logged-over areas, shrub areas, and small grassy areas.

The Roosevelt elk originally ranged in California from the San Francisco bay region northward in large numbers. The species is now found in Humboldt, Del Norte, Trinity and Siskiyou counties. The bulk of the Roosevelt elk now occupy two main areas; the Big Lagoon-Maple Creek area and the Prairie Creek-Gold Bluffs area.

The population density of elk was found to range between 24 and 32 elk per square mile at the Prairie Creek study area. A partial census of surrounding areas indicated elk to be wide spread. Three hundred and ninety-four elk were observed between Redwood Creek and the Klamath River. The investigator believes the total Roosevelt elk population in California to number over 1000 animals.

In 1957, 41 carcasses were discovered. Poaching is the major factor in elk mortality. Calves were the most severely affected of all age classes when total mortality is considered. Natality was high in 1957 with 0.93

calves per cow produced on the Prairie Creek study area. Eight of the calves succumbed to unknown causes.

The elk in the study area form groups. Three distinct group types were noted; the family group of a cow, and her offspring; the cow group, which consists of a number of family groups; and the bull group, which consists mainly of bulls of the two-year-old class and older. Old males are less gregarious than other age classes.

The elk are non-migratory and occupy relatively small areas throughout the year. Males utilize a larger area for their activities than cow groups. The movements of the groups are somewhat geared to the abundance of food. The rutting season causes a change in group movement patterns when cow group movements are somewhat limited by the harem bull. Mature bulls searching for cows may move over two miles in one day. Groups may move out of their normal activity range during times of food shortage. The elk at Prairie Creek were not observed to move into adjacent agricultural lands.

Elk not resident to an area are not rejected by resident elk. Evidence shows there is some exchange between adjacent groups.

Aggressive behavior was noted in both bull and cow

groups. Cow groups have a "leader" and possibly a "second-in-command." Bull groups show less organization in time of disturbance than cow groups.

Grasses, forbs, and ferns are the most important forage plants for elk. Shrubs are utilized during the fall and winter in certain areas. Certain cover types are preferred by elk as "bedding-areas." No preference for protective cover was noted in calving-areas.

Elk have little if any relationship with most native animals. Predation is not an important factor in elk mortality. Man and his domestic animals compete with elk for habitat. Logging practices may improve elk habitat.

Management of elk in this area should include further investigations on habitat improvement and population dynamics. Hunting may be possible on a limited basis.

With the Roosevelt elk now limited in California to a small portion of its former range, management practices should be instituted that will insure a healthy population of elk for future generations. Any practices that might be detrimental to the elk in this area should be thoroughly investigated.

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APPENDIX

Table I

A partial list of flowering plants occurring in and around the Prairie Creek Study Area

Grasses

- | | |
|----------------------------------|----------------------------|
| 1. <u>Aira caryophyllea</u> | 7. <u>Festuca megalura</u> |
| 2. <u>Anthoxanthum odoratum</u> | 8. <u>Holcus lanatus</u> |
| 3. <u>Bromus sp.</u> | 9. <u>Lolium perenne</u> |
| 4. <u>Dactylis glomerata</u> | 10. <u>Poa annua</u> |
| 5. <u>Danthonia californica</u> | 11. <u>P. pratensis</u> |
| 6. <u>Deschampsia caespitosa</u> | |

Ferns

- | | |
|----------------------------------|-------------------------------|
| 1. <u>Adiantum pedatum</u> | 4. <u>Polypodium scoleri</u> |
| 2. <u>Athyrium filix-foemina</u> | 5. <u>Polystichum munitum</u> |
| 3. <u>Lomaria spicant</u> | 6. <u>Pteris aquilina</u> |

Sedges and rushes

- | | |
|--------------------------|-----------------------------|
| 1. <u>Carex obnupta</u> | 4. <u>Juncus lescurii</u> |
| 2. <u>Carex sp.</u> | 5. <u>Luzula campestris</u> |
| 3. <u>Eleocharis sp.</u> | |

Shrubs and trees

- | | |
|------------------------------------|--------------------------------------|
| 1. <u>Abies grandis</u> | 14. <u>Rhododendron californicum</u> |
| 2. <u>Acer circinatum</u> | 15. <u>R. occidentale</u> |
| 3. <u>A. macrophyllum</u> | 16. <u>Ribes sanguineum</u> |
| 4. <u>Alnus rubra</u> | 17. <u>Rubus laciniatus</u> |
| 5. <u>Baccharis pilularis</u> | 18. <u>R. leucodermis</u> |
| 6. <u>Ceanothus thyrsiflorus</u> | 19. <u>R. parviflorus</u> |
| 7. <u>Chamaecyparis lawsoniana</u> | 20. <u>R. spectabilis</u> |
| 8. <u>Corylus rostrata</u> | 21. <u>R. thyrsanthus</u> |
| 9. <u>Gaultheria shallon</u> | 22. <u>Sequoia sempervirens</u> |
| 10. <u>Myrica californica</u> | 23. <u>Tsuga heterophylla</u> |
| 11. <u>Picea sitchensis</u> | 24. <u>Umbellularia californica</u> |
| 12. <u>Pseudotsuga taxifolia</u> | 25. <u>Vaccinium ovatum</u> |
| 13. <u>Rhamnus purshiana</u> | 26. <u>V. parvifolium</u> |
| | 27. <u>Whipplea modesta</u> |

Forbs

- | | |
|----------------------------------|---------------------------------|
| 1. <u>Asarum caudatum</u> | 6. <u>Crepis capillaris</u> |
| 2. <u>Bellis perennis</u> | 7. <u>Dentaria integrifolia</u> |
| 3. <u>Brunella vulgaris</u> | 8. <u>Galium sp.</u> |
| 4. <u>Calandrinia caulescens</u> | 9. <u>Hypochoeris radicata</u> |
| 5. <u>Cirsium arvense</u> | 10. <u>Iris douglasiana</u> |

Forbs (continued).

- | | |
|---------------------------------------|--------------------------------|
| 11. <u>Lysichiton kamtschaticense</u> | 20. <u>Rumex acetosella</u> |
| 12. <u>Mimulus guttatus</u> | 21. <u>Stachys chamissonis</u> |
| 13. <u>Oenanthe sarmentosa</u> | 22. <u>Taraxacum vulgare</u> |
| 14. <u>Orthocarpus pusillus</u> | 23. <u>Trifolium pratense</u> |
| 15. <u>Plantago lanceolata</u> | 24. <u>Urtica californica</u> |
| 16. <u>P. major</u> | 25. <u>Veronica americana</u> |
| 17. <u>Polygonum persicaria</u> | 26. <u>Viola glabella</u> |
| 18. <u>Potentilla anserina</u> | 27. <u>V. sarmentosa</u> |
| 19. <u>Ranunculus repens</u> | |

Table II

Results of sixteen line-point plots run on Boyes Prairie, Prairie
Creek Study Area, Winter 1956-'57.

Cover Type	No. of Plots	Total No. of Occurrences	% Frequency	% Cover
Litter	16	1077	100	67.3
<u>Ranunculus repens</u>	16	706	100	44.0
<u>Carex obnupta</u>	10	624	63.0	39.0
<u>Dactylis glomerata</u>	12	323	75.0	20.2
<u>Anthoxanthum</u> <u>odoratum</u>	8	267	50.0	16.6
<u>Juncus lescurii</u>	11	220	69.0	13.7
<u>Holcus lanatus</u>	9	219	56.0	13.1
<u>Trifolium</u> sp.	11	145	69.0	9.6
<u>Plantago lanceolata</u>	10	130	63.0	8.1
<u>Oenanthe sarmentosa</u>	4	98	25.0	6.1
<u>Hypochoeris radicata</u>	6	97	38.0	6.0
<u>Crepis capillaris</u>	8	62	50.0	3.8
<u>Aira</u> spp.	5	52	31.0	3.3
<u>Bellis perennis</u>	8	38	50.0	2.4
<u>Pteris aquilina</u>	2	22	12.0	1.4
<u>Cirsium arvense</u>	4	19	25.0	1.2
<u>Rumex acetosella</u>	3	12	18.7	.75
<u>Iris douglasiana</u>	1	12	6.2	.75
Bare ground	4	10	25.0	.63
<u>Brunella vulgaris</u>	4	10	25.0	.63
<u>Rubus parviflorus</u>	1	10	6.2	.63
<u>Taraxacum vulgare</u>	2	9	12.0	.56
<u>Veronica americana</u>	2	8	12.0	.50
<u>Polystichum munitum</u>	1	4	6.2	.25
<u>Juncus</u> sp.	1	2	6.2	.12
<u>Galium</u> sp.	1	1	6.2	.06
<u>Plantago major</u>	1	1	6.2	.06

Table III

Measurements of Roosevelt elk collected at
the Prairie Creek Study Area

Adult Females (inches)	Total Length	Girth	Ear Length	Hind Foot	Tail
	81	58	8.00	27	5.00
	82	58	8.25	25	4.75
	86	63	8.75	25	3.75
	88	59	8.50	26	4.50
	88	58	8.50	26	4.50
	91	62	8.75	27	6.50
	92	60	8.25	27	5.50
Average	87	60	8.47	26	4.93
<hr/>					
Immature* Females	73	49	8.25	25	3.75
	74	51	8.50	24	4.50
	75	51	7.75	25	5.00
Average	74	50	8.17	25	4.42
<hr/>					
Mature Males	81	55	7.75	26	4.25
	84	56	8.00	27	4.50
	87	54	8.00	26	4.50
	90	59	8.25	28	4.25
	94	65	8.25	28	5.00
	97	65	8.50	29	4.75
Average	92	59	8.12	27	4.54
<hr/>					
Immature* Male	67	45	6.75	25	3.50

* Two-years-old or younger.

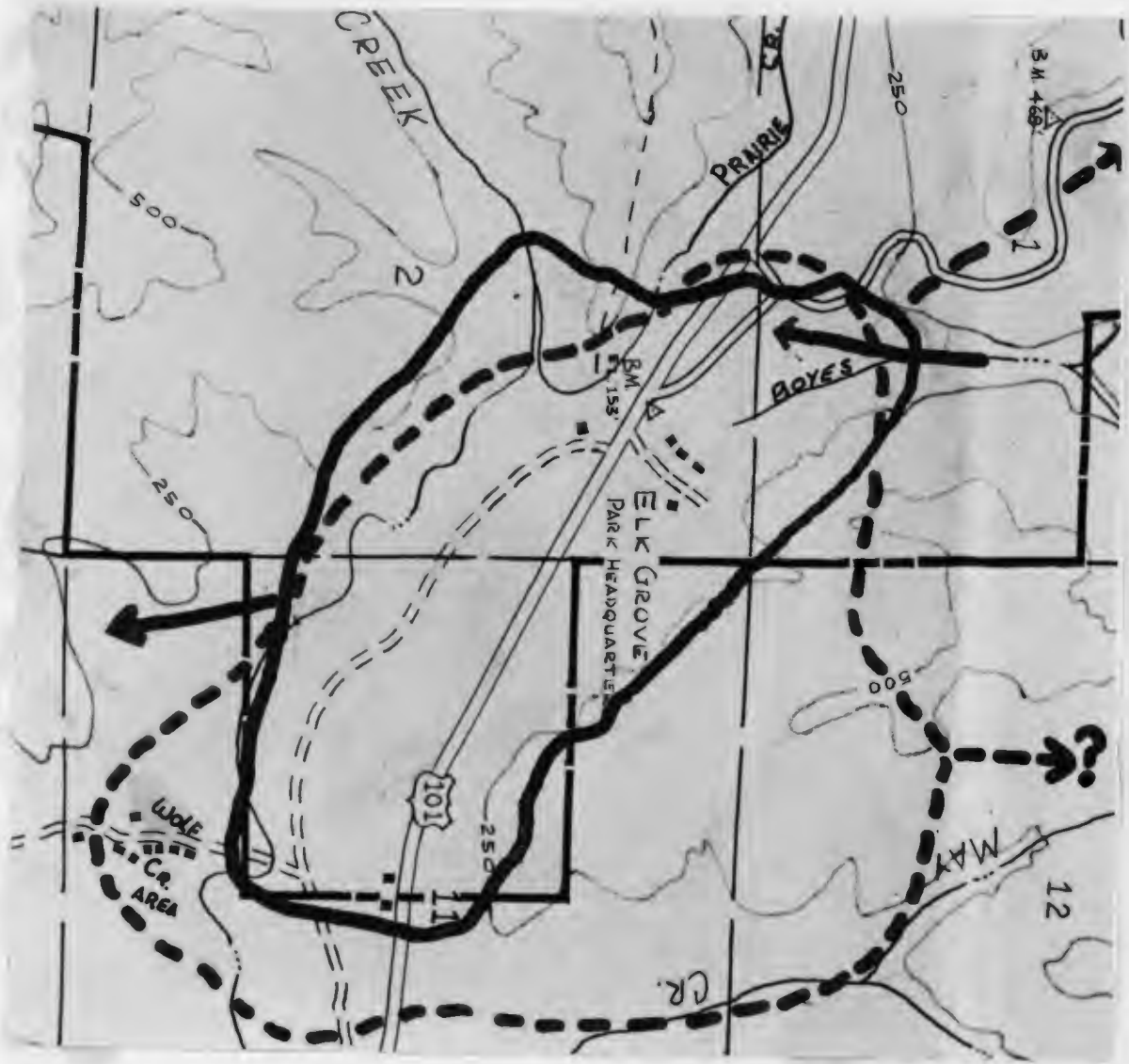


FIG. G. Activity range of the Prairie Creek elk herd. Solid line-cow group. Broken line-bull group. Arrows-movements into and out of the study area by residents and non-residents.

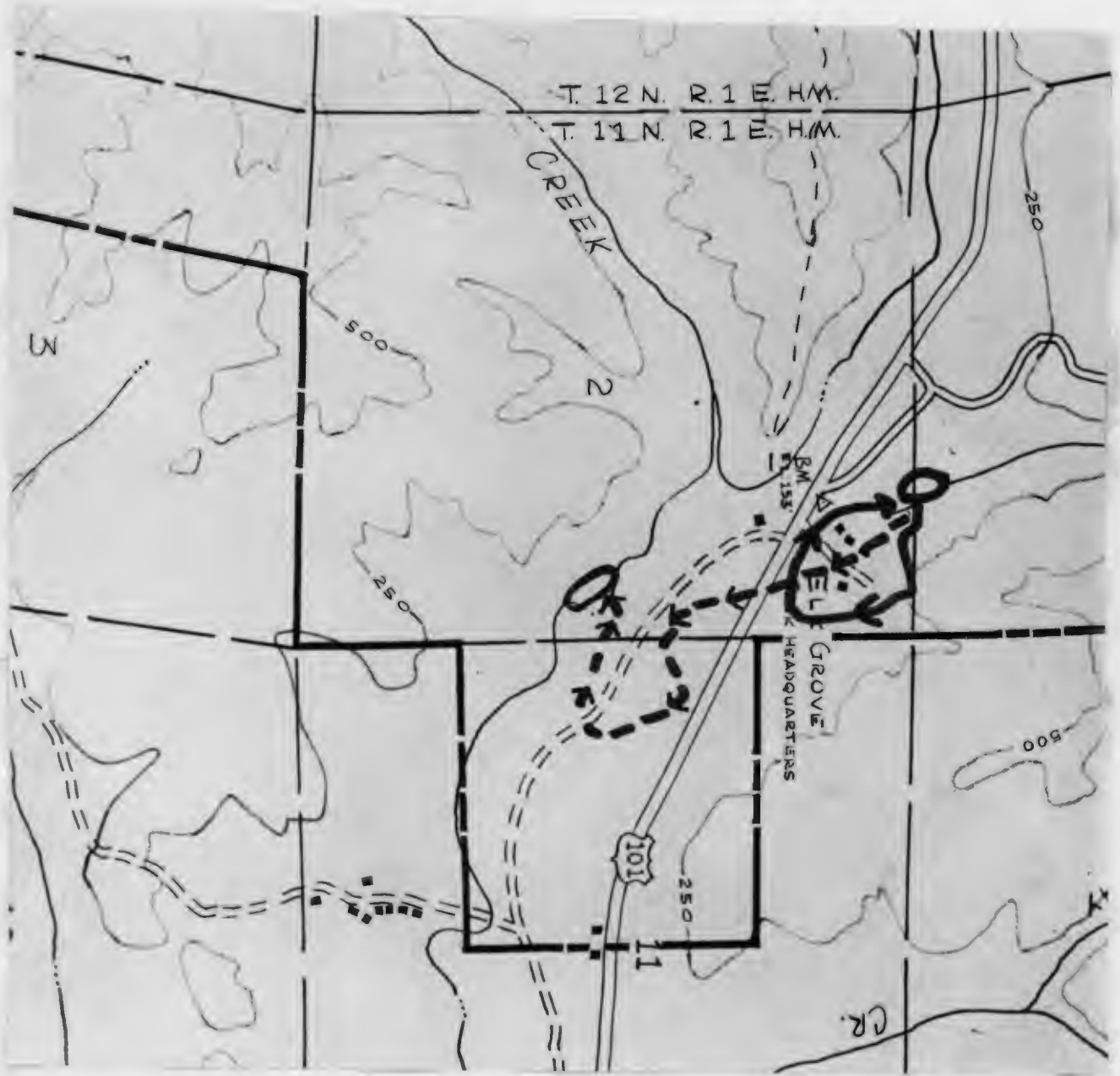


Fig. H. Typical daily movements of the cow group. Black line-Spring and Summer. Broken line-Winter.