NEVADA COOPERATIVE WILDLIFE RESEARCH

FOOD HABITS AND NUTRITION OF MULE DEER
(*Odocoileus hemionus hemionus* Rafinesque)
ON FOUR NEVADA RANGES

By Larry Arthur Doughty
June 1966

NEVADA FISH AND GAME COMMISSION

U. S. DEPARTMENT OF THE INTERIOR
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Reno

Food Habits and Nutrition of Mule Deer (<u>Odocoileus</u> <u>hemionus</u> <u>hemionus</u> Rafinesque) on Four Nevada Ranges

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Range Management

by

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INTRODUCTION

The demand on Nevada's big game herds has increased greatly during the last decade. With the rise in population comes an additional influx of hunters, who will bring pressure to bear on managing agencies to produce more deer. If these agencies are to keep pace with this increased pressure and avoid abuse of the range, they need a pool of information upon which to base management decisions.

Data on food preference and quality is important to proper management of this species. There is also a need for a method to assess the nutritional condition of these animals. In the present study an attempt was made to determine animal condition by the percent fat of various tissue samples.

This study is a portion of a cooperative research project among three agencies, the University of Nevada Agricultural Experiment Station, the Bureau of Land Management, and the Nevada Fish and Game Department. All three agencies were instrumental in making the selection of collection sites, and the Fish and Game Department was responsible for the actual collection of animals.

The principal objectives of this project were as follows: (1) to determine the food habits of mule deer (Odocoileus hemionus hemionus) on selected ranges; (2) to make nutritive determinations of key forage species on different dates for each range; (3) to attempt to develop some criteria relating animal condition to range type, condition, and season of year.

Mule deer collections were made on two summer and two winter ranges in Nevada. The rumen samples obtained from these animals were analyzed to provide quantitative botanical composition

of forage plants consumed. Forage samples were collected at various times throughout the year in order to determine the seasonal change of plant nutrients.

The results of these three phases of the study are intended to provide basic information that may have practical application in the management of Nevada deer herds and also to establish guidelines for future research.

STUDY AREAS

Four areas were selected for this study. These sites represent several different habitat types found in Nevada. It was thus hoped that a fair cross section of Nevada deer range would be investigated.

Two summer and two winter deer ranges were selected to gain a more complete picture of nutritional aspects of the animal in relation to seasonal changes. Fox Mountain in northern Nevada and Bates Mountain in the central part of the state were chosen as the summer range sites. The winter ranges selected were Morey Bench in south-central Nevada and the Pequop Mountains in the northeast. Each area is unique in itself and will be considered individually in more detail.

Fox Mountain

Fox Mountain is located in northern Washoe County and is one of several high mountainous areas that comprise the Granite Mountain Range. The elevation of the mountain peak itself is 8200 feet, but most of the collecting was done in lower adjacent areas of about 7200 feet.

The climate of Nevada is typical of the Great Basin Province (Fenneman, 1931). Maximum precipitation occurs in late winter and early spring varying from below 5 inches on the desert flats to 20 inches on the higher mountain areas. The period of heaviest snowfall occurs during late winter and with the advent of spring comes rain. Temperature fluctuations are great and range from below 0°F in the winter to values of 100°F or even higher during the hot dry summer.

Topography is characterized by the basin-range structure present in the Great Basin Province (Fenneman, 1931). This particular range is typified by several long deep canyons that grade gradually into a more level plateau with sharp rocky breaks.

The major species of the upper slopes consist of curl-leaf mountain mahogany (Cercocarpus ledifolius) interspersed by areas of bitterbrush (Purshia tridentata), low sagebrush (Artemisia arbuscula), and big sagebrush (Artemisia tridentata) with snowberry (Symphoricarpos longiflorus) and serviceberry (Amelanchier alnifolia) present in lesser amounts. Many of the steeper hill sides and rocky ledges are covered by dense growths of snowbrush (Ceanothus velutinus) and western choke-cherry (Prunus virginiana). Quaking aspen (Populus tremuloides) is found in the moister canyon bottoms in limited quantity. The lower plateau is composed chiefly of large stands of big sagebrush and bitterbrush. Cheatgrass (Bromus tectorum), sandberg bluegrass (Poa secunda), and Idaho fescue (Festuca idahoensis) make up the greater part of the grass species present, while balsam root (Balsamorhiza sagittata) and wild buckwheat (Eriogonum sp.) constitute the most abundant forbs.

It should be noted that the above discussion is merely a brief description of the general vegetation characteristics of the collection area. A description of the plant communities of Fox Mountain and the other three study locations was prepared by Berg (1966, unpublished data, Plant, Soil and Water Science Division, University of Nevada, Reno).

Several natural springs are present at the higher elevations providing water for animals throughout the year.

Although Fox Mountain is mainly considered a summer deer range, reports from Nevada Fish and Game personnel (Jack Woody, personal communication) indicate that deer will stay on late in the year and gradually move to the lower areas as the snow conditions begin to hinder their activities. Then again in the spring as the snow level recedes upward, animals begin to move up from the lower flats to the higher mountain mahogany type. Thus, there is not a mass migration of deer to and from the area, but merely an altitudinal movement that closely follows changing weather conditions.

Bates Mountain

Bates Mountain lies in the Simpson Park Mountain Range of central Nevada. The southwest portion of this range, which includes the study site, is located in southeastern Lander County. The elevation of the major portion of summer range is about 8400 feet.

The climate is again typical of the Great Basin Province.

Bates is a large mountain with numerous small basins and rims oocurring between the open ridges. Long deep canyons break from the higher areas and gradually wind down to the valley bottoms below.

There are numerous patches of quaking aspen present on the basin rims and canyon slopes. Thick stands of big sagebrush occur in the basin bottoms with an understory composed of several species of grass and forbs. Serviceberry and snowberry may be found along ridges and basin edges. The rockier rims are often covered by dense stands of choke-cherry which grades gradually into the aspen stands.

Most of the long open ridges are vegetated by low sagebrush and sandberg bluegrass with scattered browse plants being found at various locations. Several of the basin areas have limited amounts of mountain meadow present in the moister sites.

The water supply is quite ample for the area. Several natural springs in the basins give rise to small creeks which run down to the valley bottoms.

Bates Mountain is a typical deer summer range with deer coming from many miles. Deer generally begin to move into the area during early May. The exact location of the winter ranges of these deer is only partially known. In early fall the first animals begin their annual trek back to their respective winter ranges. By late fall there are very few animals remaining in the area (Merlin McColm, Nevada Fish and Game Commission, Personal Communication).

Morey Bench

Morey Bench is located on the east side of the Hot Creek Mountain Range in Nye County approximately 90 miles northeast of Tonopah, Nevada. The bench itself runs in a north-south direction for about 6 miles along the base of Morey Peak and has an elevation which approximates 6500 feet.

The Great Basin climate again predominates in the Morey area.

Topography of the site may be described as a rugged shelf or bench area breaking away sharply from the steep slopes of Morey Mountain. Several sharp, rocky ravines are present throughout the length of the bench, being formed by the drainage channels

of the upper slopes. The soil is shallow and rocky with many large boulders located along the breaks giving the area a rough appearance.

The vegetation of the upper bench and mountain slopes is composed predominantly of juniper (Juniperus osteosperma) and Pinyon pine (Pinus monophylla). Lower on the bench are large thick stands of desert bitterbrush (Purshia glandulosa) interspersed by big sagebrush, desert peach (Prunus andersonii), and skunk brush sumac (Rhus trilobata). Both Ephedra nevadenis and E. viridus are distributed thinly over the area. There is also a moderate stand of serviceberry situated near the center of the bench. Several species of grass and forbs are present in limited quantity throughout the study site. Below the bench proper lies the lower flats vegetated primarily by big sagebrush and grass.

Morey Bench is basically a winter range with very few if any deer remaining the year around. The first deer usually reach Morey in late fall and remain throughout the winter. In early spring, most of the animals begin the journey back to their summer ranges. Many of these deer travel long distances to the North to reach the summer home they left the previous fall (Marshall Humphreys, Nevada Fish and Game Commission, Personal Communication).

Pequop Mountains

The Pequop Mountain range is located in northeastern Elko County, about 30 miles east of Wells, Nevada. The range is oriented in a north-south direction and varies in elevation from about 8300 feet at the higher peaks to 6400 feet in the lower foothills.

The climate, as in the other areas, is typical of the Great Basin. One difference from the other study locations is the increased depth of snow that may accumulate during the winter.

Topography of the Pequop range is typical of the basin range mountains system. The collection area proper is characterized by many long, deep, and winding canyons that arise from the central portions of the range and gradually open up at the mountain's base. Several of these canyons are large and form small basins toward the interior of the mountain proper.

The predominant plant species comprising the major vegetational type of the area are juniper and pinyon pine. Curl-leaf mountain mahogany is also present in moderate amounts over most of the Pequop's. In the northern portion of the range, bitterbrush, snowberry, and serviceberry are found in the basins and canyons. As one moves further south stands of cliffrose (Cowania stansburiana) become more prevalent on the south facing slopes. Several species of forbs and grass are present on the north facing slopes and canyon bottoms. The more exposed lower slopes are covered typically by black sage (Artemisia nova), pinyon pine, and juniper.

The Pequop is strictly a winter range. There are seldom many deer remaining in the area during the summer months. The major part of the mountain range is used by these deer during the winter season. The animals generally move into the northern part of the range first and then gradually work further south as the harsh winter ensues.

Papez and Gruell (1963) found that small groups of deer migrate into the Pequop area from several different summer ranges

which may be as much as 90 miles distant. When spring comes the deer again leave for their respective summer ranges.

FOOD HABITS

Literature Review

The subject of food habits is of prime importance to a more complete understanding of the ecology of deer in relation to range and climatic conditions. A manager must know species preference, season of use, and the nutritive value of the forage if he is to properly manage the animal in accordance with habitat conditions.

During the past several years there has been considerable work done in the area of food habits. Basically there are two methods that can be used to determine the forage species consumed. One is by direct observation of the grazing animal, and the other involves botanical analysis of a stomach sample. The latter method has proved to more commonly used because it provides concrete information.

As early as 1934, Dixon worked on the food habits of mule deer in California. He noted the importance of forbs in the summer diet of these deer.

Carhart and Coutts (1941) and Carhart (1944) in Colorado reported that browse was an important constituent in the diet during all seasons. DeNio (1938) and Edwards (1942) also noted the importance of browse in the winter diet and indicated the use of green grass in early spring.

Smith (1952) found that deer utilized about 125 species, but that the bulk of the seasonal diet consisted of eight or fewer species. He also confirmed the heavy utilization of green grass in the spring. Ferrel and Leach (1950) collected stomach samples from the Jawbone

deer herd of California. Their analysis revealed over 89% of winter food to be browse plants. The food habits of the Doyle deer herd in northern California were described by Lassen, Ferrel, and Leach (1953). They found big sagebrush (Artemisia tridentata) and bitter-brush (Purshia tridentata) to be the principal constituents of the deer diet in winter. Green cheat grass (Bromus tectorum) was found to be the most important supplement to browse species when it greened up under mild conditions.

Julander (1955) indicated that forbs and browse accounted for most of the summer deer diet, with browse also forming a majority of the winter food intake. The foot habits of the Great Basin deer herds of California were described by Leach (1956). The plants which formed the greatest bulk of the winter food of these mule deer consisted of sagebrush, bitterbrush, juniper, and annual grasses. Leach also pointed out that food habits of a particular deer herd was dependent upon the forage species available and the climatic conditions.

Yeager (1960) stated that no one species contains the nutritive qualities required for permanent health of big game animals. This indicates the need of a mixed browse type rather than a homogenous diet of one species.

Considering these studies it becomes evident that one would find great variability in food habit studies from different areas and on the same areas under different climatic conditions. Therefore, one should not apply the results of food habit studies of one deer herd to another herd in a different area under variable climatic conditions except in a very general way.

Methods

Food habits of Nevada mule deer were determined by rumen analysis. Animal collections were made on all four study areas during three different dates. Five animals were taken each collection date. This resulted in a total of 15 deer per study area per year. The summer collections were made in May, July, and September. Winter deer were taken during December, January, and March. Animals were collected to coincide with movement onto a given range unit, after on the range a period of time, and prior to leaving on their annual migration. An attempt was made to collect only yearling does in order to reduce animal variation.

Upon obtaining the animal in the field, it was immediately field dressed and all internal organs placed on the ground. Next, the rumen was cut open and the contents mixed to insure a more random sample. Approximately $1\frac{1}{2}$-2 liters of rumen material were removed and placed in a plastic sack. This sack was securely tied, labeled as to animal, date, and location, and then placed in an insulated cooler containing dry ice. Samples were transported to the laboratory and placed in cold storage until analyzed.

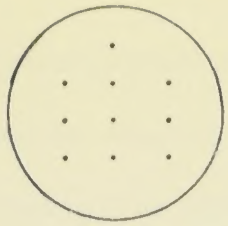
In preparation for analysis the rumen material was thoroughly washed in a 1 mm nylon mesh container. This removed most of the rumen fluid and the fine particles which were of negligible proportion. The remaining material was then again thoroughly mixed and a grab sample taken. This grab sample was placed in a plastic container containing approximately 8.5 liters of water. Enough rumen material was placed in the water

to give an average of four to seven hits per observation when analyzing the sample. These values were arrived at after some experience in using the method.

The water immersed sample was stirred from the bottom with a 1.38 cm diameter petri dish. When the rumen particles were thoroughly agitated the petri dish was raised slowly from the bottom allowing the lighter top material to settle into the dish. Upon reaching the surface, about three-fourths of the water in the dish was decanted. This sample was then prepared for analysis.

There have been several methods used to analyze the rumen contents of wild ruminants. Some workers have relied on the tedious volumetric measurement method or merely a visual estimate of the percent volume (Leach, 1956; Trout, 1964). Irrespective of the method used, complete rumen analysis is slow and time consuming. In this study a point analysis method was used to conserve time and increase data objectivity. Heady and Torell (1959), Lesperance et al. (1950), and Box and Chamrad (1964) used a point system for analysis of rumen contents. All of these point systems are a modification of Levy and Madden's (1933) point method of pasture analysis. The particular system employed here is considerably modified from any previously used and warrants a complete description.

A grid constructed from aluminum foil was developed. It contained 10 points, placed 5 mm apart and arranged in the following design:



This grid was centered under the objective of a 12X dissecting scope and taped securely to the stage. A sample obtained as previously described was then placed under the objective and on top of the grid. The points were easily seen through the petri dish and no problems arose in determining hits. The number of points covered by one half or more with plant material were recorded by plant species or by species group if positive identification was not possible. After the first observation the dish was moved 2 cm and the count was repeated. This process was continued until five readings with a possible 50 points per petri dish were recorded. The same procedure was followed for a total of four petri dish samples resulting in a possible 200 points per rumen sample. The points were converted. into a percentage for each species or species group present in the rumen sample.

The species present were determined whenever possible. No attempt was made to identify grass species and many of the more succulent forbs found were classed in one group. This was deemed necessary because ruminant digestion made identification of these species often impossible.

It was found (Box and Chamrad, 1964) that the presence of large items in the rumen sample would cause overestimation of these species. Many of the rumen samples obtained in this study did contain large leaves, stems, and other plant parts. In view of

this it was felt necessary to attempt to correct for this error.

The need for a correction was based on the assumption that the point method gives values which are actually a measure of the relative proportion of surface area rather than of weight. In order to correct for this the realtive ratios of surface area to weight must be known.

The relative surface area of each species was determined in the following manner. One gram of oven dried plant material of each species was spread at random over a 450 cm^2 grid being careful not to overlap any pieces. This grid was constructed with a dot placed in the center of each cm^2. The number of dots covered by one half or more with plant material were counted and recorded. This value was taken to represent the surface area per gram of oven dry plant material of the species in question. It should be noted that two other procedures, one consisting of a line intercept and the other of a one dot per 0.25 cm^2 grid were compared before the one dot per cm^2 was selected as the most reliable and efficient method.

The test was replicated five times for each species and the mean used in subsequent computations. Analysis of variance of all species measured yielded an F value that was highly significant at the 0.01 level. Duncan's multiple range test was used to separate mean surface area values for all species. From this analysis the means were grouped according to significance and correction factors computed (Table 1).

In calculation of the correction factors, the surface area value obtained for bitterbrush (Putr) was used as a base. All other means

Table 1. Mean surface area values and forage correction factors for selected plant species.

Species	X Area (cm^2)	Sig. Groups*	Correction Factor
Populus tremuloides	97.6	a	2.15
Symphoricarpos longiflorus	84.6	b	1.81
Prunus virginiana	79.8	bc	1.81
Balsamorhiza sagittata	74.6	c	1.65
Chrysothamnus lanceolatus	66.6	d	1.47
Bromus tectorum	66.4	d	1.47
Lupinus sp.	46.8	e	1.0
Purshia tridentata	45.8	ef	1.0
Amelanchier alnifolia	43.4	ef	1.0
Eriogonum sp.	42.2	ef	0.89
Artemisia tridentata	39.8	f	0.89
Ceanothus velutinus	39.6	f	0.89
Poa secunda	39.2	f	0.89
Cercocarpus ledifolius	31.6	g	0.67
Atriplex canscens	29.2	gh	0.67
Purshia glandulosa	24.4	h	0.53
Cowania stansburiana	24.0	h	0.53
Artemisia arbuscula	23.4	h	0.53
Pinus monophylla	13.2	i	0.25
Juniperus osteosperma	11.6	i	0.25
Ephedra viridis	10.6	i	0.25
Ephedra nevadensis	10.2	i	0.25
Grass	Avg. Grass sp.		1.18
Forbs	Avg. Forbs sp.		1.32

* Sig. groups represents the results of Duncan's Multiple Range Test. The small letters indicate significant differences between mean values. Values with the same letter are nonsignificant from one another. The dark lines represent species groups that are non-significant from one another and therefore have the same correction factor.

from the remaining species groups were divided by this value to obtain the correction factor.

The next step was to divide the percent cover (as determined by point analysis) for each species in the sample by the appropriate correction factor. The value obtained was termed the dry weight proportion (DWP). Next all DWP values for the sample were summed to get a total proportion factor (TPF). The last computation involves dividing each DWP by the TPF and multiplying by 100. These values represent the percent of that particular species in the rumen sample on a dry weight basis.

The following formulae may help to illustrate the computations involved.

(1) $$\frac{\text{Surface area of particular species}}{\text{Surface area of base (Putr)}} = \text{Correction factor}$$

(2) $$\frac{\text{\% cover (as determined by point analysis)}}{\text{Correction factor}} = \text{DWP}$$

(3) $$\sum \text{DWP (for all species in sample)} = \text{TPF}$$

(4) $$\frac{\text{DWP}}{\text{TPF}} \times 100 = \text{\% of species in rumen sample on dry weight basis}$$

The logical next step was to test the accuracy of these correction factors by applying them to artificial rumen samples of known weight percentage. Several artificial rumens were prepared. Each was composed of three different plant species in various known weight proportions.

These samples were analyzed by the point method and then converted to a dry weight basis by the method previously outlined. The results obtained from three of these artificial rumen samples are presented in Table 2.

Table 2. Comparison of artificial rumen samples (actual % wt.) with corrected and uncorrected results from the point analysis method (five replications).

	#1			#2			#3		
Species*	Brte	Basa	Artr	Pimo	Pugl	Lupine	Prvi	Cele	Eri
Actual %	30.0	40.0	30.0	20.0	40.0	40.0	30.0	35.0	35.0
Uncorrected %	24.0	70.1	5.1	13.3	23.3	63.3	63.6	12.7	23.6
Corrected %	28.0	68.2	8.0	33.2	27.3	39.5	43.5	23.6	32.9
Uncorrected %	26.2	62.1	11.7	15.4	34.6	50.0	50.0	31.4	18.6
Corrected %	26.0	54.9	19.1	34.8	36.9	28.3	28.9	49.1	21.9
Uncorrected %	29.0	40.2	30.8	27.5	38.3	34.2	41.2	25.2	37.8
Corrected %	25.0	31.0	44.0	50.8	33.4	15.8	23.2	38.3	38.5
Uncorrected %	17.6	58.8	23.7	12.6	41.4	45.9	41.7	26.0	32.3
Corrected %	16.1	47.9	35.8	28.9	44.8	26.3	23.8	39.4	36.9
Uncorrected %	24.3	59.5	16.2	19.5	21.2	59.3	56.7	21.6	21.7
Corrected %	23.3	51.0	25.7	44.0	22.6	33.4	35.6	36.6	27.8

* Abbreviation Key

Brte - *Bromus tectorum*
Basa - *Balsamorhiza sagittata*
Artr - *Artemisia tridentata*
Pimo - *Pinus monophylla*
Pugl - *Purshia glandulosa*
Lupine - *Lupinus* sp.
Prvi - *Prunus virginiana*
Cele - *Cercocarpus ledifolius*
Eri - *Eriogonum* sp.

The composition of the artificial rumen samples was as follows:

(1) Sample #1 contained 30% Bromus tectorum (Brte), 40% Balsamorhiza sagittata (Basa), and 30% Artemisia tridentata (Artr).

(2) Sample #2 contained 20% Pinus monphylla (Pimo), 40% Purshia glandulosa (Pugl), and 40% Lupinus sp. (Lupine).

(3) Sample #3 contained 30% Prunus virginiana (Prvi), 35% Cercocarpus ledifolius (Cele), and 35% Erigonum sp. (Erio).

The data show that in general the correction method converted the values in the expected direction. Considering this and the increased value of having food habits on a dry weight basis, it was considered desirable to use this correction method. Therefore, all rumen analyses data presented in this study will be expressed on a dry weight basis. It is felt that the resultant values more nearly approximate the proportion of forage actually grazed.

Results and Discussion

Following completion of the analysis of individual rumens, the data was simmarized by location and season of use. The results are presented as the percentages of rumen contents on a dry weight basis. Frequency values are the number of animals in which a species occurred.

Fox Mountain - Summer 1964

The majority of food taken during the summer consisted of browse, with an exception in May (Table 3). During this period, 50% of the diet was composed of succulent green grass. By July, there was little utilization of grass, but bitterbrush consumption had increased from less than 2% to over 50% of the feed intake (Figure 1). This species remained high through September and

Table 3. Summer food habits of 15 mule deer at Fox. Mt. on three dates during 1964. (% wt. value is the mean of five rumen samples by date and 15 for summer)

Species*	MAY % Wt.	MAY Freq.	JULY % Wt.	JULY Freq.	SEPT. % Wt.	SEPT. Freq.	SUMMER % Wt.	SUMMER Freq.
UK	0.4	1	0.2	1	-	-	0.2	2
UKF	5.4	4	10.5	5	4.1	5	6.7	14
Gr	49.4	5	2.3	3	-	-	17.2	8
Putr	1.7	2	50.7	5	38.8	5	30.4	12
Cele	32.9	5	8.6	3	27.6	5	23.0	13
Prvi	-	-	0.1	1	3.6	3	1.2	4
Prem	-	-	3.0	1	8.8	1	3.9	2
Ceve	1.7	1	15.3	4	0.5	1	5.8	6
Rum	-	-	T	1	-	-	T	1
Amal	-	-	4.6	2	9.4	4	4.7	6
Sylo	-	-	0.4	3	3.6	2	1.3	5
Art	8.5	3	0.2	1	-	-	2.9	4
Potr	-	-	2.2	1	0.8	2	1.0	3
Basa	-	-	-	-	2.9	2	1.0	2
Eri	-	-	1.8	2	-	-	0.6	2

*Abbrebiation Key

UK = Unknown
UKF = Unknown Forbs
Gr = Grass sp.
Putr = *Purshia tridentata*
Prvi = *Prunus virginiana*
Cele = *Cercocarpus ledifolius*
Prem = *Prunus emarginata*
Ceve = *Ceanothus velutinus*
Rum = *Rumex* sp.
Amal = *Amelanchier alnifolia*
Sylo = *Symphoricarpos longiflorus*
Art. = *Artemisia sp.*
Potr = *Populus tremuloides*
Basa = *Balsamorhiza sagittata*
Eri = *Eriogonum sp.*

T = Trace

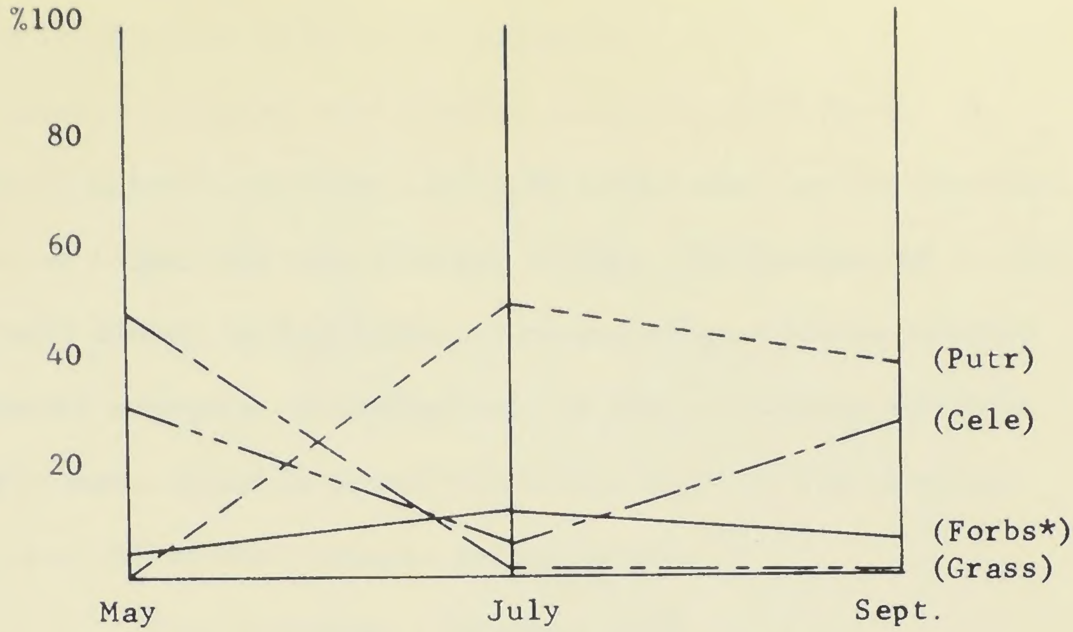


Figure 1. Graphic representation of the summer food habits of Fox. Mt. mule deer during 1964.

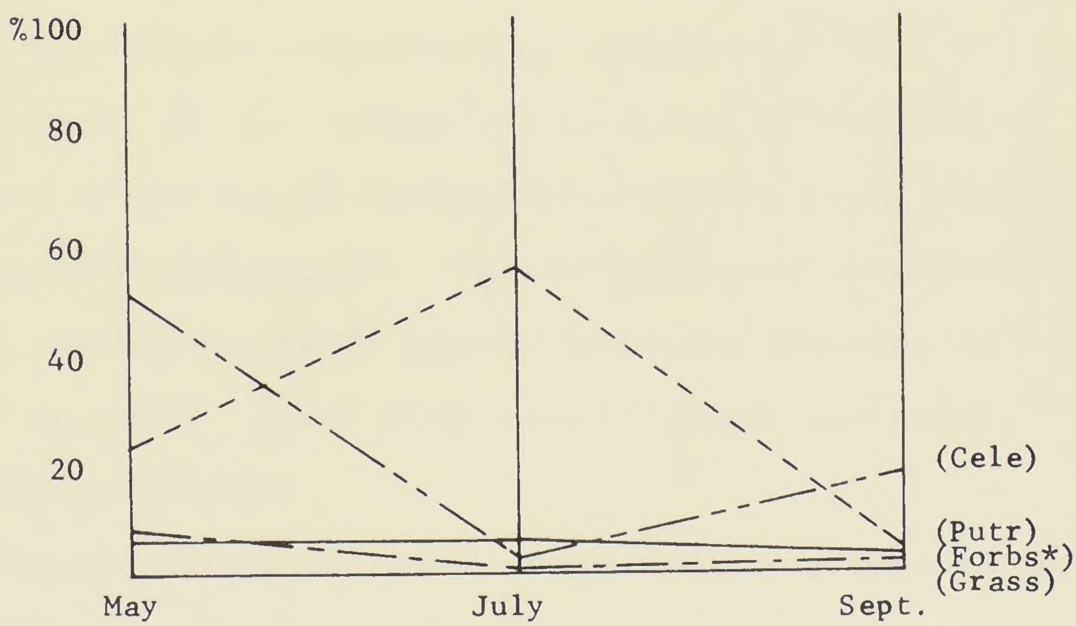


Figure 2. Graphic representation of the summer food habits of Fox Mt. mule deer during 1965.

Forbs* - includes UKF + Basa + Crac + Eri + Lup + Phl + Pol

was present in 12 of the 15 animals collected.

Mountain mahogany was another staple browse plant. It occurred in 13 animals and provided 23% of the diet for the summer season. Some sagebrush was present in May, but decreased in July and was totally absent in September Several other browse species provided lesser amounts, rounding out the diet at various periods.

Forbs were found in small quantities in 14 of the samples and added about 8% to the summer forage intake.

Fox Mountain - Summer 1965

Analysis of the 1965 summer date yielded somewhat different results from 1964 (Table 4). Grass made up only 8.9% of the May diet in 1965. This large decrease was due primarily to a 5-6 inch snow cover present during the May 1965 collection which greatly decreased the availability of green grass. Mountain mahogany and bitterbrush filled in the void during May, constituting 70% of the stomach contents. In July, bitterbrush again rose to over 50%, but decreased to less than 5% during September (Figure 2). This species was found in 10 samples. Mountain mahogany decreased during July, but was increased again by September following the same trend as in 1964. It had a frequency of 11 and contributed 25.2% to the seasonal diet.

Snowbrush utilization showed considerable increase from the previous summer. This plant provided 13.6% of the summer feed, with the heaviest period of use during September. Other browse species were present in all cases in varying but lesser amounts supplementing the major food items.

Table 4. Summer food habits of 15 mule deer at Fox. Mt. on three dates during 1965. (% wt. value is the mean of five rumen samples by date and 15 for summer)

	MAY		JULY		SEPT.		SUMMER	
Species*	% Wt.	Freq.	% Wt.	Freq.	% Wt.	Freq.	% Wt.	Freq.
UK	-	-	-	-	-	-	-	-
UKF	1.7	4	2.2	5	0.2	1	1.4	10
Gr	8.9	5	0.4	1	0.9	4	3.4	10
Art	3.9	5	1.2	1	9.8	5	5.0	11
Cele	46.4	4	1.7	4	18.5	5	25.2	13
Amal	4.2	3	-	-	-	-	1.4	3
Ceve	2.1	2	11.5	4	27.4	4	13.6	10
Putr	23.7	5	55.7	5	4.7	2	28.0	12
Sylo	1.5	3	-	-	9.7	4	3.7	7
Prvi	0.8	1	10.1	3	6.5	4	5.8	8
Prem	0.6	1	-	-	21.7	4	7.4	5
Sam	-	-	0.5	1	-	-	0.2	1
Ros	-	-	0.6	1	-	-	0.2	1
Potr	-	-	1.2	1	-	-	0.4	1
Sal	-	-	0.7	1	-	-	0.2	1
Eri	1.2	3	2.8	3	-	-	1.3	6
Lup	3.3	3	-	-	-	-	1.1	3
Phl	0.4	1	-	-	-	-	0.1	1
Basa	0.7	1	1.5	2	0.6	1	0.9	4
Crac	0.7	2	-	-	-	-	0.2	2
Pol	-	-	1.2	2	T	2	0.4	4

*Abbreviation Key

UK = Unknown
UKF = Unknown Forbs
Gr = Grass sp.
Art = *Artemisia* sp.
Cele = *Cerocarpus ledifolius*
Amal = *Amelanchier alnifolia*
Ceve = *Ceanothus velutinus*
Putr = *Purshia tridentata*
Sylo = *Symphoricarpos longiflorus*
Prvi = *Prunus virginiana*
Prem = *Prunus emarginata*
Sam = *Sambucus sp.*
Ros = *Rosa* sp.
Potr = *Populus tremuloides*
Sal = *Salix* sp.
Eri = *Eriogonum* sp.
Lup = *Lupinus* sp.
Phl = *Phlox* sp.
Basa = *Balsamorhiza sagittata*
Crac = *Crepis acuminata*
Pol = *Polygonum* sp.

Forbs again were utilized seasonally in small quantities, but added a definite boost to the total feed intake. They constituted an average of 5.4% of the total summer diet.

Although present in different proportions, the same species occurred as the major sources of feed during both years. It is felt that this variation in species proportion from year to year is a reflection of range and climatic conditions at the time of collection. An example of climatic influence was cited from grass utilization differences between 1964 and 1965. Collection of animals from different plant communities also adds to this yearly variation.

Bates Mountain - Summer 1964

The major contributor to the summer diet was the forb group (Table 5). This plant category provided 47.1% of the summer feed. It comprised 57.4% of the intake in May, decreased to 40% during July, and then increased to 44.7% in September (Figure 3). Forbs were present in all 15 rumen samples.

Grass utilization was moderate in May, but decreased to almost nothing by July. Quaking aspen was the most notable browse species. It was absent in May, but amounted to 14.3% of the diet by July. In September, aspen provided 42.7%. Wild buckwheat received heavy use during July, filling in for the reduction in forb intake. Serviceberry and choke-cherry also made a considerable contribution to the diet, fluctuating with forb and aspen use. It may be noted that although present in only small quantities, sagebrush occurred in 13 of the 15 summer samples. It is probable that sagebrush is an important species on many Nevada summer and winter ranges.

Table 5. Summer food habits of 15 mule deer at Bates Mt. on three dates during 1964. (% wt. value is the mean of five rumen samples by date and 15 for summer)

Species*	% Wt.	Freq.	% Wt.	Freq.	% Wt.	Freq.	% Wt.	Freq.
UK	-	-	-	-	-	-	-	-
UKF	57.4	5	38.4	5	44.1	5	46.6	15
Gr	17.4	5	1.8	4	0.5	2	6.6	11
Potr	-	-	14.3	3	42.7	5	19.0	8
Art	6.1	5	6.9	5	0.3	3	4.4	13
Putr	0.8	1	-	-	-	-	-	-
Amal	16.7	4	5.3	5	1.4	1	7.8	10
Prvi	1.5	2	1.6	2	9.6	1	4.2	5
Sylo	-	-	-	-	0.8	1	0.3	1
Eri	-	-	30.2	4	0.6	1	10.3	5
Rum	-	-	1.6	5	-	-	0.5	5

*Abbreviation Key

UK = Unknown
UKF = Unknown Forbs
Gr = Grass sp.
Potr = Populus tremuloides
Amal = Amelanchier alnifolia
Prvi = Prunus virginiana
Sylo = Symphoricarpos longiflorus
Eri = Eriogonum sp.
Rum = Rumex sp.
Art = Artemisia sp.
Putr = Purshia tridentata

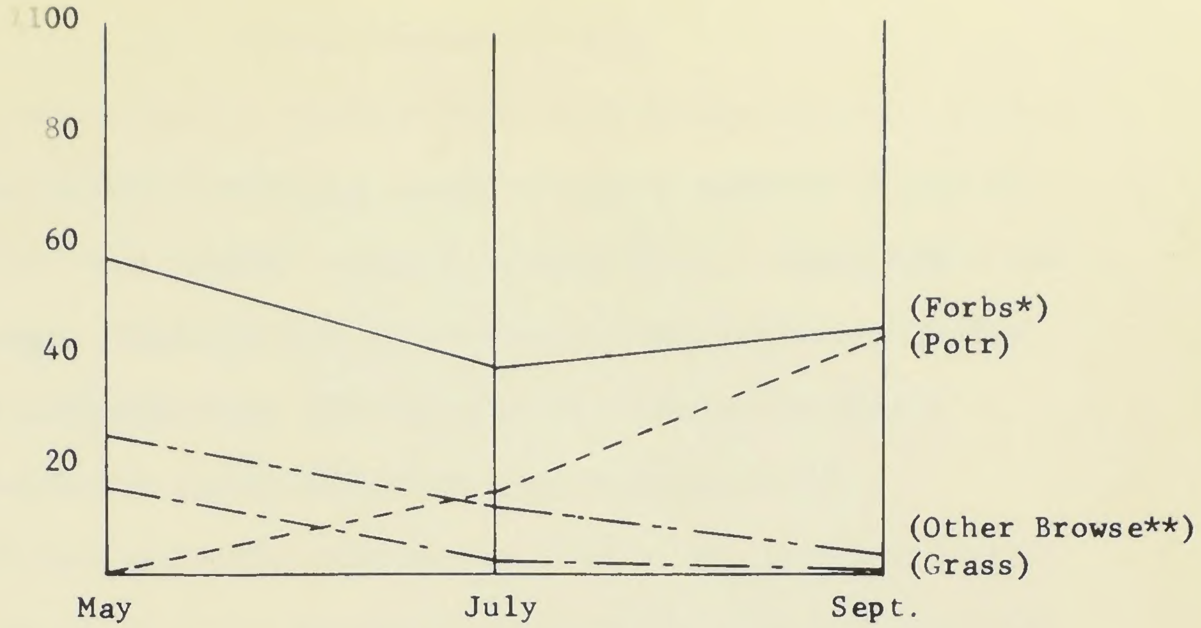


Figure 3. Graphic representation of the summer food habits of Bates Mt. mule deer during 1964.

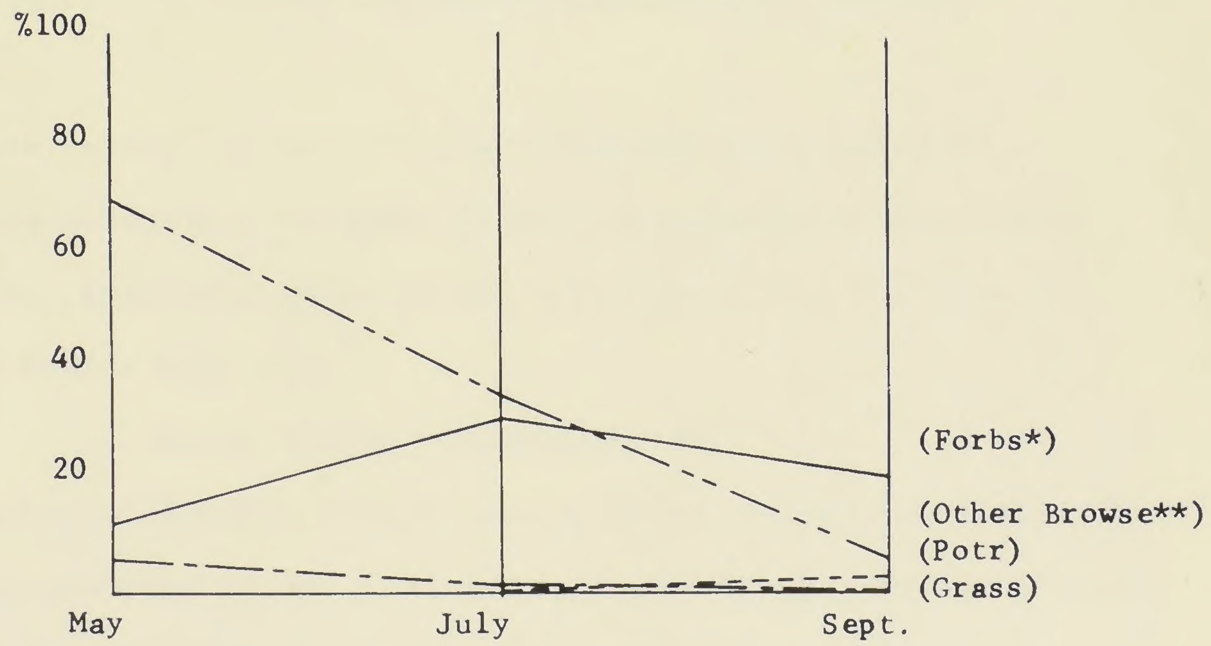


Figure 4. Graphic representation of the summer food habits of Bates Mt. mule deer during 1965.

Forbs* - includes UKF + Crac + Basa + Rum + Lup + Phl + Pen
Other browse** - includes Art + Amal + Sylo

Bates Mountain - 1965

The second year of summer data from Bates Mountain showed considerable variation from the previous year's analysis (Table 6). Forb utilization was greatly reduced, providing only about 20% of the summer forage. Heavy use of serviceberry and snowberry in May, made up the majority of the diet (Figure 4). There was also a definite reduction in grass utilization during May to 5.8%.

Sagebrush utilization had increased from the previous season. It represented 13.3% of the forage taken throughout the summer with a peak use of 26.3% in July. Wild buckwheat again received considerable use in July, accounting for 32.8% of the feed for that period. Quaking aspen, the major browse species in 1964, provided only 4.2% of the seasonal forage and was present in just two samples. In contrast to this, there was an increased utilization of choke-cherry during September.

These results, as those of Fox Mountain, show the same species being consumed, but again in varying proportions from year to year. The explanation given for the variation on Fox Mountain would apply to this area also.

Morey Bench - Winter 1964-65

The major foot item of this area is desert bitterbrush (Table 7). This species provided 44.4% of the entire winter forage and was present in all samples. A maximum consumption of 64.1% was obtained in December. This amount decreased gradually to 21.7% in March (Figure 5). Pinyon pine increased as desert bitterbrush use fell off, thus filling in the void.

Juniper was a staple item of the winter diet, contributing

Table 6. Summer food habits of 15 mule deer at Bates Mt. on three dates during 1965. (% wt. value is the mean of five rumen samples by date and 15 for summer)

	MAY		JULY		SEPT.		SUMMER	
Species*	% Wt.	Freq.	% Wt.	Freq.	% Wt.	Freq.	% Wt.	Freq.
UK	-	-	-	-	-	-	-	-
UKF	10.4	4	14.9	5	18.8	4	14.7	13
Gr	5.8	4	1.7	4	-	-	2.5	8
Art	9.5	4	26.3	5	4.1	2	13.3	11
Amal	25.0	4	7.5	3	-	-	10.8	7
Sylo	36.2	4	-	-	2.7	2	13.0	6
Prvi	8.2	3	0.4	2	24.1	4	10.9	9
Potr	-	-	-	-	12.7	2	4.2	2
Cele	-	-	-	-	2.9	2	1.0	2
Ceve	-	-	-	-	7.1	2	2.4	2
Ros	-	-	-	-	20.0	1	6.7	1
Eri	2.0	2	32.8	5	5.5	2	13.4	9
Crac	1.7	2	-	-	-	-	0.6	2
Lup	0.6	2	-	-	-	-	0.2	2
Phl	-	-	11.1	5	-	-	3.7	5
Basa	0.6	2	-	-	2.1	2	0.9	4
Pen	-	-	5.2	4	-	-	1.7	4
Pol	-	-	-	-	T	2	T	2

* Abbreviation Key

UK = Unknown
UKF = Unknown Forbs
Gr = Grass sp.
Art = *Artemisia* sp.
Amal = *Amelanchier alnifolia*
Sylo = *Symphoricarpos longiflorus*
Prvi = *Prunus virginiana*
Potr = *Populus tremuloides*
Cele = *Cercocarpus ledifolius*
Ceve = *Ceanothus velutinus*
Ros = *Rosa* sp.
Eri = *Eriogonum* sp.
Crac = *Crepis acuminata*
Lup = *Lupinus* sp.
Phl = *Phlox* sp.
Basa = *Balsomorhiza sagittata*
Pen = *Penstamen* sp.
Pol = *Polygonum* sp.

Table 7. Winter food habits of 15 mule deer at Morey Bench on three dates during 1964-65. (% wt. value is the mean of five rumen samples by date and 15 for winter)

	DEC.		JAN.		MAR.		WINTER	
Species*	% Wt.	Freq.	% Wt.	Freq.	% Wt.	Freq.	% Wt.	Freq.
UK	-	-	-	-	-	-	-	-
UKF	-	-	-	-	-	-	-	-
Gr	0.2	1	0.3	2	5.2	3	1.9	6
Art	11.6	4	11.9	5	11.7	5	11.7	14
Pugl	64.1	4	47.3	5	21.7	5	44.4	14
Juos	15.9	2	4.0	4	28.7	5	16.2	11
Cele	3.2	1	-	-	-	-	1.1	1
Epne	1.5	2	0.7	2	0.3	1	0.8	5
Amal	1.4	1	9.5	1	-	-	3.6	2
Rhtr	-	-	T	1	-	-	T	1
Pran	-	-	1.6	2	-	-	0.5	2
Opu	-	-	0.6	3	-	-	0.2	3
Brte*	-	-	0.3	2	-	-	0.1	2
Pimo	2.1	3	22.7	5	29.7	5	18.2	13
Atca	-	-	0.3	1	-	-	0.1	1
Eri	-	-	-	-	1.5	3	0.5	3
Basa	-	-	0.2	1	-	-	0.1	1
Pen	-	-	0.7	1	-	-	0.2	1
Phl	-	-	-	-	1.2	1	0.4	1

*Abbreviation Key

UK = Unknown
UKF = Unknown Forbs
Gr = Grass sp.
Art = *Artemisia* sp.
Pugl = *Purshia glandulosa*
Juos = *Juniperus osteosperma*
Cele = *Cercocarpus ledifolius*
Epne = *Ephedra nevadensis*
Amal = *Amelanchier alnifolia*
Rhtr = *Rhus trilobata*
Pran = *Prunus andersonii*
Opu = *Opuntia* sp.
Brte* = *Bromus tectorum* (seeds)
Pimo = *Pinus monophylla*
Atca = *Atriplex canescens*
Eri = *Erigonum sp.*
Basa = *Balsamorhiza sagittata*
Pen = *Penstamen* sp.
Phl = *Phlox* sp.

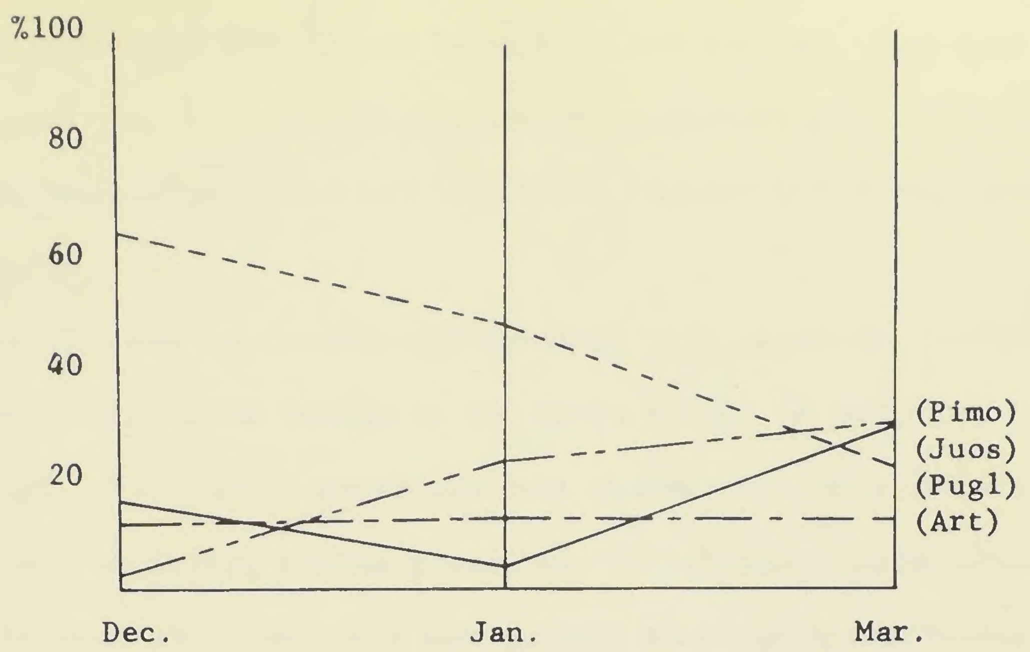


Figure 5. Graphic representation of the winter food habits of Morey Bench mule deer during 1964-65.

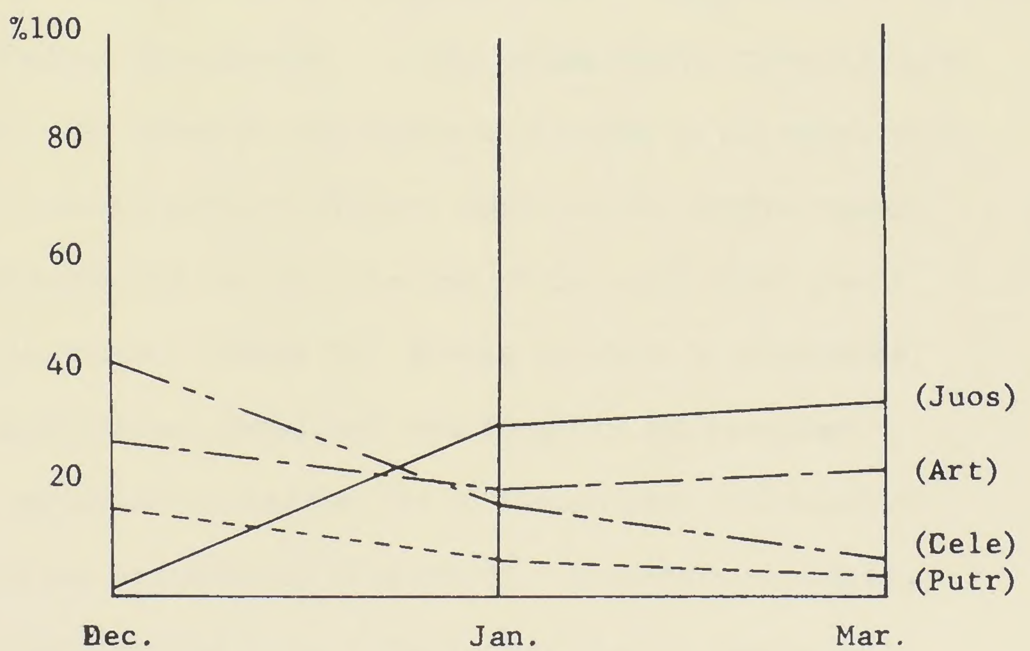


Figure 6. Graphic representation of the winter food habits of Pequop Mts. mule deer during 1964-65.

16.1% of the winter intake. It has been said that juniper is an emergency deer food, but it is indicated from these results that it will be utilized even when other foods are available. Leach (1956) reported similar findings.

Sagebrush use was relatively constant throughout the winter providing about 11% of the forage on all three dates. It occurred in all 14 samples. Very little grass use was shown, but what there was, occurred in March during spring green-up. It has been found (Dietz, Udall, and Yeager; 1965) that this new growth was highly nutritious and should improve condition of animals coming off of winter range.

Various other plant species were found in the diet, but all in lesser amounts.

Pequop Mountains - Winter 1964-65

Fifteen samples were collected over a large area of the east side of the Pequop Mountains. In this area there were several habitat types. An attempt was made to sample in all types and thus gain an overall picture of food habits of the entire range.

Sagebrush was found to be one of the main food items throughout the winter (Table 8). It was present in quantities above 20% on all three dates and was found in all samples. Bitterbrush received moderate use in December, but tapered off as the season progressed (Figure 6). Mountain mahogany provided a considerable bulk of the forage during December, declined to 17.9% in January, and was further reduced by March.

Grass again was consumed during the spring green-up in March, where it contributed 12.9% of the diet. Juniper provided a moderate amount of forage during January and March, but little

Table 8. Winter food habits of 15 mule deer at the Pequop Mts. on three dates during 1964-65. (% wt. value is the mean of five rumen samples by date and 15 for winter)

	DEC.		JAN.		MAR.		WINTER	
Species*	% Wt.	Freq.	% Wt.	Freq.	% Wt.	Freq.	% Wt.	Freq.
UK	1.9	4	0.2	1	-	-	0.7	5
UKF	-	-	0.3	1	-	-	0.1	1
Gr	0.1	1	1.2	5	12.9	5	4.7	11
Art	28.0	5	20.8	5	23.5	5	24.1	15
Putr	17.4	3	6.3	2	5.3	3	9.7	8
Cost	-	-	112.	1	-	-	3.7	1
Cele	40.8	3	17.9	3	7.2	1	22.0	7
Pimo	4.8	1	5.2	3	14.4	3	8.1	7
Juos	1.3	1	32.2	5	34.7	4	22.7	10
Amal	-	-	-	-	0.9	3	0.3	3
Lup	5.7	2	-	-	-	-	1.9	2
Cir	0.1	1	0.3	1	-	-	0.1	2
Phl	-	-	1.9	1	0.4	1	0.8	2
Eri	-	-	2.4	3	0.7	2	1.0	5

*Abbreviation Key

UK = Unknown
UKF = Unknown Forbs
Gr = Grass sp.
Art = *Artemisia* sp.
Putr = *Purshia tridentata*
Cost = *Cowania stansburiana*
Cele = *Cercocarpus ledifölius*
Pimo = *Pinus monophylla*
Juos = *Juniperus osteosperma*
Amal = *Amelanchier alnifolia*
Lup = *Lupinus* sp.
Cir = *Cirsium* sp.
Phl = *Phlox* sp.
Eri = *Eriogonum* sp.

use was evident in December. Pinyon pine and cliffrose also added to the diet in varying smaller amounts. Forbs contributed little to the diet but were present in all collections.

Conclusions and Recommendations

The species taken by mule deer and the proportion in which they are consumed vary with each range type and season of use. Food habits from the same area also vary considerably from year to year. Most of this variation is in the proportion of species consumed. There are several factors influencing this variation. Range and climatic conditions affect the food habits by their influence upon the availability of forage species. For example, in dry years there is less lush forage provided and the deer must, therefore, turn to some other source of feed that may not be typical for the animal.

In the results section it was mentioned that conditions of collection influence the data. This is true. As an illustration suppose that an animal was collected in a lush quaking aspen patch. This animal would then certainly have that species present in its rumen. Now suppose another deer was collected in a big sagebrush--forb type. This animal will probably not have much aspen present in its rumen. To counteract this type of bias, an attempt was made to collect animals in all major habitat types representative of the study locations. It is not intended here to discredit the food habits method, but merely to suggest some of the sources of data variation.

On summer ranges with varied plant communities this is more of a problem than on more homogeneous winter ranges. Therefore, it is felt necessary to have a considerable number of summer

samples to gain a more complete picture of the mule deer food habits on a particular summer range.

Another notable fact pointed out by the results is the great variety of species that deer will consume. While their diet is composed primarily of five or six species, many other species are taken in small quantities.

In managing these areas, prime consideration should be placed on the five or six primary species (Table 9). Not only is it important to know what species deer prefer but also when they prefer them. For example, one would not want cattle and deer on the same area at a time when maximum competition is expected, especially if the area possesses a limited forage supply. The managing agencies may use this information to great advantage in recommending grazing plans for these areas.

It should be noted that most of the deer collected in this study were young females. Therefore, the data presented actually represents female food habits. However, the author feels that in general there is little difference in food habits between sexes, and that this data indicates the food habits of the deer herds in general.

Table 9. Primary forage species by mule deer on four Nevada Ranges.

Fox Mountain Summer Range	Bates Mountain Summer Range	Morey Bench Winter Range	Pequop Mountains Winter Range
1. Cele*	1. Forbs	1. Pugl	1. Art
2. Putr	2. Eri	2. Artr	2. Cele
3. Ceve	3. Potr	3. Juos	3. Juos
4. Grass	4. Amal	4. Pimo	4. Putr
	5. Artr		5. Pimo
	6. Prvi		6. Cost

* Abbreviation Key

Cele - *Cercocarpus ledifolius*
Putr - *Purshia tridentata*
Ceve - *Ceanothus velutinus*
Eri - *Eriogonum* sp.
Amal - *Amelanchier alnifolia*
Artr - *Artemisia tridentata*
Prvi - *Prunus virginiana*
Pugl - *Purshia glandulosa*
Art - *Artemisia* sp.
Juos - *Juniperus osteosperma*
Pimo - *Pinus monophylla*
Cost - *Cowania stansburiana*
Grass- Grass sp.
Forbs- Forbs sp.

NUTRITIVE CONTENT OF FORAGE

Literature Review

The importance of food supply has long been recognized, but only recently has the nutrient content or quality of forages been emphasized (Swank, 1958). Hagen (1953) stated that low mule deer populations can be traced directly to either an insufficient quantity or poor quality of food. A further example of the importance of forage quality was given by Smith and Beeson (1956), who concluded that, "an inadequate intake of either energy, protein, calcium, phosphorus, cobalt, or vitamin A decrease the capacity for bearing young." Previously, Guilbert (1942) substantiated this with domestic livestock. He found that an inadequate quantity or quality food caused marked retardation of growth in young, or weight losses in adults, which results in cessation or estrus in the female, loss of sexual libido and motility of sperm, and testicular atrophy in males. Julander (1961) from studies in Utah, concluded that a summer range of sufficient high quality forage is necessary for maximum herd productivity of mule deer.

Hagen, (1953) concluded that in general the best foods (most) nutritious and palatable) are those high in crude protein and perhaps in minerals and fat. In another study (Longhurst, Leopold, and Dasmann, 1952), it was stated that protein was probably the limiting factor in health and productivity of deer. In accordance with these conclusions, Leopold et al. (1951) inferred that the content of crude protein approximately follows the gradient of palatability of the shrubs tested. Taber and Dasmann (1958) said that in general, the condition of deer followed the protein level of

forage, being high in spring and summer and gradually declining as the season progresses. It was indicated that the nutrients appearing to have the greatest effect upon mule deer nutrition are phosphorus, protein, and carotine (Dietz, 1958). Swank (1958) agreed that protein and phosphorus were of prime importance in deer health and productivity.

The exact requirements for protein are only roughly known at the present time. Einarsen (1946) worked on black-tail deer in Oregon, and concluded that 5% protein in the forage was the critical level. Later studies of the Jawbone deer herd led to the conclusion that in general, the critical level seemed to be near 7-8% for maintenance (Longhurst, Leopold, and Dasmann, 1952). More recent work on whitetails (French et al., 1955) showed the protein requirements for optimum growth to be 13-16% of the ration.

The importance of phosphorus to the metabolism and reproductive processes of the animal can hardly be overemphasized. Swank (1956) felt that phosphorus levels are probably second in importance to protein on western ranges. This same view was shared by Dietz (1965).

Morrison (1954) lists the minimum requirements for sheep as 0.17% phosphorus, but work done on whitetail deer (Magruder, et al., 1957) has shown that survival of deer in poor condition with stunted antler growth occurred at levels of 0.25% to 0.30% phosphorus fed in a daily ration of 3-4 pounds of good air-dry forage per 100 pounds of bodyweight.

In general, all plants contain the greatest amounts of protein and phosphorus during the spring growing season,

followed by a decrease in summer with minimal values reached in the winter period (Longhurst, Leopold, and Dasmann, 1952). Similar results were obtained by Hellmers (1940), Hagen (1953), Bissell and Strong (1955), Swank (1956), Dietz, Udall, and Yeager (1962), and Dietz (1965).

Dietz, Udall, and Yeager (1962), found deciduous shrubs on winter range were better sources of protein during summer than evergreen species, but did not maintain their protein level as well during the winter as evergreens. In addition, they pointed out that as protein declines with advancing phenology fat stores increase (except grasses). This provides animals an opportunity to acquire fat while on summer and fall range. Evergreens and semi-evergreen species were found to be much higher in fat than the deciduous species (Dietz, Udall, and Yeager, 1962). Bissell (1955) inferred that this high fat content was due partially to the presence of essential oils in the lipid fraction, which may have a depressing effect on the rumen microflora and therefore, upon the digestibility of these species.

Most summer range species tested increased in crude fiber and nitrogen free extract (N. F. E.) as the season progressed (Dietz, Udall, and Yeager, 1962). Ash was found to decrease from spring to fall in all cases (Dietz, Udall, and Yeager, 1962).

Aldous (1945) analyzed bitterbrush in Nevada and found protein to be concentrated in the terminal buds and leaves with decreasing amounts in the proximal portions of the twig. Several years later Dietz (1958) chemically analyzed five browse species in Colorado. His results indicated that in general, leaves have a higher protein, carotene, phosphorus, N. F. E., moisture, ash,

and calcium content than stems. Stems were found to be higher in crude fiber, while crude fat content was nearly equal.

The area of degree of utilization as it affected the nutrient content of browse was investigated by Dietz (1958). Dietz found that regardless of the degree of clipping, the nutrient content of browse was not altered.

An analysis of immature cheat grass revealed that the young plant was high in protein, moisture, and phosphorus. Based on these results, it appears that the occurrence of this highly nutritious grass at a time when most browse species are of poor quality makes for improved conditions in deer herds (Dietz, Udall, and Yeager, 1962).

No discussion of nutrient composition of forage is complete unless at least a brief mention of digestibility and intake is included.

Nichols (1938) in Arizona found that the basic maintenance ration for resting deer was 2.35 pounds of air-dried forage per hundredweight per day. In Michigan (Davenport, 1939) it was determined that 3-4 pounds of air-dried forage was necessary to prevent excessive weight loss in deer.

Studies by Smith (1950, 1959) and Dietz and Yeager (1959) concluded that big sagebrush is a highly nutritious and digestible feed if fed in a browse mixture.

Digestibility coefficients and intake values for many native and artifical feeds have been determined by Bissell (1955), French et al., (1955), Smith (1959), and Dietz, Udall, and Yeager (1962). Work of this type sheds more light upon the actual value of a nutrient in a particular forage species to the grazing animal.

Methods

Important forage species were collected seasonally. Summer collections were made in May, July, and September. The winter samples were obtained during December, January, and March. Forage material was also collected from both winter ranges during either June or July. Forage samples were collected from the respective seasonal ranges in relatively the same phenological growth stage, so far as possible.

May plants were generally in the pre-bloom stage, while plants collected during July in the height of the growing season were found to be in the bloom or dough stage. The final collection in September was made when plants were in the mature or seed cast stage, with some yellowing present in quaking aspen and serviceberry. All plants collected during the winter appeared to be dormant.

Current growth from at least 10 individual plants of each species was clipped and placed in paper sacks marked according to species, date, and location. These materials were air-dried at a temperature of 105° F for 24 hours and then ground in a Wiley mill with a screen having 1 mm openings. This finely ground plant material was thoroughly mixed, placed in tightly covered glass bottles, and then stored until chemical analysis.

Ash, crude protein, crude fat (ether extract), crude fiber, and N. F. E. were determined using standard analytical procedure, as outlined by the A. O. A. C. (1955). All constituents were determined on a moisture free basis. Phosphorus was considered, but time available precluded analysis.

The above constituents were determined because it was felt that they were the most important nutrients concerned with deer nutrition. Also, these same constituents are present in most of the literature making comparisons possible.

Results and Discussion

Chemical analysis for current growth of selected forage species from all four range sites are presented in Tables 10-13.

Protein. This essential nutrient was contained in fairly high amounts by range plants during the summer growing season. Curl-leaf mountain mahogany, quaking aspen, bitterbrush, big sagebrush, and snowbrush, were all above 10% protein in May, increased to a maximum value of up to 20% in some species during July, and then decreased to their lowest summer level by September (Figures 7-8). These values compare favorably with those found by Robertson and Torell (1959). Serviceberry and snowberry on the other hand obtained their highest value in May and decreased to a low value of about 7% in September. This may have had some bearing on the heavy use of these species during May. Lupine (*Lupinus sp.*) and Balsom root contained over 20% protein in May, gradually decreased during July, and also reached their lowest summer values in September.

There was some variation in protein content between the same species from different ranges. Those from Bates Mountain were generally higher than the values obtained from Fox Mountain. This could be a reflection of the soil and climate differences between the areas. Fox Mountain is in the rain shadow cast by the Sierra Nevada and Bates Mountain is just out of it resulting in climatic variation.

Table 10. Nutritive composition of selected forage species on Fox. Mt. summer range, 1964-65.

Species*	Date	Protein %	Crude Fat %	Crude Fiber %	N.F.E. %	Ash %
Cele	May 15, 1964	10.49	7.32	20.42	59.29	2.48
	July 10, 1964	12.58	4.96	21.14	57.64	3.68
	Sept. 11, 1964	9.90	6.82	25.00	55.12	3.16
	May 22, 1965	9.62	7.10	20.05	60.32	2.91
	July 23, 1965	11.88	5.88	31.18	47.16	3.90
	Sept. 4, 1965	10.87	5.28	24.00	55.57	3.48
Putr	July 10. 1964	15.54	2.92	18.38	58.50	4.66
	Sept. 11, 1964	9.82	5.78	23.46	57.79	3.15
	May 22, 1965	11.28	4.80	29.93	50.93	3.06
	July 23, 1965	13.07	4.50	20.92	57.42	4.09
	Sept. 4, 1965	11.21	4.44	23.56	57.42	3.37
Artr	July 10, 1964	14.11	5.68	20.37	53.92	5.92
	Sept. 11, 1964	9.18	9.32	24.33	52.84	4.33
	May 22, 1965	9.37	8.31	19.18	59.08	4.06
	July 23, 1965	11.88	7.31	22.03	53.77	5.71
	Sept. 4, 1965	8.59	4.50	25.40	56.85	4.66
Amal	July 10. 1964	11.58	2.34	16.78	63.14	6.16
	Sept. 11, 1964	8.00	4.48	24.27	58.09	5.16
	July 23, 1965	11.63	3.49	20.02	59.07	5.79
	Sept. 4, 1965	8.94	3.38	24.50	57.69	5.49
Sylo	July 10, 1964	15.45	2.30	16.92	58.18	7.15
	Sept. 11, 1964	8.53	4.72	25.56	53.74	6.45
	July 23, 1965	11.47	4.58	21.99	55.32	6.64
	Sept. 4, 1965	8.26	3.20	27.10	54.37	7.07
Ceve	Sept. 11, 1964	12.06	7.98	13.94	63.07	2.95
	May 22, 1965	11.05	6.54	14.03	65.31	3.07
	July 23, 1965	15.40	4.84	13.39	62.98	4.39
	Sept. 4, 1965	12.48	4.90	13.20	65.88	3.54
Prvi	July 23, 1965	12.33	4.67	11.42	61.80	9.78
	Sept. 4, 1965	13.14	3.68	14.30	60.71	7.17
Pose	July 10, 1964	6.26	2.16	34.06	52.36	5.16
Prem	Sept. 11, 1964	10.91	7.77	19.46	57.46	4.40

*Abbreviation Key

Cele - *Cercocarpus ledifolius*
Putr - *Purshia tridentata*
Artr - *Artemisia tridentata*
Amal - *Amelanchier alnifolia*
Sylo - *Symphoricarpos longiflorus*
Ceve - *Ceanothus veluntinus*
Prvi - *Prunus virginiana*
Pose - *Poa secunda*
Prem - *Prunus emarginata*

Table 11. Nutritive composition of selected forage species on Bates Mt. summer range, 1964-65.

Species*	Date	Protein %	Crude Fat %	Crude Fiber %	N.F.E. %	Ash %
Amal	May 26, 1964	13.68	2.99	25.52	52.99	4.82
	July 28, 1964	10.85	3.91	21.39	57.90	5.95
	Sept. 16, 1964	7.26	4.88	25.21	57.37	5.28
	June 5, 1965	21.02	2.72	14.99	54.85	6.42
	July 7, 1965	16.44	3.30	17.23	56.56	6.57
	Sept. 15, 1965	7.67	3.62	24.48	58.90	5.33
Artr	May 26, 1964	13.09	4.62	23.25	53.39	5.65
	July 28, 1964	15.36	11.26	21.96	45.26	6.16
	Sept. 16, 1964	10.03	10.20	22.61	52.37	4.79
	June 5, 1965	14.23	8.63	17.36	54.43	5.35
	July 7, 1965	18.89	5.96	19.47	47.87	7.81
	Sept. 15, 1965	10.77	5.75	23.11	56.03	4.34
Potr	May 26, 1964	16.40	4.58	21.31	52.31	5.40
	July 28, 1964	17.52	4.46	17.80	50.60	9.62
	Sept. 16, 1964	10.32	9.06	20.64	49.92	10.06
	June 5, 1965	-	-	-	-	-
	July 7, 1965	22.13	6.34	16.51	47.40	7.62
	Sept. 15, 1965	10.61	7.66	22.29	50.84	8.60
Sylo	May 26, 1964	16.05	2.79	19.85	54.80	6.51
	July 28, 1964	10.39	5.20	19.21	58.68	6.52
	Sept. 16, 1964	5.90	4.47	31.44	52.40	5.79
	June 5, 1965	15.86	3.84	12.27	61.55	6.48
	July 7, 1965	16.04	4.04	18.39	54.15	7.39
	Sept. 15, 1965	7.22	3.42	29.74	54.18	6.44
Lup	May 26, 1964	24.56	2.80	22.61	38.93	11.10
	July 28, 1964	17.76	2.84	28.84	44.02	6.54
	Sept. 16, 1964	12.91	3.14	28.37	46.99	8.59
	June 5, 1965	25.09	2.74	19.79	43.49	8.89
	July 7, 1965	21.56	2.81	25.64	42.54	7.45
	Sept. 15, 1965	17.65	2.06	24.81	48.22	7.26
Basa	May 26, 1964	20.13	4.24	21.98	37.25	16.40
	June 5, 1965	25.87	6.47	14.79	41.00	11.87
Eri	July 28, 1964	12.20	2.23	21.46	58.32	5.79
	Sept. 16, 1964	8.61	2.00	26.22	57.95	5.22
	July 7, 1965	16.01	2.72	14.75	58.14	8.38
	Sept. 15, 1965	8.86	1.39	19.84	65.51	5.40

Table 11. (Continued)

Species	Date	Protein %	Crude Fat %	Crude Fiber %	N.F.E. %	Ash %
Prvi	Sept. 16, 1964	11.81	6.92	11.53	60.21	9.51
	July 7, 1965	15.96	3.46	13.93	60.00	6.65
	Sept. 15, 1965	13.02	4.38	13.03	60.41	9.16
Chla	July 7, 1965	22.88	6.68	18.51	41.12	10.81
	Sept. 15, 1965	13.66	4.82	23.72	50.27	7.53

*Abbreviation Key

Amal - *Amelanchier alnifolia*
Artr - *Artemisia tridentata*
Potr - *Populus tremuloides*
Sylo - *Symphoicarpos longiflorus*
Lup - *Lupinus sp.*
Basa - *Balsamorhiza sagittata*
Eri - *Eriogonum sp.*
Prvi - *Prunus virginiana*
Chla - *Chrysothamnus lanceolatus*

Table 12. Nutritive composition of selected forage species on Morey Bench winter range, 1964-65.

Species*	Date	Protein %	Crude Fat %	Crude Fiber %	N.F.E. %	Ash %
Pugl	July 23, 1964	10.46	10.11	22.10	53.75	3.59
	Dec. 20, 1964	8.02	14.34	21.70	52.52	3.42
	Jan. 26, 1965	7.54	16.15	18.79	54.42	3.10
	Mar. 21, 1965	8.16	13.96	21.48	53.41	2.99
	July 27, 1965	11.41	9.04	20.86	54.94	3.75
Artr	July 23, 1964	10.10	11.54	22.54	47.23	5.59
	Dec. 20, 1964	7.28	13.70	22.30	52.46	3.86
	Jan. 26, 1965	7.08	13.19	22.36	53.46	3.91
	Mar. 21, 1965	10.61	14.56	19.92	50.75	4.16
	July 27, 1965	10.20	11.66	24.45	48.56	5.13
Pimo	Dec. 20, 1964	5.84	11.10	19.58	61.04	2.44
	Jan. 26, 1965	6.03	12.23	20.45	58.65	2.64
	Mar. 21, 1965	6.66	11.71	21.64	57.72	2.27
	July 27, 1965	7.37	12.16	23.68	54.09	2.70
Juos	Dec. 20, 1964	5.85	14.02	27.50	47.65	4.98
	Jan. 26, 1965	6.57	13.66	24.24	51.02	4.51
	March 21, 1965	5.36	15.33	23.34	51.65	4.32
	July 27, 1965	6.26	12.98	25.01	50.50	5.25
Epvi	Dec. 20, 1964	8.78	3.38	28.91	52.39	6.54
	Jan. 26, 1965	7.80	4.09	21.29	59.72	7.10
	Mar. 21, 1965	7.55	3.54	35.88	54.71	8.32
	July 27, 1965	7.12	4.30	23.94	53.92	10.72
Epne	Mar. 21, 1965	6.69	4.63	33.18	47.94	7.56
	July 27, 1965	6.59	4.42	31.67	47.20	10.12
Rhtr	July 23, 1964	10.99	3.53	14.64	65.44	5.40
Pran	July 23, 1964	7.97	4.98	19.82	61.33	5.90
Atca	July 27, 1965	17.26	2.28	19.69	45.51	11.26

*Abbreviation Key

Pugl - Purshia tridentata
Artr - Artemisia tridentata
Pimo - Pinus monophylla
Juos - Juniperus osteosperma
Epvi - Ephedra viridis
Epne - Epheda nevadensis
Rhtr - Rhus trilobata
Pran - Prunus andersonii
Atca - Atriplex canescens

Table 13. Nutritive composition of selected forage species on the Pequop Mts. winter range, 1964-65.

Species*	Date	Protein %	Crude Fat %	Crude Fiber %	N.F.E. %	Ash %
Cele	June 23, 1964	9.90	7.95	18.84	59.43	4.24
	Dec. 5, 1964	7.74	6.75	22.58	60.34	2.59
	Jan. 30, 1965	6.74	8.66	23.26	57.87	3.47
	Mar. 11, 1965	8.38	7.11	21.18	59.63	3.70
	July 28, 1965	12.22	6.54	23.25	54.37	3.62
Putr	June 23, 1964	11.43	3.44	18.75	61.87	4.51
	Dec. 5, 1964	7.62	4.42	32.76	53.11	2.09
	Jan. 30, 1965	7.09	5.12	33.00	52.49	2.30
	Mar. 11, 1965	7.79	4.88	35.61	49.49	2.23
	July 28, 1965	9.57	4.56	26.48	55.56	3.83
Artr	June 23, 1964	10.51	6.72	20.60	59.69	5.25
	Dec. 5, 1964	7.46	9.46	25.48	54.28	3.32
	Jan. 30, 1965	8.66	10.92	21.24	55.78	3.40
	Mar. 11, 1965	9.21	8.26	24.46	54.44	3.83
	July 28, 1965	8.81	11.46	22.84	51.79	5.10
Cost	Jan. 30, 1965	7.88	12.17	21.79	51.88	6.28
	Mar. 11, 1965	7.52	9.81	22.34	56.24	4.09
	July 28, 1965	10.29	8.62	20.27	56.40	4.42
Amal	June 23, 1964	9.23	3.20	19.22	64.01	4.34
	Dec. 5, 1964	4.29	4.04	34.42	54.35	2.90
	Jan. 30, 1965	5.86	4.54	31.39	55.18	3.03
Sylo	June 23, 1964	9.08	3.38	18.62	62.44	6.48
	Dec. 5, 1964	4.38	1.75	43.86	46.12	3.89
Juos	Jan. 30, 1965	6.66	14.04	23.10	51.57	4.63
	Mar. 11, 1965	6.31	11.28	35.21	52.73	4.47
	July 28, 1965	5.41	12.92	25.18	51.73	4.76
Pimo	Mar. 11, 1965	6.19	11.04	22.49	57.57	2.71
	July 28, 1965	6.30	12.45	22.47	56.24	2.54
Lup	June 23, 1964	7.35	3.66	19.47	55.18	14.34
Pose	June 23, 1964	7.32	2.20	35.19	48.89	6.40
Arar	July 28, 1965	8.43	13.76	26.61	45.53	5.67

*Abbreviation Key

Cele - Cercocarpus ledifolius
Putr - Purshia tridentata
Artr - Artemisia tridentata
Cost - Cowania stansburiana
Amal - Amelanchier alnifolia
Sylo - Symphoricarpos longiflorus
Juos - Juniperus osteosperma
Pimo - Pinus monophylla
Lup - Lupinus sp.
Pose - Poa secunda
Arar - Artemisia arbuscula

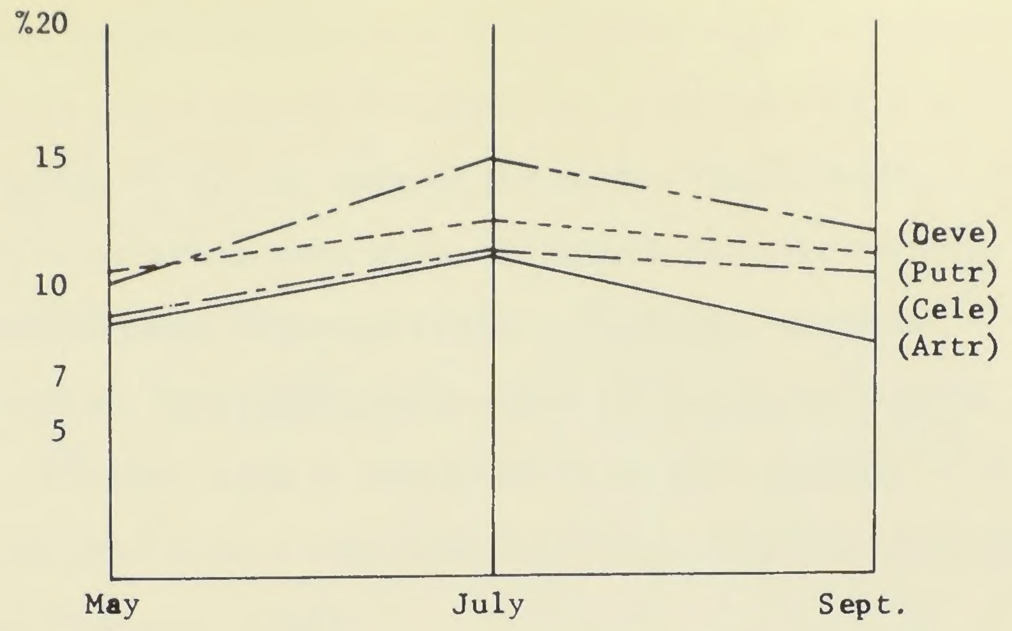


Figure 7. Protein variation of selected browse species on Fox Mt. summer range, 1965.

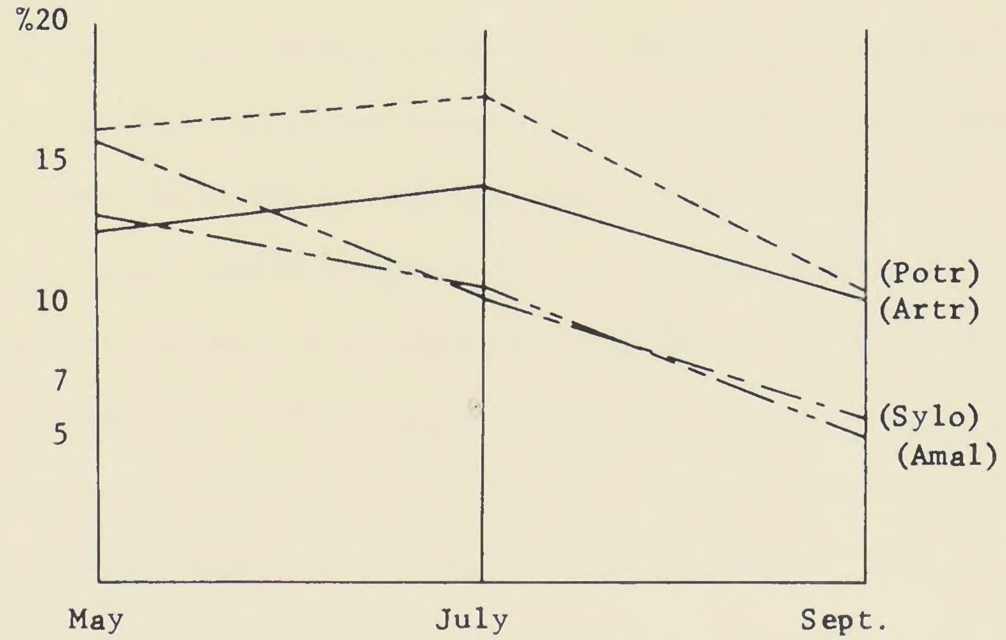


Figure 8. Protein variation of selected browse species on Bates Mt. summer range, 1964.

Winter range species were considerably lower in protein content. These plants usually reached their minimal values in January (Figures 9-10). In general the winter range plants consumed on these areas were higher in protein than the critical 5% level established by Einarsen (1946). However, mountain mahogany, juniper, and pinyon were below 7% during the peak of winter use. All other species contained 7% or more protein. The 7% level is believed to be a safe minimal figure for protein (Longhurst, Leopold, and Dasmann, 1952).

Crude Fat. The ether-extractable component was relatively low during the summer months. There seemed to be no general trend of increase or decrease of these values for the several species tested. Quaking aspen increased in fat content as the season progressed. Other species decreased or showed noticeable change in fat content with advancing summer months.

During the winter months there was a definite increase in crude fat as the protein level decreased. The evergreen and semi-evergreen species contained the highest amounts of this nutrient. Juniper, pinyon pine, desert bitterbrush, and big sagebrush possessed the most notable quantities of crude fat. This nutrient provides a concentrated food source that animals may utilize to replenish their energy reserve. In view of this the crude fat fraction may be very important during periods of stress. However, it should be noted that some of the fats and oils extracted by ether may be indigestible and even detrimental to ruminant animals (Bissell et al., 1955).

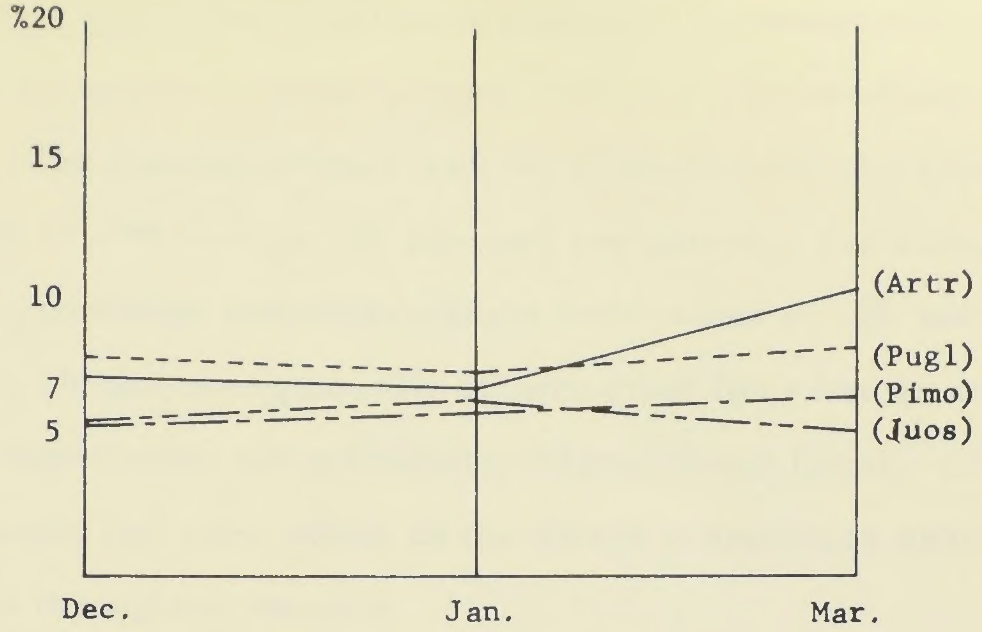


Figure 9. Protein variation of selected browse species on Morey Bench winter range, 1964-65.

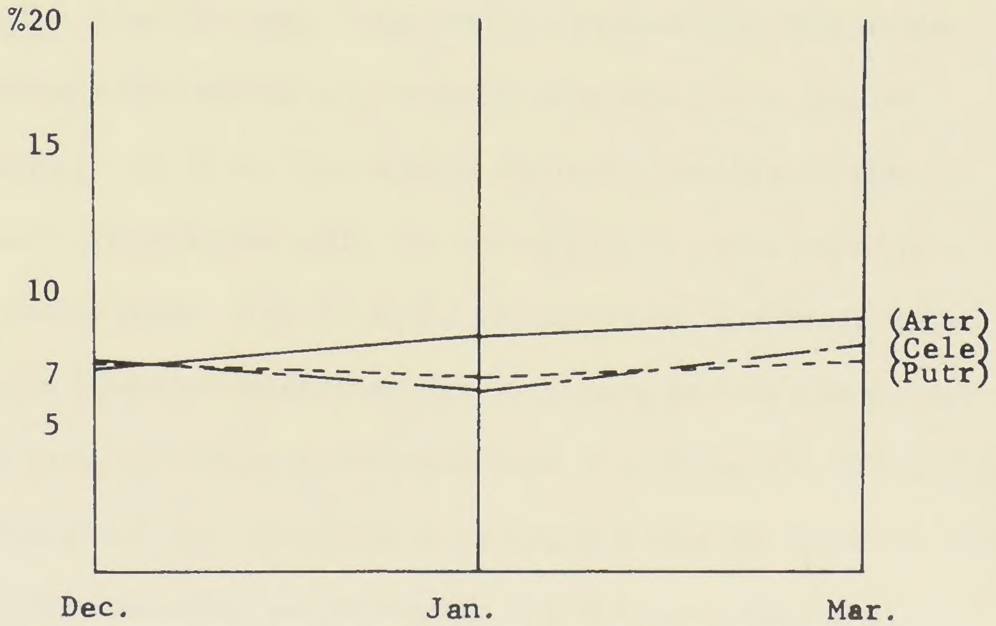


Figure 10. Protein variation of selected browse species on the Pequop Mts. winter range, 1964-65.

Crude Fiber. This constituent generally increased with seasonal progression during the summer months, with the highest values in September. The quantity of fiber was fairly similar for most species, ranging from 15-30% through the summer use period. The exceptions to this were snowbrush and choke-cherry with values of 13% and 11% respectively. It has been generally accepted that fiber has an adverse affect upon digestibility and palatability (Maynard and Loosli, 1962). This undoubtedly has some effect on the forage preferences exhibited by mule deer throughout the year.

Winter fiber values remained fairly constant with slight fluctuations for some species. Juniper decreased as the winter wore on, while pinyon pine on the other hand made a slight increase. Almost all species tested contained values of over 20% crude fiber during this winter period. Similar values were obtained in Colorado (Dietz, Udall, and Yeager, 1962).

N. F. E. The nitrogen free extract represents the more soluble carbohydrates which are readily available as a quick source of energy. N. F. E. decreased in most species as the summer season progressed with the exception of serviceberry, lupine, and buckwheat. The N. F. E. values vary inversely with crude fiber and likewise remained fairly stable during the winter period. The general range of this nutrient was from 45-60% of the total plant composition. Because it is a quick energy source, this plant portion may be very important in the energy balance of the wild ruminant.

Ash. All of the mineral matter in plant tissue is retained in the ash fraction. Ash values were generally high in May and

July, decreasing slightly during September except for quaking aspen and choke-cherry. They attained their highest value in September. Both of these species were high in ash during the summer as was balsam root.

Winter ash values remained relatively stable and no noticeable increase was found until spring growth had resumed. Big sagebrush and Mormon tea (Ephedra viridis) proved to be fairly high in ash content during this season, as compared with other species.

Conclusions and Recommendations

Analysis of selected forage species indicates that there are no gross nutritional deficiencies in the quality of summer range plants. This, of course, applies only to the nutrients analyzed for in the proximate analysis. There may be other areas in which a deficiency does exist. Phosphorus is a good example. It should be understood also that there are no established requirements for mule deer under range conditions, and therefore factors may be involved here that are not known at the present time.

Analysis of winter forage plants has revealed protein levels all above the critical 5% level (Einarsen, 1946) during the peak of winter use. However, there were some species below the safer minimal figure of 7% protein (Longhurst, Leopold, and Dasmann, 1952).

Pinyon pine and juniper were below the 7% level averaging 6.2% and 5.9% respectively throughout the winter. Curl-leaf mountain mahogany dropped down to 6.74% on the Pequop Mountains during January, but was above 7% on all other dates. On Morey Bench, pinyon pine and juniper composed 35% of the diet.

This left 65% of the winter forage containing more than 7% protein. The Pequop Mountains were similar in this respect. Approximately 65% of the winter forage here was also above the minimal 7% figure. Pinyon pine, juniper, and curl-leaf mountain mahogany constituted about 35% of the Pequop deer winter diet.

Considering this, it is felt that although these protein values lie close to the critical level, it is doubtful if there is any gross protein deficiency on these winter ranges.

If there is a major deficiency of any one factor it is probably energy. Energy is derived primarily from the metabolism of the carbohydrate and lipid fractions of the plant. Although digestibility plays a role here, the most important factor in obtaining sufficient energy is total feed intake. This is controlled directly by the forage availability. At the present time there are little if any complete data available on energy requirements of wild deer. This is an area which is in great need of research. One of the main problems inherent in the energy balance of deer is determination of the energy of voluntary activity or the energy which is used in daily movements and activity. Data of this type cannot be obtained wholly from digestion studies of tame deer, although facts obtained in these studies are essential to complete the picture. In the future, serious consideration should be given to developing methods from which the energy requirement of mule deer could be established.

Continuation of the analysis of forage species described in this paper will be of no great benefit unless new information becomes available that will make this type of data more meaningful. For example, if more were known about total feed intake by species,

and nutritive requirements then the data would have immediate use and benefit.

ANIMAL CONDITION

Literature Review

The prominence of animal condition or health in the management of deer may best be illustrated by the words of Cowan and Wood (1955), who stated that, "the animal itself presents the most satisfactory measure of adequacy of the range upon which it has grown."

Direct starvation is probably the most evident and common reason for the natural death loss of deer. Although starvation is the most striking decimating factor of deer populations, it is by no means the only loss in deer numbers attributable to poor nutrition. Longhurst, Leopold, and Dasmann (1952) state that in recent years the information available has indicated "that the incidence of parasitism and disease in animals is closely linked with the nutritional level of the host." Other workers (Taber and Dasmann, 1958; Swank, 1956) have confirmed that heavy deer losses from disease and parasitism may usually be related back to poor nutrition.

Poor condition also affects the natality factors of a deer herd. It has been stated (Taber and Dasmann, 1958) that does in poor condition do not breed as young and do not produce as many fawns when breeding as deer in good condition. This study also found a higher death loss of fawns shortly after birth in undernourished does. Verme (1965), from studies with penned whitetails concluded that the animals must be in good nutritive condition long before breeding occurs if the optimum reproduction potential is to be achieved. Other studies confirming these results were carried out by Julander (1961) and Robinette and Gashwiler (1950).

The knowledge of these facts has led researchers to develop some criteria for evaluating the condition of deer.

It is generally known that during the summer and early autumn months deer on good range build up reserves of fat distributed throughout various parts of the body. Harris (1945) described the sequence in which body fat reserves of deer were utilized. He found that the fat over the rump and saddle, followed by that between the hide and body were used first. The next step of fat utilization occurs internally as that around the kidney and intestine and finally the heart fat is utilized. The last fat thought to be utilized is that present in the bone marrow. Cheatum (1949) used the fat content of the femur marrow as an index of malnutrition. Fat depletion is recognized by a change in the marrow consistency and a general reddening in color. Later Ranson (1965) obtained results that conflict with Cheatum (1949) and Harris (1945), who said that marrow fat was not utilized until all other fat reserves have disappeared. These results showed that some internal fat is still present when the femur fat begins to be utilized.

Raush (1950) found the heart becomes flabby and yellowish in color during prolonged starvation.

An investigation of the changes in blood composition (Rosen and Bischoff, 1952) failed to show any conclusive correlation between changes in condition and hematological response.

Riney (1955) working on red deer in New Zealand, concluded that weight of kidney fat expressed as a percentage of kidney weight is a valid index of total body fat over the entire range of physical condition. The validity of kidney fat as an indicator of condition was

confirmed by Ransom (1965) in studies on white-tailed deer.

Brandy et al. (1956), working with Columbian blacktail deer, found that heart girth increases and decreases in response to a gain or loss in real body weight.

In California, a study of the adrenal cortex in relation to condition of deer (Hughes and Mall, 1958) pointed out that there was a significant negative correlation between the amount of adrenal cortex tissue and animal condition.

Riney (1950) described the external appearance of deer in poor condition. He found the lateral processes of backbone vertebrae can be seen as a faint line, and that an outline of the ribs is visible.

Density studies of mule deer body fat were conducted by Wicker (1964). The object of this study was to arrive at the density of this specific fat so that the immersion technique using the specific gravity formula could be applied to calculate total body fat of the animal.

Taber and Dasmann (1958) stated, "weight change alone is not a useful measurement of condition unless correction is made for skeletal size." In conjunction with this topic, Klein (1964) found that skeletal measurements do not fluctuate during periods of stress and therefore, serve as a more reliable index of growth. Thus, if one knew the skeletal measurements of animals in a particular range, weight values would be of some benefit in evaluating the condition of deer.

Even with all of this information the problem is not yet solved. The need for a practical method to assess the condition of deer still remains. To attain this goal a new approach was used.

In this study an attempt was made to correlate percent fat of various tissues with animal condition.

Methods

Animals were collected as described in the methods section of the food habits study. Six tissue samples were taken from each animal in the field and transported to the laboratory in insulated coolers containing dry ice, where they remained frozen until subsequent analysis. In addition, depth of subcutaneous back fat, color. and consistency of tibia bone marrow, body weights (both live and bled weight), parasitism, age, and reproductive data were recorded for each animal.

Back fat depth was measured along a cut made starting at the base of the tail and at an angle of approximately 45 degrees from the spinal column. The greatest depth of fat along this line was recorded. This was the method used by Riney (1955).

A description of the tissues taken and methods of their collection is presented below.

(1) Tail--the entire tail was removed from the skinned carcass. Then the eight terminal vertebrae were removed for analysis.

(2) Heart--the entire heart was removed from the animal and taken out of the pericardium. In the laboratory, the auricles and vessels were removed (at the junction of auricles and ventricles) leaving the muscular ventricles and fatty tissue incorporated with them.

(3) Kidney--both kidneys were removed. In the laboratory all external fat and membranes were removed. The soft tissue of

the cortex and medulla was prepared for analysis.

(4) Loin chop--a small section from the lateral sides of the transverse processes of the dorsal portion of the spinal column was removed (Figure 11). This sample included all subcutaneous back fat present on the removed loin tissue. It was then prepared for analysis.

(5) Foreleg--a section of the posterior muscle of the radius from the joint upward toward the humerus was removed and prepared for analysis (Figure 12).

(6) Hind quarter--a small section about 2 inches in depth and width was cut from the rear ham, approximately 5 inches below the tail bone (Figure 11). This was then prepared for analysis.

All of the tissue samples were finely ground in a meat grinder and mixed as thoroughly as possible. Then 100 grams (if available) of the ground tissues were placed in a foil container and forzen. The frozen tissues were then lyophilized until completely dry, which took about 24 hours. These dry samples were reground and placed in glass jars.

Duplicate one gram portions of a prepared sample were analyzed for lipid content by ether extraction using standard laboratory procedures (A. O. A. C., 1955). From this analysis the percent fat of each tissue was determined.

Another aspect pertaining to condition is the vitamin A status of the animal. The liver of each animal was frozen on dry ice and brought to the laboratory. Here a small portion of the central lobe of each liver was removed and analyzed for vitamin A and carotene using the method outlined by Davies (1939).

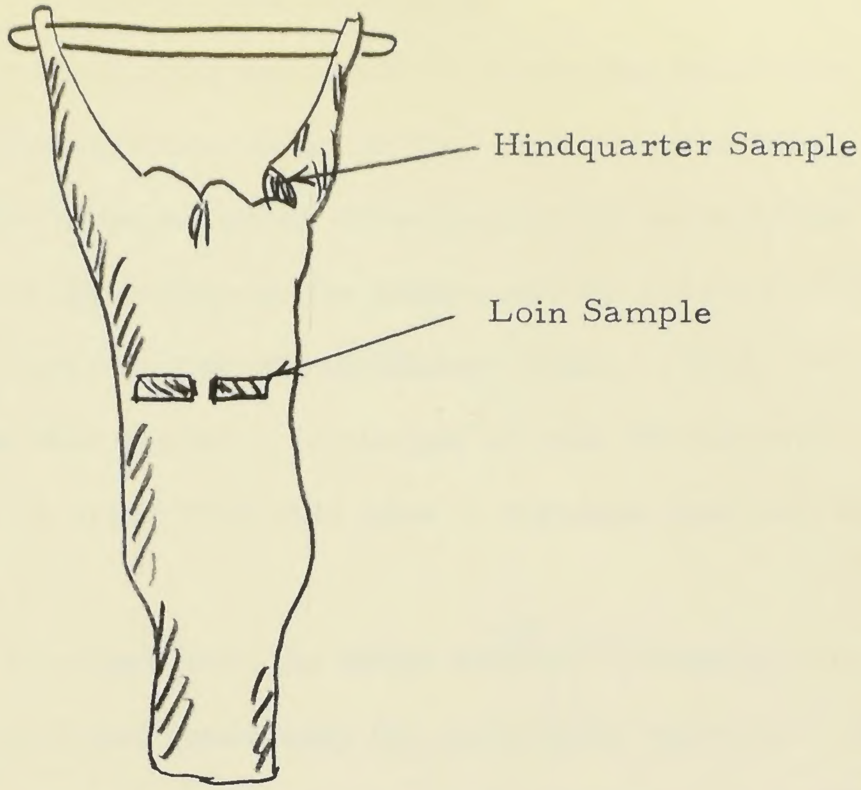


Figure 11. Location of loin and hind quarter tissue samples on skinned deer carcass.

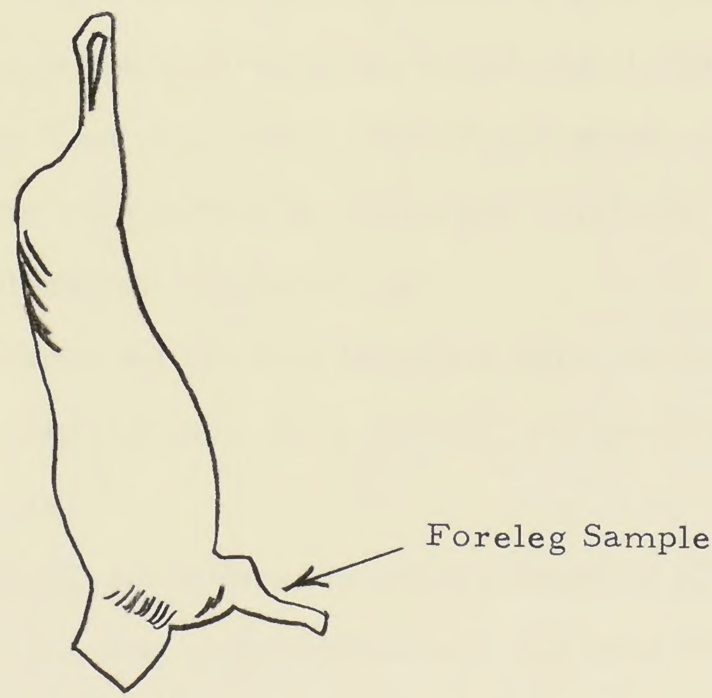


Figure 12. Location of foreleg tissue sample on skinned deer carcass.

Results and Discussion

In this study an attempt was made to relate the fat content of various tissues to the condition of the animal on a specific range. The use of fat seems to be a logical criterion for the assessment of condition since depot fat serves as the major energy reserve of the animal and thus reflects its nutritional status (Riney, 1955). Workers have also concluded that depletion in amount of body fat deposition in deer is believed to be associated with loss of strength (Leopold et al., 1951; Riney, 1955).

The values obtained from the ether extract of animal tissues were statistically analyzed separately for each study location. This was deemed necessary because each area was influenced by different environmental conditions. The statistical analysis consisted of a factorial analysis of variance (Li, 1957). The factors tested were replication (animals), date, tissue, and the tissue x date interaction. This was followed by mean separation of the significant factors using Duncans Multiple Range Test (Li, 1957). Since each study site was analyzed separately, the results will be presented similarly.

Fox Mountain - Summer 1964

Analysis of variance for the Fox Mountain data yielded a significant F value for replications, date, tissue, and the tissue x date interaction (Table 14).

There was a significant difference in fat content of all tissues between September and the May-July collections, but none from May to July.

Tissue on the other hand showed considerable variations. Tail loin, and heart fat values were significantly different from each other

Table 14. Statistical analysis of the percent fat values obtained from tissue samples at Fox Mountain, summer 1964.

Analysis of Variance

Factor	Observed F	Required F .05*	Required F .01**
*Reps	3.38	2.5	3.6
**Date	37.84	3.13	4.92
**Tissue	38.29	2.35	3.29
**T x D	7.97	1.97	2.51

Mean Separation at .05 Level

Date	% Fat $\bar{X}$	Sig.*
May	7.31	a
July	10.45	a
Sept.	20.38	b

Mean Separation at .05 Level

Tissue x Date	% Fat $\bar{X}$	Sig.*
Tail-Sept.	44.49	a
Loin-Sept.	33.50	b
Heart-Sept.	25.96	bc
Tail-July	25.02	c
Heart-July	18.73	cd
Tail-May	16.29	de
Heart-May	12.19	def
Kidney-Sept.	8.62	efg
Kidney-July	7.57	fg
Kidney-May	7.44	fg
Hind qt.-Sept.	6.96	fg
Hind qt.-July	5.18	fg
Loin-July	4.54	fg
Foreleg-May	3.61	fg
Hind qt.-May	2.79	f
Foreleg-Sept.	2.72	f
Foreleg-July	2.04	f
Loin-May	1.54	f

Mean Separation at .05 Level

Tissue	% Fat $\bar{X}$	Sig.*
Tail	28.60	a
Loin	18.86	b
Heart	13.84	c
Kidney	7.88	c
Hind qt.	4.98	de
Foreleg	2.79	f

*Sig. represents the results of Duncan's Multiple Range Test. The small letters indicate significant differences between mean values Values with the same letter are nonsignificantly different from one another.

and also the remaining three tissues. The kidney was significant from all tissue except the hind quarter. The latter tissue was nonsignificant from the foreleg.

The tissue x date interaction which should yield the most meaningful information, gave the following results. Tail tissue showed a significant increase in fat content during each of the three collection dates. The minimum mean value, 16.29%, occurred in May. This then increased to 25.02% in July and reached a maximum mean of 44.49% in the September sample. This deposition of fat with seasonal progression is what one would expect, and is the type of trend this study was meant to document. It may also be noted that the majority of fat was deposited between the July and September collections.

Samples of loin tissue from the May and July collections were found to be significantly different from the September values, but not from each other. This is because the loin sample includes all subcutaneous back fat on the tissue collected. This sample, therefore, reflects the addition of subcutaneous fat to the body and is thus limited to the period of the year that animals possess a reserve of back fat. This would limit its value as a year around indicator of condition.

The heart also had a high fat content in September, which was significantly higher than the May, but not July samples. These latter two samples also showed no meaningful difference in fat content between each other. The heart fat is thought to be one of the last fat reserves to be mobilized (Harris, 1945), but sampled in this manner, it may show some relationship to annual fat deposition and depletion.

Kidney, hind quarter, and foreleg samples yielded no meaningful trends or significant increases in fat content during the three collection dates. This suggests that they have little value as a condition index.

Bates Mountain - Summer 1964

The F values obtained from the analysis of Bates Mountain fat samples were significant for replications, date, tissue, and the tissue x date interaction (Table 15).

There was significant increase in fat content of all tissues with each collection date. The maximum values being in September.

Tail tissue was found to be significantly higher than all other tissues. The loin and heart were nonsignificantly different between themselves, but were significantly different from the other four tissues. The kidney and hind quarter samples were likewise nonsignificant from each other. The foreleg was significantly lower than all other tissues sampled.

The results of the tissue x date interaction of Bates Mountain followed a trend similar to that of Fox Mountain. Tail tissue showed a significant increase in fat content with each collection date. The mean values ranged from a minimum of 14.22% in May, to 22.32% during July and a maximum value of 64.80% in September. This is the same trend of fat deposition found on Fox Mountain. It is again apparent that most of the fat increase occurred from July to September. The results from these two areas indicate that the tail tissue sample is indicative of the seasonal deposition of body fat on mule deer. The mean maximum of Bates was 20% higher than that of Fox Mountain. This difference apparently reflects the difference in range conditions on the two areas.

Table 15. Statistical analysis of the percent fat values obtained from tissue samples at Bates Mountain, summer 1964.

Analysis of Variance

Factor	Observed F	Required F .05*	Required F .01**
**Reps	5.70	2.50	3.60
**Date	143.75	3.13	4.92
**Tissue	61.64	2.35	3.29
**T x D	34.20	1.97	2.51

Mean Separation at .05 Level

Date	% Fat $\bar{X}$	Sig.*
May	6.62	a
July	10.35	b
Sept.	28.98	c

Mean Separation at .05 Level

Tissue x Date	% Fat $\bar{X}$	Sig.*
Tail-Sept.	64.80	a
Loin-Sept.	52.84	b
Heart-Sept.	25.36	c
Tail-July	22.32	c
Heart-July	19.49	cd
Hind qt.-Sept.	18.30	cd
Tail-May	14.22	de
Heart-May	10.31	e
Kidney-July	9.81	ef
Kidney-Sept.	9.10	efg
Kidney-May	8.47	efg
Loin-July	4.38	efg
Foreleg-May	3.83	fg
Hind qt.-July	3.76	fg
Hind qt.-May	3.12	fg
Foreleg-July	2.37	fg
Loin-May	1.89	g
Foreleg-May	1.74	g

Mean Separation at .05 Level

Tissue	% Fat $\bar{X}$	Sig.*
Tail	33.78	a
Loin	19.58	b
Heart	18.39	b
Kidney	9.12	c
Hind qt.	8.39	c
Foreleg	2.65	d

*Sig. represents the results of Duncan's Multiple Range Test. The small letters indicate significant differences between mean values. Values with the same letter are nonsignificantly different from one another.

Loin tissues from May and July were nonsignificantly different from each other, but were significant from the increased fat content of the September sample. This again is probably due to the influence of subcutaneous back fat on the tissue sampled.

Heart samples from September and July were significantly higher from those of May, but not from each other. These results do not duplicate those of Fox Mountain, although there was a small but nonsignificant increase in fat with date.

Kidney, hind quarter, and foreleg again showed no definite increase in fat content with seasonal progression, except that the hind quarter sample was significantly higher in September than in May or July. This increase was undoubtedly due to heavy subcutaneous fat deposition during the September collection.

Morey Bench - Winter 1964-65

All four factors, replications, date, tissue, and the tissue x date interaction yielded a significant F value (Table 16).

The December collection was found to be significantly higher than either January or March, but no meaningful difference was present between January and March.

Analysis of the six tissues gave the following results. The tail and heart contained the highest fat content and were significant from all tissues sampled. Loin tissue was significantly different from all except the kidney. This tissue was also nonsignificant from the hind quarter. The difference between hind quarter and foreleg was nonsignificant.

In regard to the tissue x date interaction the tail again exhibited the most favorable results. A significant decrease in

Table 16. Statistical analysis of the percent fat values obtained from tissue samples at Morey Bench, Winter, 1964-65.

Analysis of Variance

Factor	Observed F	Required F .05	Required F .01
**Reps	4.70	2.50	3.60
**Date	9.88	3.13	4.92
**Tissue	74.26	2.35	3.29
**T x D	4.00	1.97	2.51

Mean Separation at .05 Level

Date	% Fat $\bar{X}$	Sig.*
Dec.	17.47	a
Jan.	12.04	b
Mar.	11.70	b

Mean Separation at .05 Level

Tissue x Date	% Fat $\bar{X}$	Sig.*
Tail-Dec.	49.71	a
Tail-Jan.	28.91	b
Tail-Mar.	27.43	b
Heart-Dec.	23.71	bc
Heart-Jan.	22.28	bcd
Heart-Mar.	19.58	cd
Loin-Dec.	15.81	de
Kidney-Mar.	9.48	ef
Kidney-Dec.	8.36	ef
Kidney-Jan.	8.02	f
Loin-Mar.	6.84	f
Loin-Jan.	6.01	f
Hind Qt.-Dec.	5.28	f
Hind Qt.-Jan.	4.35	f
Hind Qt.-Mar.	4.29	f
Foreleg-Jan.	2.65	f
Foreleg-Mar.	2.58	f
Foreleg-Dec.	1.95	f

Mean Separation at .05 Level

Tissue	% Fat $\bar{X}$	Sig.*
Tail	35.35	a
Heart	21.86	b
Loin	9.55	c
Kidney	8.62	cd
Hind Qt.	4.64	de
Foreleg	2.39	e

* Sig. represents the results of Duncan's Multiple Range Test. The small letters indicate significant differences between mean values. Values with the same letter are nonsignificantly different from one another.

fat content from a mean value of 49.71% in December to 28.81% during January was shown. Although nonsignificant, there was a slight decrease in fat content to 27.43% in March.

Heart showed a small but constant decrease in fat content, but these values were all nonsignificant by date. A minimum mean value of 19.58% was obtained in March.

The December loin samples were significantly higher in fat than the January or March values, which were nonsignificant from each other. This difference no doubt represents the mobilization of subcutaneous back fat during early winter.

Kidney, hind quarter, and foreleg fat followed no significant trend as the winter progressed.

Pequop Mountains - Winter 1964-65

The analysis of the Pequop winter fat data yielded only one significant F value. This was for the tissue factor. In other words it may be stated that the difference found among replications, date, and the tissue x date interaction was nonsignificant.(Table 17).

After mean separation of tissues it was found that the tail and heart were significantly different from all samples. Kidney tissue was significant from all samples except the loin and hind quarter. The loin followed this same trend. Hind quarter and foreleg tissue were not significantly different from one another.

The tail sample from the Pequop Mountains deviated from the general trend of fat depletion. A mean value of 34.93% was found in December. This increased to a maximum of 41.59% during January, and then decreased to a minimum mean of 29.64% in March. These changes were nonsignificant statistically (Table 17).

Table 17. Statistical analysis of the percent fat values obtained from tissue samples at the Pequop Mountains, winter, 1964-65.

Analysis of Variance

Factor	Observed F	Required F .05	Required F .01*
Reps	0.67	2.50	3.60
Date	1.75	3.13	4.92
**Tissue	49.35	2.35	3.29
T x D	0.76	1.97	2.51

Mean Separation at .05 Level

Date	% Fat $\bar{X}$	Sig.*
Jan.	15.19	
Dec.	12.43	
Mar.	12.12	

Mean Separation at .05 Level

Tissue x Date	% Fat $\bar{X}$	Sig.*
Tail-Jan.	41.59	
Tail-Dec.	34.93	
Tail-Mar.	29.64	
Heart-Mar.	22.73	
Heart-Dec.	21.21	
Heart-Jan.	20.27	
Loin-Jan.	10.87	
Hind qt.-Jan.	8.84	
Kidney-Mar.	8.32	
Kidney-Jan.	7.70	
Kidney-Dec.	7.18	
Loin-Mar.	5.77	
Loin-Dec.	5.61	
Hind qt.-Mar.	4.14	
Hind qt.-Dec.	3.79	
Foreleg-Mar.	2.14	
Foreleg-Jan.	1.88	
Foreleg-Dec.	1.68	

Mean Separation at .05 Level

Tissue	% Fat $\bar{X}$	Sig.*
Tail	35.39	a
Heart	21.40	b
Loin	7.73	c
Kidney	7.42	c
Hind Qt.	5.59	cd
Foreleg	1.96	d

* Sig. represents the results of Duncan's Multiple Range Test. The small letters indicate significant differences between mean values. Values with the same letter are nonsignificantly different from one another.

This deviation from the trend seems to dispute the results obtained from the other winter area, but it may possibly be explained by the individual variation in animals collected. Although an attempt was made to collect only yearling females, this proved to be difficult if not impossible under the collection conditions during certain periods. Most of the variation here occurred because of the influence of fawns and dry does upon the sample (Appendix Table 23). Another factor of importance is that some of the deer collected during January still possessed some back fat and appeared to be in good condition. The mildness of this winter probably had considerable influence on this sample and the condition of the animals represented by it. This deviation may also be the result of some sampling error, in that five deer in such excellent condition happened to be collected at that time.

Loin tissue fat gave a trend similar to that of the tail. A minimum mean of 5.77% was present in March indicating the mobilization of subcutaneous back fat.

The other tissues gave no concrete trends in fat depletion with seasonal progression.

Other Indices of Condition and General Remarks

One of the supplemental indices of condition recorded was the depth of subcutaneous back fat. Results from this measurement show that back fat was not present in any quantity during the summer until the September collection (Table 18). During this period subcutaneous back fat was found in depths ranging from 0 to 3/4 inch. All animals with the exception of some fawns had deposited some fat by this date. Most of the deer collected on the winter range during

Table 18. Depth of subcutaneous back fat (inches)

Fox Mountain

	Animal No.	Back Fat
	1	0
	2	0
May	3	0
	4	0
	5	0
	6	0
	7	0
July	8	0
	9	0
	10	0
	11	0
	12	0
Sept	13	1/4
	14	1/2
	15	0

Bates Mountain

	Animal No.	Back Fat
	1	0
	2	0
May	3	0
	4	0
	5	0
	6	0
	7	0
July	8	0
	9	0
	10	0
	11	5/8
	12	1/2
Sept	13	3/4
	14	1/8
	15	3/8

Pequop Mountains

	Animal No.	Back Fat
	1	1/16
	2	1/16
Dec	3	0
	4	0
	5	3/16
	6	1/16
	7	0
Jan	8	0
	9	1/8
	10	0
	11	0
	12	0
Mar	13	0
	14	0
	15	0

Morey Bench

	Animal No.	Back Fat
	1	3/16
	2	1/8
Dec	3	0
	4	3/16
	5	0
	6	0
	7	0
Jan	8	0
	9	0
	10	0
	11	0
	12	0
Mar	13	0
	14	0

December still possessed back fat up to a maximum depth of 3/4 inch. By January all animals, with the exception of two from the Pequop Mountains, had mobilized their subcutaneous reserves. During March there was no trace of back fat present on any of the collected animals. The evident limitation of this index is that it can be of use only during late summer and early winter as deer use this reserve first, having mobilized it soon after winter begins.

Visual inspection of internal fat reserves was made on each animal. As one would expect the reserves were greatest in early fall and gradually diminished throughout the winter.

Tibia bone marrow was inspected on each deer as to color and consistency. Based on the guidelines set by Cheatum (1949) none of these animals possessed marrow in a highly depleted state.

Based on the above criteria and that obtained from tissue analysis, none of the animals collected were found to be in dire nutritional stress. The author realizes the limitations of such observations, but believes that they still represent a relative indication of condition. This information indicates that the summer forage was adequate since tissue and subcutaneous fat increased during the season. There was also some stored fat at the end of the winter indicating that feed conditions up to this time were not critical for these particular deer.

It is also important to note that the results of the tissue analysis and back fat depth show the animals of each area to contain different quantities of fat during the same periods. This is no doubt a reflection of the difference in range and environment conditions present on each area. The abundance and type of forage species

present on these ranges differs. Therefore, so will the condition of the deer subsisting on them differ.

Liver Vitamin A and Carotene

Analyses of deer livers for vitamin A and carotene have established the following mean levels to be present in female Nevada mule deer on the date and location of collection.

Table 19. Liver content of vitamin A and Carotene in female Nevada mule deer.

Location	Dates	Number of Animals	Vitamin A $\bar{X}$ mcg/g	Carotene $\bar{X}$ mcg/g
Fox Mt.	May, July, Sept.	15	221.00	1.91
Bates Mt.	May, July, Sept.	15	152.00	1.28
Morey Bench	Dec., Jan., Mar.	14	157.14	2.53
Pequop Mt.	Dec., Jan., Mar.	15	190.40	1.79

Recent studies with domestic lambs have shown an average of 48.9 $\pm$ 2.97 mcg/g of vitamin A in the liver (Cline, Hatfield, and Garrigus, 1963). These results were obtained from analysis of 48 control lambs in good condition weighing approximately 67 pounds. When the liver values obtained from mule deer averaging 109 pounds are compared to these, it may be seen that these deer contained 3 to 4 times as much liver vitamin A. Although the requirements for deer are not established, it seems very probably in view of these results that Nevada female deer are not suffering from a vitamin A deficiency.

The higher liver vitamin A values obtained for deer are probably the result of a diet composed largely of browse species. It was found that most browse species, especially evergreen and semi-evergreen species, are high in carotene content (Short, Dietz, and Remmenga, 1962). The variation found in food habits on each

area would cause variation in carotene intake and result in the difference in liver vitamin A values found.

Considering that carotene is the precursor of vitamin A, the small amount of carotene present in the liver samples suggests that most of the carotene is converted to vitamin A before storage in the liver.

Parasitism

A brief autopsy was performed on each animal to gain some information on the degree of parasitism present in Nevada female mule deer. This autopsy was incomplete and only the more evident or heavy infestations of parasitic organisms were detected. The following species of endoparasites were found to occur in Nevada mule deer. (1) Fringed tapeworm (*Thysanosoma actinioides*) (2) Tapeworm (*Moniezia* sp.) (3) Botfly (*Cephynemyia pratti*) (4) Bladderworm (*Cysticercus* sp.) Species identification was made by Dr. F. D. Tibbitts, Biology Department, University of Nevada.

The only species found with relatively high incidence was the bladderworm. This is the immature stage of a tapeworm for which deer are the intermediate host. These cysts usually cause no particular harm to deer (Dasmann and Taber, 1958). Ectoparasites comprised mostly of ticks and lice were present on most animals in varying degrees.

The results of this investigation indicate that the incidence of serious intensional parasitism in Nevada mule deer is not extensive at the present time and probably has a negligible effect on the condition of these deer.

Conclusions and Recommendations

It appears that certain tissue samples may be used to reflect the general fat deposition and depletion of female Nevada mule deer seasonally. Information of this type relates directly to the condition of the animals and was the attempted goal of this pilot study.

The tail tissue gave the most favorable results. It generally reflects the trend of fat metabolism that one would expect to occur in mule deer. At the present time with only this limited amount of data, it is not possible to set specific fat values that are indicative of animal condition on these ranges, except in a general way. For example, based on the observations of this study it would be safe to say that in general any animal with a tail fat content of 30% or higher would be in good condition nutritionally. But with the accumulation of more data to substantiate and refine this initial premise it may be possible to set more specific values to indicate animal condition classes.

To achieve this latter goal it would be necessary to obtain fat values from deer over the entire range of condition and also of different ages and sex. This would include animals in prime condition as well as those in a state of nutritional stress.

During the progress of this study, environmental conditions were not severe enough to allow collection of animals that were in extremely poor condition. Therefore, as a result data was not collected on the complete range that may occur.

Other indices of condition as enumerated in the methods section and general internal fat deposits were noted for each animal. In future collections, a system of kidney fat classes such as that used by Hughes and Moll (1958) could be initiated to be correlated

with fat content of tissue samples. Riney (1955) stated that kidney fat best represents the total abdominal fat reserve, the major fat reserve of the body. In view of this, the correlation of kidney fat with that of tissue may act as an aid in attempting to establish specific tissue fat values to indicate general condition classes.

Although the best results were obtained from the tail sample, it would be of value to follow up analysis of both the heart and loin tissues. These samples while not as distinct as the tail, did show a trend in seasonal fat deposition and depletion.

One practical advantage of the tail sample would be the ease of acquisition. Hunter kills would be available, and the possibility of a biopsy technique for obtaining a tail sample from trapped deer is quite probable.

This technique offers great possibilities as a management tool to evaluate the condition of mule deer. Information on animal condition would bring to light many factors inherent in the native deer herds in such areas as range condition and population dynamics.

SUMMARY

1. Mule deer were collected on two summer and two winter deer ranges in Nevada. Fox Mountain in northern Washoe County and Bates Mountain in Lander County were the summer range sites. The winter ranges were Morey Bench in Nye County and the Pequop Mountains in northeastern Elko County. The summer collections were made in May, July, and September. Winter deer were collected in December, January, and March. Collections were made at the rate of five deer per date and location.

2. Food habits were determined both quantitatively and qualitatively by a point analysis method on dry weight basis.

The majority of the summer food taken on Fox Mountain consisted of browse with moderate consumption of green grass in the spring. The species composing the majority of the browse were bitterbrush and curl-leaf mountain mahogany.

Bates Mountain deer on the other hand utilized forbs heavily throughout the summer with quaking aspen and other browse species filling in the rest of the diet.

The major forage taken on the Morey Bench winter range was desert bitterbrush. The remaining diet consisted of big sagebrush, pinyon pine, and juniper.

Sagebrush was found to be one of the main food items on the Pequop winter range. This species was supplemented by moderate amounts of bitterbrush, juniper, pinyon pine, curl-leaf mountain mahogany, and cliffrose.

3. Nutritive composition of several selected forage species from each area was determined. The nutrients analyzed for were

protein, crude fat, crude fiber, N. F. E., and ash. It was found that protein appeared to be adequate on both summer ranges and, although approaching the minimal level during the winter was still adequate for maintenance. Crude fat was high in evergreen and semi-evergreen species during the winter months. There was a general increase in fiber with seasonal progression, while N. F. E. followed the inverse trend decreasing as the summer progressed. Ash generally reached a high in early summer with winter levels remaining fairly stable.

4. An attempt was made to determine animal condition by determination of percent fat in various tissue samples. The tissues sampled were the heart, kidney, tail, loin, foreleg, and hind quarter. It was found that certain tissue samples may be used to reflect the general fat deposition and depletion of Nevada female mule deer seasonally. The tissue yielding the most favorable results was the tail sample.

Other indices of condition such as depth of subcutaneous back fat, internal fat, parasitism, and bone marrow were also recorded for each animal. In addition, liver vitamin A was determined and there appears to be no deficiency of this vitamin in the deer sampled.

5. In the future, additional food habits work should be conducted on other important deer ranges in Nevada. Nutritive determination of the key species of these areas need not be continued, unless new information becomes available to make this date more meaningful. For example, if more were known about total intake by species and nutritive requirements then the data would have greater value. The area of energy balance is another field in great need of further research.

Analysis of tissue samples, especially the tail should be continued and an attempt made to establish condition classes based on the percent fat of these samples and other factors that may aid in this classification.

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APPENDIX

Table 20. Summary of animal data from Fox Mountain

Animal number	Age	Sex	Reproduction Data	Weight live	Weight bled
1	overmature	female	1 female fetus	-	-
2	mature old	female	1 male & 1 female fetus	-	-
3	mature	female	1 male & 1 female fetus	-	-
4	mature	female	1 male & 1 female fetus	-	-
5	mature	female	1 male & 1 female fetus	-	-
6	mature	female	wet	130	80
7	yearling	female	dry	85	60
8	mature	female	wet	133	85
9	2-year old	female	wet	115	80
10	yearling	male	-	-	51
11	2-year old	female	dry	124	86
12	yearling	male	-	103	74
13	mature	female	wet	136	94
14	mature old	female	dry	150	100
15	mature	female	wet	130	83
16	fawn	male	-	64	53
17	yearling	male	-	112	86
18	2-year old	female	1 female fetus	124	83
19	mature	female	1 male & 1 female fetus	134	89
20	mature old	female	2 female fetuses	150	91
21	mature	female	wet	128	85
22	mature	female	dry	153	113
23	yearling	female	dry	80	56
24	mature old	female	dry	160	114
25	2-year old	female	dry	122	88
26	mature	female	wet	135	85
27	mature old	female	wet	130	90
28	overmature	female	wet	133	85
29	mature	female	wet	119	86
30	mature	female	wet	115	84

APPENDIX

Table 21. Summary of animal data from Bates Mountain

Animal number	Age	Sex	Reproduction Data	Weight live	Weight bled
1	mature	female	1 male & 1 female fetus	-	-
2	yearling	female	-	-	-
3	yearling	female	-	-	-
4	mature	female	1 female fetus	-	-
5	yearling	female	-	-	-
6	mature old	female	wet	-	73
7	yearling	female	dry	92	66
8	yearling	female	dry	90	66
9	yearling	female	dry	95	64
10	yearling	male	-	83	64
11	mature	female	wet	135	101
12	mature	female	dry	132	85
13	mature	female	wet	143	103
14	mature	female	wet	155	103
15	yearling	female	dry	134	93
16	overmature	female	1 male & 2 female fetus	165	94
17	fawn	female	-	65	52
18	mature	female	2 female fetuses	165	107
19	fawn	female	-	76	61
20	yearling	female	dry	86	61
21	mature	female	wet	94	64
22	yearling	female	dry	65	46
23	mature	female	dry	103	75
24	yearling	female	dry	80	56
25	yearling	female	dry	110	79
26	yearling	female	dry	103	80
27	overmature	female	wet	113	82
28	mature	female	wet	136	91
29	fawn	female	dry	56	45

APPENDIX

Table 22. Summary of animal data from Morey Bench

Animal number	Age	Sex	Reproduction Data	Weight live	Weight bled
1	mature	female	-	131	82
2	mature	female	-	119	86
3	fawn	female	-	52	38
4	overmature	female	-	135	96
5	overmature	female	1 male & 1 female fetus	120	85
6	overmature	female	1 female fetus	115	75
7	fawn	female	-	73	55
8	fawn	male	-	53	40
9	mature	female	1 female fetus	120	86
10	2-year old	female	1 male & 1 female fetus	107	75
11	yearling	male	-	101	75
12	overmature	female	1 male & 1 female fetus	117	76
13	mature	female	2 female fetuses	110	80
14	mature	male	-	120	90

Table 23. Summary of animal data from the Pequop Mountains.

Animal number	Age	Sex	Reproduction Data	Weight live	Weight bled
1	mature	female	-	152	102
2	mature old	female	-	131	89
3	fawn	male	-	65	41
4	fawn	male	-	55	38
5	yearling	female	-	112	80
6	fawn	male	-	72	47
7	overmature	female	3 male fetuses	125	90
8	mature	female	1 female fetus	118	82
9	mature old	female	1 male & 1 female fetus	135	90
10	overmature	female	2 male fetuses	123	86
11	yearling	female	-	88	65
12	mature	female	2 female fetuses	135	90
13	mature	female	1 male fetus	113	80
14	mature	female	1 female fetus	105	71
15	mature	male	-	112	86