Food and range use habits of whitetail deer on Missouri River bottomlands in Northcentral Montana
by Eugene Oliver Allen

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE in Fish and Wildlife Management
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Abstract:
A study was conducted on Missouri River bottomlands in northcentral Montana from June 1964 to June 1965 to obtain quantitative data on food and range use habits of the whitetail deer. Four vegetation types, including cottonwood, meadow, greasewood and weed were quantitatively sampled to aid in evaluating the results. The willow type was also described, Range use was evaluated from 4,647 field observations of whitetails. Forty and 33 per cent of summer observations and 22 and 35 per cent of fall observations were made in the meadow vegetation type and alfalfa fields respectively. Fifty per cent of winter and 19 per cent of spring observations were in the cottonwood type. The weed type accounted for 26 and 53 per cent of winter and spring observations respectively.

Food habits were evaluated from analyses of 48 rumen samples and examination of 57 feeding sites. Browse averaged 45, 8l, 65 and 43 per cent of the contents of rumen samples for summer, fall, winter and spring respectively and was the most important forage class for all seasons except summer, Forbs averaged 54, 17, 29 and 18 per cent respectively and constituted the most important class during summer.

Grass was present in rumen samples during all seasons but was a mirior item except in spring when its volume averaged 38 per cent. Examination of feeding sites generally supported the data from rumen content analyses but indicated a greater use of forbs, Western snowberry (Symphoricarpos occidentalis), which occurred in 95 per cent of all rumen samples and had a yearlong average volume of 27 per cent, appeared to be the most important single food plant, Volume of snowberry in rumen samples decreased from 60 to 1 per cent and, volume of koehia (Kochia seoparia) increased from 6 to 51 per cent between early and late winter, - That near depletion of snowberry about mid-winter resulted in increased use of less valuable, but-more available plants, was suggested by the physical condition of the deer. Below average hog-dressed weights, low kidney fat indices and low values for femur marrow fat in most whitetails examined, indicated the deer were in relatively poor physical condition.

In December 1964, classification of 188 whitetails showed a low fawn/doe ratio of 16 to 100, Twenty-four fetuses for 12 pregnant females collected between December 1964 and June 1965, indicated the prenatal fawn production rate for 1965 was high and may have been a compensation for the poor fawn crop for 1964.

Relatively few observations of mule deer or elk on the "bottoms", especially during winter and spring, precluded any significant competition with the whitetail. There was a severe overlap in the use of browse by cattle and whitetails during winter as indicated by utilization of browse plants along transects located on both cattle-used and cattle-free areas. The heavy use of browse by cattle was apparently aggravated by reduced availability of grass during winter because of deep snow and by a reduced hay crop for supplemental winter feeding.

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ABSTRACT

A study was conducted on Missouri River bottomlands in northcentral Montana from June 1964 to June 1965 to obtain quantitative data on food and range use habits of the whitetail deer. Four vegetation types, including cottonwood, meadow, greasewood and weed were quantitatively sampled to aid in evaluating the results. The willow type was also described. Range use was evaluated from 4,647 field observations of whitetails. Forty and 33 per cent of summer observations and 22 and 35 per cent of fall observations were made in the meadow vegetation type and alfalfa fields respectively. Fifty per cent of winter and 19 per cent of spring observations were in the cottonwood type. The weed type accounted for 26 and 53 per cent of winter and spring observations respectively.

Food habits were evaluated from analyses of 48 rumen samples and examination of 57 feeding sites. Browse averaged 45, 81, 65 and 43 per cent of the contents of rumen samples for summer, fall, winter and spring respectively and was the most important forage class for all seasons except summer. Forbs averaged 54, 17, 29 and 18 per cent respectively and constituted the most important class during summer. Grass was present in rumen samples during all seasons but was a minor item except in spring when its volume averaged 38 per cent. Examination of feeding sites generally supported the data from rumen content analyses but indicated a greater use of forbs. Western snowberry (Symphoricarpos occidentalis), which occurred in 95 per cent of all rumen samples and had a yearlong average volume of 27 per cent, appeared to be the most important single food plant. Volume of snowberry in rumen samples decreased from 60 to 1 per cent and volume of kochia (Kochia scoparia) increased from 6 to 51 per cent between early and late winter. That near depletion of snowberry about mid-winter resulted in increased use of less valuable, but more available plants, was suggested by the physical condition of the deer. Below average hog-dressed weights, low kidney fat indices and low values for femur marrow fat in most whitetails examined, indicated the deer were in relatively poor physical condition.

In December 1964, classification of 188 whitetails showed a low fawn/doe ratio of 16 to 100. Twenty-four fetuses for 12 pregnant females collected between December 1964 and June 1965, indicated the prenatal fawn production rate for 1965 was high and may have been a compensation for the poor fawn crop for 1964.

Relatively few observations of mule deer or elk on the "bottoms", especially during winter and spring, precluded any significant competition with the whitetail. There was a severe overlap in the use of browse by cattle and whitetails during winter as indicated by utilization of browse plants along transects located on both cattle-used and cattle-free areas. The heavy use of browse by cattle was apparently aggravated by reduced availability of grass during winter because of deep snow and by a reduced hay crop for supplemental winter feeding.

INTRODUCTION

Whitetail deer (Odocoileus virginianus) occur extensively on many portions of the hundreds of miles of flood-plains along rivers and other major streams of central and eastern Montana. Very little quantitative data on the food habits and range-use of the whitetail on this habitat type in Montana have been obtained. Smith (1952) suggested that the one food habit characteristic that may have general application to a big game species is the one expressing the importance of forage classes. Results of extensive and intensive studies in other localitites, particularly in Eastern North America, have only general application to Montana. The lack of specific data for the whitetail in central and eastern Montana has hindered the establishment of sound management practices..

This study was conducted on a number of more or less typical bottomlands along the Missouri River in central Montana about 35 miles northeast of the village of Roy. Fulltime field studies of food and range-use habits were conducted from June 1964 to June 1965. Relationships of the whitetail to agriculture, domestic livestock and other big game species were also considered.

DESCRIPTION OF THE AREA

The study area was located on a portion of the Charles M. Russell Game Range, which is administered by the U. S. Fish and Wildlife Service in Fergus and Phillips counties in the "breaks" of central Montana. The terrain of the "breaks" (Fig. 1) through which the Missouri River flows, is quite rough and has been described in some detail by Mackie (1965). Elevation of the ridges overlooking the river is approximately 2,900 feet and they typically slope down to the flood plain at a relatively steep angle. The flood plain of the river ranges in width from .5 to 1 mile and has an average elevation of approximately 2,270 feet. The study area consisted of a straight-line distance of about 23 miles (31 river miles) and included 20 "bottoms" and 3 islands (Fig. 2). These "bottoms", ranging in size from 144 to 644 acres, have been created by the winding course of the river and usually alternate between the north and south sides (Figs. 1 & 2).

The climate of the area is typically one of relatively short, hot summers and long, cold winters. Records for the U. S. Department of Commerce weather station at Roy 8NE, located about 25 miles southwest of the center of the study area, show a 21-year (1943-1963) annual mean temperature of 44°F with January as the coldest month with an average of 16°F and July as the warmest at 71°F. Mean annual precipitation is 13.49 inches with 75 per cent falling from May through September. Average snowfall is 25 inches and normally accounts for about 10 per cent of the annual precipitation. Warm, southwesterly "chinook" winds are characteristic and usually prevent any significant accumulation of snow.

Figure 1b. The study area, showing extent of the June flood.

Figure 1a. Terrain of the river bottom study area and the adjacent "breaks".

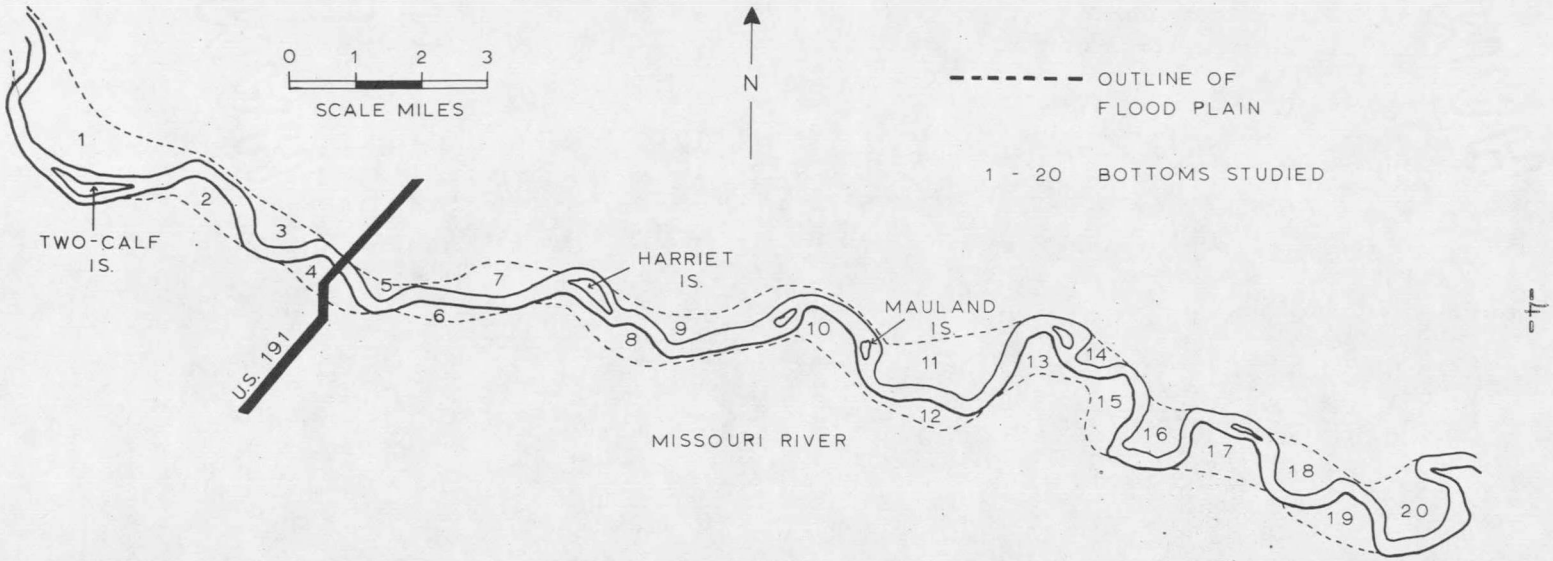

Figure 2. Map of the study area.

Data for the study period were available from the U. S. weather station at Roy 24NE Mobridge, located towards the west end of the study area. The year was "abnormal" in some respects. The summer was slightly warmer and the winter considerably colder than average. December with an average temperature of 5°F was one of the coldest periods on record. Total snowfall was nearly three times the average with 19.5 inches falling in December and 45 inches in the period of December through February. With few thawing days from November 25 to mid-February, snow cover accumulated to 15 inches by mid-December and ranged from 15 to 25 inches until mid-February. Spring break-up of the Missouri occurred on April 9, about two weeks later than normal.

Extremely heavy rain in the upper Missouri River drainage resulted in a major flood which inundated the study area from June 11 to June 16, 1964 (Fig. 1). The lower portion of the study area was flooded more severely than the upper with respect to both depth of water and length of inundation.

The unusual weather phenomena during the year of the study directly influenced the habits and general ecology of the whitetail deer of the area.

METHODS

To determine range use and habitat relationships, regular and systematic observations with the aid of a 25X spotting scope and 7X binoculars were made during morning and evening periods from different vantage points overlooking the study area. Usually two or three "bottoms" could be observed from the same point. Big game and livestock were recorded at 15-minute intervals as to species, time of observation, activitiy, occurrence by vegetation type, location, and when practicable by sex and age class.

Food habits were determined by feeding site examinations and rumen analyses. For tabulation the aggregate percentage method was used (Martin, et al, 1946). Feeding sites were examined as soon as practicable after observed animal use and all recent instances of plant utilization were recorded by species (Cole, 1956). Forty-eight whitetails provided rumen samples at the rate of four per month with the exception of five each in October and March and two each in June, 1964 and May and June, 1965. One quart rumen samples were analyzed following Cole (1956) with the recognizable items being volumetrically measured and expressed as percentages.

The different vegetation types were defined and sampled to determine seasonal species composition and abundance. Greasewood and meadow types were sampled by a method described by Daubenmire (1959). Vegetation in each of 40, 20 by 50 centimeter plots along a transect was recorded as to species and per cent canopy coverage. A modification of this method was used for five stands of cottonwoods and two of weeds. A 40-point

transect was run in each stand with the location of each point being determined by means of a random walk. Predetermined distances between points ranged from 10 to 70 paces. At each point in the cottonwood stands the species of the nearest tree as well as its distance from the point and its DBH (diameter at breast height) were recorded. A circular plot 10 feet in diameter was defined at each point and low-growing vegetation within was recorded by species and abundance. Utilization of key browse plants on sample units were evaluated (Cole, 1958) in relation to use by whitetails, other big game and/or livestock.

To aid in the interpretation of food habits and range use data, I secured information relating to the physical condition and productivity of the whitetail. Condition of individual deer examined during collecting periods and at hunter check stations was judged by body weight, amount of kidney fat and the condition of femur bone marrow. Productivity was evaluated from fawn/doe ratios established during aerial and ground surveys, embryo counts for dead females examined and the counting of corpora lutea in gross sections of ovaries.

VEGETATION

While the flood plain usually ended abruptly at the steep slopes of the "breaks", occasionally there was a gently sloping area of sagebrush/grassland or greasewood (Sarcobatus vermiculatus) between the two. The slopes were predominantly covered with a pine/juniper or fir/juniper community (Mackie, 1965).

Cottonwood, willow, meadow and greasewood vegetation types covered about 30, 10, 10 and 15 per cent of the flood plain respectively. Alfalfa fields with 25 per cent coverage and grain fields accounted for the remainder. There was a general tendency for the greasewood type to be located next to the slopes; the cottonwood type next to the river; and the willow type on the downstream side of sandbars (Fig. 3). The meadow type was of more general occurrence.

Plant identification was verified by Dr. W. E. Booth, Montana State University, and nomenclature follows Booth (1950) and Booth and Wright (1959).

Cottonwood

The cottonwood vegetation type (Fig. 4) was dominated by plains cottonwood (Populus sargentii). Average DBH was 15.03 inches (10.61 - 20.53) and average distance between trees was 29 feet (23.5 - 37.5). The only other trees encountered were boxelder (Acer negundo) and peachleaf willow (Salix amygdaloides), both being quite scarce. Conspicuous shrubs in the understory were western snowberry (Symphoricarpos occidentalis) and nootka rose (Rosa nutkana) (Table I). Western wheatgrass (Agropyron smithii) was the most abundant grass with hemp dogbane (Apocynum cannabinum)

Figure 3. A "bottom" showing typical arrangement of vegetation types. Greasewood in left foreground; fallow field in center; cottonwood in background next to river.

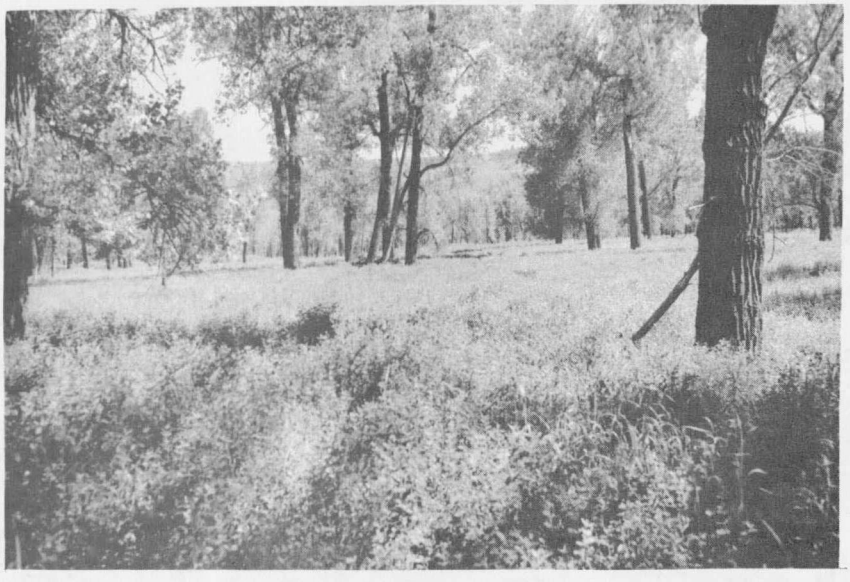

Figure 4. The cottonwood vegetation type.

TABLE I. CONSTANCY, CANOPY-COVERAGE AND FREQUENCY OF PLANTS FOUND ON THE COTTONWOOD VEGETATION TYPE. 1/

Plants 2/	Cy/Cov/Fr 3/
Shrubs	
Populus sargentii (seedling)	100/ 2 /57
Symphoricarpos occidentalis	100/ 2 /47
Rosa nutkana	100/ 2 /55
Cornus stolonifera	60/ 1 / 5
Salix spp.	60/ 1 / 8
Forbs	
Apocynum cannabinum	100/ 2 /55
Xanthium strumarium	100/ 1 /43
Cirsium arvense	80/ 1 /19
Medicago lupulina	60/ 1 /18
Solidago gigantea	60/ 1 /14
Glycyrrhiza lepidota	80/ 1 /10
Taraxacum officinale	40/ 1 / 6
Unid. forb	40/ 1 / 5
Grass	
Agropyron smithii	100/ 2 /63
Elymus canadensis	80/ 1 /33
Bromus inermis	80/ 1 /21
Spartina pectinata	80/ 1 / 7

1/ Data are for 200 10-foot diameter circular plots occurring as 40 in each of 5 stands.

2/ Includes only those having an average frequency-of-occurrence of five per cent or greater. Other plants are listed in Appendix Table XIII.

3/ Constancy/canopy-coverage/frequency.
Constancy - mean per cent occurrence among stands.
Canopy-coverage - mean per cent canopy-coverage for all plots with 1 = 0-5 per cent, 2 = 5-25 per cent, and 3 = 25 per cent or greater.
Frequency - mean per cent occurrence among plots.

and cocklebur (Xanthium strumarium) the most common forbs. Heavy siltation from flooding, often exceeding eight inches, undoubtedly altered the "normal" species composition. The high frequency-of-occurrence of cottonwood seedlings was related to flooding.

Meadow

The meadow type (Fig. 5) was characterized by extreme abundance of western wheatgrass (Table II). Snowberry, the only shrub recorded, was locally abundant. Common forbs were erect knotweed (Polygonum erectum), littlepod falseflax (Camelina microcarpa), prairie pepperweed (Lepidium densiflorum), fanweed (Thlaspi arvense) and kochia (Kochia scoparia).

Greasewood

A relatively dense stand of greasewood with plants ranging in height from about three to five feet was characteristic (Fig. 6). Three thousand feet of line intercept (Canfield, 1941), with 500 feet in each of six stands, was used to determine canopy-coverage of shrub growth greater than one foot in height. Average canopy-coverage was 48 per cent (39-56). Greasewood averaged 40 per cent with silver sagebrush (Artemisia cana) and green rabbitbrush (Chrysothamnus viscidiflorus) about four per cent each. Snowberry, rose and big sagebrush (A. tridentata) together totaled less than one per cent.

Composition and characteristics of low-growing vegetation is shown in Table III.

Willow

Dense stands of willow (Fig. 7) ranged in width from about 10 to over

Figure 5. The meadow vegetation type in foreground with cottonwood in background.

Figure 6. The greasewood vegetation type.

TABLE II. CONSTANCY, CANOPY-COVERAGE AND FREQUENCY OF PLANTS FOUND ON THE MEADOW VEGETATION TYPE. 1/

Plants 2/	Cy/Cov/Fr 3/
Forbs	
Polygonum erectum	80/ 2 / 31
Camelina microcarpa	40/ + / 27
Lepidium densiflorum	40/ + / 24
Thlaspi arvense	80/ + / 24
Kochia scoparia	60/ + / 21
Lactuca serriola	80/ + / 12
Medicago sativa	100/ + / 12
Chenopodium glaucum	20/ + / 11
Unid. forb	40/ + / 8
Chenopodium album	40/ 9 / 7
Iva axillaris	20/ + / 6
Lappula redowskii	60/ + / 5
Vicia americana	40/ + / 5
Unid. forb	20/ + / 5
Grasses	
Agropyron smithii	100/ 92/100
Hordeum jubatum	20/ 1/ 14
Agropyron trachycaulum	20/ +/ 10
Stipa viridula	40/ +/ 7

1/ Data are mean percentages for 200 20 X 50 cm. plots occurring as 40 in each of five stands.

2/ Includes only those having an average frequency-of-occurrence of five per cent or greater. Other plants are listed in Appendix Table XIII.

3/ Constancy/canopy-coverage/frequency.
Constancy - mean per cent occurrence among stands.
Canopy-coverage - mean per cent canopy-coverage for all plots. A + indicates a value of less than one per cent.
Frequency - mean per cent occurrence among plots.

TABLE III. CONSTANCY, CANOPY-COVERAGE AND FREQUENCY OF PLANTS FOUND IN THE UNDERSTORY OF THE GREASEWOOD VEGETATION TYPE. 1/

Plants 2/	Cy/Cov/Fr 3/
Shrubs 4/	
Sarcobatus vermiculatus	100/ + /23
Chrysothamnus viscidiflorus	34/ + /11
Artemisia cana	17/ + / 7
Forbs	
Lepidium densiflorum	84/ 2 /45
Plantago spinulosa	67/ 2 /45
Chenopodium album	100/ 1 /42
Polygonum erectum	100/ + /30
Thlaspi arvense	67/ + /25
Kochia scoparia	17/ 1 /16
Unid. forb	17/ + /15
Atriplex spp.	34/ 1 /13
Camelina microcarpa	34/ + / 5
Grasses	
Agropyron smithii	100/ 60/82
Poa secunda	67/ + /47
Poa compressa	67/ 1 /16

1/ Data are mean percentages for 240 20 X 50 cm. plots occurring as 40 in in each of six stands.

2/ Includes only those having an average frequency-of-occurrence of five per cent or greater. Other plants are listed in Appendix Table XIII.

3/ Constancy/canopy-coverage/frequency.
Constancy - mean per cent occurrence among stands.
Canopy-coverage - mean per cent canopy-coverage for all plots. A + indicates a value of less than one per cent.
Frequency - mean per cent occurrence among plots.

4/ Includes only those of less than one foot in height. Canopy-coverage of taller shrubs was determined by line intercept and is discussed in text.

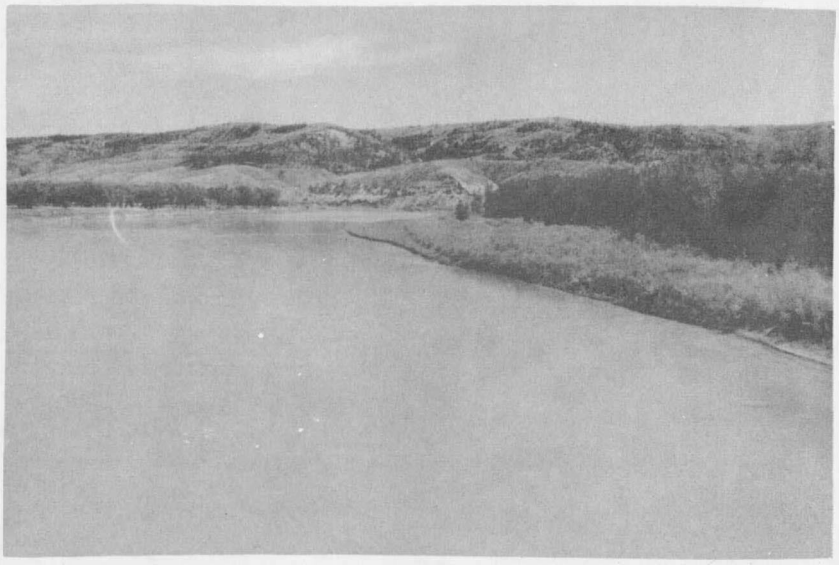

Figure 7. The willow vegetation type next to river.

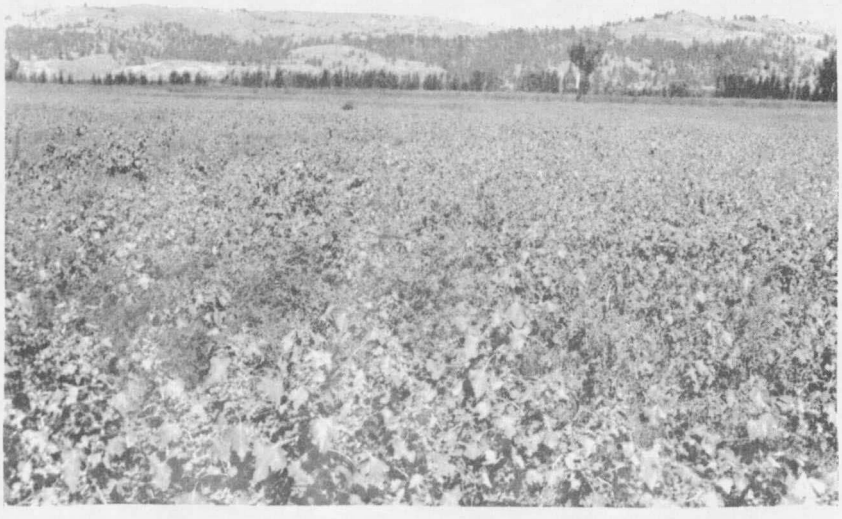

Figure 8. The weed vegetation type.

100 yards. Heights of individual plants were from 5 to 15 feet. Sandbar willow (S. interior), Mackenzie willow (S. mackenziana) and Bebb willow (S. bebbiana) were common; pussy willow (S. discolor) and peachleaf willow were scarce. Ground vegetation, mostly seeldings of cottonwood and willow, was sparse, probably more than usual due to flooding.

Weed

Vegetation characteristics of the weed type (Fig. 8) are shown in Table IV. These measurements were from formerly flooded grain fields. Former alfalfa fields, except for an occasional alfalfa plant, appeared similar.

TABLE IV. CONSTANCY, CANOPY-COVERAGE AND FREQUENCY OF PLANTS FOUND ON THE WEED VEGETATION TYPE. 1/

Plants 2/	Cy/Cov/Fr 3/
Shrubs	
Populus sargentii (seedlings)	100/ 3 /92
Salix interior	50/ 1 /12
Forbs	
Xanthium strumarium	100/ 3 /90
Chenopodium spp.	100/ 2 /74
Amaranthus hybridus	100/ 2 /62
Amaranthus graecizans	100/ 2 /55
Unid. forb	100/ 2 /52
Geum triflorum	100/ 1 /45
Kochia scoparia	100/ 2 /42
Taraxacum officinale	100/ 1 /42
Centaurea repens	100/ 1 /25
Ambrosia trifida	50/ 1 /17
Salsola kali	100/ 1 /15
Chenopodium album	100/ 1 /12
Cirsium arvense	100/ 1 /12
Convovulvus arvense	50/ 1 /12
Iva axillaris	100/ 1 /12
Rumex maritimus	100/ 1 /12
Chaenactis douglasii	50/ 1 /10
Polygonum coccineum	50/ 1 /10
Grasses	
Hordeum spp. (barley)	100/ 1 /37
Setaria viridis	100/ 1 /35
Panicum capillare	50/ 1 /15

1/ Data are for 80 10-foot diameter circular plots occuring as 40 in each of two stands.

2/ Includes only those having an average frequency-of-occurrence of 10 per cent or greater. Other plants are listed in Appendix Table XIII.

3/ Constancy/canopy-coverage/frequency.
Constancy - mean per cent occurrence among stands.
Canopy-coverage - mean per cent canopy-coverage for all plots with 1 = 0-5 per cent, 2 = 5-25 per cent, and 3 = 25 per cent or greater.
Frequency - mean per cent occurrence among plots.

DISTRIBUTION AND RANGE USE

Table V shows the relative seasonal use of different vegetation types as indicated by 4,647 deer observations made mostly during 143 morning or evening observation periods. Whitetails used the cottonwood type extensively for all activities and observing animals there was difficult. The cottonwood type was considered to be of greater importance during all seasons than was indicated, especially during summer and fall when deer were more difficult to observe (Table VI) because of foliation, hunting, forage and/or weather.

Deer observations made during the summer were concentrated on meadow and alfalfa types. Percentages of observations summer to fall remained about the same for alfalfa, decreased on meadows and increased on cottonwood and weed types. I recorded a higher percentage of deer in cottonwood than any other type during winter, the season of its apparent greatest usage. More than one-half of the deer observed in spring were using the weed type. The percentage of deer observed on meadows increased in late April and May, coinciding with the initial green-up of grasses and forbs.

The distribution of whitetails during summer, fall and early winter was quite general. During late winter two concentration areas were evident. Number one included "bottoms" 8, 9 and Harriet Island; number two, 16 and 17 (Fig. 2). Thirty and 18 per cent of the maximum of 272 whitetails observed on all "bottoms" during ground and aerial surveys in December were on areas one and two respectively. Figures for 240 deer in February were 36 and 51 per cent. Movement within concentration areas

TABLE V. PERCENTAGES OF DEER OBSERVATIONS BY VEGETATION TYPES DURING SEASONS. 1/

Vegetation Type	Summer June-Aug	Fall Sept-Nov	Winter Dec-Feb	Spring Mar-May
Greasewood	5/ 3 2/	*/-	3/ 3	6/ 6
Meadow	40/43	22/ 22	6/ 7	15/ 16
Willow	1/ 1	3/ 3	7/ 7	4/ 2
Cottonwood	4/ 2	17/ 16	50/ 46	19/ 19
Alfalfa	33/34	35/ 37	1/ 2	*/*
Weed	13/14	22/ 22	26/ 31	53/ 55
others	4/ 3	*/-	7/ 4	2/*
Total deer Observations 3/	932/808	290/274	1604/1259	1821/1664

1/ One observation equals one deer observed during a 15-minute interval.

2/ Percentage of total observations/percentage of observations of feeding deer. A * indicates a value of less than one per cent.

3/ Total observations/observations of feeding deer. Includes repeated observations of some individuals.

TABLE VI. VARIATIONS IN "OBSERVABILITY" OF THE WHITETAIL BY MONTH.

	Ave. per observation	Total seen per month 1/		Ave. per observation	Total seen per month
Jun	3.4	124	Dec	6.8	139
Jul	3.5	186	Jan	8.0	219
Aug	4.6	203	Feb	11.1	412
Sep	4.3	92	Mar	12.2	691
Oct	4.5	37	Apr	7.1	189
Nov	5.2	32	May	3.6	39

1/ Includes repeated observations of some individuals.

was extensive.

Groups of whitetails were seen throughout the year in the "breaks", some more than three miles from the river.

FOOD HABITS

Except for winter, when results of the two methods of study were closely comparable, the analyses of rumens indicated a much greater use of browse than did the feeding site examinations (Table VII). I attribute these differences largely to biased sampling of feeding sites. Feeding deer were difficult to observe in the cottonwood vegetation type except in winter when 9 of the 12 feeding sites in this type were examined, (Table VIII). Contents of rumens apparently gave a better representation of the different vegetation types used by feeding deer. Parts of plants identified were: browse - stems, leaves and berries; forbs - leaves, stems, flowers and seed heads; grass - green blades, dry blades and seed heads.

Summer

Contents of rumens averaged 45 per cent browse and 54 per cent forbs (Table VII). Western snowberry (Symphoricarpos occidentalis) had the greatest volume of any browse plant. Plains cottonwood (Populus sargentii) and red osier dogwood (Cornus stolonifera) also had significant volumes. Alfalfa (Medicago sativa) had the highest average volume of all plants and constituted more than 91 per cent of one rumen sample. In three rumens taken from deer collected on "bottoms" where alfalfa was abundant its volume averaged 73 per cent and in seven rumens from deer on "bottoms" where alfalfa was scarce, 23 per cent. For these same samples average volume for all forbs was 77 and 41 per cent respectively, suggesting an increased use of browse rather than other forbs where alfalfa was scarce. Grass was represented in 60 per cent of the rumen

TABLE VII. WHITETAIL FOOD HABITS AS DETERMINED BY ANALYSES OF 48 RUMEN SAMPLES AND EXAMINATION OF 57 FEEDING SITES.

Plants	Summer (June 22-Aug 31) 18 sites 2326 1/ % use	Summer 10 rumens % vol.	Fall (Sep-Nov) 5 sites 614 1/ % use	Fall 13 rumens % vol.	Winter (Dec-Feb) 24 sites 3202 1/ % use	Winter 12 rumens % vol.	Spring (Mar 1-Jun 8) 10 sites 1323 1/ % use	Spring 13 rumens % vol.
Artemisia cana	-	-	-	-	-	17/T	20/ 8	24/T
A. longifolia	-	-	-	-	4/T	33/12	10/T	-
A. tridentata	-	-	-	-	4/ 3	8/T	-	8/T
Chrysothamnus viscidiflorus	-	-	-	-	8/ 3	8/T	10/T	31/ 2
Cornus stolonifera	-	40/ 8 2/	-	8/T	-	-	-	-
Pinus ponderosa	-	-	-	8/T	-	33/ 2	-	-
Populus sargentii	-	80/11	-	100/12	8/T	58/16	-	100/22
Pseudotsuga taxifolia	-	-	-	8/T	8/T	33/ 6	-	8/T
Rhus trilobata	-	10/T	-	-	12/ 4	-	-	8/T
Rosa nutkana	-	70/ 2	20/T	85/ 1	42/11	66/T	20/ 3	31/ 1
Salix spp.	11/ 5 3/	60/ 2	-	69/ 4	8/ 4	17/T	10/10	31/ 4
Sarcobatus vermiculatus	-	-	-	-	4/ 4	-	10/T	-
Symphoricarpos occidentalis	-	100/19	40/37	100/55	50/29	100/25	20/11	85/10
Unid. browse	-	60/ 3	-	92/ 8	-	75/ 1	-	69/ 3
Other browse, 6 plants 4/	-	30/T	-	23/T	4/T	33/ 1	-	15/T
Total browse	11/ 5	100/45	40/38	100/81	66/62	100/65	40/33	100/43
Apocynum cannabinum	11/ 6	10/T	-	-	-	-	-	-
Centaurea repens	17/ 4	-	-	-	-	8/ 3	-	-
Chenopodium album	-	-	-	-	25/ 1	-	-	-
Convovulvus arvense	-	30/ 4	-	8/T	-	-	-	-
Helianthus spp.	-	10/T	-	-	-	33/ 5	10/T	-
Kochia scoparia	33/12	80/ 1	-	47/ 2	38/24	66/14	30/15	15/T
Medicago sativa	71/66	90/39	40/40	69/ 7	4/ 4	8/T	10/10	15/ 2
Polygonum ramosissimum	5/ 4	-	-	-	-	-	-	-

TABLE VII. (Continued)

Plants	Summer (June 22-Aug 31) 18 sites 2326 1/ % use	Summer 10 rumens % vol.	Fall (Sep-Nov) 5 sites 614 1/ % use	Fall 13 rumens % vol.	Winter (Dec-Feb) 24 sites 3202 1/ % use	Winter 12 rumens % vol.	Spring (Mar 1-Jun 8) 10 sites 1323 1/ % use	Spring 13 rumens % vol.
Rumex spp.	-	30/T	-	31/ 3	-	8/T	-	8/T
Tragopogon dubius	-	-	-	-	-	-	-	15/ 7
Yucca glauca	-	-	-	-	-	25/ 2	-	-
Unid. forbs	-	100/ 7	-	100/ 4	-	41/ 2	-	61/ 5
Other forbs, 17 plants 4/	22/ 3	70/ 1	-	47/T	21/ 2	41/ 2	20/ 3	31/ 4
Total forbs	100/95	100/54	40/40	100/17	58/32	92/29	50/34	69/18
Agropyron smithii	-	-	20/ 2	-	21/ 3	-	30/30	-
Hordeum spp.	-	10/T	20/20	15/T	17/ 3	25/ 5	20/ 3	47/14
Unid. Gramineae spp.	-	50/T	-	85/1	-	41/T	-	85/24
Unid. grasslike	-	20/T	-	8/T	-	-	-	-
Total grasses	-	60/T	40/22	92/ 2	38/ 6	58/ 6	30/33	92/38
Mushrooms	-	10/T	-	47/T	-	8/T	-	15/T

1/ Total recorded instances of plant use.

2/ Per cent frequency of use by rumens/mean aggregate percentage of total volumes of all rumens. "T" is less than one per cent.

3/ Per cent frequency of use by sites/mean aggregate percentage of total instances of plant use on all sites.

4/ Six browse plants and 17 forbs, none of which had an individual usage value of 2.5 per cent or greater or a frequency value of 25 per cent or greater for any season, have been omitted. They are: browse plants - Acer negundo, Artemisia frigida, Juniper scopuloram, Prunus virginiana, Ribes spp. and Spiraea spp.; forbs - Amaranthus hybridus, Ambrosia trifida, Chenopodium spp., Cirsium spp., Descurainia spp., Euphorbia spp., Grindelia squarrosea, Iva xanthifolia, Lactuca serriola, Lepidium densiflorum, Liatris punctata, Lomatium spp., Melilotus spp., Polygonum spp., Taraxacum officinale, Thlaspi arvense and Vicia americana.

TABLE VIII. DISTRIBUTION OF FEEDING SITES EXAMINED BY SEASON AND VEGETATION TYPE.

Vegetation Type	Season				
	Summer	Fall	Winter	Spring	Total
Weed	3	1	9	3	16
Cottonwood	1	1	9	1	12
Meadow	7	1	-	3	11
Alfalfa	5	2	1	1	9
Greasewood	1	-	3	1	5
Willow	1	-	-	1	2
Juniper	-	-	2	-	2
Total	18	5	24	10	57

samples but its volume was insignificant.

Feeding site examinations revealed significant use of several forbs, including hemp dogbane (Apocynum cannabinum), Russian knapweed (Centaurea repens), kochia (Kochia scoparia) and bushy knotweed (Polygonum ramosissimum) which were insignificant items in rumen contents. Feeding site examinations also corroborated the data from rumen samples that alfalfa was a preferred plant.

Fall

During fall, use of browse increased and use of forbs decreased as compared to summer. They constituted 81 and 17 per cent respectively of the rumen samples. Grass occurred in 92 per cent of the rumen samples but its volume averaged only two per cent. Snowberry was the most important

single item with an average of 55 per cent and constituted as much as 94 per cent of the contents of one rumen sample. Cottonwood and willow (Salix spp.), the only other browse plants of significance, averaged 12 and 4 per cent respectively. While no forb averaged more than seven per cent for the season, alfalfa, kochia and dock (Rumex spp.) were of major importance in two, one and one rumen samples respectively.

Feeding site examinations did not reveal significant use of any plant not represented in rumen samples.

Winter

Volume of browse decreased and volume of forbs increased in rumen samples as compared to fall. Grass had an average frequency of 58 per cent and average volume of 6 per cent. Snowberry had the greatest average volume for all browse plants with cottonwood and longleaf sagebrush (Artemisia longifolia) also significant. Of forbs, kochia had the greatest average volume. Seed heads of barley (Hordeum spp.) constituted 63 per cent of the volume of one rumen sample and accounted for nearly all of the grass use.

Feeding site examinations suggested that two browse plants, nootka rose (Rosa nutkana) and greasewood (Sarcobatus vermiculatus), were of more importance than was indicated by rumen samples.

Rumen samples from four deer collected in the "breaks" indicated a similar use of forage classes but differences in individual species as compared to the eight taken on the "bottoms". The former rumens accounted for most of the use for sagebrush (Artemisia spp.), ponderosa pine (Pinus

ponderosa), Douglas fir (Pseudotsuga taxifolia), sunflower (Helianthus spp.) and soapweed (Yucca glauca). Longleaf sage and sunflower, with volumes averaging 37 and 14 per cent, were the most important browse plant and forb respectively. Two feeding sites examined in the "breaks" showed significant use of skunkbrush sumac (Rhus trilobata) which was not represented in any rumen sample.

The volume of browse in rumens taken from the "bottoms" decreased from 73 per cent in early winter to 45 per cent in late winter, while values for forbs increased from 14 to 51 per cent. Kochia, which accounted for most of the increased volume of forbs, increased from 6 to 41 per cent between early and late winter. Snowberry, which decreased from 60 to 1 per cent, was replaced in importance by cottonwood which increased from 9 to 46 per cent.

Spring

The percentage of browse in rumen samples for spring, 43 per cent, was lowest for any season. Green forbs appeared in late April and immediately became a major item in rumens, although the seasonal average of 18 per cent was below the forb value for winter. Grass volume increased to 38 per cent, its highest seasonal value. Most of the use of grass occurred during a short period in April with the initial "green-up". Contents of four rumens taken between April 22 and 29 averaged 77 per cent grass. Cottonwood was the most important browse plant for the season while snowberry ranked second. Willow was significant in each of two individual rumen samples. Salsify (Tragopogon dubius) was the most

used forb, constituting as much as 81 per cent of a single rumen sample. Barley seed heads averaged 14 per cent for the season and 33 per cent in March samples, reflecting heavy use of unharvested barley fields during early spring.

Feeding site examinations suggested more use on sagebrush, kochia and alfalfa than was indicated by rumen analyses. Feeding sites also suggested that western wheatgrass (Agropyron smithii) was the unidentified green grass found in large quantities in some rumen samples.

Summary and Discussion

Certain seasonal trends in the utilization of forage classes were indicated. Forbs were only slightly more important during summer than browse, and use of grass was insignificant. During fall, use of browse increased to its highest seasonal level while forb use decreased to its lowest. Grass use remained minor. Use of browse for the entire winter period, although less than fall, was still about twice that of forbs, the use of which had increased over fall. The decrease in browse use for the entire winter period as compared to fall was due to the decreased use of browse after mid-winter. It appeared that heavy, yearlong use of snowberry resulted in near depletion about mid-winter when deer utilized less palatable, but more available plants including cottonwood and dry forbs. That the increased use of the latter plants was related to depletion of more valuable plants was suggested by physical condition of the deer (see following section). Use of grass increased slightly during winter but was still minor. Use of browse decreased to its lowest

seasonal level during spring while use of grass was at its highest. Forb use decreased in spring as compared to winter, even though it was the most prominent forage class late in the period.

Snowberry, which appeared to be the most important single food plant for deer on the study area, occurred in 95 per cent of all rumens and had a yearlong average volume of 27 per cent. While McKean (1954) considered snowberry to be the most important single food plant for whitetails in North Dakota, others have found it to be of lesser importance. In Idaho, Roberts (1956) found summer to be the only season of significant snowberry use by the whitetail. I believe that heavy utilization of snowberry during my study was a reflection of availability. Limited data suggest both dogwood and skunkbrush were more "preferred" than snowberry, but their abundance was very low.

PHYSICAL CONDITION AND PRODUCTIVITY

Physical Condition

Hog-dressed weights were recorded for 54 whitetail deer taken from the study area (Table IX). These weights appear below average when compared to weights for more than 1,500 whitetails weighed at hunter check stations in various localitites of Montana between 1948-1963 (Mackie, 1964). For the periods June-December and January-June, weights for males and females of all age classes from the study area averaged 6-25 and 17-40 per cent less respectively than those recorded by Mackie (1964). For October through December, when most of Mackie's weights were recorded, weights for females of all age classes from the study area averaged 14-23 per cent less while weights for males averaged 9 per cent more, nearly equal to, 17 and 30 per cent less for the $1\frac{1}{2}$, $2\frac{1}{2}$, $3\frac{1}{2}$-$5\frac{1}{2}$ and $6\frac{1}{2}$ or older classes respectively.

A kidney fat index was determined for each of 42 whitetail deer collected from the study area. That such an "index" can be used for an indicator of physical condition has been noted by Riney (1955) and his method was used, except no trimming was done. The weight of fat around the kidneys was expressed as a percentage of kidney weight (Table X). These indices indicated a decline in physical condition during winter, generally coinciding with a decrease in the use of browse.

Samples of femur marrows were taken from each of the eight deer collected in late spring for fat content determination by ether extraction. Values in Table XI were determined by the Chemistry Department Station, Montana State University. Ransom (1965) found femur marrow

TABLE IX. AVERAGE WEIGHT, RECORDED BY SEX AND AGE CLASS, FOR 54 WHITE-TAIL DEER FROM THE STUDY AREA.

	Age Class							
	1½		2½		3½-5½		6½ plus	
Period	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
Jun-Dec	91/5	75/3 1/	122/5	87/4	129/9	80/6	108/1	99/1
Jan-Jun	83/1	68/2	93/4	73/2	98/6	76/4	-	81/1
Oct-Dec	110/2	75/3	131/3	85/2	136/6	82/2	108/1	99/1

1/ Hog-dressed weight/sample size.

TABLE X. PER CENT OF KIDNEY FAT FOR 42 WHITETAIL DEER FROM THE STUDY AREA.

	Kidney Fat	
Period	♂♂	♀♀
Jun-Jul	19/6 1/	-
Aug-Sep	33/2	24/6
Oct-Nov	67/3	114/1
Dec-Jan	28/3	94/5
Feb-Mar	25/4	40/4
Apr-Jun	12/5	16/3

1/ Weight of kidney fat expressed as a percentage of kidney weight/ sample size.

fat was a better indicator for physical condition than was kidney fat, when values for the latter fell below 30 per cent. My results show low femur fat for most specimens and agree with Ransom (1965) in showing an irregularity in values for kidney fat as compared to values for femur fat.

TABLE XI. PER CENT FAT CONTENT OF FEMUR MARROWS FROM EIGHT WHITETAIL DEER FROM THE STUDY AREA.

Date Collected	Femur Marrow Fat ♂♂	♀♀
Apr 22	25/ 9 1/	48/ 8
Apr 29		75/14
Apr 29		96/27
May 13	19/ 9	
May 17	42/14	
Jun 7	90/13	
Jun 8	87/16	

1/ Per cent of ether extractable fat in femur marrow/per cent kidney fat. Figures are for individual animals.

All values for kidney fat were below 30 per cent.

Productivity

In December 1964, 188 whitetails were classified by sex and age during an intensive survey of the study area by helicopter. This survey showed only 16 fawns per 100 females and 12 fawns per 100 adults. A survey in January 1962, involving 120 whitetails showed 122 fawns per 100 adults (Peek, 1961). Summer surveys for the years 1949-1955 showed fawn to doe ratios ranged from 62-132 per 100 (U. S. Fish and Wildlife Service Files). I attribute the abnormally low fawn/doe ratio for the study period to poor condition of females resulting from generally poor

range condition which was aggravated by the June flood. The flood forced most of the deer off the "bottoms" for one to several weeks and resulted in reduced forage in most areas. Some fawns possibly were direct casualties of the flood. That most of the potential December fawns were lost prenatally or shortly after birth was suggested by "dry" udders for three of six females collected in August and September. Kidney weights for these females averaged only 24 per cent. Several authors, including Cheatum and Severinghaus (1950), Pimlott (1959) and others, have related low reproductive rates of various big game species to poor range conditions.

The December 1964 survey showed a sex ratio of 37 males to 100 females for 168 adults. This ratio is similar to those found by Gunvalson, et al (1952) for whitetails in Minnesota on areas of overpopulation and deteriorated winter range conditions.

Twelve pregnant females, collected from the study area between December 26, 1964 and April 29, 1965, yielded 24 fetuses; all were carrying twins except for one each with three and one. Examination of gross sections of ovaries from 11 of the above deer for corpora lutea (Cheatum, 1949) indicated an ovulation rate of 2.2. The prenatal fawn production rate was unusually high for 1965, possibly representing a compensation for the abnormally low fawn crop for 1964.

The sex ratio for 13 "sexable" fetuses was seven males to six females. Twenty-four fetuses were aged following Armstrong (1950). The average breeding date was November 26 (November 7-December 10) and the

average fawning date June 16 (May 28-June 30).

The distribution by sex and age for 57 whitetails from the study area was as follows: $1\frac{1}{2}$ years, 8 males and 5 females; $2\frac{1}{2}$, 11 males and 7 females; $3\frac{1}{2}$-$5\frac{1}{2}$, 14 males and 9 females; and $6\frac{1}{2}$ plus, 1 male and 2 females.

INTERSPECIFIC RELATIONS

The "breaks" surrounding the study area supported relatively large numbers of mule deer and a small number of elk. These animals occasionally used the whitetail habitat on the "bottoms". Cattle were found on some "bottoms" throughout the year. The intensity of seasonal use of the various vegetation types on "bottoms" by each of the three animals is shown in Table XII.

Relatively few mule deer were observed on "bottoms" (Table XII) as compared to whitetail deer (Table V). Except for fall, when about one mule deer observation was recorded for $2\frac{1}{2}$ whitetail observations, sightings of mule deer were rare. The meadow vegetation type provided most observations. Mackie (1965) studied the range use habits of mule deer of the Missouri Breaks. He noted an increase in summer and fall usage of "bottoms" by mule deer which he attributed to dessication of forage in the "breaks". Two feeding sites of mule deer examined during summer and one during winter on "bottoms" suggested food habits similar to the whitetail. Alfalfa in summer and kochia in winter were the most used plants. Despite these similarities in food habits, I concluded there was little competition, particularly during winter and spring, between whitetail and mule deer on the "bottoms" because of light use by the latter.

Seasonal observations of elk on "bottoms" followed the same general pattern as that for mule deer. Alfalfa averaged 43 per cent and grass, a minor item in the whitetail diet, averaged 21 per cent for five feeding sites examined on the "bottoms" during fall. While certain similarities

TABLE XII. PERCENTAGES OF MULE DEER, ELK AND CATTLE OBSERVATIONS BY VEGETATION TYPES DURING SEASONS. 1/

Greasewood			Meadow			Willow			Cottonwood			Alfalfa			Weed			Others		
MD	E	C 2/	MD	E	C	MD	E	C	MD	E	C	MD	E	C	MD	E	C	MD	E	C
									Summer 34/34/881 3/											
12	-	34	32	9	31	-	-	3	21	-	2	18	35	17	17	53	5	-	3	8
									Fall 117/118/727											
4	-	1	62	50	49	3	8	5	3	16	10	1	17	10	22	6	24	5	3	1
									Winter 17/11/1624											
12	-	36	-	-	17	18	10	5	-	45	23	-	-	-	70	45	16	-	-	3
									Spring 3/-/690											
-	-	75	-	-	20	-	-	1	33	-	-	-	-	-	67	-	2	-	-	2

1/ One observation equals one animal observed during a 15-minute interval.

2/ MD = Mule Deer; E = Elk; C = Cattle.

3/ Total seasonal observations for mule deer/elk/cattle. Includes repeated observations of some individuals.

were evident for food habits of whitetail deer and elk, light use of the "bottoms" by the latter precluded any significant competition.

Greatest seasonal use of "bottoms" by cattle occurred in winter, but usage for other seasons was also high. Greasewood was the most used vegetation type during all seasons except fall when meadow was most used. Grass, which averaged 54 per cent for 20 feeding sites examined during the year, was preferred during all seasons with western wheatgrass

the most used species. Browse was of major importance during winter when grass was less available because of deep snow. Snowberry, cottonwood, willow and greasewood were the most used browse plants and utilization was extreme in some areas. Willows along two transects on "bottoms" frequented by cattle throughout the year averaged 24 per cent use when evaluated in November and 54 per cent in May. Willows along a similar transect on an area without cattle showed 2.5 per cent use in November and 4 per cent in June. A fence permitted cattle to use only one part of "bottom" 17 (Fig. 2). Utilization of snowberry and cottonwood was evaluated along one transect for each plant on each side of the fence. Use on snowberry and on cottonwood was 13 and 11 per cent respectively on the cattle-free portion. Values for the other part were 38 and 54 per cent. The heavy use of snowberry and cottonwood by cattle appeared significant since these plants rated first and second in the yearlong food of the whitetail. The June flood reduced the amount of hay available for supplemental winter feeding of cattle during the study period. Deep snow hindered the use of grass. These probably contributed to severe overlap on use of browse by cattle and whitetail deer.

APPENDIX

TABLE XIII. PLANTS HAVING AN AVERAGE FREQUENCY-OF-OCCURRENCE OF 5 PER CENT OR LESS ON COTTONWOOD, MEADOW AND GREASEWOOD TYPES, AND LESS THAN 10 PER CENT ON THE WEED TYPE. (SEE TABLES I - IV IN TEXT)

Plants	Vegetation Type			
	Cotton-wood	Meadow	Grease-wood	Weed
Shrubs:				
Acer negundo	X			
Artemisia cana			X	
Atriplex nuttallii				X
Chrysothamnus viscidiflorus			X	
Eurotia lanata				X
Gutierrezia sarothrae			X	
Populus sargentii (saplings)	X			
Ribes spp.	X			
Symphoricarpos occidentalis		X	X	
Forbs:				
Achillea millefolium		X	X	
Ambrosia trifida	X			
Artemisia ludoviciana	X			
Asclepias speciosa	X			
Asparagus officinalis	X			
Aster commutatus	X		X	
A. occidentalis			X	
Aster spp.		X		
Atriplex spp.			X	
A. argentea			X	
A. rosea			X	
Bidens cernua	X			
Brassica niger				X
Centaurea repens	X			
Chenopodium spp.		X	X	
C. album	X			
C. glaucum				X
Cirsium arvense		X		
Convovulvus arvense	X			
Conyza canadensis	X			
Descurainia pinnata		X		
Equisetum arvense	X			
Euphorbia glytosperma		X		
Gaura coccinea			X	

TABLE XIII. Continued

Plants	Vegetation Type			
	Cotton-wood	Meadow	Grease-wood	Weed
Glycyrrhiza lepidota		X		
Grindelia squarrosa			X	
Helianthus annuus				X
H. petriolaris		X	X	
Kochia scoparia	X			
Lactuca pulchella	X			
Medicago sativa	X		X	
Melilotus officinalis			X	
Opuntia polycantha			X	
Plantago major	X			X
P. spinulosa		X		
Polygonum spp.				X
P. erectum	X			X
Rumex crispus	X			X
R. maritimus				X
Thlaspi arvense	X			X
Tragopogon dubius	X	X		
Vicia americana	X			
Grasses:				
Agropyron spicatum	X			
A. trachycaulum			X	
Avena fatua		X	X	X
A. sativa				X
Bromus inermis		X		
B. tectorum	X			
Distichlis stricta		X		
Echinochloa crusgalli	X			
Erogrostis hypnoides				X
Hordeum jubatum		X		
H. pusillum			X	
Muhlenbergia racemosa	X			
Panicum capillare		X		
Poa compressa	X	X		
Setaria lutescens		X		
Stipa viridula			X	

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