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BEHAVIOR OF THE RATTLESNAKE MULE DEER  
ON THEIR WINTER RANGE

by

EDWARD D. BAILEY

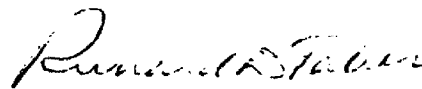
B.S., Montana State University, 1958

Presented in partial fulfillment of the requirements  
for the degree of Master of Science

Montana State University

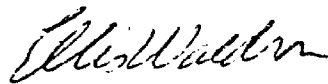
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## INTRODUCTION

In order to manage any animal effectively, a basic understanding of that animal is a prime requisite. This study, concerned with the behavior of the Rocky Mountain Mule Deer (Odocoileus hemionus hemionus), is an attempt to obtain this basic understanding on the social and psychological level as well as the physiological level.

The mule deer that winter on Wallman Ridge (also called Strawberry Ridge) in the Rattlesnake drainage were chosen for study because the area is accessible throughout the winter months and the animals could be observed from a distance thereby minimizing to some extent the disturbance due to the observer's presence.

It has long been thought by many that snow is the factor which causes migration of deer from the summer range to the winter range (Dixon, 1930). Others have suspected quality and availability of food - thus incorporating snow and frost as factors (Russell, 1932). Still others have given various other reasons mostly pertaining to weather phenomena. But there is no certainty. It has been observed that deer have chosen to remain on an overbrowsed range when a short distance away there was good feed (Taber and Dasmann, 1958). Snow is again used as a reason. Cold air drainage has been suggested. More recently habit or tradition has



become a suspected cause (Dasmann and Taber, 1956). This study was set up to observe the winter behavior and ecology of the mule deer wintering on Wallman Ridge with the object of gaining a deeper understanding of these intrinsic and extrinsic factors which govern their lives during the winter period.

The objectives of the study were:

1. To observe seasonal and daily movement patterns and attempt to correlate these movements with weather conditions and time.
2. To observe individual and social behavior as influences on movement and concentration on the winter range.
3. To determine wintering populations and herd composition.
4. To determine the effect of predation on population, herd composition and behavior.
5. To determine the place of instinct, drive and learning in the mule deer's life during the winter.
6. To observe concentrations as a means of determining deer use on various portions of the winter range for the purpose of locating the critical forage areas.

It was hoped these objectives could be attained by the intensive observation of individually recognizable deer within small groups as well as the aggregation as a whole. Then, by noting the behavior of these animals in natural experiments involving weather, predation and time, as well as instances of intraspecific relationships of various

nature, to assess as objectively as possible the importance of these factors to the well-being - the psychological and physiological comfort - of the animals. Thus, it was an attempt to gain a basic understanding of the Rattlesnake mule deer specifically and, mule deer behavior in general as a step toward the ultimate understanding of mule deer ecology.

## STUDY AREA

Location and Description. Wallman Ridge is located between Rattlesnake Creek and Spring Creek. The ridge terminates at the junction of these two streams. From the foot, the ridge runs north-northeastward for about three miles. The distance between the two streams varies from a half mile at the narrowest place to one and one half miles at the widest part. The study area lies approximately six and a half miles north of the Montana State University campus in sections 10, 11, 14 and 15 of township 13 N, range 19 W.

The area investigated in this study includes the southeast, south, southwest and west faces of Wallman Ridge. The northwest face is timbered for about half its area and is normally covered with a heavier snow blanket than the other faces and is not frequented by the animals to as great an extent as the slopes facing the sun and so was only casually observed. The study area covers about three and one half square miles (Figure 1).

The portion of the ridge under observation supports primarily a shrub type vegetation with isolated patches of moderately dense pole size trees. The dominant shrubs present are Snow brush (Ceanothus velutinus), Nine-bark (Physocarpus malvaceus), Service berry (Amelanchier alnifolia),

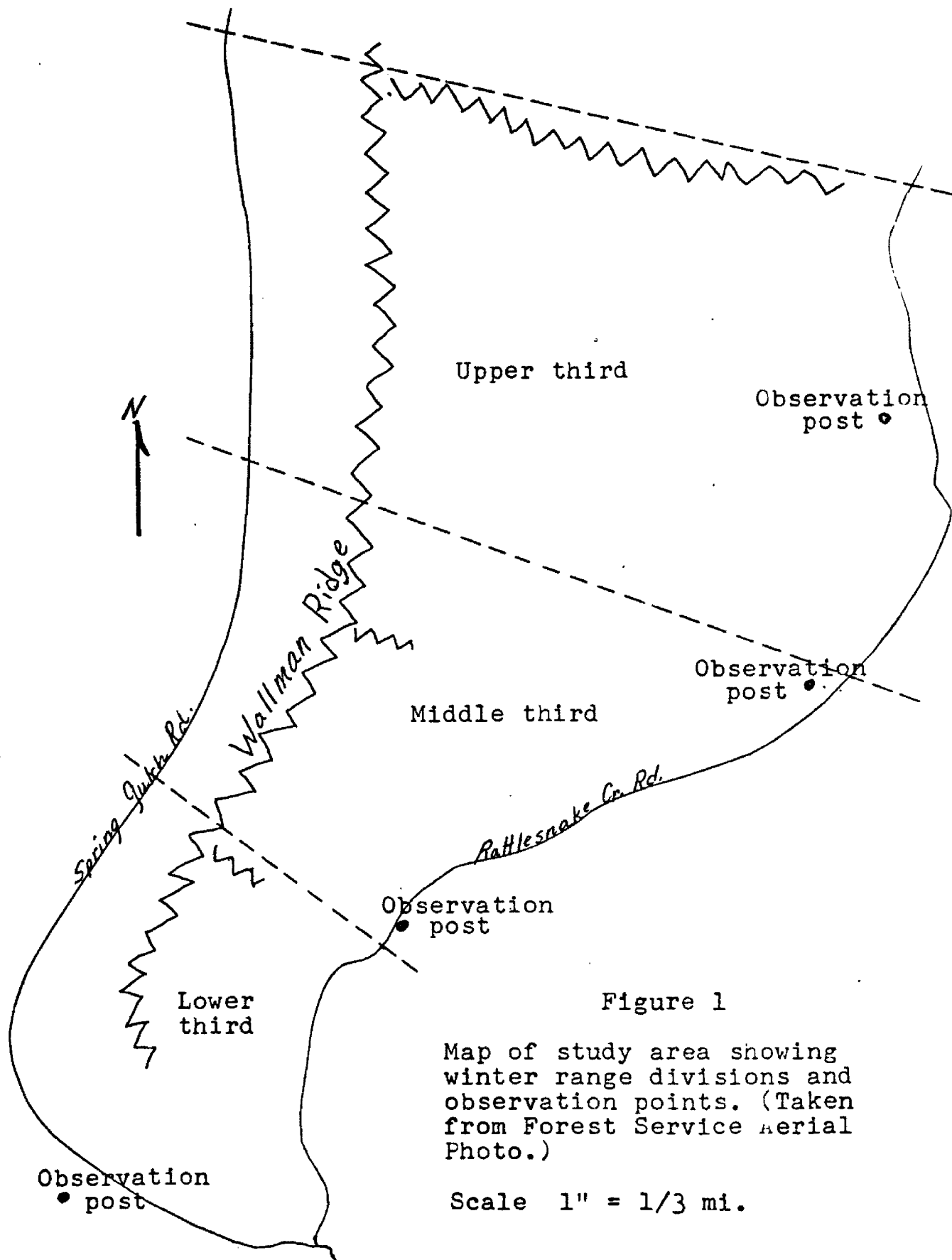


Figure 1

Map of study area showing winter range divisions and observation points. (Taken from Forest Service Aerial Photo.)

Scale 1" = 1/3 mi.

Chokecherry (Prunus Virginiana L. var. demissa), Willow (Salix sp.), Mountain maple (Acer glabrum). Common and scientific names of shrubs and bushes are those proposed by Davis (1952).

Trees growing in the study area include Ponderosa pine (Pinus ponderosa), Douglas fir (Pseudotsuga menziesii) and Western larch (Larix occidentalis). The common and scientific names of trees are in accord with Harlow and Harrar (1950).

Low growing shrubs such as Kinnickinnick (Arctostaphylos uva-ursi) and Oregon grape (Berberis repens) are found over most of the area as are such grasses as Junegrass (Koeleria cristata) and Bluebunch wheat grass (Agropyron spicatum) and sedge (Carex sp.). Common and scientific names of grasses are in agreement with Hitchcock (1950).

General climate. Between December and April the temperatures in the study area have a wide range from a low in late January of minus 25 to minus 30 degrees F. to a high in April of plus 65 to plus 75 degrees F. There is a general cooling trend from the twenties in December to about minus 20 degrees F. in late January and continuing cold until mid February when a warming trend occurs. The most snowfall usually occurs in late December through January when depths of three feet are not uncommon. With the warming in February this snow settles and becomes crusted. At this time the south and southwest slopes may become clear of snow in

comparatively small areas.

Sunshine is a fairly scarce commodity during the winter months with completely clear days occurring only one day out of every four or five on the average.

Winds are usually from the south and southwest, having a tendency to follow the Rattlesnake Valley. This is especially so during late winter when the warming trend takes place.

The general climate on the study area is felt to be about average for western Montana, perhaps less severe than many places such as the Drummond area fifty miles to the east but generally about the same as most mule deer winter ranges in this locality.

History of the study area. White (1958) asserts that during the history of the entire Rattlesnake drainage, the lower portion was nearly all burned in 1919. This includes the study area on Wallman Ridge. The natural plant succession has brought the study area to a brush stage on the dryer, more exposed sites and to pole size trees on the more mesic north exposures, making the area ideal winter range (Lutz, 1955). The upper portion of the winter range was logged in 1956, thus nearly completely removing the overstory and encouraging the brushy understory, which is utilized by wintering mule deer.

Currently the area is unused by man during the winter except on weekends when it serves recreationists as a hiking

area. The hiking is most often accompanied by target practice with pistol and rifles and on several occasions people were observed shooting shotguns. Much of the target practice goes on in the bottoms close to the road and about a quarter of a mile from large deer concentrations. As the weather becomes more pleasant in March, the weekend traffic increases, but the majority of the people observe nature from their automobiles while driving up the road. Seldom are there more than two or three people walking up the ridge to where the deer are located.

Population and composition of deer herd. The number of deer using the area varies during the winter as an increasing number of deer arrive on the wintering grounds from December to February. The highest population occurs from mid February to mid March, then decreases gradually as deer leave the area until April when nearly all the migratory animals are gone from the study area. At this point it should be made clear that not all the mule deer using the area in winter are migrants. An estimated 12 or 15 mule deer are resident animals and these few spend the entire year in the area. Seven animals were seen on the upper portion of the study area the last week of June and nine animals were observed in the same area in late August. At these times, according to White (1958), the mule deer are high on their summer range located 5 to 6 miles further north. So, it can be seen that at no time does the population on the winter

range fall to zero. The resident deer however, account for only about 10% of the peak winter population.

During the winter of 1958-59 the highest number of deer using the study area was estimated to be 125. The highest actual count was 105 on March 14, 1959. These deer were in two large groups, one of 55 animals seen on the Spring Gulch side of the ridge and the second group of 50 seen on the Rattlesnake Creek side. At this time both groups were located on the southern-most portion of the ridge.

In the 1959-60 winter, the population was about the same with an estimated peak number of 115 animals. The highest actual count of 73 animals occurred February 17, 1960 when one large loosely formed aggregation of between 70 and 80 animals was observed spread over the middle third of the range with a small group in the upper third (See Figure 1 for location of these areas).

The largest single concentration of animals in 1959 was seen on March 6 when a total of 95 to 100 animals formed one group. During 1960 the largest grouping occurred on February 17, a group of 70 to 80 animals.

The composition of the wintering herd shows some change as the winter progresses. The change occurs primarily in the fawn numbers. Although the decimation of the fawn population is a gradual thing, it can be shown by dividing the winter into two parts; early winter from December until mid February and late winter from mid February through April.



Since many errors occurred when trying to classify yearling animals under any conditions except those of ideal visibility and opportunity for good comparison with other animals, yearling does are classed with adult does and yearling bucks with adult bucks for composition counts. It was found the doe-fawn ratio for early winter 1958-59 was 1:.5 and became 1:.3 during late winter. The doe-buck ratio was 1:.3 for the entire winter.

During early winter of 1959-60, the doe-fawn ratio was 1:.66 and became 1:.5 during late winter. The doe-buck ratio for the period was 1:.5. These ratios expanded to the peak populations for the two years appear in tabular form in Table I.

It can be seen from Table I that during the 1958-59 winter there was a loss of an estimated 12 fawns and in 1959-60 an estimated loss of 10 fawns. There was no evidence of starvation in either year and the fawn mortality was felt to be due entirely to predation. This will be discussed more

TABLE I  
ESTIMATED SEX AND AGE COMPOSITION

	Does	Fawns	Bucks
1958-59			
Early winter	75	37	25
Late winter	75	25	25
1959-60			
Early winter	54	37	26
Late winter	54	27	26

fully under intraspecific relationships.

The decrease in the doe population the second winter is possibly due to the dispersion effect caused by pre-fawning interspecific stress. This will be explained later under interspecific relationships.

## METHODS

Observation and notes. During the winter of 1957-58 a pilot study was initiated. The purpose of the weekend observations made during this phase of the project was to determine what was the winter range. Although it was a well known fact locally that mule deer winter in this area, there was little known about actual numbers of animals or precisely which portion of the lower Rattlesnake drainage was intensively used by the deer. It was at this time that the limits of the study area were established and the range divided into three arbitrary parts depending on elevation levels and deer use. The upper third, the highest, is utilized least, the middle third, utilized more heavily than the upper but less than the lower third which is lowest in elevation and receives the highest deer-day use. In area, the upper third is largest, about one and one half square miles, the middle third is about one square mile in area and the lower third is about three quarters of a square mile (Figure 1).

For the main part of the study in the 1958-59 and 1959-60 winters, four vantage points were selected from where the greater part of the study area could be observed. These observation points (Figure 1) were between  $\frac{1}{4}$  and  $\frac{1}{2}$  mile from the deer, so as to keep disturbance to a minimum. During

1958-59, a twenty and sixty power spotting scope was used to observe the animals and the next year a twenty and thirty power spotting scope was used. A total of nearly a thousand hours was spent in observing the deer.

Notes were taken in a loose leaf notebook with the left hand page for notes and the right hand page a mimeographed map of the study area with a scale of 3 inches to 1 mile. Each day's notes were entered on a separate sheet and map. Use of a larger scale map 1 inch to 500 feet was attempted but the size of this map proved too cumbersome and particularly unsatisfactory under conditions of rain or snow.

Weekend observations during the main part of the study were held to a minimum in the hopes of eliminating "help" from the people using the area for recreation purposes.

Three recording hygrothermographs were used during the 1958-59 winter and one during the 1959-60 winter as a means of obtaining temperature and relative humidity data from the area. Charts were collected once weekly from these recorders.

During the first winter, one instrument was placed at surface level in partial shade, another at 25 inches above the surface level (approximately body height of a deer) in partial shade and the third at body height in a location exposed to full sunlight. During the second year, the only hygrothermograph used was placed in partial shade at body height.

Wind speed was gauged by use of the Beaufort scale of wind intensity (Hodgson, 1957) and direction was determined by observing the way the trees, bushes and grass leaned or the direction of the blowing snow.

Snow depth and surface condition was estimated by observing how deeply the animals sank into it and by weekly hikes through the area.

Marking and individual identification. The success of tracing the movements of deer depends to a great extent on the observer's ability to recognize individual animals and groups of animals. To aid in the identification several marking methods were considered. Pelage dye is only temporary so was ruled out for the two year study. The terrain and expense involved precluded live trapping techniques. Collars had been successful in California (Jordan, 1958) and previously in Missouri (Progulske, 1957), so a plastic necktie type collar similar to the one used for marking geese (Craighead and Stockstad, 1958) was designed in the form of a snare so the animals would mark themselves automatically. This technique, however, met with poor success as only three animals were marked, all in 1959. A yearling male was marked in March with a pink neck band and red tail. He was referred to as PR. An adult doe and a female fawn were marked in late April, 1959. The adult had a blue neck band with blue tail, the fawn a purple neck with a blue tail. The adult doe was referred to as BB and the fawn as PB. The

buck PR was not seen during the winter of 1959-60 and perhaps he was killed or the neck band came off. BB and PB both were seen during the second winter at intervals from January through March.

To augment the artificial marking, natural markings were used. Subtle or easily confused markings were avoided. In this way sixteen additional animals were recognizable during the second winter. Six of these were females, the remaining thirteen males. Only six animals were identifiable in 1958-59, four of which were recognized the following winter. Most of the natural markings were notched ears, one doe carried a large Y shaped scar, two were crippled males, one was a female with a nearly completely black tail, one adult male had a large lump on his neck that resembled a goiter and one male had an oddly square shaped rump patch. These deer were referred to by appropriate initials. Animals with distinguishing characteristics which were identified only once were not included among these recognizable deer. The known animals will be described more fully as they are used to illustrate movement patterns.

The identifiable animals and the groups in which they were observed during the two winters appears in Table II. It can be seen in Table II that during 1958-59, two distinct groups were recognized and during 1959-60 four groups were recognized, two of which were the same as the first year. These groups will be referred to as group A, Group B, Group BB and group PB.

TABLE II  
 NUMBER OF OBSERVATIONS OF INDIVIDUALLY IDENTIFIABLE  
 DEER IN EACH GROUPING

Known Individuals 1958-59	Sex	Group Designations									
		A	B	BB	PB	A/B	A/BB	A/PB	B/BB	B/PB	BB/PB
VR	M	12	-	-	-	6	-	-	-	-	-
CL	M	10	-	-	-	7	-	-	-	-	-
PR	M	-	4	-	-	1	-	-	-	-	-
LE	F	-	2	-	-	1	-	-	-	-	-
YS	F	2	-	-	-	1	-	-	-	-	-
CE	F	-	2	-	-	1	-	-	-	-	-
1959-60											
VR	M	7	-	-	-	3	-	-	-	-	-
CL	M	7	-	-	-	3	-	-	-	-	-
LE	F	-	6	-	-	1	-	-	4	-	-
BB	F	-	-	3	-	-	-	-	3	-	-
AL	M	-	7	-	-	2	-	-	4	-	-
DE	M	-	6	-	-	2	-	-	2	-	-
NE	F	5	-	-	-	3	-	-	-	-	-
Cr.R	M	4	-	-	-	-	-	-	-	-	-
Cr.L	M	3	-	-	-	2	-	-	-	-	-
PB	F	-	-	-	5	-	-	-	-	-	-
SP	M	5	-	-	-	1	-	-	-	-	-
SE	M	2	-	-	-	-	-	-	-	-	-
SF	M	2	-	-	-	2	-	-	-	-	-
LF	M	2	-	-	-	2	-	-	-	-	-
YS	F	2	-	-	-	-	-	-	-	-	-
NL	M	1	-	-	6	-	-	-	-	-	-
BT	F	4	-	-	-	-	-	-	-	-	-
NR	M	2	-	-	-	2	-	-	-	-	-

## MOVEMENTS

### Seasonal.

Arrival on and departure from the winter range. There was no exact time of arrival on the winter range that would be applicable to the whole herd. Rather, arrival was characterized both years by a loose drifting pattern with some animals appearing in mid December while others were not seen until the first week of February.

The groups were small in number when first arriving and were of two forms. The family group was composed of from one to three adult does with their fawns and one to four or five yearlings or, simply an adult doe with her fawn(s). These family groups then, varied in number from a minimum of two to a maximum of ten or twelve animals. Noticeable by their absence from these family groups were bucks above the yearling class. These adult bucks formed their own groups of between four and six animals. This group picture was however not true in every case. Adult males often remained solitary and occasionally joined family groups for several days during all activity or joined a family group just during feeding for a single day.

Also, this group formation seldom applied to non-migratory deer. The residents tended to form bands apart from the migratory deer during the early winter. These bands were composed of one or two adult males, several adult females



and their fawns and several yearling animals of both sexes.

By the beginning of February these groups merged to form larger bands until two large groups were identifiable. Group A at this time was located about a mile and a half south of group B, concentrating in the middle third primarily. Group B concentrated in the upper third ranging in an east-west direction for a distance of about  $1\frac{1}{2}$  miles and in a north-south direction  $\frac{1}{2}$  mile (See Figure 2). Group A occupied a smaller area of about one mile north and south and  $\frac{1}{4}$  mile east and west. This grouping was observed both winters.

Throughout the study, none of the identifiable animals of group A were ever seen in the part of the upper third occupied by group B. It was believed that group A animals arrived on the winter range west of the group B concentrating area and followed a southward route into area 1. Group B animals turned eastward into the upper third. Thus the two distinct groups were formed.

These two groups maintain their relative positions until mid February when most of group B moves southward and merges with group A, forming a single aggregation which is more or less stable for a period of three to four weeks. This movement of group B to join group A took place during a single day both winters. It occurred on February 19 in 1959 and on February 17 in 1960. Part of this movement was observed in 1959. Little feeding was seen during the move.

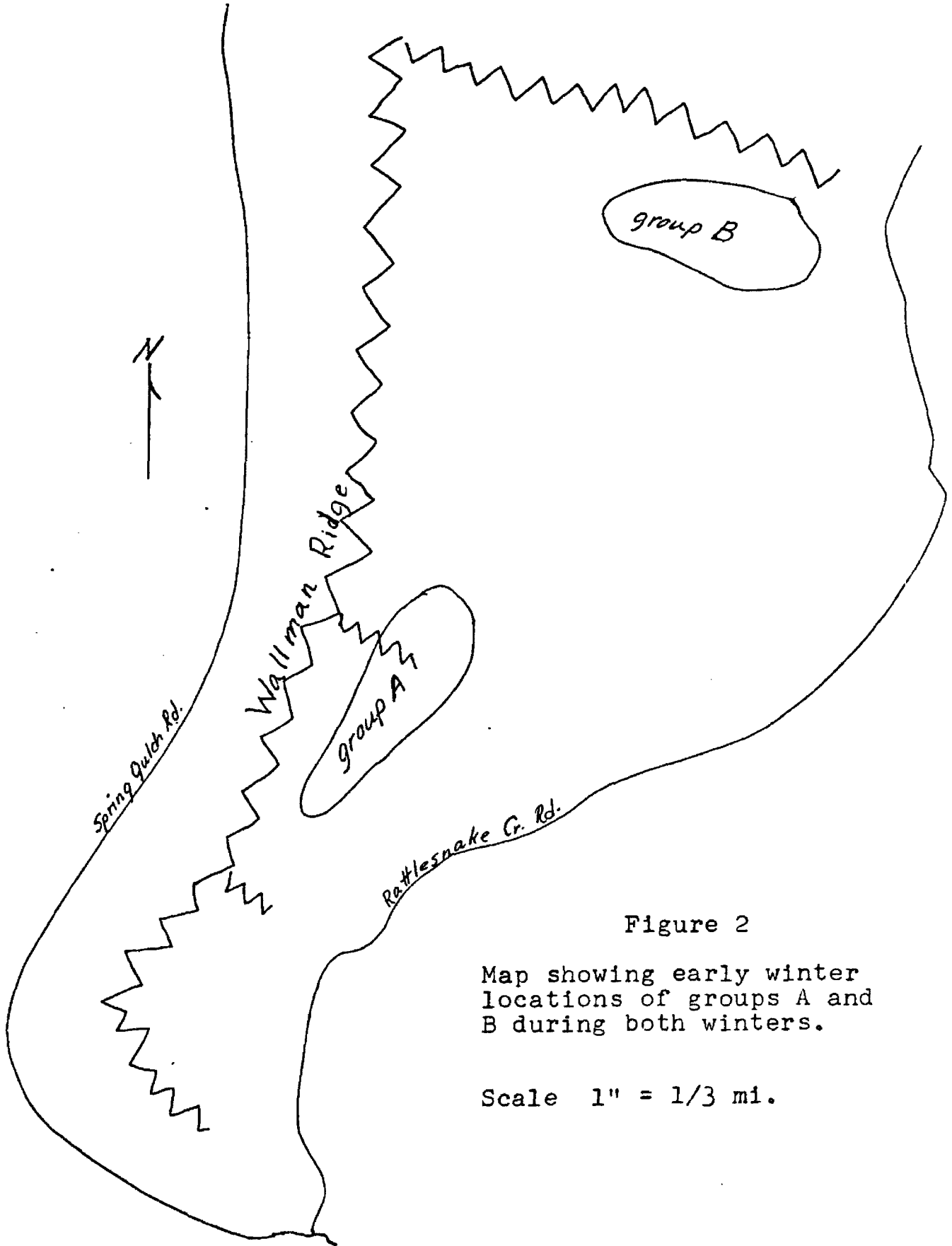


Figure 2

Map showing early winter locations of groups A and B during both winters.

Scale 1" = 1/3 mi.

The group was widely scattered in the eastern (lower portion) of the upper third. The animals had been resting. At 12:45 p.m. the deer in the upper third rose, moved southward, walking fast, then running until they joined with a group of seven deer. All deer around this group also started moving, until a single group of 27 deer was formed, all walking slowly, taking occasional bites of browse. Other small groups joined this large group and all animals moved into the middle third by 2:00 p.m. where they began feeding more than a mile south of their starting point. The next day group A animals were observed with these group B deer and they remained together as a large aggregation until March 16.

The merging of the two groups was not observed in 1960. But the two separate groups were identified on February 15. On February 17 animals from both groups were identified in the middle third nearly a mile and a half south of the group B location of two days before. Deer from group B were last seen in the middle third on March 18 in 1960. A small part of group B, about a dozen animals, broke off and remained in the upper third throughout the winter. These animals were recognized by the presence of doe BB. Another group of fifteen deer was identified by doe PB and an adult buck with a small notch on the tip of his left ear. The BB and PB groups did not merge during the winter but rather maintained separate identities throughout.

The departure from the winter range commenced the last

week of March. Prior to the departure there was a noticeable disbanding of animals similar to the early winter merging but reversed and with a major difference being that the phase characterized by two large groups was eliminated. It was characterized by the breaking off of groups of animals numbering up to fifteen to twenty accompanied by a general northward drift of all animals as well as movement toward the top of the ridge. These groups further dwindled in size until the family groups and the buck groups were again formed. The family groups grew smaller as yearling animals split away from adult does. Fawns were still seen with their mothers during late March and April.

Location of groups. The locations of the groups of deer are shown in Figures 3 and 4. It can be seen that the patterns for the two years resemble each other with one major exception. During March of 1960 the animals did not concentrate on the Spring Gulch side of Wallman Ridge as they did between March 1 and 15 in 1959. The downward movement in 1960 carried most of them only to the southern part of the middle third of the range and into the northern most portion of the lower third. The PB group was the only group to frequent the south exposure on the Spring Gulch side during the second winter and this group was seen there on only one day, March 18. This group next appeared on March 23 on the complete opposite end of the range, about 3 miles north of its location on March 18. It was during this period that

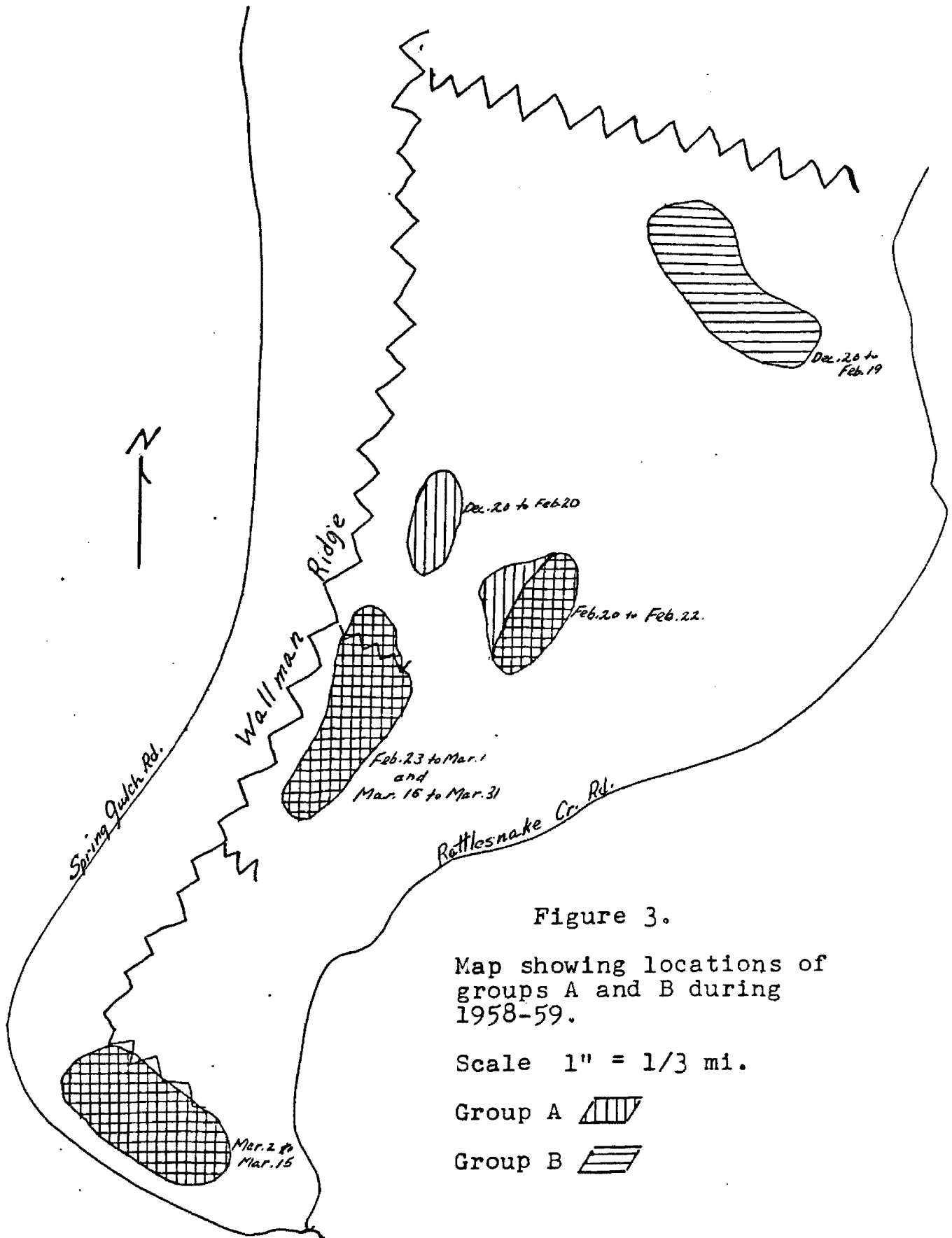




Figure 3.

Map showing locations of groups A and B during 1958-59.

Scale 1" = 1/3 mi.

Group A 

Group B 

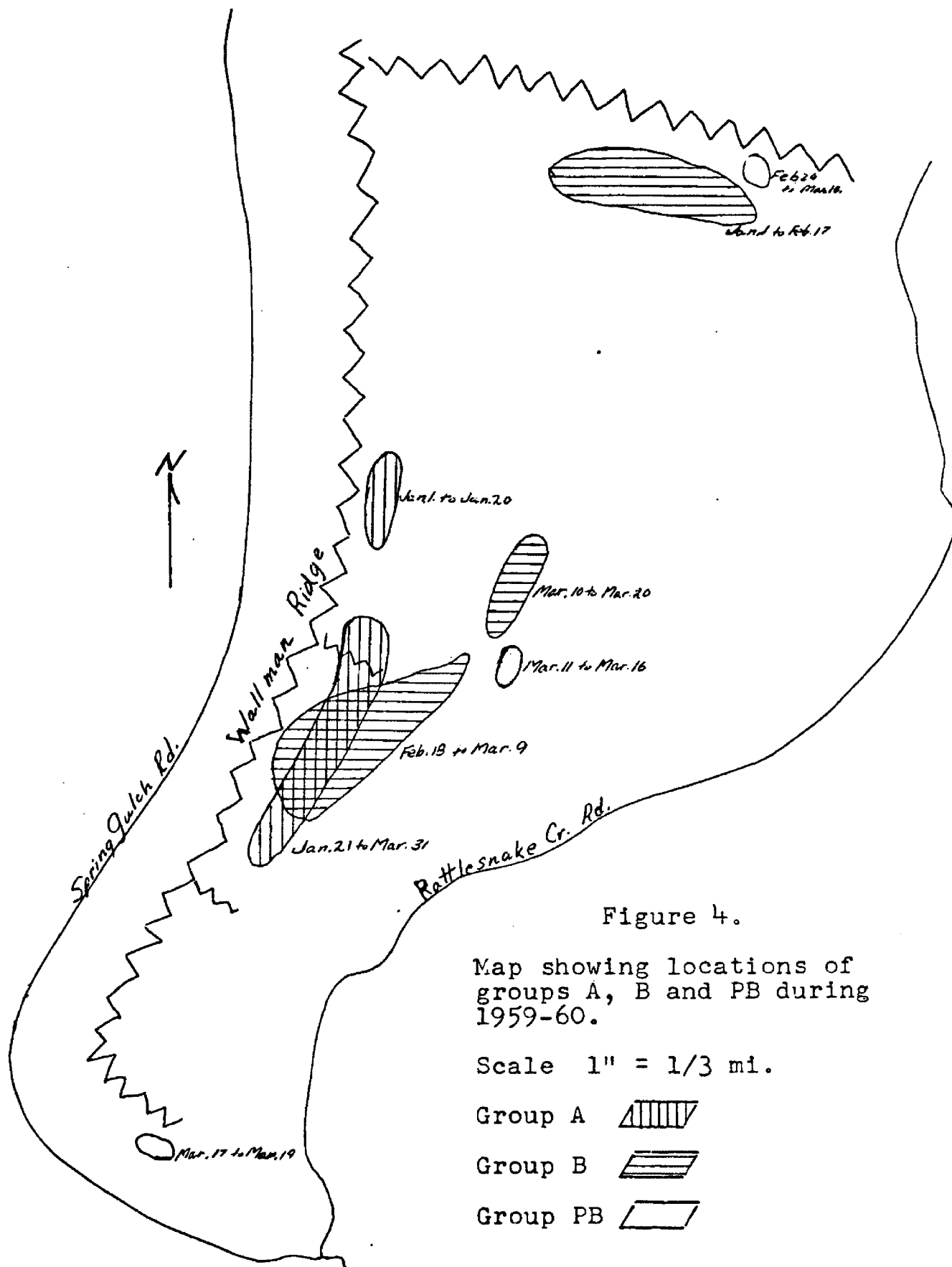
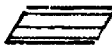



Figure 4.

Map showing locations of groups A, B and PB during 1959-60.

Scale 1" = 1/3 mi.

Group A 

Group B 

Group PB 

the general northward drift started. Group B animals were observed south of the PB group on March 16 and north of it on March 18. So group B was moving north while PB group was moving south and they passed each other. By March 25, animals from both these groups were in the northern most part of the winter range.

Ignoring for the moment the BB and PB groups, it was observed both years that group A tended to frequent the middle third of the range while group B was located on the upper third. These groups joined in mid February and at this time occupied the middle third. In the 1958-59 winter this total aggregation moved to the Spring Gulch side of the ridge during the first two weeks of March while in 1959-60 this aggregation remained in the middle third during this two week period. So, speaking generally, the middle third of the ridge receives and supports the greatest part of the herd between February 15 and March 15 and the Spring Gulch side may be used by all or none of these animals, as was seen in the study.

Returning to groups BB and PB, it was seen that these two groups tended to frequent the upper third for most of the winter. BB group stayed quite high the entire year, moving into the northern portion of the middle third for only a few days then moving back to the upper third again. PB group made a quick trip to the Spring Gulch side but returned within five days to the upper third. These two groups appeared to move independently of the two larger

groups and of each other except during the early part of the winter when the BB group was part of the larger group B. However, when the group B animals moved southward, BB group remained.

Concentration of the aggregations. The deer population for both years became more concentrated from the beginning of the winter until March. After mid March the density of the concentrations decreased.

The concentrations for the two years were similar through January and from March 15 through mid April. But during the first half of February in 1960 the concentrations resembled those of February 15 through 22, 1959. The size of the aggregations during the last half of February, 1960 resembled those of the first half of March, 1959. It appeared the higher concentrations occurred two weeks earlier in 1960 than in 1959. And, the size of the largest concentration in 1960 was considerably smaller than in 1959.

Considering the total number of animals using the winter range and the approximate area the total number occupies during a given period it is possible to estimate deer density during this period. By observing the size of the groups throughout the year and plotting them in a tabular form, the changes in density and group size throughout the winter can be seen. Table III is a Tabular representation of density and concentrations during 1958-59. Table IV is the density and concentration for the 1959-60 winter. Average snow



TABLE III.  
 WINTER RANGE POPULATION - 1958-59

Date	Location Winter Range <sup>1</sup>	Ave. No. Seen Per Day	Density <sup>2</sup>	Concentrations	Snow Depth and Condition
Dec.20- Jan.15	Upper third	18	10-15/sq.mi.	Small groups, widely scattered	4-6 in. Slight crust
Jan.16- Jan.20	Upper third	22	10-15/sq.mi.	Small groups, widely scattered	10-12 in. Wet, no crust
Jan.21- Jan.31	Upper third	23	10-15/sq.mi.	Small groups, less scattered	3-4 in. Heavily crusted
Feb. 1- Feb.15	Upper and middle thirds	35	15-18/sq.mi.	Large groups, two main concentrations	18-22 in. Slightly crusted
Feb.15- Feb.22	Middle third	40	30-35/sq.mi.	Large groups, two concentrations	22-24 in. Slightly crusted
Feb.22- Feb.28	Lower third	40	40-45/sq.mi.	Large groupings in small area	18-20 in. Wet and settling
Mar. 1- Mar.15	Lower third	95	125-150/sq.mi.	One large group. Entire herd.	14-16 in. Heavily crusted
Mar.15- Mar.31	Lower and middle thirds	45	20-25/sq.mi.	Three large groups. Widely spread.	8-12 in. Heavy crust. Bare areas
Apr. 1- Apr.15	Lower, middle & upper thirds	20	4-8/sq. mi.	Very small groups. Widely scattered.	Mostly bare. Snow only in shaded areas.

<sup>1</sup> Winter range divided into thirds according to elevation.

<sup>2</sup> Density computed on size of area used by the deer at these times, not total area of the winter range.

TABLE IV  
WINTER RANGE POPULATION - 1959-60

Date	Location Winter Range <sup>1</sup>	Ave. No. Seen Per Day	Density <sup>2</sup>	Concentrations	Snow Depth and Condition
Dec.20- Jan.15	Upper third	15	8-10/sq.mi.	Small groups widely scattered	16-20 in. Powdery.
Jan.16- Jan.20	Upper third	18	12-15/sq.mi.	Small groups, widely scattered	12-14 in. Slightly crusted.
Jan.21- Jan.31	Upper and middle thirds	20	12-15/sq.mi.	Small groups, less scattered	10-12 in. Slightly crusted.
Feb. 1- Feb.15	Upper and middle thirds	60	30-40/sq.mi.	Two large loosely formed groups	8-10 in. Crusted with large bare areas.
Feb.15- Feb.29	Middle third	70	80-90/sq.mi.	Large single group in small area	5-6 in. Crusted Bare on exposed faces.
Mar. 1- Mar.15	Middle, lower thirds	65	50-60/sq.mi.	Large single group, widely spread	5-6 in. Heavy crust. Exposed faces bare.
Mar.16 Mar.31	Lower, middle & upper thirds	35	20-25/sq.mi.	Small groups, widely scattered	Snow only in shaded areas.
Apr. 1- Apr.10	Upper third	10	5-7/sq.mi.	Very small groups, widely scattered	Bare of snow.

<sup>1</sup> Winter range divided into thirds according to elevation.

<sup>2</sup> Density computed on size of area used by deer at these times, not total area of winter range.

depth and condition for these periods are also given. These density changes are shown graphically in Figure 5. By observing where on the range these concentrations occurred and the number of days the deer stayed in each location, it is possible to make an estimate of deer-days use on the various areas. The deer-day use appears in Table V.

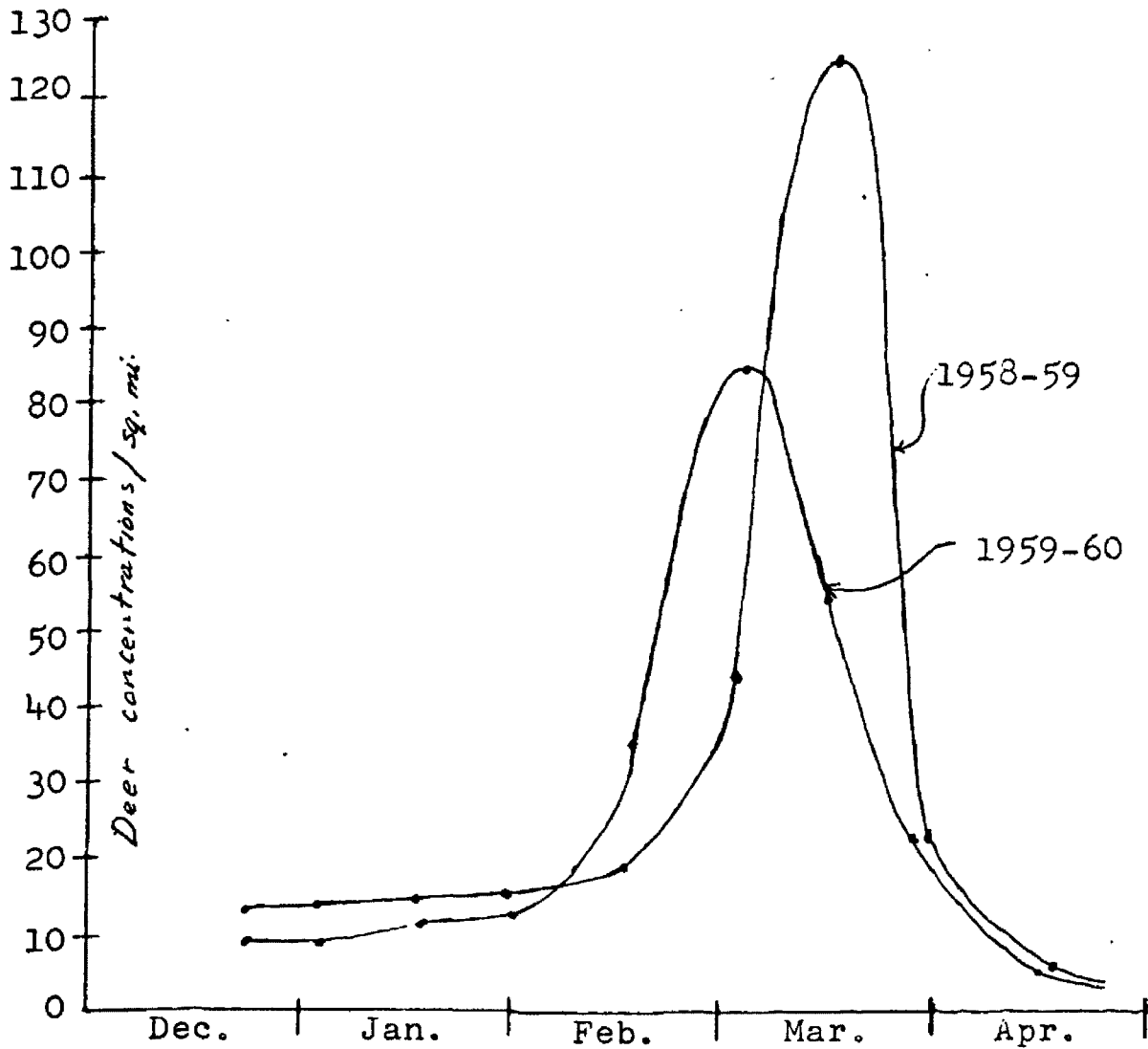
TABLE V  
DEER-DAYS USE OF THE WINTER RANGE

	Upper third	Middle third	Lower third	Total
Area in Acres	960	640	480	2080
Deer-days 1958-59	1148	1002	2030	4180
Deer-days 1959-60	1408	2696	261	4365

Most of the use in the upper third was in the higher portion of this area, the southern half being scarcely utilized either year. The use in the middle third was primarily in the southern half of this portion both years. The use on the lower third in 1958-59 was on the Spring Gulch side, the southern most part, while in 1959-60, the use was on the northern portion of this third.

From Table V it is evident that the use of the range varied considerably over the two year study period. The difference in deer-day use of the upper third was relatively small and for practical purposes could be considered the same for the two years. However, the middle third received

Figure 5  
Densities<sup>1</sup> for 1958-59 and 1959-60



<sup>1</sup>Density computed on area deer occupied, not the total area of the winter range.

over twice the use in 1959-60 it did in 1958-59 while the lower third received nine times more use in 1958-59 than in 1959-60.

The high number of deer-days on the lower third for the first winter was accounted for mostly by the heavy concentration of deer the first two weeks of March. At this time nearly a hundred deer were observed in this area every day for fourteen days. This accounted for 1400 deer-days. A similar heavy concentration on the extreme southern reaches of the ridge did not occur in 1959-60. The deer at this period stayed in the middle third. Had the deer moved to the lower area in 1960 for a two week period, the use would have been nearly the same both years. A possible explanation of why this movement to the Spring Gulch side of the lower area did not occur in 1960 is offered in the next section under snow depth as it affects movements.

Relation of weather and movements. In December of 1958 when the deer arrived on the winter range, there was little snow present, while in December of 1959, snow was about 20 inches deep. The preceding month for each year showed very little snow in 1958 and quite deep snow in 1959. Yet the animals arrived on the winter range on approximately the same date with the onward drift starting about mid December both years.

Dixon (1934) said that the migration is brought on by a deep snow that makes food unavailable or limits the animals'

mobility. White (1958) also suggested that snow hinders mobility and causes the move to the winter range. Darling (1937) points out that red deer (Cervus elaphus L.) may move before a snow storm hits, a suggestion that animals can in some way foretell weather conditions. Russell (1932) suggested lowered temperatures and snow as factors causing the movement toward the winter range, but also said that the deer move even if no snow occurs. Carter (1951) found that 18-20 inches of snow hampers mule deer movement and considered this to be the critical depth. Bowes (1957) said mule deer avoid north exposures because there was 70% more snow there than on south exposures.

In California Taber and Dasmann (1958) found that deer tend to seek the warmer south slopes at night and in winter indicating temperature might have an effect. But Darling (1937) said the red deer did not mind cold as such and that the animals were more affected by sharp alterations in temperature, and tended to seek the most even temperature. Rain according to De Vos (1958) hindered movement in moose in Canada. This was also seen in the red deer in Scotland (Darling, 1937).

The data for 1959-60 would agree more closely with the above mentioned thoughts on snow depth as a cause for migration than would the data for 1958-59. However, it was observed during the study that there was a pronounced downward movement of the group B deer in mid February. In 1959 this movement from the upper to the middle third occurred

on February 19. At this time the snow was 22 to 24 inches deep and slightly crusted. On February 22, 1959 the temperature became warm and there was considerable rain, making the snow soft and causing it to settle to 10 or 12 inches. At this time there was a large scale movement of animals from the middle third to the lower third. A period of cold weather followed causing severe crusting and the deer moved to the south end of the ridge where some of the area was bare. They remained there two weeks before moving back into the middle third which had by then also become clear of snow. This movement fits well with the idea that the snow depth or surface condition as a mobility inhibitor causes the movement. But in 1960 this same movement of group B animals occurred again, this time on February 17. The upper third of the study area was bare of snow as was the rest of the range. The browse quantity was greater in the upper third than the middle or lower thirds, the temperature probably did not vary greatly due to any altitudinal difference as the difference is at most 200 feet. The weather was clear or partly cloudy for several days preceding and succeeding the move and yet the move occurred just as it had the year before and could certainly not be attributed to any similarity in snow depth or surface condition.

The 1958-59 winter was about an average one for western Montana. The conditions occurring in February 1959 are the normal and resemble those occurring at this time during most winters. The 1959-60 winter was milder than normal from the

second week of February until the end in late March. Had 1960 been a normal winter, the movement the deer made would have taken them to the location on the winter range which would in the observers opinion be most advantageous as far as mobility (and consequently food getting) is concerned.

In 1959 the deer continued the movement to the extreme end of the ridge. At this time the snow was very well crusted and would nearly but not quite support an adult deer. The only area free of snow was the extreme southern exposure of the ridge and it was to this area the deer moved. This again is in agreement with inhibition of mobility by snow as a stimulus for causing movement. However, the PB group of deer made this same movement at a slightly later time the next winter when there was no snow to speak of on the study area.

During March, 1960, the entire aggregation did move somewhat to the lower third for one day but most returned to the middle third by the next day. According to Edwards (1956) animals use areas during open years which are inaccessible during snow year, but this, although a possible explanation of why the deer used the middle third the second winter and not the first, does not explain why they moved from the upper third which was also free of snow.

If this movement is put on a stimulus-response basis it can be more easily explained. Scott (1958) points out that a stimulus is an environmental change either outside the animal or inside and the response is an attempt to adapt



to this change. Guthrie (1952) suggests that a movement, once started, maintains itself by the stimuli it produces or is maintained by further stimulation from the environment (external or internal). Maintaining stimuli from within might be, for example, such motives as hunger, thirst or discomfort and from without might be weather phenomena, food abundance or danger.

Assuming then that some stimulus situation, the exact nature of which is unknown, occurred in mid February, just prior to the movement made by the group B deer. This stimulus might have been a single thing like day length, angle of incidence of light or hormonal balance or could have been a combination of these. At any rate, a stimulus situation occurred. The movement from the upper third to the middle third was stimulated by the unknown stimulus situation. In 1959 this movement continued beyond the middle third to the lower third while in 1960 it stopped in the middle third. If assuming a movement ends when there is no longer a stimulus present, it is assumed that some stimulus was present the first winter which caused the deer to move to the lower third. This stimulus, which could be referred to as a maintaining stimulus, was absent the second winter so the movement ended on the middle third. Had the same stimulus situation existed both winters, it is believed the movement patterns would have been more similar. This is not to imply that the maintaining stimulus is related to the stimulus which started the move. It may or

may not be, this is not known. It was suspected that the original stimulation was time oriented and the second stimulus did not depend on time but was weather controlled. The maintaining stimulus might have been the presence of crusted snow on the middle third in 1959. Its presence provided the maintaining stimuli and the deer continued the movement until a goal was reached. The goal in this case could have been the maximum possible mobility. The absence of the crusted snow the second year let the movement stop on the middle third where the goal of maximum possible mobility was again reached. Hull (1951) suggests in the third postulate of his behavior theory that responses which are stimulated by a need of an animal are not a random selection of the animal's responses but are those which will most probably fill the need. Supposing the need of the group B mule deer was the maximum possible mobility, the movement they made both winters was directed to satisfy this need.

Basing a generalization on these theories, it is believed that the group B deer movement was a response to a stimulus situation and the continuance of this movement was dependent on the presence of maintaining stimuli. It is further believed that the movement was purposeful in that it was goal directed (Hinde, 1959).

Place of learning in movements - traditional. In Figures 3 and 4 it is seen that groups A and B are separate entities during the early portion of the winter, becoming a

single aggregation only after the movement southward by group B in mid February. The question as to why these groups shared the same range for half the winter but not for the entire winter is a very pertinent one. Dasmann and Taber (1956) observed that deer in California migrated even though summer range remained free of snow and attributed this, in part at least, to tradition. These writers also suggested that one possible reason deer are not prone to use areas which are new to them is they might not have any way of knowing a new area exists. This is a way of saying that the habit of using a new area has not yet been developed or that they have not yet learned to use the area. Koffka (1935) points out that animals, learning by repetition, effect an integration of similar elements in a repeated situation and learning is the act of adjusting to a complex repetitive situation. Scott (1956) believes that in higher animals it is probable that social relationships are affected by the processes of adaptation and habit formation. If this is true, then it can probably be stated that the reason group A moved to the middle third of the range while group B moved to the upper third for the first part of both winters is that this is what the groups had learned to do and it has become a habit, i.e. tradition. Groups PB and BB appeared to be fragments of the larger group B. Both these groups occupied the upper third with group B and appeared to be part of it until group B moved southward. At this

time these small groups remained behind. Group BB then moved southward and spent the remainder of the winter on the southern most portion of the upper third of the range. This area had seen comparatively little deer use in the past. There was no evidence of hedging seen on the shrubs in this area, more of the surface cover was in browse species than the remainder of the range and generally it appeared to be the area best able to support deer on the whole winter range. The lack of use in the past indicated that BB group had probably just recently started using this portion and the area was not used previously by any group. That group B animals were not aware that this area existed seems very unlikely because they passed through it on their southward movement. But this movement, described earlier, was rather fast at this place and feeding during the movement was limited to a bite here and there with hardly a pause. So it is supposed that group B animals knew of the area's presence but had not formed the habit of stopping there. The habit appeared rather to be to move quickly through this area to the middle third without stopping.

The perpetuation of a habit once it is formed is thought to be a process of passing from doe to fawn. Russell (1932) indicated that fawns stay with their mothers during the fall and spring migrations and so form the habit of using the same routes and same wintering areas. In this way the fawn learns the route to be taken and learns the areas to be used.

This then becomes the traditional or habitual pattern and the size of a group using a certain area will, in the absence of limiting factors, keep increasing. The process of habit formation in fawns will be described more fully in a separate section later under instincts and learning.

The PB group movement pattern in 1960 was very similar to the movements by group B in 1959. But these movements occurred independently of group B movements in 1960. The feeding sites used by the PB group in 1960 were identical to those of group B in 1959 and again independent of group B feeding places of 1960. Again it should be mentioned that the movement of PB group in 1960 was made in the absence of snow and carried these animals to the Spring Gulch side at the southern most part of the range. The 1960 movements of group B preceded those of group PB by about two weeks, and so limiting the possibility of one group simply following another but pointing up the possibility that the movement had become traditional. That group B stopped in the middle third while PB group moved all the way to the extreme lower end of the ridge might be due to a conditioned response on the part of group PB to a different stimulus or set of stimuli from that of group B. It is not intended that this statement be taken as a final answer, it is merely a suggested possibility that cannot be proven until these animals are observed to repeat these performances over a period of

years.

Deer immigration from adjacent area. During the first two weeks in March, 1959, deer were observed on the road along Spring Gulch Creek and several well used trails crossed this road indicating there was a movement of deer to and from Wallman Ridge. It was believed that at least some of the deer using Wallman Ridge in 1959 were deer from the Spring Gulch ridge which crossed Spring Gulch and spent at least the first two weeks of March, 1959 on Wallman Ridge. This movement of immigrating animals was not noticed in 1960 and there was also an absence of trails across Spring Gulch. This might be further indication of lack of maintaining stimuli causing a failure to repeat the movement of the deer in 1960 as has been suggested in the case of group B.

Daily time-space patterns.

Feed-rest-feed complex and relation to weather. Throughout the study, the deer generally followed a set pattern of feeding from before daylight until between 9:30 and 11:30 a.m. then resting through the mid-day hours and feeding again usually from between 2:00 and 4:00 p.m. until after dark. This pattern varied little from December to April for both winters. Dixon (1934) found the same winter feeding pattern in California. However, Linsdale and Tomich (1953), also working in California, observed that the mule deer they studied generally fed throughout the daylight hours during the

winter months from December through March and only resumed the noon-day resting in April.

Darling (1937) found that the red deer generally feed from very early morning, rest between 10:00 a.m. and 3:00 p.m. with perhaps a half hour feeding period around noon and feed from 3:30 p.m. until late evening. Browman and Hudson (1957) observed penned mule deer in western Montana and found that morning and afternoon feeding separated by several hours of rest during the middle of the day was the general daily activity pattern. This same winter feeding pattern was observed to be present in domestic sheep (Scott, 1945).

It was observed that bucks tended to rest a little longer during the noon hours than does. Bucks generally stopped active feeding and bedded down before the does and fawns and usually stayed bedded for some time after the afternoon feeding had become general in does and fawns. So that generally speaking, the bucks rested one-half to one hour longer than did the does and fawns. Fawns rested less than does. Nearly every day some fawns could be observed feeding straight through the day without resting.

It was suspected at the beginning of the study that the daily activity would vary with temperature and relative humidity and it was thought that on warm days activity would decrease at an earlier hour in the day and resume at a later time than on cool days. In 1958-59 this was not the case,

but rather an opposite effect was noticed in April, 1959 when the warmest day showed the shortest rest period. It was then attempted to correlate relative humidity (R.H.) with the time the morning feeding stopped but it was found to vary widely and followed no pattern. But, by observing the length of time the animals rested and plotting it with the mean R.H. for the day it was seen that during low R.H. the deer rested a shorter time than during high R.H. It is true that R.H. and temperature tend to vary inversely, but when mean temperature was plotted with resting time, it was found these two factors did not show a constant relationship. For example, on March 26 the temperature was high and resting time was also high but on April 9, the temperature was nearly the same as March 26 and resting time was very low (Figure 6).

By plotting the 1959-60 mean daily temperatures and humidities with minutes of rest on a graph, the same picture appears as for 1958-59. The R.H. and rest time run in a parallel fashion but again temperature has no constant relationship (Figure 7). The number of deer used in these experiments varied from a low of 15 to a high of 73. The data were used only when at least 15 animals were in the immediate vicinity of the hygrothermographs in order to use just those located in approximately the same climatic environment that was being measured.

Darling (1937) observed that high humidity tended to



Figure 6

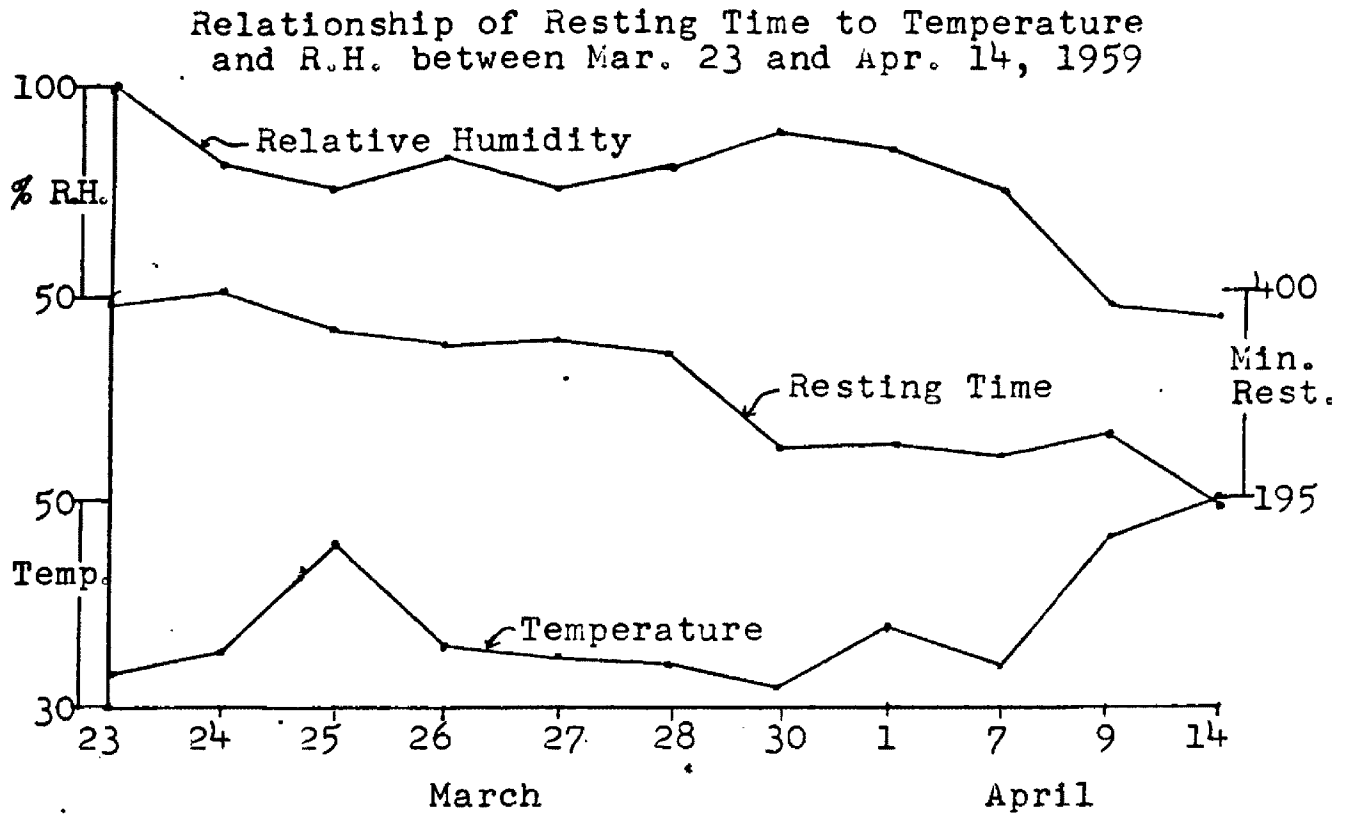
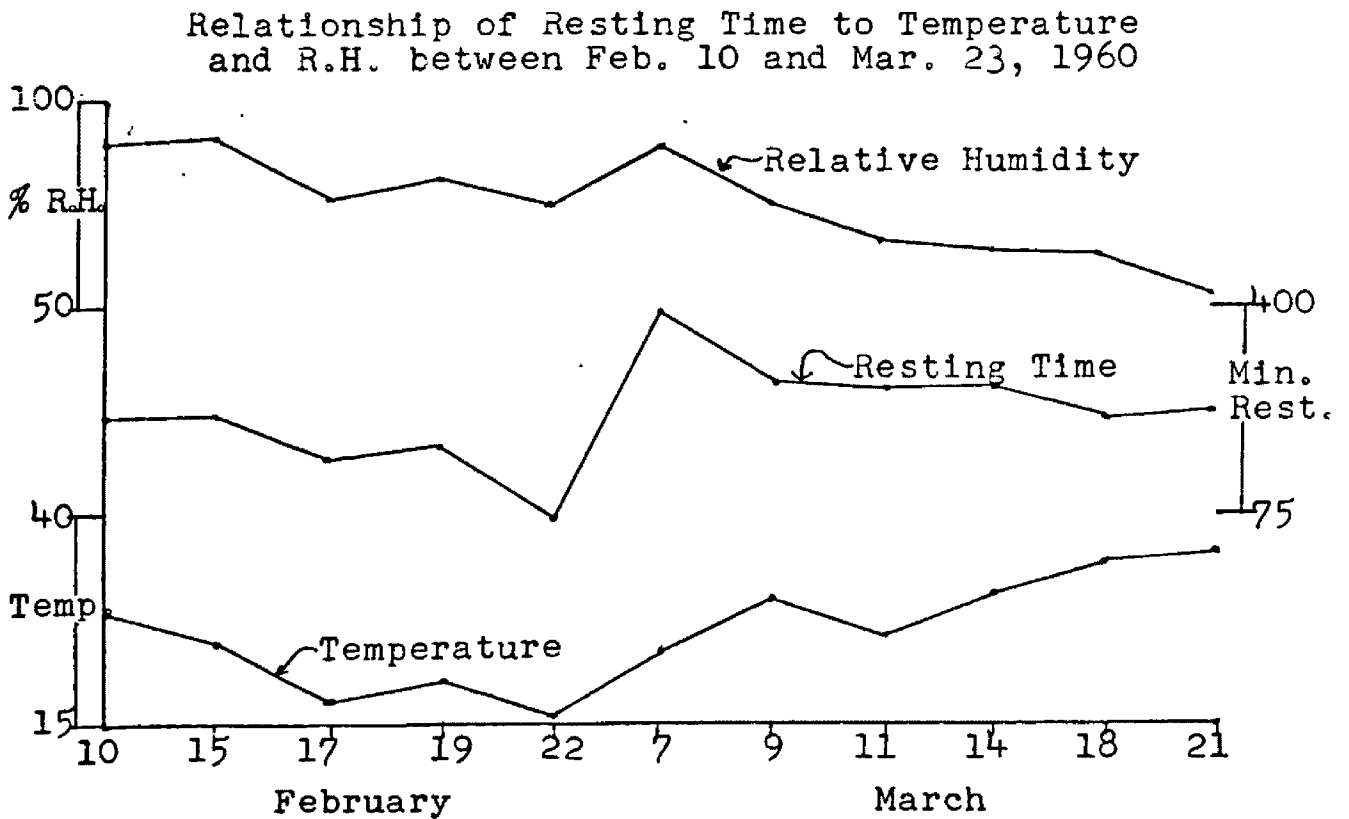


Figure 7



make red deer inactive and Lindsdale and Tomich (1953) discovered the same effect on mule deer. Hediger (1950) suggested there is an optimum temperature and humidity for each species and higher or lower than this optimum reduces activity.

In an unpublished experiment of my own on white laboratory rats it was found that under conditions of increased humidity with temperature constant, the voluntary activity decreased. However, under conditions of constant humidity and increased temperature it was found that activity again decreased. This effect of temperature on rat activity was also observed by Richter (1922) and Browman (1943). The former also suggested the probability of an optimum temperature at which activity would be greatest.

If increased temperature influenced deer activity the way it influenced the activity of laboratory rats, it could not be determined in this study. The effect of humidity might have an over shadowing effect, but it appeared to be more closely correlated with daily deer activity than did temperature.

Wind effect varies with the activity taking place. Throughout the study special effort was made to observe the deer during times of what are generally considered by humans to be unpleasant weather. A windy winter day is one of these unpleasant times. Deer were observed on many occasions to be feeding in a location fully exposed to the wind. They

made no organized effort to feed away from the wind. Some animals faced it others were faced away and others stood broadside to it. Even winds of 20 to 25 miles per hour did not appear to influence the feeding movements or shorten the time spent feeding. At these times however, the fawns especially, but also older animals bristled their hair giving them a dark ruffled appearance. This was particularly noticeable on the forequarters of the animals but not restricted to the foreparts. When deer were resting, the wind had a decided influence. If the wind was strong the bed was located on the sheltered side of a tree or clump of trees or behind a log or stump, never in an exposed position. If the deer were bedded and the wind changed direction or became stronger, the animals moved out of its way to lie down in another place within a few minutes. The location of beds in respect to weather will be discussed more fully a little further on.

Rain or snow seemed to have little effect on feeding animals except that during such weather, humidity was usually fairly high and on such days deer tended to rest longer than on clear days of low humidity. If deer were observed feeding and a sudden rain or snow shower occurred, the deer usually kept feeding. Also, when resting animals were observed in the open and rain or snow started falling, there was no effort made to seek shelter, rather they remained in the open, getting up occasionally to shake themselves, then

lying down again.

Feeding movements and habits. While actively feeding, the study deer covered little actual distance. Usually, feeding commenced very soon after an animal got up from its bed and in the vicinity of the bed. In nearly every case observed, the deer followed the same pattern of behavior. The animal rose front end first and stood for a minute or two, then either licked itself at someplace on the hind legs (this was observed to occur at every place from the hip to the hoof) or stretched. The order of these last two activities appeared in the sequence mentioned or reversed. The stretch always ended by lifting the tail straight up. Then the deer started feeding. Occasionally the first bites were taken without moving at all, but at most times the deer moved two or three steps to start feeding. The deer were never seen to move more than ten or fifteen feet away from the bed before starting to feed unless something startled them, in which case they usually ran away or moved slowly away from the vicinity.

For the most part, the deer stayed in one area for several days. Animals of group A spent nearly the entire second winter in an area  $\frac{1}{2}$  mile long by  $\frac{1}{4}$  mile wide. Animals of this group were often observed for 3 or 4 consecutive days in an area 200 yards in diameter. Occasionally a feeding movement would carry some animals  $\frac{1}{8}$  mile or more but this was mostly accompanied by some other factor. This

might be a quick move by a small group of animals toward a large group or, on days when the wind was gusty and changeable and the deer were unusually irritable. The latter type of movement was usually characterized by short periods of feeding broken by periods of watchfulness and sometimes bolting for several hundred yards before feeding was resumed. An example of this type of feeding activity occurred March 16, 1960. A group of 12 mule deer were feeding in an easterly direction in a gully in the southern part of the middle third. They fed for about 50 yards then turned northward for about 100 yards. Here they all became alert and stood looking in various directions for a few minutes before resuming feeding in a southerly direction for 10 to 20 yards. They again became alert and all watched in different directions. One animal jumped a few yards and the group bolted in a southward direction for a quarter of a mile. They all stopped and again looked in various directions before resuming feeding.

The method of feeding tended to be a stereotyped pattern which all the animals followed. It invariably was characterized by feeding on one shrub for several minutes, then moving to another for several minutes, then to another. A second animal often followed the first for two or three stops so it is believed a single animal very rarely took all the available browse from a bush before moving to the next. This is further substantiated by the use on ceanothus. It could

be seen where a few stems had been nipped from one place on one bush and the remainder of the bush was untouched. Adjacent bushes would be unused and then another bush perhaps ten feet away showed use. So, it was generally seen that the feeding pattern was to take a little from one place, then a little from another place and so on rather than to make a clean sweep.

The species of browse taken by deer did not remain constant throughout the winter. Service berry and chokecherry appeared to be the preferred food for the most part, but these two were supplemented by a variety of other foods. In December 1958 most of the area was bare and there was much evidence of grass use. At this time the basal portion of the bunch grasses was still green although the tops were cured. It appeared both the dry and green portions were taken. At this time woolly mullein (Verbascum thapsus) was also utilized, primarily the seed heads. Kinnickinnick was taken also, as was sedge. Use of serviceberry, chokecherry and willow was quite heavy at this time also.

During the early part of the 1959-60 winter the snow was powdery and deer could paw through it easily so these same low growing species were used. There was less use on the mullein the second year, however.

As the winters progressed, the use of grasses and low shrubs decreased markedly and use of the tree and taller

shrub type browses was increased. The use of ceanothus was much higher in March than in the preceding months. This occurred both winters. Contrary to Asher's (1951) observations, it was found the deer take the leaves and stems of ceanothus. The leaves are brittle during the winter and those which are broken off and fall to the ground are not picked up so it might appear the deer strip the leaves and use only the stems as he suggested.

There is little question that serviceberry and chokecherry are the most heavily utilized species and probably the preferred food. No other species shows the hedged appearance indicative of heavy use that these two show. Carter (1951) found this true for another location in western Montana also.

Lovaas (1958) found that mule deer in eastern Montana made heavy use of shepherdia (Shepherdia canadensis). Although this species is present on Wallman Ridge there was no evidence of use on it. Use of ninebark was negligible in 1958-59 and not observed at all in 1959-60. However, the broomlike appearance of this species in the areas receiving heaviest use indicate it has been utilized somewhat in the past.

It should be fairly obvious that the types of food taken depends to a great extent on what is available. When surface plants are easily obtained they are readily taken,

when a crusted snow makes these low growing species less available, a higher percentage of taller species will be taken.

Rest places - location and reuse. Beds were usually located in respect to the next feeding place more than the preceding feeding place. As pointed out earlier, undisturbed feeding started from the bed, whereas at the end of feeding the deer many times moved several hundred yards to a bed site. As often though, the bed was located in the same area in which the animals had been feeding.

The usual bed location was at the base of a bush or tree on the down hill side and parallel to the ridge top so the animal's body was comparatively level. It was usually in a location with a view of the slope below. The bed was constructed or hollowed by scraping the place with a front foot before lying down.

During rain or snow the animals did not appear to make a special effort to select a sheltered place but stayed in the open. However, if there was a strong wind blowing the choice of a bed site appeared more deliberate. In these cases the bed was invariably located in a sheltered place such as the leeward side of a large tree or clump of trees or bushes, or behind logs or in the shelter of a hill. At these times the site differed considerably from the usual in that the bed might be on the up hill side of a tree or clump of trees and the animal had little or no view of the slope



below.

It was mentioned earlier that if the wind changed direction or intensity an exposed animal would leave the bed and find another. This was observed on six occasions. On one occasion two adult bucks had five different beds within an hour as the wind changed direction, gradually swinging from southwest to east. Each time the direction changed the exposed animal got up, moved a short distance around a small hill and again lay down. These two bucks kept leap-frogging each other as one or the other was exposed to the wind. Another example involved between 45 and 50 animals. These were all bedded on the leeward northwest side of a stand of pole sized trees. The wind made a sudden shift to the southwest and all the animals moved to the northeast side.

In incidents such as these, the relocation of a rest site was not as rapid as might be implied. When the deer were roused from a bed for any reason such as this there was nearly always a short feeding period of 5 to 30 minutes before bedding again. When a large number of deer were involved as in the second example, many did not lie down again but kept feeding for several hours. And, those that did lie down again were seen to feed at least for a short time before bedding.

When a large number of deer used an area for several days there was much reuse of old beds. In the early part of the second winter there was a large herd of deer using one

area for several days. At this time two particular bed sites were used every day for three days and by different animals on each day. Whether there is a preference for a pre-made bed or whether the location was a preferred one for any other reason is not known. It is possible the reuse was accidental. Rather, it is believed there is a preference for one location over another but the reasons behind this preference are not known.

## INDIVIDUAL BEHAVIOR

Senses. Nearly all contact with the environment is through the senses of sight, smell and hearing. Stimuli from the environment are received by one or more of these senses. Smell is the best developed, hearing is next best and sight the least developed (Darling, 1937). However, sight is well developed for moving objects but very poor for stationary objects (Dixon, 1934).

It is very difficult for a human observer to determine what stimuli a deer is receiving, what it can smell and hear. Since humans tend to perceive the environment primarily by sight, it is less difficult to understand what a deer sees.

In a human situation two or more of these senses are usually used simultaneously or in rapid succession. If an unusual sound is heard, the head is turned to bring the eyes toward the direction of the sound. So one sense rarely is used alone. This is also true in mule deer. But in deer the sense of smell is used extensively to verify something seen or heard. And, deer usually bring the three senses to bear on a stimulus.

It was possible on countless occasions to observe deer feeding about  $\frac{1}{4}$  mile away apparently undisturbed. On several occasions a deliberate effort was made to attract the attention of the deer by movement with a minimum of sound by

walking away from the observation post and back again, then immediately watching the animals through the spotting scope. On each attempt, the animals that were attracted stood facing the observer in the characteristic pose described by Dixon (1934). The front feet were close together the neck extended upward so the deer stood as tall as possible. The ears were out from the head at a 45 degree angle and turned toward the observer. There was seen on occasions of excellent visibility, also a slight dilation of the nostrils and sometimes the tongue was seen to be drawn over the nose several times in quick succession.

This same experiment using a sound such as a sharp whistle but no movement produced the same results on each attempt.

Sight of an object alone seldom caused flight. On many occasions when the wind was from the deer, it was possible to walk in plain view of the deer directly toward them to within distances of from 30 to 100 yards before they took flight. When the wind blew toward the deer it was seldom possible to get closer than 300 to 400 yards. However, it should be pointed out that when walking toward deer in plain view, the movement had to be constant. It was found that erratic movement such as walking then stopping then walking usually caused the deer to move around a little and when this situation occurred it was impossible to move close to

them. Also it was found that moving from their sight then reappearing brought about uneasiness in the deer and made approach to close range impossible.

The sense of smell was believed to be the critical determiner of the flight distance of the deer. No matter what the distance between the observer and the deer, if the deer got the scent of the observer they took flight. Altmann (1958) lists wind direction and strength as the two foremost factors limiting flight distance. This was also found to be the case in this study primarily because the scent was carried to the deer on the wind as were sounds. But sounds appeared to be a weaker flight evoking stimulus than scents.

#### Communication.

Pose or aspect of other animals. Animals do not possess a language as such, but, particularly in the socially living species, each individual has a certain number of innate movements and sounds for expressing feelings. It also has innate and learned ways of reacting to these signals whenever it sees or hears them in other animals of its species (Lorenz, 1952). The chief form of communication among the deer appeared to be the pose or aspect or posture of other deer. If one deer assumed the alert pose described previously, other animals nearby also became alert. This alertness then tended to spread throughout the group, but was not directed in the same direction by every deer. Rather, it

tended to be directed toward whatever direction the deer were facing before they became alert. Also, the intentness of the alert pose waned more quickly in the deer who were stimulated secondarily than in deer who received the stimulus primarily. This same type of communication was observed to take place if one animal started bounding. All deer in the vicinity quickly became alert and on occasion also started running in the direction the original animal took. If the bounding of a lone animal occurred, it was noticed that if it only traveled a short distance and then stopped, the strength of the secondary stimulation decreased with the distance from the bounding animal. The lone animal appeared to be a center of activity. The deer closest to it ran a short distance, deer farther away became alert and walked a few steps, deer still farther away became alert but did not move, and deer farthest from the center took no visible notice.

This manner of communication has been variously named. Scott (1945, 1958) calls it allelomimetic behavior; Tinbergen (1953) uses McDougall's term, "sympathetic induction," others have termed it contagious behavior, infectious behavior and a variety of other names. For the purposes of this paper it will be called infectious behavior. The effectiveness of infectious behavior as a means of communication quite probably rests on the tendency to escape - avoid enemies. Since the deer rely on flight as the primary escape mechanism, the

flight tendency takes precedence over other activity (Hediger, 1955) and at any indication of danger such as alert pose in another animal or bounding in another animal the flight reaction is quickly brought into play. This is primarily a form of ocular communication.

The threatening pose was observed throughout the study. This pose consists of stretching the neck forward in a straight line with the back. The ears are laid back along the neck. The mouth may be open or closed and the front feet are spread wide apart. This pose might be followed by a lunge toward another animal but usually the pose is enough to end any disagreement which might have existed.

Vocal and olfactory. Hediger (1955) also lists acoustic and olfactory means of communication. As the deer were mostly observed at great distances it was impossible to tell whether any sound was made as a warning of danger. The snorting of a startled animal is a commonly heard sound among hunters.

Quite possibly a frightened or annoyed deer could have a glandular secretion which might be a means of communication through olfactory receptors but this could not be observed in this study.

#### Gait.

Walking. While feeding, the walking from one bush to another could probably better be described by the word

ambling. The nose was held very close to the ground and the feet were dragged quite noticeably but lifted over any obstruction such as a branch or twig or downed tree. The pace was very slow with long pauses separating a series of short steps.

The pace was faster in movement from one place to another where no feeding was taking place. During such a movement the head was carried well out front and level with or lower than the line of the back. There were periodic pauses when the lead animal stopped and stood erect in the alert pose. This pause lasted several minutes before the movement was resumed. During these pauses, the lesser animals of the group browsed a little or also assumed the alert pose.

Aggressiveness was characterized by the threatening pose. When walking was involved, the steps were long, quick ones and usually only two or three steps were taken. More often an aggressive movement resembled a very fast walk, or a spraddle legged trot and the body appeared lower than in a normal trot.

Trotting and bounding. Primarily, these gaits were used for escape. The trot was characterized by a smooth appearing leg motion. The head was held very high, the ears pointed upward and forward so the body was held in much the same pose as the alert stance. Trotting appeared to be the weaker escape attempt. It occurred often before the animal



started bounding and again after the animal stopped bounding. It also occurred when the source of danger - in most cases the observer - was at a considerable distance from the animals and the flight appeared organized to some degree. Whenever retreating deer were observed to trot they were strung out in single file.

The bounding gait which the mule deer exhibited when in full flight was the one best suited to the terrain (Dixon, 1934). On the brushy, rocky, steep-sided slopes of Wallman Ridge, it would be very difficult for the deer to move rapidly at any other gait. Although the bounding appeared awkward and slow the deer were observed to cover distances of up to a half mile in less than a minute. Some years ago the observer clocked a mule deer doe at 47 miles per hour.

The distance covered in a single bound varied somewhat but generally measured 17 to 21 feet. The height of each bound was estimated between 4 and 6 feet but could never be measured accurately.

Bounding occasionally occurred when a deer descended very steep terrain but as soon as more level ground was reached the walk was resumed.

The trot exhibited in aggressive movements has been described above. This occurred on a few occasions during the study. Two of these incidents deserve mention. The first incident occurred March 11, 1959 when CL, an adult male, attacked VR, a male of the same size. Both of these

were group A animals. CL ran in the characteristic aggressive posture perhaps 15 yards toward VR. Both animals reared and struck with the front feet until VR moved away and CL lay down in the place VR had been feeding. The other incident occurred February 5, 1960 when a doe of BB group was attacked by a coyote. The deer threw off the coyote, then chased it for about 30 yards. During the chase the doe was in the typical aggressive posture. These two incidents are mentioned because they involved the longest distances seen to be covered in aggressive movements.

Displacement activity. If two opposing and equal responses are elicited a third seemingly unrelated response frequently occurs. This response is displacement activity. Tinbergen (1935) referred to it as "flight or fight" and Thorpe (1956) termed it appetitive behavior. In various species it takes many forms. In birds it sometimes takes the form of nest building activity or feeding activity or preening the plumage or even sleep posture may be assumed (Tinbergen, 1935). In the mule deer of the Rattlesnake it normally took the form of feeding activity. The displacement feeding differed from regular feeding primarily in degree. The usual method of displacement feeding involved actually nipping off a few stems and eating them but never more than a few bites were taken. On some occasions several bushes were used by a single animal. Displacement feeding was always of short duration, lasting at most to 10 or 15

minutes as contrasted to 4 or 5 hours observed when deer were intensively feeding. Displacement feeding was also characterized by an alert attitude being exhibited at intervals of a few minutes. Sometimes no browse was actually eaten during displacement feeding, although twigs were taken into the mouth, they were not nipped off. Active feeding was always evidenced by the sharp upward movement of the head as each twig was nipped off. This did not occur in much of the displacement feeding.

This activity could be elicited by the observer moving slowly toward the animals. The conflicting flight or stay responses in the deer resulted in displacement feeding. At these times the deer moved to a distance of several hundred yards and exhibited this type of behavior. When wind change caused the deer to move from their beds a type of displacement feeding much like normal feeding was observed in nearly every case before the animals bedded again. The howling of a coyote also elicited displacement behavior.

It appeared that any stimulus which was too weak to cause flight but strong enough to rouse the animals caused displacement feeding. This is the typical "flight or fight" described by Tinbergen (1935).

A second type of displacement activity, observed only once, occurred February 22, 1960. Something had startled a group of 15 mule deer and they ran behind a spur ridge. In a few minutes five males came bounding back from behind the

ridge. They stopped and looked toward where they had been. Then one male mounted another, a younger buck with a crippled left shoulder. He stayed up for a few seconds, then after a pause of two or three minutes mounted again. Both animals involved were adult so it seemed improbable that it was play as was noticed in young domestic male sheep by Scott (1945). The late date limits the possibility of actual sexual activity and since both deer had dropped their antlers sometime previously, it could be assumed activity of the testes was in a declining state (Turner, 1955). But no other incidents of this type were observed so no comparisons could be made.

## INTRASPECIFIC RELATIONSHIPS

Dominance. In the wintering population as a whole a social hierarchy was seen to exist. This hierarchy was to a great extent sex determined. Adult males were dominant over adult females as well as yearling males and females. Yearling males were dominant over most adult females and all younger females. Fawns were always the subordinate animals. - This same social order was observed by Browman and Hudson (1957) in penned mule deer.

Within a buck group the largest animal was normally the dominant one while all were carrying antlers. However, antlers appeared to be a major badge of social prestige and the social order was seen to change in the group when some dropped their antlers while lower animals still carried theirs. The antlered males increased their status over previously dominant animals. After all males shed however, the social order returned to what it had been previously. Woodbury (1941) found that the size and shape of the horns determined social standing among domestic cattle. Hediger (1955) suggests also that antlers are a significant factor in social status. Darling (1937) found that adult red deer stags with fork horns were dominant over males with full antlers indicating shape of antlers might also be a determining factor among deer.

While bucks in the study area carried antlers, they

showed their authority by hooking another animal in much the same manner seen in domestic cattle. After the antler drop which was completed by the third week of February, the fore feet were used as weapons of aggression.

In family groups, the leader was also the dominant animal. This animal, always a doe, was dominant over every other doe in the group and over any yearling males that might be in the group. Her authority was seldom demonstrated except by display. An incident was observed in March of 1960 where a lead doe threatened a yearling male of her group and followed with the complete aggression sequence including striking at him with her front feet. But this type of display was rarely demonstrated quite so actively.

Leadership. Leadership does not necessarily follow the pattern of dominance (Allee, 1938). Among the aggregation as a whole, a doe always led in a movement or an organized retreat; the bucks, although dominant, never led the group. When deer were startled however, this organization completely broke down and the animals retreated in a mass.

In doe groups an adult doe led and was dominant, while in buck groups there was no evidence of leadership shown but rather any animal of the group might lead. This same general pattern was observed by Lindsdale and Tomich (1953), Darling (1937), Hediger (1955), Altmann, (1956), and many others.

Feeding conflict. The dominance relationship in a

large feeding aggregation determines which animal gets the food. The high status animals get first choice of food. This is not a case of subordinate animals waiting until a superordinate animal has fed but rather of the dominant animal claiming the feeding location. This was usually done without an aggressive pose being assumed. Generally the following sequence was adhered to - subordinate animal feeding near dominant one, dominant one walks up behind subordinate and strikes once with a front foot without rearing, a second blow followed if first had no effect, subordinate animal walks away to another bush nearby, dominant starts feeding where subordinator had been.

In 1958-59 this type of conflict was observed throughout the year with incidence increasing until late March when it became less frequent. In 1959-60 it was observed with about equal frequency throughout the winter with somewhat fewer occurrences at the beginning and end of the winter. The overall frequency appeared to be decidedly less in the second winter.

It will be noticed that the availability of food due to deeper and more heavily crusted snow could be considered decidedly lower in the first winter while aggregation sizes were nearly the same both winters. It is believed, therefore, that the higher frequency of conflict in 1958-59 was due more to a comparative shortage of food than to crowding.

Rest conflict. The same general pattern of competition

observed for feeding sites was observed in competition for resting sites. One observed incident will serve as an example. On February 3, 1960, twenty-five mule deer were feeding high on the upper third of the range. Resting was seen to gradually begin at 11:00 a.m., when a doe was observed to lie down next to a thick stand of small Douglas fir trees. The wind increased considerably and exposed animals, formerly bedded, began moving into the trees. A large male walked up to the doe and struck her with one front foot. The doe rose quickly and moved away. The buck then lay down where she had been. The doe then scraped a bed at a place 10 to 15 yards lower on the slope beside a willow clump and lay down. This second place appeared to be more exposed judging by the movement of the bushes around her.

Throughout both years, this rest place competition did not vary greatly except with a possible slight increase during the first part of March 1959 when the deer were at the highest density. But it appeared common throughout the entire study.

It can be seen however that the dominant animals get the choice bedding sites and choice feeding places. This then has an effect on survival. It is suspected that survival potential varies directly with social status so that the lower the animal is in the dominance hierarchy the lower his chance for survival. Since the fawns were found to be the lowest animals in the dominance order, they would have



the smallest chance for survival. This is generally considered to be true, but usually most weight is placed on the feeling that the fawns are unable to reach food the larger animals can reach. Also, fawns are growing and have less experience and are often more active than adults. Little consideration has been given to the fact that fawns are driven from available feed and driven from the better rest sites to the more exposed ones. Calhoun (1950) found this same general food-rest place competition relationship in his study of penned wild rats. The larger ones got more food and best bedding places and so were better able to survive in a competitive situation.

Graf (1956) reported territorialism in deer with marked areas. This, he observed, was primarily done by the bucks rubbing their antlers against trees and bushes and by sparring with a bush. During the study, evidence was found that such rubbing had occurred. But the rubbing trees and bushes which had been used showed the rubbing had been done several months prior to the arrival of the mule deer on the winter range and it was supposed that this possible show of territorialism was done by summer resident deer, not the migrants, and probably occurred during the rut in November. The dominance and leadership patterns were not connected with established feeding or resting territories. Had there been established territories, it is probable that all deer violating the boundaries would have been driven away no matter what

their social status. However, adult bucks were never observed to drive fawns away from food or rest places directly. Fawns received punishment only from does and young bucks. This is the usual social hierarchy pattern, the top animals molest only the animals directly beneath them on the social scale but do not molest the lowest animals.

Irritability and intolerance. An increase of irritability and intolerance due to increased density could not be seen conclusively in this study. However, it is suspected that intolerance is to some degree density dependent. During the peak concentrations of 1960, conflict was noticed more often, but this could be attributed to the fact that more deer were visible at one time than during periods when the deer were less concentrated.

The increasing intolerance and irritability associated with depletion of available food appeared more plainly during the study period. This has been explained previously under feeding conflict. Although evidence is not conclusive, the comparison of the two years does imply a correlation.

Dasmann and Taber (1956) state that irritability in deer tended to increase as food supply decreased and that incidents of aggression were more frequent when deer density was high. Scott (1958) reports that hungry mice fight over food and do not tolerate contact with strange individuals. This tends to substantiate the feeling that irritability is both density dependent and food dependent, but these factors

are difficult to separate in a field study as they usually occur almost simultaneously.

That does show an increasing irritability as the fawn drop approaches is a well established fact. This irritability and intolerance for the yearlings and fawns of the group was seen to occur only to a small extent before the deer left the winter range. However, this intolerance might to some degree account for the decrease in the doe population over the two years by causing some emigration from the herd. Also, the does impregnated as yearlings, seeking a secluded place to drop their fawn might account for a degree of emigration. It is possible this could cause a fluctuating year to year doe population. Among tagged white-tailed deer in Minnesota, it was found by Carlsen and Farmers (1957) that the greatest distances moved from point of tagging occurred in deer under  $2\frac{1}{2}$  years old.

#### Cooperation.

Mutual grooming. During the 1958-59 winter, mutual grooming was first noticed on March 4, 1959 and last observed on March 26, 1959. Between these dates it was observed on several occasions. Usually it involved a doe and fawn, on one occasion two yearling males and twice between two adult does.

The second winter it was first seen on February 10, 1960, again on February 22 and on February 29. Through

March it was observed nearly every day until March 21, after which it was not observed.

Mutual grooming was observed by Lindsdale and Tomich (1953) to be exhibited by both sexes and all age classes and they pointed out that this activity is mostly limited to the head and neck. But no mention was made of this activity occurring at any particular time of the year, as was seen in the Rattlesnake mule deer.

The second year this behavior was noticed in all ages and in both sexes but was not observed between sexes in adult deer. It was always seen to take place between two bucks, two does or doe and fawn, never between buck and doe.

The time involved in this behavior varied between a few minutes at the minimum to  $\frac{1}{2}$  hour maximum and was never a continuous activity but was punctuated by pauses of one to three minutes and at times a little longer. Whenever deer were observed in this activity there were several other animals nearby. It was never observed in a solitary pair. It usually occurred soon after the start of the afternoon feeding period.

Although usually concentrated around head and neck, it was often observed to involve shoulders and back also. On one occasion a fawn was being licked by a doe in the head and ears region while the fawn licked the doe's belly. On another occasion a fawn was seen licking a doe around the base of the tail.

The procedure was for the most part instigated first by one animal licking another, the second usually started licking the first almost immediately once the behavior was initiated.

No reason is known why mutual grooming behavior reached a peak through the month of March, but it was not observed at any other time with the exception of the three instances seen in February of 1960. It might be coincidental that at about the time the last mutual grooming was observed there was also a breaking down of the large groups.

Infectious behavior. This term has already been mentioned under the section of communication in respect to escape behavior. But infectious behavior was not limited to escape from enemies or potential enemies. It was very evident in feeding and resting as well as general irritability of the deer group. Whenever there was a change in activity, a degree of infectious behavior could be seen.

Fawns often were seen to keep feeding while the adult animals rested. This was particularly noticeable during the late part of both winters. On several occasions it was noticed that when two or three fawns fed close to a resting adult animal, it got up and started feeding also. This was followed by nearby animals joining the feeding activity and the reaction spread throughout the group. This reaction however would not occur if the animals had just bedded down, but it was noticed that the speed of the reaction as well as

the completeness of it varied with the length of time the group as a whole had been resting. If the feeding stimulus occurred at 2:30 or 3:00 in the afternoon the reaction was usually very rapid and involved nearly every animal, but if it occurred at 12:30 or 1:00 in the afternoon usually only a few animals joined for a short while, then lay down again. If it occurred before noon, usually no animals joined but rather, the feeding animals tended to stop feeding and instead, bedded very soon.

Resting also tended to follow a similar pattern but the adult males usually were the first to lie down. This reaction also tended to spread toward the periphery of a circle with the first resting animals as the center. As in feeding, the speed and completeness of the resting reaction increased with time, the longer the animals had been feeding, the faster and more complete the resting reaction.

Feeding and resting occupied nearly all the mule deer's time while on the winter range and these two activities occurred in a fairly stable pattern. However, neither of these activities happened spontaneously to the entire aggregation. Each activity was initiated by some member or members of the group and the others followed. The initiator(s) might be any member from the most to the least dominant. Even in an organized withdrawal from a danger, real or suspected, the group leader will lead the retreat but the initiation of alertness may be by the smallest fawn although

he might not recognize the source as a danger because he has never seen it before, he does recognize it as something unusual and becomes alert, which brings on alertness in the other animals. An example of this occurred when the observer, attempting to stalk a buck group, was seen by the youngest member, a yearling male. This yearling became alert and watched intently. It was several seconds before the other members joined. It was several minutes before they all moved away slowly. As it was only a hundred yards between deer and observer, scent could not have been a factor or they probably would have all gone without standing alert and the retreat would have been rapid. The observer was not seen by all the animals but as soon as one animal recognized the potential danger and made the first move the group retreated.

The value of infectious behavior in survival is obvious, probably more so in escape reactions than in feeding and resting. Cooperation of this type is always positive in respect to feeding, resting and escape (Collias, 1950) in that it initiates these activities which serve to keep the animal alive.

## INTERSPECIFIC RELATIONSHIPS

Mule deer-white-tailed deer. The study area is not only the wintering ground for mule deer, it is also the summer and winter range of an estimated twenty white-tailed deer. These white-tails summer on the upper portion of the area along with a few resident mule deer. As winter approaches, these white-tails move southward ahead of the immigrating mule deer. In December it is not uncommon to see 5 or 6 feeding or bedded high on the ridge in the areas the mule deer will occupy in January and February. The white-tails keep moving southward and down hill as the mule deer move into the area, but keeping ahead of the migration. These white-tails have first chance at the browse as they move southward so the summer's growth is already utilized to some extent before the mule deer get to it. In this way they offer direct competition for the available food.

Four instances of mule deer-white-tailed deer compatibility were observed during the study. Each instance involved one white-tail and a group of mule deer, in one case two mule deer, in another 55 as the two extremes. These shows of mutual acceptance always were seen during feeding activity and were characterized by a single white-tail feeding with a group of mule deer. The mule deer did not seem to take notice of the lone animal of a different species. On one of these occasions something startled the group and



they moved out of the feeding area in a long single line, the white-tail was also in the line between the center and back end and appeared to be very much a part of the group.

Only one instance of intolerance was observed. It occurred on March 4, 1959 when 7 mule deer and 5 white-tails were feeding very close together but each species in its own group. One white-tail moved out from its group toward the mule deer and two mule deer ran at it striking with their front feet. When the white-tail rejoined its group the mule deer started feeding again. This lone incident might be an indication of interspecific dominance.

As the mule deer drift northward toward the summer range the white-tails move also to occupy the vacated range. It was noticed that the illustrations of mutual acceptance tended to occur mostly during the time of highest mule deer concentrations from mid February to mid March and it might be the mule deer are somewhat more amiable concerning individual spacing at this time. But on the evidence available, this is purely speculation and could not be proved. At any rate, there appeared to be an interspecific intolerance in the group to group relationship based on the group distances which were maintained during the entire study period indicating preference for animals of the same species when they are present.

Deer-coyote. The only source of deer loss observed throughout the two years of study was predation by coyotes

(Canis latrans). There was no evidence of starvation and although bobcats (Lynx rufus) frequented the area as shown by their tracks, no predation by this animal was seen. On three occasions tracks of mountain lion (Felis concolor) were seen but no kills attributed to these big cats were located although it is quite possible one or more could have occurred.

During the 1958-59 winter seven mule deer kills were found, six of these occurred during late February and early March around the extreme southern portion of Wallman Ridge. It was estimated that about twelve deer were taken by coyotes the first year. Of the 7 deer kills located, all whose age could be determined were fawns. Where sex could be determined from the remains it was found two were female, one male. This, however, is no indication of the sex ratio of deer killed by coyotes. Taber and Dasmann (1954) report appreciably higher mortality in male than in female deer under 18 months of age. If true that more male fawns are killed by coyotes, it might be part of the explanation why the male to female ratio in yearling and adult animals is so much reduced as compared to the male to female ratio in the fawn class. The fawn sex ratio was approximately 1:1 whereas adult female to male ratios were 1:.3 the first year and 1:.5 the second. Also, it was observed on a few occasions that male fawns wandered farther from their mother than did doe fawns. If this is generally true, male fawns

would be slightly more vulnerable to predation. But, as there was little protection of young by the doe noticed, this factor alone would not increase their vulnerability to an appreciable extent. Rather, does were observed very frequently to drive their own fawns from feeding places and resting places.

In 1959-60 five known deaths occurred on Wallman Ridge and it was estimated that ten animals were killed. Again there was no indication of starvation or predation by any wild animal other than the coyote. Four of the known deaths were caused by coyotes. The remaining animal's cause of death could not be determined but possibly was coyote predation although the story seen by tracks in the snow did not resemble the usual coyote "technique". There was a profusion of coyote tracks around the remains, however.

The efficiency of a pack of coyotes in making a deer kill was a constant source of amazement. Two distinct types of "strategy" were observed. The first, used when the ground was bare of snow, was observed February 5, 1960. Three coyotes were seen walking abreast about 200 yards apart, at least one more coyote was downhill from these but not in sight. They walked "casually" into the midst of a herd of 45-50 mule deer, going past several deer. The lowermost coyote came up directly beside a doe and suddenly turned and leaped at her hitting her front right shoulder. She threw him off and struck him with her front foot then chased

him for a short distance. At the time the coyote leaped, the two coyotes above dashed quickly to the scene. The deer herd was frightened and ran up the hill in a mass, then formed very tight groups of 2 to 7 animals to a group and looked back. At this moment an unseen coyote below yelped several times and the three coyotes from above ran down hill out of sight. There followed two series of howls and yelping and then the coyotes could be heard yipping periodically as though fighting. It was believed a kill was made but none was found. The entire incident lasted only a few minutes and within 15 minutes the deer resumed feeding again.

The second "strategy", observed directly on February 13, 1959 and indirectly by tracks in the snow on four other occasions was used when there was a crusted snow which supported the coyotes but not a deer. This situation existed through much of the first winter. During the second year it existed only on the north exposures of the ridge. This "strategy" followed a set pattern.

A pack of 3 to 7 coyotes waited near the periphery of a group of feeding deer. When a deer moved out from the herd the coyotes rushed in behind it yelping and howling in an attempt to run the deer into the deeper snow of a north exposure or downhill into the deeper snow in the bottoms. The coyotes thus kept harassing the deer until it was weakened by loss of blood or was fatigued. Then they all jumped the animal and literally tore it to pieces. An adult deer can

usually get back into the herd but fawns are less able to and this might explain the high number of fawns killed as compared to adult animals. The incident seen February 13, 1959 followed this pattern but a doe and fawn were involved with 6 coyotes. They were herded away from the deer group in the fashion described. The fawn carcass was found. It was reported to the observer a few weeks later that a doe carcass was found in the same vicinity. This could have been the doe which was seen being chased by coyotes on February 13.

A lone coyote was seen on one occasion carrying a good sized portion of a deer leg. A doe and two fawns watched his approach. When he got to within a hundred yards or so of the deer he laid the leg beside a log and ran straight at the deer. The deer bounded away and the coyote stopped the chase and returned to the deer leg and started eating it.

This type of harassment, although not directly harmful to the deer, does require the use of energy and during the winter months an excessive use of energy is in the long run harmful in that it gradually lowers the condition of the deer.

The unusual feature of the deer-coyote relationship is the deer did not appear to have any fear of coyotes when they were seen. The observer witnessed several instances where one or two coyotes walked past feeding deer at distances of only a few feet and the deer showed no indication of being disturbed. On the other hand coyotes were heard

howling east of the Rattlesnake Creek,  $\frac{1}{2}$  mile from a group of deer feeding on Wallman Ridge and the deer immediately became alert. That deer do not recognize a potential enemy when a coyote is seen appears impossible. More probable is that they associate only the howling of coyotes when making a kill with danger and do not associate the presence of one or two quietly walking coyotes with danger. As has been said, animals receive signals from movements or posture or bearing of other animals of the same or different species. It has been found that it was easier for this observer to walk casually up to deer than to attempt stalking them. Quite possibly the bearing of the observer kept the deer calm in the former method and caused suspicion in the latter. If this is true, then the attitude of a walking coyote would convey one meaning to a deer while a rushing or howling coyote quite another meaning.

The coyotes were seen to appear on the winter range about simultaneously with the deer and to disappear with them. Palmer (1954) suggests, in discussing the coyotes' habits, that they migrate to the lower elevations in winter and to the higher elevations in summer. In this case, the coyotes' movements would parallel those of the mule deer and quite possibly there is coyote predation on this herd of deer the year round.

White (1958) found in his summer ecology study of the Rattlesnake deer herd that the summer doe-fawn ratio for

1958 was 1:.66. It was found in this study that when these deer arrived on the winter range the doe-fawn ratio was 1:.5 and when they left the winter range the ratio had become 1:.33. This loss of about half the fawn population during the winter is attributable almost entirely to coyote predation.

Deer-magpie. The magpie (Pica pica hudsonia) was seen everywhere and almost constantly on Wallman Ridge during the two years of this study and nearly always close to or with a group of mule deer. It was the common thing to see a dozen or more magpies sitting on trees, stumps or on the ground in the same area with a group of deer or sitting on a feeding or resting deer. Magpies sitting on deer appeared to be feeding, presumably on ectoparasites they found on the deer (Riney, 1951). Most usually the magpies stayed on the back or lower neck of a standing deer. The deer showed little annoyance at the pecking of the birds except when the bird moved up around the region of the eyes and nose and at the base of the deer's tail. The magpie was usually shaken off when these areas were invaded.

When the deer was resting, the magpies frequently walked around the animal pecking at the hoofs, the chest or belly. At these times the birds were often seen pecking in the ear and around the face of the deer. Usually only one bird worked on an animal, sometimes two.

It was believed that the magpie is a beneficial associate

of the deer in that it removes ectoparasites from the deer and aids generally in the grooming of the deer particularly in places the deer has difficulty reaching such as ears and neck. This magpie-mule deer association was also observed by Browman and Hudson (1957). Another possible asset of the magpie is to act as a sentry (Riney, 1951). The perch in a tree gives the magpie a visual advantage and any approaching danger will send him flying away. This might also serve to warn the deer of some unknown danger well ahead of seeing, smelling or hearing it.

Deer-man. As has been mentioned previously, the study area was used quite extensively for weekend recreation purposes. This did not in itself seem to hurt the deer directly but rather was a disturbance source and this over the long period of a winter could have been a debilitating thing tending to lower the condition of the animals.

Actual cases of poaching, although assumed to occur, were not seen. The degree to which this form of predation might affect mule deer numbers is unknown but it is suspected that it is negligible. Primarily the weekend shooting disturbed the deer in that it tended to upset the daily feed-rest-feed routine which in addition to causing physical discomfort probably caused mental discomfort as well since any change in the routine activity was seen to put the animals into nervous or irritable state.

One instance of possible poaching was seen in January,



1959. A white-tailed male, already crippled during the preceding hunting season as evidenced by a broken back leg with the broken edges rounded, was killed to relieve its suffering. On examining the animal it was found that two wounds had recently been incurred. The size and depth of these wounds indicated they had been made with a small bore gun, probably a .22 caliber pistol or rifle. This animal might have been shot merely for the sake of shooting something and not poaching particularly for meat.

The most unusual aspect of the deer-man relationship is the attitude of the deer toward man in the winter as compared to the hunting season. On February 20, 1960, a Saturday, several people were shooting shotguns less than  $\frac{1}{4}$  mile from a group of 25-30 mule deer. The shooting was continuous for nearly two hours with possibly a hundred shots fired. During this entire barrage, the deer stood in an alert pose and watched the shooters who were in plain view of the deer. The deer did not run away, as most hunters will agree they probably would have if it had been the hunting season. A possible explanation again is in the aspect of the hunter as compared to the aspect of the target shooter. Hunters stalk through the woods, target shooters talk, shout, move around unconcealed and in general look quite different from a hunter. This will be discussed more fully in the next section under learning.

## INSTINCTS, DRIVES AND LEARNING - PLACE IN SURVIVAL

Instincts and drives. For the purposes of this paper, instinct is any behavior that is innate and requires no learning. This will include drives, biological, physiological and psychological. Fear and sociality will also be classed as instincts. It is obvious each of these involves learning but only in so much as reaction is concerned, not starting the action. Fear for example is to be considered instinctive but the reaction to a fear situation is learned such as which direction to go for escape, to run or walk or indeed whether to move at all. Thorpe (1956) lists a minimum of six instincts: nutrition, fighting, reproduction, social relations, sleep and care of body surface. These also involve learning to a great extent. In ruminants, for example, the young finds the source of milk only by experience (Hediger, 1955). Again, the nutrition instinct is present, the satisfaction of the hunger is learned. The line between instinctive and learned behavior is narrow but very pronounced.

Fear among humans might well be a learned thing, but in mule deer fear is believed to be innate. Newly born fawns "freeze" when a potential enemy, i.e. a strange animal, human or otherwise, approaches. A fawn less than three days old can be approached and even touched occasionally (Dixon, 1934). At one day of age a fawn could not possibly have

learned to fear a man. Probably it fears anything that is unknown and at that time the only animal a fawn knows is its mother and most likely is afraid of every other animal. Miller (1948) considers fear an acquirable drive. Experimenting with rats, he found fear to be as strong as or stronger than hunger as a drive. The escape reaction in deer is in line with this theory. Escape from a danger or possible danger, which is in a basic sense fear, is nearly always stronger than the feeding drive (Hediger, 1955).

Sociality is generally considered to be present to a greater or lesser degree in nearly all mammals, birds and fish as well as the insects, though some species tend to be more social than others. Mule deer are highly social animals and are referred to generally as the most gregarious of the small deer. The need for another member of the species to be present is quite pronounced. Mule deer separated from the group while feeding have been seen on numerous occasions to run quickly to the group to continue feeding. During several movements, one or two deer were observed to loiter, feeding while the others of the group kept moving. These isolated animals quickly ran to join the group. Only very rarely was a mule deer seen alone and in the cases where one did appear to be solitary, there was no proof one or more animals were not very close by but hidden from view. When a danger or suspected danger was present, the deer always tended to form a very tight group. If the

danger did not materialize the group gradually spread as the animals started feeding.

Both these instincts serve primarily to aid the animal in his attempt to survive. Fear of unusual or out of place circumstances was believed to be the basis for the alert aspect, escape or displacement activity invariably ensued pending the outcome of verification by the senses. Possibly the fawns coming to the winter range for the first time have never seen a human and have never learned in what way humans are dangerous yet by his pose he gives warning to the other animals. If escape activity follows, it is usually always initiated by an adult deer; the fawn follows. Instances of this type of behavior were seen repeatedly, some have been previously cited and to list others would merely be repetition. That the fawn follows in an escape movement is an important part of the pattern. In this way the fawn learns what is to be run from. The association is established and on the next occurrence of the situation the fawn immediately knows when he sees a human in the same context the next step after verifying the presence of a human will be to escape. Each new situation is first feared. Even in investigative behavior, the animal is cautious in his approach and caution implies fear.

That sociality is a protective device can be seen in the examples of coyote predation. When an animal becomes separated from his group he is more vulnerable. Predation

by animals (man excluded) in nearly every instance, but not necessarily all, occurred when the animal was separated from the group either by running away from the group or being prevented from joining the group when it ran away. Hunting by man, of course, does not agree with this pattern since man can kill from a distance.

The presence of other animals also tends to increase food intake (Allee, 1938). This was seen in the infectious behavior involved in the onset of feeding activity mentioned earlier. However, there is believed to be a limit to the density of a social group of mule deer beyond which the crowding directly or indirectly results in conflict between individuals of the group. The mule deer is not a contact animal. The only actual body contact between any two animals observed was mutual grooming, fighting and the one instance of displacement sexual activity. The contact between animals associated with breeding occurs before the animals reach the winter range. When resting, there was always some space between each animal, never were two resting animals seen to touch. Even when the tight group associated with a danger was formed, each animal maintained some space between the adjacent animal and itself. The spacing, however, was not a consistent distance. It varied from a minimum of a few inches to a maximum of several feet. This spacing pattern was also seen in an organized movement when a group was in a string, moving in single file. The distance between

animals was very nearly uniform. When the line stopped for any reason, the spacing was held for a short period before the line broke as one or more animals moved out of it and the line then became a group formation. While feeding, the spacing pattern varied considerably with the browse density. The browse species were not spread uniformly but rather had a clumped distribution. The deer followed the clumped pattern of the feed, as one, two or three animals fed in one clump, with a comparatively large space to the next clump of animals. But the overall picture of the entire feeding group showed a maintained space between animals at each feeding place. The greatest exception to the spacing pattern in feeding activity was seen in the fawns when feeding beside adult males. The mature bucks tolerated fawns to an amazing extent and it was not uncommon to see a large buck feeding with a fawn, the two animals both eating from the same branch with a distance of only a few inches between their noses. Does and young bucks were never seen to tolerate another animal so close or to be tolerated so close to another animal. This tolerance of the lowest members of a social scale by the highest members is very common in a social animal while there is usually a marked tendency to keep a definite distance between individuals (Hediger, 1955).

The drives listed as instinctive include the sex drive which was seen only on one occasion. A male smelled where a female had urinated, turned back his lip in the normal

pose of a rutting male when in contact with a female in heat, then attempted to mount the doe. She turned away quickly and both animals started feeding. This occurred in March, 1959 which is very late for any sexual activity. Usually, the rut is finished before the deer arrive on the winter range, the height occurring a month prior to the arrival of the first migrants. Russell (1932) found in California that the rut was coincident with arrival on the winter range but such was not the case in the Rattlesnake deer.

Physiological drives include primarily satiation of appetite and general physical comfort. Woodbury (1956) points out the importance of physical comfort in animals intimating that nearly all activity is directed toward physical comfort. In this study it was found that high humidity is associated with decreased activity. High humidity, in all probability, could be considered as an uncomfortable condition and not conducive to a great amount of activity. Sundstroem (1931) found in the laboratory rat that high humidity as well as a variety of other conditions of temperature and wind caused discomfort in the rat and food intake declined as comfort declined.

Psychological drives are believed to be also present in the mule deer. These are distinct from physiological as they imply mental well being. Mental well being was seen in animals following a normal daily routine. Any upset in the routine was seen to cause nervousness among the animals and

they became nervous and took flight quickly and on very slight provocation. Days when the wind was gusty and changeable induced this nervousness as did human activity such as target shooting.

These drives mentioned are all generally thought to be innate. Satisfaction of these drives is to a large extent learned. In feeding for example, the hunger is innate but what to eat to satisfy that hunger is learned either by trial and error or by eating with an adult animal, taking the same things it takes.

The value of these drives in survival of the species is obvious. Mental well being might be more obscure in its value. Primarily, when deer are calm and undisturbed, there is little movement, little energy is expended. This conservation of energy contributes to the general condition of the animal. On the other hand, nervous or disturbed animals move about and so expend more energy thus deteriorating the general condition.

### Learning.

#### Fawn imprinting on doe and the relation to range use.

Does seek seclusion from the group to give birth to their fawns (Dixon, 1934) as do cow elk when dropping their calves (Altmann, 1956). So, for the first part of their lives, the young deer knows of only one other "friendly" animal, its mother. The fawn, after a few days, follows its



mother. As a reward type of thing, the fawn has its hunger satisfied in the form of nursing, its social instinct satisfied by the presence of the mother, its fears to some extent defined by its mother and its mental and physical state in general controlled by the actions of the mother.

Lorenz (1952) has pointed out the strong tendency for imprinting in geese and dogs at certain stages in their development. Beach and Jaynes (1954) suggest that the tendency for elk calves to stay with their mother is a type of imprinting. Hediger (1955) sites cases of imprinting of various wild animals in zoos on their keepers as well as on other animals of a different species. He also points out cases of American bison imprinting on man on horseback during the early days of the west. Imprinting has been shown in many birds and fish. Cases of something similar have been observed in insects. Quite possibly it occurs in nearly all mammals also (Thorpe, 1956).

It is strongly suspected that the tendency for a young animal to imprint on its mother exists among mule deer also. The fawn stays with the doe through the summer and accompanies her on the migration route to the winter range and again on the return to the summer range (Russell, 1932). It was seen throughout the study that fawns were seldom far from the does and when a doe moved for any reason, the fawn followed her. That this early imprinting and complete following of the doe will perpetuate traditional migration routes and use

of traditional winter ranges, seems highly probable. Woodbury (1956) reports the mule deer in the Kaibab in Arizona had migration patterns so fixed that when too many had accumulated for the food supply they remained and starved rather than go to other areas less crowded. He suggests the deer migrate because they "have learned to find more comfortable quarters for winter in the lowlands" and they have fixed the routes of travel so they are retraced each year. This tendency might be stronger in the female, since the female fawns usually are more firmly attached to the doe and tend to remain with her longer (Dasmann and Taber, 1956).

Definitions of learning exist in great profusion but there is general agreement among them on most points. For this paper, behavior patterns formed or adaptive changes in behavior as a result of individual experience will be considered learning. The experience, in this case, can be considered the stimulus. Hilgard (1956) reports that a stimulus gains its full associative strength on the occasion of its first pairing with a response. Granting the validity of this statement, it follows that the behavior pattern is established the first time the situation is experienced. Transferring this theory to an experience in the life of a mule deer fawn, the following sequence might be seen. The fawn sees, smells and/or hears the approach of a man. This has never before been experienced. The doe, also aware of

the presence of a man, takes flight, the fawn follows. This then is a behavior pattern established in the fawn, the stimulus is the man's presence, detected through the senses, the response is escape. Paired the first time, the association of man and escape has reached its full strength and the whole experience has created in the fawn a behavior pattern through experience - learned behavior.

It can be assumed this stimulus-response association is present in all learning (Scott, 1958). For its first year of life, the fawn, with the exception of some male fawns (Dasmann and Taber, 1956), stays with its mother and any learning on the part of the fawn is certainly influenced by the mother. The movements a doe makes in migration are followed by the fawn and when the doe moves to a certain part of the winter range, the fawn does also.

It has been pointed out that four independent groups of deer frequented the winter range on Wallman Ridge. Group A went directly to the middle third of the ridge, fawns of this group would learn to do this the first winter and tend to repeat it the next winter. Group B animals moved onto the upper third for the first part of the winter until some unknown stimulus(i) elicited the move to the middle third. At this time the BB group remained behind, splitting off from group B. The stimulus(i) which caused the response in group B did not affect BB animals which moved at a later time and in a different pattern although the route was

practically parallel to that of group B. Group PB responded to still another different situation. Fawns of these groups learn the movements, the stimuli and the responses by the association process described. In this manner the use of certain areas by individual groups becomes traditional and is handed down from generation to generation. However, the precise nature of the stimuli is obscure. Riess (1950) sites the study of von Frisch when he demonstrated that the angle of the sun's rays has an important stimulus value for dancing behavior in bees prior to breeding. This might also be considered a possibility for stimulating a movement in deer. Lincoln (1950) reports quantity of light and day length as being responsible for stimulating migration in birds. Russell (1932) associates physiological rhythm with migration rhythm. Regardless of what the stimuli might be, their existence is strongly believed and that the movements seen in the Rattlesnake deer occurred both years under completely different conditions of snow and other weather phenomena yet on nearly the same date indicates a specific pattern in time rather than relation to weather. Hediger (1950, 1955) points out the time importance in animal behavior patterns with several outstanding examples, not only time in a seasonal sense but to within minutes. The manner in which animals determine time, however, is not well understood. Some possibilities might be day length or angle of the sun's rays.

Assuming a fawn learns the route of travel, the stimuli associations and the movement patterns the first year of its life, and that once learned these patterns become very difficult to alter, it follows that the fawn will move in the same pattern the second year as a yearling animal as it did when a fawn. In this manner, the original imprinting of the fawn on the doe determines the traditional areas of the range which will be used by each succeeding generation. Since these areas are, to the fawn, the only ones that exist, these are the ones which will be used regardless of the condition of the browse.

The origination of new travel routes and movement patterns can only be speculated upon. Some possibilities will be proposed here. Suppose, for example, a doe was killed in the hunting season and a female fawn was left to fend for itself. If it survived on an area which was located by chance and which was not used previously by deer, the next year it would return to this same area and the next again, bringing its own fawn, thus starting a new traditional range. Another way might be for does emigrating from the herd to drop their fawns, locating in new areas. Cases of isolation of a doe from the main group by something as a sudden deep snow might initiate a new tradition. Geological changes such as appear during an earth quake or large rock or snow slides might change a movement pattern. Dispersal of groups by predators like the coyote in present times and by wolves

in the past might force deer into new areas (Riney, 1951). Competition with other big game species such as elk might also alter traditions. However, it appears that the establishment of new traditional patterns is comparatively rare. If it were more common, more than the two main groups would be seen on Wallman Ridge and aggregations would not become quite so large if there were a constant formation of new travel routes and new areas of use.

Hilgard (1956) points out in his analysis of Guthrie's contiguous conditioning theory that when a combination of stimuli has accompanied a movement, this combination, on its recurrence tends to be followed by that movement. It is felt that it is by this perpetuated or habituated association of stimuli and movement that a group of deer using an area not previously used will continue to use this area and will respond to the same stimuli in the same way for generations to come and until all animals which have learned this particular tradition are either dead or have through some series of events learned some other tradition to replace it.

Accomodation to humans. During the study there was much evidence seen to substantiate the belief that mule deer accomodate to humans. The initial accomodation involved the vehicle used during the study. The road paralleling Wallman Ridge is in plain view of the ridge and any vehicle on the road can easily be seen from the ridge. It was observed on numerous occasions when stopping the jeep and quickly looking

at deer feeding on the hillside that rarely more than one or two animals raised their heads to look. However, whenever another vehicle went up the road, even if it did not stop, every deer in the group watched until it passed from their sight more than a mile beyond them. The road was used by logging trucks for part of each winter. The deer paid no attention to them either. The jeep and trucks were seen by the deer nearly every day and ignored while automobiles, which were infrequent, received the most attention.

On February 14, 1960, the observer and another person approached 45-50 animals of group B. These deer retreated before they could be approached closer than  $\frac{1}{2}$  mile. Three days later the observer alone approached to 100 yards from these same animals before they retreated. This same type of situation occurred many times throughout the study in various forms. That the deer recognized the observer from another individual person is not so likely as that they developed an association concerning only one person, not two. When two or more people appeared it was a different situation from the times one person arrived in a jeep that rattled quite noisily up the road. They recognized the situation as a whole. From experience with the situation they grew used to it. Hilgard (1956), citing Thorndike's laws of use and disuse, points out that the response weakens if practice is not continued. No consequences followed when the deer remained in the presence of the observer so the escape response

became weakened but only to the situation as a whole, not to the observer specifically. That is, the appearance of the observer in another context was to the deer not the same situation and therefore brought about a different response. Therefore, it can be said the deer learned the observer did not represent a danger when in a certain situation but did not learn to recognize the observer out of the context of this harmless situation. The recognition of situations as a whole rather than a particular aspect of it has been pointed out earlier in respect to target shooting as compared to the shooting in hunting season. Here, the shooting, in one situation, was disturbing, but did not elicit the escape response, while in the other situation it did result in the escape response. This again is the situation as a whole, not an isolated facet of it.

Snare avoidance. The use of the snare as an attempted marking technique provided some interesting observations on learning. Aside from perhaps frightening an animal caught in one, the snare does not cause any physical harm. In a one month period from mid February to mid March, 1960, thirty snares were tripped by deer. There were five cases of deer going under. The snares were about 18 inches from the ground and required that a deer lower its head almost to the ground to get under. This could have been accidental as a deer feeds in this posture. However, on three occasions during this period deer walked up to the snare, stopped and



either went around it, returning to the trail directly beyond the snare or turned around and retraced their steps. As each of the three snares had been tripped previously, there is a limited possibility that the snare itself was overly obvious. It is more probable that these three deer had learned in some way to avoid the snares. The movement around a snare was observed on one occasion. An adult doe was seen walking on a trail toward a snare. The snare was partly visible to the observer and the actions of the deer completely visible. The doe approached to within approximately 8 feet of the snare and stopped. She stood with head about back level and neck straight forward for several seconds. Then she turned off the trail, pushed through thick brush around the snare, keeping about the same distance from the snare and returned to the trail beyond. As deer habitually use established trails the only reason possible for her to leave the trail was to avoid the snare. How the snare was recognized is not known, perhaps by smell or sight. However, the indication that it was recognized remains and that the movements made in this case were in response to the snare was quite probably due to a learned association by having been previously caught and having escaped. That not every deer avoided the snares is evident by the fact that thirty had been tripped in the one month period by deer passing through them. What other escape techniques the deer might have learned regarding the snare markers is not known

but a large part of the lack of success using this marking system is felt to be justly attributed to learned responses on the part of individual deer which led to escape. White (1958), using one shot dye markers on mule deer, reports similar avoidance of these marking guns after they had once been fired.

## SUMMARY AND CONCLUSIONS

It was observed that the movement patterns for the two winter study periods appeared to be very similar in nearly all respects. The arrival of the animals on the winter range occurred about the same time and in the same manner both years. The movements to and from the study area were characterized by a gradual drifting of small groups rather than the sudden arrival of the wintering population as a whole in one simultaneous movement.

It was observed that the daily activity pattern followed a feed-rest-feed complex and the rest period occurred during the middle of the day from between 9:30 and 11:30 a.m. to between 1:30 and 3:30 p.m. generally. The length of the rest period or the inactivity period was found to vary with the relative humidity, being longer on more humid days and shorter on less humid days. No direct relationship between activity and temperature could be found. Wind influence on animal activity was great while the animals were resting, but less important when during active feeding. There was a marked tendency for the deer to rest in places sheltered from the wind. Precipitation in the form of rain or snow appeared to have little direct affect on the deer except as related to humidity or accompanied by wind. Deer were not observed to take shelter as a result of rain or snow alone.

Communication between deer was primarily observed to

take the form of poses or postures. Various stereotyped postures could be distinguished - alertness, aggressiveness, feeding, resting and movements from one place to another. The alert pose warned other deer of danger so they also became alert. This has been referred to as infectious behavior. Infectious behavior is characterized not by imitation but rather by the pose of one deer creating a "mood" in other deer. In this manner the pose and infectious behavior serve as protective devices for the entire group, for in this way, the group as a whole is as alert as its most alert member. The aggressive pose saved the deer from actual conflict as most disagreements were settled by a pose rather than actual fighting.

Displacement activity appeared usually in the form of feeding with one instance of sexual displacement activity. Displacement feeding was seen to occur when the flight stimulus was not strong enough to elicit the escape response and differed from actual feeding both in duration and intensity.

Dominance of the herd was by the adult males. This was independent of leadership which was seen in adult does, usually with fawns. Does without fawns were never observed to be leaders. Dominant deer had the choice of feeding and resting sites while leaders determined the direction of movement and the travel route. The social hierarchy was both an asset in that it limited actual fighting and a detriment

as it put fawns at a distinct disadvantage in the survival struggle.

Intolerance appeared to increase as deer became more concentrated and as food availability decreased. However, as these two occurred simultaneously or as a result of each other, they were difficult to separate.

Mutual grooming appeared to be at a high rate of incidence during March and was observed much less frequently earlier and not at all later than March.

The total number of animals using the winter range was nearly the same both winters. The estimated high population in 1958-59 was 125 animals while in 1959-60 it was 115 animals. The doe-buck ratio showed some change over the two year period being 1:.3 the first winter and 1:.5 the second winter. The doe-fawn ratios were seen to change during the course of each winter. The first winter the doe-fawn ratio during the early part of the winter was 1:.5 and at the end of the winter was 1:.33. During the second winter this ratio was 1:.66 for the beginning of the winter and 1:.5 at the end.

There was little if any change in numbers of adults during the course of each winter as mortality due to malnutrition or predation among the adult deer was negligible. However, there were decidedly fewer does in the herd the second year. Reasons for this decline in doe number might be due to emigration of animals, hunting mortality or some

more obscure reason.

The white-tailed deer in the area are in competition with the mule deer for food but the mule deer appeared to be the more dominant species. The coyote was the most common predator in the area and approximately 10 per cent of the deer herd was killed each winter by coyote predation. Most of the predation occurred in the fawn class, indicating that fawns were more vulnerable than adults. No differential vulnerability due to sex could be determined. Magpie-deer relationship was generally seen to be of a mutually beneficial nature. Man acts primarily as a disturbing element among the deer on Wallman Ridge and it was felt that only a small portion if any of the mortality could be attributed to human use of the area.

Instinctive behavior among the mule deer is difficult to describe as each instinctive action also involves learning. Certain activities were credited to instinct because they were believed to be innate drives and it was supposed that the satiation of these drives was accomplished through learning.

The fact that fawns stay almost exclusively with their mothers was taken as an indication that a form of imprinting had taken place. The following of the does by the fawns dictated the area of the winter range the fawns used. By learning processes the fawns form the proper time-space and stimulus-response associations and traditional travel routes

and feeding areas are maintained through habit formation. The continuous process of handing down from mother to fawn perpetuates the traditions.

The mule deer tended to show accommodation to situations as a whole rather than to isolated aspects which were out of context. This was seen in accommodation to the observer particularly where the observer was alone in the one situation and accompanied by another person in the other situation. The observer was the same but was not a disturbing factor while in one context and was a disturbing factor in another.

The importance of tradition in survival lies primarily in that the time and place associations are repeated year after year. The deer are always in a familiar environment. This means there are known escape routes, bedding areas and feeding grounds. The mule deer on the winter range depends on distance from the danger or hiding from the danger. As the winter range is very open, escape cover involves movement into places out of sight of the danger by quickly running to areas in defilade such as around a hill or over a ridge. Habitual use of an area provides the knowledge of where these areas are in relation to the deer. In this way, escape is not blind running, but running which is directed toward some particular area. So, it is seen that behavior patterns are directed toward survival of the animal, individual behavior toward survival of the individual and group

behavior toward the survival of the group. This of course is not a conscious thing on the part of the deer but has probably evolved through a selection process. The tradition preserves behavior patterns which are helpful or good (to the population) and mortality eliminates the harmful or bad ones.

Two main groups could be seen on the winter range both years with two smaller groups recognizable only during the second year as subgroups of group B. Group A tended to occupy the middle third of the range throughout most of the winter while group B spent the first part of the winter on the higher upper third of the range, joining group A on the middle third in mid February. This group B movement from upper to middle third occurred on nearly the same date both years although snow conditions were very different. The snow in 1959 was about 20 inches deep and somewhat crusted when the movement occurred while in 1960 the southeast exposures were bare of snow when the movement occurred. The browse in the upper third is in considerably better condition and more abundant than in the middle third so the movement was actually made from good forage to poorer forage. This indicates the stimulus(1) was not the conditions of weather or the availability of food but rather was related to an instance in time so the movement occurred about the same time each year and independent of something like weather



conditions which would vary from year to year.

That the specific groups tended to occupy the same general area each year in a recurring pattern indicated that the areas used were traditionally set areas, used habitually year after year. This tradition is maintained by the does of the group and is transferred to the fawns by an association process. The association of these movements with certain stimuli constitutes a learning process and when these certain stimuli recur, the movement is repeated in the same manner and using the same travel routes. This implies memory in the deer. This implication is supported by what is known of tradition and habit in higher animals including humans.

It has been attempted throughout the study and writing of this paper to be as objective as possible. That subjectivity has crept into it however, is inevitable, for as Schneirla (1950) points out, the field investigator is not an unbiased registering instrument. It is suspected the observer in this study quite probably falls within this judgment.

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