1971

Food Habits of Deer In The Southern Black Hills As Determined By The Point Technique

Theron E. Schenck

FOOD HABITS OF DEER IN THE SOUTHERN BLACK HILLS AS DETERMINED BY THE POINT TECHNIQUE

By

THERON E. SCHENCK II

A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Major in
Wildlife Biology, South Dakota
State University

1971

FOOD HABITS OF DEER IN THE SOUTHERN BLACK HILLS AS DETERMINED BY THE POINT TECHNIQUE

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser — Date

Head — Date
Dept. of Wildlife and
Fisheries Sciences

FOOD HABITS OF DEER IN THE SOUTHERN BLACK HILLS AS DETERMINED BY THE POINT TECHNIQUE

Abstract

THERON E. SCHENCK II

White-tailed (Odocoileus virginianus) and mule deer (Odocoileus hemionius) were collected in 1968 and 1969 for a study of food habits. Rumen contents were analyzed by use of the point-analysis technique and weights. This is the first food habits study from the southern Black Hills and is necessary for proper deer management.

To evaluate the suitability of the point technique for Black Hills vegetation, an artificial population was constructed from known weights of a forb, (Achillea lanulosa), grass (Oryzopsis asperfolia), rose (Rosa sp.), kinnikinnick (Arctostaphylos uva-ursi), and ponderosa pine (Pinus ponderosa). Each population was tested with 100-point trials and 200-point trials. Comparisons of point percentages to weight percentages were: forb - 24.3 to 14.8, grass - 26.5 to 25.7, rose - 10.2 to 10.8, kinnikinnick - 24.8 to 29.3, and pine - 16.3 to 18.3 percent. Forb estimates were significantly different ($P>0.05$) using chi-square analysis. Browse, grasses and forbs were estimated with no significant differences ($P>0.05$) using chi-square analysis: forbs - 24.3 to 14.8, grasses - 26.5 to 25.7 and browse 51.3 to 58.4 percent.

Twenty stomach samples were separated by hand after point analysis. Estimates of relative composition by hand separation and points for ten major species were: mountain mahogany (Cercocarpus montanus), 15.2 to

13.7; ponderosa pine, 12.3 to 13.9; juniper (Juniperus spp.), 9.6 to 12.8; grasses, 9.4 to 10.3; kinnikinnick, 7.4 to 9.6; snowberry (Symphoricarpos spp.), 5.2 to 7.3; rose, 5.1 to 5.7; Oregon grape (Mahonia repens), 3.9 to 5.5; bedstraw (Galium sp.), 2.5 to 4.7; and old-man's bead (Usnea sp.), 4.2 to 3.8 percent. Paired-"t" tests showed there was no significant difference ($P>0.05$) between the estimated relative composition either by hand separation or by points. No difference in estimation between hand separation and point percentages was seen in class estimation of the hand-separated material: forbs, 11.9 to 17.9; grasses, 9.4 to 10.3; and browse, 69.1 to 58.7 percent.

Analysis of 52 rumen samples collected in the fall showed kinnikinnick, grasses, Oregon grape, snowberry (Symphoricarpos spp.), and forbs to be important food species.

Analysis of 64 rumen samples collected in the winter indicated that ponderosa pine, mountain mahogany, and common juniper (Juniperus communis) were the most important food species. Other winter foods of importance were kinnikinnick, forbs, grasses, snowberry and Rocky Mountain juniper (Juniperus scopulorum).

Point analysis of content in nine rumen collected in the summer showed that alfalfa (Medicago sativa), clover (Trifolium pratense), grasses and forbs were the most important foods.

ACKNOWLEDGEMENTS

Many thanks are due Dr. Raymond Linder, Leader of the South Dakota Cooperative Wildlife Research Unit[1], who acted as my major adviser for this study. Robert Dahlgren edited the manuscript and has helped with many suggestions along the way. Drs. Donald Progulske and Kieth Severson also have made helpful suggestions during the course of the project. Art Richardson, Lyle Peterson, and Jerry Kranz and others from the South Dakota Dept. of Game, Fish, and Parks helped collect the samples. Art Richardson is largely responsible for the many samples collected and deserves a special note of thanks. Drs. Donald Dietz and John Thilenius of the Rocky Mountain Forest and Range Experiment Station, Rapid City, South Dakota, provided much guidance and many facilities throughout the study. Mr. Charles Taylor of South Dakota State University identified plants from the study area. Jim Gebhart and Charles Elliott spent much time and effort in the hand-separation portion of the study.

My wife, Paulette, has been a source of comfort and inspiration throughout the study and during the typing of the many copies of the thesis.

Financial assistance was provided by the South Dakota Department of Game, Fish and Parks under Pittman-Robertson Project W-75-R.

---

[1] The South Dakota Department of Game, Fish and Parks, South Dakota State University, Bureau of Sport Fisheries and Wildlife, and the Wildlife Management Institute, cooperating.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
DESCRIPTION OF STUDY AREA	2
METHODS	4
RESULTS AND DISCUSSION	9
Evaluation of Point Technique	9
Fall Food Habits	13
Winter Food Habits	17
Summer Food Habits	21
Interaction Between Mule and White-tailed Deer	24
CONCLUSIONS	26
LITERATURE CITED	28
APPENDICES	29

LIST OF TABLES

Table		Page
1	Comparison of known weights to estimated weights as determined by the point technique.....	10
2	Classes of forbs, grasses and browse as determined by the point technique compared to known weights.....	10
3	Percent weight of major plant species in 20 rumen samples as determined by hand separation and point analysis.....	11
4	Percent weight of classes of vegetation in 20 rumen samples as determined by hand separation and point analysis.....	11
5	Frequencies of occurrence of major plant species found in 20 rumen samples as determined by hand separation and point analysis.....	12
6	Plants occurring in the rumen of 29 deer, fall 1968....	15
7	Plants occurring in the rumen of 23 deer, fall 1969....	16
8	Pooled percent composition, percent frequency and abundance ratings of browse species for all plant transects, southern Black Hills, 1968-1970.....	18
9	Plants occurring in the rumen of 35 deer, winter 1969..	20
10	Plants occurring in the rumen of 29 deer, winter 1970..	22
11	Plants occurring in the rumen of nine deer, summer 1969	25

LIST OF FIGURES

Figure		Page
1.	Rumen samples were placed on a tray and analyzed using the point technique.....	7
2.	The relationship between the occurrence of important food species in the rumen and in the field, fall 1968 and 1969. Species above the regression line occurred more often in the rumen than in the field; the converse is true for those below the regression line.....	19
3.	The relationship between the occurrence of important food species in the rumen and in the field, winter 1969 and 1970. Species above the regression line occurred in the rumen more often than in the field; the converse is true for those below the regression line.....	23

LIST OF APPENDICES

Appendix		Page
A.	List of plants mentioned in the text arranged alphabetically by common name; the scientific names follow Fernald (1950).....	30
B.	Comparison of known percent weight to percent weights as determined by point analysis.....	31
C.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in eight rumen samples, Area I, fall 1968.....	32
D.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in ten rumen samples, Area II, fall 1968.....	33
E.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in 11 rumen samples, Area III, fall 1968.....	34
F.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in six rumen samples, Area I, fall 1969.....	35
G.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in eight rumen samples, Area II, fall 1969.....	36
H.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in nine samples, Area III, fall 1969.....	37
I.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in 12 rumen samples, Area I, winter 1969.....	38
J.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in 12 rumen samples, Area II, winter 1969.....	39
K.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in 11 rumen samples, Area III, winter 1969.....	40

Appendix

		Page
L.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in nine rumen samples, Area I, winter 1970.....	41
M.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in nine rumen samples, Area II, winter 1970.....	42
N.	Frequencies of occurrence, percent composition, and importance ratings for plant species found in 11 rumen samples, Area III, winter 1970.....	43
O.	Percent occurrence, percent composition, and abundance rating on all plant availability transects in Area I, southern Black Hills, 1968-1970.....	44
P.	Percent occurrence, percent composition, and abundance rating on all plant availability transects in Area II, southern Black Hills, 1968-1970.....	45
Q.	Percent occurrence, percent composition, and abundance rating on all plant availability transects in Area III, southern Black Hills, 1968-1970.....	46

INTRODUCTION

Deer have long been an important natural resource of the Black Hills. However, plant indicator species have begun to show signs of over-utilization on the winter deer range (Richardson, personal communication, 1969). Habitat disturbance by logging and type-conversion activities has also caused concern. It is important to know what effects these activities are having on the carrying capacity of the deer range and on herd condition.

A study of deer food habits in the Black Hills was completed in 1946 (Hill 1946). More recent data on the quality and availability of deer food were needed to make an accurate appraisal of the range conditions. Food habits of white-tailed deer were studied in the northern Black Hills from 1966 to 1968 (Schneeweis 1969). I began study in the southern Black Hills in 1968 to determine the principal and preferred foods throughout the fall, winter, and summer.

DESCRIPTION OF STUDY AREA

The study area in Custer and south Pennington counties was selected with cooperation of Department of Game, Fish and Parks personnel. The area was approximately 525 square miles in size. Average January and July temperatures at Custer, located at the northeast edge of the study area are 26 F to 77 F (U.S. Dept. of Interior 1962). Average annual precipitation at Custer is 17 inches, which occurs primarily in early spring and late fall. Snowfall accumulates in gullies and on north-facing slopes which have steep sides.

The area is dominated by rolling uplands of limestone plateau with elevations ranging from 5,500 to over 6,500 feet. It is cut deeply by stream drainages in the northern portion. The southern and western portions of the area grade from high limestone to rolling short and mid-grass prairies of the red valley region which surrounds the entire Black Hills. Soils of the area are shallow or eroded badlands types (U.S. Dept. of Agriculture and U.S. Dept. of Interior 1967). The area is drained by French Creek and intermittent tributaries of the Cheyenne River.

The study area was divided into three parts according to major vegetation differences for sampling purposes. Area 1 was located in the northwest corner of Custer County. Its boundaries were U.S. Highway 16 on the west, Summit Ridge (F.S. 265) and Custer Limestone roads (F.S. 284) on the north, and a line from Wildcat Draw to Teepee Work Center on the east. Dominant vegetation types were mountain mahogany[1] and juniper

---

[1] A list of plants referred to in this thesis is shown in Appendix A (Fernald, 1950).

interspersed with extensive stands of ponderosa pine. Bottomlands contained mixed species of plants.

The boundaries of Area II were the Custer Limestone road (F.S. 284) on the north and U.S. Highway 16 on the south and east. This area was in the limestone plateau with elevations from 5,300 to 6,400 feet above sea level. The dominant vegetation type was ponderosa pine with a few stands of aspen.

Area III boundaries were Wyoming-South Dakota state line, a line from Loring Siding to mile-post 39 on the south, U.S. Highway 16 on the north, and highways 85 and 89 on the east. This area included limestone hills, broad open valleys and mid- to short-grass prairies. Dominant vegetation included mountain mahogany, juniper, ponderosa pine and grasses. Cultivated crops were not common, however, alfalfa and small grains did occur. Major land use of the area was grazing and timber production. Nearly all of the land in the area was administered by the Bureau of Land Management or the U.S. Forest Service.

Mammals common to the area included white-tailed deer, mule deer, pronghorn (Antilocapra americana), coyote (Canis latrans), striped skunk (Mephitis mephitis), yellowbelly marmot (Marmota flaviventris), porcupine (Erethizon dorsatum), and red squirrel (Tamiasciurus hudsonicus). Elk (Cervus canadensis) and bobcat (Lynx rufus) were also seen infrequently within the study area. Burt and Grossenheider's (1952) Field Guide to the Mammals was used as the authority for scientific names of the mammals.

METHODS

Three deer were collected from each of the three areas each month from September 1968 to April 1969 and from September 1969 to April 1970. Approximately one quart of rumen material was taken from each deer collected. Excess fluids were removed from the sample by squeezing the sample in cheesecloth. Each sample was placed in a plastic bag, labeled, and frozen. Age, sex, condition of the animal, general description of the area, and snow cover and depth were recorded for each sample. Plant availability at each kill site was determined at the time of collection or as soon after collection as possible.

To determine plant availability, a 250-foot transect was set up in each of the four cardinal directions starting at the approximate location of the kill. Plant species closest to the investigator's toe and above the snow were recorded every four steps. Twenty-five (25) plants were recorded on each transect for a total of 100 plants for each kill site. Plant abundance ratings were calculated by multiplying the average percent occurrence of the plant on all transects by the average percent composition of the plant on each transect. Average percent composition was calculated by dividing the number of times the plant occurred on the transect by the total number of plants recorded.

Plant importance ratings were calculated by multiplying the average percent composition of each species in the rumen by the average percent occurrence of the plant species in all rumen. These values were then multiplied by 100 to obtain whole numbers.

Importance ratings and abundance ratings were compared by chi-square

to determine if a difference existed between the amount of a plant species at a kill site and the amount eaten by the deer.

Abundance ratings and importance ratings were plotted on a graph to determine if the material occurred in the sample in the same ratio as it occurred in the field. Species which are plotted above the regression line indicate that they occur in the rumen in a greater proportion than in the field. Those plotted below the regression line indicate that they occur in larger amount in the field than in the rumen samples.

In the laboratory each rumen sample was washed through a 3.36 mm screen. That screen was selected so that the size of the particles sampled would be similar to those sampled from the northern Black Hills (Schneeweis 1969).

Material from all samples which remained on the screen was identified by the point analysis technique. Twenty samples were also hand-separated to species. For hand-separation, material was kept moist during sorting to prevent drying and loss of distinguishing characteristics.

For point analysis, material retained on the larger screen was placed on a white enamel tray 30 x 60 cm and examined using a modification of the point analysis method described by Heady and Van Dyne (1965). A Bausch and Lomb stereo microscope with a variable magnification from 7X to 30X and a pointer in one eye-piece was mounted on an adjustable base (B and L Model SK). The entire system was mounted on a 3/4" plywood board 80 by 120 cm. The arm holding the microscope was adjusted to prevent lateral movement. Rails were constructed so the pan could be moved from side to side. The rails were marked with notches 3 cm apart along the

leading edge. The pan was marked along the leading edge with a center mark and the sides were marked every 1.5 cm (Fig. 1).

The rinsed rumen sample was placed on the pan and distributed as evenly as possible over the pan bottom and pressed down. The center mark on the pan was placed on a starting point on the rail and the pointer was placed on a mark on the edge of the tray. The particle lying under the pointer was then identified and recorded. If the particle could not be identified to genus and species it was recorded as a forb, grass, unknown browse or unknown. The tray was moved along the rails until plant material at ten points had been identified. The pointer was then moved forward one mark and another series of ten points recorded. This process continued until 100 points had been recorded. The sample was then mixed thoroughly and redistributed and another series of 100 points completed. The mean of the two 100 point series was used for analysis. It was assumed that distribution of plant material on the tray was random.

To evaluate the suitability of the point technique for Black Hills vegetation, three artifical populations were constructed from known weights of forb (yarrow), rose, grass (ricegrass), kinnikinnick, and ponderosa pine. Each population was placed in a blender and ground for 30 seconds each, and then placed on a white enamel tray for point analysis. A series of 100 points was taken, the material redistributed, and a second series of 100 points recorded. A second series of 200 points was taken after redistribution to test if any difference in the estimation of the populations occurred using 100 points or 200 points.

Fig. 1. Rumen samples were placed on a tray and analyzed using the point technique.

Results were tested by chi-square analysis to determine if the estimated population differed from the known population. Results of the 100 and 200 point trials were tested using the paired-"t" test to see if they were different.

A further test of the technique was carried out on rumen samples from the study area. Twenty samples were analyzed by the point method and also hand separated. The point data was compared to the hand-separation data by paired-"t" test.

Seasons of the year as used in this study were fall (October, November, and December), winter (January, February, March, and April), and summer (July, August, and September). Spring collections were not made as it was difficult to identify pregnant does and conditions did not warrant the collection of pregnant deer.

RESULTS AND DISCUSSION

Evaluation of Point Technique

Work by Chamrad and Box (1964) indicated the point technique to be a fast, unbiased method of analyzing rumen contents provided (1) the sample was adequately mixed and (2) there were no unusually large items in the sample. They reported that percentage volume estimates may be taken from hits in most cases.

Harker et al. (1964) used the point technique to estimate species composition on a percent dry-weight basis in esophageal-fistula samples. They found the microscopic point method gave a satisfactory estimate of species composition on a percent dry-weight basis.

Dirschl (1962) in a study of rumen analysis techniques of the pronghorn found that washed material remaining on the sieve screen with a mesh size of 5.5 mm adequately represented contents of the entire sample. He also stated that volumetric procedures were more variable than weight procedures in determining percentages of food species.

Artificial Population. —— Results of point analysis of artificial populations composed of plant materials similar to the rumen contents of deer collected in the Black Hills are shown in Tables 1 and 2.

Table 1. Comparison of known weights to estimated weights as determined by the point technique.

Species	Known Percent Weights	Estimated Percent Weights
Forbs	15.8	24.3*
Grasses	25.7	26.5
Rose	10.7	10.2
Kinnikinnick	29.3	24.8
Pine	18.3	16.3

* Significant at 0.05.

Table 2. Classes of forbs, grasses and browse as determined by point technique compared to known weights.

Class	Known Percent Weight	Estimated Percent Weight
Forbs	15.8	24.3
Grasses	25.7	26.5
Browse	58.3	51.3

Table 3. Percent weight of major plant species in 20 rumen samples as determined by hand separation and point analysis.

Species	Percent weight	
	Hand Separation	Points
Mountain mahogany	15.2	13.7
Ponderosa pine	12.3	13.9
Juniper	9.6	12.8
Grasses	9.4	10.3
Kinnikinnick	7.4	9.6
Coralberry	5.2	7.3
Rose	5.1	5.7
Oregon grape	3.9	5.5
Bedstraw	2.5	4.7
Old-man's beard	4.7	3.8
Others	25.9	12.7

Table 4. Percent weight of classes of vegetation in 20 rumen samples as determined by hand separation and point analysis.

	Percent weight	
	Hand Separation	Points
Forbs	11.9	17.9
Grasses	9.4	10.3
Browse	69.1	58.7
Unidentified	9.6	13.1

Table 5. Frequencies of occurrence of major plant species found in 20 rumen samples as determined by hand separation and point analysis.

Species	Percent occurrence	
	Hand Separation	Points
Kinnikinnick	60	65
Ponderosa pine	65	65
Juniper	50	55
Grasses	55	55
Rose	40	45
Bedstraw	35	40
Coralberry	30	35
Mountain mahogany	20	25
Oregon grape	20	25
Old-man's beard	15	20

Differences between estimates of percent weights using points and known percent weights were not significant ($P>0.05$) except for forbs, as determined by chi-square analysis of the means of all points (Table 1). Results of the artificial population study also indicated that the three classes of plants could be estimated accurately (Table 2). Paired-"t" tests showed no significant differences ($P>0.05$) between estimates made by the 100 and 200 point trials (Appendix B).

Possible sources of error in the point technique have been cited by Chamrad and Box (1964) and Robel and Watt (1970). The greatest error in the artificial population estimates was probably due to the lack of uniformity in the size of the particles of forbs. The forbs were dried and fragile while the other four species were green and succulent. This

dried condition and the consequent brittleness could have caused an increase in numbers of particles. Since the point technique measures surface area, the increased area of forbs would be over-estimated.

Comparison of Hand Separation and Point Analysis. —— Paired-"t" tests showed there was no significant difference ($P>0.05$) between the estimated percent weight of plant composition by hand separation and by point analysis (Table 3). There were also no differences ($P>0.05$) between weight estimates of vegetation classes by point analysis and hand separation (Table 4).

Frequencies of occurrence of major species in the artificial population as determined by the point technique were not significantly different ($P>0.05$) from those determined by hand separation (Table 5); however, the point technique identified trace material which was missed by hand separation (17 species identified by hand; 20 species by point). In hand-separated samples 81 percent of the material could be identified and 96 percent could be identified by point analysis. The larger amount in point analysis may have resulted from the relatively large particles which were retained on the 3.36 screen. Another factor contributing to the more efficient identification by point analysis was that some particles were too small to be separated by hand but were identified under the stereo microscope.

Fall Food Habits.

Fall rumen samples were taken from 29 deer in 1968; 12 from bucks

and 17 from does. Twenty-seven (27) species or groups of plants were identified from the 1968 samples. Important foods were Oregon grape, grasses, forbs, snowberry, and kinnikinnick (Table 6). Percent composition, percent frequency, and importance ratings for all plant species or groups of plants found in the rumen samples from areas I, II, and III during the fall of 1968 are shown in appendices C, D, and E.

In 1968, grasses were the second most important food. Snowberry was an important fall food and seemed to make up a large part of the diet of the deer early in the fall. Samples contained large pieces of stems, leaves, and mature fruits. Alfalfa also had a relatively constant importance rating. Apparently deer use this species whenever it occurs near wooded areas.

Twenty-three (23) samples were collected from the study area during the fall of 1969; 9 from bucks and 14 from does. Twenty-one (21) species or groups of plants were identified from these samples. Kinnikinnick, forbs, Oregon grape, grasses, and mountain mahogany were the most important food species found in fall 1969 (Table 7). Percent composition, percent frequency, and importance ratings for all species or groups of plants found in these samples from areas I, II, and III during the fall of 1969 are listed in appendices F, G, and H.

Oregon grape, kinnikinnick, grasses, and forbs were the most important fall foods for both sampling periods. Other important fall foods were snowberry, mountain mahogany, and alfalfa. Hill (1946) found Oregon grape and kinnikinnick to be important fall foods in the northern Black Hills and Schneeweis (1969) found that Oregon grape and common

Table 6. Plants occurring in the rumen of 29 deer, fall 1968.

Species	Percent Composition	Percent Frequency	Importance Rating
Oregon grape	50.7	27.6	15.0
Grasses*	19.4	72.4	14.0
Forbs*	16.9	69.0	11.7
Snowberry	26.1	26.7	7.0
Kinnikinnick	13.7	48.3	6.6
Alfalfa	33.7	13.8	4.7
Common juniper	15.1	31.0	4.7
Bedstraw	8.2	44.8	3.7
Mountain mahogany	18.1	17.2	3.1
Ponderosa pine	10.0	27.6	2.8
Unidentified	3.7	55.7	2.1
Clover	11.4	17.2	1.9
Rabbitbrush	26.0	7.0	1.8
Rocky Mountain juniper	24.5	7.0	1.7
Old-man's beard	8.5	17.2	1.5
Rose	3.8	34.5	1.3
Serviceberry	4.8	17.2	0.8
Phlox	7.3	10.3	0.7
Pussytoes	10.6	7.0	0.7
Cocklebur	7.0	10.3	0.7
Yarrow	15.0	3.4	0.5
Ricegrass	5.5	10.3	0.4
Browse*	8.0	7.0	0.3
Buffalobean	8.0	3.4	0.3
Yucca	1.5	3.4	0.1
Chokecherry	1.0	3.4	Tr.
Fungi	0.5	13.8	Tr.

* Not identified to species

Table 7. Plants occurring in the rumen of 23 deer, fall 1969.

Species	Percent Composition	Percent Frequency	Importance Rating
Kinnikinnick	25.0	60.9	15.2
Forbs	12.0	95.6	11.5
Oregon grape	23.0	39.1	9.0
Mountain mahogany	27.8	26.1	7.3
Grasses	10.4	69.6	7.2
Bedstraw	9.0	69.6	6.3
Ponderosa pine	14.0	39.1	5.5
Alfalfa	22.4	21.7	4.9
Rose	14.1	30.4	4.3
Red clover	24.6	13.4	3.3
Phlox	72.0	4.3	3.0
Unidentified	3.7	78.3	2.9
Cockleour	12.8	17.4	2.2
Fungi	27.5	4.3	1.2
Snowberry	5.6	18.6	1.1
Ricegrass	15.0	4.3	0.6
Common juniper	2.7	21.7	0.6
Old-man's beard	5.5	8.7	0.5
Serviceberry	3.7	13.4	0.5
Aster	3.0	8.7	0.3
Yucca	2.0	4.3	Tr.

juniper were important fall foods. Hill also found forbs and buckbrush to be important fall foods.

Kinnikinnick, Oregon grape, juniper and mountain mahogany were found in greater amounts in the rumen than in the field (Table 8 and Fig. 2). Serviceberry, ponderosa pine and snowberry were found in lesser amounts in the rumen than occurred in the field. Even though snowberry was not eaten in as large a quantity as it occurs in the field, it was considered an important food because of the large quantity available.

Data were not gathered on availability of forbs and grasses, but I believe that these species occurred in the rumen more often than in the field.

Winter Food Habits.

Winter rumen samples were taken from 12 bucks and 23 does collected in 1969. Twenty-two (22) species or groups of plants were found in the samples.

Important foods were ponderosa pine, mountain mahogany, kinnikinnick, common juniper, grasses and forbs (Table 9). Percent composition, percent frequency, and importance ratings for all species found in the samples from areas I, II, and III during winter 1969 are listed in appendices I, J, and K.

Twenty-nine (29) rumen samples were collected during the winter of 1970; 11 from bucks and 18 from does. Twenty (20) plant species or groups of plants were identified from the samples. Important food species were forbs, ponderosa pine, common juniper, kinnikinnick, grasses and mountain

Table 8. Pooled percent composition, percent frequency, and abundance ratings of browse species for all plant transects, southern Black Hills, 1968-1970.[1]

Species	Percent Composition	Percent Frequency	Abundance Ratings
Snowberry	33.0	87.5	28.9
Ponderosa pine	23.5	67.5	15.9
Fringed sage	18.6	52.5	9.8
Rose	8.1	73.7	6.0
Mountain mahogany	33.8	11.3	3.8
Kinnikinnick	16.0	20.0	3.2
Oregon grape	14.2	20.0	2.8
Serviceberry	6.7	35.0	2.3
Currant	3.6	31.3	1.1
Common juniper	2.3	43.8	1.0
Buffaloberry	3.8	16.3	0.6
Nine-bark	4.9	11.3	0.6
Chokecherry	2.7	17.5	0.5
Aspen	4.1	8.7	0.4
Rocky Mountain juniper	4.4	6.2	0.3
Skunkbrush sumac	3.8	5.0	0.2

[1] Data for individual species found in appendices M, N, and O for individual study areas.

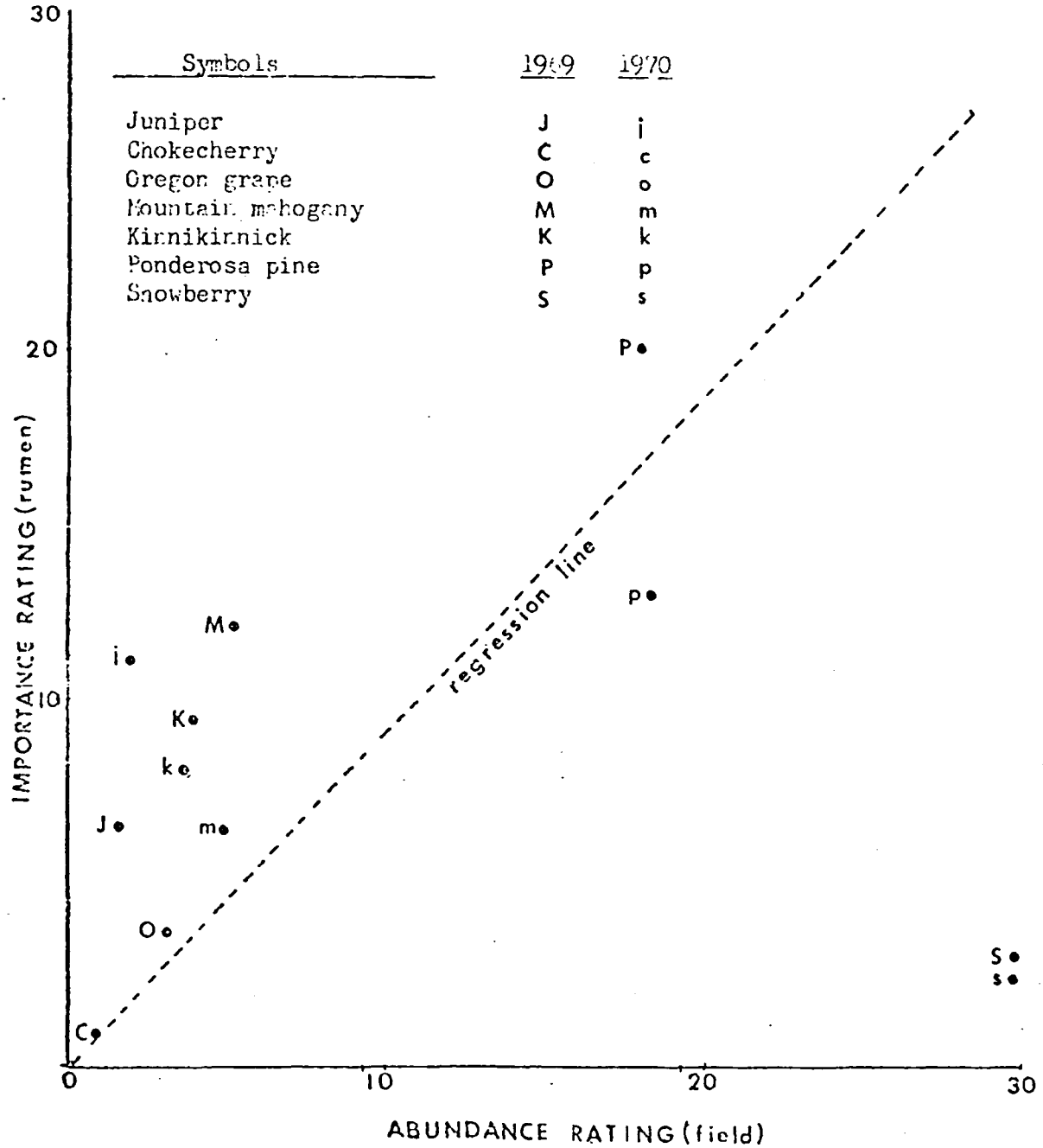

Fig. 3. The relationship between the occurrence of important food species in the rumen and in the field, winter 1969 and 1970. Species above the regression line occurred in the rumen more often than in the field; the converse is true for those below the regression line.

Table 9. Plants occurring in the rumen of 35 deer, winter 1969.

Species	Percent Composition	Percent Frequency	Importance Rating
Ponderosa pine	31.9	65.7	20.9
Mountain mahogany	65.0	20.0	13.0
Kinnikinnick	14.6	57.1	8.3
Common juniper	27.6	28.6	7.9
Grasses	11.1	60.0	6.7
Forbs	11.8	57.1	6.7
Rocky Mountain juniper	50.0	8.6	4.3
Pussytoes	26.8	14.3	3.8
Oregon grape	22.3	17.1	3.8
Old-man's beard	18.7	20.0	3.7
Bedstraw	10.8	34.3	3.7
Rose	11.5	28.6	3.3
Phlox	40.0	5.7	2.3
Snowberry	24.1	9.4	2.3
Unidentified	2.4	42.8	1.0
Aster	15.5	5.7	0.9
Chokecherry	10.7	8.7	0.9
Ricegrass	6.5	5.7	0.3
Twinflower	1.3	11.4	0.1
Fungi	4.8	tr.	tr.
Clover	2.0	2.8	tr.

mahogany (Table 10). Percent composition, percent frequency, and importance rating for all plant species or groups of plants found in areas I, II, and III during winter 1970 are listed in appendices L, M, and N.

Ponderosa pine, mountain mahogany, forbs, common juniper, kinnikinnick, and grasses were the most important winter foods for both sampling periods. The number of deer eating ponderosa pine was nearly equal in both sampling periods. However, the mean amount found in each sample was nearly 50 percent less in 1970 as compared to 1969. It appears that ponderosa pine is an important food of deer. Use of kinnikinnick remained nearly constant from 1969 to 1970 with only slight changes in importance rating. Mountain mahogany, common juniper, and Rocky Mountain juniper were used in the greatest amounts. However, use of these species was limited by their distribution. Grasses were also an important food source.

Pine, common juniper, Rocky Mountain juniper, Oregon grape, and kinnikinnick were eaten in greater amounts than they were observed on the availability transects (Table 8 and Fig. 3). Snowberry was the only species which was not eaten in greater amounts than was observed on the availability transects. Species which were not recored on availability transects but which were an important part of the winter diet included old-man's beard, phlox, forbs, grasses, and bedstraw.

Summer Food Habits.

Rumen samples were taken from nine deer during the months of July,

Table 10. Plants occurring in the rumen of 29 deer, winter 1970.

Species	Percent Composition	Percent Frequency	Importance Rating
Forbs	19.6	65.5	12.8
Ponderosa pine	19.3	62.2	12.0
Common juniper	42.2	27.6	11.6
Kinnikinnick	18.9	55.0	10.4
Grasses	13.1	75.9	9.9
Mountain mahogany	33.5	20.6	6.9
Bedstraw	17.7	27.6	4.9
Snowberry	17.7	19.5	3.4
Rose	6.7	31.0	2.1
Rocky Mountain juniper	15.7	10.3	1.6
Unidentified	2.9	51.7	1.5
Phlox	10.8	13.7	1.5
Serviceberry	34.5	3.4	1.2
Pussytoes	5.7	20.6	1.2
Twinflower	9.0	6.9	0.6
Yucca	9.0	3.4	0.3
Alfalfa	2.0	6.9	0.1
Buffaloberry	3.5	3.4	0.1
Currant	1.0	6.9	tr.
Fungi	0.1	3.4	tr.

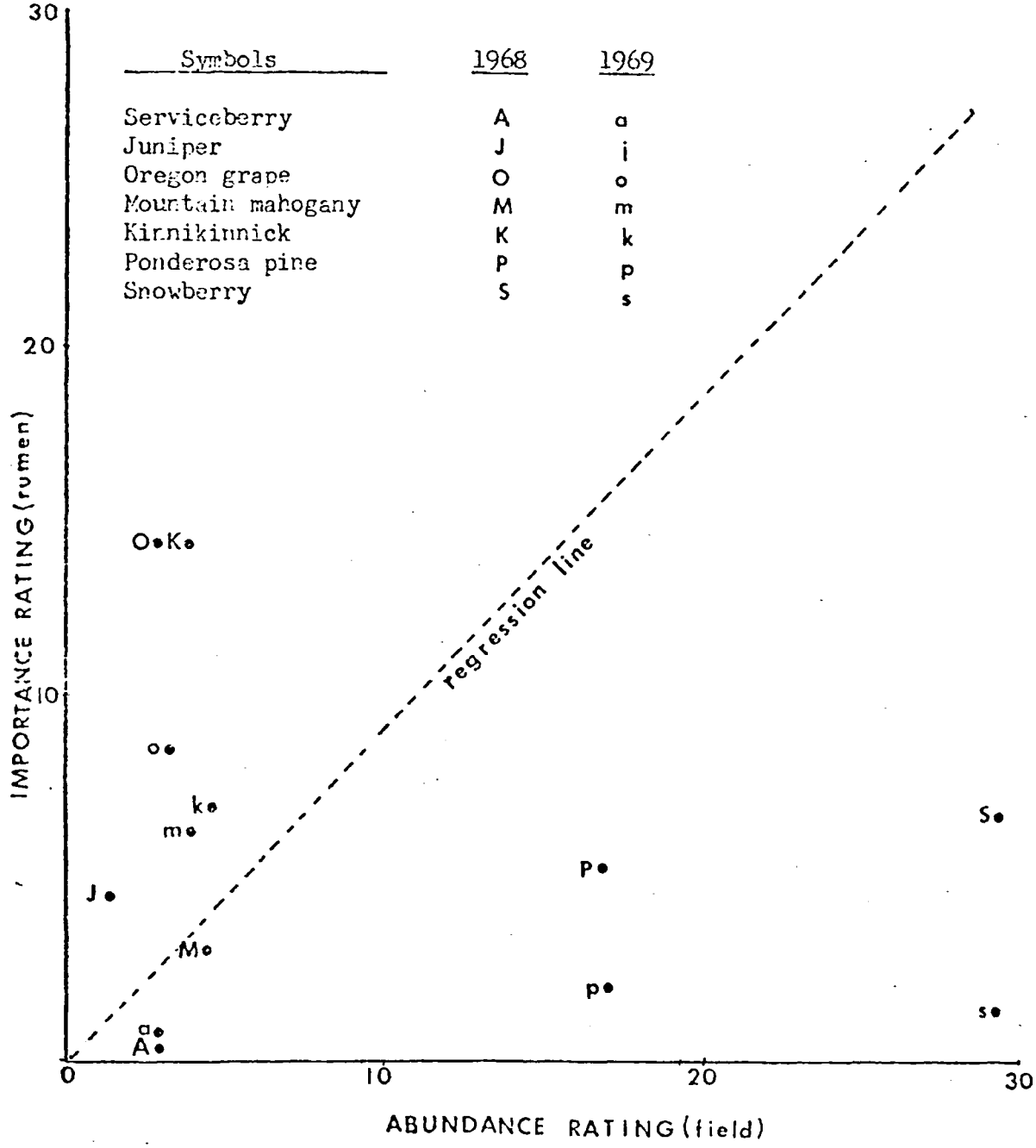

Fig. 2. The relationship between the occurrence of important food species in the rumen and in the field, fall 1968 and 1969. Species above the regression line occurred more often in the rumen than in the field; the converse is true for those below the regression line.

August, and September 1969, eight from bucks and one whose sex was not recorded. Twenty (20) plant species or groups of plants were identified in the samples. Important summer foods were clover, alfalfa, forbs and grasses (Table 11).

Interactions Between Mule and White-tailed Deer.

A comparison of the food habits of mule and white-tailed deer could not be made as there were too few samples; however, a few generalities may be drawn.

Thirty-one (31) percent of the samples came from mule deer while 69 percent were from white-tailed deer. This is approximately the same ratio of the mule deer to white-tailed deer found on the study area (Richardson, personal communication, 1969).

Food habits data for each species indicated that both species had similar diets within a given portion of the study area. For example, in 1968 in area II, kinnikinnick had an importance rating of 13.3 for white-tailed deer and 10.0 for mule deer. Importance rating of mountain mahogany was 16.7 in three mule deer and 18.0 in three white-tailed deer collected in February 1969 on area II.

Table 11. Plants occurring in the rumen of nine deer, summer 1969.

Species	Percent Composition	Percent Frequency	Importance Rating
Alfalfa	59.6	88.9	49.4
Clover	30.5	66.0	20.0
Forbs	28.3	55.5	14.1
Grasses	18.0	44.0	9.0
Snowberry	19.6	33.0	6.5
Bedstraw	9.5	33.3	3.1
Ponderosa pine	5.3	55.5	2.6
Unidentified	4.6	55.5	2.3
Cocklebur	13.0	22.2	2.1
Vetchling	3.2	50.0	1.6
Serviceberry	6.0	22.2	0.9
Fungi	2.0	33.3	0.6
Wild strawberry	2.0	33.3	0.6
Oregon grape	3.0	22.2	0.5
Aster	3.0	11.1	0.5
Twinflower	1.0	22.2	0.2
Rose	1.0	22.2	0.2
Chokecherry	2.0	11.1	0.2
Ricegrass	1.0	22.2	0.2
American vetch	0.9	11.1	0.1

CONCLUSIONS

Point analysis was a reliable technique for measuring composition of plant material in rumen samples from deer in the Black Hills. However, care must be taken to assure that particles in the sample are of uniform size and evenly distributed over the surface of the examining tray. Trace material in the rumen samples was also measured with greater accuracy by point analysis than by hand separation. Only 4 percent of the sample was classed as unidentified with point analysis while 19 percent was not identified by hand separation.

The important fall foods found in the rumen of 52 deer examined were kinnikinnick, grasses, Oregon grape, snowberry, and forbs. Kinnikinnick, grasses, Oregon grape and forbs were eaten more frequently than they occurred in the field. Snowberry was an important food source because of its wide distribution and abundance.

Ponderosa pine, mountain mahogany, and common juniper were the most important foods in the diet of 64 deer collected during the winter. Other winter foods of importance were kinnikinnick, snowberry, Rocky Mountain juniper, forbs and grasses.

Nine rumen samples collected in the summer showed that alfalfa, clover, grasses, and forbs were the most important summer food species.

Kinnikinnick and Oregon grape seem to be the most important food species in the Black Hills. These species are abundant in the southern Black Hills as well as in the northern Black Hills. This study reinforces the findings of previous studies, and I feel that further research is needed to develop some method of measuring deer usage on kinnikinnick and

Oregon grape.

Mountain mahogany appears to be limited to the western and southern Black Hills while other species such as burr oak, spruce and ironwood occur only in the northern portions. With these differences in plant composition, it seems that more research will be needed throughout the Black Hills to establish a practical management program for deer range.

LITERATURE CITED

Burt, W. H., and R. P. Grossenheider. 1952. A field guide to the mammals. Houghton-Mifflin Co., Boston. 284pp.

Chamrad, A. D., and T. W. Box. 1964. A point frame for sampling rumen contents. J. Wildl. Mgmt. 28(3):473-477.

_____ 1968. Food habits of white-tailed deer in south Texas. J. Range Mgmt. 21(3):158-164.

Dirschl, H. J. 1962. Sieve size related to analysis of antelope rumen contents. J. Wildl. Mgmt. 26(3):327-328.

Fernald, M. L. 1950. Gray's Manual of botany. American Book Co. New York. 1632pp.

Harker, K. W., Torell, D. T., and G. M. Van Dyne. 1964. Botanical examination of forage from esophageal fistulas in cattle. J. Anim. Sci. 23(4):468-469.

Heady, H. F., and G. M. Van Dyne. 1965. Prediction of weight composition from point samples. J. Range Mgmt. 18(2):144-148.

Hill, R. 1946. Palatability ratings of Black Hills plants for white-tailed deer. J. Wildl. Mgmt. 10(1):47-54.

Robel, R. J., and P. G. Watt. 1970. Comparison of food habits analysis. J. Wildl. Mgmt. 34(1):210-213.

Schneeweis, J. C. 1969. A food habits study of white-tailed deer in the northern Black Hills. Master's Thesis. South Dakota State University, Brookings. 59pp.

U.S. Department of Interior, 1962. Decennial census of United States climate--monthly normals of temperature, precipitation, and heating degree days. South Dakota. Climatography of the United States, No. 81-34. Washington, D. C. 411pp.

U.S. Department of Agriculture and U.S. Department of Interior. 1967. Black Hills area resource study. Washington, D. C. 225pp.

APPENDICES

Appendix A. List of plants mentioned in the text arranged alphabetically by common name; the scientific names follow Fernald (1950).

Common name	Scientific name
Alfalfa	Medicago sativa L.
American vetch	Vicia americana Muhl.
Aspen	Populus tremuloides Michx.
Aster	Aster sp. L.
Bedstraw	Galium boreale L.
Buffaloberry	Shepherdia canadensis L.
Buffalobean	Astragalus succulentus L.
Bur oak	Quercus macrocarpa
Chokecherry	Prunus virginiana L.
Clover	Trifolium pratense L.
Cocklebur	Xanthium sp. L.
Common juniper	Juniperus communis L.
Coralberry	Symphoricarpos orbiculatus
Currant	Ribes sp.
Fringed sage	Artemisa frigida Willd.
Fungi (mushroom)	--
Ironwood	Ostrya virginiana
Juniper	Juniperus spp. L.
Kinnikinnick	Arctostaphylos uva-ursi
Mountain mahogany	Cercocarpus montanus
Nine-bark	Physocarpos monogymus L.
Old-man's beard	Usnea sp.
Oregon grape	Mahonia repens
Phlox	Phlox sp. L.
Ponderosa pine	Pinus ponderosa L.
Pussytoes	Antennaria sp. Gaertn.
Rabbitbrush	Chrysothamnus nauseosus
Ricegrass	Oryzopsis asperfolia Michx.
Rocky Mountain juniper	Juniperus scopulorum L.
Rose	Rosa sp. L.
Serviceberry	Amalanchier alnifolia L.
Skunkbrush sumac	Rhus trilobata Nutt.
Snowberry	Symphoricarpos spp. Duham.
Spruce	Picea glauca
Twinflower	Linnaea boreale L.
Vetchling	Lathyrus ochrolaucus Hook.
Wild strawberry	Fragaria ovalis L.
Yarrow	Achillea lanulosa L.
Yucca	Yucca glauca Nutt.

Appendix B. Comparison of known percent weight to percent weights as determined by point analysis.

Species	Population 1		Population 2		Population 3		Mean of 3 Populations	
	Known	Estimated	Known	Estimated	Known	Estimated	Known	Estimated
			100 Point Trials					
Forbs	13.9	22.6	13.9	21.6	19.7	27.0	15.8	24.3*
Grasses	24.2	24.6	24.2	25.8	28.8	27.0	25.7	26.5
Rose	5.8	6.2	5.8	7.0	20.7	17.8	10.7	10.2
Kinnikinnick	36.1	28.8	36.1	27.0	15.8	17.8	29.3	24.8
Pine	20.0	18.2	20.0	18.6	15.0	10.5	18.3	16.3
			200 Point Trials					
Forbs	13.9	22.8	13.9	24.0	19.6	22.5	15.8	24.3*
Grasses	24.2	25.5	24.2	25.5	28.8	30.8	25.7	26.5
Rose	5.8	6.2	5.8	6.6	20.7	17.8	10.7	10.2
Kinnikinnick	36.1	29.8	36.1	28.0	15.8	17.8	29.3	24.8
Pine	20.0	15.9	20.0	15.9	15.0	11.6	18.3	16.3

* Significant difference ($P \leq 0.05$)

Appendix C. Frequencies of occurrence, percent composition, and importance ratings for plant species found in eight rumen samples, Area I, fall 1968.

Species	Percent Composition	Percent Frequency	Importance Rating
Oregon grape (Mahonia repens)	59.0	37.5	22.1
Common juniper (Juniperus communis)	20.1	50.0	10.0
Snowberry (Symphoricarpos sp.)	35.0	25.0	8.7
Unidentified grasses	16.2	50.2	8.1
Mountain mahogany (Cercocarpus montanus)	12.1	62.5	7.6
Unidentified forbs	8.0	87.5	7.0
Rocky Mountain juniper (Juniperus scopulorum)	42.2	12.5	5.3
Kinnikinnick (Arctostaphylos uva-ursi)	3.7	87.5	3.2
Red clover (Trifolium pratense)	12.0	25.0	3.0
Bedstraw (Galium boreale)	6.2	37.5	2.3
Pussytoes (Antennaria sp.)	5.3	25.0	1.3
Unidentified browse	8.0	12.5	1.0
Rose (Rosa sp.)	7.0	12.5	0.9
Yarrow (Achillea lanulosa)	7.5	12.5	0.9
Ponderosa pine (Pinus ponderosa)	6.5	12.5	0.8
Unidentified	1.5	37.5	0.6
Cocklebur (Xanthium sp.)	5.0	12.5	0.5
Serviceberry (Amalanchier alnifolia)	4.0	12.5	0.5
Phlox (Phlox sp.)	3.0	12.5	0.3
Chokecherry (Prunus viginiana)	1.0	12.5	0.1
Currant (Ribes sp.)	0.1	12.5	0.1

Appendix D. Frequencies of occurrence, percent composition, and importance ratings for plant species found in ten rumen samples, Area II, fall 1968.

Species	Percent Composition	Percent Frequency	Importance Rating
Unidentified forbs	20.1	90.0	18.0
Oregon grape (Mahonia repens)	29.0	50.0	14.5
Kinnikinnick (Arctostaphlos uva-ursi)	22.4	60.0	13.4
Alfalfa (Medicago sativa)	37.5	30.0	11.3
Bedstraw (Galium sp.)	13.3	50.0	6.6
Unidentified grasses	8.8	60.0	5.3
Snowberry (Symphoricarpos sp.)	10.5	35.0	3.0
Unidentified	3.8	60.0	2.3
Rabbitbrush (Chrysothamnus nauseosus)	18.0	10.0	1.8
Ponderosa pine (Pinus ponderosa)	5.7	30.0	1.7
Rose (Rosa sp.)	3.4	40.0	1.4
Common juniper (Juniperus communis)	6.5	20.0	1.3
Old-man's beard (Usnea sp.)	4.5	30.0	1.3
Rocky Mountain juniper (Juniperus scopulorum)	7.0	10.0	0.7
Clover (Trifolium pratense)	5.0	10.0	0.5
Yarrow (Achillea lanulosa)	3.5	10.0	0.3

Appendix E. Frequencies of occurrence, percent composition, and importance ratings for plant species found in 11 rumen samples, Area III, fall 1966.

Species	Percent Composition	Percent Frequency	Importance Rating
Unidentified grasses	26.4	100.0	26.4
Snowberry (Symphoricarpos spp.)	45.5	45.5	20.6
Unidentified forbs	25.3	36.4	9.2
Ponderosa pine (Pinus ponderosa)	14.4	36.4	5.1
Common juniper (Juniperus communis)	14.1	27.3	3.8
Kinnikinnick (Arctostaphylos uva-ursi)	18.5	18.2	3.4
Unidentified	4.6	63.6	2.9
Old-man's beard (Usnea sp.)	14.5	18.2	2.6
Clover (Trifolium sp.)	22.0	9.1	2.0
Alfalfa (Medicago sativa)	14.0	18.2	2.5
Bedstraw (Galium sp.)	4.4	45.4	2.0
Phlox (Phlox sp.)	9.5	18.2	1.7
Ricegrass (Oryzopsis asperfolia)	15.0	9.1	1.4
Cocklebur (Xanthium sp.)	8.0	18.2	1.4
Rose (Rosa sp.)	3.2	45.4	1.4
Serviceberry (Amelanchier alnifolia)	8.0	18.2	1.4
Rabbitbrush (Chrysothamnus nauseosus)	8.0	9.1	0.7
Buffalobean (Astragalus succulentus)	8.0	9.1	0.7
Fungi	2.0	9.1	0.7
Yucca (Yucca glauca)	1.5	9.1	0.1

ppendix F. Frequencies of occurrence, percent composition, and importance ratings for plant species found in six rumen samples, Area I, fall 1969.

pecies	Percent Composition	Percent Frequency	Importance Rating
regon grape (Mahonia repens)	24.6	83.3	20.4
ungi	34.0	50.0	17.0
nidentified forbs	15.8	100.0	15.8
nowberry (Symphoricarpos spp.)	16.4	83.3	13.6
innikinnick (Actostaphylos uva-ursi)	15.4	83.3	12.8
ountain mahogany (Cercocarpus montanus)	10.0	50.0	5.0
nidentified	5.0	100.0	5.0
edstraw (Galium sp.)	6.0	50.0	3.0
nidentified grasses	8.5	33.3	2.8
ose (Rosa sp.)	4.7	50.0	2.3
ocklebur (Xanchium sp.)	4.0	16.7	0.7
hlox (Phlox sp.)	1.0	16.7	0.1

Appendix C. Frequencies of occurrence, percent composition, and importance ratings for plant species found in eight samples, Area II, fall 1969.

Species	Percent Composition	Percent Frequency	Importance Rating
Kinnikinnick (*Arctostaphylos uva-ursi*)	31.6	87.5	27.6
Unidentified forb	16.9	100.0	16.9
Oregon grape (*Mahonia repens*)	21.0	50.0	10.5
Unidentified grasses	11.7	87.5	10.2
Bedstraw (*Galium* sp.)	5.8	75.0	4.3
Clover (*Trifolium pratense*)	17.3	25.0	4.3
Snowberry (*Symphoricarpos* spp.)	11.3	37.5	4.2
Yucca (*Yucca glauca*)	2.0	12.5	2.5
Unidentified	2.6	87.5	2.3
Ponderosa pine (*Pinus ponderosa*)	4.5	50.0	2.3
Rose (*Rosa* sp.)	7.5	25.0	1.9
Alfalfa (*Medicago sativa*)	6.0	25.0	1.5
Common juniper (*Juniperus communis*)	2.1	50.0	1.0
Fungi	7.0	12.5	0.9
Cocklebur (*Xanthium* sp.)	7.0	12.5	0.9
Pussytoes (*Antennaria* sp.)	6.0	12.5	0.8
Serviceberry (*Amelanchier alnifolia*)	2.0	25.0	0.5
Aster (*Aster* sp.)	2.0	25.0	0.5

Appendix H. Frequencies of occurrence, percent composition, and importance ratings for plant species found in nine samples, Area III, fall 1969.

Species	Percent Composition	Percent Frequency	Importance Rating
Unidentified forbs	16.9	88.8	15.0
Ponderosa pine (Pinus ponderosa)	27.0	55.0	15.0
Mountain mahogany (Cercocarpus montanus)	36.3	53.3	12.0
Alfalfa (Medicago sativa)	33.3	33.3	11.0
Bedstraw (Galium sp.)	13.1	77.7	10.1
Unidentified grasses	9.6	77.7	7.4
Ricegrass (Oryzopsis asperfolia)	66.0	11.1	7.3
Kinnikinnick (Arctostaphylos uva-ursi)	26.0	22.2	5.7
Snowberry (Symphoricarpos spp.)	12.5	44.4	5.5
Clover (Trifolium pratense)	20.5	22.2	4.5
Old-man's beard (Usnea sp.)	5.5	22.2	1.2
Serviceberry (Amalanchier alnifolia)	7.0	11.1	0.7
Rose (Rosa sp.)	3.5	22.2	0.7
Common juniper (Juniperus communis)	5.0	11.1	0.5

Appendix I. Frequencies of occurrence, percent composition, and importance ratings for plant species found in 12 rumen samples, Area I, winter 1969.

Species	Percent Composition	Percent Frequency	Importance Rating
Mountain mahogany (Cercocarpus montanus)	64.3	41.7	26.0
Rocky Mountain juniper (Juniperus scopulorum)	72.5	16.7	12.1
Unidentified forbs	12.7	58.3	10.3
Oregon grape (Mahonia repens)	32.0	25.0	8.0
Phlox (Phlox sp.)	72.0	8.3	5.9
Ponderosa pine (Pinus ponderosa)	28.6	16.7	4.7
Common juniper (Juniperus communis)	24.7	16.7	4.1
Unidentified	6.0	66.0	3.9
Unidentified grasses	6.4	58.3	3.7
Chokecherry (Prunus virginiana)	30.0	8.3	2.5
Pussytoes (Antennaria sp.)	10.0	16.7	1.6
Bedstraw (Galium sp.)	3.4	41.7	1.4
Coralberry (Symphoricarpos orbiculatus)	9.0	8.3	0.7
Rose (Rosa sp.)	4.0	16.7	0.6
Ricegrass (Oryzopsis asperfolia)	5.0	8.3	0.4
Kinnikinnick (Arctostaphylos uva-ursi)	0.8	33.3	0.3
Clover (Trifolium pratense)	2.0	8.3	0.2
Twinflower (Linnaea borealis)	1.0	8.3	0.1

Appendix J. Frequencies of occurrence, percent composition, and importance ratings for plant species found in 12 rumen samples, Area II, winter 1969.

Species	Percent Composition	Percent Frequency	Importance Rating
Kinnikinnick (*Arctostaphylos uva-ursi*)	20.6	100.0	20.6
Ponderosa pine (*Pinus ponderosa*)	18.5	91.7	17.5
Common juniper (*Juniperus communis*)	29.2	58.3	17.0
Old-man's beard (*Usnea* sp.)	26.5	33.3	8.8
Unidentified forbs	15.8	50.0	7.9
Unidentified grasses	14.5	50.0	7.2
Rose (*Rosa* sp.)	12.0	50.0	6.0
Oregon grape (*Mahonia repens*)	18.5	16.6	3.1
Snowberry (*Symphoricarpos* spp.)	6.8	25.0	1.7
Unidentified	4.5	16.6	0.7
Ricegrass (*Oryzopsis asperfolia*)	8.0	8.3	0.7
Pussytoes (*Antennaria* sp.)	1.0	8.3	0.1
Twinflower (*Linnaea borealis*)	6.0	16.6	0.1
Chokecherry (*Prunus virginiana*)	1.0	8.3	tr.

Appendix K. Frequencies of occurrence, percent composition and importance ratings for plant species found in 11 rumen samples, Area III, winter 1969.

Species	Percent Composition	Percent Frequency	Importance Rating
Ponderosa pine (Pinus ponderosa)	30.1	90.9	27.3
Snowberry (Symphoricarpos spp.)	38.3	36.4	13.9
Mountain mahogany (Cercocarpus montanus)	66.8	18.2	12.1
Unidentified forbs	16.7	63.6	10.6
Unidentified grasses	12.8	72.7	9.3
Kinnikinnick (Arctostaphylos uva-ursi)	10.7	36.4	3.9
Rose (Rosa sp.)	17.0	18.0	3.0
Aster (Aster sp.)	15.5	18.2	2.8
Bedstraw (Galium boreale)	9.3	27.3	2.5
Old-man's beard (Usnea sp.)	8.3	27.3	2.3
Common juniper (Juniperus communis)	22.0	9.1	2.0
Unidentified	3.1	45.5	1.4
Yarrow (Achillea lanulosa)	8.0	9.1	0.7
Phlox (Phlox sp.)	8.0	9.1	0.7
Rocky Mountain juniper (Juniperus scopulorum)	5.0	9.1	0.4
Twinflower (Linnaea borealis)	3.0	9.1	0.3
Oregon grape (Mahonia repens)	1.0	9.1	0.1
Ckokecherry (Prunus virginiana)	1.0	9.1	0.1

Appendix L. Frequencies of occurrence, percent composition, and importance ratings for plant species found in nine rumen samples, Area I, winter 1970.

Species	Percent Composition	Percent Frequency	Importance Rating
Unidentified forbs	32.8	55.5	18.2
Ponderosa pine (Pinus ponderosa)	36.8	44.4	16.3
Snowberry (Symphoricarpos spp.)	38.0	33.3	12.6
Mountain mahogany (Cercocarpus montanus)	12.1	77.8	11.9
Unidentified grasses	12.1	77.8	9.4
Bedstraw (Galium boreale)	36.0	22.2	7.9
Common juniper (Juniperus communis)	28.0	11.1	3.1
Unidentified	3.1	77.8	2.4
Pussytoes (Antennaria sp.)	5.6	33.3	1.8
Oregon grape (Mahonia repens)	13.0	11.1	1.3
Kinnikinnick (Arctostaphylos uva-ursi)	12.0	11.1	1.3
Rose (Rosa sp.)	2.7	33.3	0.9
Rocky Mountain juniper (Juniperus scopulorum)	7.0	11.1	0.8
Phlox (Phlox sp.)	2.5	22.2	0.6
Old-man's beard (Usnea sp.)	2.0	22.2	0.4

Appendix M. Frequencies of occurrence, percent composition, and importance ratings for plant species found in nine rumen samples, Area II, winter 1970.

Species	Percent Composition	Percent Frequency	Importance Rating
Common juniper (Juniperus communis)	38.3	66.7	25.5
Kinnikinnick (Arctostaphylos uva-ursi)	20.5	66.7	13.6
Ponderosa pine (Pinus ponderosa)	9.1	88.9	8.0
Old-man's beard (Usnea sp.)	16.5	44.4	7.3
Snowberry (Symphoricarpos spp.)	21.3	33.3	7.0
Unidentified grasses	9.0	66.7	6.0
Serviceberry (Amalanchier alnifolia)	34.5	11.1	3.8
Rose (Rosa sp.)	9.5	33.3	3.1
Bedstraw (Galium boreale)	13.3	22.2	2.9
Unidentified forbs	6.3	44.4	2.8
Twinflower (Linnaea borealis)	9.0	22.2	2.0
Oregon grape (Mahonia repens)	1.3	66.7	0.9
Unidentified	1.0	33.3	0.3
Currant (Ribes sp.)	1.0	22.2	0.2

Appendix N. Frequencies of occurrence, percent composition, and importance ratings for plant species found in 11 rumen samples, Area III, winter 1970.

Species	Percent Composition	Percent Frequency	Importance Ratings
Unidentified forbs	18.4	90.9	16.7
Kinnikinnick (Arctostaphylos uva-ursi)	21.0	72.7	15.3
Unidentified grasses	16.6	81.8	13.5
Ponderosa pine (Pinus ponderosa)	21.3	54.5	11.6
Mountain mahogany (Cercocarpus montanus)	31.0	27.3	8.5
Common juniper (Juniperus communis)	80.0	9.1	7.2
Oregon grape (Mahonia repens)	64.0	9.1	5.8
Bedstraw (Galium boreale)	10.8	36.4	3.9
Rocky Mountain juniper (Juniperus scopulorum)	20.0	18.2	3.6
Phlox (Phlox sp.)	19.0	18.2	3.4
Snowberry (Symphoricarpos spp.)	9.3	27.3	2.5
Unidentified	3.8	45.4	1.7
Pussytoes (Antennaria sp.)	5.6	27.3	1.5
Yucca (Yucca glauca)	9.0	9.1	1.8
Rose (Rosa sp.)	2.0	27.3	0.5
Alfalfa (Medicago sativa)	2.0	18.2	0.4

Appendix O. Percent occurrence, percent composition and abundance rating on all plant availability transects in Area I, southern Black Hills, 1968-1970.

Species	Percent Composition	Percent Frequency	Abundance Rating
Snowberry (*Symphoricarpos* spp.)	39.7	80.0	31.8
Ponderosa pine (*Pinus ponderosa*)	28.6	70.0	20.2
Mountain mahogany (*Cercocarpus montanus*)	50.2	30.0	15.1
Oregon grape (*Mahonia repens*)	17.3	40.0	6.9
Fringed sage (*Artemisia frigida*)	10.8	60.0	6.5
Kinnikinnick (*Arctostaphylos uva-ursi*)	15.9	35.0	5.6
Rose (*Rosa* sp.)	4.3	75.0	3.2
Buffaloberry (*Sheperdia canadensis*)	3.7	30.0	1.1
Rocky Mountain juniper (*Juniperus scopulorum*)	4.4	25.0	1.1
Common juniper (*Juniperus communis*)	3.8	30.0	0.9
Serviceberry (*Amalanchier alnifolia*)	3.0	30.0	0.9
Currant (*Ribes* sp.)	4.2	20.0	0.8
Chokecherry (*Prunus virginiana*)	4.7	15.0	0.7
Nine-bark (*Physocarpus montanus*)	5.0	10.0	0.5
Aspen (*Populus tremuloides*)	2.5	10.0	0.2

Appendix P. Percent occurrence, percent composition and abundance rating on all plant availability transects in Area II, southern Black Hills, 1968-1970.

Species	Percent Composition	Percent Frequency	Abundance Rating
Snowberry (Symphoricarpos spp.)	35.5	100.0	35.5
Kinnikinnick (Arctostaphylos uva-ursi)	18.9	65.5	12.4
Rose (Rosa sp.)	8.8	82.8	7.3
Ponderosa pine (Pinus ponderosa)	14.6	44.8	6.6
Oregon grape (Mahonia repens)	11.1	27.5	3.0
Fringed sage (Artemisia frigida)	11.4	24.1	2.7
Serviceberry (Amalanchier alnifolia)	4.9	41.3	2.0
Currant (Ribes sp.)	3.3	37.9	1.2
Common juniper (Juniperus communis)	2.9	37.9	1.0
Chokecherry (Prunus virginiana)	2.8	37.9	1.0
Buffaloberry (Sheperdia canadensis)	3.9	24.1	0.9
Aspen (Populus tremuloides)	4.8	17.2	0.8
Nine-bark (Physocarpus montanus)	5.5	13.8	0.7
Mountain mahogany (Cercocarpus montanus)	3.0	3.4	tr.

Appendix Q. Percent occurrence, percent composition, and abundance rating on all plant availability transects in Area III, southern Black Hills, 1968-1970.

Species	Percent Composition	Percent Frequency	Abundance Rating
Snowberry (Symphoricarpos spp.)	39.0	80.6	31.4
Ponderosa pine (Pinus ponderosa)	25.1	87.0	21.8
Fringed sage (Artemisia frigida)	24.9	74.1	18.4
Rose (Rosa sp.)	10.0	64.5	6.4
Serviceberry (Amalanchier alnifolia)	11.0	32.2	3.5
Currant (Ribes sp.)	3.4	32.2	1.1
Common juniper (Juniperus communis)	3.4	25.8	0.8
Kinnikinnick (Arctostaphylos uva-ursi)	5.4	16.1	0.8
Skunkbrush sumac (Rhus trilobata)	3.8	12.9	0.5
Nine-bark (Physocarpus montanus)	2.5	6.4	0.5
Chokecherry (Prunus virginiana)	1.4	16.1	0.2
Mountain mahogany (Cercocarpus montanus)	1.1	6.4	0.1