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Title DISTRIBUTION PATTERNS OF BLACK-TAILED DEER (ODOCOILEUS HEMIONUS COLUMBIANUS) IN RELATION TO ENVIRONMENT

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Direct observation of a known number of black-tailed deer (Odocoileus hemionus columbianus), within the Cedar Creek study enclosure in the Tillamook Burn, Oregon, was carried on throughout 1964. Observations were made from three huts located outside of the enclosure on surrounding prominences. During this period, 1,410 hours of observational time yielded 6,746 sightings of deer. The distribution and activities of these deer were related to forage availability, plant communities, and climatic conditions.

Extremes and sharp changes in temperature influenced deer activity. Deer became inactive when temperatures exceeded 60 degrees Fahrenheit. Both low temperature and sudden drops in temperature resulted in greatly reduced activity.

Deer showed seasonal preferences for huckleberry-salal, big-leafed maple, and alder plant communities, while use of the vine

maple community remained high throughout the year. The thimbleberry and bracken fern communities received relatively low use by deer. Plotted ratios of these preferences indicate winter survival value for deer in the juxtaposition of certain plant communities and a nonrandom distribution of deer.

Seasonal distribution of deer was also influenced by elevation. Deer sighted above 1,500 feet msl made up 84.7 percent of the total annual sightings. Seasonal peaks of daily activity were recorded as follows: midday peaks during January and February followed by early morning peaks during March, April, and May; slight late morning peaks and high twilight peaks in June through August; high early morning peaks and slighter twilight peaks in September; peaks in early morning and at midday with some revival at twilight in October; high activity throughout the day with a peak at midday in November; and high activity from midmorning to twilight during December.

Home range size was influenced by sex, age, available forage, water, cover, and prevailing weather. The largest annual home range was 312 horizontal acres and the smallest 86 horizontal acres. Size of monthly home ranges varied from 12.8 to 39.6 percent of the annual home range sizes.

There was considerable variability in the distribution of deer among major land units.

DISTRIBUTION PATTERNS OF BLACK-TAILED DEER (*ODOCOILEUS HEMIONUS COLUMBIANUS*) IN RELATION TO ENVIRONMENT

by

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INTRODUCTION

This is a report on a study of distribution patterns of black-tailed deer (Odocoileus hemionus columbianus) in relation to measured environment, as obtained by direct observation throughout 1964. The study enclosure, 340 horizontal surface acres, is located in the Tillamook Burn, Tillamook County, Oregon. I attempted to relate the activity of deer to previously and currently available forage, to plant communities, and to climatic conditions.

This study was completed during the sixth year of a ten year program initiated by the Oregon State Game Commission and the Oregon State Board of Forestry to obtain data on the interrelation of black-tailed deer and Douglas fir (Pseudotsuga menziesii) in the Tillamook Burn.

DESCRIPTION OF THE CEDAR CREEK STUDY ENCLOSURE

Location

The study area is located in the Coast Range Mountains of northwestern Oregon, approximately 18 miles inland from the coastal town of Tillamook, in that portion of Tillamook County known as the Tillamook Burn.

Size and Physiography

Approximately 340 horizontal acres are enclosed by about 2.9 miles of essentially deer-proof, woven-wire fence, topped with two to three strands of barbed wire. Three distinct land units are recognized within the enclosure: the East Drainage, the West Drainage, and the Flats. These units are indicated in Figure 1 by broken lines. The East and West drainages originate within the enclosure. A central ridge divides the two drainages and drops sharply to the eastern edge of the Flats. Each drainage contains several narrow ridges with many steep slopes, often approaching 80 percent in grade. The Flats is confined to an elevational belt from 800 to 1,400 feet, but most of the unit lies below 1,100 feet. Two lesser ridges extend into the central portion of the Flats, diminishing before they reach the lower boundary of the enclosure. The topography of the Flats

resembles the knob-kettle type of glaciated area. The area has been described by Bailey (1963) and Crouch (1964).

Soils

Five soil series are found within the enclosure (Bailey, 1963). The sediment-derived Astoria and Trask series are found below 1,300 feet elevation. The Hembre II series is found at both high and low elevations, while Hembre I and Kilches soils are restricted to high elevations. The latter three series are of basaltic origin.

Climate

Being west of the summit, the area is characterized by high precipitation. A 130-inch 25-year average was obtained from a station (Glenora) located three miles from the study area (Bailey, 1963). Maritime influences result in cool, wet winters with prolonged snow cover sufficient to restrict deer travel above 2,000 feet in elevation. The summers are usually dry and hot, but small, non-intermittent creeks occur in the study area.

Local Fauna

The fauna of the Tillamook Burn is typical of extensive seral growth areas in the coastal mountains of the Pacific Northwest. There are high populations of black-tailed deer and Roosevelt elk (Cervus canadensis roosevelti). With the exception of Roosevelt elk and black bear (Ursus americanus), the species composition within the enclosure is comparable to that found throughout the Burn. Coyotes (Canis latrans) and bobcats (Lynx rufus) are common; however, bobcats are usually more abundant on high ground. Mountain lions (Felis concolor) and black bears are present in low numbers and are usually transient. Several species of hawks and owls are seasonal residents. Ruffed grouse (Bonasa umbellus) are found in the creek bottoms while blue grouse (Dendragapus obscurus) frequent the high ground. Coveys of mountain quail (Oreortyx picta) are often seen on the hillsides. Populations of song birds are high in summer, but few birds remain during the winter. Brush rabbits (Sylvilagus bachmani) abound at the lower elevations, and snowshoe hares (Lepus americanus) are common throughout the area. A detailed description of the region's fauna is given by Bailey (1936).

Plant Communities

The enclosure contains the typical seral plant growth that follows fires or clear-cut logging in the Coast Range Mountains of northwestern Oregon. The majority of species present existed as minor components of the pre-burn forest (Crouch, 1964). The vegetation within the enclosure has been studied by Bailey (1963) and Crouch (1964). The latter author (Crouch, 1964) considered environmental factors influencing plant growth, while Bailey (1963) described six seral plant communities and their associated physical environments. Bailey's (1963, p. 37-53) six seral plant communities are identified as follows:

Acer circinatum/*Corylus californica*[1] (ACCI/COCA)

Vaccinium parvifolium/*Gaultheria shallon* (VAPA/GASH)

Pteridum aquilinum/*Lotus crassifolius* (PTAW/LOCR)

Rubus parviflorus/*Trientalis latifolia* (RUPA/TRLA)

Acer macrophyllum/*Symphoricarpos mollis* (ACMA/SYMO)

Alnus rubra/*Acer circinatum* (ALRU/ACCI) communities.

Henceforth, each established plant community will be referred to by the common name of the first species in the name, that is, *Acer circinatum*/*Corylus californica* will be called the vine maple community.

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[1] *Corylus californica* of Bailey (1963) is classified as *Corylus cornuta* in Crouch (1964).

METHODS

Collection of Experimental Animals

The period, July 1 to November 21, 1963, was devoted to the capture of black-tailed deer from surrounding areas for introduction into the Cedar Creek enclosure. Records for capture and release into the Cedar Creek enclosure are given in Table 1. A CO_2 Cap-Chur rifle, (Palmer Chemical and Equipment Company, Inc., Atlanta, Georgia) firing a 1 cc., 50 cal. syringe with a three-fourths inch (NE-2), barbed needle point was used to paralyze the deer. Succinylcholine chloride in 20mg./cc. and 50mg./cc. solutions were used as immobilizing agents. The deer were captured at night, by spotlighting along various logging roads. Of the deer taken in this manner, 34 were released in the enclosure, two dying shortly thereafter.

The 1964 Marking System

In order to identify individual deer as effectively as possible, the collar and streamer designs previously used in the enclosure were modified. Collars and streamers were made of nylon-interwoven vinyl material. The collar flaps, five- by twelve-inch strips, were secured around the animal's neck with a polyethylene braided rope. The streamers, except for fawns, were narrow strips

Table 1. A record of the capture and release of individual deer into the Cedar Creek study enclosure during 1963.

Sex and Age Class	Date of Capture and Release	Location of Capture
Adult Female		
No. 1	September 11, 1963	Jordan Creek Road
2	September 20, 1963	Cedar Creek Road
3*	September 21, 1963	Cedar Creek Road
4	September 21, 1963	Cedar Creek Road
5	September 18, 1963	Cedar Creek Road
6	August 22, 1963	South Fork Camp
7	September 17, 1963	Cedar Creek Road
8	August 24, 1963	South Fork Camp
9	July 2, 1963	Jordan Creek Road
10*	September 19, 1963	Route 6, one mile west on South Fork Road
10	November 21, 1963	Cedar Creek Road
Adult Male		
0	July 10, 1963	Route 6, one mile west of South Fork Camp
S	July 13, 1963	South Fork Camp
V	October 23, 1963	Archery Road
X	October 30, 1963	South Fork Camp
H	November 8, 1963	Saddle Mountain Road
J	November 20, 1963	Cedar Creek Road
Z	November 20, 1963	Upper Jordan Creek Road
Yearling Female		
No. 3	October 15, 1963	Cedar Creek Road
4	October 23, 1963	South Fork Road
5	November 15, 1963	Jordan Creek Road
7	September 17, 1963	Cedar Creek Road
Yearling Male		
No. 1	July 9, 1963	Jordan Creek Road
2	October 8, 1963	Cedar Creek Road
6	November 13, 1963	Saddle Mountain Road
8	November 16, 1963	Jordan Creek Road
Female Fawn		
W-W	October 8, 1963	South Fork Camp
R-O	September 19, 1963	South Fork Road
R-W	September 18, 1963	Cedar Creek Road
W-R**	December 27, 1963	E. E. Wilson Game Farm
Male Fawn		
O-G	October 23, 1963	Archery Road
O-O**	December 27, 1963	E. E. Wilson Game Farm
O-R**	December 27, 1963	E. E. Wilson Game Farm
O-Y**	December 27, 1963	E. E. Wilson Game Farm

*Animals found dead shortly after introduction

**Bottle-fed fawns

one and one-half by ten inches, while fawn streamers measured one and one-half by six inches. Ear streamers were attached to the animal by "shoulder-socket" type ear tags that fitted through the grommets located on the heads of the streamers. A No. 9 sheep bell was tied into the collar rope on adult animals, and a No. 8 bell was used for yearlings. Fawns of the year wore ear streamers only.

The marking system included several additional features: (1) except for fawns of the year, each animal wore a collar with numerals (letters on adult males) on the upper surface, readable at distances up to one-half mile under ideal conditions; (2) in adult animals, sex and age were indicated by the color of the collar; (3) yearlings wore blue collars with a white center strip; and (4) the color of the left ear streamer indicated the sex of all animals.

Weather Instruments

Weather data were collected during 1964 from eight-day meteorographs and a rain guage (Table 2). All elevational measurements were standardized to mean Sea level.

Table 2. Weather instrumentation and station altitudes at Cedar Creek, 1964.

Station	Elevation (feet msl)	Instrumentation
I	750	Hygrothermograph and bucket-type rain guage
II	1,300	Barothermohygrograph
III	2,150	Hygrothermograph
IV	1,300	Hygrothermograph

All meteorographs were housed 48 inches above the ground in standard U.S.D.A. instrument shelters. Instrument charts were changed at seven-day intervals in association with weekly fence checks.

Forage Production and Utilization

The work of Crouch (1964) was used as the source of information on past forage production and utilization by deer within the enclosure. Crouch's field work was performed between June, 1961, and February, 1964.

During the winter of 1964, supplementary information on utilization of browse plants was obtained from four browse transects. The four woody plant browse transects were established December 1, 1963, on approximately north-, east-, south-, and west-facing slopes, ascending from 800 to 2,150 feet of elevation. The south-facing transect was located on a ridge within the enclosure, while the other three transects were placed outside the enclosure on major ridges in the Cedar Creek Drainage. Each transect was divided into six sample points (800 feet, 1,070 feet, 1,340 feet, 1,610 feet, 1,880 feet, and 2,150 feet). At each elevational point a circle with a 50-foot radius was established and ten specimens of woody plants were tagged for biweekly checks.

Plant Communities

Movement and activity sightings were related to the findings of Bailey (1963), who characterized the seral plant communities and determined the vegetation-soil relationships within the study area. During 1963, A. W. Bailey and W. W. Hines (unpublished report) mapped the plant communities within the enclosure. The percentage of horizontal surface acres occupied by the various plant communities was calculated by planimetry. Frequency of occurrence of the various plant communities was determined from a gridded aerial photograph (Oregon State Board of Forestry, 1959).

Periodic Observation

Sightings of deer were placed on a gridded map derived from the Cedar Creek aerial photograph. Each square represented 1.3 horizontal acres.

In December of 1963, three observation huts measuring four by four by five feet were constructed of galvanized iron sheathing and two-by two-inch wood framing. During December, one observation hut was placed on a prominence which overlooked the Flats. However, as a result of adverse weather, it was late January, 1964, before the other two observation huts were in place overlooking the East and West drainages, respectively.

When the three observation huts were manned, approximately 70-80 percent of the enclosure would be surveyed. Initially, an attempt was made to obtain equal observation hours under similar weather conditions from each observation post, but it was soon evident that this could not be done.

The posts were manned by the author with the assistance of an undergradute aide and workers from the South Fork Forestry Camp. Each observation post was equipped with a pair of 10 x 50 or 7 x 50 field glasses and a 15x to 60x spotting scope.

RESULTS

Air Temperature

As daily and seasonal deer movement is influenced by air temperature, the daily maximum-minimum temperature records were obtained from four instruments located in the Cedar Creek Drainage. Temperatures were graphed as average weekly maximums-minimums and weekly extremes (Figures 2-5). The yearly maximum temperature recorded during 1964 was 90° F, and and the minimum temperature was minus three degrees. Figures 2-5 show that there was considerable daily temperature fluctuation, particularly during the summer, resulting in cool nights throughout the year. The relation between maximum temperature, minimum relative humidity (based on four-week averages), and precipitation at Station I is shown in Figure 6. High temperature was associated with low humidity and light precipitation. The minimum temperature differences between Stations I, II, III, and IV (with 32 and 20 degrees Fahrenheit used as reference values) are summarized in Table 3. The enclosure was coldest at high elevations but warmest at intermediate elevations.

Relative Humidity

Maximum-minimum relative humidities were obtained from three elevational levels, 750 feet, 1,300 feet, and 2,150 feet, at Stations I, III and IV, respectively. Relative humidity and

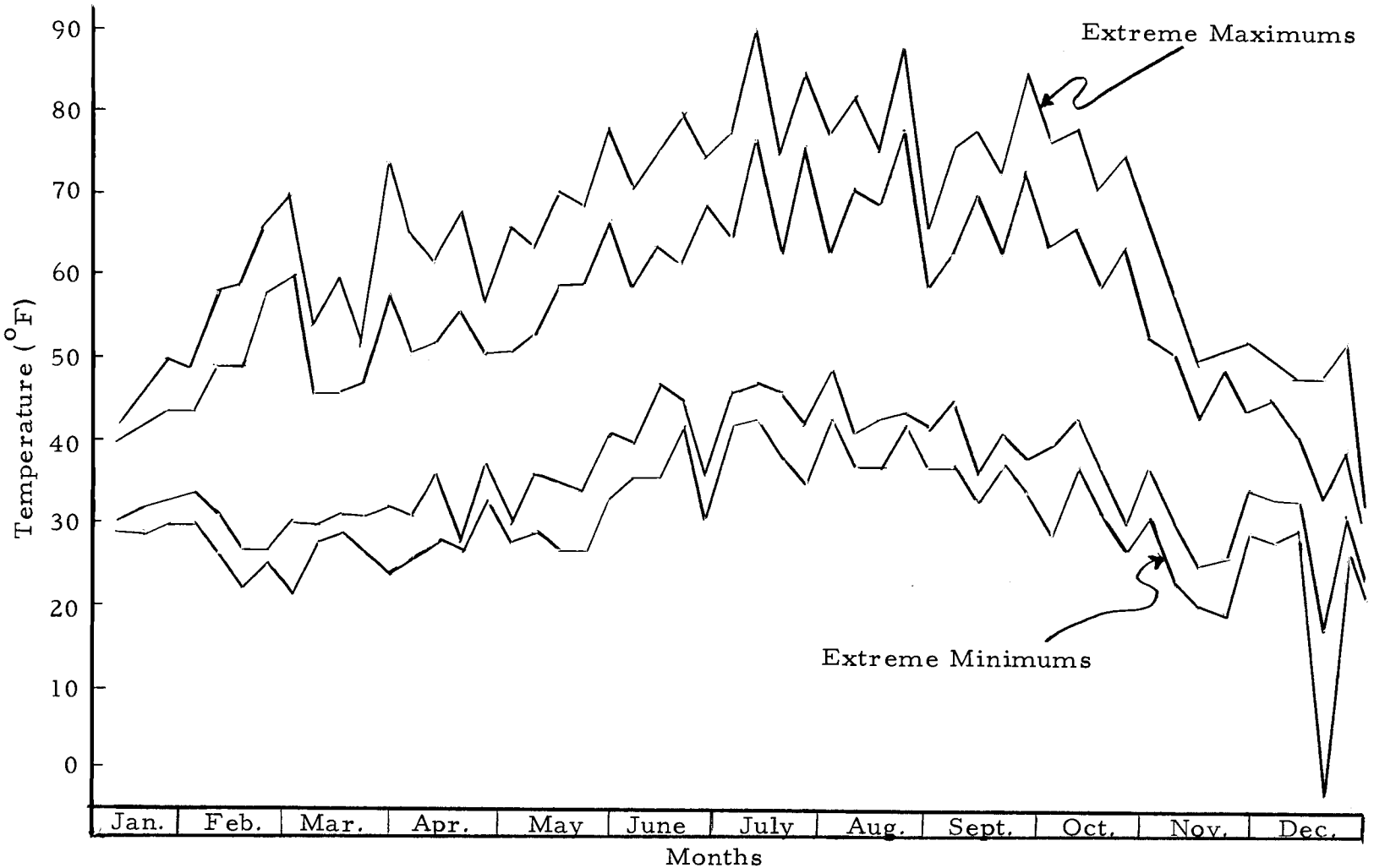

Figure 2. Average weekly maximum-minimum temperatures and weekly temperature extremes at Station I (750 feet msl elevation) during 1964.

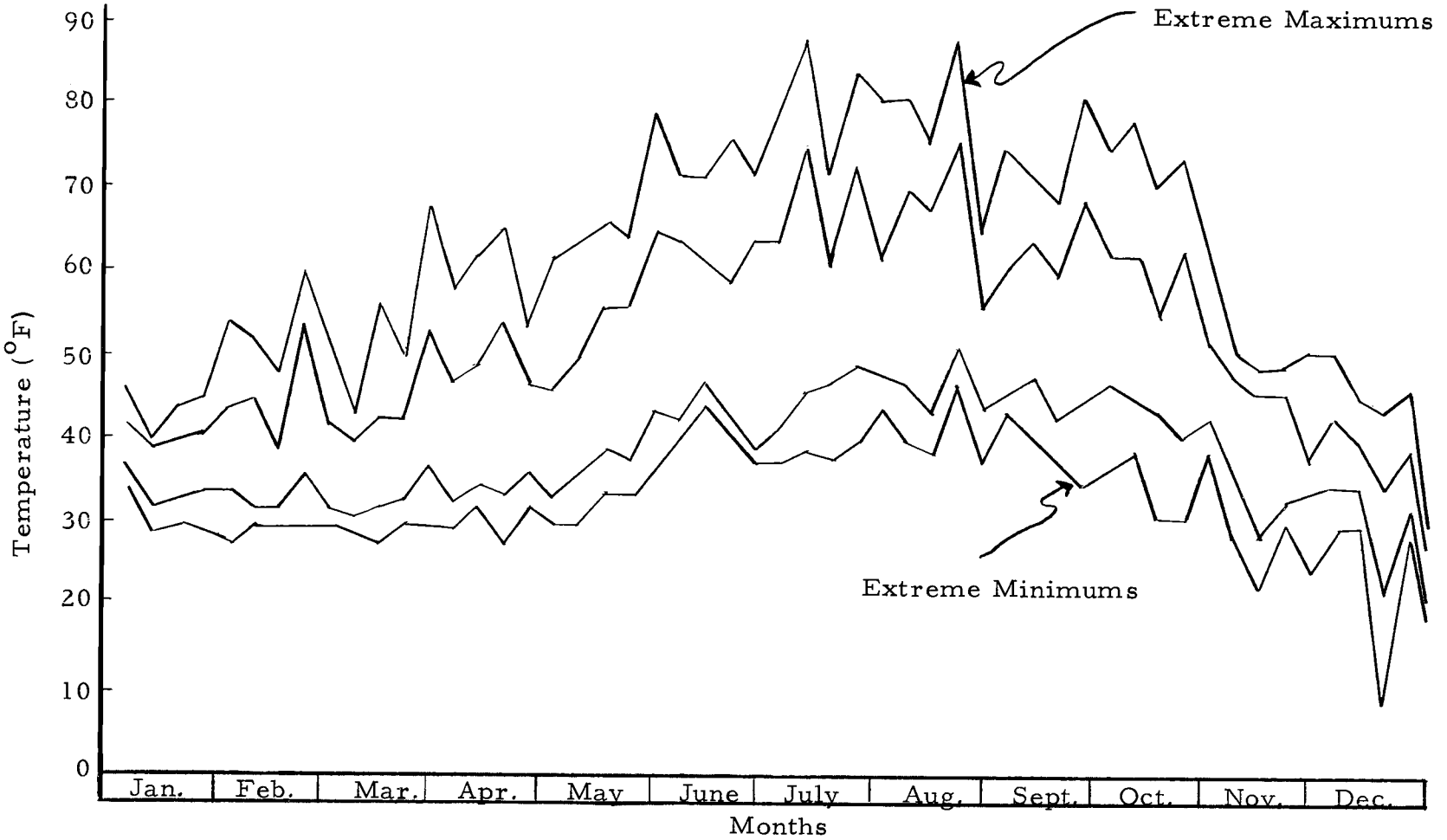

Figure 3. Average weekly maximum-minimum temperatures and weekly temperature extremes at Station II (1, 300 feet msl elevation) during 1964.

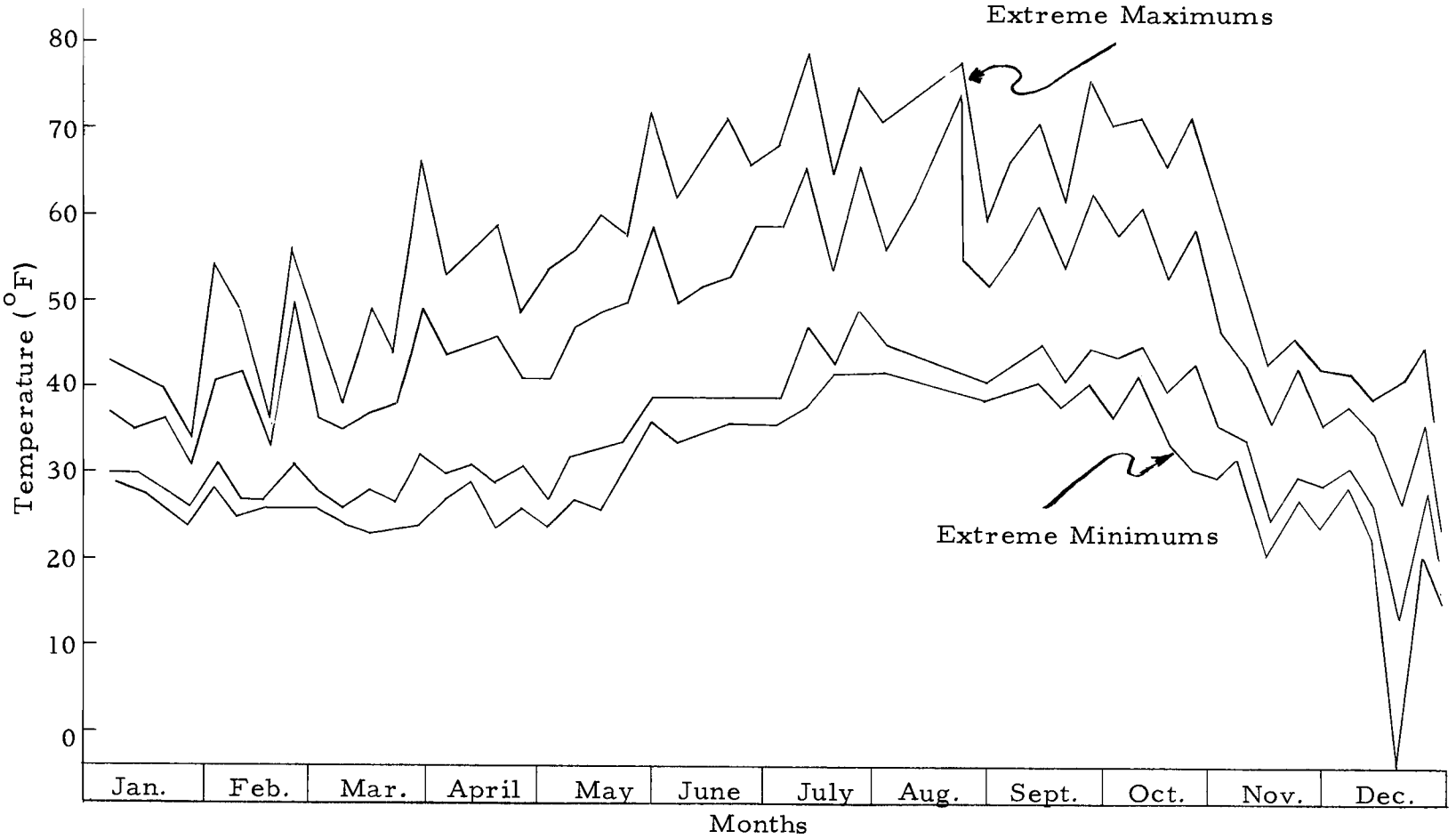

Figure 4. Average weekly maximum-minimum temperatures and weekly temperature extremes at Station III (2, 150 feet msl elevation) during 1964.

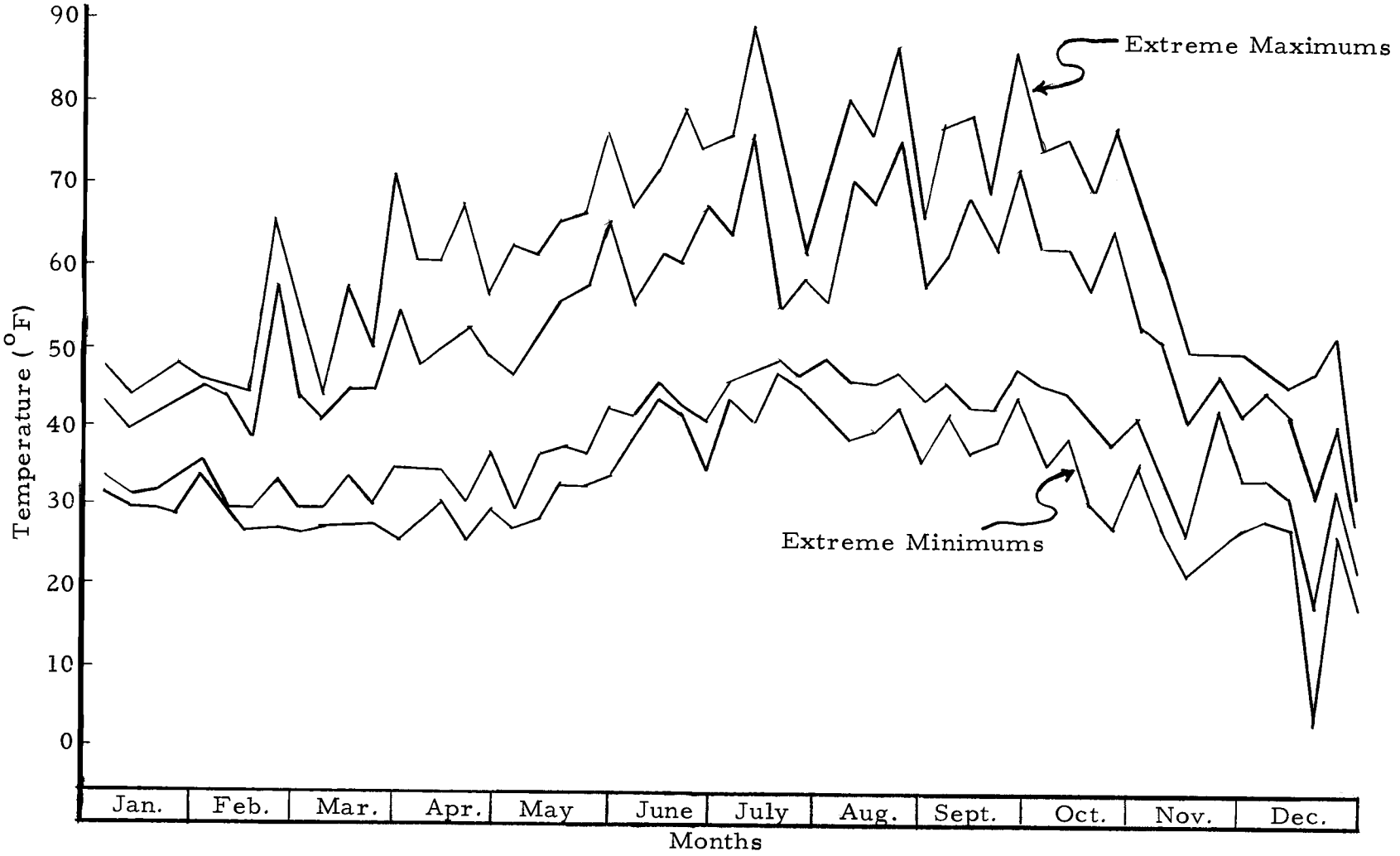

Figure 5. Average weekly maximum-minimum temperatures and weekly temperature extremes at Station IV (1, 300 feet msl elevation) during 1964.

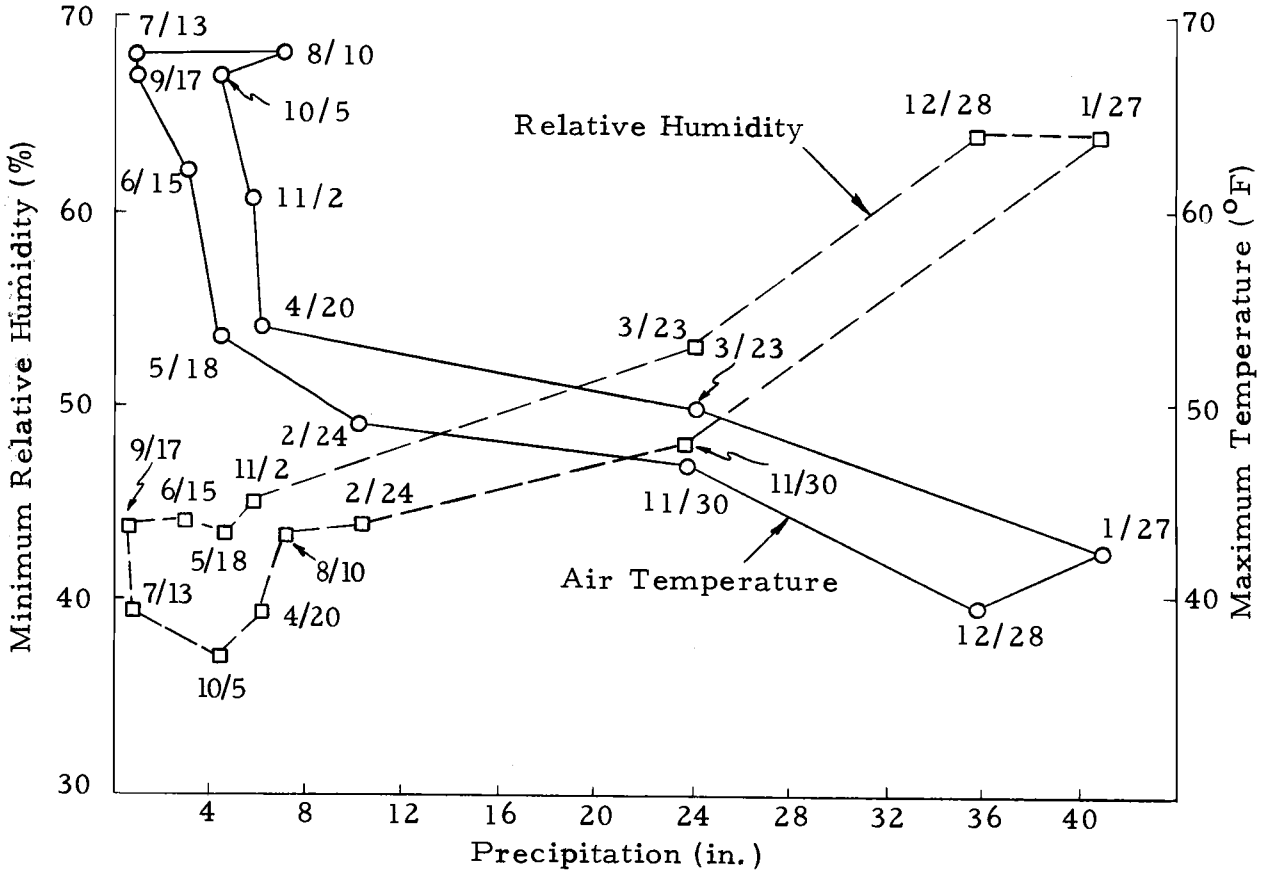

Figure 6. Average four-week maximum temperature, mean four-week minimum relative humidity, and four-week precipitation relationships at Station I during 1964.

Table 3. Summary of minimum temperatures, 1964.

Elevation Above Sea Level	Days With Periods Below 32°F.	Days When Entire 24 Hours Were Below 32°F.	Days With Periods Below 20°F.
Station I 750 feet msl elevation	147 January-June October-December	8 8 in December	3 year low December (-3°F.)
Station II East drainage 1,300 feet msl elevation	102 January-May October-December	9 3 in November 6 in December	3 year low December 2°F.
Station IV West Drainage 1,300 feet msl elevation	119 January-May October-December	8 8 in December	3 year low December 4°F.
Station III Top Flat 2,150 feet msl	175 January-May October-December	37 6 in January 3 in February 8 in March 1 in April 5 in November 14 in December	6 year low December (-3°F.)

barometric pressure records for Station II are not included due to instrument failure.

Only rarely did the maximum relative humidity not exceed 90 percent at night; however, there was considerable daily and seasonal variation in minimum relative humidity. Elevational relationships of average biweekly minimum relative humidities at the three stations are shown in Figure 7. The seasonal changes in comparative average biweekly minimum relative humidities at Stations I and IV based on Station III are presented in Figure 8. Station III was chosen as the base line because the highest minimum relative humidities prevailed there. Figure 8 depicts the influence of elevation on minimum relative humidity.

Precipitation

The regional weather was typified by high winter precipitation with brief periods of clearing weather occurring during February and March. The summer was relatively dry. Eastward moving low pressure areas from the Pacific Ocean caused nearly all precipitation, and a total of 167.5 inches was measured at the Cedar Creek field station during 1964. The weekly values for the year are presented in Figure 9. The maximum rainfall occurred in January and the minimum in September, while rates of precipitation varied from steady mists to torrential downpours.

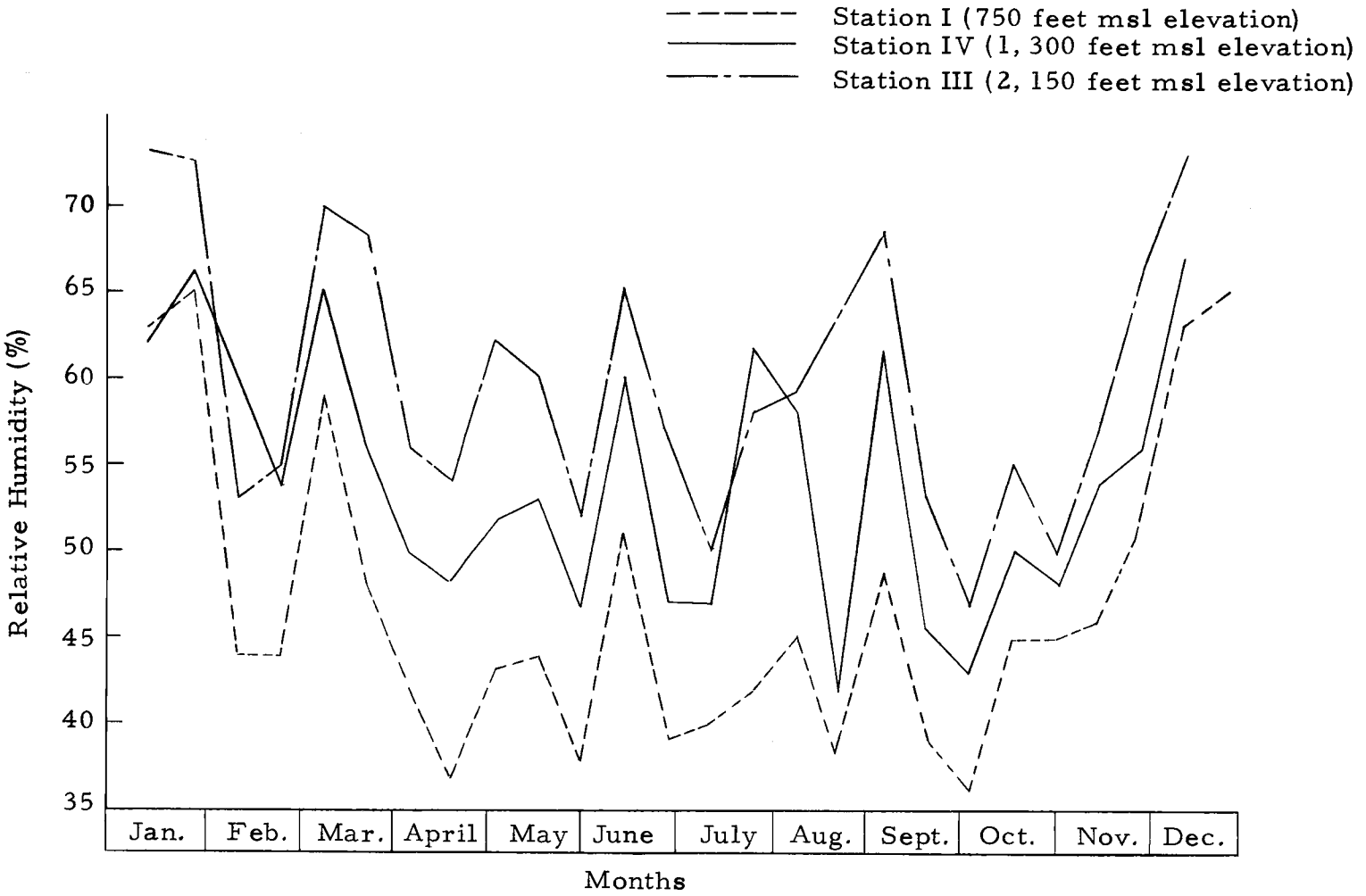

Figure 7. Average biweekly minimum relative humidity from three different elevational levels at Stations I, IV, and III during 1964.

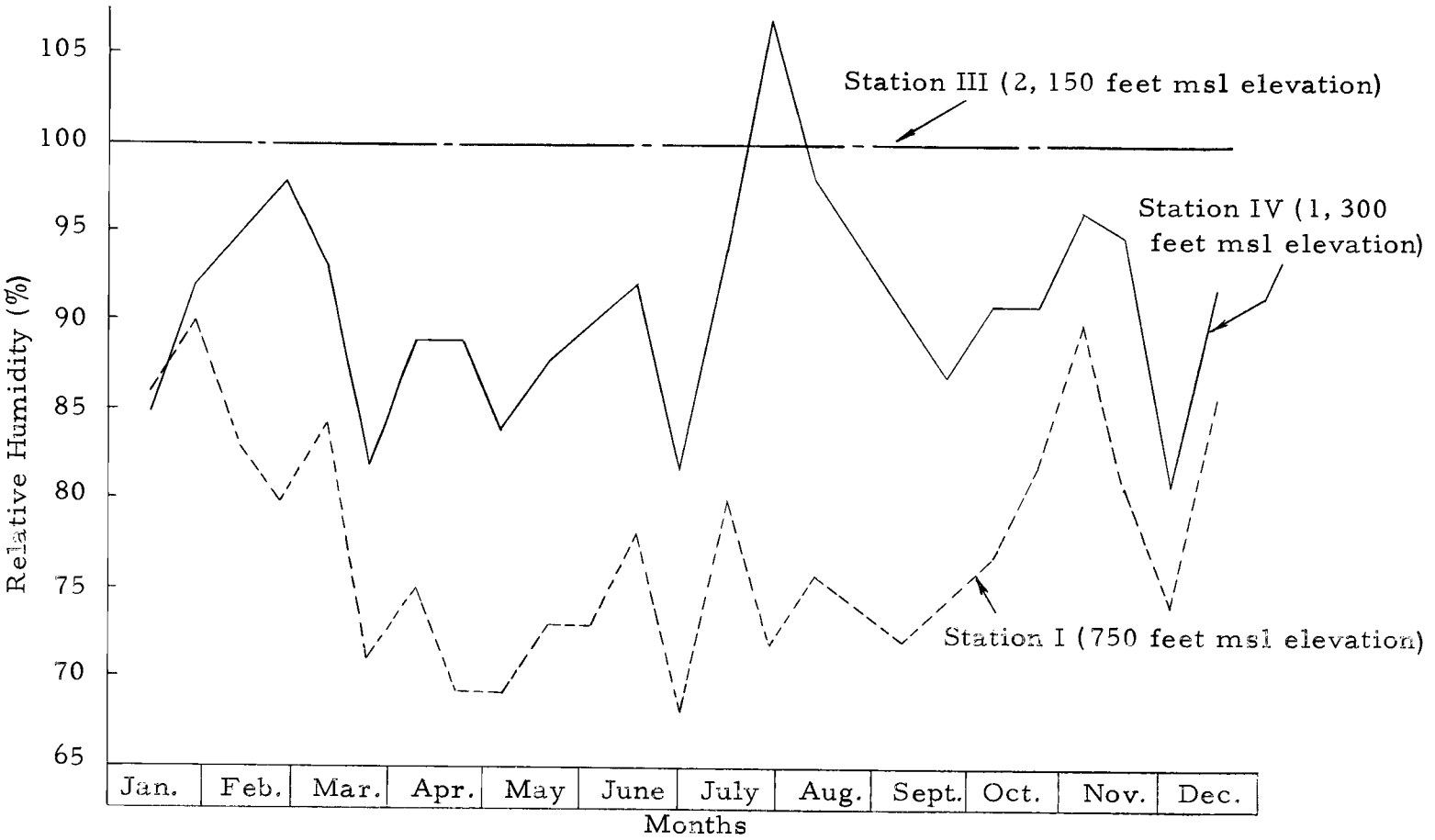

Figure 8. Seasonal changes in the comparative average biweekly minimum relative humidity at Stations I, IV, and III, based on Station III as the 100 percent line.

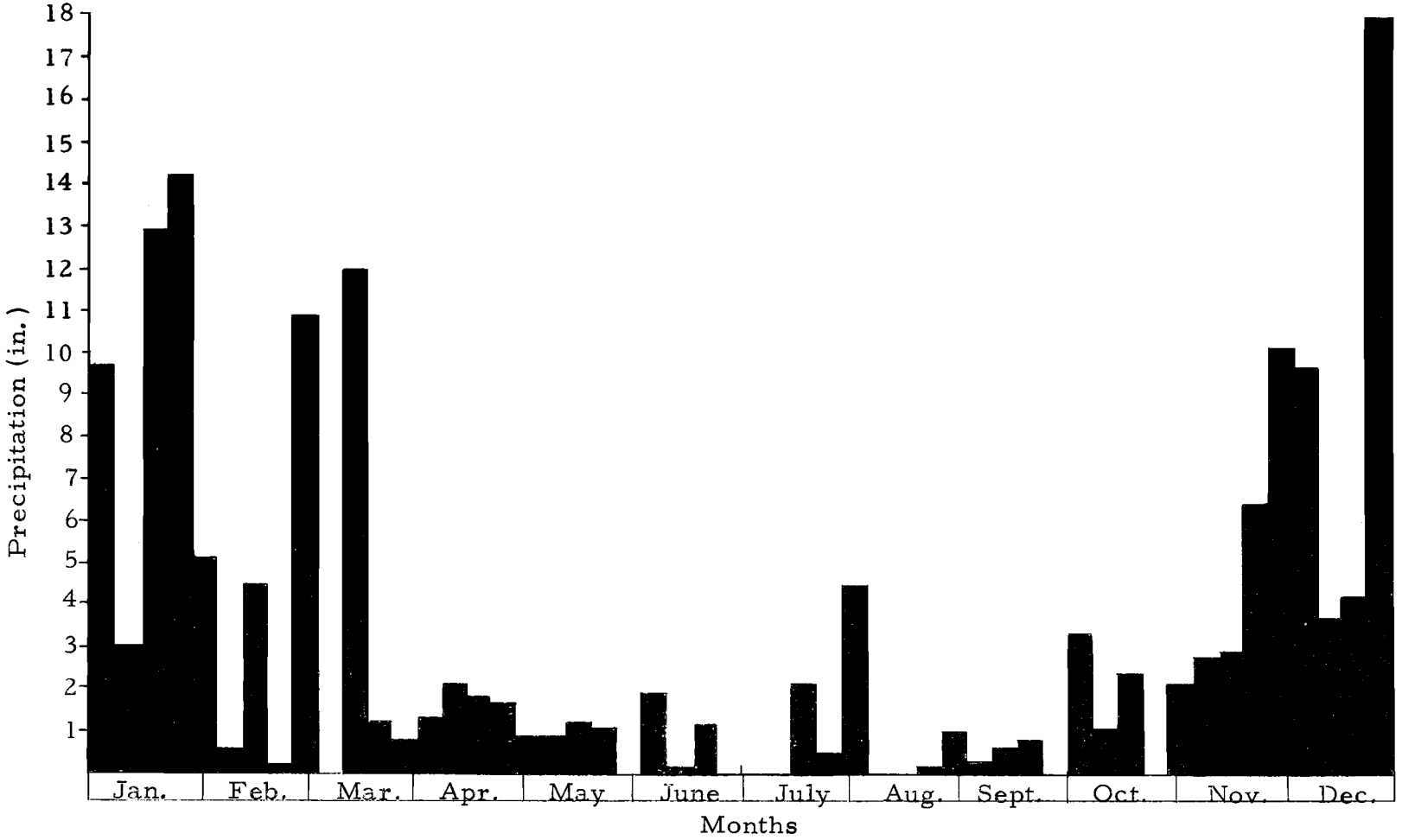

Figure 9. Weekly precipitation at Station I (750 feet msl elevation) during 1964.

The winter of 1964 was typically mild, with little snow cover remaining within the study area for more than three consecutive days. Below 1,200 feet elevation, the longest period of snow cover was 36 hours. Elevational influence upon depth of snow cover is illustrated by Table 4.

Table 4. Elevational influence on snow depth.

Date	Altitude (feet msl)	Snow Depth (inches)
January 19, 1964	800	1-3
	1,070	3-6
	1,340	5-7
	1,610	8-10
	1,880	12-15
	2.150	20-24

Snow cover in excess of 12 inches appeared to hinder deer movement above 1,700 feet elevation. Depths of 18 inches or more resulted in no travel above 1,700 feet. Snow depths of 20 inches makes travel very difficult for white-tailed deer (Odocoileus virginianus) (Taylor, 1956).

Forage Production and Utilization

Forage production and utilization data compiled between June, 1961, and February, 1964, by Crouch (1964) were employed to interpret the observed distribution of deer. Crouch (1964, p. 17) used 110 macroplots 30 x 52 feet with 1,560 square feet of area to measure

production and utilization.

Table 5 shows the percentages of deer observed above and below the 1,500-foot contour. Periods of occasional snow cover during January, February, and March induced deer to move to higher ground where they utilized red huckleberry and salal. During April and May they sought the new growth of vine maple, alder, red huckleberry, trailing blackberry, grasses, and forbs which were undergoing more rapid growth at lower elevations. From June through September, daytime activity at higher elevations remained steady (Table 5); however, observation at first light of fresh deer trails leading from high locations to lower ones where deer were sighted, suggested that considerable nocturnal activity occurred at high elevations. In October, prior to the rut, many deer moved to high ground. The weather was atypically sunny with warm, dry winds out of the east, and activity during daylight hours was greatly reduced. At rutting time, deer activity again shifted to the lower elevations. This general circumstance continued until late December when heavy snow cover forced them to higher ground. However, two of the older bucks, having terminated their rutting activities in early December, moved to high elevations previous to snowfall.

The yearly percentage of total deer sightings below 1,500 feet elevation was 84.7 percent, 5.5 times the number of deer sighted above 1,500 feet. Crouch (1964, p. 137), by use of vegetation

TABLE 5. Monthly distribution of deer sighted above or below an altitude of 1, 500 feet msl, 1964.

Months	Number of Times Individual Deer Sighted Above 1, 500 feet msl	Percentage of Total Sightings	Number of Times Individual Deer Sighted Below 1, 500 feet msl	Percentage of Total Sightings	Total Sightings
January	42	28.6	105	71.4	147
February	99	38.1	161	61.9	260
March	98	23.4	321	76.6	419
April	79	11.0	637	89.0	716
May	96	8.4	929	90.6	1, 025
June	87	17.2	420	82.8	507
July	99	14.1	602	85.9	701
August	89	16.3	457	83.7	546
September	96	15.4	527	84.6	623
October	100	29.7	237	70.3	337
November	76	8.4	828	91.6	904
December	60	11.9	445	88.1	505
Totals	1, 021		5, 669		6, 690
Percent		15.3		84.7	

macroplots found that animals were more abundant on flatter areas at lower elevations. This author (pp. 68 and 73) also determined that there were approximately 2. 2 times as many browse plants and 3. 7 times as much green forage produced below 1, 500 feet elevation.

Deer movements are often governed by both forage availability and prevailing weather. Consequently, information on plant species consumed and the physiographic features of the areas where deer concentrate is important in determining why animals show location preferences. Low elevation, low percent of slope, southeast aspect, convex slope form, soil depth and type, high surface disturbance, and plant community (vine maple and huckleberry-salal being highest) all contribute to higher production of preferred forage species (Crouch, 1964), and the majority of these physiographic features can be seen on the sites most frequented by feeding deer. Knowledge of the value of these land features to the potential and current production of forage allows the field man to better evaluate large land units by visual survey.

In order to evaluate the influence of slope exposure on winter use by deer, single woody plant browse transects were established on north-, east-, south-, and west-facing slopes. Since the enclosure was primarily south-facing, the three remaining transects were established on major ridges outside of the study area. Data obtained from transect checks provided additional information on the

preference by deer for certain browse species.

The results of biweekly measurements on these four browse transects are assembled in Table 6. Deer exhibited a strong preference for red huckleberry (Vapa) on all transects. The mean percentage of transect use was lowest within the enclosure, possibly due to elk exclusion, while the corresponding value for the three transects outside the study area were quite similar. The lowest elevation received the least use in all transects, and intermediate elevations received the greatest use. The high percentage of use for the 2,150-foot elevational point on the east-facing slope resulted from its location on a well-traveled elk route.

Douglas fir is considered a winter survival food for deer in the Tillamook Burn (Lightfoot and Hines, 1960; Bailey, 1963, p. 2; and Crouch, 1964, p. 75). This was verified by determining the date of initial use by deer and its relation to snow cover. Initial use of Douglas fir in the four transects by deer, elk, and rodents (including lagomorphs) is given in Table 7. No differentiation between use by hares, rabbits, mice, and mountain beavers was made. All were grouped under rodents. First use occurred between January 3 and January 17, 1964, most likely after the snowfall of January 12, 1964.

Snow cover in excess of two feet at 2,000 feet elevation forced deer to lower elevations where the availability of preferred species was greatly restricted by light snow cover.

Table 6. Deer, elk, and rodent utilization in four woody plant browse transects (800 feet msl to 2,150 feet msl elevation) from December 1, 1963, to April 15, 1964, in the Cedar Creek Drainage.

Elevation (feet msl)	Percentage of Utilization		Species Utilized	Species Present[#]
	Deer and Elk	Rodents[@]		
North-facing Slope				
800[#]	none	20	Vapa	Vapa, Alru, Acci, Coco
1,070	30	30	Vapa, Alru[¢]	Vapa, Alru, Hodi
1,340	50	none	Vapa	Vapa, Alru
1,610	40	none	Vapa	Vapa, Acci
1,880	10	none	Vapa	Vapa, Acci
2,150	10	30	Vapa, Alru,[%] Acci[¢]	
Transect Mean	23	13		
East-facing Slope				
800	no sample			
1,070	none	none	none	Vapa, Sasp, Alru
1,340	20	none	Vapa	Vapa, Acci
1,610	none	none	none	Vapa, Acci
1,880	30	none	Vapa	Vapa, Alru, Acci
2,150	80	none	Vapa, Alru[%]	Vapa, Alru, Acci
Transect Mean	26	0		
South-facing Slope[&]				
800	none	20	Acci, Rhpu	Alru, Acci, Hodi, Rhpu, Coco
1,070	10	none	Vapa	Vapa, Alru, Acci, Coco, Rogy
1,340	none	none	none	Vapa, Acci, Hodi
1,610	10	10	Vapa	Vapa, Acci, Cesa, Coco, Rogy, Hodi
1,880	20	none	Vapa	Vapa, Acci Cesa
2,150	10	none	Vapa	Vapa, Alru, Acci, Hodi, Prem, Saca
Transect Mean	8.3[*]	5		

Continued

Table 6-continued

Elevation (feet msl)	Percentage of Utilization: Deer and Elk	Rodents@	Species Utilized	Species Present#
West-facing Slope				
800	none	none	none	Alru, Acci
1,070	30	none	Vapa	Vapa, Acci, Hodi
1,340	20	none	Vapa	Vapa, Alru, Acci, Hodi
1,610	90	none	Vapa, Hodi, Alru%	Vapa, Alru, Hodi
1,880	none	none	none	Vapa, Hodi
2,075	none	none	none	Vapa, Alru, Acci, Hodi
Transect Mean	23	0		

KEY

@Includes lagomorphs, use by hares, rabbits and rodents was not differentiated
#Key at end of table
$Ten tagged plants at each elevation
%Elk only
¢Rodents only
ℰWithin study area
*Low value possibly due to elk exclusion

Woody plant species

Acci - Acer circinatum - vine maple
Vapa - Vaccinium parvifolium - red huckleberry
Saca - Sambucus caerules - blue elderberry
Alru - Alnus rubra - red alder
Hodi - Holodiscus discolor - ocean spray
Rogy - Rosa gymnocarpa - little wood rose
Cesa - Ceanothus sanguineus - redstem ceanothus
Rhpu - Rhamnus purshiana - cascara
Prem - Prunus emarginata - wild cherry
Coco - Corylus cornuta - western hazel
Sasp - Salix sp. - willow sp.

Table 7. The first Douglas fir utilization by deer, elk, and rodents recorded in four woody plant browse transects during 1964, in the Cedar Creek Drainage.

Elevation (feet msl)	Trees Checked	Utilization
North-facing Slope		
800-1,070	83	5 deer/elk
1,070-1,340	71	2 deer/elk, 5 rodents*
1,340-1,610	185	5 deer/elk
1,610-1,880	24	0 No Use
1,880-2,150	9	0 No Use
Totals 800-2,150	372	12 deer/elk, 5 rodents
Percent 100	100	3.2 1.3
East-facing Slope		
800-1,070	126	25 deer/elk, 2 rodents
1,070-1,340	69	12 deer/elk, 2 rodents
1,340-1,610	8-inch snow cover	Unknown
1,610-1,880	10-inch snow cover	Unknown
1,880-2,150	12-inch snow cover	Unknown
Totals 800-1,340	195	38 deer/elk, 4 rodents
Percent 40	100	19.5 2.1
South-facing Slope**		
800-1,070	89	1 deer
1,070-1,340	6	0 No Use
1,340-1,610	0	0 No Use
1,610-1,880	121	1 deer
1,880-2,150	56	0 No Use
Totals 800-2,150	272	2 deer
Percent 100	100	0.7
West-facing Slope		
800-1,070	24	0 No Use
1,070-1,340	3	0 No Use
1,340-1,610	148	0 No Use
1,610-1,880	59	0 No Use
1,880-2,150	6	0 No Use
Totals 800-2,150	240	0
Percent 100	100	0

*Rodents includes lagomorphs. No differentiation was made between use by hares. rabbits, mice, and mountain beavers.

**South-facing slope within the Cedar Creek study area, no elk present.

Consequently, the deer utilized Douglas fir at lower elevations until preferred species were once again available. At lower elevations snow depths were not sufficient to make the deer totally dependent on Douglas fir and other survival foods such as vine maple, alder, sword fern, and Oregon grape (Berberis nervosa). Wind action resulted in large patches of exposed forage on the west-facing slope, where no fir utilization occurred.

Deer Sightings and Plant Communities

In order to supplement the evaluation of forage conditions in the enclosure, the observed presence of animals was related to each plant community. Table 8 gives monthly percentages of total deer sightings in each plant community within the enclosure. The percentage of total horizontal surface acreage of various plant communities and their percent frequency of occurrence are included for comparison. Sightings in the vine maple community remained relatively consistent throughout the year. Deer presence in the huckleberry-salal community increased in late winter peaking in May and declined throughout the rest of the year. In the big-leafed maple community, deer sightings increased throughout the summer and peaked in October. Relatively few deer were observed throughout the year in the bracken fern and thimbleberry communities. Occurrence in the alder community was highest in the spring and fall.

Table 8. Monthly percentage of deer occurrence by plant community during 1964.

Plant Communities	Percentage of Deer Sightings by months												Percentage of Study Area in Plant Community*	Percent Frequency of Plant Community based on Location Squares
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.		
Vine Maple	67.4	47.3	44.4	58.1	54.2	47.1	58.5	51.6	58.4	47.5	62.6	62.7	52.0	54.5
Huckleberry-Salal	11.6	27.7	29.8	26.0	34.4	29.8	24.1	22.7	18.0	16.0	12.9	13.3	10.5	26.2
Big-leafed Maple	5.4	15.4	15.3	7.0	5.5	9.5	12.1	12.1	12.8	17.8	10.1	11.3	10.0	19.6
Bracken Fern	9.5	6.5	4.0	4.6	2.2	7.3	2.4	7.1	3.9	6.8	5.2	4.4	14.0	29.7
Thimbleberry	5.4	2.7	6.0	3.4	2.4	5.5	2.3	5.9	4.5	11.3	6.5	5.5	13.0	22.0
Alder	0.7	0.4	0.5	1.0	1.3	0.8	0.6	0.6	2.4	0.6	2.8	0.5	0.5	2.8
Number of Sightings of Deer for the Month	147	260	419	716	1,025	507	701	546	623	337	600**	505		
Size of Enclosure Herd	30	30	30	29	26	32	33	33	31	30	29	29		

*Total acreage of the various plant communities: vine maple, 176.8 acres; huckleberry-salal, 35.7 acres; big-leafed maple, 34.0 acres; bracken fern 47.6 acres; thimbleberry, 44.2 acres; and alder, 1.7 acres (acres based on horizontal surface measurement).

**304 movement sightings deleted because of forced nature resulting from rutting activities.

Feeding activities and bed site locations are compiled on a monthly basis in Tables 9 and 10. In general, the percentages of feeding deer sightings by plant community (Table 9) are comparable to the "total sightings" percentage values in Table 8, suggesting that deer forage in all of the locations in which they are observed. However, increases in the percentage of bedded deer sighted indicated a definite selection of cool situations.

The relation between deer location and the six plant communities expressed as a ratio between community frequency of occurrence and the percentage of deer sighted in each community is illustrated by Figure 10. This ratio serves as an index to plant community preference by deer. At various times of the year, deer showed preferences for four of the six plant communities. Deer numbers were relatively consistent in the vine maple community, possibly because of the community's large acreage. The low occurrence of deer in bracken fern and thimbleberry communities was probably due mainly to the exposed nature of the plant communities at high elevations. Feeding deer/plant community and bed site/plant community relationships are shown in Figures 11 and 12. In both categories, the deer showed preference for the same four of the six plant communities. Bedded and feeding trends did not necessarily parallel one another throughout the year. High temperature influence resulted in the selective use of plant communities for bed sites; whereas, lack

Table 9. Monthly percentage of deer feeding activity by plant community during 1964.

Plant Communities	Percentage of Feeding Deer Sightings by Months												Percentage of Study Area in Plant Community*	Percent Frequency of Plant Community based on Location Square
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.		
Vine Maple	70.3	42.9	41.3	60.7	53.5	48.9	60.1	53.5	61.3	53.3	68.6	63.1	52.0	54.5
Huckleberry-Salal	15.4	29.9	32.6	23.0	35.5	30.6	23.1	21.7	17.8	15.7	10.8	13.2	10.5	26.2
Big-leafed Maple	3.3	18.5	14.2	5.6	5.0	8.1	10.9	10.4	9.5	10.3	9.8	11.0	10.0	19.6
Bracken fern	6.6	6.5	4.2	4.6	2.3	6.3	2.9	7.5	4.1	7.7	3.9	4.6	14.0	29.7
Thimbleberry	4.4	2.2	7.1	4.6	2.5	5.4	2.5	6.3	4.8	12.3	5.3	5.7	13.0	22.0
Alder	0.0	0.0	0.6	1.5	1.2	0.7	0.5	0.6	2.5	0.7	1.6	2.4	0.5	2.8
Number of Sightings of Deer for Month	91*	184	310	520	842	509	594	480	560	261	490	418		
Size of Enclosure Herd	30	30	30	29	26	32	33	33	31	30	29	29		

*Movement sightings combined with feeding sightings, except for November, when rutting activities influenced movements.

Table 10. Monthly percentage of bedded deer locations by plant community during 1964.

Plant Communities	Percentage of Bedded Deer Sightings by Months												Percentage of Study Area in Plant Community*	Percent Frequency of Plant Community based on Location Squares
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.		
Vine Maple	62.5	57.9	53.2	57.1	57.4	39.8	49.6	37.9	33.3	27.6	60.9	60.9	52.0	54.5
Huckleberry-Salal	5.4	22.4	22.0	27.1	29.5	26.5	29.9	30.3	19.0	17.1	13.6	13.8	10.5	26.2
Big-leafed Maple	8.9	7.9	18.3	7.5	7.7	15.4	18.7	24.3	42.9	43.4	10.0	12.6	10.0	19.6
Bracken Fern	14.3	6.6	3.7	4.4	1.6	11.2	0.0	4.5	1.6	4.0	4.6	3.5	14.0	29.7
Thimbleberry	7.1	3.9	2.8	3.1	2.2	6.1	0.9	3.0	1.6	7.9	7.3	4.6	13.0	22.0
Alder	1.8	1.3	0.0	0.8	1.6	1.0	0.9	0.0	1.6	0.0	3.6	4.6	0.5	2.8
Number os Sightings of Deer for the Month	56	76	109	196	183	98	107	66	63	76	110	87		
Size of Enclosure Herd	30	30	30	29	26	32	33	33	21	30	29	29		

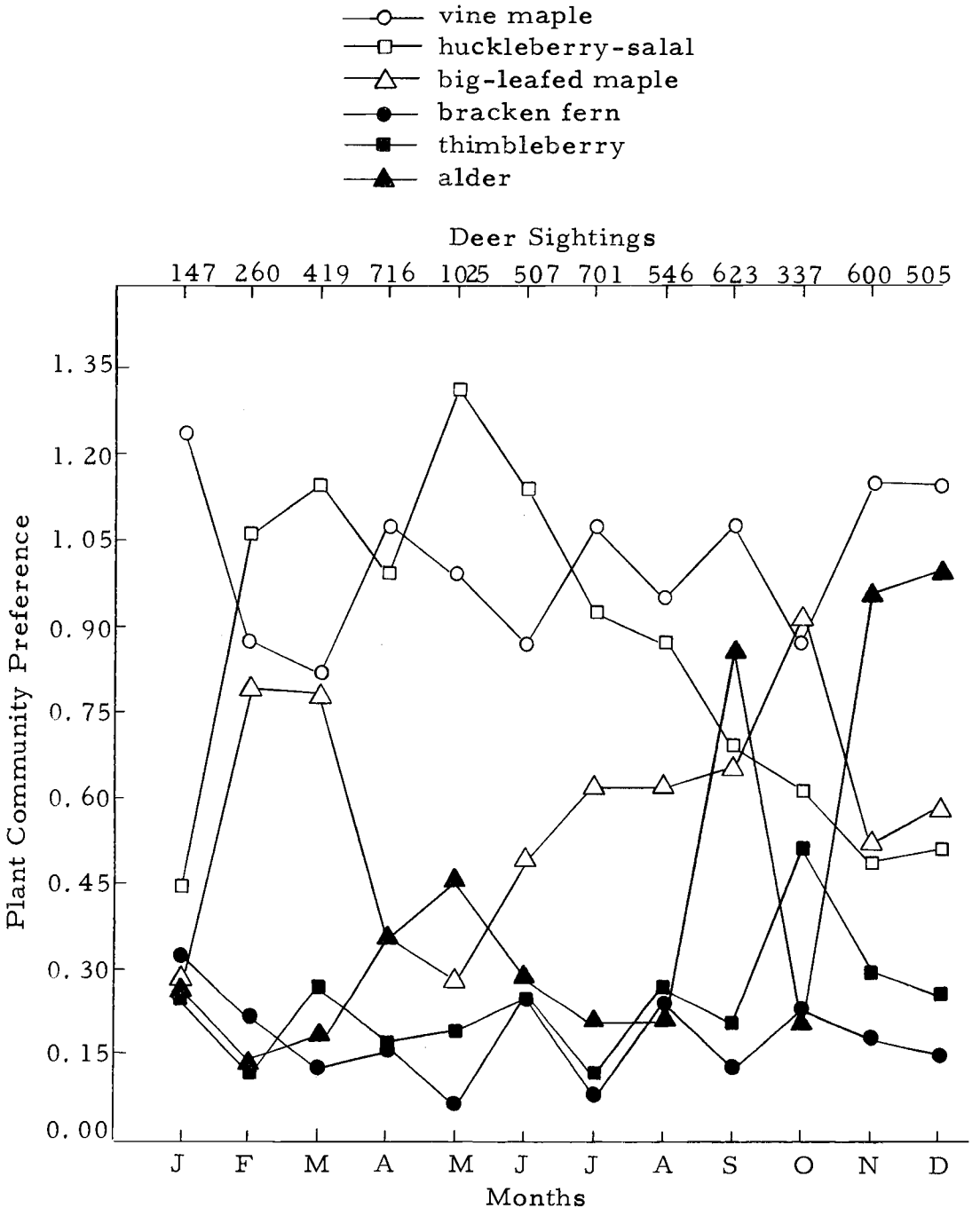

Figure 10. Location of deer by plant community during 1964, expressed as a ratio between plant community frequency of occurrence and the percentage of deer sighted in each community.

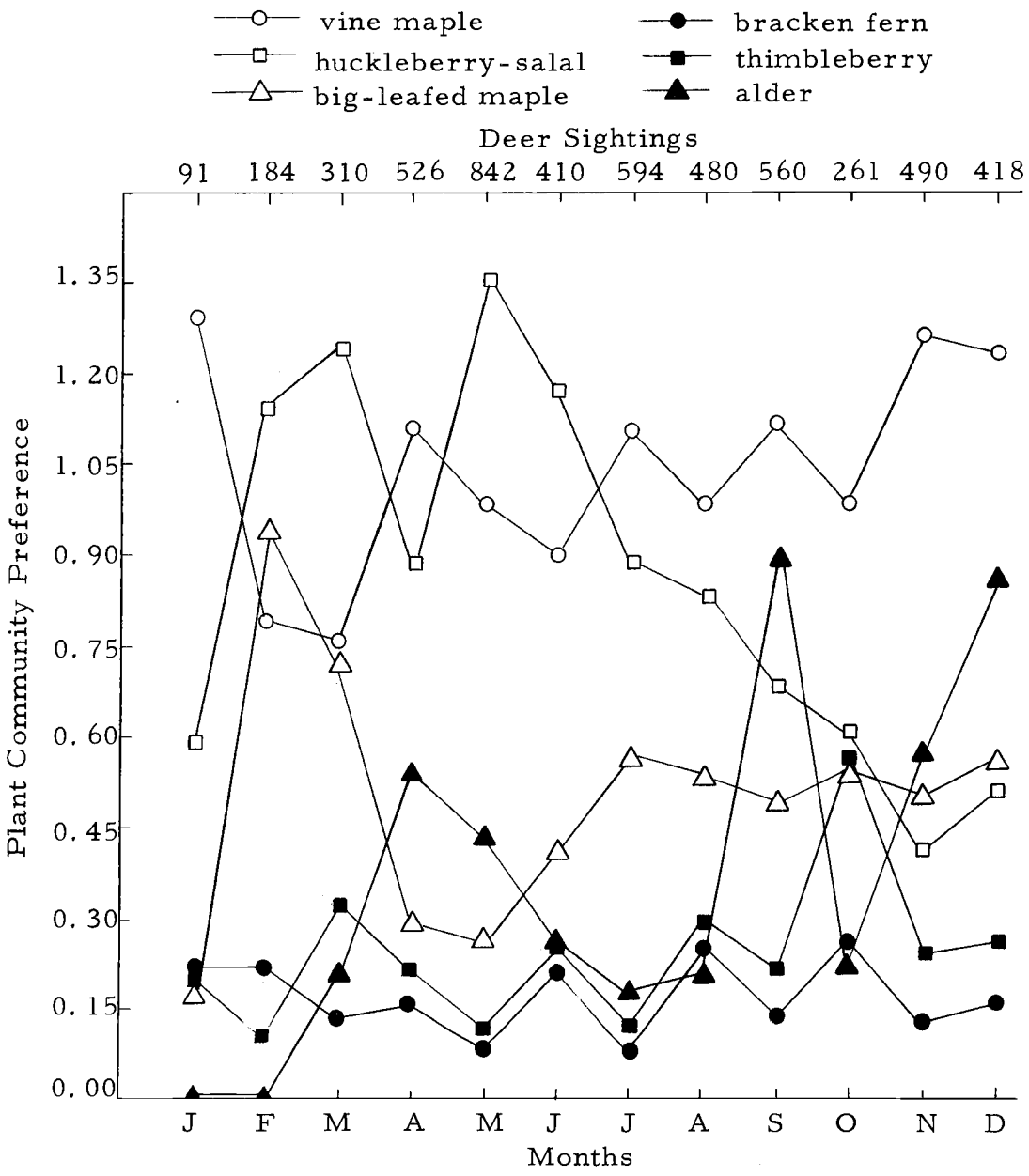

Figure 11. Location of feeding deer by plant community during 1964, expressed as a ratio between plant community frequency of occurrence and the percentage of deer sighted in each community.

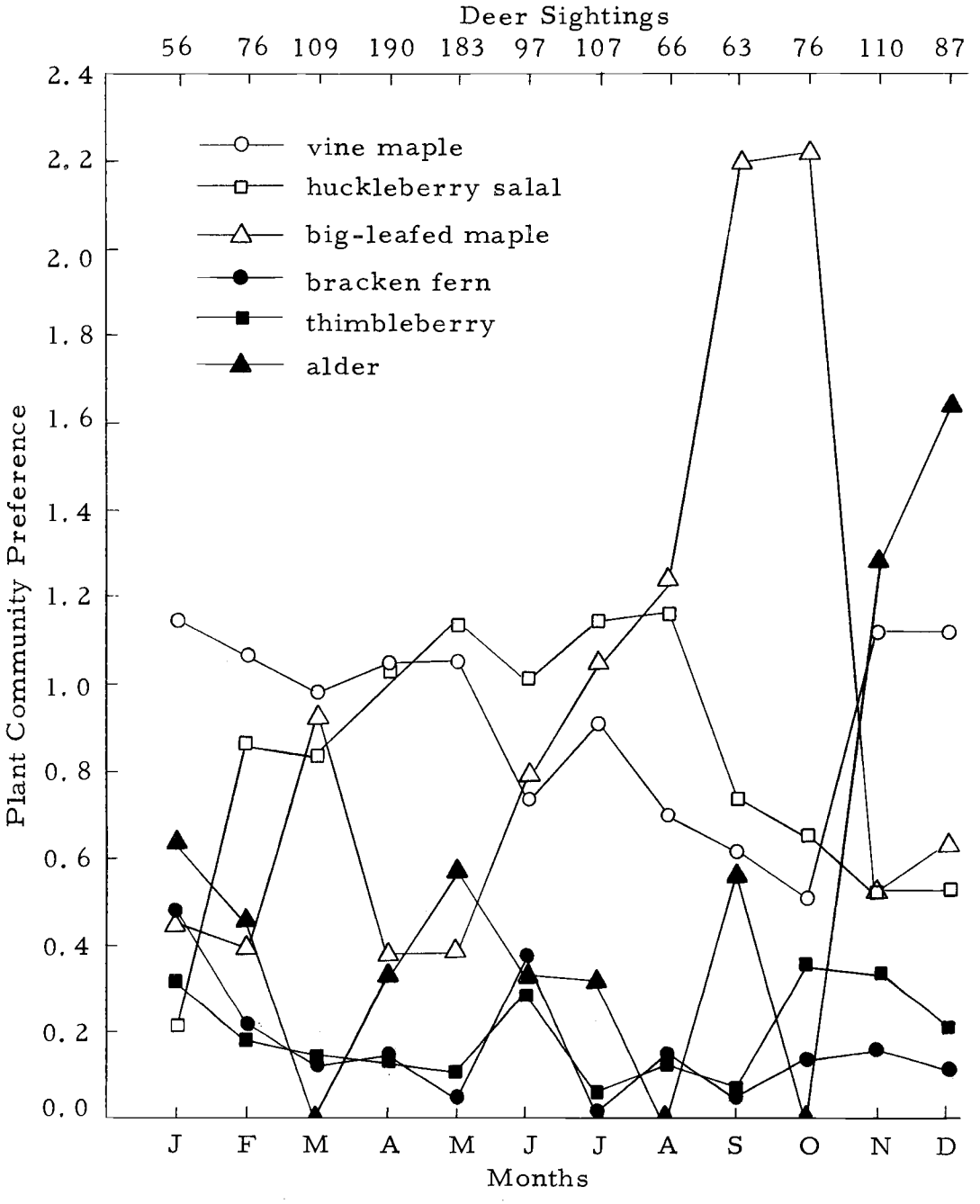

Figure 12. Location of bedded deer by plant community during 1964, expressed as a ratio between plant community frequency and the percentage of deer sighted in each community.

of winter forage resulted in selective utilization of communities high in preferred forage. However, during the wintry period, deer bedded on their feeding grounds. They seldom made an attempt to seek cover and appeared oblivious to the rain.

The percentage of bedded deer sighted in the big-leafed maple plant community increased sharply during late summer; the use of this community for bed sites steadily increased from 7.7 percent of total monthly sightings in May to 43.4 percent in October, then declined rapidly to 10.0 percent in November. This selection is vividly illustrated in Figure 12.

A second index to deer/plant community relations is shown in Figure 13 where deer occurrence in each plant community is plotted against the total area of that plant community and expressed as a ratio between their respective horizontal surface-acre values, where:

The summation of individual home ranges in horizontal surface acres (h. s. a.) x Percentage of deer sighted in that plant community

= Deer acres (h. s. a.) in that plant community

then:

$$\frac{\text{Number of deer acres in plant community}}{\text{Total acreage of plant community}} = \text{Acreage ratio}$$

Therefore:

Acreage ratio = index of intensity of acreage use by deer of a plant community

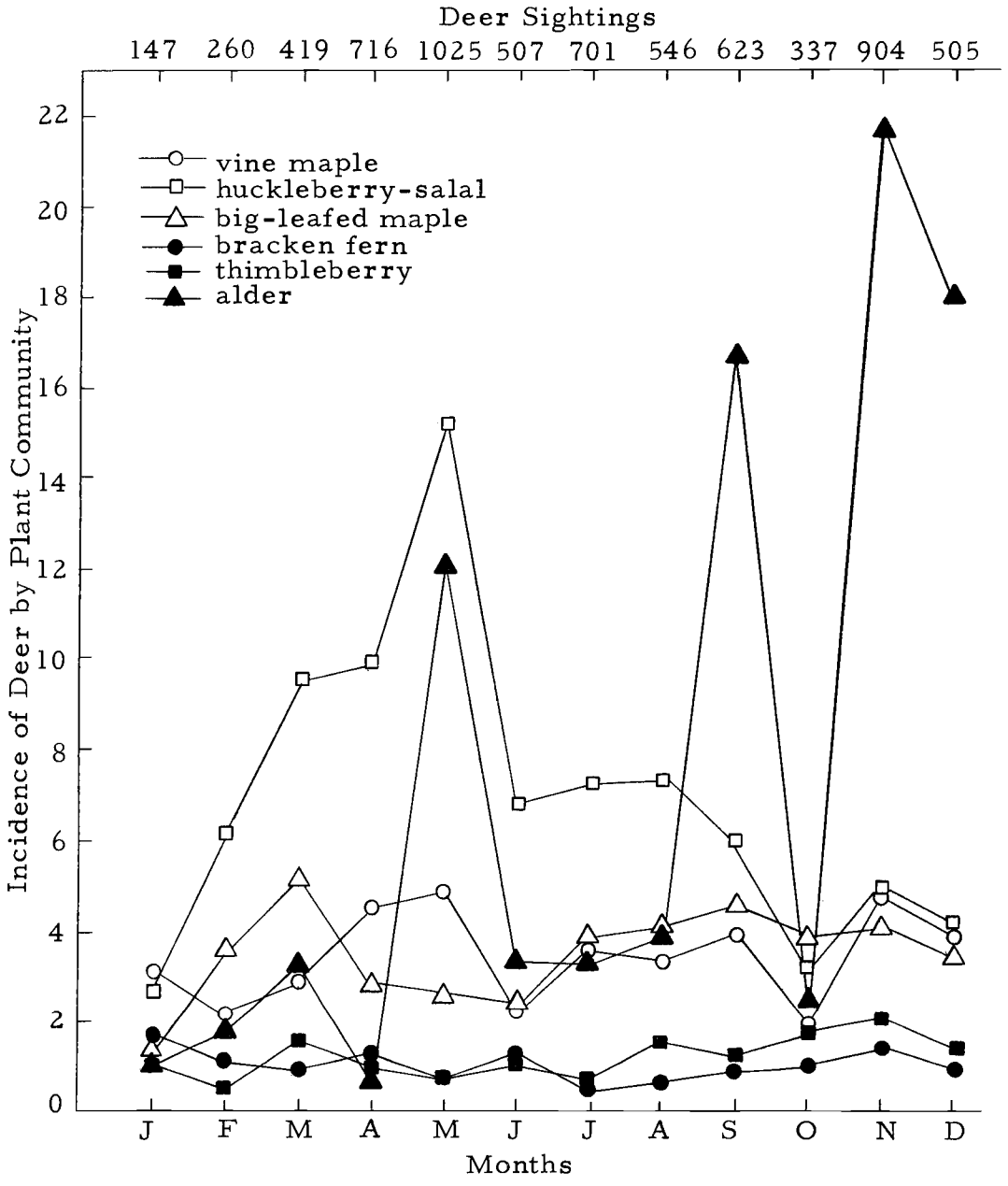

Figure 13. Deer occurrence by plant community during 1964, expressed as a ratio between plant community horizontal surface acres of deer occurrence (deer-acre) and the total horizontal surface acreage of that plant community.

Both the huckleberry-salal and alder communities are of relatively low acreage and both received heavy seasonal use by deer, indicating periods of intensive deer occupation. Since these deer foraged on virtually every acre traversed, the value of these small plant communities is considerable. However, the value of plant communities of relatively high acreage may be obscured in Figure 13. Therefore, the ratios in Figures 10 and 13 should be considered together for better evaluation of deer use/plant community relationships.

Observed Deer

During 1964, 1,410 hours of observation yielded 6,746 deer sightings. The greatest number of monthly deer sightings occurred in May and the least in January. However, the highest number of sightings per hour of observation occurred in December while the lowest occurred in January (Table 14). Tables 11, 12, and 13 give the average monthly deer sightings, average number of feeding, and bedded deer on an hourly basis. Yearly averages are presented in Table 14. Standard Time was used throughout the study.

Seasonal activity by black-tailed deer was characterized as follows: midday peaks during January and February followed by early morning peaks during March, April, and May; slight late morning peaks and high twilight peaks in June through August; high early morning peaks and slighter twilight peaks in September; peaks

TABLE 11. The average number of deer sighted per hour for each month, 1964.

Hour Standard Time	Month											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
4:00a. m.					11. 7	3. 0						
5:00a. m.					5. 4	5. 8	5. 1	2. 0				
6:00a. m.			5. 1	19. 0	5. 1	6. 5	7. 2	4. 0	11. 5	15. 0		
7:00a. m.			2. 3	8. 0	4. 9	4. 2	5. 2	5. 9	8. 4	7. 5	6. 3	
8:00a. m.	1. 0	1. 8	4. 4	8. 0	3. 2	3. 0	6. 7	8. 1	7. 0	3. 9	5. 4	10. 5
9:00a. m.	1. 0	2. 7	4. 1	6. 4	3. 8	2. 1	3. 6	4. 5	5. 2	3. 6	4. 8	10. 3
10:00a. m.	3. 3	3. 9	4. 3	11. 1	3. 8	2. 4	3. 3	3. 2	1. 6	3. 1	5. 5	7. 3
11:00a. m.	3. 6	2. 9	3. 4	6. 4	2. 3	1. 7	1. 7	3. 9	2. 4	2. 0	10. 5	5. 9
12:00n.	3. 4	4. 6	4. 0	4. 4	2. 4	1. 3	3. 4	4. 0	2. 1	19. 0	6. 7	7. 1
1:00p. m.	2. 0	3. 3	5. 3	10. 6	4. 6	0. 9	3. 6	1. 6	0. 8	10. 7	4. 0	7. 5
2:00p. m.	1. 7	2. 2	3. 1	5. 4	2. 1	1. 2	3. 3	1. 2	1. 3	6. 0	6. 2	13. 5
3:00p. m.	1. 7	5. 3	4. 1	7. 1	4. 9	2. 6	2. 7	1. 9	0. 8	2. 0	3. 2	9. 9
4:00p. m.	0. 7	3. 3	3. 1	4. 1	4. 7	1. 6	1. 6	2. 1	0. 6	1. 0	4. 1	10. 4
5:00p. m.			1. 8	4. 7	6. 4	2. 1	5. 1	2. 4	2. 7	4. 1	5. 5	9. 3
6:00p. m.			1. 1	4. 0	2. 9	2. 0	5. 7	4. 8	7. 3	7. 4		
7:00p. m.					2. 0	12. 0	9. 6	10. 2	5. 7			
8:00p. m.							8. 0					
Total Sightings for Time Period	147	260	419	716	1, 025	507	701	546	623	337	600	505
Total Hours of Observation	62	80	112	100	236	146	139	141	142	74	123	56
Enclosure Herd Size	30	30	30	29	26	32	33	33	31	30	29	29

TABLE 12. The average number of feeding deer sighted per hour for each month, 1964.

Hour Standard Time	Month											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
4:00a. m.					11.2	3.0						
5:00a. m.					5.3	5.1	5.1	2.0				
6:00a. m.			5.1	19.0	4.4	5.2	6.3	4.4	11.2	14.0		
7:00a. m.			1.9	0.0	4.0	3.5	4.1	5.6	7.4	7.1	5.8	
8:00a, m.	0.0	1.8	4.1	5.5	2.3	2.6	5.3	6.0	5.7	2.9	4.8	10.4
9:00a. m.	0.3	2.1	3.1	4.6	2.9	1.7	2.8	3.6	4.4	2.6	4.2	9.8
10:00a. m.	1.8	2.4	2.6	8.1	2.8	1.8	2.4	3.1	1.0	2.4	3.7	7.3
11:00a. m.	1.9	1.9	2.1	4.7	2.3	1.4	0.9	3.4	2.1	0.0	6.5	4.2
12:00n.	2.9	3.2	3.4	3.0	1.6	0.8	3.4	3.2	1.4	9.0	6.0	5.0
1:00p. m.	1.0	2.9	3.8	5.9	3.4	0.7	2.7	1.1	0.8	5.3	2.8	5.4
2:00p. m.	1.3	1.8	2.1	4.4	1.3	0.5	2.5	0.8	0.8	3.7	4.1	11.6
3:00p. m.	1.4	3.8	3.1	5.4	3.6	1.6	1.9	1.8	0.4	0.9	2.5	7.4
4:00p. m.	0.7	2.1	2.6	3.0	3.0	0.5	1.6	1.6	0.6	1.0	3.4	8.6
5:00p. m.			1.8	3.3	5.6	1.3	4.0	2.0	2.4	3.3	5.1	9.3
6:00p. m.			1.1	4.0	2.1	1.3	5.1	4.6	7.3	7.4		
7:00p. m.					1.3	12.0	9.2	9.9	5.2			
8:00p. m.							7.6					
Total Sightings for Time Period	91	184	310	520	842	409	594	480	560	261	490	418
Total Hours of Observation	62	80	112	100	236	146	139	141	142	74	123	56
Enclosure Herd Size	30	30	30	29	26	32	33	33	31	30	29	29

TABLE 13. The average number of bedded deer sighted per hour for each month, 1964.

Hour Standard Time	Month											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
4:00a.m.					0.5	0.0						
5:00a.m.					0.1	0.6	0.0	0.0				
6:00a.m.			0.0	0.0	0.7	1.2	0.9	0.0	0.3	1.0		
7:00a.m.			0.4	8.0	0.9	0.7	1.1	0.3	1.0	0.5	0.6	
8:00a.m.	1.0	0.0	0.3	2.5	1.0	0.5	1.3	2.2	1.2	1.0	0.7	0.1
9:00a.m.	0.7	0.7	1.0	1.8	0.8	0.4	0.8	1.0	0.8	1.0	0.6	0.5
10:00a.m.	1.5	1.5	1.7	3.0	1.0	0.7	0.9	0.1	0.6	0.7	1.8	0.0
11:00a.m.	1.8	1.0	1.4	1.7	0.0	0.3	0.9	0.5	0.3	2.0	4.0	1.7
12:00n.	0.6	1.4	0.6	1.5	0.8	0.5	0.0	0.8	0.7	10.0	0.7	2.1
1:00p.m.	1.0	0.4	1.5	4.7	1.3	0.2	1.0	0.4	0.0	5.3	1.2	2.1
2:00p.m.	0.3	0.5	1.0	1.0	0.8	0.7	0.8	0.4	0.5	2.3	2.1	1.8
3:00p.m.	0.3	1.5	1.1	1.7	1.3	1.0	0.8	0.1	0.4	1.1	0.7	2.6
4:00p.m.	0.0	1.2	0.5	1.1	1.7	1.3	0.0	0.5	0.0	0.0	0.8	1.8
5:00p.m.			0.0	1.5	0.7	0.8	1.1	0.4	0.3	0.9	0.4	0.0
6:00p.m.			0.0	0.0	0.8	0.7	0.6	0.2	0.1	0.0		
7:00p.m.					0.7	0.0	0.5	0.3	0.5			
8:00p.m.							0.4					
Total Signtings for Time Period	56	76	109	196	183	98	107	66	63	76	110	87
Total Hours of Observation	62	80	112	100	236	146	139	141	142	74	123	56
Enclosure Herd Size	30	30	30	29	26	32	33	33	31	30	29	29

TABLE 14. Deer activity in 1964.

Month	Average Number of Deer Sightings Per Hour		
	Deer	Feeding Deer	Bedded Deer
January	2.4	1.5	0.9
February	3.3	2.3	1.0
March	3.7	2.8	1.0
April	7.2	5.3	1.9
May	4.3	3.6	0.8
June	3.5	2.8	0.7
July	5.0	4.3	0.8
August	3.9	3.4	0.5
September	4.4	4.0	0.5
October	4.5	3.5	1.0
November	4.9	4.0	0.9
December	9.0	7.4	1.5
Yearly Average	4.7	3.7	1.0

in early morning and at midday with some revival at twilight in October; high activity throughout the day with a peak at midday in November; and high activity from midmorning to twilight during December.

The peaks for feeding activity (Table 12) followed closely those for average deer sightings, again, reflecting the fact that deer utilize forage on all locations. However, average bedded deer sightings were usually influenced by whether or not the observers had animals under observation before the animals bedded, since bedded animals were often hard to detect. The high average value for bedded animals at noon during October was due to their exposed locations on high ground. Relatively high values during November and December resulted from rutting activities and the heavy snow cover of late December.

The monthly overall activity of deer based on average monthly deer sightings per hour during 1964 is given in Table 14. April was characterized by intensified movement which was continued into May. During July there was a revival of daytime activity by nursing does and their newborn fawns. November and December values were influenced by rutting activities; however, the high value for the year in December reflects the influence of snow cover more than the rut.

Home Range Size

The home range size for individual deer by sex and age class was calculated by the perimeter-point method (Tables 15 and 16), as suggested by Odum and Kuenzler (1955). The reliability of the home range values is indicated by monthly observation frequencies for individual animals. Also included in Table 15 are yearly average values for home range size and sightings per month.

The largest average monthly home range occurred in the adult male class, followed closely by yearling males, then two-year-old females; two-year-old males, adult females, and male fawns had intermediate average monthly home ranges. Yearling females and female fawns had the smallest average monthly home ranges.

Table 16 gives the annual home range sizes and the total number of sightings for individual deer. Also included in Table 16 are the percentages of annual home-range acreage used for the average monthly home ranges of individual deer, and the percentages used for the monthly home ranges during the month of maximum observation of the individual. Annual home ranges varied from approximately one-eighth to one-half square mile in size. If the actual acreage of the broken terrain could be measured, the home range values would approach one-fourth to three-quarters of a square mile.

Table 15. Monthly home ranges in horizontal surface acres and number of sightings of individual deer during 1964.

Age Class and Sex	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Averages
Adult Female													
No. 1	34(9)[a]	32(13)	38(12)	39(31)	46(36)	36(28)[b]	27(22)	27(18)	35(18)				35(23)
2	48(11)	42(10)	45(19)	36(27)	57(46)	31(28)	14(14)[b]	55(24)	55(21)	60(16)	39(38)	22(19)	42(23)
3	15(6)	24(7)	38(15)	45(31)	63(51)	34(17)[b]	34(14)	50(24)	48(23)	53(15)	48(48)	39(27)	41(23)
4	28(3)	35(13)	46(17)	50(25)	63(33)	25(5)	15(6)[b]	38(18)	48(15)	1(1)	49(22)	35(13)	36(14)
5	22(4)	53(19)	42(18)	60(30)	76(56)	22(21)[b]	38(22)	35(14)	34(8)	35(8)	43(42)	39(20)	42(22)
6	21(4)	43(6)	52(15)	60(44)	56(75)	22(22)[b]	20(34)	39(14)	45(30)	38(25)	42(36)	75(33)	43(28)
7	25(4)	21(11)	28(18)	45(29)	55(53)	39(44)[c]	46(64)	41(31)	34(12)	6(7)	29(9)	34(11)	34(24)
8	52(4)	20(5)	31(15)	74(48)	62(60)	17(22)[b]	42(25)	35(20)	39(26)	29(7)	52(34)	38(18)	41(24)
9		18(3)	35(12)	31(26)	45(32)	13(21)[b]	18(9)	25(12)	11(5)	8(2)	36(22)	3(3)	22(13)
10	27(5)	11(4)	18(6)	17(13)	49(18)	15(18)[b]	35(13)	32(33)	73(33)	28(15)	39(20)	25(11)	30(16)
Monthly Averages	30(6)	30(9)	37(15)	46(30)	57(46)	25(23)	29(22)	38(21)	42(19)	29(11)	42(30)	34(17)	37(21)

Average Home Range Size and Number of Sightings for Sex and Age Class 37(21)

Continued

Table 15-continued

Age Class and Sex	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Averages
Adult Male													
0	24(5)	21(10)	62(29)	32(22)	98(77)	41(41)	63(79)	42(38)	31(28)	15(13)	70(51)	36(18)	45(34)
H	29(4)	32(14)	32(21)	39(30)	76(73)	39(42)	49(67)	45(33)	29(33)	17(12)	46(30)	38(22)	39(32)
S	38(6)	39(15)	50(20)	59(36)[d]									47(19)
X	29(9)	34(15)	60(20)	49(35)[e]									43(20)
Z	63(8)	18(9)	67(16)	59(36)[e]									52(17)
Monthly Averages	37(6)	29(13)	54(21)	48(32)	87(75)	40(42)	56(73)	44(36)	30(31)	16(13)	58(41)	37(20)	45(24)
Average Home Range Size and Number of Sightings for Sex and Age Class 43(28)													
Two-year-old Female (1963 yearling)													
No. 3	22(6)	57(15)	56(18)	42(24)	73(38)	42(17)	28(18)[b]	45(15)	46(23)	32(13)	61(42)	35(20)	45(21)
No. 4	7(3)	41(9)	35(14)	76(39)	62(62)	48(14)	28(22)	39(14)	35(13)	8(8)	64(31)	48(15)	41(20)
No. 5	36(5)	21(6)	27(12)	78(42)	55(51)	18(12)[b]	35(12)	46(10)	24(13)	13(5)	10(5)	17(11)	32(15)
No. 7	35(2)	24(13)	49(15)	57(28)	94(35)	42(8)[f]	17(8)	32(10)	95(33)[g]	28(12)	43(20)	34(12)	46(16)
Monthly Averages	25(4)	36(11)	42(15)	63(33)	71(47)	38(13)	27(15)	41(12)	50(21)	20(10)	45(25)	34(15)	41(18)
Average Home Size and Number of Sightings for Sex and Age Class 40(18)													

Continued

Table 15-continued

Age Class and Sex	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Averages
Two-year-old Male (1963 yearling)													
No. 1	22(5)	7(2)	35(6)	64(13)	39(14)	6(5)	48(12)	39(4)	24(10)	29(14)	31(14)	24(8)	31(9)
No. 6	35(5)	38(11)	56(23)	39(23)	91(62)	53(30)	59(40)	24(17)	39(13)	21(17)	35(13)	46(18)	45(23)
No. 8	35(4)	28(15)	49(17)	91(20)	92(29)	27(11)	52(23)	35(8)	7(2)	14(3)	49(15)	1(1)	40(12)
Monthly Averages	31(5)	24(9)	47(15)	65(19)	74(35)	29(15)	53(25)	33(10)	23(8)	21(11)	38(14)	24(9)	39(15)
Average Home Range Size and Number of Sightings for Sex and Age Class 38(15)													
Yearling Female (1963 fawn)													
N-O	1(1)	1(1)	11(9)	34(16)	67(21)	8(4)	15(7)	17(4)	31(13)	8(6)	42(19)	28(10)	22(9)
R-W	6(3)	1(1)	11(9)	41(14)	71(22)	10(5)	20(6)	8(4)	29(14)	8(6)	35(20)	21(9)	22(9)
No. 2							32(27)[h]	60(29)	49(43)	24(28)	41(57)	67(32)	46(36)
W-W		1(1)	18(10)	25(8)[d]									14(6)
W-R	21(6)	24(7)	28(6)[d]										24(6)
Monthly Averages	9(3)	7(3)	17(9)	33(13)	69(22)	9(5)	22(13)	28(12)	36(23)	13(13)	39(32)	39(17)	26(13)
Average Home Range Size and Number of Sightings for Sex and Age Class 25(13)													

Continued

Table 15-continued

Age Class and Sex	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Averages
Yearling Male (1963 Fawn)													
O-R	42(6)	36(7)	43(7)	35(18)	43(23)	55(15)	35(28)	34(14)	41(25)	28(7)	119(59)	55(24)	47(19)
O-Y	45(6)	31(7)	34(7)	38(17)	41(25)	55(15)	36(27)	32(16)	41(26)	22(5)	52(41)	73(23)	42(18)
J								59(37)[j]	55(44)	41(32)	78(24)	49(17)	56(31)
O-O	28(6)	27(8)	25(7)	32(15)[d]									28(9)
O-G[k]	20(3)	3(3)	6(2)[d]										10(3)
Monthly Averages	34(5)	24(6)	27(6)	35(17)	42(24)	55(15)	36(28)	42(22)	46(32)	30(15)	83(41)	59(21)	37(16)
Average Home Range Size and Number of Sightings for Sex and Age Class 41(18)													
Fawn Female (1964)													
G-G						12(4)	39(13)	49(16)	36(21)	29(6)	52(26)	35(16)	36(15)
G-Y						11(6)	11(9)	13(7)	49(26)	35(22)	52(38)	78(33)	36(20)
G-W						17(8)	13(3)	38(9)	15(10)	4(3)	8(4)	17(12)	16(7)
G-R						5(4)	14(4)	21(11)	10(5)	8(2)[m]			12(5)
G-O						31(11)	21(13)	1(1)[m]					17(13)
W-W							17(9)	14(2)[m]					16(6)
Monthly Averages						16(7)	19(9)	23(8)	28(16)	19(8)	37(23)	43(20)	22(11)
Average Home Range Size and Number of Sightings for Sex and Age Class 24(11)													

Continued

Table 15-continued

Age Class and Sex	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Averages
Fawn Male (1964)													
O-O						24(12)	43(19)	32(11)	35(13)	34(11)	42(37)	39(20)	36(18)
O-W						15(5)	36(16)	48(24)	48(24)	48(16)	57(50)	45(29)	42(23)
O-Y						6(7)	21(2)[m]						14(5)
O-G						1(1)[n]							1(1)
Monthly Averages						12(6)	33(12)	40(18)	42(19)	41(14)	50(44)	42(25)	23(12)
Average Home Range Size and Number of Sightings for Sex and Age Class 34(17)													

[a](number) equals the number of monthly sightings for that individual deer.
[b]Doe gave birth during month.
[c]Doe did not fawn in 1964.
[d]Animal killed by coyotes.
[e]Animal escaped from enclosure.
[f]Animal gave birth sometime during the last five days of June.
[g]Animal wandered about enclosure after losing fawn.
[h]Animal introduced into the enclosure on July 15, 1964.
[j]Animal introduced into the enclosure on August 3, 1964.
[k]Partial albino (about 30 percent white).
[m]Animal assumed dead, cause unknown.
[n]Animal never seen after original sighting (was captured and marked).

Table 16. Annual home ranges, total annual sightings, and percentage of monthly use of annual home ranges by individual deer during 1964.

Individual	Annual Home Range (horizontal acres)	Number of Times Individual Deer Were Sighted During 1964	Percentages of Annual Home Range Acreage	
			Average Monthly Home Range	Monthly Home Range During the Month of Maximum Observation
Adult Female				
No. 2*	177	273	23.7	32.2 October
3	169	278	24.3	33.9 May
4	257	171	14.0	24.5 May
5	190	262	22.1	40.0 May
6	150	338	28.7	37.3 December
7	130	293	26.2	35.4 May
8	159	284	25.8	39.0 April
10	142	189	21.1	51.4 September
Averages	172	261	23.2	36.7
Adult Male				
O	294	411	15.3	33.3 May
H	199	381	19.6	38.2 May
Averages	247	396	17.5	35.8
Two-year-old Female				
No. 3	194	249	23.2	31.4 May
4	155	244	26.5	49.0 April
5	155	184	20.6	35.5 April
7	256	196	18.0	36.7 September
Averages	190	218	22.1	38.2
Two-year-old Male				
No. 1	201	107	15.4	19.4 April
6	220	272	20.5	41.4 May
8	312	148	12.8	29.5 May
Averages	244	224	16.2	30.1
Yearling Female				
R-W	94	113	23.4	75.5 May
N-O	98	111	22.4	72.4 May
Averages	96	112	22.9	74.0
Yearling Male				
O-Y	153	215	27.5	34.0 December
O-R	143	233	32.9	83.2 November
Averages	148	224	30.2	58.6

Continued

Table 16-continued

Individual	Annual Home Range (horizontal acres)	Number of Times Individual Deer Were Sighted During 1964	Percentage of Annual Home Range Acreage	
			Average Monthly Home Range	Monthly Home Range During the Month of Maximum Observation
Female Fawn				
G-Y	91	141	39.6	85.7 December
G-G	114	102	31.6	45.6 November
G-W	86	49	18.6	19.8 August
Averages	97	97	29.9	50.4
Male Fawn				
O-W	152	164	27.6	33.1 November
O-O	121	123	29.8	34.7 July
Averages	137	144	28.7	33.9

*Annual Home ranges were calculated for only those deer with twelve month records with the exception of newborn fawns.

The largest home range of 312 horizontal surface acres belonged to a two-year-old male. An adult male had the second largest home range (294 horizontal surface acres). All of the two-year-old animals had home ranges exceeding the median home range size. Fawns occupied the smallest home ranges, while the smallest home ranges determined from data for the full year proved to be female yearlings'.

That part of the annual home range used for the average monthly home range varied between 12.8 and 39.6 percent for individual deer. During the month of maximum observation of each individual, the value for the monthly home range varied from 19.4 to 85.7 percent. However, 81 percent of the animals used less than half of their calculated annual home range.

Distribution of Deer by Major Land Units

Monthly distribution of deer based on the three major land units within the enclosure (East Drainage, West Drainage, and the Flats) are shown in Table 17. Also included is the relative number of "activity-centers" in each area. An "activity-center" in this study is defined as the area in which an animal concentrated its feeding and resting activities for that month.

The low number of monthly deer "activity-centers" in the West Drainage shows that deer utilization of this portion of the

Table 17. Monthly deer occurrence and monthly "activity-centers" during 1964, at Cedar Creek, based on the three major land units within the enclosure.

East Drainage Unit (134 horizontal surface acres)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Number of Sightings	56	184	261	377	583	293	372	288	218	112	299	122
Number of Individuals	18	17	21	24	21	18	17	20	19	14	20	17
Age Class and Sex												
Adult Female	7	7	9	9	9	7	7	6	8	4	7	7
Adult Male	5	5	5	5	4	2	2	2	2	2	2	2
2-yr. -old Female						3	2	2	2	1	3	1
2-yr. -old Male						2	2	3	1	2	3	3
Yearling Female	3	2	4	4	5			2				
Yearling Male	3	3	3	3	3				3	3	3	2
Fawn Female						2	3	3	1	1		
Fawn Male				3		2	1	2	2	1	2	2
Number of Deer with "Activity-centers" in the Area	12	16	17	16	15	13	12	14	11	10	7	9
Age Class and Sex												
Adult Female	5	7	7	7	7	5	5	6	5	4	3	3
Adult Male	5	5	5	5	4	2	2	2	2	1	1	2
2-yr. -old Female						1				1	1	1
2-yr. -old Male						2	2	2	1		1	2
Yearling Female	1	1	2	2	2					2		
Yearling Male	1	3	3	2	2			1	1			
Fawn Female						2	2	1	1	1		
Fawn Male						1	1	2	1	1	1	1

Continued

Table 17-continued

West Drainage Unit (83 horizontal surface acres)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Number of Sightings	11	8	22	34	36	28	22	49	61	89	69	46
Number of Individuals	6	3	9	10	13	4	4	5	10	18	15	8
Age Class and Sex												
Adult Female	3	2	2	4	3	2	2	2	5	7	4	4
Adult Male	2		3		2					2	1	2
2-yr. -old Female		1				1	1	2	2	2	3	1
2-yr. -old Male								1	2	3	1	
Yearling Female	1		2	4	3						3	
Yearling Male			2	2	3							1
Fawn Female					2					2	3	
Fawn Male						1	1		1	2		
Number of Deer with "Activity-centers" in the Area	1	2	1	1	1	2	4	1	4	9	3	4
Age Class and Sex												
Adult Female	1	1	1	1	1	1	2	1	1	2	2	3
Adult Male										2		
2-yr. -old Female							1		1	2	1	1
2-yr. -old Male									2	2		
Yearling Female		1										
Yearling Male												
Fawn Female										1		
Fawn Male						1	1					

Continued

Table 17-continued

Flats Unit (122 horizontal surface acres)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Number of Sightings	80	68	136	305	406	186	307	209	344	136	536	337
Number of Individuals	24	17	23	19	22	20	27	25	24	23	25	24
Age Class and Sex												
Adult Female	6	5	6	6	8	5	8	7	7	8	7	6
Adult Male	3		3		2						2	2
2-yr. -old Female						5	4	4	4	3	3	3
2-yr. -old Male						2	3	1	2	1	2	2
Yearling Female	3	3	4	4	5	2	2	3	3	3	3	3
Yearling Male	4	1	2	3	3	2	2	2	3	3	3	3
Fawn Female	4	4	4	3	2	3	5	6	3	3	3	3
Fawn Male	4	4	4	3	2	1	3	2	2	2	2	2
Number of Deer with "Activity-centers" in the Area	16	12	12	12	10	17	15	18	16	11	19	16
Age Class and Sex												
Adult Female	2	2	2	2	2	4	3	3	4	3	4	3
Adult Male											1	
2-yr. -old Female						4	3	4	3	1	2	2
2-yr. -old Male						1	1	1			2	1
Yearling Female	3	2	3	3	3	2	2	3	3	3	3	3
Yearling Male	3			1	1	2	2	2	2	1	3	3
Fawn Female	4	4	3	3	2	3	4	5	3	2	3	3
Fawn Male	4	4	4	3	2	1			1	1	1	1

enclosure was comparatively slight. One exception occurred during October, when many deer moved in and out of the head of the West Drainage.

The enclosure herd displayed more extensive movements during May and early June. At this time, several does which subsequently fawned changed their home ranges. This relocation resulted in the presence of three pregnant does in the West Drainage, four pregnant does in the East Drainage, and five pregnant does on the Flats at the time of fawning. This pre-fawning shift resulted in greater dispersion of pregnant animals; however, other deer remained in areas previously occupied.

DISCUSSION

Weather

Air Temperature

Temperature extremes are major factors, influencing both seasonal and daily movements of mule deer (Odocoileus hemionus) (Lindsdale and Tomich, 1953; Dasmann and Dasmann, 1963). In the present study, deer became generally inactive when air temperatures exceeded 60° F. Total inactivity above 60° F did not occur until weekly extreme temperatures remained consistently above 60° F (Figures 2-5). However, during late winter and early spring the response to such temperatures was variable. Many deer moved to exposed slopes to feed on the new plant growth, and some animals bedded in full sunlight. In Colorado, Loveless (1964) found that when spring temperatures exceeded 45° F mule deer moved into the shade. While on the Hastings Reservation in California, mule deer sought shade at 60 to 65° F but did not become inactive until temperatures exceeded 80° F (Lindsdale and Tomich, 1953). Taber and Dasmann (1958) working on black-tailed deer, reported findings similar to Lindsdale and Tomich (1953). It is probable that differences in the threshold temperature for general inactivity reflect racial adjustments to local climatic factors.

During the heat of the day, nursing does, their fawns, and yearling females milled about for brief periods in the drainage bottoms under the dense cover of alder trees. The combination of an additional need for forage by nursing does and a midday nursing period were seemingly responsible for such activity. The female yearlings in the groups were probably active primarily because the other animals were moving. For black-tailed deer, Dasmann and Taber (1956) found that nursing does and their family groups foraged later in the morning under the dense cover in the canyon bottoms during periods of high temperature but that all of the deer were usually bedded after midday.

During the period from November to early May, temperatures usually remained below 60° F and were associated with high precipitation. Both minimal temperature and sharp temperature changes influenced deer movement.

Winter temperatures in western Oregon do not approach the low temperatures associated with concentration and dispersal on most mule deer (Loveless, 1963) and white-tailed deer (Hamerstrom, Jr., and Blake, 1939) wintering ranges. In Scotland, Darling (1937) reported that low temperatures were responsible for concentrations of red deer (Cervus elaphus). However, temperatures were low enough to cause deer to avoid drainage bottoms and to prefer southerly exposures. Lindsdale and Tomich (1953) and Taber and

Dasmann (1958) reported that California deer evade canyon bottoms and northerly exposures during periods of low temperature.

In December when temperatures dropped below 20° F, the deer remained bedded until midmorning and overall activity was reduced. In California it was observed that mule deer stay bedded for long periods under extreme cold and wind (Lindsdale and Tomich, 1953).

Sudden temperature changes (8-19° F within one hour) shortly after sunset during periods of clear weather in February and March sharply reduced deer activity. Similar observations were reported for black-tailed deer night time activity in Oregon by Anderson (1959).

High winds in association with low temperatures were of primary concern to the deer. During periods of cold weather, deer evaded those slopes which received the brunt of the high velocity winds. This was particularly true of the West Drainage, where recorded temperatures were higher then those for lower elevations where deer activity was high. In the present study, the choice of bed sites indicated a strong preference for areas that were protected from the prevailing winds. Many such sites were on open ground and afforded little protective cover. In Maine, Robinson (1960) reported that white-tailed deer selected the most favorable microclimates for bed sites regardless of the available cover. However, deer may actually seek out colder localities to escape the compounded influence of strong winds and low temperatures (Hamerstrom, Jr., and Blake, 1939).

Relative Humidity

Although extremes and sudden changes in temperature are important in influencing deer movements, they must be considered in conjunction with relative humidity. Darling (1937), while placing great emphasis on the state of wetness or dryness of the atmosphere as one of the most potent influences on movement of red deer, stated that a dual consideration of temperature and relative humidity is necessary. McCullough (1960) suggested that temperature is the most important climatic factor influencing black-tailed deer activity in western Oregon but concluded (1964) that although it is impossible to separate the effect of relative humidity from that of temperature, relative humidity is a primary stimulus for migration of black-tailed deer. The activities of white-tailed deer on the Edwards Plateau of Texas were markedly influenced by relative humidity (Hahn, 1949). In addition, Lindsdale and Tomich (1953) reported that relative humidity is an effective regulator of mule deer activity in California.

Since the maximum relative humidity values were consistently high throughout the year, the directive influence of daily maximum relative humidity was considered to be of low importance in the present study, especially since common values applied for days on which widely divergent levels of deer activity occurred. McCullough (1964), working in a high percipitation area, also stated that in the

coastal Northwest daily high values for maximum relative humidity were too consistent to be of great influence on deer movements.

There was considerable seasonal variation in daily minimum relative humidity at Cedar Creek. Minimum relative humidity did not noticeably influence deer activity during the high precipitation period of January, February, March, November, and December. Activity levels remained constant on days of high and low minimum relative humidity.

This is in sharp contrast to the April-May period when deer activity sharply increased as minimum relative humidity was steadily falling. Newly available forage, lower precipitation, higher temperatures, and a greatly increased duration of sunshine were associated with the lower biweekly minimum relative humidity and undoubtedly were factors contributing to increased activity. Considerable play behavior was involved, in the above activity and two to five does and yearlings were observed engaging in games of tag for several minutes at a time. Two-year-old bucks chased each other about and engaged in head pushing contests.

In October, when minimum relative humidity was consistently rising, overall deer activity was greatly reduced. This condition existed throughout the entire Tillamook Burn, and during the October deer hunting season hunters complained vigorously of the scarcity of deer. Game officers in the area commented on the unually low

number of deer sighted during the hunt. October of 1964 was atypically warm and dry, with long periods of prevailing dry winds from the east.

The seasonal influence of minimum relative humidities during June through October could not be divorced from the high temperatures with which they were associated. However, during June when the biweekly values for minimum relative humidity fluctuated sharply, the deer did not noticeably reduce their daily period of inactivity. On particular days when minimum relative humidity remained high because of sporadic light precipitation, some deer foraged leisurely throughout the day.

On the H. J. Andrews Forest in the Blue River area of western Oregon, McCullough (1964) found that spring migration began when minimal relative humidity dropped below 60 percent and was completed by the time it reached 40 percent, and that the reverse was true for the fall migration. During the migratory period biweekly means of minimum relative humidity ranged from 52 to 57 percent. At Cedar Creek, biweekly means of minimum relative humidity for 1,300 and 2,150 feet elevation fell in and out of this range throughout 1964. Only the biweekly values for 750 feet of elevation remained below the migrational values. The available data only allows one to say that there was apparently an elevational influence on minimum relative humidity and that there was a definite downward trend in

the minimum relative humidity values at the time when deer normally make seasonal elevational migrations. It seems unlikely that specific values of a climatic factor such as relative humidity which is subject to considerable variation from year to year would be a primary stimulus for migrational phenomenon which characteristically shows little variation from year to year. Unfortunately, however, the constancy of seasonal trends in minimum relative humidity were inadequately known so that its possible role as a migration cue could not be isolated from the other environmental changes which occurred during periods of seasonal migration.

Precipitation

Precipitation should be considered in association with temperature and relative humidity. As would be expected, increases in temperature resulted in lower relative humidities. Maximal temperatures and minimal relative humidities occurred during the driest period of the year.

The 167.5 inches of precipitation recorded at Cedar Creek places 1964 among the high precipitation years. However, the winter months are typically a period of high precipitation. Once the winter rains have begun in the fall, the deer rapidly adjusted to the surrounding dampness. During the rainy season, deer were equally active during heavy or light rainfall. On the Andrew Forest in

western Oregon, deer were routinely observed feeding during rainfall and seemed oblivious to it (McCullough, 1964).

Statements of workers vary somewhat on the importance of moisture in influencing deer movements. Darling (1937) felt that rains did not appear to exercise much influence on movement, except that steady rain tended to restrict it. Lindsdale and Tomich (1953) stated that rain greatly restricted activity and movements. These disparities probably stem from the adjustment of deer to local conditions.

During the relatively dry summer and early fall months, several days of warm, dry weather followed by heavy rainfall resulted in greatly reduced deer activity. If the heavy rains persisted for more than a day, deer activity increased somewhat during the following days. Shortly after the rains ceased, deer activity increased suddenly, remaining at a high level for several hours. On days of light rainfall, deer foraged to noon or later before seeking cover for the midday period of rest.

Snowfall during the winter of 1964 was typically light at lower elevations, and deer were little influenced by it below 1,200 feet elevation. The only marked reaction to snow cover was that deer moved to sites below 1,700 feet elevation. However, the deer within the enclosure spent most of the winter below this elevation even though the snow line was often above 2,000 feet of elevation.

A combination of low temperature, strong northwesterly winds, and a general lack of winter forage on the exposed slopes kept the deer at lower elevations.

The deer did not necessarily descend to elevations that were completely free from snow cover. In the East Drainage, deer remained at about 1,500 feet of elevation where patchy snow cover occurred in depths of four to eight inches. Deer were often observed to bed in snow when snow-free ground was only a few feet away. Deer consistently bedded down or were bedded when a snowstorm started.

Cowan (1947) stated that six inches of snow altered the types of food consumed by deer in Canada. This circumstance also holds true for the study area, since six inches of snow cover renders much of the trailing blackberry (Rubus ursinus) and grasses unavailable. However, shortly after accumulation at lower elevations, snow cover is normally removed by heavy rainfall.

At the end of December, 1964, snow cover ranged in depth from two feet in the drainage bottoms to over four feet above 2,000 feet elevation. Many deer were forced down from higher elevations and were located on the ridges two to four hundred feet above the drainage bottoms. Under existing snow cover, wind action on the slopes and a more abundant supply of woody browse plants made these locations most favorable for deer.

The weather settled, temperatures dropped, and snow cover remained for most of January, 1965. During January, sporadic observation of the deer showed that the enclosure animals moved up and into the huckleberry-salal plant community sites located mostly between 1,200 and 1,500 feet of elevation. These sites were among the first to have open ground, and the deer remained there foraging on red huckleberry, salal, and low ground forage as it became available. As the bottom ground became free of snow cover, the enclosure deer including those that normally winter at higher elevations moved to lower ground to utilize the trailing blackberry leaves that had been protected from the low temperatures by the snow cover. The deer had utilized Douglas fir along with the other woody survival foods throughout the period of snow cover.

Forage Production and Utilization

The study area has been burned by three wildfires since 1933 (Cronemiller, 1933; McArdle, 1933; and Highsmith, Jr., Beh, and Beh, 1952). Investigations on Vancouver Island (Cowan, 1945), in California (Longhurst, Leopold, and Dasmann, 1952), in western Washington (Brown, 1961), and in western Oregon (Einarsen, 1946; Chatelain, 1947; Rieck, 1952; and Dealy, 1959) have demonstrated the increased carrying capacity of both burned and clear-cut areas for deer.

Trailing blackberry, red huckleberry, salal, and grasses make up the bulk of the deer diet during fall, winter, and early spring. The seasonal diets of black-tailed deer within the Tillamook Burn have been reported by Einarsen (1946), Chatelain (1947), and Crouch (1964). A similar diet has been reported for blacktails in western Washington (Brown, 1961). High production of these food items occurs in the vine maple and huckleberry-salal plant communities (Crouch, 1964). Both vine maple and huckleberry-salal communities occur predominately below 1,500 feet, 93 and 82 percent, respectively. Trailing blackberry production is high in the bracken fern community. However, this plant community occurs primarily on the exposed slopes above 1,500 feet where unfavorable weather conditions prevail throughout the wintry period. Deer will not actively feed on these exposed sites unless the food supply becomes inadequate on favorable sites.

Thimbleberry becomes a principle food item during the summer and early fall. It has been recognized as an important summer forage by Lindzey (1943), Chatelain (1947), Crouch (1964), and others. Deer tend to utilize the thimbleberry plant mostly within the vine maple community at lower elevations, where they are taller (4-5 feet, as compared to 2-3 feet, Bailey, 1963) and have larger leaves than those plants at higher elevations. The limited productivity of the Kilches soil upon which the thimbleberry community

occurs (Bailey, 1963) may be reflected in the choice of forage plants from lower elevations.

The mild winter of 1964 resulted in only light to moderate browsing by deer. The preference shown for red huckleberry as a browse plant was also noted by Crouch (1964). Although vine maple was not browsed during 1964, plants showed signs of heavy browsing in the past. The heaviest browsing at intermediate levels reflects minimum snow depths and relatively favorable weather conditions at these levels.

Observed Deer and Plant Communities

Indices to Plant Community Preferences by Deer

The two indices to plant community preferences (Figures 10-13) indicate both winter survival value for deer in the juxtaposition of vine maple, huckleberry-salal, and big-leafed maple plant communities, and the nonrandom distribution of these deer resulting from seasonal selections of various plant communities for feeding areas and bed sites.

The peaks of the first index (Figure 11) can all be accounted for in terms of forage availability, with two exceptions. The exceptions are the summer period of bed site preference in the big-leafed maple community and the November-December period in the alder

community resulting from chase activity during the rut.

Preference for the vine maple community was high due to the relative abundance of trailing blackberry and grasses found there. February and March increases for the huckleberry-salal community were the result of periods of snow cover rendering much of the forage in the vine maple situation unavailable. During the same period added sunlight and higher temperatures produced greening of the grasses, particularly on the exposed slopes within the big-leafed maple community, and deer moved to take advantage of the new plant growth.

Alder leaves were among the first to appear in late March and April, and the deer utilized them as they became available. Similar observations were made by Crouch (1964). By April, new leaves of red huckleberry and vine maple were being readily taken along with forbs and the new growth of trailing blackberry. The wide distribution of summer forage permitted deer to remain spread out among the various plant communities. The sudden increased use of the alder community during September, seemingly, verifies Crouch's (1964) statement of fall resumption of foraging on alder leaves. The bracken fern and thimbleberry communities received low preferences for reasons given elsewhere in this report.

Since the second index, the "acreage ratio" (Figure 13) tends to magnify the low acreage communities of huckleberry-salal and

alder and reduces the larger vine maple community, a dual consideration of Figures 10 and 13 is desirable for best determining their values for deer. The huckleberry-salal plant community appears to be a key to winter survival when deer are subjected to temporary unavailability of forage at lower elevations.

The "acreage ratio" is not as practical an index as the former plant community preference ratio, since the community preference ratio requires only knowledge of the locations of deer and an area measurement of existing plant communities, whereas, the necessary data for home ranges of individual deer that are used in calculating the "acreage ratio" are most difficult to obtain.

The "acreage ratio" does not give an index to the intensity of utilization of any particular acreage within a plant community. It is only an estimation of utilization for the - entire - plant community.

Seasonal Peaks of Daily Activity

Daily peaks of activity during January and February most probably reflect the influence of a limited forage supply and unfavorable weather conditions. Daily activity was characterized by brief periods of feeding and rest. Animals fed for approximately 15 to 60 minutes, then bedded for similar intervals. In March, deer began to seek out sporadic new woody plant growth. By April, deer moved in response to new sources of forage which occurred at lower

elevations and on southerly slopes. Springtime use of southerly slopes for foraging was reported in western Oregon by Anderson (1959) and Dealy (1959).

Deer were moving at daylight, actively feeding on the new leaf growth. Many deer had routine daily travel routes. Most animals followed a routine for three to five days, and then, for undetected reasons, changed their patterns of travel. Some animals were so consistent in their daily movements and activities that the observer could foretell, two to three hours in advance, the future activities and locations of the animals concerned.

Maximum temperature was the governing factor for seasonal peaks of daily activity during mid-May through October when weekly extremes consistently exceeded 60° F. The daily activity peaks during November and December were primarily influenced by rutting activities. Constant pursuit of does resulted in many forced movements.

The 1964 seasonal peaks of daily activity (Tables 11-14) observed within the study enclosure were similar to those reported for mule deer in California by Lindsdale and Tomich (1953). Observed summer activity peaks were also comaprable to those reported for black-tailed deer in California by Taber and Dasmann (1958).

Home Range Size

Home range, in the present sutdy, is considered to be that area normally occupied by an individual deer while engaged in the processes of feeding, resting, and escape activities. This definition is basically the same as that given for the home range of black-tailed deer in the chaparral of California by Dasmann and Taber (1956). In general, the home range of a mammal is defined as that area, usually around a home site, over which the animal normally travels in search of food (Burt, 1943), again, basically the same as the definition applied in this study.

The home ranges of North American Cervidae have been extensively investigated (Table 18). Food, water, cover, climate, and reproductive activities are primary factors in influencing home range size. Within the enclosure, juxtaposition of food, water, cover, and discontinuity of terrain allowed deer to occupy small home ranges. Einarsen (1946) reported that black-tailed deer occupied restricted ranges in the Tillamook Burn.

That deer have very definite home ranges is evidenced by the fact that there have been many reports of habitat changes which resulted in die-offs as the deer did not move to new locations (Stoddart and Rasmussen, 1945; Dasmann and Taber, 1956; Thomas et al., 1964; and others).

Table 18. A comparison of some home range estimates for North American deer of the genus Odocoileus.

Species Sex and/or Age Class	Annual Home Range Size	Location	Source
Odocoileus hemionus			
Adult female	130-257 acres*	Tillamook Burn, western Oregon	Cedar Creek Study 1964
Adult male	199-294		
Two-year-old female	155-256		
Two-year-old male	201-312		
Yearling female	94-98		
Yearling male	143-153		
Female fawn	86-114		
Male fawn	121-152		
Does, fawns, and young deer	Up to 1.25 miles in diameter	Willapa Hills area, western Washington	Zwickel, Jones, and Brent (1953)
Bucks	Slightly larger than above		
Deer	Did not exceed 0.25 miles in diameter within the experimental enclosure	Angeles National Forest California	Cronemiller and Bartholomew (1950)
Deer	Summer, 0.50-0.75 miles; Winter, 0.25-0.37 miles	Toulumne County California	Leopold et al. (1951)
Deer Adult does Adult bucks	Up to 1.50 miles in diameter 750-1325 yards in diameter Mostly between 900-1400 yards	North Coast Ranges California	Dasmann and Taber (1956)
Deer	0.50 miles in diameter	Lake County, California	Dasmann and Taber (1953)
Odocoileus virginianus			
Deer	Somewhat less than 1.50 miles	Edwards Plateau, Texas	Thomas et al. (1964)
Does Bucks	60-340 acres 240-880 acres	Welder Wildlife Refuge Texas	Michael (1965)

*Horizontal surface acres.

In the present study, both sex and age in addition to available forage and climate influenced the size of annual and monthly home ranges. Periods of noticeable change in home range size occurred in the spring, during early summer, and with the rut.

All deer extended their movements in the spring in response to the newly available forage. Increased forage availability resulted in deer use of areas previously lacking in winter forage. Milder weather resulted in more use of exposed sites. With the appearance of summer forage, home range sizes decreased again, leveling off for all animals except pregnant does. Pregnant does sharply reduced their home range size with fawning. However, Michael (1965), working in Texas, reported that movement of white-tailed does during fawning underwent no change. By late summer, the nursing does have extended their ranges.

The home ranges of all animals were influenced by rutting activities. Increases in home range size occurred in both sexes and all age classes. All bucks, including yearling males, wandered extensively, seeking out does and pursuing them throughout the day. This is contrary to Taber and Dasmann's (1958) report that yearling black-tailed bucks showed no interest in the rut. Adult bucks restricted their interest to adult and two-year-old does. Yearling females were chased by two-year-old and yearling bucks. The young bucks pursued older does less frequently. Female and male fawns

were often separated from their maternal does, wandered, and joined other animals.

Adult bucks, and to a lesser degree, two-year-old bucks spent the greater part of the year on high ground in the East Drainage, occasionally crossing over to the upper part of the West Drainage. Lindzey (1943) reported a preference for high elevations by black-tailed bucks in western Oregon. Black-tailed bucks tended to winter at higher elevations than other deer on Vancouver Island (Taylor, 1956).

The size of home range differed for female and male fawns since the maternal does of male fawns occupied larger home ranges than does with female fawns. No significance is attached to the fact that does with larger home ranges had male fawns.

The two-year-old animals were the most mobile age class, corroborating the observations of Brown (1961) on blacktails in western Washington.

Winter groups of from three to nine animals were commonly seen. Temporary increases in group size resulted from snow cover. Social grouping broke down between late May and early July. Small late summer and early fall groups joined to form the larger winter groups.

Sex and age differences in the mean values of home range size were distinct, despite social grouping tendencies which tended to

equalize home range size within groups of animals of different sex and age.

Distribution of Deer by Major Land Units

Most deer were sighted on the Flats and at the lower and middle elevations of the East Drainage. Similar observations were made during the winters of 1962 and 1963 by Crouch (1964). These areas are dominated by vine maple and huckleberry-salal plant communities. Existence of the best supply of preferred forage, a minimum duration of snow cover and relative freedom from cold winds (Crouch, 1964) seem to be the primary factors for encouraging the selective use of these areas.

The higher elevations were rarely used by deer except during the summer months when forage was available, and most sightings occurred in the East Drainage. Crouch (1964) observed that during the winter, deer seldom visited the highest parts of the enclosure and were most often observed in the East Drainage on the southeasterly slopes at lower and intermediate elevations and on the Flats.

Occurrence of deer in the West Drainage was relatively low throughout the year, with the majority of sightings occurring at low elevations on the southwesterly side of the drainage. This is the only portion of the drainage in which vine maple and huckleberry-salal plant communities predominate and are found together. The

remaining portion of the West Drainage is comprised primarily of the thimbleberry plant community which has a low winter forage value. There is also a general scarcity of grasses and other green herbage in this unit, whereas this forage often comprises up to 50 percent of the deer diet during the winter season (Crouch, 1964).

Snow cover remains longest in the bottom and on the southeasterly side of the West Drainage. The West Drainage, except for the low elevation area on the southwesterly side, receives the brunt of the prevailing cold northwesterly winds.

Deer also avoided the windward side of the main ridge formed by the East and West drainages and the exposed upper portion of the East Drainage when strong winds and low temperatures prevailed. The combined influence of wind and low temperature on the use by deer of different land sites appears secondary only to forage considerations.

SUMMARY AND CONCLUSIONS

1. The objectives of this study were to relate the distribution and activities of deer to previously and currently available forage, plant communities, and to climatic conditions.

2. Direct observation of deer within a 340 horizontal acre enclosure was carried on throughout 1964.

3. Three distinct land units are recognized within the enclosure: the East Drainage, West Drainage, and the Flats.

4. Five soil series are found within the enclosure. The Astoria, Trask, and Hembre II at low elevations and the Hembre I, Hembre II, and Kilches soils at high elevations.

5. The study area is characterized by high precipitation. Maritime influences result in cool, wet winters with prolonged snow cover usually above 2,000 feet. Summers are usually dry and hot.

6. Six seral plant communities were recognized within the enclosure. These were:

Acer circinatum/Corylus californica
Vaccinium parvifolium/Gaultheria shallon
Pteridium aquilinum/Lotus crassifolius
Rubus parviflorus/Trientalis latifolia
Acer macrophyllum/Symphoricarpos mollis
Alnus rubra/Acer circinatum

7. Thirty-four deer were captured from surrounding areas with propelled immobilizing agents and released within the study enclosure.

8. A marking system permitted positive identification of individual deer.

9. Weather data for temperature, relative humidity, and precipitation were collected throughout 1964. Instrumentation consisted of four, eight-day meteorographs located at three elevational levels (750 feet msl, 1,300 feet msl, and 2,150 feet msl) and a rain guage located at 750 feet msl.

10. Supplementary information on utilization of browse was obtained from four woody plant browse transects located on four major ridges in the Cedar Creek Drainage. Only the transect on the south-facing slope was within the study enclosure.

11. Observations were made from huts located on surrounding prominences outside the enclosure.

12. Extremes and sharp changes in temperature influenced deer activity.

13. Deer consistently sought cover by midmorning when weekly extremes in temperature exceeded 60° F.

14. Definite downward trends in biweekly minimum relative humidity occurred during seasons associated with elevational migrations of black-tailed deer in western Oregon.

15. An elevational influence on minimum relative humidity was recorded. Minimum relative humidity values were predominantly greater at higher elevations.

16. Winter rains did not influence deer activity, whereas heavy summer rainfall sharply reduced deer activity.

17. There was an elevational influence on the distribution of deer with 84.7 percent of all deer sighted during the year being seen below 1.500 feet msl elevation.

18. Inspection of browse transects revealed that red huckleberry was the principle browse plant, that vine maple and alder were unimportant as browse, and that the initial browsing of Douglas fir began with the first snow cover.

19. Deer showed seasonal preferences for huckleberry-salal, big-leafed maple, and alder plant communities, while use of the vine maple community remained high throughout the year.

20. Deer bedded on their feeding grounds during the winter season. However, high temperatures during warm seasons influenced their moving from feeding areas to bed sites in different plant communities.

21. Deer showed a high preference for bed sites in the big-leafed maple community from May through October.

22. Plotted ratios of two indices to plant community preferences by deer indicate winter survival value for deer in the juxtaposition of certain plant communities, and the nonrandom distribution of deer.

23. During 1964, 1,410 hours of observational time yielded 6,746 sightings of deer. The greatest number of sightings occurred in May and the least in January.

24. Seasonal peaks of daily activity by deer were recorded as follows: midday peaks during January and February followed by early morning peaks during March, April, and May; slight late morning peaks and high twilight peaks in June through August; high early morning peaks and slighter twilight peaks in September; peaks in early morning and at midday with some revival at twilight in October; high activity throughout the day with a peak at midday in November; and high activity from midmorning to twilight during December.

25. Age and sex influenced the size of both monthly and annual home ranges.

26. Size of home ranges varied between one-fourth and one-half square mile, while the monthly home ranges represented only a fraction of the annual home ranges.

27. Monthly home range size for individual deer increased due to seasonal behavioral changes associated with reproduction and forage availability. Home range size increased during the fall breeding period and with renewed forage growth in the spring. It decreased sharply for maternal does during early summer, recovering in midsummer.

28. Social grouping tendencies tend to coordinate the relative size of monthly and annual home range for individual animals within a group.

29. Adult and two-year-old bucks showed preferences for high ground at all seasons.

30. The lack of a good supply of winter forage and unfavorable weather conditions resulted in considerable variability in the distribution of deer among the major land units.

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