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Introduction

The white-tailed deer *(Odocoileus virginianus)* and mule deer *(O. hemionus)* are native to the Black Hills of South Dakota. They were reported by a scientific expedition to the Black Hills under Lt. Col. Richard Irving Dodge in 1875 (South Dakota Department of Game, Fish and Parks 1959).

Deer are important game animals in South Dakota. Annual harvests have ranged from a low of 4,315 in 1958 to a high of 42,663 in 1953. The deer population has widely fluctuated and reached a high in 1953 when severe over-utilization of browse resulted. Following a cutback of the population during the 1953-58 hunting seasons, deer numbers again increased. In 1966 some workers felt that browse plants were again in danger of overuse. It appeared from observation that there were not enough good deer foods to adequately winter the increasing population (unpublished records of the South Dakota Department of Game, Fish and Parks).

One important aspect of managing a game species is to be familiar with its food source. This is particularly true with deer since they are dependent upon limited areas in the winter and can easily over-utilize food on those areas and decrease the carrying capacity. The last reported food habits study in the Black Hills was completed by Hill (1946). Since current information on food habits was essential for proper management of the deer resource, a project was initiated in 1966.

This study was conducted in two parts for Master of Science theses by the senior authors of Parts I and II. The study in the Northern Black Hills (Part I) was completed in 1968. Principal and preferred foods

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were determined for the winter and summer and a pasture study was conducted to measure production and utilization of foods in a typical aspen stand during the summer months. The study in the Southern Black Hills (Part II) was made in 1968 and 1969. Objectives were to determine the principal plants used by mule and white-tailed deer in fall, winter and summer. The utility of the point-analysis technique for measuring rumen contents was evaluated and the technique was applied to rumen contents examined. The studies were supported by the South Dakota Department of Game, Fish and Parks under Federal Aid Project W-75-R through the South Dakota Cooperative Wildlife Research Unit (South Dakota State University, the Bureau of Sport Fisheries and Wildlife, the South Dakota Department of Game, Fish and Parks and the Wildlife Management Institute, cooperating). Special acknowledgement is extended to the personnel of the Wildlife Habitat Project, Rocky Mountain Forest and Range Experiment Station, Rapid City, for their assistance in both studies. Dr. Donald Dietz, Project Leader, and Harold E. Messner, Range Technician, were particularly helpful in the development of techniques for analysis of rumen content and the equipment used for the point-analysis method described in Part II. The assistance of William Hepworth, Director of Technical Research, Wyoming Game and Fish Department, in securing the two deer used in the pasture study described in Part I is gratefully acknowledged.

We acknowledge the advice and editorial assistance received from Robert B. Dahlgren, assistant leader, South Dakota Cooperative Wildlife Research Unit. Paul F. Springer was the former leader of the Unit under whose direction the project was begun. Thanks are also extended to Donald R. Progulske, former head, Department of Wildlife and Fisheries Sciences, for help throughout the study and W. Lee Tucker, Experiment Station Statistician, South Dakota State University, for statistical advice.

Part I. Northern Black Hills

James C. Schneeweis, Kieth E. Severson and Lyle E. Petersen

Description of Study Area

The study area, approximately 1,200 square miles, was located in the northern portion of the Black Hills National Forest, Lawrence County, South Dakota. Average January and July temperatures for the area were 24.3 F. and 69.3 F. Average annual precipitation varied from 17 to 24 inches (U. S. Department of Interior 1962).

The area was characterized by hilly to mountainous terrain with broad valleys, grassy meadows, and deep rugged canyons and gulches. Altitudes ranged from approximately 4,000 to 7,000 feet. Soils of the area were shallow or eroded badland types which were the result of local geology and physiography. Dominant vegetation type was ponderosa pine[1] interspersed with stands of aspen (Fig. 1). Large stands of white spruce were at higher elevations, especially on north facing slopes. Creek bottoms contained a mixture of deciduous trees. Farming was common in the foothills with corn, wheat, alfalfa, oats and dairy products the most important commodities.

Figure 1. The dominant vegetative type in the northern Black Hills is ponderosa pine interspersed with stands of quaking aspen. (Cooperative Wildlife Research Unit photo by James C. Schneeweis.)

Methods

Rumen Content

Fall stomach samples were collected from hunter-killed deer during November of 1966 and 1967. Winter samples were collected during January, February, and March of 1967 and 1968, and nine deer were collected in aspen stands during August 1967.

An attempt was made to collect an equal number of deer each month from typical areas. Age, sex, animal condition, and a general description of the area including vegetation and snow depth were recorded for all samples.

Winter kill sites were located the following summer to estimate vegetation availability at the time of collection using a 500-foot transect in each of four cardinal directions starting at the approximate location of kill. Plant species closest to the investigator's toe and above the known snow depth at the time of collection were recorded every four steps. Fifty plants were recorded per transect giving a total of 200 plants for each kill site. An abundance rating was obtained by determining the average number of times each species occurred on the transects.

A fall preference index was calculated by multiplying the percent average weight in rumen samples by the percent frequency of occurrence of each species in the rumen (May 1962). These values were then multiplied by 100 to obtain whole numbers. It was not feasible to relate rumen contents to forage available because the location of the hunter-kill could not be precisely determined. A modification of the method described by Bellrose and Anderson (1943) was used to obtain a winter plant preference rating by dividing average percent weight of each species in rumen samples by average percent abundance of each species on winter-availability transects.

One quart of the rumen contents from each deer was washed through two sieve screens—3.36 mm and 2.0 mm mesh sizes. Material retained on the larger screen was separated by species, while particles on the smaller screen were examined for trace items but were not sorted. Separated material was oven-dried for 48 hours and percent weight for each species was calculated.

Laboratory analysis of summer rumen contents consisted of washing material over a sieve screen with a mesh size of 2.0 mm and placing the washed material on an enamel pan. A species list was made and each species was ranked according to its estimated abundance. Abundance values ranged from one for trace items to five for species considered very abundant. Average abundance values for each species were determined by dividing the sum of abundance values for a species by the total number of stomachs examined. Importance of each species was obtained by multiplying the abundance value of a species by average percent coverage for that species obtained from quaking aspen transects.

[1]Common and scientific names after Beetle (1970) are shown in Appendix Table 1. Oregon grape (creeping barberry) and vetchling (cream peavine) are used throughout the bulletin since they are the names commonly used in the Black Hills.

Species Composition of Quaking Aspen Stands

Ten 500-foot transects were used to estimate composition and coverage of understory vegetation in four quaking aspen stands in June 1967. A one-square-foot frame was placed at the tip of the investigator's toe on every fourth step. Fifty plots were sampled on each transect. All plant species that were either inside or extending over the plot to a height of 5 feet were recorded. Canopy coverage for each species was estimated with grasses and forbs treated as groups. Data from all transects were averaged. Standard deviations of means for the 13 highest-coverage species were determined. The chi-square test was used to determine if significant differences existed in understories of the four stands.

The transect site most closely matching the average of the transect from all stands was chosen as most representative of the stands studied. A 29,250-square-foot deer enclosure was erected on that site in July 1967. The enclosure was divided into an 18,900-square-foot utilization section and a 10,350-square-foot control section.

Pasture Study

A seven-year-old white-tailed buck and a two-year-old white-tailed doe were obtained from the Wyoming Game and Fish Department in mid-July 1967. They were kept in a holding pen for one week and fed vegetation cut from aspen understories to familiarize them with types of food found in the aspen pasture. The deer were then placed in the utilization section of the pasture for 18 days to estimate plant utilization and preference.

Total forage production on the control section was estimated by clipping annual growth of all species to a height of 5 feet in 22 9.6-square-foot plots. Clipping was done in late August when vegetation was considered to be at peak production. Total green weight for plots by strata (0-2 and 2-5 feet) was obtained immediately after clipping. Material was then dried in paper sacks for two weeks and air-dried weights by species and strata were determined.

Forty 9.6-square-foot plots were established in the utilization section after deer were removed from the pasture. All plots were at least 10 feet from the fence to avoid heavily trampled areas. Utilization by species by strata (0-2 and 2-5 feet) was estimated for each plot. An importance rating was determined for plants within the pasture by multiplying average utilization of a species by average weight in grams for that species in control plots. The product represented the average weight for each species consumed by the deer and is indicative of importance because it considers both palatability and availability. Weights were totaled and the percent each species made up of total production was then divided into percent consumed to obtain a preference rating based on weight consumed divided by weight produced for each species. This rating represents the animal's preference if all species were equally abundant.

Results and Discussion

Fall Food Habits

Rumen content samples were collected from nine bucks, six does, and three deer of unknown sex taken by hunters in November 1966. There was no snow on the ground during the collection period. In 1967, ingesta samples were collected from the rumens of seven bucks, eight does, and nine of undetermined sex during the hunting season. Snow depth for the collection period in 1967 averaged 3 inches.

Forty-nine species of plants were found in the rumen samples during the 2 years (Table 1). Oregon grape (creeping barberry) was the most important species in the fall and was more than twice as important as any other plant species (Fig. 2). The second most important species was bearberry manzanita (kinnikinnick) in 1966 and common juniper in 1967. Availability of bearberry manzanita, a prostrate shrub, was drastically reduced in 1967 by snow cover of only 3 inches (Fig. 3). During the 1966 collection period, no snow was present and bearberry manzanita was readily available as food. Availability of common juniper, a bushy shrub 2 or more feet in height, was not affected by light snow cover (Fig. 4). Results indicate that with bearberry manzanita less available, much more common juniper was eaten. In fall of 1966, with no snow, common juniper received an importance rating of only 0.1. Bearberry manzanita was the third most important species in 1967 even with 3 inches of snow on the

Figure 2. Oregon grape (creeping barberry), a low-growing evergreen shrub, is very palatable to deer in fall and winter. (U. S. Forest Service photo by Roger R. Kerbs.)

Figure 3. Bearberry manzanita (kinnikinnick), a prostrate evergreen shrub, is very palatable to deer but is generally unavailable when snow depth exceeds 10 inches. (U. S. Forest Service photo by Kieth Severson.)

Figure 4. Common juniper, a bushy shrub 2 or more feet high, becomes an important deer food as snow depth increases. (Cooperative Wildlife Research Unit photo by Raymond L. Linder.)

ground. Signs left by deer pawing to browse bearberry manzanita commonly were observed when snow depths were less than 10 inches.

Several cultivated species were present in fall samples. Wheat, corn and oats infrequently occurred but alfalfa was present in 55.6 percent of the 1966 samples and 20.8 percent of the 1967 samples. Apparently, some deer in forest areas adjacent to farmlands show a marked preference for crops such as alfalfa. Although numerous species of forbs were found in fall samples, they were not considered important as a group for either fall period.

Winter Food Habits

Samples were taken from the rumens of 11 bucks and 11 does collected during January, February and March of 1967. Average snow depth at collection sites was approximately 15 inches. Ten samples were collected from seven bucks and three does during February and March 1968. Average snow depth at collection sites was slightly more than 1 inch.

Forty-one species or groups of plants were found in the samples during the two years. Most important winter food in 1967 was common juniper (Table 2) and its importance rating was the highest for any plant during both winters. The use of juniper was probably due to its relative availability in deep snow. Oregon grape was still the second most important species even though availability of common juniper was approximately 2.5 times greater than Oregon grape because of snow. However, preference rating of Oregon grape was more than twice that of common juniper. It should be pointed out that although average snow cover was 15 inches, several sites were without snow when deer were collected. It was on these open sites that almost all of

Table 1. Results of analysis of 18 rumen samples taken in November, 1966, and 24 in November, 1967, from white-tailed deer in the northern Black Hills.

Species	Percent Frequency		Percent Weight		Importance Rating	
	1966	1967	1966	1967	1966	1967
Oregon grape	83.5	83.3	27.1	25.3	22.6	21.0
Common juniper	11.1	62.5	0.7	14.5	0.1	9.1
Bearberry manzanita	83.5	75.0	11.9	6.1	9.9	4.6
Alfalfa	55.6	20.8	1.0	11.6	0.6	2.4
Western snowberry	55.6	45.8	3.8	1.5	2.1	0.7
Grasses	89.0	41.6	5.8	1.6	0.5	0.6
Unidentified forbs	72.3	25.0	1.9	2.3	1.4	0.6
Ponderosa pine	61.2	54.2	4.2	1.0	2.6	0.5
Red clover	55.6	20.8	1.3	2.4	0.7	0.5
Snowbrush ceanothus	27.8	12.5	6.5	2.3	1.8	0.3
Vetchling	22.2	45.8	Tr	0.6	Tr	0.3
Bur oak	61.2	16.7	3.4	1.5	2.1	0.2
Corn	5.6	8.3	1.6	8.3	0.1	0.2
Lichen	22.2	41.6	1.3	0.5	0.3	0.2
Aspen	55.6	41.6	4.9	0.4	2.7	0.2

Table 2. Principal foods in rumen samples of 22 deer collected in January, February and March, 1967, and from 10 deer taken in February and March, 1968 in the northern Black Hills.

Species	Percent Frequency		Percent Weight		Preference Ratio		Importance Rating		Average Percent Availability	
	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968
Common juniper	73.9	90	26.8	8.7	0.8	0.5	922.1	154.4	32.2	17.9
Oregon grape	91.3	100	24.0	40.4	1.8	2.5	319.9	647.9	13.3	16.1
Oats	13.0	10	8.5	7.0	----	----	-------	-------	------	------
Bearberry manzanita	60.9	70	5.3	7.2	4.4	1.0	6.3	53.1	1.2	7.4
Ponderosa pine	87.0	90	4.6	9.8	0.3	2.6	84.5	37.4	18.3	3.8
Lichen	60.9	40	4.0	Tr	----	----	-------	-------	------	------
Bur oak	47.8	10	3.7	0.5	0.6	0.5	22.8	0.5	6.2	1.0
Snowbrush ceanothus	8.7	10	2.5	Tr	4.4	----	1.4	-------	0.6	------
Pine bark	21.7	------	1.5	------	----	----	-------	-------	------	------
Saskatoon serviceberry	43.5	30	1.2	3.6	0.2	2.4	9.2	5.5	7.4	1.5
Grasses	60.9	100	1.0	2.8	0.1	0.2	16.2	50.7	15.6	18.1
Aspen	47.8	20	0.6	Tr	0.2	----	3.1	-------	3.5	------
Sedge	8.7	------	0.5	------	----	----	-------	-------	------	------
Red clover	17.4	10	0.5	Tr	0.8	----	0.3	-------	0.6	------
Alfalfa	8.7	------	0.5	------	0.1	----	1.7	-------	3.5	------
Common chokecherry	17.4	------	0.4	------	0.0	----	4.9	-------	11.3	------

the available Oregon grape was found. During the winter of 1968, with a snow cover of only 1-2 inches, Oregon grape was the most important species based on both average weight and importance rating.

Bearberry manzanita was eaten in moderate amounts during both winters. Habeck (1959), in a study of central Wisconsin deer range, found that ground layer plants, such as bearberry manzanita, were important winter deer foods in areas where snow accumulation was not heavy. Although very little bearberry manzanita was available in 1967, it made up 5.3 percent of the average rumen sample by weight. In 1968, with much more bearberry manzanita available because of less snow, it accounted for 7.2 percent of the weight of the samples. Hill (1946) found that bearberry manzanita was the most important winter food for white-tailed deer in the northern Black Hills. A preference rating of 4.4 for bearberrry manzanita in 1967 was the highest recorded for any species during the two winters. However, preference rating for bearberry manzanita in 1968 was only 1.0.

Pine needles were eaten in fairly large amounts during both winters. About twice as much pine was found in 1968 winter samples as in 1967 even though snow depth at collection sites was much less in 1968. One winter sample in 1968 contained 92.0 percent pine needles and

thus the indicated importance of pine may be misleading. Deer use of pine needles from recently cut trees, such as a logging operation, is common and these needles are apparently very palatable. Utilization of needles from nearby uncut trees may be low even though they may be readily available. Hill (1946) found that pine received very little utilization during winter months even though it was readily available.

Bur oak by weight made up 3.7 percent of 1967 samples; however, 1968 winter samples contained less than 1.0 percent. The preference ratings for both winters were low. Apparently deer ate more bur oak during periods of heavy snow cover because availability of more preferred vegetation was reduced. Snowbrush ceanothus was the second most highly preferred food for both winter periods. However, in was available in only small amounts and therefore was not important.

Lichens occurred throughout the study area on pine and spruce trees and were found in fall and winter samples both years. It appeared that more lichens were eaten as the snow depth increased.

Winter rumen contents sampled in 1968 contained more than twice as much grass by weight as 1967 samples. However, availability of grass on winter collection sites in 1968 was only slightly more than for 1967 sites.

Forbs were present in larger quantities in 1968 winter samples than in 1967 samples. However, forbs as a group were not considered important for either winter.

Species Composition of Quaking Aspen Stands

Scattered stands of aspen occur throughout the northern Black Hills. These appear to be the result of past fires and are a successional stage which will be replaced by the climax coniferous type, ponderosa pine (Baker 1918). Peattie (1953) stated that the chief factor in success of aspen in the western United States is fire. Daubenmire (1953) found aspen on 7 of 13 habitat types in northern Idaho and eastern Washington and in each case it occupied a seral position.

By observation, it would appear that aspen stands receive heavy use by deer during summer months. One reason for heavy use undoubtedly is dense growth and wide variety of plant species found in aspen understories. An example of a typical aspen understory can be seen in Figure 5. By contrast, Figure 6 shows an aspen understory in winter.

Thirty-two species or groups of plants occurred in ten 500-foot transects located in four aspen stands (Table 3). The frequency and percent cover for each species is listed in Appendix Table 2. Chi-square tests showed understories significantly different ($P<0.01$). Differences were especially noticeable for grasses in which cover ranged from 4.6 percent in stand number 2 to 25.4 percent in stand number 3. Cover differences might be the result of differences in cattle use among stands. It appeared that as cattle use increased some grasses also increased while many forbs decreased.

Figure. 5. A typical quaking aspen understory in the summer contains a wide variety of shrubs and forbs. (Cooperative Wildlife Research Unit photo by James C. Schneeweis.)

Figure 6. Food is available in a quaking aspen stand in the winter except when heavy snows occur. (Cooperative Wildlife Research Unit photo by James C. Schneeweis.)

Overstory composition and density among aspen stands were also found to be variable. The most important species associated with aspen in terms of basal area was paper birch. On one transect, birch was actually the dominant species. Ponderosa pine was present in all stands and occurred in 9 of 10 transect overstories. The other three overstory species present were bur oak, Saskatoon serviceberry, and white spruce.

Table 3. Average percent frequency and percent coverage of understory vegetation for 10 quaking aspen transects, northern Black Hills, June, 1967.

Species	Percent Frequency	Percent Coverage
Vetchling	64.1	12.9
Grasses	71.1	12.8
Unidentified forbs	72.5	12.0
Beaked filbert	24.1	10.3
Oregon grape	51.8	9.7
Aster	47.0	9.5
Saskatoon serviceberry	37.0	8.9
Western snowberry	60.0	8.5
Western bracken	24.7	7.1
Canada scurvyberry	55.5	5.6
Veiny meadowrue	31.4	4.4
Red clover	11.3	2.4
Wood's rose	20.3	2.2
American vetch	17.0	2.2
Dwarfed blackberry	14.1	1.9
Pyrola	16.8	1.8
Bearberry manzanita	4.7	1.6
Wildbergamot beebalm	12.8	1.5
Wild strawberry	16.6	1.4
Silvery lupine	11.0	1.1
Common dandelion	10.5	1.1
Common chokecherry	9.8	1.1
Violet	14.3	trace
Wartberry fairybells	6.9	trace
Aspen	5.5	trace
Western yarrow	5.5	trace
Black sanicle	3.2	trace
Bur oak	2.2	trace
Princespine pipsissewa	1.9	trace
Pussytoes	1.0	trace
Paper birch	0.9	trace
Sedge	0.8	trace

Pasture Study

Two white-tailed deer were placed in the utilization section of the pasture on July 21, 1967, and were removed on August 8, 1967 (Fig. 7). Thirty-seven species of plants occurred in the sample plots. Most important food species were vetchling (cream peavine), Saskatoon serviceberry, bur oak, and American vetch. Highest utilization in the upper stratum (2-5 feet) was 79.6 percent for vetchling while lowest was 13.5 for beaked filbert (Table 4). In general, it appeared that deer preferred the lower vegetation. The most highly preferred food species was vetchling. Saskatoon serviceberry and bur oak were also highly preferred. No utilization was detected on 12 species within the pastures. Quaking aspen sprouts and common everlasting were heavily utilized but were present in only small amounts and therefore were not considered important. Oregon grape was present in moderate amounts but received only trace utilization. The most abundant plants as a group were grasses. However, less than 1.0 percent of available grass was eaten. In general, shrubs were slightly more important as a group than forbs, even though the most important single species was vetchling.

The weight utilization method provided an opportunity to estimate total forage production for a representative aspen site in the northern Black Hills. This was done by clipping annual growth of all species up to 5 feet in height in the control

Table 4. Average utilization and importance of plant species eaten by two white-tailed deer in a representative quaking aspen pasture, northern Black Hills, summer 1967.

Species	Average Percent Utilization 100	Importance Rating	Preference Rating
2-5 Ft. in Height			
Bur oak	0.695	1.5	5.1
Saskatoon serviceberry	0.569	0.9	5.5
Vetchling	0.796	0.3	6.5
Beaked filbert	0.135	0.2	0.9
Common chokecherry	0.150	---	---
0-2 Ft. in Height			
Vetchling	0.270	3.3	2.0
Saskatoon serviceberry	0.365	2.0	2.7
American vetch	0.335	1.0	2.7
Shinyleaf spiraea	0.113	0.6	0.8
Beaked filbert	0.050	0.5	0.4
Silvery lupine	0.200	0.4	1.5
Bur oak	0.249	0.3	1.7
Western snowberry	0.072	0.2	0.6
Veiny meadowrue	0.055	0.2	0.6
Common chokecherry	0.193	1.2	15.5
Grasses	0.007	0.1	0.1
Western bracken	0.013	0.1	0.1
Wood's rose	0.092	0.1	1.0
Aster	0.012	---	---
Spreading dogbane	0.038	---	---
Wildsarsaparilla araia	0.018	---	---
Wildbergamot beebalm	0.004	---	---
Aspen	0.769	---	---
Common everlasting	0.343	---	---
Oregon grape	0.006	---	---
Canada scurvyberry	0.008	---	---
Black sanicle	0.004	---	---

section. Total green weight for all species was 2,650 pounds per acre. Air-dried weight of the same material was 865.1 pounds per acre. Production ranged from 130.6 pounds per acre for grasses (Table 5) to a trace for others such as common dandelion and common yampa. Vetchling produced the most forage of any single species, 124.5 pounds per acre.

Summer Food Habits

Thirty-seven species or groups of plants were identified in the rumen contents of five bucks and four does collected on aspen areas adjacent to the pasture site. Importance ratings for all species or groups found in summer rumens are listed in Table 6. Results of rumen analysis did not completely agree with those of the pasture utilization study. Such rela-

tionships are not unusual and have been discussed in studies by Norris (1943) and Severson et al. (1968). Several species, including vetchling and Saskatoon serviceberry, were important in both cases along with shinyleaf spiraea which was moderately important in the pasture study. Bur oak, considered important in the pasture study, was not important in the summer study of rumen contents because of low availability. For aspen stands in general, bur oak comprised less than 1.0 percent of total coverage. However, deer showed a high preference for that species when it was present in the understory as demonstrated in the pasture study. Mushrooms were very abundant in stomachs but did not occur in either pasture or aspen transects. It appeared that a very high preference was shown for this food item. American vetch was relatively more important in the pasture study than in stomach samples. Although deer were collected in aspen stands, they probably did not do all of their feeding there. This could seriously bias the importance ratings because availability data were from aspen sites only.

Figure 7. White-tailed deer in the pasture used to measure forage production and utilization and importance of plant species eaten by deer in a quaking aspen stand. (Cooperative Wildlife Research Unit photo by James C. Schneeweis.)

Table 5. Total air-dried forage production, by strata and species, in a northern Black Hills quaking aspen stand, August, 1967.

Species	Pounds per Acre (Air-dried)
2-5 Ft. in Height	
Bur oak	22.0
Saskatoon serviceberry	15.3
Vetchling	3.5
Beaked filbert	16.6
Common chokecherry	trace
0-2 Ft. in Height	
Vetchling	121.0
Saskatoon serviceberry	56.0
American vetch	28.5
Shinyleaf spiraea	58.5
Beaked filbert	91.7
Silvery lupine	20.7
Bur oak	13.0
Western snowberry	29.0
Veiney meadowrue	27.8
Common chokecherry	6.0
Grasses	130.6
Western bracken	63.0
Wood's rose	7.7
Aster	36.4
Spreading dogbane	3.0
Wildsarsaparilla aralia	6.0
Wildbergamot beebalm	27.3
Red clover	30.3
Oregon grape	38.0
Black sanicle	3.0
Northern bedstraw	2.0
Pyrola	4.0
Wartberry fairybells	3.0
Others	8.2
Total	865.1

Table 6. Importance ratings of plant species found in rumens of nine white-tailed deer collected in quaking aspen stands in the northern Black Hills, August, 1967.

Species	Importance Rating
Vetchling	34.4
Saskatoon serviceberry	21.7
Shinyleaf spiraea	11.6
Western snowberry	6.6
Beaked filbert	5.8
Grasses	5.6
False solomonseal	3.1
Wood's rose	2.7
Veiny meadowrue	2.5
Red clover	1.3
American vetch	1.0
Silvery lupine	0.9
Bur oak	trace
Aspen	trace
Black sanicle	trace
Wartberry fairybells	trace
Ponderosa pine	trace
Paper birch	trace
Dwarfed blackberry	trace
Aster	-----
Mushroom	-----
Wildsarsaparilla aralia	-----
Wild strawberry	trace
Darkthroat shootingstar	-----
Sawsepal penstemon	-----
Canada scurvyberry	-----
Northern bedstraw	-----
Lichen	-----
Wood lily	-----
Black medic	-----
Violet	trace
Common everlasting	-----
Colorado blueyedgrass	-----
Common chokecherry	trace
Heartleaved alexanders	-----

Summary and Conclusions

The most important food item of white-tailed deer in the northern Black Hills during fall and winter was Oregon grape. This species was abundant, evenly distributed and highly preferred, making it suitable as a key indicator plant for range condition and trend surveys. However, because of its low growth form, the availability of Oregon grape decreased with increasing snow cover. During periods of heavy snow cover, common juniper replaced Oregon grape as the most important species. Bearberry manzanita was highly preferred and was also important during periods of little or no snow cover. Ponderosa pine, lichens and bur oak were eaten in moderate amounts but were of secondary importance as winter food items.

From observations, aspen stands appeared to be heavily used by deer during summer months. A pasture food habits study on a representative aspen site indicated most important foods were vetchling, Saskatoon serviceberry, bur oak, and American vetch. Rumen content analysis from deer collected in aspen stands showed vetchling, Saskatoon serviceberry and shinyleaf spiraea to be important food items.

Total forage production from 0-5 feet in height for a representative aspen site in the northern Black Hills was 2,650 pounds per acre green weight or 865.1 pounds per acre air-dried weight.

Part II. Southern Black Hills

Theron E. Schenck III, Raymond L. Linder, and Arthur H. Richardson

Description of Study Area

The study area in western Custer and southwestern Pennington counties was approximately 525 square miles. Average January and July temperatures at Custer are 26 F and 77 F (U. S. Department 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 (Fig 8). It is deeply cut by stream drainages in the northern portion. The southern and western portion 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 badland types (U. S. Department of Agriculture and U. S. Department of the 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 (Fig. 9). Area I was located in the northwest corner of Custer County. Boundaries were U. S. Highway 16 and the Wyoming-South Dakota state line on the west, Summit Ridge (Forest Service 265) to Wildcat Draw on the north, and a line from Wildcat Draw to Tepee Work Center on the east. Dominant vegetation types were mountain mahogany (True mountain mahogany) and juniper interspersed with extensive stands of ponderosa pine. Bottomlands contained mixed species of plants.

The boundaries of Area II were the Custer Limestone Road (Forest Service 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. The dominant vegetation type was ponderosa pine with a few stands of aspen.

Area III boundaries were the Wyoming-South Dakota state line, a line from Loring Siding to milepost 39 on the south, U. S. Highway 16 on the north, and highways 385 and 89 on the east. This area included limestone hills, broad open valleys and mid- to short-grass prairies. Dominant vegetation included true mountain mahogany, juniper, ponderosa pine, grasses and various forbs.

Although cultivated crops were not common, there were fields of alfalfa and small grains. Major land use of the area was grazing and timber production. Nearly all the public land in the area is administered by the United States Forest Service.

Figure 8. Rolling uplands of limestone plateau predominate in the southern Black Hills study area. (Department of Game, Fish, and Parks photo by Arthur H. Richardson.)

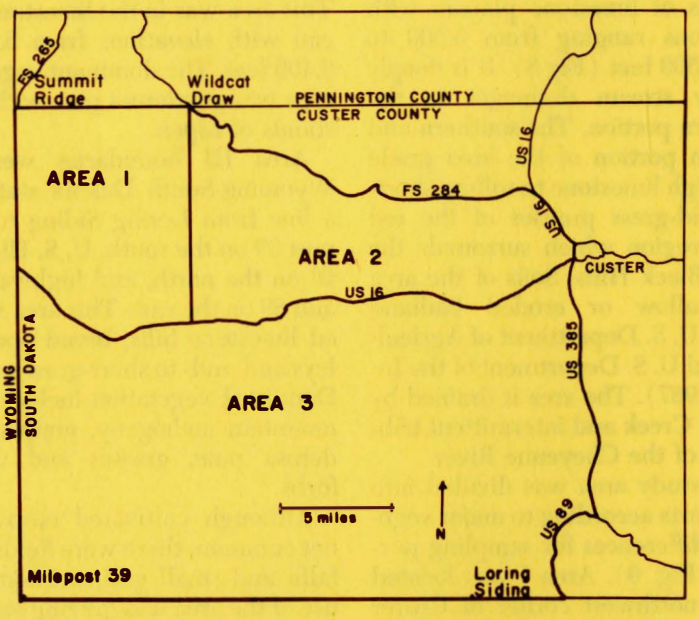

Figure 9. The study area in the southern Black Hills was divided into three parts according to vegetative cover for collecting deer.

Methods

Rumen Analysis

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 and three from each area during the summer of 1969. Approximately one quart of rumen material was taken from each deer, and plant availability at the kill site was determined. 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. Abundance ratings were calculated by multiplying the average percent composition of the plant on each transect by the average percent occurrence on all transects. Average percent composition was calculated by dividing the number of times the plant occurred on the transect by the total number of plants recorded.

Importance ratings of plants as deer food were calculated by multiplying the average percent occurrence of plant species in the rumen by average percent occurrence of plant species in all samples and multiplying 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 available at a kill site and the amount eaten by deer. Abundance ratings and importance ratings were also plotted on a graph to determine if the material occurred in the sample in the same ratio as it occurred in the field. Species plotted above the regression line occurred in larger amounts in the rumen than in the field samples.

Rumen samples were washed through a 3.36 mm screen. Material from all samples which remained on the screen was identified by the point analysis technique. Twenty samples were also hand-separated to species.

Point-Analysis Technique

Material retained on the 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 eyepiece was mounted on an adjustable base (B and L Model SK). The entire system was mounted on a 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. 10).

The rinsed rumen sample was placed on the pan, distributed over its bottom and pressed down. 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, 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 10 points was recorded. This process continued until 100 points had been recorded. The sample was then thoroughly mixed and redistributed, and vegetation at another series of 100 points was identified. The average of the two 100-point trials was used for analysis. It was assumed that distribution of plant material was random.

The feasibility of the point technique for Black Hills vegetation was evaluated by constructing three artificial populations from known weights of western yarrow, wood's rose, ricegrass, bearberry manzanita and ponderosa pine. Each population was placed in a blender, ground for 30 seconds, 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 was 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. 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.

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 were compared to the hand-separation data by paired-"t" test.

Seasons of the year were classified: fall (October, November, and December); winter (January, February, March, and April); and summer (July, August, and September).

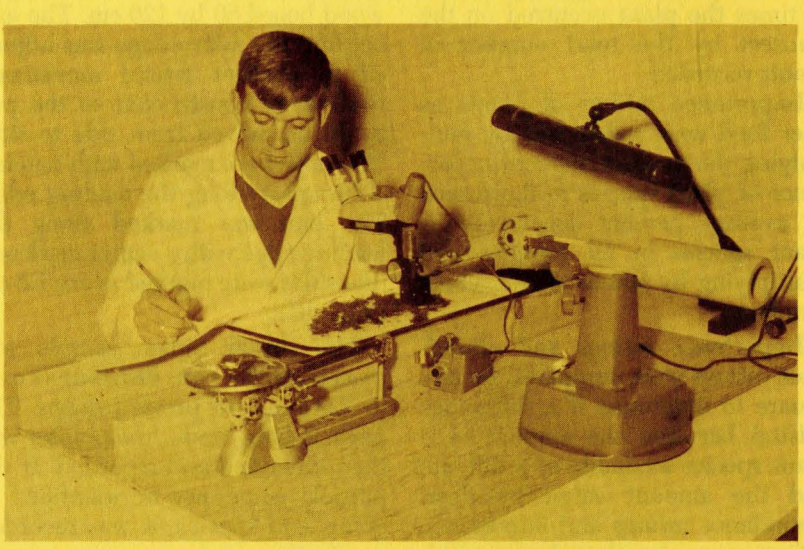

Figure 10. Rumen samples from deer collected in the southern Black Hills were analyzed by the point-analysis technique. (Cooperative Wildlife Research Unit photo by Theron E. Schenck, III).

Results and Discussion

Evaluation of Point Technique

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 7). Results of the artificial population study also indicated that the three classes of plants could be accurately estimated. Paired-"t" tests showed no significant differences ($P<0.05$) between estimates made by the 100 and 200 point trials.

Work by Chamrad and Box (1964) indicated that the point technique was a fast, unbiased method of analyzing rumen contents provided the sample was adequately mixed and 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 in cattle. They found that the microscopic point method gave a satisfactory estimate of species composition on a percent dry-weight basis.

In a study of rumen analysis techniques of the pronghorn *(Antilocapra americana)*, Dirschl (1962) 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.

Table 7. A comparison 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
Shrubs	58.3	51.3
Wood's rose	10.7	10.2
Bearberry manzanita	29.3	24.8
Ponderosa pine	18.3	16.3

*Significant difference ($P<0.05$)

Possible sources of error using the point-technique have been cited by Chamrad and Box (1964) and Robel and Watt (1970). The error in artificial population estimates of forbs was probably due to lack of uniformity in size of particles. 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 number of particles. Since the point technique measures surface area, the increased area of forbs would have been over-estimated.

Comparison of Hand Separation and Point Analysis

Paired-"t" tests showed there was no significant difference between the estimated percent weight of plant composition by hand separation and by point analysis (Table 8). There were also no differences ($P<0.05$) between weight estimates of vegetation classes by point analysis and hand separation. It was also found that 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 8); 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, whereas 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 3.36mm 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. Oregon grape, grasses and forbs had the highest importance ratings of the 27 species or groups of plants in the samples (Table 9). Western snowberry was also important and made up a large part of the diet of the deer early in the fall. Samples contained large pieces of western snowberry stems, leaves, and mature fruits. Alfalfa also had a relatively constant importance rating.

Twenty-one species or groups of plants were identified in rumen samples taken from 23 deer in the fall of 1969. Bearberry manzanita, forbs, Oregon grape, grasses, and mountain mahogany were the most important fall food species in 1969 (Table 9).

Oregon grape, bearberry manzanita, grasses, and forbs were the most important fall foods for both sampling periods. Western snowberry, mountain mahogany, and alfalfa were other important fall foods. For deer in the northern Black Hills, Hill (1946) found that Oregon grape and bearberry man-

Table 8. Percent weight and percent occurrence of major plant species and classes of vegetation in 20 rumen samples as determined by hand separation and point-analysis.

Vegetation	Percent Weight		Percent Occurrence	
	Hand Separation	Point-Analysis	Hand Separation	Point-Analysis
Forbs	11.9	17.9	---	---
Shrubs	69.1	58.7	---	---
Unidentified	9.6	13.1	---	---
Mountain mahogany	15.2	13.7	60	65
Ponderosa pine	12.3	13.9	65	65
Common juniper	9.6	12.8	50	55
Grasses	9.4	10.3	55	55
Bearberry manzanita	7.4	9.6	40	45
Western snowberry	5.2	7.3	35	40
Wood's rose	5.1	5.7	30	35
Oregon grape	3.9	5.5	20	25
Northern bedstraw	2.5	4.7	20	25
Lichen	4.7	3.8	15	20
Others	25.9	12.7	---	---

zanita were important fall foods and Schneeweis et al. (1972) found that Oregon grape and common juniper were important fall foods.

Bearberry manzanita, Oregon grape, common juniper and mountain mahogany were found in greater amounts in the rumen than in the field (Table 10 and Fig. 11). Saskatoon serviceberry, ponderosa pine and western snowberry were found in lesser amounts in the rumen than in the field. Even though western snowberry was not eaten in the same proportion as it occurred in the field, it was considered an important food because of the large quantity available (Fig. 12).

Winter Food Habits

Important foods in rumens of 35 deer collected during the winter of 1969 were ponderosa pine, mountain mahogany, bearberry manzanita, common juniper, grasses and forbs (Table 12). Forbs, ponderosa pine, common juniper, bearberry manzanita, grasses and mountain mahogany were the most important species in rumen samples taken from 29 deer in the winter of 1970 (Table 13).

Ponderosa pine, mountain mahogany, forbs, common juniper, bearberry manzanita, 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 average amount in each sample was almost 50 percent less in 1970 as compared to 1969. Use of bearberry manzanita remained nearly constant from 1969 to 1970 with only slight changes in importance rating. Mountain mahogany and common

Table 9. Plants occurring in the rumens of 29 deer in the southern Black Hills in the fall of 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
Western snowberry	26.1	26.7	7.0
Bearberry manzanita	13.7	48.3	6.6
Alfalfa	33.7	13.8	4.7
Common juniper	15.1	31.0	4.7
Northern 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
Red clover	11.4	17.2	1.9
Rubber 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
Wood's rose	3.8	34.5	1.3
Saskatoon 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
Western yarrow	15.0	3.4	0.5
Roughleaf ricegrass	5.5	10.3	0.4
Browse	8.0	7.0	0.3
Groundplum milkvetch	8.0	3.4	0.3
Soapweed yucca	1.5	3.4	0.1
Common chokecherry	1.0	3.4	trace
Fungi	0.5	13.8	trace

Table 10. Plants occurring in the rumens of 23 deer in the southern Black Hills in the fall of 1969.

Species	Percent Composition	Percent Frequency	Importance Rating
Bearberry manzanita	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
Northern bedstraw	9.0	69.6	6.3
Ponderosa pine	14.0	39.1	5.5
Alfalfa	22.4	21.7	4.9
Wood's 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
Cocklebur	12.8	17.4	2.2
Fungi	27.5	4.3	1.2
Western 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
Saskatoon serviceberry	3.7	13.4	0.5
Aster	3.0	8.7	0.3
Soapweed yucca	2.0	4.3	trace

juniper were used in greater amounts; however, use of these species was limited by their distribution.

Pine, common juniper, Rocky Mountain juniper, Oregon grape, and bearberry manzanita were eaten in greater amounts than was observed on the availability transects (Table 11 and Fig. 13). Western snowbery was the only species which was not eaten in greater amounts than was observed on the transects. Species which were not recorded on transects but were an important part of the winter diet included old-man's beard, phlox, forbs, grasses and northern bedstraw.

Summer Food Habits

Rumen samples were taken from nine deer during the months of July, August, and September 1969. Twenty plant species or groups of plants were identified. Important summer foods were red clover, alfalfa, forbs and grasses (Table 14).

Diets of Mule and White-tailed Deer

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

Thirty-one percent of the samples came from mule deer, while 69 percent were from white-tailed deer. Based upon field observations, this is approximately the same ratio of mule deer to white-tailed deer found on the study area. Food habits data for each species indicated that both species had similar diets within a given portion of the study area. For example, in Area II, the importance rating of bearberry manzanita was 13.3 for white-tailed deer and 10.0 for mule deer in 1968; and the importance rating of mountain mahogany was 16.7 in three mule deer and 18.0 in the three white-tailed deer collected in February 1969.

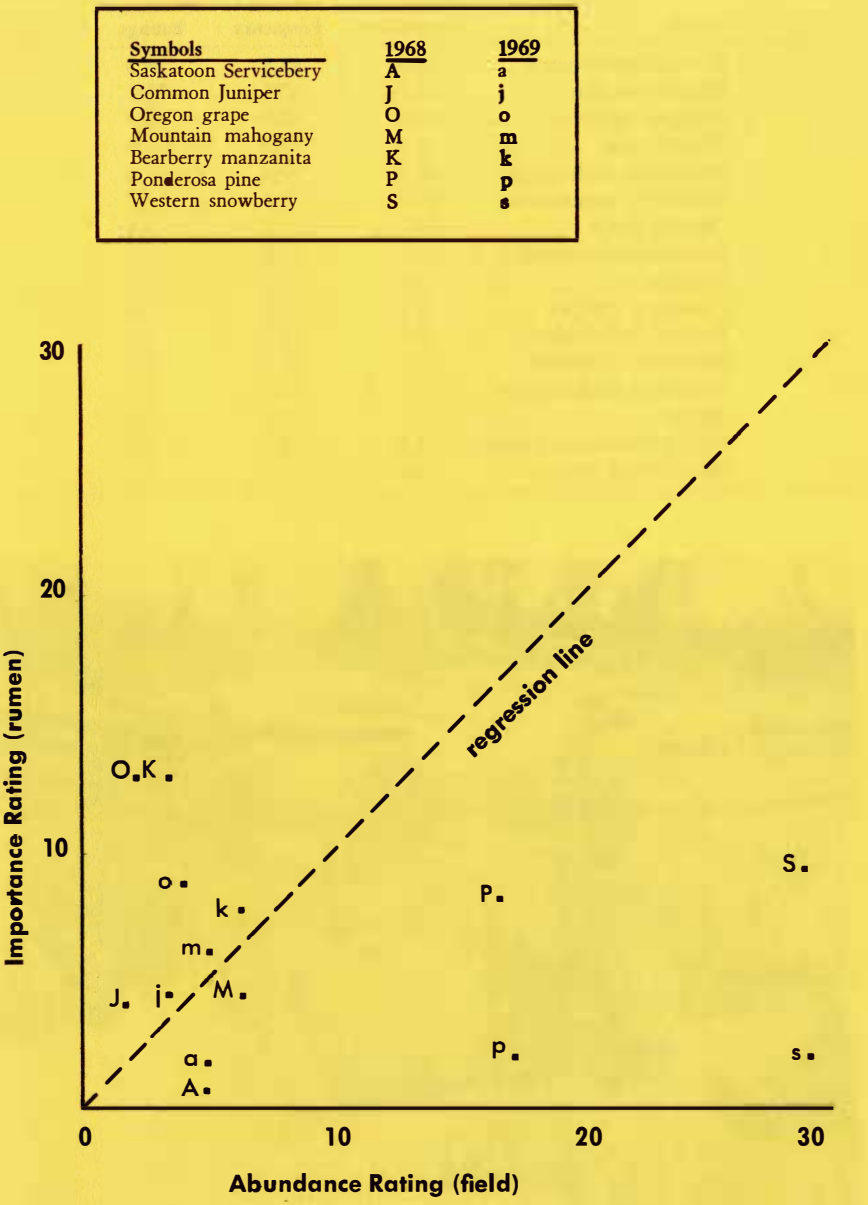

Figure 11. The relationship between the occurrence of important food species in the rumen and in the field, 1968 and 1969. Species above the regression line occurred more often in the rumen than in the field; the converse was true for those below the regression line.

Table 11. Plants recorded on transects in the southern Black Hills, 1968-70.

Species	Percent Composition	Percent Frequency	Abundance Ratings
Western snowberry	33.0	87.5	28.9
Ponderosa pine	23.5	67.5	15.9
Fringed sagewort	18.6	52.5	9.8
Wood's rose	8.1	73.7	6.0
Mountain mahogany	33.8	11.3	3.8
Bearberry manzanita	16.0	20.0	3.2
Oregon grape	14.2	20.0	2.8
Saskatoon serviceberry	6.7	35.0	2.3
Currant	3.6	31.3	1.1
Common juniper	2.3	43.8	1.0
Russett buffaloberry	3.8	16.3	0.6
Mountain ninebark	4.9	11.3	0.6
Common 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

Figure 12. Snowberry is widely distributed and is considered to be an important food for deer. (Department of Game, Fish and Parks photo by Arthur H. Richardson.)

Symbols	1969	1970
Comon Juniper	J	j
Common Chokecherry	C	c
Oregon Grape	O	o
Mountain Mahogany	M	m
Bearberry Manzanita	K	k
Ponderosa Pine	P	p
Western Snowberry	S	s

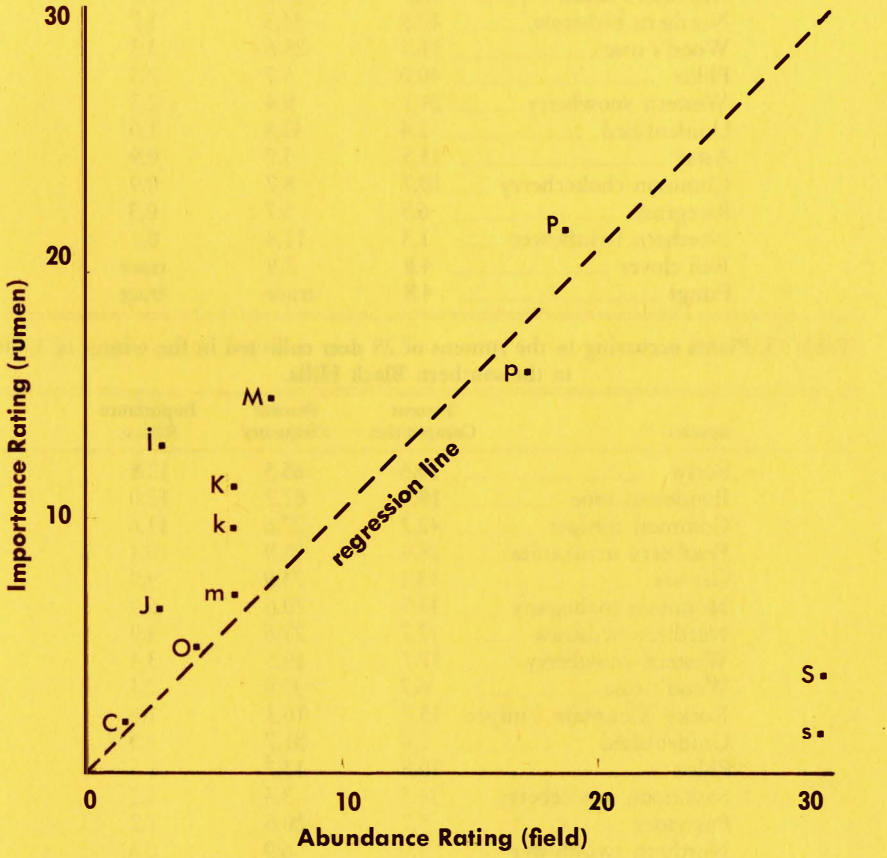

Figure 13. The relationship between the occurrence of important food species in the rumen and in the field, winter 1969 and 1970. Species above the regression line occurred in the rumen more often than in the field; the converse was true for those below the regression line.

Table 12. Plants occurring in the rumens of 35 deer collected in the winter of 1969 in the southern Black Hills.

Species	Percent Composition	Percent Frequency	Importance Rating
Ponderosa pine	31.9	65.7	20.9
Mountain mahogany	65.0	20.0	13.0
Bearberry manzanita	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
Northern bedstraw	10.8	34.3	3.7
Wood's rose	11.5	28.6	3.3
Phlox	40.0	5.7	2.3
Western snowberry	24.1	9.4	2.3
Unidentified	2.4	42.8	1.0
Aster	15.5	5.7	0.9
Common chokecherry	10.7	8.7	0.9
Ricegrass	6.5	5.7	0.3
Northern twinflower	1.3	11.4	0.1
Red clover	4.8	2.8	trace
Fungi	4.8	trace	trace

Table 13. Plants occurring in the rumens of 29 deer collected in the winter of 1970 in the southern Black Hills.

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
Bearberry manzanita	18.9	55.0	10.4
Grasses	13.1	75.9	9.9
Mountain mahogany	33.5	20.6	6.9
Northern bedstraw	17.7	27.6	4.9
Western snowberry	17.7	19.5	3.4
Wood's 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
Saskatoon serviceberry	34.5	3.4	1.2
Pussytoes	5.7	20.6	1.2
Northern twinflower	9.0	6.9	0.6
Soapweed yucca	9.0	3.4	0.3
Alfalfa	2.0	6.9	0.1
Russet buffaloberry	3.5	3.4	0.1
Currant	1.0	6.9	trace
Fungi	0.1	3.4	trace

Table 14. Plants occurring in the rumens of nine deer collected in the southern Black Hills in the summer of 1969.

Species	Percent Composition	Percent Frequency	Importance Rating
Alfalfa	59.6	88.9	49.4
Red clover	30.5	66.0	20.0
Forbs	28.3	55.5	14.1
Grasses	18.0	44.0	9.0
Western snowberry	19.6	33.0	6.5
Northern 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
Saskatoon 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
Northern twinflower	1.0	22.2	0.2
Wood's rose	1.0	22.2	0.2
Common chokecherry	2.0	11.1	0.2
Ricegrass	1.0	22.2	0.2
American vetch	0.9	11.1	0.1

Summary and Conclusions

The point-analysis technique was used to measure the composition of plant material in rumen ingesta samples from deer in the southern Black Hills. This technique was a reliable method for estimating rumen contents; however, when using this technique, 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 rumen content samples was measured with greater accuracy by point-analysis than by hand separation. Only 4 percent of the sample was not identified by point-analysis as compared to 19 percent in hand-separated samples.

The most important fall foods found in the rumens of 52 deer were bearberry manzanita, grasses, Oregon grape, western snowberry, and forbs. Bearberry manzanita, grasses, Oregon grape and forbs were eaten more frequently than they occurred in the field. Western snowberry was an important food source because of its wide distribution and abundance.

The most important winter foods in the diet of 64 deer were ponderosa pine, mountain mahogany, and common juniper. Other foods of importance were bearberry manzanita, western snowberry, Rocky Mountain juniper, forbs and grasses.

The most important summer foods in the rumen samples of nine deer were alfalfa, clover, grasses and forbs. Alfalfa fields are widely scattered throughout the study area. Deer evidently use these fields in early spring when alfalfa is becoming green, and again in the fall when the seed is maturing.

Literature Cited

Baker, F. S. 1918. Aspen as a temporary forest type. J. Forest. 16 (3):294-303.

Beetle, A. A. 1970. Recommended plant names. Wyo. Agric. Expt. Sta. Res. Jour. 31. Univ. Wyo., Laramie. 124 pp.

Bellrose, F. C., and H. G. Anderson. 1943. Preferential rating of duck food plants. Ill. Nat. Hist. Survey Bull. 22(5):417-433.

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

Daubenmire, R. F. 1953. Classification of the conifer forest of eastern Washington and northern Idaho. Northwestern Sci. 28(1): 17-24.

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

Habeck, J. R. 1959. A vegetational study of the central Wisconsin deer range. J. Wildl. Mgmt. 23 (3):273-278.

Harker, K. W., D. T. Torell, and G. M. Van Dyne. 1964. Botanical examination of forage from esophageal fistulas in cattle. J. Ani. 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.

May, M. 1962. Production and forage preference on subalpine sheep ranges of the Bighorn National Forest, Wyoming. Rocky Mountain Forest and Range Experiment Station, Res. Notes No. 53, U. S. Dept. Agr., Washington, D. C. 8 pp.

Norris, J. J. 1943. Botanical analyses of stomach contents as a method of determining forage consumption of range sheep. Ecology 24 (3):244-251.

Peattie, D. C. 1953. A natural history of western trees. Houghton-Mifflin Co., Boston. 751 pp.

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

Schneeweis, J. C., K. E. Severson, and L. Petersen. 1972. Food habits of deer in the Black Hills. Part I. Northern Black Hills. S. D. Agr. Expt. Sta. Bulletin 606.

Severson, K., M. May and W. Hepworth. 1968. Food preferences, carrying capacities, and forage competition between antelope and domestic sheep in Wyoming's Red Desert. Uni. Wyo. Agr. Expt. Sta. Sci. Mono. No. 10, 51 pp.

South Dakota Department of Game, Fish and Parks. 1959. Annual Report. Pierre. 154 pp.

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

United States Department of the 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. 411 pp.

Appendix Table 1. Common and Scientific Names of Plant Species Used in the Text.

Common name(s)	Scientific name
Alfalfa	*Medicago sativa* L.
American vetch	*Vicia americana* Muhl.
Aspen (quaking aspen)	*Populus tremuloides* Michx.
Aster	*Aster* spp. L.
Beaked filbert	*Corylus cornuta* Marsh.
Bearberry manzanita (kinnikinnick)	*Arctostaphylos uva-ursi* (L.) Spreng
Black medic	*Medicago lupulina* L.
Black sanicle	*Sanicula marilandica* L.
Bur oak	*Quercus macrocarpa* Michx.
Canada scurvyberry	*Maianthemum canadense* Desf.
Cocklebur	*Xanthium* spp. L.
Colorado blueyedgrass	*Sisyrinchium montanum* Greene
Common chokecherry	*Prunus virginianus* L.
Common dandelion	*Taraxacum officinale* Weber
Common everlasting	*Anaphalis margaritacea* (L). Benth. & Hook
Common juniper	*Juniperus communis* L.
Common yampa	*Perideridia gairdneri* (H&A) Mathias
Corn	*Zea mays* L.
Cream peavine (vetchling)	*Lathyrus ochroleucus* Hook.
Creeping barberry (Oregon grape)	*Berberis repens* Lindl.
Currant	*Ribes* spp. L.
Darkthroat shootingstar	*Dodecatheon pauciflorum* (Durand) Greene
Dwarfed blackberry	*Rubus pubescens* Raf.
False solomonseal	*Smilacina stellata* (L.) Desf.
Fringed sagewort	*Artemisia frigida* Willd.
Groundplum milkvetch	*Astragalus succulentus* Lindl.
Grouse whortleberry	*Vaccinium scoparium* Leiberg
Heartleaved alexanders	*Zizia aptera* (Gray) Fern.
Juniper	*Juniperus* spp. L.
Kinnikinnick (bearberry manzanita)	*Arctostaphylos uva-ursi* (L.) Spreng
Lichen	*Usnea* spp.
Mountain ninebark	*Physocarpus monogymus* L.
Mountain mahogany	*Cercocarpus montanus* Raf.
Northern bedstraw	*Galium boreale* L.
Northern twinflower	*Linnaea boreale* L.
Oat	*Avena* spp. L.

Appendix Table 1. (Continued)

Common name(s)	Scientific name
Oregon grape (creeping barberry)	*Berberis repens* Lindl.
Paper birch	*Betula papyrifera* Marsh.
Phlox	*Phlox* spp. L.
Ponderosa pine	*Pinus ponderosa* L.
Princespine pipsissewa	*Chimaphila umbellata* (L.) Bart.
Pussytoes	*Antennaria* spp. Gaertin.
Pyrola	*Pyrola* spp. L.
Quaking aspen	*Populous tremuloides* Michx.
Red clover	*Trifolium pratense* L.
Rocky Mountain juniper	*Juniperus scopulorum* L.
Roughleaf ricegrass	*Oryzopsis asperfolia* Michx.
Rubber rabbitbrush	*Chrysothamnus nauseosus* (Pallas) Britt
Russet buffaloberry	*Shepherdia canadensis* L.
Saskatoon serviceberry	*Amelanchier alnifolia* L.
Sawsepal penstemon	*Penstemon glaber* Porsh.
Sedge	*Carex* spp. L.
Shinyleaf spiraea	*Spiraea lucida* Dougl.
Silvery lupine	*Lupinus argenteus* Pursh.
Skunkbrush sumac	*Rhus trilobata* Natt.
Snowberry	*Symphoricarpos* spp. Duham.
Snowbrush ceanothus	*Ceanothus velutinus* Dougl.
Soapweed yucca (small soapweed)	*Yucca glauca* Nutt.
Spreading dogbane	*Apocynum androsaemifolium* L.
True mountain mahogany (mountain mahogany)	*Cercocarpus montanus* Raf.
Veiny meadowrue	*Thalictrum venulosum* Trel.
Vetchling (cream peavine)	*Lathyrus ochrolaucus* Hook.
Violet	*Viola* spp. L.
Wartberry fairybells	*Disporum trachycarpum* (Wats.) Benth. & Hook.
Western bracken	*Pteridium aquilinum* (L). Kuhn
Western snowberry	*Symphoricarpos occidentalis* Hook.
Western yarrow	*Achillea lanulosa* Nutt.
Wheat	*Triticum* spp. L.
White spruce	*Picea glauca* (Moench.) Voss
Wildbergamot beebalm	*Monarda fistulosa* L.
Wildsarsaparilla aralia	*Aralia nudicaulis* L.
Wild strawberry	*Fragaria ovalis* (Lehm.) Rydb.
Wood lily	*Lilium philadelphicum* L.
Wood's rose	*Rosa woodsii* Lindl.

Appendix Table 2. Percent frequency and percent cover of understory species in four quaking aspen stands.

Species	Aspen Stands: Percent Coverage of Aspen Stand Number 1	2	3	4	Average	Aspen Stands: Percent Frequency of Aspen Stand Number 1	2	3	4	Average
Beaked filbert	15.7	6.1	2.4	17.2	10.3	28.0	16.0	6.5	46.0	24.1
Vetchling	14.9	20.2	10.4	6.2	12.9	77.4	78.0	45.0	56.0	64.1
Saskatoon serviceberry	13.7	6.5	6.8	5.4	8.0	56.0	34.0	26.0	32.0	37.0
Shinyleaf spiraea	13.0	11.0	6.9	7.2	9.5	66.7	54.0	35.4	32.0	47.0
Grasses	9.9	4.6	25.4	11.4	12.8	68.0	59.0	87.5	70.0	71.1
Oregon grape	8.9	17.5	5.2	7.3	9.7	56.0	74.0	33.4	44.0	51.8
Western snowberry	8.2	11.9	7.2	6.7	8.5	56.0	72.0	51.6	60.0	59.9
Unidentified forbs	5.6	14.0	10.5	17.7	11.9	50.8	88.0	67.0	84.0	72.4
Veiny meadowrue	4.4	7.9	1.7	3.4	4.3	26.7	48.0	11.0	40.0	31.4
False Solomonseal	3.8	----	0.8	----	1.1	49.2	----	6.5	----	13.9
Western bracken	3.6	7.4	8.9	8.4	7.1	15.4	28.0	23.4	32.0	24.7
Wood's rose	2.3	2.8	1.4	2.1	2.1	22.0	24.0	12.5	22.0	20.1
Common chokecherry	2.0	1.6	0.2	0.6	1.1	16.0	12.0	1.5	10.0	9.9
Wildbergamot beebalm	1.7	1.7	2.2	0.2	1.4	13.3	18.0	18.0	2.0	12.8
American vetch	1.4	2.4	2.2	2.6	2.1	12.0	22.0	10.0	24.0	17.0
Snowbrush ceanothus	1.3	----	----	----	0.3	0.7	----	----	----	0.2
Wild strawberry	0.9	2.2	1.5	1.2	1.4	12.0	23.0	13.5	18.0	16.6
Violet	0.7	1.1	1.1	0.5	0.8	12.7	19.0	14.5	10.0	14.0
Pyrola	0.7	0.5	2.0	3.9	1.8	7.3	8.0	18.0	34.0	16.8
Silvery lupine	0.7	1.1	1.2	1.2	1.0	6.6	13.0	10.5	14.0	11.0
Common everlasting	0.7	0.1	----	----	0.2	6.6	1.0	----	----	1.9
Bur oak	0.7	0.4	0.1	----	0.3	5.3	3.0	0.5	----	2.0
Sedge	2.0	----	0.2	----	0.5	2.0	----	1.0	----	0.7
Black sanicle	4.7	----	----	0.5	11.3	4.7	----	----	6.0	2.7
Wartberry fairybells	0.4	1.9	0.2	0.8	0.8	3.2	16.0	2.5	6.0	7.0
Aspen	2.7	0.1	0.9	0.9	1.1	2.7	1.0	6.5	12.0	5.6
Common dandelion	0.3	0.9	2.4	0.6	1.0	2.0	11.0	21.0	8.0	10.5
Red clover	0.3	3.2	4.9	1.2	2.4	0.7	16.0	20.5	8.0	11.3
Bearberry manzanita	0.2	0.1	4.8	----	1.3	1.3	1.0	16.5	----	4.7
Dwarfed blackberry	0.2	0.3	----	6.4	1.7	2.0	2.0	----	46.0	12.5
Western yarrow	0.1	0.3	1.2	0.6	0.5	1.3	4.0	10.5	6.0	5.4
Princespine pipsissewa	trace	0.2	0.1	----	0.1	0.7	3.0	4.0	----	1.9
Canada scurvyberry	----	5.6	7.1	5.6	4.6	----	57.0	56.0	60.0	43.2
Common juniper	----	0.9	0.4	----	0.0	----	1.0	1.0	----	0.5
Paper birch	----	0.3	0.1	1.0	0.3	----	1.1	0.5	2.0	0.9
Pussytoes	----	0.1	0.3	----	0.1	----	1.0	3.0	----	1.0
Grouse whortleberry	----	----	1.6	----	0.4	----	----	8.0	----	2.0
Russet buffaloberry	----	----	----	1.3	0.3	----	----	----	2.0	0.5
Ponderosa pine	----	----	----	0.1	----	----	----	----	2.0	0.5