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AN ECOLOGICAL STUDY OF THE COLUMBIAN BLACK-TAILED DEER IN A LOGGED ENVIRONMENT

by

DALE RICHARD McCULLOUGH

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APPROVED:

Jay B. Long

Associate Professor of Fish and Game Management

In Charge of Major

V. E. Dimick

Head of Department of Fish and Game Management

[signature]

Chairman of School Graduate Committee

H. P. Hansen

Dean of Graduate School

Date thesis is presented 4/11/60

Typed by Karen McCullough

ABSTRACT

A study of the effects of old-growth Douglas-fir logging upon the Columbian black-tailed deer *Odocoileus hemionus columbianus* (Richardson) was conducted from January 8 to December 30, 1958 in the H. J. Andrews Experimental Forest near Blue River, Oregon. Objectives of the study were to obtain information about the activities, behavior, movements, migrations, and general ecology of the black-tailed deer in a logged environment.

The night spotlight sampling method was used to study the deer while they occupied the summer range (the Andrews Forest) from April through September. The entire road system of the area was sampled twice weekly, and deer present were sighted by eye reflection of the spotlight beam. With the aid of binoculars, an attempt was made to classify deer sighted according to age, sex, activity and location. Sampling was begun one to two hours after darkness, and the sample was usually completed in three to four hours. Using procedures similar to the spotlight method, daylight samples were taken during June and July on the same dates as the spotlight samples. Daylight sampling was begun shortly after daylight and required three to four hours to complete. In the wintering grounds at lower elevations to which the deer migrate in September these sampling methods proved unsuccessful. Therefore, a foot travel method was employed for this segment of the study, and much greater emphasis was placed upon the interpretation of sign.

Pre-logging records indicated that few deer used the area prior to initial logging in 1950. Deer numbers increased, however, in the excellent browse conditions of brushy successional stages of vegetation following the removal of the virgin timber. The creation of edge habitat by the staggered-setting, clear-cut unit method of logging further benefited the deer population.

A sex ratio of 1 buck per 3.24 does and an age ratio of 4.19 adults per yearling were derived from the spotlight data. Fawning occurred mainly during June, and a ratio of 1.4 to 1.5 fawns per doe was approximated from the spotlight and daylight samples. Single deer or

groups of two were encountered most frequently during the summer months, while groups numbering three or more predominated during periods of migration and during the winter months. The overall effect of predators on the herd appeared to be relatively unimportant.

Weather conditions, especially temperature, appeared to affect the daily activities of deer. Night spotlight samples taken following days of high temperature averaged higher in deer sightings than samples following days of low temperature. This was the result of more deer being active (as opposed to bedded) on nights following days of high temperature. Wide variations in day to day temperatures resulted in similarly wide variations in the number of deer sighted by the spotlight sampling method. Deer were distributed nearly evenly between north and south slopes until June when a movement to the north slope occurred. This aspect was slightly favored by deer through the remainder of the summer. On the north slope, units below 2,500 feet in elevation were preferred, although deer showed a tendency to move upward during mid-summer. In August this trend was reversed when a sharp downward movement occurred. On the south slope, elevational preference was evident only during August, when 83 percent of the deer were sighted above 2,250 feet.

The spring migration into the Andrews Forest occurred as a gradual upward drift in March, and by early May most of the population had arrived. Many deer were found to return to their home ranges of the previous summer. The downward fall migration followed two main routes, and was unusual in that it occurred during September, long before the advent of inclement weather. Both migrations were correlated with temperature changes. Bottom lands and sites of old logging operations or burns on exposed south slopes were utilized by deer as wintering grounds.

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Professor Jay Long, Dr. H.J. Rayner, Professor Charles Warren, Mr. Jack Rothacher, Mr. Arthur S. Einarsen, and Mr. William Lightfoot critically reviewed the manuscript.

To my wife, Karen, who encouraged, advised, reviewed, brewed coffee, and typed, may I say that I'm going to have the last word. Thanks.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

AN ECOLOGICAL STUDY OF THE COLUMBIAN BLACK-TAILED DEER IN A LOGGED ENVIRONMENT

INTRODUCTION

A study of the Columbian black-tailed deer, *Odocoileus hemionus columbianus* (Richardson), inhabiting the logged environment of the H.J. Andrews Experimental Forest in the west-central Oregon Cascades was conducted from January 8 to December 30, 1958. The study was a part of a long term project to determine the effects of clear-cut, staggered-setting logging of old-growth Douglas-fir upon wildlife.

The black-tailed deer, native to the Douglas-fir region of the west coast, has for centuries subsisted in clearings and along forest edges where low shrubs furnish adequate browse. Under the vast stands of mature timber, the understory was sparse in the constant shade of the closed canopy. Only low densities of deer could survive on the meager forage found under the virgin timber. However, when some agent resulted in the removal of forest competition, communities of low-growing herbs and shrubs dominated the early successional stages of vegetation. It was in these areas of optimal browse conditions that the black-tailed deer thrived.

In primitive times, fire was probably the most important agent causing destruction of Douglas-fir timber; hence, it was the most important factor in the creation of habitat suitable for deer occupation. At the present time, however, great effort is exerted toward the prevention and control of forest fires. Consequently, under normal conditions, commercial logging has replaced fire as the major factor in the creation of favorable conditions for deer use.

Within recent years, the United States Forest Service has inaugurated a timber management plan to log old-growth Douglas-fir stands on a sustained yield basis. Since the program involves vast holdings of land, a considerable amount of deer habitat will be created in the process. Deer herds will become established where they did not before exist, and sizable populations are expected to develop.

The need for judicious management of this big-game resource to prevent conflicts with other land uses and to maintain healthy, vigorous herds will be acute. Before wise management can be applied, information concerning the black-tailed deer, its behavior, and its requirements in the new environment must be acquired.

In 1950 when the U.S. Forest Service established the H.J. Andrews Experimental Forest in the central Cascades, the Oregon Cooperative Wildlife Research Unit* under the

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*Oregon State Game Commission, U.S. Fish and Wildlife Service, Wildlife Management Institute, Agricultural Research Foundation, and Oregon State College, cooperating.

leadership of Arthur S. Einarsen, Biologist, U.S. Fish and Wildlife Service, arranged to conduct investigations of the logging practices and their effects upon fish and wildlife. The prime purpose of the research program was to produce basic information upon which sound fish and wildlife management practices could be established.

An important contribution to the study of black-tailed deer in the Andrews Forest was made by Healy (2), who studied deer behavior and nutritional properties of important browse species using crude protein as an index.

The present study was designed to obtain information on the life history and ecology of the black-tailed deer in the logged environment. The field work began in January 1958, and ran through December of the same year. Additional observations were made during the spring of 1959.

METHODS

The Andrews Forest herd occupied the Experimental Forest during the summer, and migrated in the fall to the lower elevation wintering range. Sampling methods which gave good results on the summer range were impractical on the wintering grounds, and it was necessary to substitute an alternate method.

On the summer range, sampling at night with a spotlight gave satisfactory results. The spotlight sampling technique as described by Dealy (2, p. 25) was modified to suit the conditions of the present study. The method involved driving slowly over the road system of the area while covering the ground area at the side of the road with a spotlight beam. Any deer present were sighted when the light struck their eyes and was reflected back to the observer. The reflected light was quite brilliant, and could be seen at a considerable distance with little difficulty. However, the body form could be made out only on deer relatively close to the road. When possible, the deer were classified with the aid of binoculars as to age, sex, activity, and location. These and other pertinent data were recorded on mimeographed forms. The six-volt Unity 4535 hand spotlight rated at approximately 100,000 candlepower, recommended by Dealy (2, p. 26), was employed and proved to be quite satisfactory.

The sampling method was well suited to the area because of the network of all-weather roads running through the relatively small logged units. Distances from the edges of the units to the road were short enough so that the entire logged areas were usually within range of the spotlight beam, and could be plainly viewed from the vehicle. Since logging of the units was recent, the secondary successional stages of vegetation had not reached a height that seriously interfered with the spotlight beam.

The major drawback of the method was its ineffectiveness in the timbered areas, and consequently, only the logged units were covered. Any deer in the timber at the time of the spotlighting were undetected. Other disadvantages of the spotlight method were interference in some places with the beam by development of vegetation, and interference by adverse weather conditions such as fog, snow, or heavy rain. Another undesirable factor was the conditioning of the deer to repeated spotlighting. Eventually the deer's interest in the sweeping light waned, and they would not look toward the light. However, a deer's eyes will cause a dim reflection even though its head is held at a considerable angle to the light beam. Special vigilance was exerted to detect such reflections.

Spotlight samples of the Andrews Forest were taken twice weekly from the beginning of April until the end of September. This period covered the time from when the deer moved into the area in April until the occurrence of the fall migration in early September. For the months of April through July the spotlight samples were taken on Tuesday and Thursday nights. Sampling was begun generally one to two hours after darkness. The schedule was changed to Tuesday and Friday nights during August and September in order to facilitate other project work. If adverse weather, such as heavy fog, rain, or snow drastically reduced the penetration of the spotlight beam on the night scheduled, the sample was postponed until the following night. Time required to complete the sampling varied with the number of deer sighted, but was usually from three to four hours.

In addition to the spotlight samples, daylight samples were taken on the same days as the spotlight samples during the months of June and July. Similar procedures were used in taking the two types of samples in an effort to obtain comparable results. Daylight samples were started shortly after daylight, and like the spotlighting, varied in length from three to four hours. All deer sighted were recorded as to sex, age, activity, and location.

Unfortunately, several units (Table 1) could not be covered by sampling methods requiring a vehicle because impassable earth slides blocked the roads to these units.

A more difficult situation was encountered in the study of the herd during the winter months. The extent of the fall migration and the areas utilized as wintering grounds were not known, and had to be determined before an appropriate method of study could be adopted. Examination of areas at lower elevations which were potential wintering areas ruled out the use of the spotlight or daylight sampling methods since they included mainly sites of old logging operations that had grown up with a thick cover of vegetation where spotlighting could not be used effectively. In addition, most of the areas had been logged by track-type tractor, and were inaccessible to a wheeled vehicle; hence, foot travel was the only practical method that could be employed.

In order to trace the route and extent of the fall migration, it was desired to mark deer while they were on the summer range in the Andrews Forest. Bait testing stations were established to test the possibility of a trapping and marking program. Baits tested included carrots, celery, lettuce, cabbage, apples, sugar, salt, cracked corn, rolled oats, rabbit pellets, and grass hay. A total of six testing stations were established during winter and spring in areas of known deer concentrations, and although deer tracks often passed directly through the test stations, no bait was taken. Tests conducted periodically through the year gave similar results.

The prospect of a trapping program was abandoned and marking with dyes was attempted. A total of five deer were marked with dye using a special marking device which was developed. This consisted of an arrow tipped with a dye-filled, breakable glass bulb measuring one and one-half inches in diameter. When the arrow struck a deer, the glass bulb shattered, splattering the dye on the animal. Red printer's ink thinned with equal parts of kerosene was used as the marking liquid.

In addition to the five deer marked in this manner, two other deer were recognizable on sight. A fawn was ear-tagged with a cattle tag covered with "Scotchlite" reflector material, and an adult buck could be recognized because of a deformed antler.

The total of seven recognizable deer was too low to produce satisfactory results, and none of the deer were sighted after they left the Andrews Forest. A notice in a local news sheet did not result in any reports from deer hunters or local residents as to the whereabouts of the marked animals.

The failure of the marking program and the inaccessibility of the lower areas precluded use of a sampling method of the efficiency of those utilized on the summer range. The only feasible method of study was by foot travel, with a consequent lower number of deer sightings. Much greater emphasis was placed on interpretation of "sign", especially tracks, and it was by this means that the fall migration routes and location of the wintering grounds were established.

Weather data of the area, including daily temperature, relative humidity, and rainfall were obtained through the courtesy of the Willamette Research Center of the U.S. Forest Service.

THE ENVIRONMENT

Description of the Area

The 15,000 acre Andrews Experimental Forest, which is a portion of the Willamette National Forest, is located in Lane and Linn Counties, a short distance northeast of the town of Blue River, Oregon. It is shaped like a large triangle and encompasses the Lookout Creek drainage. The sides of the triangle are formed by three ridges, with Lookout Ridge, which lies generally east and west, forming the base. To the south of Lookout Ridge, away from the Andrews Forest, lies the McKenzie River Valley.

Topography of the area is characterized by long, steep slopes which begin at Lookout Creek in the valley and sweep upward on either side of the drainage to the tops of the bordering ridges. Numerous relatively level benches are located on the sides of the slopes. Elevation varies from approximately 1,500 feet above sea level at the confluence of Lookout Creek with Blue River up to about 5,300 feet at Carpenter Mountain located at the northeast point and Lookout Mountain near the southeast corner of the triangle.

Numerous small tributaries descend from the sides of the ridges and eventually empty into Lookout Creek at the bottom. Lookout Creek flows into Blue River just outside of the Experimental Forest at the southwest corner of the triangle. Blue River eventually joins the McKenzie River approximately eight miles downstream at the town of Blue River.

The climate of the area is characterized by two distinct seasons, the hot and dry summer period and the rainy winter period. During the summer months, little rainfall generally occurs. The skies are often cloudless, and the relative humidity is low. Many of the small tributaries dry up, and the water level of all the streams usually becomes low. The extreme conditions of the day are relieved at night when cool temperatures are the rule, and the relative humidity nearly always rises above 90 percent.

Heavy rainfall and high humidity characterize the remainder of the year. Fog and low-hanging clouds often shroud the area. Lower winter temperatures turn the rain to snow. During mild winters, the lower elevations may remain free of snow all winter long, but generally most of the area is blanketed by snow. The snow line may fluctuate considerably during a single winter.

Old-growth Douglas-fir (Pseudotsuga menziesii), typical of the western slope of the Cascade Mountain Range, covers most of the study area. In some areas second-growth timber can be found where fires have removed the original stands, but these areas are not extensive. Species associated with the Douglas-fir stands are western hemlock (Tsuga heterophylla) and western red cedar (Thuja plicata).

Mountain hemlock (Tsuga mertensiana), Pacific silver fir (Abies amabilis), noble fir (Abies procera), and western white pine (Pinus monticola) can be found at the higher elevations. Broad-leafed trees commonly found in the area include red alder (Alnus rubra), bigleaf maple (Acer macrophyllum), vine maple (Acer circinatum), golden chinkapin (Castanopsis chrysophylla), willow (Salix spp.), Pacific madrone (Arbutus menziesii), and Pacific dogwood (Cornus nuttallii).

Mountain meadows, ranging in size from less than one acre up to approximately 80 acres, are found on the easternmost ridge.

History of the Area

The H.J. Andrews Experimental Forest was established in 1948 to provide a place for experimentation and demonstration of improved methods of multiple-use management, particularly in old growth Douglas-fir forests on (mountain) watersheds (16, p. 2). Logging activities began in 1950, and since that time approximately 1,200 acres of timber have been harvested. Harvest of the mature stand has been by the staggered-setting, clear-cut, unit (or block) method, (Figure 1) with the "high lead" system of yarding being used. The clearcut units range from less than one acre to approximately 70 acres in size. Following logging, the units were control-burned to remove the slash

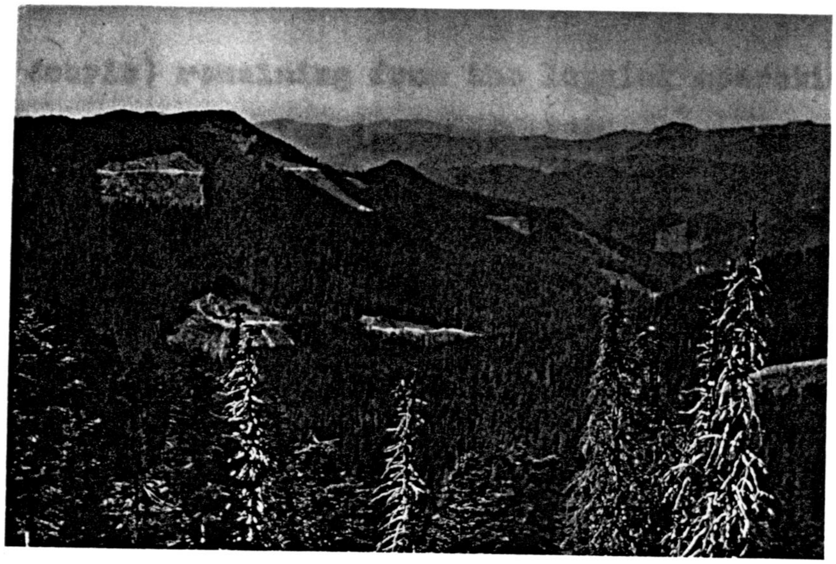


Figure 1. Down-drainage view of the H.J. Andrews Experimental Forest, showing the staggered setting method of logging.

Figure 2. A pregnant black-tailed doe feeding on a lush growth of perennial fire-weed in a recently logged unit. Picture taken in late May 1958.

(logging debris) remaining from the logging operation. Table 1 contains detailed information on the logging program prior to the present study.

Although pre-logging records of game on the Andrews Forest are meager, it appears that few deer occupied the area. Old timers, familiar with the area for years previous to logging, remember little deer sign. Forest Service personnel working in the drainage noted only occasional deer tracks. It is probable that few of the animals were resident in the area, but were wandering through the drainage in search of more favorable habitat. Since the black-tailed deer has for centuries been an inhabitant of burned-over habitat types, its survival has hinged on its ability to search out the openings. Mobility, therefore, became a necessary part of the blacktail's nature, and few places can be found in the study area where sign is completely lacking.

Perhaps a few deer were resident to the Andrews Forest Area, and inhabited the mountain meadows on the easternmost ridge as they do yet today. Here on the rocky, wet sites, red alder can be found growing in thick clumps, and this would furnish food for a small number of deer.

In general, however, the area was not suited for deer production. The towering Douglas-fir timber stand effectively closed out the sun's rays, and only a few

Table 1. Detailed Information on the Logged Units of the Andrews Forest Prior to 1958.

Unit	Acreage	Aspect	Elevation	Date Logged	Date Burned
1B	40	North	1,650-2,250	1950	1951
1C	30	North	1,600-2,000	1950	1951
1D	38	North	2,200-2,600	1950	1951-52
1E*	37	North	2,000-2,750	1951-52	1952
1F	68	North	2,400-3,000	1951	1952
1G	34	North	2,550-3,000	1951	1952
1H	44	North	3,250-4,000	1951-52	1952
1I	66	North	3,000-4,000	1951-52	1952
2A	24	North	1,800-2,000	1951-52	1952
2B	22	North	1,950-2,350	1951-52	1952
2C	36	North	1,850-2,200	1952	1952
2D	33.5	North	2,000-2,500	1952	1952
2E*	44	North	2,200-2,750	1952	1953
3A	54	South	1,550-2,000	1952	1952
3B	21	South	1,800-2,100	1952	1953
3C	50	South	1,850-2,350	1952-53	1953
3D	15	South	1,800-2,200	1952-53	1953
3E	27	South	2,150-2,750	1952-53	1953
3F	50	South	2,050-2,650	1953	1953
3G	41	South	2,500-2,750	1953	1953
3H	29	South	2,700-2,950	1953	1953

Table 1 - continued

Unit	Acreage	Aspect	Elevation	Date Logged	Date Burned
3I	44	South	2,800-3,250	1953	1953
S1	0.7	South	1,850-2,200	1954	1954
S2	1.5	South	1,950-2,250	1954	1954
S3	3.3	South	1,950-2,300	1954	1955
S4	8.3	South	1,950-2,350	1954	1955
S5*	2.3	South	2,500-2,550	1954	1954
S6*	3.1	South	2,550-2,600	1954	1954
S7*	4.0	South	2,600-2,750	1954	1955
G1*	4.0	South	3,050-3,150	1954	1955
G2*	2.0	South	3,100-3,150	1954	1955
G3*	1.0	South	3,050	1954	1955
G4*	0.75	South	3,000	1954	1955
G5*	0.5	South	3,000	1954	1955
G6*	0.25	South	3,000	1954	1955
G7*	0.125	South	3,050	1954	1955
5A	70.5	South	2,000-2,700	1954	1955
5B*	48	South	2,900-2,500	1954-55	1955
5C*	20	South	3,200-3,400	1954-55	1955
6A	45	North	3,500-4,000	1956	1957
6B	56	North	3,500-4,000	1956	1957

*Not sampled by the spotlight or daylight cruise techniques because earth slides prevented access by vehicle.

shade-tolerant species could survive. Vine maple, salal, rhododendron, and sword fern made up the bulk of the understory, and even these species were irregular in distribution.

When the forest canopy is removed by logging, conditions suitable for growth of a great number of plant species are created. Sunlight reaches the earth, and many shrubs, freed from the forest suppression, assume vigorous growth. Invader species, not a part of the original forest understory, are carried as seed by wind, birds, and other animals, and soon become established on the logged areas. Within a short time the exposed ground is covered by a thick, vigorous growth of plant cover. Important plant species of the successional stages following logging are listed in Table 2.

The availability of an abundance of excellent deer food made possible a build-up of the deer population in the Andrews Forest. Although slow at first, the population has increased rapidly during the last few years, and now a sizable herd occupies the area during the summer months.

Availability of suitable deer food is but one of the factors resulting from a staggered-setting system of timber harvest which favor deer production. One important factor is the creation of edge type habitat. Removal of timber from a number of small units results in a far greater amount of edge area than would be obtained from a single

Table 2. Average Percent Cover of Important Plant Species On Low Elevation, North Slope Logged Units of the Andrews Forest. Modified from Yerkes (17, p. 69-70).

HERBACEOUS SPECIES		Growing season after burning 1	2	4	5	6
Survivors of understory						
All species		1.8	0.3	1.3	0.8	0.8
Invading annuals						
Wood groundsel (*Senecio sylvaticus*)		12.0	4.4	0.3	0.1	0.0
Annual epilobium (*Epilobium spp.*)		0.1	5.9	0.4	0.1	0.6
Others		0.9	0.1	0.2	0.1	0.0
	Total	13.0	10.4	0.9	0.3	0.6
Invading perennials						
Fire-weed (*Epilobium angustifolium*)		11.9	9.7	11.2	5.4	4.7
Pearly everlasting (*Anaphalis margaritacea*)		0.0	0.1	0.2	0.1	0.1
Western hawkweed (*Hieracium albertinum*)		0.0	0.0	0.1	0.3	0.2
Slender cudweed (*Gnaphalium microcephalum*)		0.1	0.0	0.0	0.0	0.1
Thistle (*Cirsium spp.*)		0.1	0.2	0.1	0.1	0.4
Others		1.9	0.2	3.6	1.3	0.3
	Total	14.0	10.2	15.2	7.2	5.8
Total herbaceous		28.8	20.9	17.4	8.3	7.2

Table 2 - continued

WOODY SPECIES		Growing season after burning 1	2	4	5	6
Survivors of understory						
Vine maple (*Acer circinatum*)		0.7	1.4	0.7	1.6	1.5
Oregon grape (*Berberis nervosa*)		0.5	0.3	0.4	0.3	0.3
Salal (*Gaultheria shallon*)		0.1	0.5	0.1	0.4	0.3
Rhododendron (*Rhododendron spp.*)		0.4	1.0	0.3	0.4	0.7
Wild blackberry (*Rubus vitifolius*)		5.2	6.5	5.6	3.6	2.5
Twin-flower (*Linnaea borealis*)		0.9	1.5	1.5	3.6	5.0
Whipple-vine (*Whipplea modesta*)		0.2	0.0	0.9	0.4	0.7
Others		0.6	0.0	0.0	0.4	0.0
	Total	8.6	11.2	9.5	10.7	11.0
Invaders						
Elderberry (*Sambucus spp.*)		0.3	0.2	0.8	0.5	0.2
Thimble berry (*Rubus parviflorus*)		0.1	0.2	0.5	0.3	0.1
Willow (*Salix spp.*)		0.1	0.9	0.4	0.8	0.1
Others		0.0	0.4	1.3	1.6	1.7
	Total	0.5	1.7	3.0	3.2	2.1
Total woody		9.1	12.9	12.5	13.9	13.1
Total herbaceous and woody		37.9	33.8	29.9	22.2	20.3

large cutting. Because of the proximity of the food supply in the cut areas, the remaining timber receives heavy utilization, and becomes valuable for satisfying the requirements of deer.

Predators

Although many predatory species, including black bear (*Ursus americanus*), coyote (*Canis latrans*), and bobcat (*Lynx rufus*) are resident to the area, little information concerning their effect upon the deer herd was obtained. Black bears were observed on several occasions during the study. Cursory examination of one scat revealed a portion of a fawn hoof. No coyotes were observed within the study area, but the amount of sign found along trails and roadways evidenced their presence.

Two bobcats were seen in the Andrews Forest, both spotlighted on the night of May 13. The tracks of several cougars (*Felis concolor*) were found on the ridges bordering the forest, and sighting of two cougars near the confluence of Lookout Creek was reported. While domestic dogs (*Canis familiaris*) were known to run deer in the McKenzie Valley, they presented no problem in the study area. Possible avian predators which were observed included the golden eagle (*Aquila chrysaetos canadensis*) and the bald eagle (*Haliaeetus leucocephalus*).

Predation effect of many of the above can be discounted because of rarity of the species in the area or lack of effectiveness or both. Probably the most important predators in the Andrews Forest are the coyote, the black bear, and the cougar. While undoubtedly some deer, especially the more vulnerable fawns, fall prey each year, the meager evidence suggests that the overall effect of predators on the Andrews herd is small. Only two cases of possible predation mortality, both fawns, were found during the one-year study period, and in neither instance could it be determined that the actual kill was made by a predator. It may well be that the predatory species were acting as scavengers upon fawns that succumbed to other factors.

HERD COMPOSITION

Age Composition

Of the 1,022 deer spotlighted during the summer months on the Andrews Forest, 518 were classified according to age (Table 3). The number of unidentified deer is quite high because age identification was often difficult. Many sightings were made from a distance at which only the "eye-shine" could be distinguished. While the placement of the eyes and head motions are often indicative of age, such criteria were not used. Only deer that were viewed within easy identification range, and could be positively classified as to age were so recorded.

Over the season, an adult to yearling ratio of 4.19:1 was obtained. It may be that this figure is high because of the progressive difficulty of identification of yearlings as the summer advanced. Identification was easiest during the months of April and May because of the marked discrepancy in size, the adults being considerably larger than the fawn-like yearlings. As the season progressed and the yearlings approached maturity, the group characteristics gradually disappeared, and identification, especially by spotlight, became difficult. Slightly smaller size and presence of spike antlers in the males were the only readily recognizable identifying features. This

Table 3. Age Composition of Black-tailed Deer Spotlighted in the Andrews Experimental Forest during 1958.

Month	Adults	Year-lings	Fawns	Uniden-tified	Total
April	21	7	0	30	58
May	74	25	0	139	238
June	33	4	3	112	152
July	114	31	21	125	291
August	100	19	36	84	239
September	18	0	14	12	44
Total	360	86	74	502	1022

slight difference in size was difficult to distinguish in the limited light of the spotlight, and in many sightings no other deer were present for comparison. Consequently, only the deer that were spotlighted in favorable conditions relatively close to the road could be identified specifically as yearlings or adults during the late summer months.

In view of these circumstances, it may be that the April and May ratio of three adults to one yearling is a more accurate figure. This speculation is substantiated by the results obtained from the June and July daylight samples and the general daylight observations during July and August. The former gave a figure of 2.63 adults per yearling, while the latter yielded a 3:1 ratio identical to the April and May spotlight results. It should be noted that identification of yearlings during the late summer periods was accomplished more easily by daylight than by artificial light. The observer's sense of perspective was better in daylight, and size of the deer could be more easily determined by comparison with the surroundings. Animals could be identified as to age with the aid of binoculars at ranges far beyond the identification range of the spotlight beam.

The role of the fawns in herd composition will be discussed under the heading of reproduction.

Sex Ratio

A sex ratio of 1 buck to 3.24 does was obtained from 301 deer classified during spotlight samples. The data obtained from the daylight samples and general observations compared favorably, yielding ratios of 1:4 and 1:3.43 respectively. The difference of results between methods is inconsequential considering the variables involved in sampling. Although there are many factors affecting age composition sampling, there is sufficient evidence to believe that there are several does for every buck in the Andrews herd.

The reason for the preponderance of does in the population is cause for speculation. It does not appear to be due to sex ratio at birth. Robinette (12, p. 419), working with mule deer (Odocoileus hemionus), derived a sex ratio of 111 males to 100 females from 1,924 fetuses, and a 122 to 100 ratio for fawns a few days old. It is possible that a similar sex ratio of fawns exists in the black-tailed deer, since it is a subspecific form of the mule deer. From a limited sample of black-tailed deer fawns, Taber (13, p. 96) derived a sex ratio of 127 males per 100 females.

It seems doubtful that the environment would favor survival of one sex of fawn over the other, but Taber and Dasmann (14, p. 310) reported a sex differential in mortality of blacktail fawns in California. They suggest that the higher rate of mortality of males is due to a higher metabolic rate, which results in greater aggresiveness. This would tend to place the males in situations with which they are unable to cope more often than the more cautious females. However, the authors attribute the majority of such mortality to starvation and accidents, neither of which seems to be an important factor in the Andrews Forest herd at present. Winter survival among fawns of the Andrews Forest herd could be expected to be nearly equal for the two sexes. In the Fishlake Forest herd of Utah, Robinette (11, p. 12) found winter mortality of 332 fawns to be divided equally between the sexes. Little indication exists that predacious animals are selective of sex.

It appears, therefore, that the primary cause of the unbalanced ratio of males to females can be traced to the legal hunter harvest. In addition to the regular buck season, Oregon has had an antlerless deer harvest in one form or another since 1952. In the seven hunting seasons from 1952 through 1958, bucks have comprised over two-thirds of the annual take. The portion of male deer in the total kill ranged from 79 percent in 1952 to 66 percent in 1958 with an average of 72 percent for the period (9, p. 3). It seems logical that a heavy harvest of males could have a considerable effect on the sex ratio of a deer herd. Lauckhart (6, p. 156) relates an instance in Thurston County, Washington, where a ratio of 1 buck to 1.58 does was reduced to 1 buck to 2.8 does in one year of heavy hunting. In the area where the present study was conducted an appreciable portion of the hunting pressure comes from local residents, since hunters from population centers in the Willamette Valley usually journey to eastern Oregon to hunt the mule deer. Local hunters, being more familiar with the deer and the area, may be more successful in finding and killing bucks. This factor may also have contributed to the unbalanced sex ratio of the Andrews herd.

Reproduction

The first signs of the approach of the fawning season were observed in mid-May when the breeding does began to appear heavy with fawn (Figure 2). Toward the end of May and the beginning of June the females appeared awkward in their movements, burdened by the additional weight, but their appearance belied the agility they displayed on occasions. During this period, the does leave the company of other adult deer and drive off their previous year's fawns, now yearlings, if they are still following.

A location furnishing good concealment, usually in the timber surrounding a logged unit, is chosen as the fawning site. Some of the older does may return to the same area for fawning year after year. Jay Gashwiler, U.S. Fish and Wildlife Service biologist, reported (personal conversation) a semi-tame doe that had borne fawns in the same location in unit 2B for two seasons previous to this study. The doe again fawned in the same area during the study.

Although some early births may have already occurred, the bulk of the fawning began around the 10th of June. Fawns first began to show up in both the spotlight counts and the daylight counts on the 19th of June. They were strong enough to move well, indicating an age of approximately 4 to 10 days. Fawns were observed regularly in the samples after this date. The latest known fawn birth occurred in the 1st week of July. A weak male fawn, not more than three or four days old, was found in unit 5A on July 8. In general, it can be said that the fawning period extended over the month of June with the greatest portion being dropped around mid-month.

The young fawns spend much of their early life bedded in heavy cover while the doe goes about her daily activities. The does are often seen feeding or resting while the hidden fawns go undetected; consequently, an accurate sample of fawns is difficult to obtain.

The night spotlight samples for July, August, and September yielded a total of 71 fawns and 232 adults. Since approximately one out of four adult animals in the Andrews herd is a male, one-fourth of the 232 adults was discounted in figuring fawn production. This resulted in 174 adult does to 71 fawns for a ratio of 1 doe per .41 fawns. Considering the excellent condition of the range, the figure appears exceptionally low. It seems even more erroneous when the matter of twin births is taken into account. Of the 71 fawns sighted, 42 were the result of twin births, which means an actual total of only 50 births out of 174 does, leaving 124 does unaccounted for. If such is the case, 71 percent of the adult does in the population must have been barren, or have lost their fawns shortly after parturition. While barrenness or loss of fawn undoubtedly occurred in some instances, a number of does spotlighted with no fawns seen nearby were observed to be lactating. Hence, many does sighted had apparently produced fawns which were hidden at the moment, resulting in a major source of error.

A system used by Batterson of the Oregon Game Commission, reported by Cowan (1, p. 532), to determine approximate reproduction of a deer herd consists of counting only the does which have fawns following. While the method does not take into account barren does or those that have lost their fawns, it does indicate the relative fertility of the productive females of the herd. In applying this system to the spotlight data, a modification was made. Quite often the spotlight samples revealed bedded fawns, with no does present in the vicinity. In the analysis, a doe was added for each such fawn observed since her existence was highly probable.

Analyzed by this method, the spotlight data yielded 50 does with 71 fawns for a ratio of 1:1.42. There were 21 sets of twins out of 50 births, indicating that 42 percent of the fertile does bore twin fawns. Similar analysis of the combined daylight sample and general observations resulted in the sighting of 28 does and 43 fawns for a 1:1.54 ratio. Of the 28 does, 15, or 53.6 percent, had twins following them. It is probable that the reproductive rate of the Andrews herd is in the neighborhood of 1.4 to 1.5 fawns per doe, indicating satisfactory reproduction.

Fawn survival appeared to be high, but according to Cowan (1, p. 533), losses of not less than 20 percent or more than 33 percent between pregnancy and two months of age are probable on good range. Information pertaining to losses before birth was completely lacking in the study, and only two cases of post-natal fawn mortality were known. A fawn hoof was found in a black bear scat, but it was not known that the bear made the actual kill. The other known case was reported by Mr. Jack Rothacher of the Forest Service who found a portion of dried fawn skin that had apparently been chewed by scavengers. Again the actual cause of death was not ascertained, and may or may not have been the work of predators. Since many potential predators frequent the area, it seems highly likely that some young fawns fall prey to them. It is of interest to note that most of the fawns observed during the study were seen below 2,700 feet in elevation, while the heaviest sign of coyotes and black bears was found at elevations above 3,000 feet. Such a distribution would no doubt reduce the number of encounters between fawn deer and two of the main predatory species resident to the area.

The gestation period in the coast deer has been established at approximately seven months (3, p. 260; 1, p. 531). Since the fawn-drop extended from approximately June 1 to July 1, the rut of the previous fall must have occurred primarily during the month of November. Limited observations indicate that the 1958 fall rut occurred during approximately the same period as in the previous year. A prime four-point buck harvested on October 19 showed no physical signs of breeding condition. Several mature bucks harvested during the special season held November 15 and 16, 1958, had swollen necks, indicating rutting activities.

During the rut, the Andrews herd is on the wintering areas. Here adverse effects of an unbalanced sex ratio upon breeding would be minimized. Since the receptive period of does lasts from a few hours to less than a day (10, p. 30), it is important that a mate be found quickly. The black-tails in this area do not "yard" like the eastern white-tailed deer, nor do they form the large groups often encountered on the winter range of the mule deer. Coast deer groups at this time of year rarely exceed six or eight animals in the area studied. Reduction of the available space of the wintering grounds as compared with the summer range tends to congregate the herd, and receptive does would normally be in the proximity of a suitable mate.

CHARACTERISTICS AND BEHAVIOR

Group Size

During the year, group size of blacktails varied considerably. While single animals or groups of two were sighted most frequently, total numbers of deer were often higher in the larger groups. Groups of five and six occurred quite regularly, while larger aggregations were rarely observed.

A definite seasonal trend in group size was revealed by the spotlight sample data. During the spring migration period in April, over 60 percent of the total number of deer were in groups of three or more. Upon arrival at the summer range, the deer quickly dispersed over the logged units and occupied the entire range. The "spreading out" resulted in the breakdown of the larger migrational groups. In effect, the deer were spread thinner and could more efficiently utilize the abundance of favorable habitat. The trend toward small groups continued as the summer progressed, and hit its peak during July when over 80 percent of the population occurred singly or in groups of two deer.

Little change in group size occurred from July to August, but groups tended to be slightly larger, possibly because of the more frequent appearance of fawns accompanying the does on their nightly foraging trips.

With the approach of September, the deer began forming larger aggregations, prior to the fall migration out of the summer area. Larger groups occurred through the remainder of the year on the winter grounds, with the possible exception of during the hunting season. Observations made during this period were too limited to reach any conclusions concerning the effects of hunting on group size.

The general trend, therefore, was toward the formation of relatively large groups during the winter and migration periods, and smaller ones during the summer range occupancy.

Reaction to Weather

During the summer, daily weather conditions had a marked effect upon the activities of the black-tailed deer. Their pattern of feeding and resting was often influenced by weather phenomena.

In studying the effects of weather on the behavior of the Andrews deer herd, it was often difficult to isolate a specific causative factor, since rainfall, temperature, and relative humidity are inter-related forces.

Variation in the pattern of daily deer activities caused by maximal relative humidity was probably slight owing to its consistency. Maximum for the day nearly always occurred during the night when relative humidity ranged generally from 90 to 100 percent. On only seven occasions during the hottest summer months did it drop into the eighties. Never did lows occur on successive nights and only once was relative humidity below 85 percent.

Similarly, minimal daily temperature remained fairly constant during the summer months, and night temperatures fell consistently into the forties and fifties during this season.

Several aspects must be considered when discussing the effects of rain upon the activity of black-tailed deer. In the study area, rain had little direct effect. Deer showed a general disregard for any discomfort resulting from rains, and carried on their daily activities in near-normal fashion. The usual nature of the rain in the area is a slow, steady drizzle which probably adds to the deer's tolerance. This, plus the fact that the blacktail has become ecologically adapted to the high rainfall region of western Oregon, results in slight direct effect on deer activities. Nevertheless, rain, through its influence on temperature and relative humidity, may have a considerable indirect effect upon daily activity of deer.

During the summer, the temperature is much lower on cloudy, overcast days than on clear, sunny days. Rainfall, of course, has a very decided lowering effect upon temperature, and causes a sharp increase in relative humidity. During May, for example, the temperature on clear days averaged 77.5° while on rainy days it was 65°F. Minimal humidity on clear days was 38 percent while on rainy days it was 55 percent. The above figures are generally representative of the modifying effects of rainfall upon temperature and relative humidity.

Temperature is probably the most important weather phenomenon influencing deer activity in the Andrews Forest, but it is impossible to separate the effect of relative humidity from that of temperature. Daily low relative humidity is roughly in inverse proportion to daily maximal temperature, hence the two must be considered as a complex in their combined effects upon deer activity. Hereafter, the mention of temperature should be interpreted to include the associated relative humidity.

Black-tailed deer are not physiologically equipped to withstand high temperatures, and when the heat becomes oppressive they prefer to seek cover. According to Linsdale and Tomish (8, p. 305), black-tailed deer begin to show discomfort when the temperature approaches 80°F. Since the summer temperatures in the Andrews Forest are frequently above 80°, deer often forsake daytime feeding and retire to the protection of the virgin timber. Here, they spend the day in the shade of the closed canopy and await more favorable conditions before feeding.

Data gathered during June and July by the daylight sampling method were tabulated according to temperature. An average of 8.3 deer per sample was obtained from six samples taken on cloudy or rainy days when the temperature was below 80°F., while 11 samples taken on days with temperatures of 80°F. or above, averaged 4.2 sightings per sample. While the low number of observations per sample would preclude any definite statements, they give indications that more deer are active on cool than on hot days.

It should be pointed out that the daylight cruise samples were taken during the morning hours, often before temperatures had reached 80°F. on the hot days. Deer, however, began showing a response to the heat well before it reached the critical 80°F. point.

It appears, therefore, that lighter daytime feeding would result in higher night-time feeding, and consequently, higher counts during the night spotlight samples. While such is generally true, it should be realized that the relationship is not so simple, and that many factors besides daytime temperatures are involved.

Deer, even on cool days, tend to feed more heavily during the morning and evening. It is possible for deer which do not feed during hot days to complete feeding in the cool period from sunset until darkness. These animals may finish feeding and bed down again before it becomes dark enough to conduct the spotlight sample. This could have a marked effect on spotlight results since the number of deer sighted is highest when the percentage of active deer is highest (Table 4).

Table 4. Summary of Bedded and Active Deer Spotlighted in the Andrews Forest by Month. Percentages are presented in parentheses.

	April	May	June	July	August	Sept.
Bedded deer	28(48)	74(31)	65(43)	88(30)	73(30)	12(27)
Active deer	30(52)	164(69)	87(57)	202(70)	166(70)	32(73)
Total deer	58	238	152	290	239	44
Average No. of deer per sample	7.3	29.8	19.0	29.1	29.9	7.3

From Table 4 it can be seen that the highest deer counts were obtained during the months of May, July, and August when the percentage of active deer recorded was in the vicinity of 70. During June, when the percent of active deer dropped to 57, the sample mean dropped accordingly. The months of April and September are not similar since the sample means reflect an actual change in total population numbers because of migration.

The higher percentage of active deer in the spotlight samples is reflected by a higher proportion of deer feeding at night. Figure 3 illustrates the relationship between the spotlight sample mean and maximal daily temperature mean for the days when the spotlight samples were taken. As temperatures increased so did the spotlight sample means. A decrease in mean temperature during June was reflected in a decrease in the sample mean. Here again,

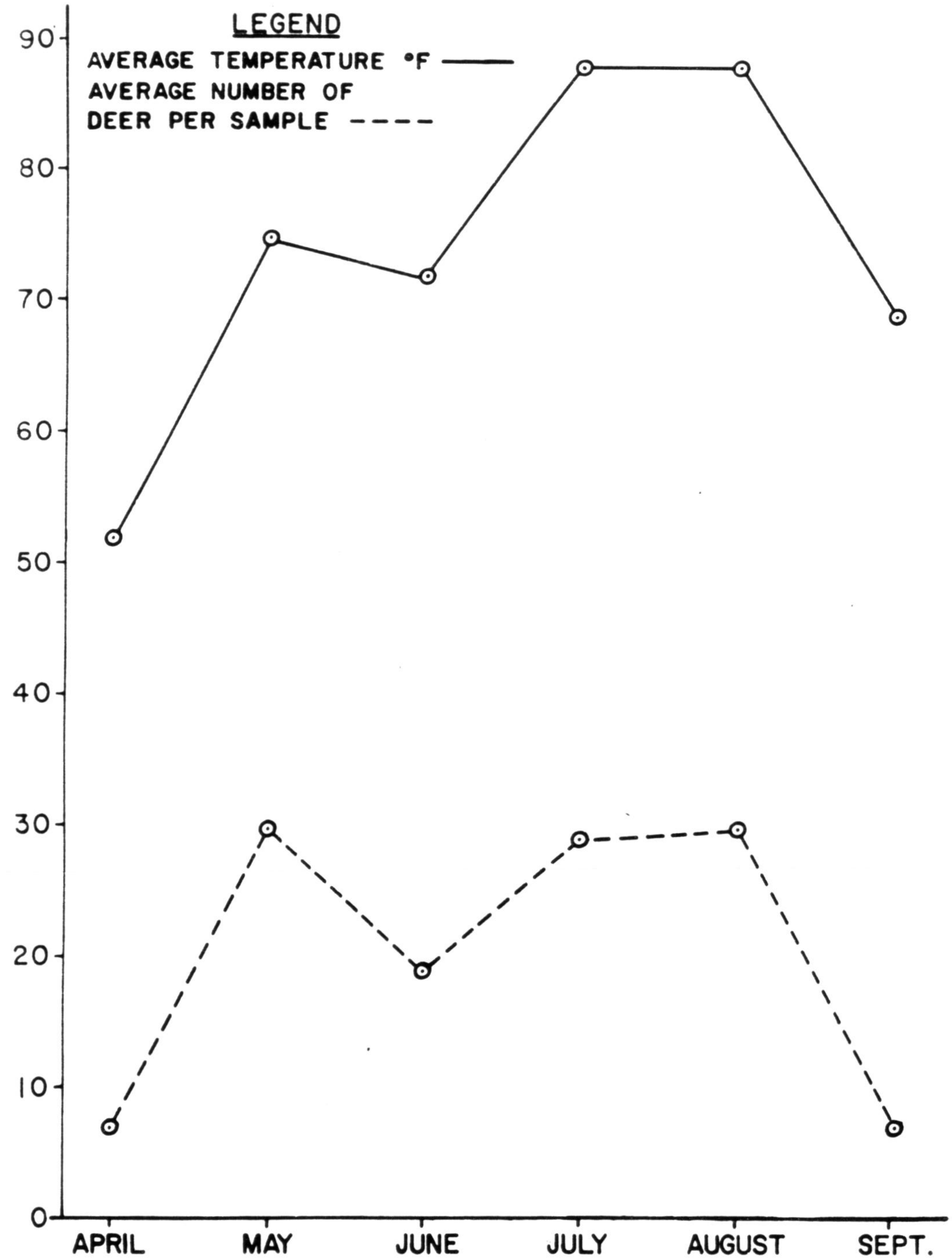
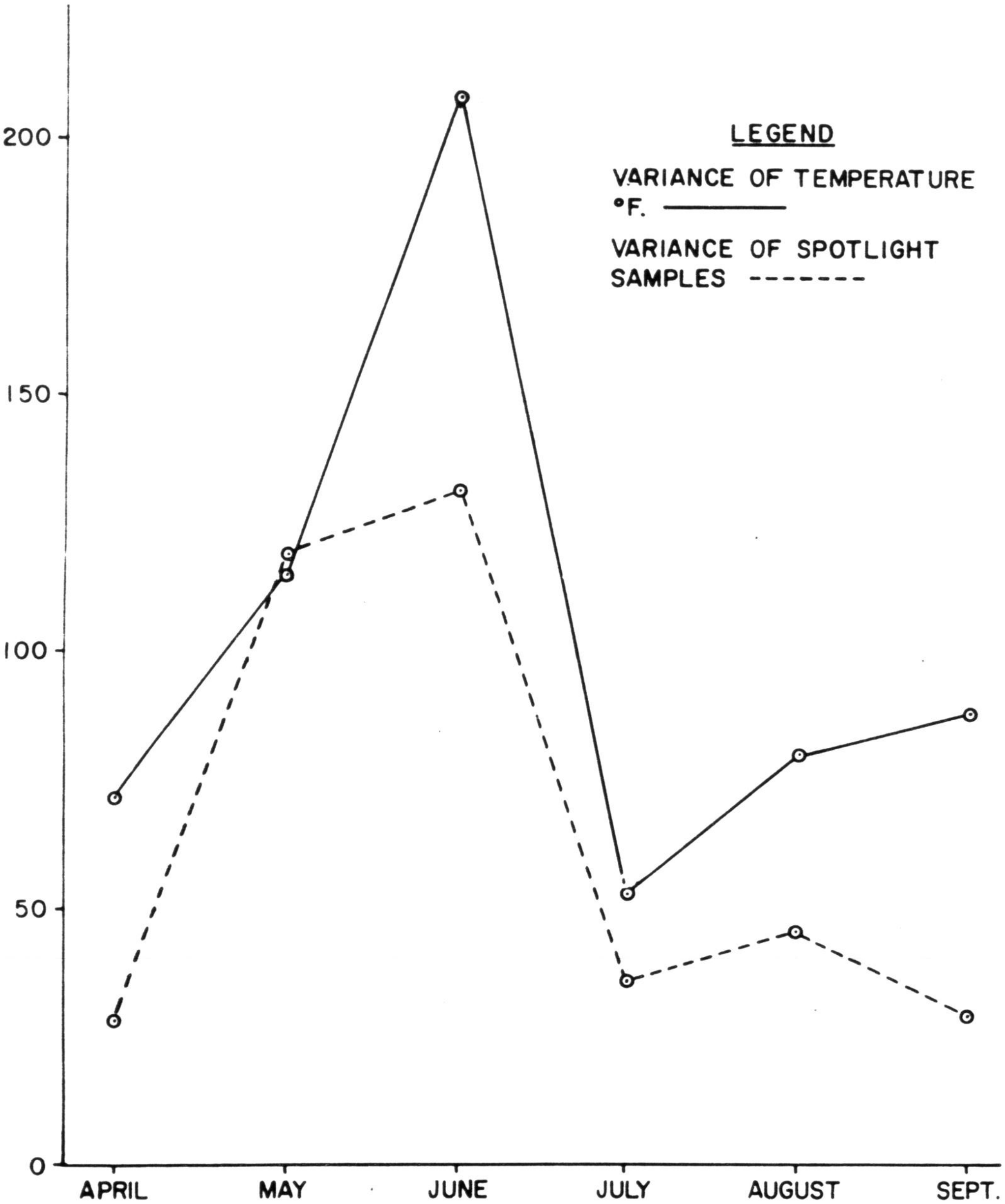


FIGURE 3 AVERAGE NUMBER OF DEER SIGHTED PER SAMPLE IN RELATION TO THE AVERAGE OF MAXIMAL DAILY TEMPERATURES FOR THE DAYS OF SAMPLING.



$$\text{VARIANCE} = \frac{\sum y^2 - \frac{(\sum y)^2}{n}}{n-1}$$

WHERE y IS THE NUMBER OF DEER PER SAMPLE AND n IS THE NUMBER OF SAMPLES PER MONTH.

FIGURE 4. COMPARISON BY MONTH OF THE VARIANCE OF SPOTLIGHT SAMPLES AND MAXIMAL DAILY TEMPERATURE ON DAYS OF SAMPLING.

April and September are not comparable because of migrational changes in population numbers.

It was also found that wide fluctuations in temperature resulted in wide fluctuations in the spotlight sample observations (Figure 4). During May and June periodic cloudy and rainy weather caused temperatures to drop, which resulted in a wide temperature variation from day to day. The variation of numbers of deer sighted by the spotlight method also ranged widely. Lack of rainfall and generally clear skies resulted in fairly constant high daily temperatures during July and August. The variation in the number of deer spotlighted per sample was less during this period than in the months of May and June.

Movements

The early period during April and May on the summer range is characterized by a considerable amount of movement. Yearlings are being driven away by does as the fawning season approaches. Many two-year-old does are leaving the maternal group to bear young for the first time. It is from the younger deer classes that much of the recruitment for newly logged units is obtained. As the fawning season passes and summer begins, home ranges become well defined. Certain groups become recognizable, and are repeatedly sighted in the same general area. The deer tend to be habitual in their activities, and the same groups will continually be spotlighted within the same area of less than one acre. Fawns also are often found in the same place night after night.

Home ranges of deer in the Andrews Forest are small, probably because of the excellent interspersion of vegetative type. The requirements of food, water, and cover can be satisfied in nearly all of the logged units. Generally the home range consisted of a logged unit and the adjoining timber. In only one case was a group known to include two units in its home range.

Little preference between north and south slopes was exhibited in April and May, since deer numbers were fairly well divided between the two exposures (Table 5). A movement toward the units with a north exposure occurred during June, and deer showed a slight preference for north slopes for the remainder of the season.

Table 5. Distribution of Deer According to Slope, Obtained by the Spotlight Sampling Method. Percentages are presented in parentheses.

	April	May	June	July	August	Sept.
North slope units	27(47)	120(50)	95(62)	150(52)	133(56)	26(59)
South slope units	30(53)	118(50)	57(38)	139(48)	106(44)	18(41)

The preference can probably be attributed to several factors, the most important being temperature. As previously pointed out, black-tailed deer are intolerant of high temperatures, hence would probably prefer cooler north slopes during the hot summer months. Taber and Dasmann (15, p. 2) have suggested 55° to 65°F. as the optimal temperature range for black-tailed deer in the chaparral area of California. Assuming the preference of the Andrews Forest herd to be similar, the optimal temperature range is more nearly met on the less exposed north slopes. Most of the movements of the deer in the area indicate a temperature preference approximating that suggested by Taber and Dasmann.

The second factor that appears to affect slope preference is condition of the forage. Development of forage is later on the north slopes (2, p. 29-30), therefore it remains succulent until later in the season. The north aspect is exposed to direct sunlight for shorter periods during the day, which probably results in higher forage palatability. Also, as pointed out by Yerkes (17, p. 52), total cover is higher on the north slopes which results in a higher availability of usable forage. However, more than adequate forage is available on the south slopes, hence the last factor would probably have a minor influence on deer distribution.

In the logged units on the north slope, the deer

Table 6. Distribution of Deer According to Elevation, Obtained by the Spotlight Sampling Method. Percentages are given in parentheses.

	North Slope 1500-2500	North Slope 2500-4000	South Slope 1500-2250	South Slope 2250-3250
April	18(67)	9(33)	11(37)	19(63)
May	79(66)	41(34)	61(52)	57(48)
June	58(61)	37(39)	25(44)	32(56)
July	90(60)	60(40)	68(49)	71(51)
August	94(71)	39(29)	18(17)	88(83)
September	19(73)	7(27)	4(22)	14(78)

preferred the lower elevations (Table 6). Of the deer spotlighted throughout the season, 60 to 70 percent were in units at an elevation below 2,500 feet. From Table 6 it can be seen that there was a general tendency for the deer to move upward from April through July. Perhaps this may be attributed to temperature changes, and the earlier stage of growth of the vegetation at the higher elevations on north aspects (2, p. 29). This trend continued until the middle of August, when a sharp downward movement began. No explanation for the sudden downward shift can be found. Weather conditions during this period remained nearly constant, and no particular change in vegetation was noticed.

Distribution of deer on units with a southern exposure was quite variable during the year. The only definite altitudinal preference shown was in August when 83 percent of the deer were found above 2,250 feet (Table 6). Since differences in environmental conditions such as exposure to sun, temperature, and vegetative development, of units at various elevations on the south slope were more uniform than those on the north slope, deer distribution patterns could be expected to be less definite. The south slope, also, was not as high as the north, and deer movement between units did not represent as great a change in elevation.

Migration

The Andrews Forest herd is migratory in nature, occupying the experimental forest during the summer and moving out of the area to the lower elevations for the winter. In this manner the deer are able to occupy the environment furnishing the most suitable conditions for survival. The migratory habit has undoubtedly developed as an adaptation to winter snow conditions. Blacktails occupying ranges lying below winter snowlines do not generally exhibit a migratory habit.

The first sign of the upward migration in the spring was found during mid-March, when movements of deer in the lower elevations became apparent. By late March, concentrations of deer had built up along the top of Lookout

Ridge near the southwest border of the Andrews Forest. Here they remained for several weeks, apparently awaiting conditions to their liking before moving into the area.

The spotlight samples were begun on the 2nd of April, and the first deer sightings were made on the night of the 8th. Thereafter followed a gradual buildup of numbers, until a leveling off period was reached in early May.

Movement into the area was not controlled by distribution of snow. While a limited amount of snow remained on the higher parts of Lookout Ridge, the area was generally open. Access to the Andrews Forest via the drainage proper was completely free of snow for a considerable length of time before any movement into the area occurred. Movement to a location near the area was accomplished early. The actual occupation appeared to be associated with temperature increase (Figure 5) although not necessarily caused by it. Similar correlations probably could be found with vegetative development or the photo-period among other factors. During March and early April, temperatures were in the forties and fifties. In the first half of April, deer began to drift slowly into the area, and the spotlight samples showed a gradual upward trend. However, when high temperatures occurred on the last days of April and early May, the spotlight counts mounted rapidly. Although part of the increase in numbers sighted undoubtedly was due to heavier night feeding because of temperature increases, it

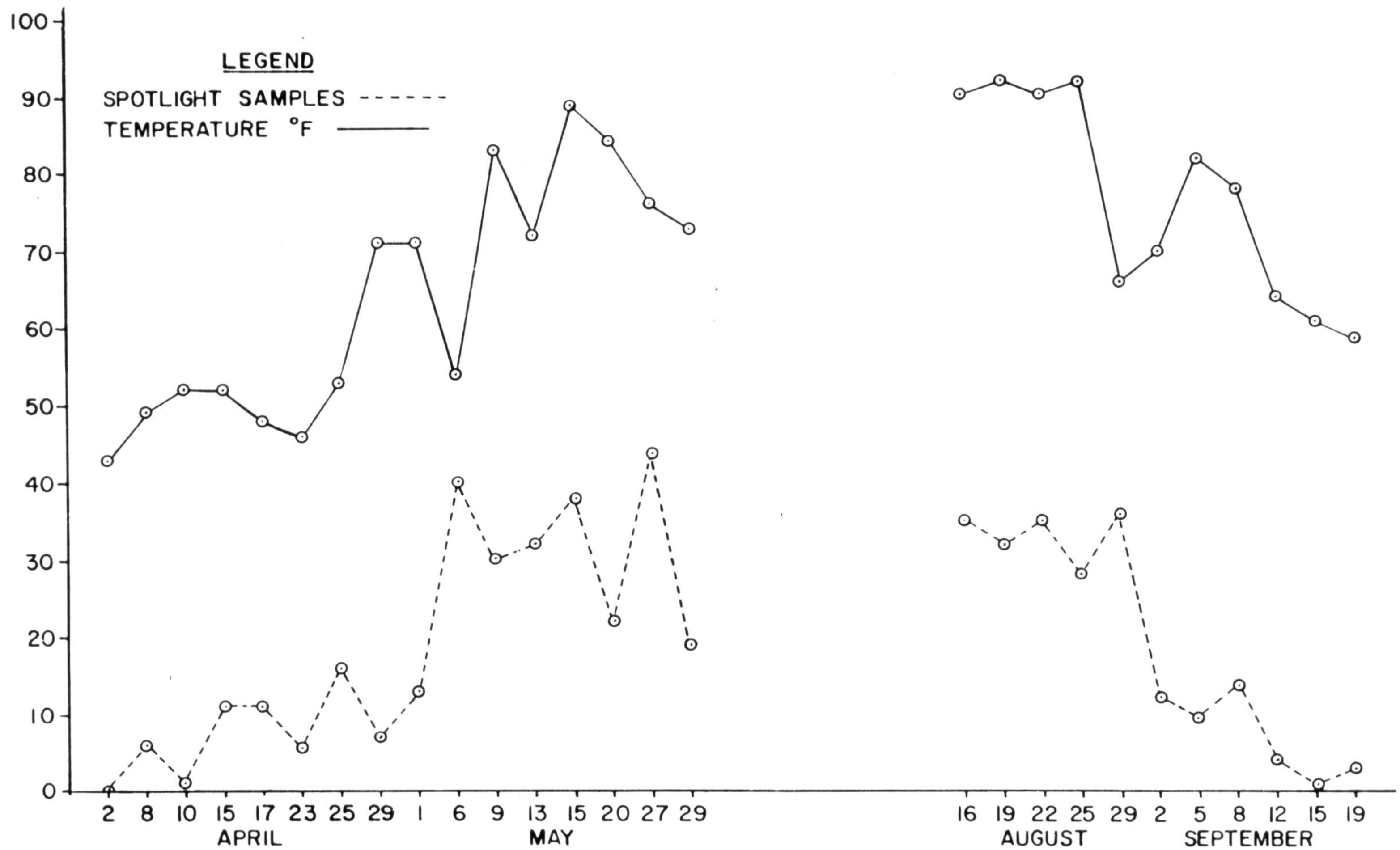


FIGURE 5. SPOTLIGHT SAMPLES TAKEN DURING THE MIGRATION PERIODS, SHOWING THE RELATIONSHIP BETWEEN NUMBER OF DEER SEEN AND MAXIMAL DAILY TEMPERATURE.

is believed that the majority of the increment was the result of migration. Deer were regularly seen moving along the roadway toward the Andrews Forest during this period. Apparently, when conditions in the study area became favorable, the migration was greatly accelerated.

The early migrants tended to remain in logged units near the lower end of the Lookout Creek drainage, but as the migration progressed a general dispersion over the area occurred. By mid-May, most of the logged units were occupied by deer.

Several spotlight samples taken during the spring of 1959 revealed that many deer return to their home range of the previous year. Out of thirteen groups sighted in one spotlight sample, five were recognized as those occupying the same home ranges the previous summer.

Most black-tailed deer herds migrate in the fall as a direct result of snowfall, which forces them downward out of the summer range (1, p. 572). The deer in the Three Sisters Wilderness Area, for example, have a well-defined migrational pattern, remaining at elevations near the crest of the Cascade range until fall snows drive them down. The migrational trek covers a distance of approximately 15 miles, and is largely accomplished in a matter of a few days.

The fall migration of the Andrews herd is unique in that it occurs early in the fall, long before inclement weather begins. Movement out of the area began early in September, and by the 20th of the month only occasional animals remained (Figure 5). The first snowfall came on November 13th, nearly two months after the deer had left the experimental forest.

The early departure of deer, because of its variation from the usually held concept of a fall migration, poses a question of interpretation. The upper limits of the winter grounds are located at approximately the snowline since black-tailed deer in this area show marked intolerance toward snow. The snowline is generally located in the vicinity of the Lookout Creek-Blue River confluence; therefore, the distances from the summer range in the Andrews Forest to the wintering areas are extremely short, in some cases less than one mile. Because of the short distance, there is some question whether the deer are making a local movement rather than a migration.

Since the majority of deer then occupy south slopes a short distance away, it may be argued that the movement is simply a local shift made in response to weather or vegetative conditions. If such were the case, there would be no need for the deer occupying the south slope in the Andrews Forest to move, yet they abandoned the area at the same time as the remainder of the herd. Concerning the fall movement of the Andrews Forest herd Dealy (2, p. 40) stated, "Since deer actually moved out of the logged units during August and September, it can be assumed from limited signs that they moved up and out of the drainage into high mountain meadows, old burns and old logged units which were their habitat before logging began in the study area". Evidence obtained during the present study tends to refute the assumption that the herd moves up during the period of fall movement. A considerable amount of sign was found to indicate that movement down-drainage was occurring, and examination of the high elevations on the northern-most and eastern-most ridges, including the meadows, revealed nearly no sign of deer during this period. Although deer were present near the top of Lookout Ridge, outside the boundaries of the experimental forest, there is little reason to believe that they were part of the Andrews herd, since deer were resident to this area all summer long. It will be pointed out later that deer tended to cross Lookout Ridge via a low saddle. It seems logical that such a tendency toward utilizing the lowest passage would not be exhibited if the deer were moving to the higher elevations.

An extremely comprehensive marking study would be necessary to gain complete information concerning the fall movement. It is suggested, however, that until information to the contrary is obtained, it should be considered a migration for the reasons already stated, and because it occurs at approximately the same time annually. Also, the distance covered during the move, although short, takes the deer from the summer range to the wintering grounds. The cause of the early migration is by no means understood. While the timing is closely correlated with the drying up of perennial fire-weed, there remains an abundance of browse of preferred species. Water, while not as readily available as it was earlier in the season, is still widespread and abundant.

Weather conditions remained essentially unchanged, with the exception of the first fall rain, 0.39 of an inch, which fell on August 29, causing a drop in maximal daily temperature. The main drop in deer numbers followed the drop in temperature (Figure 5). Thereafter, the decline in spotlight sample counts generally reflected the decline in maximal daily temperature, but it is not known whether or not this was the causative factor for migration.

Fisher et al. (5, p. 10) reported a similar situation in the Interstate Deer Herd. They state, "While, according to local folklore, migrations start with fall storms, actually they start with an almost imperceptible change in weather. Storms intensify movement. However, the trigger that starts the migration is probably the seasonal drop in temperature." Seasonal temperature decline, then, may well be the cause of the early migration of the Andrews herd.

There were two principal paths used by deer during the fall migration. One is through a low saddle in Lookout Ridge where the elevation drops to 3,200 feet from its

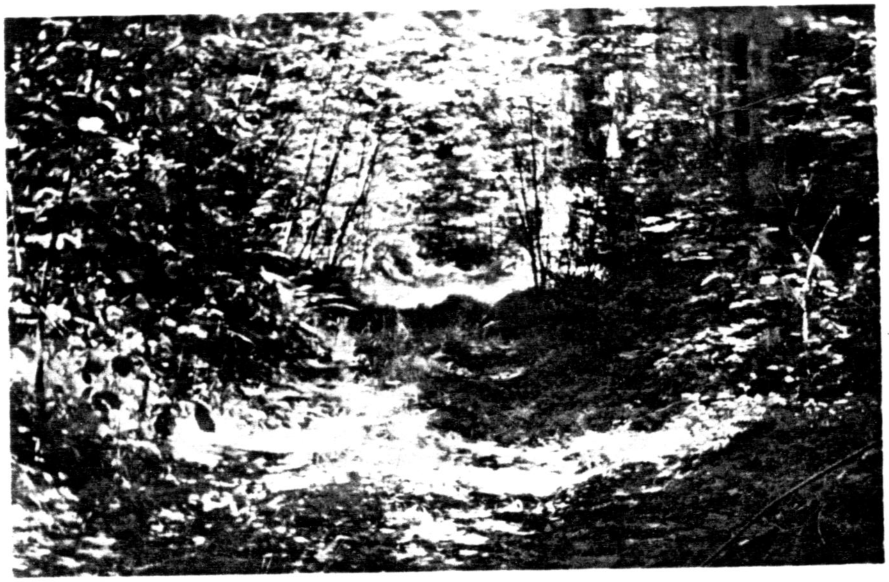


Figure 6. Old Logging Road Along Blue River
Used as a Route of Migration.

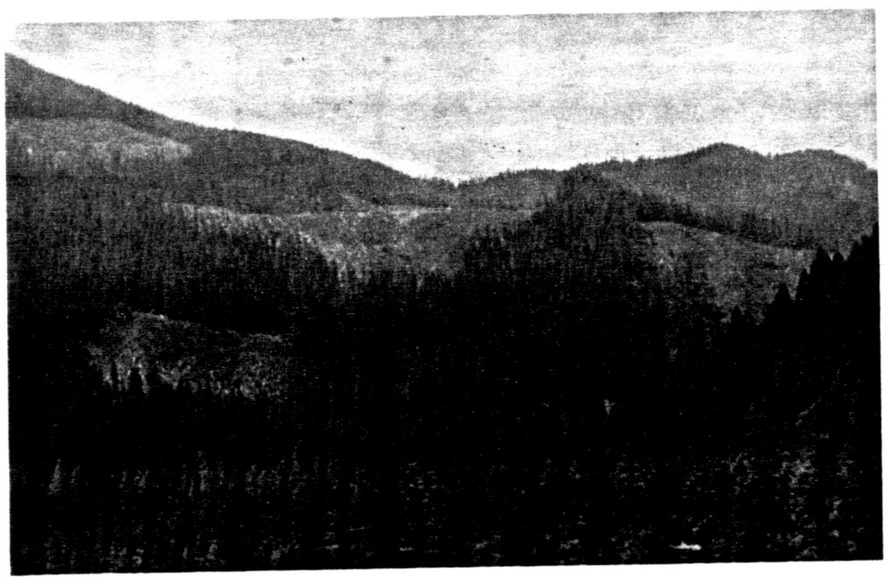


Figure 7. Low Saddle in Lookout Ridge
Used by Migrating Deer.

usual 4,000 feet or more height (Figure 7). This route provides a quick and easy passage from the north slope units over the top of Lookout Ridge to the south slope Mill Creek Units, which are located on the main McKenzie River drainage. It is a short distance, the saddle being less than one mile from some of the north slope Andrews Forest units.

The other route used in the fall migration is down the Lookout Drainage, which is a gradual, but constant downhill trek. Although the migration is not restricted to a single trail, often deer using the route take advantage of access roads for easy traveling. Many, when reaching the Blue River, cross it near the Lookout Creek confluence and move along an old abandoned logging road that parallels the river on the west side (Figure 6).

Although the evidence is inconclusive, it is possible that the deer use the same route habitually, not switching from one to the other. A definite indication that such is the case was obtained following the first snowfall of the season on November 13. The following day, a complete reconnaissance of the Andrews Forest was made in search of deer sign. In the snow, two sets of tracks were found that led from unit 1B up through the low saddle in Lookout Ridge. These animals preferred to move through approximately one foot of snow to pass over the top of the ridge rather than move down along the drainage which was free of snow.

According to Leopold et al. (7, p. 81), each deer in the Jawbone Deer Herd in California has a highly specific winter home range to which it returns each year. The authors state that "Close observation of the deer arriving on the winter range indicates that each adult animal knows precisely where it is going and leaves the main trail (and the company of other migrating deer) at the most convenient point to reach its own customary wintering area." Considering such to be the case with the Andrews herd, and since many deer are known to return to the same home locale on the summer range, such would indicate that the migrational path between the two areas is also quite well defined. Each deer would have a separate home range for summer and winter connected by the migrational route between the two. Therefore, individual animals, though they chose their own home areas, would habitually tend to follow the same migration route year after year. Since there are two main routes of migration, this assumption would further suggest that the deer first inhabiting the early cuttings originated from two separate sources, to which each returns in the winter by separate migrational routes.

The deer in this area winter on the exposed south-facing slopes and protected valleys at the lower elevations. Generally, these areas are sites of old logging operations where the virgin timber has been removed, and low-growing shrubs and trees furnish food within reach of the deer.

Einarsen (4, p. 311) has shown that crude protein of browse decreases during periods of cloudy and dull weather. This is an important consideration during the rainy winter months when little sunshine reaches the plants. The crude protein level of five percent is given by Einarsen as the critical point below which malnutrition and deer losses can be expected. Comparisons of crude protein percentages by Dealy (2, p. 33) between logged and canopied areas, on January 15, 1956, indicated that food plants in canopied areas were consistently lower in nutritional value. Crude protein levels of plants taken under the timber often yielded percentages below the five percent level considered by Einarsen to be critical.

The above studies emphasize the necessity of logged areas for overwintering deer. It is not enough that a high total acreage be available for the animals at the low elevations. These areas must also be covered by a growth of lesser vegetation in a brushy early stage of forest succession, since only such types of vegetation will furnish browse in quantity, and of a sufficient nutrient content to safely overwinter black-tailed deer.

The south slopes utilized by wintering deer are in the best position to benefit from what little sunshine occurs during the winter period. South slopes have the added advantage of affording easy downward movement in case of additional snowfall. The black-tailed deer studied are quite intolerant of snow, and as little as five inches of snow may cause them to move down. On February 28 approximately four to five inches of snow fell. The deer in a logged unit on the south slope of Lookout Ridge away from the Andrews Forest moved to a unit roughly 500 to 1,000 feet lower in elevation. A relatively heavy snowfall on November 14 drove the deer from many of the higher areas of the wintering grounds. As the snowline receded during the following weeks, the deer drifted upward again and reoccupied their former range up to the snowline.

Such elevational movements in response to snowfall are quite common and may occur repeatedly during a single winter. It is apparent that a considerable reduction of available wintering areas would result from heavy and persistent winter snows. It was such a situation which led Dealy (2, p. 36-38) to misinterpret such a movement as a deer migration. Unusually persistent snows during the winter of 1956, when Dealy's observations were taken, masked the character of the movement. The areas from which deer movements were observed by Dealy are in average winters below the snowline, and hence are a part of the normal wintering area.

Thus far, only the upper limits of the wintering grounds have been discussed. Since the trapping and marking program failed, no means of determining the full extent of the migration was available. While many deer undoubtedly wintered close to the upper altitudinal limits, there is much evidence indicating that at least a portion of the herd moved down into bottomlands and deltas next to the McKenzie River. Numerous tracks were followed that led down to the river, but there was no means of determining whether or not they were made by deer from the Andrews Forest, since they could not be traced back that far. It should be pointed out that black-tailed deer are excellent swimmers, hence water is seldom a barrier to movements. Deer were known to have crossed Blue River frequently, and several reliable persons reported observing deer crossing the swift current of the McKenzie. One person, whose place of work was close to the river, related having seen four deer crossing at various times during the period of downward migration. He noted that none of the animals fought the current, but rather swam calmly until footing was gained on the far side. Norman Johnson, U.S. Fish and Wildlife Service Biologist, told of flushing a blacktail doe which plunged into the Willamette River and crossed to the other side. He expressed the opinion that the deer swam across on a straighter course than would have been possible for his Labrador retreiver.

It is possible, therefore, that deer from the Andrews

Forest could have crossed the McKenzie River and moved downstream but it seems doubtful that they would move far, since adequate wintering range is available in this area. It is believed that few, if any, of the Andrews deer move beyond the town of Blue River.

SUMMARY

A study of the Columbian black-tailed deer, <u>Odocoileus hemionus columbianus</u> (Richardson), inhabiting the logged environment of the H.J. Andrews Experimental Forest in the west-central Oregon Cascades was conducted from January 8 to December 30, 1958. The study was a part of a long term project to determine the effects of clear-cut, staggered-setting logging of old-growth Douglas-fir upon wildlife.

Night spotlight samples were taken twice weekly from April through September, while the deer were on their summer range in the Andrews Forest. The logged areas were covered by the beam of a hand spotlight while driving the road system of the area. Deer present were observed by the reflection of light from their eyes. Binoculars were used in an attempt to classify the deer according to age and sex. Sampling was begun one to two hours after darkness and was usually completed in three to four hours.

Daylight samples were taken during the months of June and July on the same days as the night samples. Similar procedures were used in conducting the two types of samples. Daylight sampling was started shortly after daylight and required three to four hours to complete. These sampling methods were not successful in the lower elevations to which the Andrews Forest herd migrated during the winter, consequently, a foot travel method of study was

used for this segment of the study. Greater emphasis was placed on the interpretation of sign.

Limited information indicates a low number of deer were resident to the area prior to the beginning of logging activities in 1950. Deer increased during the successional stages of brushy vegetation that developed following the removal of the canopy of mature timber. Deer further benefited from the creation of edge habitat resulting from the corridors of timber remaining between the logged units.

Ratios of 4.19 adults per yearling, 3.24 does per buck and 1.42 fawns per doe were obtained from the spotlight samples taken during the summer. Group size tended to be small during the summer, with single animals and groups of two predominating. Larger groups were encountered during the periods of migration and during the winter. The overall effect upon the herd by predators, including the cougar, coyote, and black bear, which occur in the area, appeared to be relatively unimportant.

Temperature appeared to be the most important weather phenomenon affecting activities of the Andrews Forest herd. Spotlight samples following days of high temperature revealed higher averages of deer sightings, which were a reflection of the percentage of deer active rather than bedded during the sampling period. This may have been attributable to the animals' feeding at night to avoid high daytime temperatures. High variations in temperature during a month resulted in similarly high variations in spotlight sample counts.

No preference between north or south slopes was exhibited by deer during the early season, but a movement toward the north slopes occurred during June, and this aspect was slightly favored through the remainder of the summer. On the north slope, logged units below 2,500 feet in elevation were preferred during the summer, although there was a general tendency for the animals to move to the higher elevations during mid-summer. This trend was sharply reversed in August when a downward movement occurred. Elevational preference on the south slope was evident only during the month of August when 83 percent of the deer were sighted above 2,250 feet.

The spring migration began in late March, and was completed by early May. The movement into the area occurred as a gradual drift as the deer spread out and occupied the logged units. Many deer were found to return to their home ranges of the previous summer. Two main routes were utilized during the fall migration from the area. This migration was unusual in that it occurred during September, long before the start of inclement weather. Both spring and fall migrations were correlated with temperature changes, although not necessarily caused by them.

Logged or burned areas on exposed south slopes and bottom lands at the lower elevations were used by the deer as wintering grounds. The need for non-timbered areas to carry the deer safely through the winter is based on nutritional quality as well as quantity of the available browse.

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