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A Food Habits Study of Whitetail Deer In The Black Hills

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A FOOD HABITS STUDY OF WHITETAIL DEER IN THE NORTHERN BLACK HILLS

BY

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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

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Abstract

JAMES CARL SCHNEEWEIS

Food habits of whitetail deer (Odocoileus virginianus) in the northern Black Hills were studied during fall and winter 1966-67 and 1967-68 and also during summer 1967. Summer study was confined to aspen (Populus tremuloides) areas and involved stomach analysis and a pasture study. Fall and winter food habits were determined by stomach analysis only.

Associated aspen vegetation was sampled to find a representative site for construction of a 0.7-acre enclosure. Two deer were placed in an utilization section of the enclosure for 18 days during mid-summer. Annual growth was clipped in a control section of the pasture to estimate total forage production.

Analysis of 42 fall rumen samples showed that Oregon grape (Mahonia repens) was the most important fall food species. Bearberry (Arctostaphylos uva-ursi) and common juniper (Juniperus communis) were also important.

Analysis of 32 winter rumen samples indicated that Oregon grape and common juniper were the most important. Other winter foods of moderate importance were bearberry, grasses, ponderosa pine (Pinus ponderosa), bur oak (Quercus macrocarpa), and lichens (Usnea sp.).

Snow depth was the most important factor affecting availability. As snow depth increased common juniper use increased while Oregon grape and bearberry use decreased. Forbs were not important food items during fall and winter.

Significant differences were found in understory coverage and composition among aspen stands.

Results of summer stomach analysis did not completely agree with pasture results. Important pasture food species were vetchling (Lathyrus ochroleucus), American vetch (Vicia americana), serviceberry (Amelanchier alnifolia), and bur oak. Most important food species from analysis of nine summer stomachs were vetchling, serviceberry, mushrooms, aster (Aster leavis), and spiraea (Spiraea lucida).

Total forage production on a representative aspen site was found to be 2,650 pounds per acre green weight or 835.1 pounds per acre air-dried weight.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDIX TABLES

Appendix Page

LIST OF FIGURES

INTRODUCTION

A deer food habits study has not been conducted in the northern Black Hills for over 20 years. Only limited information is available on the plant species composition of the deer range. Some workers feel browse plants are in worse condition now than in 1955 following a period of severe over-use. By observation it appears there is not a great enough quantity of indicator species, commonly considered good deer food, to adequately winter the present deer population. Also, during the past few years, certain plant species, primarily aspen and paper birch (Betula papyrifera)[1], have been subjected to a program of type conversion by the U. S. Forest Service in an attempt to increase timber production.

The South Dakota Department of Game, Fish and Parks feels that such conversion, if allowed to continue, could substantially lower carrying capacity of the forest for deer and also affect herd condition. With this in mind, the South Dakota Cooperative Wildlife Research Unit, in conjunction with the Department of Game, Fish and Parks, the U. S. Forest Service and South Dakota State University initiated a deer food habits study in the northern Black Hills in September 1966. Objectives of this study were 1) to determine principal and preferred foods of whitetail deer throughout winter, 2) to estimate availability of preferred foods on winter range, and 3) to determine principal and preferred foods of whitetail deer in a typical aspen stand in summer.

[1]Scientific names of plants after Fernald (1950) and Rydberg (1922).

DESCRIPTION OF STUDY AREA

The study area, located in the northern portion of the Black Hills National Forest, Lawrence County, South Dakota, is bordered by Wyoming, U. S. Highway 14 and U. S. Highway 85 (Figure 1). It is approximately 1200 square miles in size. Average January and July temperatures at Lead, located on the east central edge of the area, are 24.3 F and 69.3 F (Anonymous 1967). Average annual precipitation at Lead varies from 17 to 24 inches. Most precipitation occurs during the growing season, however, snowfall may accummulate to four feet in depth at higher elevations in winter.

The area is characterized by hilly to mountainous terrain with broad valleys, grassy meadows, and deep rugged canyons and gulches. Altitudes range from approximately 4,000 feet in the eastern and northern foothills to over 7,000 feet at the highest peaks. The Black Hills consist of large sedimentary domes and more resistant igneous cones. Soils of the area are shallow or eroded badlands types which are the result of local geology and physiography. The entire area is drained by tributaries of the Belle Fourche River, the largest of which is Spearfish Creek (Anonymous 1967).

Dominant vegetation type is ponderosa pine interspersed with temporary stands of aspen. Extensive stands of white spruce (Picea glauca) are at higher elevations, especially on north-facing slopes. Creek bottoms contain a mixture of deciduous trees, the

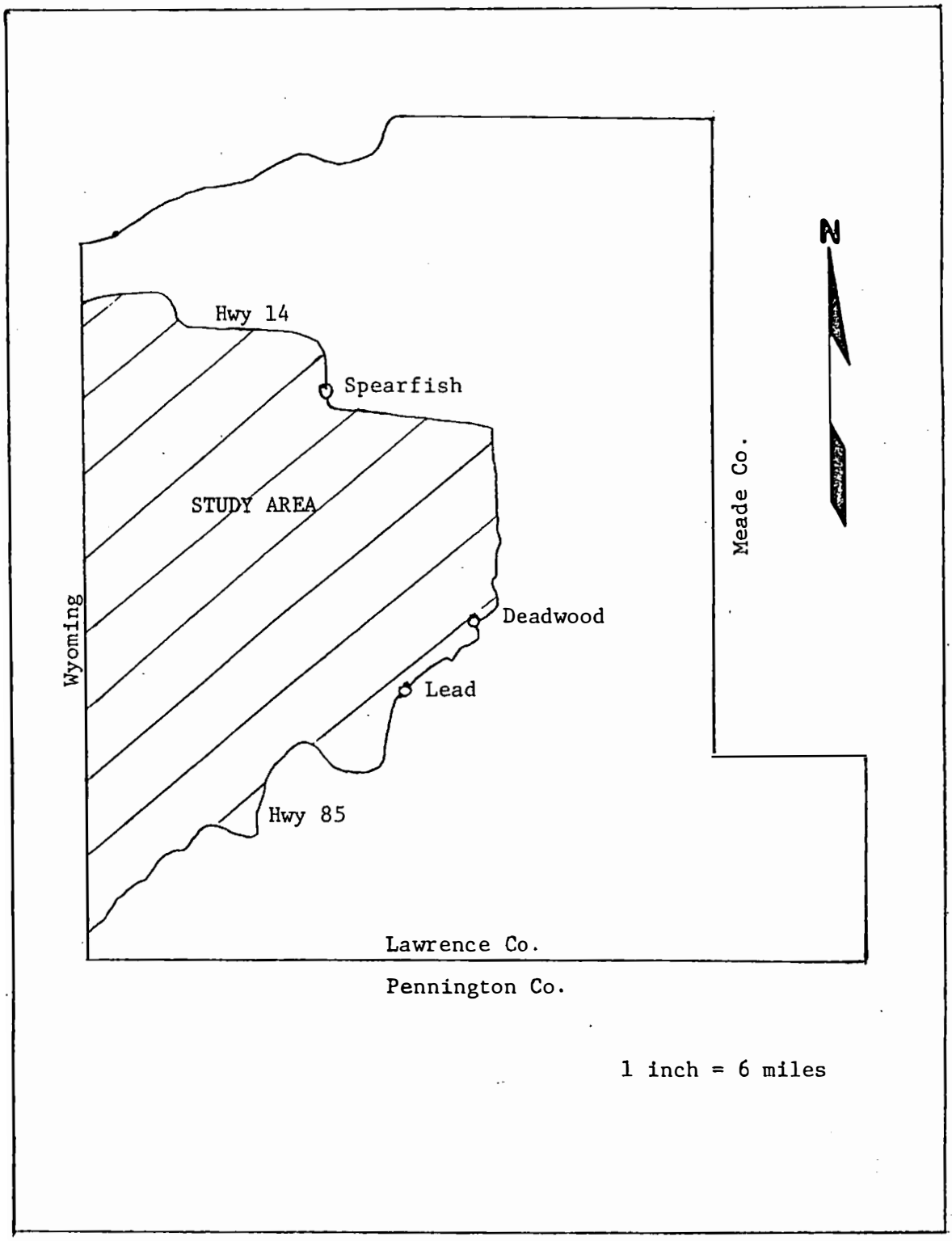

Figure 1. Location of study area in Lawrence County, South Dakota.

most prominent being American elm (Ulmus americana), box elder (Acer negundo), green ash (Fraxinus lanceolata), bur oak, chokecherry (Prunus virginiana), hop hornbeam (Ostyra virginiana), paper birch, cottonwood (Populus deltoides), aspen and several species of willow (Salix sp.). Farming is common in the foothills and corn, oats, wheat, barley, alfalfa, and dairy products are the most important commodities.

Mammals common on the area include whitetail deer, mule deer (Odocoileus hemionus)[2], coyote (Canis latrans), striped skunk (Mephitis mephitis), yellowbelly marmot (Marmota flaviventris), whitetail jackrabbit (Lepus townsendi), porcupine (Erethizon dorsatum), beaver (Castor canadensis), and red squirrel (Tamiasciurus hudsonicus). Approximately 150 elk (Cervis canadensis) are also present on the area. Permits are issued to local ranchers by the U. S. Forest Service to graze cattle and sheep on public lands.

[2]Scientific names of mammals after Burt and Grossenheider (1964).

METHODS

Fall stomach samples were collected from hunter-killed deer during November 1966 and 1967. Approximately one quart of ingesta was taken from the rumen. Excess fluids were removed by squeezing the material in cheesecloth. The samples were placed in plastic bags or paper cartons, labeled, and frozen for later analysis. A game collection form was completed for each sample. It included sample number, date and location, age, sex and condition of animal, and a general description of the area including vegetation and snow depth.

Winter samples were collected by South Dakota Department of Game, Fish and Parks personnel during January, February, and March 1967 and 1968. An attempt was made to collect an equal number of deer each month from typical wintering areas. Two rumen samples were also obtained from road-killed deer during winter 1967. Winter samples were handled in the same manner as those collected in fall. Kill sites were marked by blazing several nearby trees and plotting the location on a map.

In the laboratory each rumen sample was washed through two sieve screens with 3.36 mm and 2.0 mm mesh sizes. Material retained on the larger screen was placed on an enamel pan and separated by species. Material was kept moist during sorting to prevent drying and loss of distinguishing characteristics. A reference plant

collection was used to aid in identifying plant particles. Material remaining on the 2.0 mm screen was examined for trace items but was not sorted. Sorted material was oven-dried for 48 hours at 50 C and percent weight for each species was calculated.

Winter kill sites were located the following summer to estimate availability at the time of collection. A 500-foot transect was set up in each of the 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 kill were recorded every four steps. A hand compass was used to approximate a constant direction. 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 determined by multiplying the percent average weight in the rumen sample and the percent frequency of occurrence of each species (May 1962). These values were then multiplied by 100 to obtain whole numbers. A modification of the method described by Bellrose and Anderson (1943) was used to obtain a winter plant preference rating. It was obtained by dividing average percent weight of each species in rumen samples by average percent abundance of each species on winter availability transects.

Nine deer were collected by the investigator in aspen stands during August 1967. Laboratory analysis of stomach 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 aspen transects.

In June 1967, ten 500-foot transects were set up in four aspen stands to determine composition and coverage of understory vegetation. Four transects were run in the largest stand and only one in the smallest. Three criteria were used in choosing transect locations: 1) the site had to be readily accessible for possible future intensified study, 2) transects had to be at least 100 feet from disturbed areas such as roads and fire trails, 3) transects had to be at least 500 feet apart.

A one-square-foot frame was placed at the tip of the investigator's toe on every fourth step. Assuming a 30-inch stride, four steps would equal approximately ten feet. Fifty plots were set

up on each transect. All plant species which were either inside or extending over the plot to a height of five feet were recorded. Plot coverage for each species was estimated, with grasses and unidentified forbs treated as groups. A hand compass was used to maintain a straight line. Each transect was marked at both ends to facilitate relocation. Data from all transects were averaged. Standard deviations of means for the 13 highest-coverage species were determined.

Overstory density and composition were also determined. Density was obtained with the use of a wedge prism at 50-foot intervals along each transect. It was recorded as square feet of basal area at diameter breast height for each overstory species.

The chi-square test was used to determine if there were significant differences in understories of the four stands and in overstories of each transect.

The transect site with the smallest deviation from average was chosen as most representative of the four aspen stands studied. In July 1967, a 29,000-square-foot deer enclosure was erected on that site. This pasture was located approximately in the middle of the transect with the transect running length-wise through the center. The enclosure fence was ten feet high. It consisted of a bottom four-foot-high snow fence section and two, three-foot-high sections of woven wire. The two woven wire sections were connected

at the seven-foot-high level with hog rings and the lower section of the woven wire was connected to the snow fence with baling wire. The fence was fastened to the aspen trees thus eliminating the need for additional posts. This resulted in an irregular fence line.

The enclosure was divided into an 18,900-square-foot utilization section and a 10,350-square-foot control section. The dividing fence consisted of two, three-foot sections of woven wire attached directly to aspen trees.

A seven-year-old whitetail buck and a two-year-old whitetail 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 foods found in the aspen pasture. The deer were then placed in the utilization section of the pasture for 18 days so plant utilization and preference could be determined.

Total forage production on the pasture site was estimated by clipping annual growth of all species in sample plots of the control section to a height of five feet. Clipping was done in late August when vegetation was considered to be at peak of production. Total green weight for plots by strata was obtained by use of a gram scale immediately after clipping. Material was dried in paper sacks for two weeks and air-dried weight by species and strata

was determined to the nearest 0.1 gram for each plot. Total pounds of forage and the amount each species contributed to the total was obtained by multiplying weight in grams by 10.

Prior to releasing deer in the pasture, 30 clusters of browse plants between two and five feet in height were tagged. Each cluster contained three plants and each plant was tagged once. The tagged portion of the plant included at least three leader groups. Total length of annual growth and number of leaves or parts of leaves were recorded for each tagged twig.

Tagged twigs were examined periodically while the deer were in the pasture to determine when desired utilization had been obtained. After the deer were removed, all tagged twigs were remeasured and percent utilization of annual growth and leaves was determined (Aldous 1945).

Forty 9.6-square-foot plots were established in the utilization section after the deer were removed. All plots were at least 10 feet from the fence to avoid heavily trampled areas. The plot frame was made of #9 iron wire and was three sided. Each side was approximately 3.1 feet long. A one-quarter-inch wooden dowel was used as the fourth side and was put in place after the frame was set in vegetation. This permitted the plot to be placed around tree trunks which occasionally occurred in sample plots. Utilization classes and the average for each class are shown below:

Percent Utilization	Class	Class Average
1 - 5	1	3
5 - 25	2	15
25 - 50	3	37.5
50 - 75	4	62.5
75 - 95	5	85
95 - 100	6	97.5

Utilization by species in each stratum was determined by multiplying the sum of the number of times the species occurred in each class by the respective class average. The sum of these products was then divided by the total number of times the species occurred in all plots.

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 sample plots. This figure represented the average weight for each species consumed by the deer. Weights were totaled and the percent each species made up of the total weight consumed was calculated. The percent each species made up of total production was then divided into this figure to obtain a preference rating based on weight consumed over weight produced for each species.

Weight comparisons were used to determine utilization for species considered most important (Beruldsen & Morgan 1934). All annual growth of nine selected species which occurred in sample plots was clipped and placed in paper sacks. Sacks were numbered and green weight for each plot was determined. Plant material in 0-2 foot and 2-5 foot strata was treated separately. Twenty-two 9.6 square-foot plots were similarly established in the control section of the pasture. Annual growth of the nine selected species was clipped and handled in the same manner as described for the utilization section. Material was allowed to dry in sacks for two weeks. It was then separated by species and air-dried weight to the closest 0.1 gram was determined for each plot. Average air-dried weight per plot was determined by species and strata for both sections of the pasture. Differences in average weight between utilization and control sections for each species were assumed to be amounts consumed by deer.

RESULTS AND DISCUSSION

Stomach content analysis has been used by many investigators to determine food habits of wild animals. Roberts (1956) and others found by washing and sorting rumen material from whitetail deer they could obtain a reasonably accurate record of what the animals had eaten. Norris (1943) pointed out that rumen analysis was not entirely accurate in sheep because of a differential rate of digestion among plant food species. Severson (1966) indicated that rumen analysis has the advantage of determining trace food items that would probably not be found in vegetative food habits methods. Dirschl (1962), in a study of pronghorn (Antilocapra americana) rumen analysis techniques, found that washed material remaining on a sieve screen with a mesh size of 5.66 mm adequately represented contents of the entire sample. He also stated that volumetric procedures were more variable than weight procedures in determining precentages of food species eaten.

Fall Food Habits

Availability of stomach samples from hunter-killed deer during November 1966 and 1967 provided an opportunity to determine fall food habits. Stomach samples were collected from gut piles by the investigator and by Department of Game, Fish and Parks personnel. Because mule deer were also present on the area, rumen material was not taken from a gut pile unless positive species identification

could be made. This was often accomplished by talking with hunters who knew of a particular animal killed. On several occasions, gut piles were positively identified by closely examining the hair cut from the anal region and left with the pile.

Because of extensive movements of deer during hunting season it was felt the area a deer was killed in did not necessarily reflect where the animal had last fed. It is quite possible deer sought areas of heavy protective cover to avoid being disturbed by hunters. If this were true, a knowledge of availability of vegetation in the area where a deer was killed would be of no value in determining preferences for plant food species. For this reason, no availability data were obtained for fall collections.

Eighteen stomach samples were collected from hunter-killed deer in 1966. Of these, nine were bucks, six were does, and three came from gut piles in which sex was not determined. There was no snow on the ground during the collection period. Thirty-six species or groups of plants were identified in samples. Food species considered most important follow:

Species	Percent Frequency	Percent Weight	Importance Rating
Oregon grape (Mahonia repens)	83.5	27.1	22.6
Bearberry (Arctostaphylos uva-ursi)	83.5	11.9	9.9
Aspen (Populus tremuloides)	55.6	4.9	2.7
Ponderosa pine (Pinus ponderosa)	61.2	4.2	2.6
Bur oak (Quercus macrocarpa)	61.2	3.4	2.1
Wolfberry (Symphoricarpos occidentalis)	55.6	3.8	2.1

Percent frequency of occurrence, percent average weight and importance rating of each species or group found in the fall 1966 samples are presented in Appendix A.

Twenty-four stomach samples were collected from hunter-killed deer in 1967. These included seven bucks, eight does, and nine of undetermined sex. Average snow depth for the collection period was three inches. Thirty-nine species or groups of plants were found in the stomachs. Plant species considered important follow:

Species	Percent Frequency	Percent Weight	Importance Rating
Oregon grape (Mahonia repens)	83.3	25.3	21.0
Common juniper (Juniperus communis)	62.5	14.5	9.1
Bearberry (Arctostaphylos uva-ursi)	75.0	6.1	4.6
Alfalfa (Medicago sativa)	28.8	11.6	2.4

Appendix B shows the percent frequency of occurrence, percent weight and importance rating of all food species found in the fall 1967 samples.

Oregon grape was the most important species for both fall periods and was more than twice as important as the next plant species. In 1966 the second most important species was bearberry. Hill (1946), in a food habits study of whitetail deer in the northern Black Hills, found that both Oregon grape and bearberry were important fall foods. In 1967 the second most important food

was juniper. Life forms between juniper and bearberry could account for differences in importance between the two years. Availability of bearberry, a horizontal prostrate shrub, could be drastically reduced by a snow cover of only a few inches. During the 1966 collection period, no snow was present and bearberry was apparently readily available as food. In 1967, snow cover of three inches probably reduced availability of bearberry. Availability of common juniper, a bushy shrub two or more feet in height, would not be affected by a light snow cover. Results seem to indicate that as bearberry became less available much more juniper was taken. In fall of 1966, with no snow, juniper received an importance rating of only 0.1. In 1967, with three inches of snow, bearberry was still third most important.

Several agricultural species were present in samples from fall 1966 and 1967. Wheat, corn and oats, were present in one sample each and in 1966 alfalfa was present in 55.6 percent of the stomachs. However, the combined importance rating of the four species was less than one. In 1967 samples, alfalfa, corn and sorghum were present. Sorghum was found in one sample and corn occurred in two. Alfalfa occurred in 20.8 percent of the stomachs and had the fourth highest importance rating for the period. Four of the five samples contained more than 50 percent alfalfa by weight and one of the four was almost entirely alfalfa with only

traces of other species. Apparently some deer in forest areas adjacent to farmlands show a marked preference for crops such as alfalfa. It appears snow cover reduced the availability of native species and was in part responsible for some animals eating alfalfa. A large portion of farm crops found in rumen samples probably came from state owned farms which are scattered along the northern edge of the forest.

Although numerous species of forbs were found in the samples, they were not considered to be important as a group for either fall period. Hill (1946) found forbs made up a considerable portion of a whitetail's diet in fall.

Winter Food Habits

Rumen samples from 11 bucks and 11 does were collected during January, February and March of 1967. Average snow depth for collection sites was approximately 15 inches. Thirty-seven species or groups of plants were found in the samples. Food species considered most important follow:

Species	Percent Frequency	Percent Weight	Importance Rating
Common juniper (Juniperus communis)	73.9	26.8	922.1
Oregon grape (Mahonia repens)	91.3	24.0	319.9
Ponderosa pine (Pinus ponderosa)	87.0	4.6	84.5
Bur oak (Quercus macrocarpa)	47.8	3.7	22.8
Bearberry (Arctostaphylos uva-ursi)	60.9	5.3	6.3
Lichen (Usnea sp.)	60.9	4.0	--

Percent frequency of occurrence, percent average weight, preference and importance ratings and percent total availability for all plant species are shown in Appendix C. Winter importance ratings are the product of average availability of a plant species on the range and average percent weight in the rumen samples. Fall importance ratings did not include availability and were simply the product of the average percent weight and average frequency of occurrence.

Ten stomach samples were collected during February and March of 1968 from seven bucks and three does. Average snow depth on collection sites was slightly more than one inch. Twenty-three species or groups of plants were found in the samples. Important species follow:

Species	Percent Frequency	Percent Weight	Importance Rating
Oregon grape (Mahonia repens)	100	40.4	647.9
Common juniper (Juniperus communis)	90	8.7	154.4
Bearberry (Arctostaphylos uva-ursi)	70	7.2	53.1
Grasses	100	2.8	50.7
Ponderosa pine (Pinus ponderosa)	90	9.8	37.4

Percent frequency of occurrence, percent average weight, preference and importance ratings and availability for all species are presented in Appendix D.

Most important winter food in 1967 was common juniper. The importance rating it received that year was the highest for any plant during both winter periods. High importance of juniper during winter of 1967 was probably due to deep snow cover which drastically reduced availability of lower vegetation. Despite relatively deep snow cover, Oregon grape was still the second most important species. Percent availability of juniper was approximately 2.5 times greater than Oregon grape. However, preference rating of Oregon grape was more than twice that of juniper. Hill (1946) found that Oregon grape was important as a winter food but as snow depth increased Oregon grape use decreased while juniper use increased. It should be pointed out that although average snow depth was 15 inches, several sites were without snow when deer were collected. It was on these open sites where almost all of the available Oregon grape was found. During 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. Importance rating of Oregon grape indicated it was highly preferred by deer.

Bearberry 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 were important winter deer foods in areas where snow accumulation was not heavy. In 1967, even though very little bearberry was available, it made

up 5.3 percent of the average rumen sample by weight. In 1968, with much more bearberry available because of less snow, it accounted for 7.2 percent of the weight of the samples. Hill (1946) found that bearberry was the most important winter food for whitetail deer in the northern Black Hills.

A preference rating of 4.4 for bearberry in 1967 was the highest recorded for any species during the two winters. However, preference rating for bearberry in winter of 1968 was only 1.0. It appears that as availability of other species increased because of less snow, preference for bearberry decreased.

There are two possible ways in which deer obtain bearberry during periods of moderate snow cover. Often open areas on south-facing slopes and wind-blown ridges and under dense pine and spruce stands provide some bearberry for deer. Availability transects, which were not run at the time deer were collected, could not detect these open areas. However, even with absence of such open areas, deer probably get some ground vegetation such as bearberry by pawing or digging.

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 winter samples even though snow depth at collection sites was much less in 1968. One stomach in 1968 contained 92 percent pine but, since only ten samples were obtained, results

of importance of pine were misleading. One explanation for apparently higher use of pine in 1968 is that deer were collected somewhat later in winter when more preferred browse had already been eaten. There was more pine available on 1967 collection sites and it received a preference rating of only 0.3. However, in 1968, less pine was found on collection sites and preference rating was 2.6. Deer were not collected on the same sites during both winters and therefore decrease in availability of pine from 1967 to 1968 does not necessarily reflect a general change in range condition. Importance rating for pine was more than twice as high in 1967 because there was more pine present in the transects studied even though deer did not eat as much that year. Hill (1946) found that pine received very little utilization during winter months even though it was available in large amounts.

Lichens were found throughout the study area growing on pine and spruce branches and bark and were found in fall and winter samples both years. Lichens were often attached to pine bark in samples. The bark was detached and recorded separately. In 1967 lichens made up 4.0 percent of the weight in winter samples. It appeared that as snow depth increased more lichens were eaten. Availability of lichens would not be affected by snow while that of bearberry and Oregon grape decreased with

snow cover. However, in fall samples this trend for lichens did not occur. Almost three times as much lichen occurred in fall 1966 samples as compared to fall 1967 samples even though there was no snow during the 1966 collection period but approximately three inches during the 1967 fall collection period. Hill (1946) found lichen increased in both amount eaten and preference from fall to winter periods. Winter rumen samples in 1968 contained more than twice as much grass by weight as 1967 winter samples. However, availability of grass on 1968 winter collection sites was only slightly more than it was for 1967 sites. With less snow cover in 1968, deer may have obtained grass in open areas or by pawing, neither of which would be reflected by availability transects.

Bur oak made up 3.7 percent by weight of 1967 winter samples. However, 1968 winter samples contained less than one percent of oak. The preference rating for both winters was low. It is possible deer ate more oak during periods of heavy snow cover because availability of more preferred vegetation was reduced.

Several species including chokecherry, wolfberry (Symphoricarpos occidentalis), filbert (Corylus cornuta), and spiraea, were readily available during one or both winter periods but were found only in small amounts in samples. Hill (1946) found aspen, filbert, white spruce and spiraea to be unpalatable during winter months and he rated chokecherry as being of low palatability.

Forbs were present in larger quantities in 1968 winter samples than 1967 samples. However, forbs as a group were not considered important for either winter period. Hill (1946) found large amounts of forbs in winter stomach samples.

Mountain laurel (Ceanothus velutinus) was the second most highly preferred food species for both winter periods. However, it is available in only small amounts and cannot be considered important.

Species Composition of 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 stated that in each case aspen occupied a seral position.

By observation it would appear aspen stands receive heavy use by deer during summer months. One reason for heavy use is undoubtedly dense growth and wide variety of plant species found in aspen understories. An example of a typical aspen understory can be seen in Figure 2. By contrast, Figure 3

shows the same aspen understory in winter. Understories of ponderosa pine are much more open with less available forage (Figure 4). An overview of an aspen stand with interspersed pine is shown in Figure 5.

Thirty-two species or groups of plants occurred in ten, 500-foot transects located in four aspen stands. Of these, there were 17 species of both forbs and woody plants and the two other groups were grasses and sedges (Table 1). Chi-square tests showed understories and overstories significantly different at the 0.01 level. Differences were especially noticable for grasses in which coverage ranged from 4.6 percent in one stand to 25.4 percent in another. Coverage 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. Percent frequency and coverage for each of the four stands are presented in Appendix E, F, G and H respectively.

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. Pine was present in all stands and occurred in 9 of 10 transect overstories.

Figure 2. Aspen understory, northern Black Hills, summer 1967.

Figure 3. Aspen understory, northern Black Hills, winter 1968.

Figure 4. Pine understory, northern Black Hills, summer 1967.

Figure 5. View of aspen with interspersed pine, northern Black Hills, summer 1967.

Table 1. Average percent frequency and percent coverage of understory vegetation for 10 aspen transects, northern Black Hills, June 1967.

Species	Percent Frequency	Percent Coverage
Vetchling (Lathyrus ochroleucus)	64.1	12.9
Grasses	71.1	12.8
Unidentified forbs	72.5	12.0
Filbert (Corylus cornuta)	24.1	10.3
Oregon grape (Mahonia repens)	51.8	9.7
Spiraea (Spiraea lucida)	47.0	9.5
Serviceberry (Amelanchier alnifolia)	37.0	8.9
Wolfberry (Symphoricarpos occidentalis)	60.0	8.5
Pasture brake (Pteridium aquilinum)	24.7	7.1
Wild-lily-of-the-valley (Maianthemum canadense)	55.5	5.6
Meadowrue (Thalictrum venulosum)	31.4	4.4
Clover (Trifolium pratense)	11.3	2.4
Wild rose (Rosa woodsii)	20.3	2.2
American vetch (Vicia americana)	17.0	2.2
Wild raspberry (Rubus sp.)	14.1	1.9
Shinleaf (Pyrola sp.)	16.8	1.8
Bearberry (Arctostaphylos uva-ursi)	4.7	1.6
Wild bergamot (Monarda fistulosa)	12.8	1.5
Wild strawberry (Fragaria ovalis)	16.6	1.4
Lupine (Lupinus argenteus)	11.0	1.1
Dandelion (Taraxacum officinale)	10.5	1.1
Chokecherry (Prunus virginiana)	9.8	1.1
Violet (Viola adunca)	14.3	trace
Yellow mandarin (Disporum lanuginosum)	6.9	trace
Aspen (Populus tremuloides)	5.5	trace
Yarrow (Achillea lanulosa)	5.5	trace
Black snakeroot (Sanicula marilandica)	3.2	trace
Bur oak (Quercus macrocarpa)	2.2	trace
Prince's pine (Chimaphila umbellata)	1.9	trace
Pussytoes (Antennaria parvula)	1.0	trace
Paper birch (Betula papyrifera)	0.9	trace
Sedge (Carex sp.)	0.8	trace

The other three overstory species present were bur oak, serviceberry, and white spruce. Basal area in square feet per acre for all overstory species on each transect and averages for all transects are shown in Appendix I.

Summer Food Habits

Two whitetail deer were placed in the utilization section of the pasture on July 21, 1967, and were removed on August 8, 1967. Figure 6 shows one of the deer inside the pasture during the study.

Utilization by leaf count and annual growth of four high woody species follow:

Species	Percent Utilization by Leaf Count	Percent Utilization by Annual Growth
Bur oak (Quercus macrocarpa)	82.9	35.2
Serviceberry (Amelanchier alnifolia)	76.0	42.3
Paper birch (Betula papyrifera)	57.6	0
Filbert (Corylus cornuta)	11.8	9.1

The leaf count method probably represents a more accurate measure of utilization than does measurement of annual growth. It appeared that at least some of the annual growth was removed by deer as accessory material while they were eating leaves. Cook and Stoddart

(1953), in a food habits study of sheep in Utah, pointed out that leaf utilization more closely approaches total utilization than does twig utilization for browse species in summer.

A second measure of utilization inside the pasture was obtained by estimating use for each species within the sample plots. Forty plots were used which represented approximately two percent of the utilization section of the pasture. Utilization was estimated by strata to determine if deer showed a preference for higher vegetation.

Thirty-seven species of plants occurred in the sample plots. Most important food species were vetchling, serviceberry, bur oak, and American vetch. Highest utilization in the upper stratum was 79.6 percent for vetchling while lowest was 13.5 percent for filbert (Table 2). In general it appeared deer preferred higher vegetation. Of five species in the upper stratum which were utilized, only one, chokecherry, received less use than it did in the lower stratum. The most highly preferred food species was American vetch which received a rating of 4.8 and had an estimated utilization of 33.5 percent (Table 3). Serviceberry was the second most highly preferred species with a rating of 2.7. Vetchling was also highly preferred with a rating of 2.4. Bur oak was utilized in moderate amounts and was fairly abundant on the range. However, its preference rating was 0.9 which indicated that there

Table 2. Average utilization and importance of plant species eaten by two whitetail deer in a representative aspen pasture, northern Black Hills, summer 1967.

Species	Average Percent Utilization	Importance Rating
2-5 Ft in height		
Bur oak (Quercus macrocarpa)	69.5	17.4
Serviceberry (Amelanchier alnifolia)	56.9	10.0
Vetchling (Lathyrus ochroleucus)	79.6	3.2
Filbert (Corylus cornuta)	13.5	2.6
Chokecherry (Prunus virginiana)	15.0	--
0-2 Ft in height		
Vetchling (Lathyrus ochroleucus)	27.0	37.4
Serviceberry (Amelanchier alnifolia)	36.5	24.7
American vetch (Vicia americana)	33.5	10.9
Spiraea (Spiraea lucida)	11.3	7.6
Filbert (Corylus cornuta)	5.0	5.3
Lupine (Lupinus argenteus)	20.0	4.7
Bur oak (Quercus macrocarpa)	24.9	3.7
Wolfberry (Symphoricarpos occidentalis)	7.2	2.4
Meadowrue (Thalictrum venulosum)	5.5	1.8
Chokecherry (Prunus virginiana)	19.3	1.3
Grasses	0.7	1.0
Pasture brake (Pteridium aquilinum)	1.3	0.9
Wild rose (Rosa woodsii)	9.2	0.8
Aster (Aster laevis)	1.2	0.5
Dogbane (Apocynum androsaenifolium)	3.8	0.1
Wild sarsparilla (Aralia nudicaulis)	1.8	0.1
Wild bergamot (Monarda fistulosa)	0.4	0.1
Aspen (Populus tremuloides)	76.9	--
Everlasting (Anaphalis margaritacea)	34.3	trace
Oregon grape (Mahonia repens)	0.6	trace
Wild-lily-of-the-valley (Maianthemum canadense)	0.8	trace
Black snakeroot (Sanicula marilandica)	0.4	trace

Table 3. Preference ratings of plants eaten by two whitetail deer in a representative aspen pasture, northern Black Hills, summer 1967.

Species	Preference Ratings
2-5 Ft in height	
Vetchling (Lathyrus ochroleucus)	1.6
Bur oak (Quercus macrocarpa)	1.4
Serviceberry (Amelanchier alnifolia)	1.1
Filbert (Corylus cornuta)	0.3
0-2 Ft in height	
American vetch (Vicia americana)	4.8
Serviceberry (Amelanchier alnifolia)	2.7
Vetchling (Lathyrus ochroleucus)	2.4
Lupine (Lupinus argenteus)	1.8
Chokecherry (Prunus virginiana)	1.7
Spiraea (Spiraea lucida)	1.1
Bur oak (Quercus macrocarpa)	0.9
Filbert (Corylus cornuta)	0.4
Wolfberry (Symphoricarpos occidentalis)	0.3
Pasture brake (Pterdium aquilinum)	0.1
Grasses	trace
Meadowrue (Thalictrum venulosum)	trace
Aster (Aster leavis)	trace
Oregon grape (Mahonia repens)	trace
Wild rose (Rosa woodsii)	trace

was proportionately more oak on the range than deer consumed. No utilization was detected on 12 species within the pasture. Two forbs, wild bergamot (Monarda fistulosa) and pasture brake (Pteridium aquilinum) were abundant in pasture understory but were utilized in very slight amounts. Aspen sprouts were heavily utilized but present in only small amounts and therefore were not considered important. No aspen was encountered in sample plots of the control section. Pine, bearberry, and common juniper were present in the understory of the utilization section of the pasture but did not occur in the sample plots. These plants were examined individually after deer were removed but no utilization was detected. Oregon grape was available in moderate amounts but received only a trace of utilization. The most abundant plants as a group were grasses. Four species of grass present were smooth brome grass (Bromus inermis), Kentucky blue grass (Poa pratensis), orchard grass (Dactylis glomerata), and schizachne (Schizachne purpurascens). They accounted for 14.95 percent of the total available forage by weight. However, less than one percent of available grass was eaten. Hill (1946) also found grasses low in palatability during summer months.

In general, browse species were slightly more important as a group than forbs, even though the most important single species was a forb, vetchling.

The weight utilization method, which involved comparing average plot weights of annual growth from utilization and control sections, was probably most variable of the four methods used. Although vegetation within the two sections of the pasture appeared to be homogeneous, it apparently was not. This seemed to be indicated since several species including bur oak, filbert, Oregon grape, and pasture brake averaged higher weights in the utilization than the control section of the pasture. Sample size for both sections was approximately two percent of the area. Average plot weights for utilization and control section species considered important and apparent utilization by weight in percent is shown in Appendix K. Because of apparent lack of homogeneity, percent utilization as shown in Appendix K is questionable and is presented mainly to show results of utilization by weight technique. Stoddart and Smith (1955) pointed out heterogeneity of most western ranges makes this method impractical because of the large number of sample plots required.

Deer appeared to behave normally during the pasture study. By observation it appeared that most feeding occurred in early morning or late evening and, at least on several occasions, continued after dark. Fresh water was provided each day but little was used. A small block of salt was also placed inside the pasture. The deer moved throughout the utilization section of the pasture but

usually bedded down in the same spot each day. There were few, if any, disturbances of the animals and even placing fresh water inside the pasture did not alarm them.

Since the deer were raised in captivity and were semi-tame they were much easier to use in an experiment of this type. The one-week conditioning period, during which time deer were fed vegetation cut from aspen understories, no doubt reduced error which could result from using deer which were unfamilar with aspen understory vegetation. It became apparent after feeding deer in the conditioning pen for several days that they developed preferences for certain species of plants.

Thirty-seven species or groups of plants were identified from five buck and four doe stomachs collected on aspen areas adjacent to the pasture site. Important food species in stomachs analyzed follow:

Species	Percent Frequency	Average Abundance	Relative Importance
Vetchling (Lathyrus ochroleucus)	100.0	2.7	34.4
Serviceberry (Amelanchier alnifolia)	100.0	2.4	21.7
Mushroom	77.7	2.3	--
Aster (Aster leavis)	66.6	1.9	--
Spiraea (Spiraea lucida)	55.5	1.2	11.6

Percent frequency of occurrence, average abundance and relative importance of all species or groups found in summer stomachs are presented in Appendix J. Stomach analysis results did not agree

completely with those of the pasture utilization study. Several species, including vetchling and serviceberry, were important in both cases along with spiraea which was moderately important. Bur oak received a fairly high average abundance rating but was not considered important because of low availability. Importance ratings for summer stomachs were obtained by multiplying the average abundance rating by average percent coverage from the 10 aspen transects. For aspen stands in general, bur oak comprised less than one percent of total coverage. Since moderate amounts of oak were found in stomachs, deer showed a high preference for that species. However, preference rating for oak from the pasture study was less than one. Mushrooms were very abundant in stomachs but did not occur in either pasture or aspen transects. It would appear that a very high preference was shown for this food item. Aster was also found in large amounts in stomachs but received only slight utilization in the pasture. This species was not well developed in early June when transects were run and therefore an importance rating for this species was not obtained for stomach analysis data. American vetch was of more importance in the pasture study than in stomach samples. Although deer were collected in aspen stands, they most likely did not do all of their feeding there. This could seriously bias the importance ratings because availability data were from aspen sites only.

Forage Production

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 five feet in height in the control section (Figure 7). Total green weight for all species was 2,650 pounds per acre. Air-dried weight of the same material was 835.1 pounds per acre. Production ranged from 130.6 pounds per acre for grasses to a trace for common dandelion (Taraxacum officinale) and perideridia (Perideridia gairdneri). Vetchling produced the most forage for any single species, 124.5 pounds per acre. Total forage production for all species found in the control section of the pasture is presented in Table 4.

Figure 6. Deer inside aspen pasture, northern Black Hills, summer 1967.

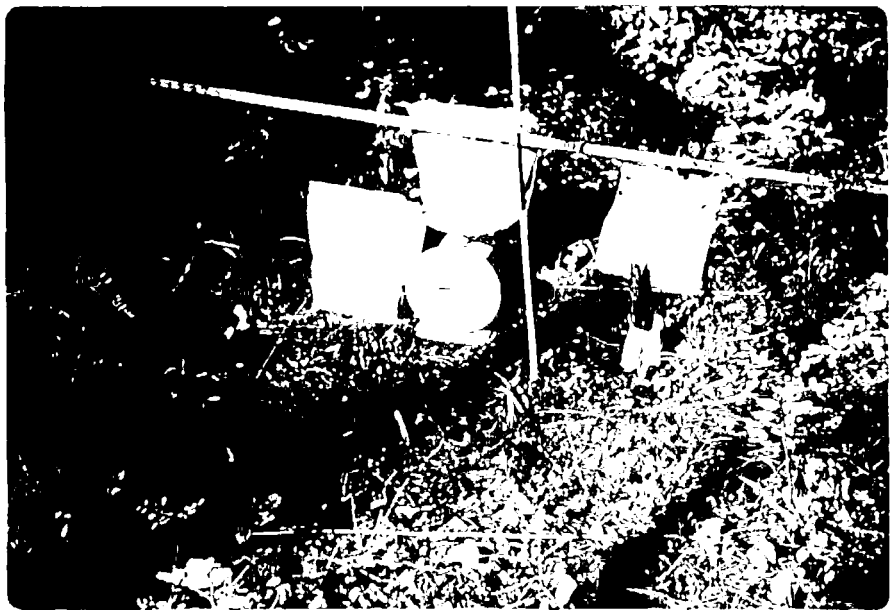

Figure 7. Clipped plot in control section of aspen pasture, northern Black Hills, summer 1967.

Table 4. Total forage production by species from 0-5 feet in a typical aspen stand, northern Black Hills, August 1967.

Species	Pounds/Acre
Grasses	130.6
Vetchling (Lathyrus ochroleucus)	124.5
Filbert (Corylus cornuta)	108.3
Serviceberry (Amelanchier alnifolia)	71.3
Pasture brake (Pteridium aquilinum)	63.0
Spiraea (Spiraea lucida)	58.5
Oregon grape (Mahonia repens)	38.0
Aster (Aster leavis)	36.4
Bur oak (Quercus macrocarpa)	35.0
Clover (Trifolium pratense)	30.3
Wolfberry (Symphoricarpos occidentalis)	29.0
American vetch (Vicia americana)	28.5
Meadowrue (Thalictrum venulosum)	27.8
Wild bergamot (Monarda fistulosa)	27.3
Lupine (Lupinus argenteus)	20.7
Wild rose (Rosa woodsii)	0.8
Wild sarsaparilla (Aralia nudicaulis)	0.6
Chokecherry (Prunus virginiana)	0.6
Shinleaf (Pyrola sp.)	0.4
Yellow mandarin (Disporum lanuginosum)	0.3
Dogbane (Apocynum androsaemifolium)	0.3
Black snakeroot (Sanicula marilandica)	0.3
Thimbleberry (Rubus parviflorus)	0.2
Bedstraw (Galium boreale)	0.2
Violet (Viola adunca)	0.2
Bearberry (Arctostaphylos uva-ursi)	0.1
Wild-lily-of-the-valley (Maianthemum canadense)	0.1
Lattice-leaf (Goodyera oblongifolia)	0.1
Downy yellow violet (Viola pubescens)	0.1
Wild strawberry (Fragaria ovalis)	0.1
Dwarf raspberry (Rubus pubescens)	trace
Everlasting (Anaphalis margaritacea)	trace
Yarrow (Achillea lanulosa)	trace
Bluebell (Campanula rotundifolia)	trace
Perideridia (Perideridia gairdneri)	trace
Dandelion (Taraxacum officinale)	trace

CONCLUSIONS

The most important food item of whitetail deer in the northern Black Hills during fall and winter is Oregon grape. This species is 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 is decreased with increasing snow cover. During periods of snow cover, common juniper replaces Oregon grape as the most important species. Bearberry is highly preferred and is also important during periods of little or no snow cover. Ponderosa pine, lichens and bur oak were eaten in moderate amounts but are of secondary importance as winter food items.

There is considerable variation in species composition and density of aspen understories. It appears that in stands which receive heavy use by cattle, grasses are increasing while many forbs are decreasing. Overstory composition was also found to be variable with large amounts of paper birch present in some stands.

Aspen stands appear 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, serviceberry, bur oak, and American vetch. Deer preferred higher vegetation. Analysis of stomach samples collected from nine deer in aspen

stands adjacent to the pasture site did not completely agree with pasture results. Aster and spiraea replaced American vetch and bur oak as important species.

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 835.1 pounds per acre air-dried weight.

RECOMMENDATIONS

1. A study be conducted to learn more about ecology of Oregon grape in the northern Black Hills.

2. Range condition and trend surveys be established which consider Oregon grape as the key indicator species.

3. An experiment be set up to determine proper use factors for Oregon grape and common juniper.

4. A study be conducted to determine effects of cattle feeding and trampling on aspen understories.

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APPENDIX

Appendix A. Frequency of occurrence, percent weight, and importance of plant species found in 18 whitetail deer stomach samples, northern Black Hills, November 1966.

Species	Percent Frequency	Percent Weight	Importance Rating
Oregon grape (Mahonia repens)	83.5	27.1	22.6
Bearberry (Arctostaphylos uva-ursi)	83.5	11.9	9.9
Aspen (Populus tremuloides)	55.6	4.9	2.7
Ponderosa pine (Pinus ponderosa)	61.2	4.2	2.6
Bur oak (Quercus macrocarpa)	61.2	3.4	2.1
Wolfberry (Symphoricarpos occidentalis)	55.6	3.8	2.1
Fungi	61.2	3.3	2.0
Mountain laurel (Ceanothus velutinus).	27.8	6.5	1.8
Unidentified forbs	72.3	1.9	1.4
Clover (Trifolium pratense)	55.6	1.3	0.7
Alfalfa (Medicago sativa)	55.6	1.0	0.6
Grasses	89.0	5.8	0.5
Shinleaf (Pyrola sp.)	50.0	0.6	0.3
Wheat (Tricitum sp.)	5.6	5.5	0.3
Lichen (Usnea sp.)	22.2	1.3	0.3
Pussytoes (Antennaria parvula)	33.3	0.7	0.2
Hawthorn (Crataegus sp.)	11.1	1.5	0.2
Corn (Zea mays)	5.6	1.6	0.1
Common juniper (Juniperus communis)	11.1	0.7	0.1
Vetchling (Lathyrus ochroleucus)	22.2	trace	trace
Wild rose (Rosa woodsii)	22.2	trace	trace
Serviceberry (Amelanchier alnifolia)	22.2	trace	trace

Appendix A. (continued)

Species	Percent Frequency	Percent Weight	Importance Rating
Shrubby cinquefoil (Potentilla fruiticosa)	16.7	trace	trace
Smooth sumac (Rhus glabra)	16.7	trace	trace
Prince's pine (Chimaphila umbellata)	16.7	trace	trace
Paper birch (Betula papyrifera)	11.1	trace	trace
Spiraea (Spiraea lucida)	5.6	trace	trace
Chokecherry (Prunus virginiana)	5.6	trace	trace
Redosier dogwood (Cornus stolonifera)	5.6	trace	trace
White spruce (Picea glauca)	5.6	trace	trace
Hop hornbeam (Ostrya virginiana)	5.6	trace	trace
Wild strawberry (Fragaria ovalis)	5.6	trace	trace
American elm (Ulmus americana)	5.6	trace	trace
Apple (Pyrus malus)	5.6	trace	trace
Oats (Avena sp.)	5.6	trace	trace

Appendix B. Frequency of occurrence, percent weight, and importance of plant species found in 24 whitetail deer stomach samples, northern Black Hills, November 1967.

Species	Percent Frequency	Percent Weight	Importance Rating
Oregon grape (Mahonia repens)	83.3	25.3	21.0
Common juniper (Juniperus communis)	62.5	14.5	9.1
Bearberry (Arctostaphylos uva-ursi)	75.0	6.1	4.6
Alfalfa (Medicago sativa)	20.8	11.6	2.4
Wolfberry (Symphoricarpos occidentalis)	45.8	1.5	0.7
Grasses	41.6	1.6	0.6
Unidentified forbs	25.0	2.3	0.6
Ponderosa pine (Pinus ponderosa)	54.2	1.0	0.5
Clover (Trifolium pratense)	20.8	2.4	0.5
Pine bark	29.2	1.5	0.4
Mountain laurel (Ceanothus velutinus)	12.5	2.3	0.3
Vetchling (Lathyrus ochroleucus)	45.8	0.6	0.3
Bur oak (Quercus macrocarpa)	16.7	1.5	0.2
Corn (Zea mays)	8.3	8.3	0.2
Lichen (Usnea sp.)	41.6	0.5	0.2
Aspen (Populus tremuloides)	41.6	0.4	0.2
Sorghum (Sorgum vulgare)	4.2	3.5	0.2
Wild bergamot (Monarda fistulosa)	16.7	0.6	0.1
Hawthorn (Crataegus sp.)	8.3	1.5	0.1
Pussytoes (Antennaria parvula)	12.5	0.4	0.1
Buttercup (Ranunculus aquatilis)	8.3	0.7	0.1
American elm (Ulmus americana)	8.3	0.6	0.1
Twinflower (Linnaea borealis)	4.2	0.4	0.1

Appendix B. (continued)

Species	Percent Frequency	Percent Weight	Importance Rating
Serviceberry (Amelanchier alnifolia)	16.7	trace	trace
Fungi	12.5	trace	trace
Yarrow (Achillea lanulosa)	12.5	trace	trace
Shinleaf (Pyrola sp.)	8.3	trace	trace
Buffaloberry (Sheperdia argentea)	8.3	trace	trace
Spiraea (Spiraea lucida)	8.3	trace	trace
Lupine (Lupinus argenteus)	8.3	trace	trace
Filbert (Corylus cornuta)	4.2	trace	trace
Box elder (Acer negundo)	4.2	trace	trace
Willow (Salix sp.)	4.2	trace	trace
Bur clover (Medicago hispida)	4.2	trace	trace
White spruce (Picea glauca)	4.2	trace	trace
Smooth sumac (Rhus glabra)	4.2	trace	trace
American vetch (Vicia americana)	4.2	trace	trace
Wild rose (Rosa woodsii)	4.2	trace	trace

Appendix C. Frequency of occurrence, percent weight, preference, and importance ratings of plant species found in 22 deer stomachs collected in the northern Black Hills during January, February, and March of 1967, and average availability of plant species on collection sites.

Species	Percent Frequency	Percent Weight	Preference Rating	Importance Rating	Average Percent Availability
Common juniper (Juniperus communis)	73.9	26.8	0.8	922.1	32.2
Oregon grape (Mahonia repens)	91.3	24.0	1.8	319.9	13.3
Oats (Avena sp.)	13.0	8.5	--	--	--
Bearberry (Arctostaphylos uva-ursi)	60.9	5.3	4.4	6.3	1.2
Ponderosa pine (Pinus ponderosa)	87.0	4.6	0.3	84.5	18.3
Lichen (Usnea sp.)	60.9	4.0	--	--	--
Bur oak (Quercus macrocarpa)	47.8	3.7	0.6	22.8	6.2
Mountain laurel (Ceanothus velutinus)	8.7	2.5	4.4	1.4	0.6
Pine bark	21.7	1.5	--	--	--
Serviceberry (Amelanchier alnifolia)	43.5	1.2	0.2	9.2	7.4
Grasses	60.9	1.0	0.1	16.2	15.6
Aspen (Populus tremuloides)	47.8	0.6	0.2	3.1	3.5
Sedge (Carex sp.)	8.7	0.5	--	--	--
Clover (Trifolium pratense)	17.4	0.5	0.8	0.3	0.6
Alfalfa (Medicago sativa)	8.7	0.5	0.1	1.7	3.5
Chokecherry (Prunus virginiana)	17.4	0.4	0.0	4.9	11.3
Pusseytoes (Antennaria parvula)	17.4	0.3	--	--	--
Paper birch (Betula papyrifera)	13.0	0.3	0.1	0.8	2.8
Smooth sumac (Rhus glabra)	8.7	0.3	0.3	0.3	0.1
American elm (Ulmus americana)	13.0	0.2	0.3	0.2	0.8
Wolfberry (Symphoricarpos occidentalis)	34.8	0.2	trace	3.1	15.3
Fungi	21.7	0.3	--	--	--

Appendix C. (continued)

Species	Percent Frequency	Percent Weight	Preference Rating	Importance Rating	Average Percent Availability
Shinleaf (Pyrola sp.)	13.0	0.1	0.6	trace	0.1
Black snakeroot (Sanicula marilandica)	13.0	0.1	0.2	trace	0.3
Wild rose (Rosa woodsii)	13.0	0.1	trace	0.2	3.6
Filbert (Corylus cornuta)	8.7	trace	trace	0.2	4.6
Fringed sage (Artemisia ludoviciana)	8.7	trace	0.5	trace	0.1
Wild raspberry (Rubus sp.)	4.3	trace	0.3	trace	0.7
Buffaloberry (Shepherdia argentea)	4.3	trace	0.3	trace	0.1
Hop hornbeam (Ostrya virginiana)	4.3	trace	trace	trace	1.9
American vetch (Vicia americana)	4.3	trace	0.2	trace	0.1
Skunkbush sumac (Rhus trilobata)	4.3	trace	trace	trace	0.6
White spruce (Picea glauca)	4.3	trace	trace	0.4	19.7
Redosier dogwood (Cornus stolonifera)	4.3	trace	trace	trace	3.2
Hawthorn (Crataegus sp.)	4.3	trace	0.1	trace	0.3
Unidentified forbs	34.8	trace	trace	trace	2.7
Prince's pine (Chimaphila umbellata)	4.3	trace	--	--	--

Appendix D. Frequency of occurrence, percent weight, preference, and importance ratings of plant species found in 10 deer stomachs collected in the northern Black Hills during February and March of 1968, and average availability of plant species on collection sites.

Species	Percent Frequency	Percent Weight	Preference Rating	Importance Rating	Average Percent Availability
Oregon grape (Mahonia repens)	100	40.4	2.5	647.9	16.1
Ponderosa pine (Pinus ponderosa)	90	9.8	2.6	37.4	3.8
Common juniper (Juniperus communis)	90	8.7	0.5	154.4	17.9
Bearberry (Arctostaphylos uva-ursi)	70	7.2	1.0	53.1	7.4
Oats (Avena sp.)	10	7.0	--	--	--
Serviceberry (Amelanchier alnifolia)	30	3.6	2.4	5.5	1.5
Grasses	100	2.8	0.2	50.7	18.1
Unidentified forbs	20	1.3	0.4	4.5	3.4
Pussytoes (Antennaria parvula)	30	0.8	--	--	--
Twinflower (Linnaea borealis)	30	0.6	0.7	0.5	0.8
Lichen (Usnea sp.)	40	trace	--	--	--
Wolfberry (Symphoricarpos occidentalis)	30	trace	--	--	7.5
Aspen (Populus tremuloides)	20	trace	--	--	--
Shinleaf (Pyrola sp.)	20	trace	--	--	trace
Clover (Trifolium pratense)	10	trace	--	--	--
Pine bark	10	trace	--	--	--
Fungi	10	trace	--	--	--
Mountain laurel (Ceanothus velutinus)	10	trace	--	--	--
Lupine (Lupinus argenteus)	10	trace	--	--	--
Wild rose (Rosa woodsii)	10	trace	--	--	--
Spiraea (Spiraea lucida)	10	trace	trace	--	1.0
White spruce (Picea glauca)	10	trace	--	--	5.3
Bur oak (Quercus macrocarpa)	10	0.5	0.5	0.5	1.0

Appendix E. Percent frequency and percent coverage of understory species in aspen stand No. 1.

Species	Percent Frequency	Percent Coverage
Filbert (Corylus cornuta)	28.0	15.7
Vetchling (Lathyrus ochroleucus)	77.4	14.9
Serviceberry (Amelanchier alnifolia)	56.0	13.7
Spiraea (Spiraea lucida)	66.7	13.0
Grasses	68.0	9.9
Oregon grape (Mahonia repens)	56.0	8.9
Wolfberry (Symphoricarpos occidentalis)	56.0	8.2
Unidentified forbs	50.8	5.6
Meadowrue (Thalictrum venulosum)	26.7	4.4
False Solomon's seal (Smilacina stellata)	49.2	3.8
Pasture brake (Pteridium aquilinum)	15.4	3.6
Wild rose (Rosa woodsii)	22.0	2.3
Chokecherry (Prunus virginiana)	16.0	2.0
Wild bergamot (Monarda fistulosa)	13.3	1.7
American vetch (Vicia americana)	12.0	1.4
Mountain laurel (Ceanothus velutinus)	0.7	1.3
Wild strawberry (Fragaria ovalis)	12.0	0.9
Violet (Viola adunca)	12.7	0.7
Shinleaf (Pyrola sp.)	7.3	0.7
Lupine (Lupinus argenteus)	6.6	0.7
Everlasting (Anaphalis margaritacea)	6.6	0.7
Bur oak (Quercus macrocarpa)	5.3	0.7
Sedge (Carex sp.)	2.0	0.5
Black snakeroot (Sanicula marilandica)	4.7	0.4
Yellow mandarin (Disporum lanuginosum)	3.2	0.4
Aspen (Populus tremuloides)	2.7	0.4
Dandelion (Taraxacum officinale)	2.0	0.3
Clover (Trifolium pratense)	0.7	0.3
Bearberry (Arctostaphylos uva-ursi)	1.3	0.2
Raspberry (Rubus sp.)	2.0	0.2
Yarrow (Achillea lanulosa)	1.3	0.1
Prince's pine (Chimaphila umbellata)	0.7	trace

Appendix F. Percent frequency and percent coverage of understory species in aspen stand No. 2.

Species	Percent Frequency	Percent Coverage
Vetchling (Lathyrus ochroleucus)	78.0	20.2
Oregon grape (Mahonia repens)	74.0	17.5
Unidentified forbs	88.0	14.0
Wolfberry (Symphoricarpos occidentalis)	72.0	11.9
Spiraea (Spiraea lucida)	54.0	11.0
Meadowrue (Thalictrum venulosum)	48.0	7.9
Pasture brake (Pteridium aquilinum)	28.0	7.4
Serviceberry (Amelanchier alnifolia)	34.0	6.5
Filbert (Corylus cornuta)	16.0	6.1
Wild-lily-of-the-valley (Maianthemum canadense)	57.0	5.6
Grasses	59.0	4.6
Clover (Trifolium pratense)	16.0	3.2
Wild rose (Rosa woodsii)	24.0	2.8
American vetch (Vicia americana)	22.0	2.4
Wild strawberry (Fragaria ovalis)	23.0	2.2
Yellow mandarin (Disporum lanuginosum)	16.0	1.9
Wild bergamot (Monarda fistulosa)	18.0	1.7
Chokecherry (Prunus virginiana)	12.0	1.6
Violet (Viola adunca)	19.0	1.1
Lupine (Lupinus argenteus)	13.0	1.1
Dandelion (Taraxacum officinale)	11.0	0.9
Common juniper (Juniperus communis)	1.0	0.9
Shinleaf (Pyrola sp.)	8.0	0.5
Bur oak (Quercus macrocarpa)	3.0	0.4
Yarrow (Achillea lanulosa)	4.0	0.3
Wild raspberry (Rubus sp.)	2.0	0.3
Paper birch (Betula papyrifera)	1.0	0.3
Prince's pine (Chimaphila umbellata)	3.0	0.2
Everlasting (Anaphalis margaritacea)	1.0	0.1
Aspen (Populus tremuloides)	1.0	0.1
Bearberry (Arctostaphylos uva-ursi)	1.0	0.1
Pussytoes (Antennaria parvula)	1.0	0.1

Appendix G. Percent frequency and percent coverage of understory species in aspen stand No. 3.

Species	Percent Frequency	Percent Coverage
Grasses	87.5	25.4
Unidentified forbs	67.0	10.5
Vetchling (Lathyrus ochroleucus)	45.0	10.4
Pasture brake (Pteridium aquilinum)	23.4	8.9
Wolfberry (Symphoricarpos occidentalis)	51.6	7.2
Wild-lily-of-the-valley (Maianthemum canadense)	56.0	7.1
Spiraea (Spiraea lucida)	35.4	6.9
Serviceberry (Amelanchier alnifolia)	26.0	6.8
Oregon grape (Mahonia repens)	33.4	5.2
Clover (Trifolium pratense)	20.5	4.9
Bearberry (Arctostaphylos uva-ursi)	16.5	4.8
Dandelion (Taraxacum officinale)	21.0	2.4
Filbert (Corylus cornuta)	6.5	2.4
Wild bergamot (Monarda fistulosa)	18.0	2.2
American vetch (Vicia americana)	10.0	2.2
Shinleaf (Pyrola sp.)	18.0	2.0
Meadowrue (Thalictrum venulosum)	11.0	1.7
Dwarf blueberry (Vaccinium scoparium)	8.0	1.6
Wild strawberry (Fragaria ovalis)	13.5	1.5
Wild rose (Rosa woodsii)	12.5	1.4
Lupine (Lupinus argenteus)	10.5	1.2
Yarrow (Achillea lanulosa)	10.5	1.2
Violet (Viola adunca)	14.5	1.1
Aspen (Populus tremuloides)	6.5	0.9
False Solomon's seal (Smilacina stellata)	6.5	0.8
Common juniper (Juniperus communis)	1.0	0.4
Pussytoes (Antennaria parvula)	3.0	0.3
Yellow mandarin (Disporum lanuginosum)	2.5	0.2
Chokecherry (Prunus virginiana)	1.5	0.2
Sedge (Carex sp.)	1.0	0.2
Paper birch (Betula papyrifera)	0.5	0.1
Prince's pine (Chimaphila umbellata)	4.0	0.1
Bur oak (Quercus macrocarpa)	0.5	0.1

Appendix H. Percent frequency and percent coverage of understory species in aspen stand No. 4.

Species	Percent Frequency	Percent Coverage
Unidentified forbs	84.0	17.7
Filbert (Corylus cornuta)	46.0	17.2
Grasses	70.0	11.4
Pasture brake (Pteridium aquilinum)	32.0	8.4
Oregon grape (Mahonia repens)	44.0	7.3
Spiraea (Spiraea lucida)	32.0	7.2
Wolfberry (Symphoricarpos occidentalis)	60.0	6.7
Wild raspberry (Rubus sp.)	46.0	6.4
Vetchling (Lathyrus ochroleucus)	56.0	6.2
Wild-lily-of-the-valley (Maianthemum canadense)	60.0	5.6
Serviceberry (Amelanchier alnifolia)	32.0	5.4
Shinleaf (Pyrola sp.)	34.0	3.9
Meadowrue (Thalictrum venulosum)	40.0	3.4
American vetch (Vicia americana)	24.0	2.6
Wild rose (Rosa woodsii)	22.0	2.1
Buffaloberry (Shepherdia argentea)	2.0	1.3
Wild strawberry (Fragaria ovalis)	18.0	1.2
Lupine (Lupinus argenteus)	14.0	1.2
Clover (Trifolium pratense)	8.0	1.2
Paper birch (Betula papyrifera)	2.0	1.0
Aspen (Populus tremuloides)	12.0	0.9
Yellow mandarin (Disporum lanuginosum)	6.0	0.8
Yarrow (Achillea lanulosa)	6.0	0.6
Chokecherry (Prunus virginiana)	10.0	0.6
Dandelion (Taraxacum officinale)	8.0	0.6
Violet (Viola adunca)	10.0	0.5
Black snakeroot (Sanicula marilandica)	6.0	0.5
Wild beramot (Monarda fistulosa)	2.0	0.2
Ponderosa pine (Pinus ponderosa)	2.0	0.1

Appendix I. Density of overstory species for 10 aspen transects measured in square feet per acre using breast-height diameter, northern Black Hills, summer 1967.

Species	Transect Number										Average
	1	2	3	4	5	6	7	8	9	10	
Aspen (Populus tremuloides)	101.5	90.5	101.5	61.0	90.0	99.5	60.0	79.0	76.5	32.5	79.2
Ponderosa pine (Pinus ponderosa)	15.0	5.0	0	8.5	8	5.0	36.0	2.0	1.0	30.0	11.1
Paper birch (Betula papyrifera)	2.5	15.5	13.5	29.5	16.5	3.0	28.5	27.0	35.0	47.5	21.9
Bur oak (Quercus macrocarpa)	11.5	5.0	0	0	0	8.5	0	0	2.0	0	2.7
Serviceberry (Amelanchier alnifolia)	0	0	0	0	2.5	0	0	0	0	0	.3
White spruce (Picea glauca)	0	0	0	0	0	1.0	0	0	0	0	.1
Totals	130.5	116.0	115.0	99.0	117.0	116.0	124.5	108.0	114.5	110.0	115.3

Appendix J. Percent frequency, average abundance, and importance of plant species found in nine whitetail deer stomachs collected in aspen stands in the northern Black Hills, summer 1967.

Species	Percent Frequency	Average Abundance	Importance Rating
Vetchling (Lathyrus ochroleucus)	100.0	2.7	34.4
Serviceberry (Amelanchier alnifolia)	100.0	2.4	21.7
Spiraea (Spiraea lucida)	55.5	1.2	11.6
Wolfberry (Symphoricarpos occidentalis)	55.5	0.8	6.6
Filbert (Corylus cornuta)	22.2	0.6	5.8
Grasses	44.4	0.4	5.6
False solomon's seal (Smilacina stellata)	33.3	0.6	3.1
Wild rose (Rosa woodsii)	66.6	1.2	2.7
Meadowrue (Thalictrum venulosum)	33.3	0.6	2.5
Clover (Trifolium pratense)	55.5	0.6	1.3
American vetch (Vicia americana)	22.2	0.4	1.0
Lupine (Lupinus argenteus)	44.4	0.8	0.9
Bur oak (Quercus macrocarpa)	88.9	1.6	trace
Aspen (Populus tremuloides)	55.5	1.1	trace
Black snakeroot (Sanicula marilandica)	55.5	0.6	trace
Yellow mandarin (Disporum lanuginosum)	22.2	0.2	trace
Ponderosa pine (Pinus ponderosa)	11.1	0.1	trace
Paper birch (Betula papyrifera)	11.1	0.2	trace
Wild raspberry (Rubus pubescens)	11.1	0.1	trace
Aster (Aster leavis)	66.6	1.9	--
Mushroom	77.7	2.3	--
Wild sarsaparilla (Aralia nudicaulis)	11.1	0.1	--
Wild strawberry (Fragaria ovalis)	33.3	0.6	trace
Shooting star (Dodecatheon pauciflorum)	11.1	0.2	--

Appendix J. (continued)

Species	Percent Frequency	Average Abundance	Importance Rating
Beard tongue (Pentstemon glaber)	11.1	0.1	--
Wild-lily-of-the-valley (Maianthemum canadense)	33.3	0.9	--
Redstraw (Galium boreale)	11.1	0.3	--
Lichen (Usnea sp.)	11.1	0.1	--
Wood lily (Lilium philadelphicum)	33.3	0.4	--
Bur clover (Medicago lupulina)	22.2	0.2	--
Wild violet (Viola sp.)	33.3	0.4	trace
Everlasting (Anaphalis margaritacea)	22.2	0.4	--
Blue-eyed grass (Sisyrinchium montanum)	11.1	0.1	--
Chokecherry (Prunus virginiana)	11.1	0.2	trace
Zizia (Zizia aptera)	1.1	0.1	--

Appendix K. Average plot weights in grams by species for utilization and control sections of deer pasture and apparent utilization by weight for two whitetail deer on a typical aspen site, northern Black Hills, summer 1967.

Species	Average Weight		Percent Apparent Utilization
	Control Section	Utilization Section	
2-5 Ft in height			
Serviceberry (Amelanchier alnifolia)	1.53	0.33	78.4
Bur oak (Quercus macrocarpa)	2.20	0.56	74.6
Filbert (Corylus cornuta)	1.66	1.64	trace
Vetchling (Lathyrus ochroleucus)	0.35	0.06	82.1
0-2 Ft in height			
Serviceberry (Amelanchier alnifolia)	5.60	1.71	69.5
Bur oak (Quercus macrocarpa)	1.30	4.42	--
Filbert (Corylus cornuta)	9.17	11.00	--
Vetchling (Lathyrus ochroleucus)	12.10	5.82	51.9
Oregon grape (Mahonia repens)	3.80	6.34	--
Pasture brake (Pteridium aquilinum)	6.30	7.94	--
Wild rose (Rosa woodsii)	0.77	0.35	54.6
Spiraea (Spiraea lucida)	5.85	3.50	40.2
Wolfberry (Symphoricarpos occidentalis)	2.90	1.97	32.1