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Food Habits of the Sharp-Tailed Grouse (Pedioecetes Phasianellus Jamesi) and The Greater Prairie Chicken (Tymphanuchus Cupido Pinnauts) In Western South Dakota

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FOOD HABITS OF THE SHARP-TAILED GROUSE (PEDIOECETES PHASIANELLUS JAMESI) AND THE GREATER PRAIRIE CHICKEN (TYMPANUCHUS CUPIDO PINNATUS) IN WESTERN SOUTH DAKOTA

BY

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

Thesis Adviser Date

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Abstract

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Summer food preferences were determined for 48 adult sharp-tailed grouse (Pedioecetes phasianellus jamesi) in a mixed grass habitat. Seasonal foods were determined for 659 sharptails and prairie chickens (Tympanuchus cupido pinnatus). Vegetation analysis of four selected study areas indicated significant differences ($P < .05$) in grassland and brushy draw habitats. Of plant food items, cultivated crops were first in importance on the basis of crop analysis by volumetric comparison for summer, fall, and winter for prairie grouse. Common dandelion (Taraxacum officinale) ranked first (72.2 percent) in importance by volume for 63 sharptails during spring. Short-horned grasshoppers (Acrididae) were the most important insect item by volume for summer, fall, and winter. Preference indices for food items taken by 48 adult sharp-tailed grouse during summer indicated selectivity for rose (Rosa arkansana) hips, wolfberry (Symphoricarpos occidentalis) fruits, clovers (Trifolium spp.), and prickly lettuce (Lactuca Serriola) flower heads. Cultivated

crops were fifth in importance based on the food-preference index. Short-horned grasshoppers were consumed in approximate proportion to their availability.

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INTRODUCTION

Sharp-tailed grouse (Pedioecetes phasianellus jamesi) and greater prairie chicken (Tympanuchus cupido pinnatus) were once abundant on much of the Great Plains but are absent over much of their former range. Prairie grouse are the most abundant upland game species in western South Dakota. A review of hunter harvest data (1945-64) reveals an average of 15,900 hunters harvest 74,000 prairie grouse annually in South Dakota (Henderson 1965).

To effectively develop a habitat-management plan for prairie grouse, research studies are needed on their food habits and food preferences during all seasons of the year. Since the beginning of studies in economic ornithology in this country, stomach examinations have been important (Kalmbach 1934). Davison (1940) stated that a practical problem is the determination of the relative importance of available plants as foods for any given species of animal. Food habits research, according to Hungerford (1957), is a necessary step in planning habitat improvement programs.

Objectives of this study were to: (1) determine what prairie grouse in western South Dakota eat during various seasons, (2) devise a food-preference index for foods eaten by prairie grouse, and (3) relate the findings of the food-preference study to habitat.

REVIEW OF LITERATURE

Sharp-tailed Grouse

Schmidt (1936) reported that in Wisconsin browse was available throughout the winter and was the most important winter food of sharptails. Items browsed were buds, catkins, and twigs of white birch, aspen, balsam, poplar, willow, bog birch, and leather-leaf. When not covered by snow, smartweed seeds, berries of wintergreen, snowberry, and cranberry were eaten.

After studying droppings, interpreting tracks, and observing the Columbian sharp-tailed grouse in Utah during the winter of 1936-37, Marshall and Jenson (1937) concluded grouse fed on available foods, and as snow depth increased more use was made of taller plants. They ranked principal foods by frequency of use from October 1936 to May 1937. Wheat ranked first in frequence in October and November, second in December, and was unimportant in January and February. Wheat ranked first in March and April, and second to alfalfa in May. They found insects appearing in the diet in May.

Swenk and Selko (1938) reported on crop and gizzard contents from 29 sharptails shot during October in western Nebraska. Plant material comprised 99.3 percent of the total food recovered. Animal matter amounted to only 0.28 percent of the total food, and of this 82 percent was grasshoppers and lady-bird beetles. Principal plant

food items were dandelion, 21.59 percent; common prairie rose, 16.36; white clover, 16.17; sweet clovers, 13.41; wolfberry, 4.30; prairie ground cherry, 2.9; grass leaves, 2.17; and climbing poison ivy, 2.00.

Baumgartner (1939) made some observations on Michigan sharp-tailed grouse during various seasons of the year. During mild winter weather birds preferred areas where green herbaceous plants, persistent fruits, or grains were not covered by snow. During stormy weather they browsed on aspen and white birch buds and catkins. Their diet during mating season consisted of succulent vegetation which grew in moist places. By late May and June their diet turned to plants and fruits of strawberry and leaves of clover, dandelions, and other herbs. Fruits of fire cherry, raspberry, hawthorn, rose and quantities of white clover and dandelion made up their diet in early August.

In analyzing 550 droppings of sharp-tailed grouse collected in October and November from Minnesota, Swanson (1940) found a limited number of items. Wild buckwheat ranked first by frequency of occurrence (94.5 percent) and third by percent volume (10.2 percent). However, bearberry, which ranked fifth by frequency (87.2 percent), ranked first by percent volume (50.9 percent).

Aldous (1943) found that prairie wild rose was the most important autumn food in North Dakota, making up 55 percent by

volume of the contents of 19 gizzards and 60 percent of the contents of 6 crops. Animal material was entirely Orthoptera (9 percent by volume in gizzards and 36 percent in crops).

Hart et al. (1950) analyzed droppings and a few crops and stomachs from road-killed and predator-killed Columbian sharp-tailed grouse in Utah. Food found in a limited number of crops and stomachs collected during early winter was mainly waste wheat and knotweed seeds. Insects and leafy material were more important during the summer, and constituted 80 to 100 percent of the diet of juvenile birds up to three weeks of age. As snow depth increased during winter, wild rose hips, willow, poplar, maple, chokecherry, and serviceberry buds were taken. Native bunchgrasses were important in the diet from May through December.

Kobriger (1965) analyzed crops and gizzards from sharptails taken from the sandhills in Nebraska during 1962 and 1963. Principal summer foods of 46 young by percent volume were: clovers, 35.0 percent; rose, 10.2; unclassified vegetation, 4.6; sand cherry, 4.3; and other items less than 4.0. Insects made up 12.3 percent by volume overall but constituted 60 percent of the diet to 7 weeks of age. Clovers were the most important food item of 44 adults during summer, constituting 53.7 percent by volume, followed by rose, 8.5 percent. Insects constituted only 5.1 percent of the adult's summer diet. Fall foods were rose, 46.4 percent; clovers, 15.6;

nightshade, 10.5; ground cherry, 7.2; and common dandelion, 3.2. Insects made up 7.9 percent by volume during the fall.

Prairie Chicken

An early study of the food habits of prairie chickens revealed that the bulk of their diet is plant material (McAtee and Beal 1924). Insects, particularly grasshoppers, were important in the remaining portion of the diet.

Gross (1930) analyzed crop and stomach contents from 17 prairie chickens collected in September, October, and November in Wisconsin. Vegetable matter constituted 72 percent of the total food. Plant foods eaten in the largest quantities were ragweed seeds, oats, clover, acorns, and various buckwheat species.

Viehmeyer (1941) generalizing on the status of the food supply in the sandhill region of Nebraska, stated corn, small grains, and sorghum had replaced some of the native food species and that this change was for the better.

Lehmann (1941), in studying Attwater's prairie chicken, found that adult stomachs contained 88.28 percent plant material and 11.72 percent insect material. Seeds and seed pods made up more than 50 percent of material in the stomachs of 18 adults, and native plants were most important.

Yeatter (1943) analyzed stomachs of 14 young prairie chickens which averaged 9 to 10 weeks of age collected in Illinois in June,

July, and August. He found vegetable matter constituted 60.5 percent by volume. Dewberry, cherry, wheat and buttonweed made up 80 percent of the vegetable material while grasshoppers made up 55 percent of the animal matter. Plant material made up 91 percent of the volume of the foods found in 10 adults collected during the same period. Seventy-eight percent of the animal material was shorthorned grasshoppers and ground beetles. Buttonweed, giant ragweed, dewberry, flowering spurge, goldenrod and wheat composed 83.7 percent of the plant material. He wrote that the diet of very young prairie chickens probably consists entirely of animal matter, but as the young mature their diet gradually changes to seeds, succulent vegetation and fruits.

Mohler (1952) observed prairie chickens feeding in southwest Nebraska during the fall and winter and noted the birds fed in cornfields 37 times, in shocked sorghums 21 times, and in rye stubble and shocked Sudan grass four times each.

Baker (1953) analyzed 65 droppings, 29 crops, and 20 gizzards from Kansas prairie chickens collected during October of 1950 and 1951. He found that 95.6 percent of the food was plant material, while insects made up only 0.31 percent. Cultivated crops made up 73.7 percent of the total.

Ammann (1957) studied the feeding habits of prairie grouse during winter in Michigan. He observed prairie chickens eating

chokeberry and sumac fruit, goldenrod and yarrow, and aspen and bog birch browse were taken most often when the snow was deep. Waste buckwheat, barley, wheat, and flax seeds were eaten when snow cover was thin or nonexistent.

Hammerstrom et al. (1957) noted the feeding habits of prairie chickens on areas in Wisconsin moderately to lightly farmed. Budding occurred in autumn, winter and spring. They noticed that corn was eaten regularly in autumn long before the temperature dropped below zero. Prairie chickens continued to eat corn into March and April and after the spring thaw.

Korschgen (1962) analyzed 5,040 prairie chicken droppings that were collected over a two-year period in Missouri and found that eight species of cultivated grains made up 74 percent of the diet. Animal material was not important during any month, making up only 0.6 percent of the annual diet of adults.

STUDY AREA

Prairie grouse habitat types in western South Dakota include short grass, mid grass, brushy draws, trees and cropland. Four study areas, each containing two or more habitat types, were set up in the Chestnut soil region (Fig. 1). The areas (mid grass, short grass, badlands grass, and river bottom) hereafter are referred to as Units I, II, III, and IV respectively.

Annual temperature averages 45-48 degrees and precipitation averages 14-18 inches annually (Westin et al. 1959) in the areas. Short and mid grasses dominate the vegetation. Major land use of the area is cattle grazing. Cropland consists of small grains, predominantly wheat, and alfalfa used for hay.

Unit I, an area of 200 square miles, contained mid grass (Fig. 2), cropland, and brushy draw (Fig. 4) habitat types. Soils range from sandy in the southern part of the county to silty in the northern part. It is characterized by a series of benches and buttes underlain by Tertiary sandstones, siltstones, and shale. Elevations range from 2800 to 3600 feet (Westin et al. 1959). Dominant rangeland vegetation included western wheatgrass (Agropyron Smithii)[1], annual bromes (Bromus japonicus, B. tectorum), blue grama (Bouteloua gracilis), sedges (Carex spp.), needle-and-thread

[1] Scientific names are according to Fernald (1950) and Stevens (1950).

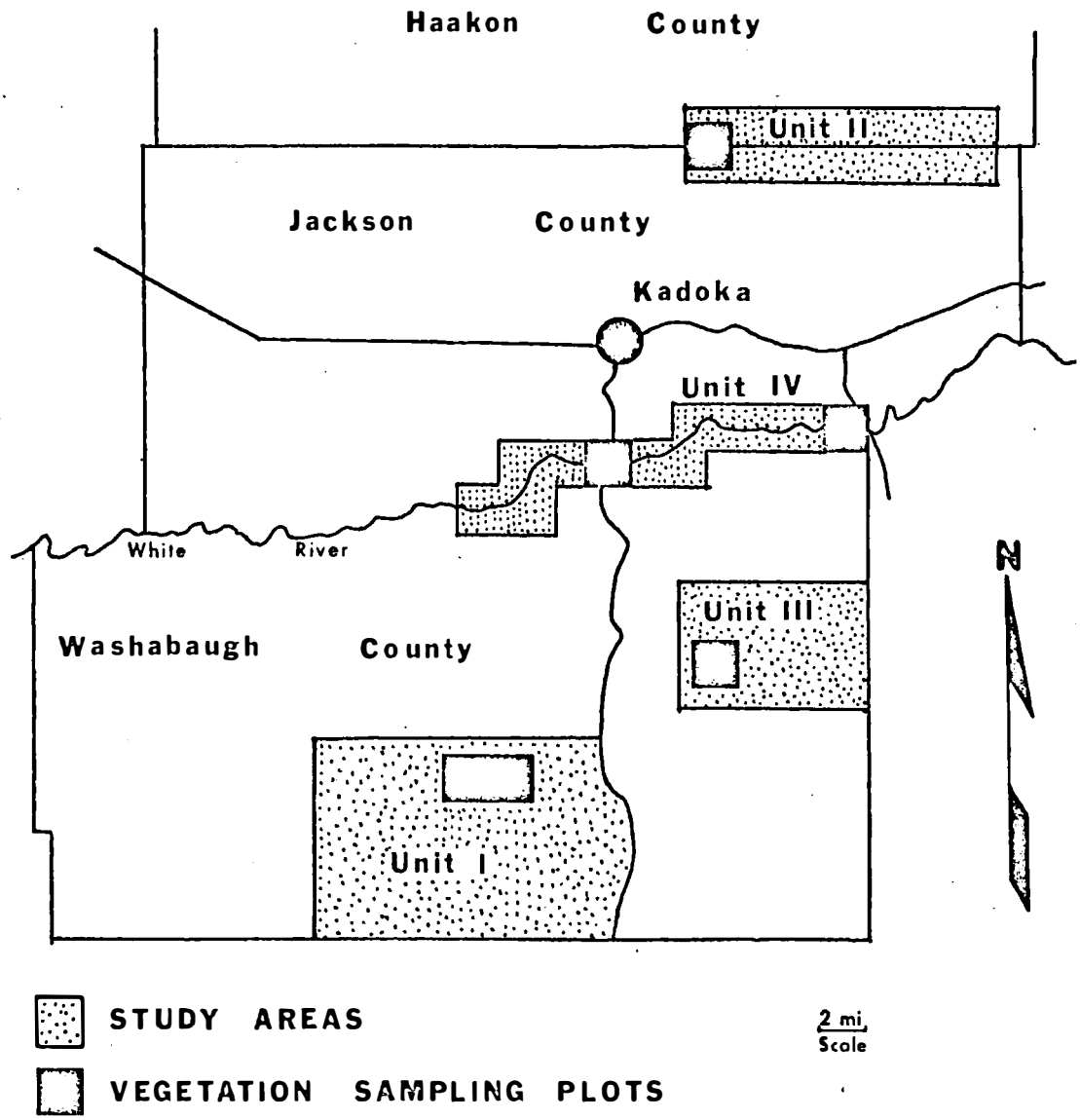

Fig. 1. Sharp-tailed grouse study areas.

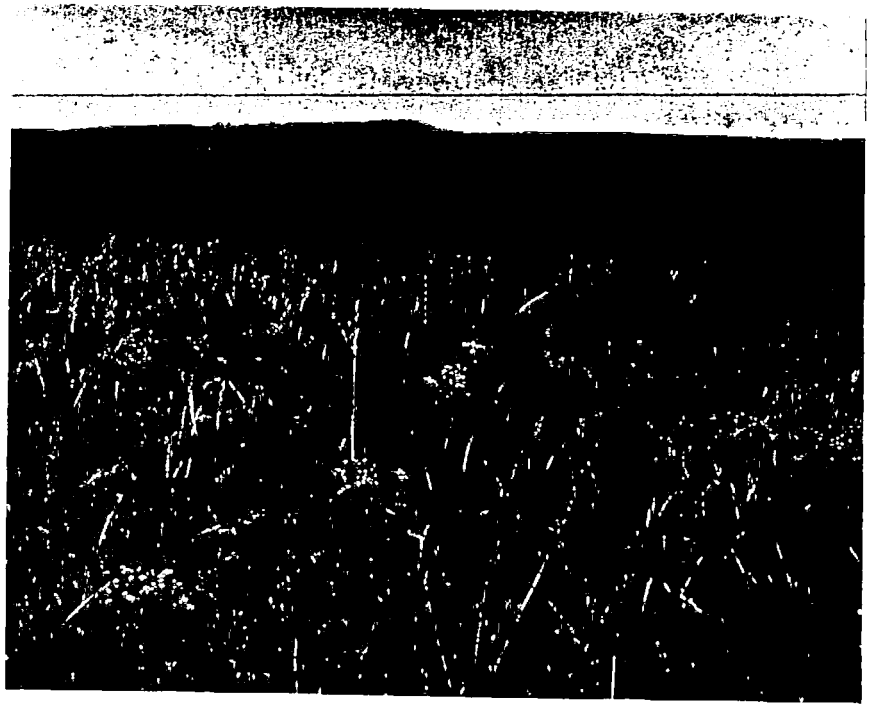

Fig. 2. Typical mid grass type in Units I and III.

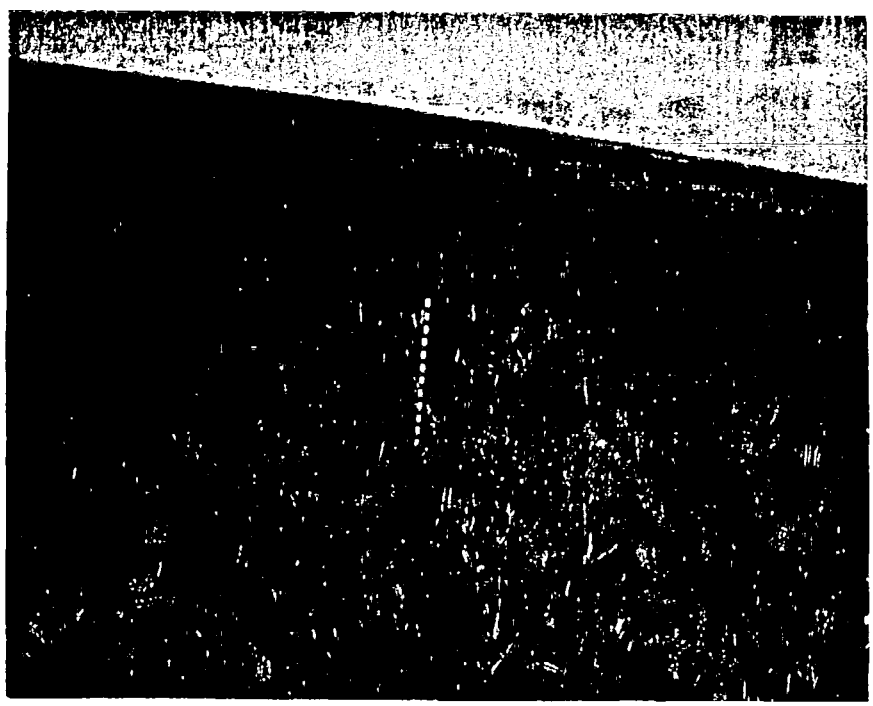

Fig. 3. Typical short grass type in Unit II.

(Stipa comata), sand dropseed (Sporobolus cryptandrus), wooly plantain (Plantago Purshii), tall-headed coneflower (Ratibida columnifera), scurf pea (Psoralea tenuiflora), green sage (Artemisia Dracunculus), blue stickseed (Lappula echinata), and daisy fleabane (Erigeron strigosus). Brushy draws in this unit contained American elm (Ulmus americana), green ash (Fraxinus pennsylvanica), boxelder (Acer Negundo), wolfberry (Symphoricarpos occidentalis), and rose (Rosa arkansana) (Fig. 5). Small grains made up 13 percent of cropland acreage in Washabaugh County and 2.4 percent was alfalfa (Konrad and Potas 1967).

Unit II (short grass area) included 68 square miles containing short grass (Fig. 3), cropland, and a few brushy draw habitat types. This unit was in the "gumbo region", a plastic clay soil which weathers from the underlying Pierre shale. Strata of the shale are soft and easily eroded forming rounded hills and ridges. Elevations are from 1800 to 2800 feet (Westin et al. 1959). Grassland vegetation in this unit included western wheatgrass, blue grama, buffalo grass (Buchloe dactyloides), sideoats grama (Bouteloua curtipendula), sedges, annual bromes, green needlegrass (Stipa viridula), red threeawn (Aristida longiseta), gumweed (Grindelia squarrosa), wooly plantain, phlox (Phlox andicola), wild vetch (Vicia americana), stiffstem flax (Linum rigidum), and red mallow (Sphaeralcea coccinea). No brushy draws were present on the

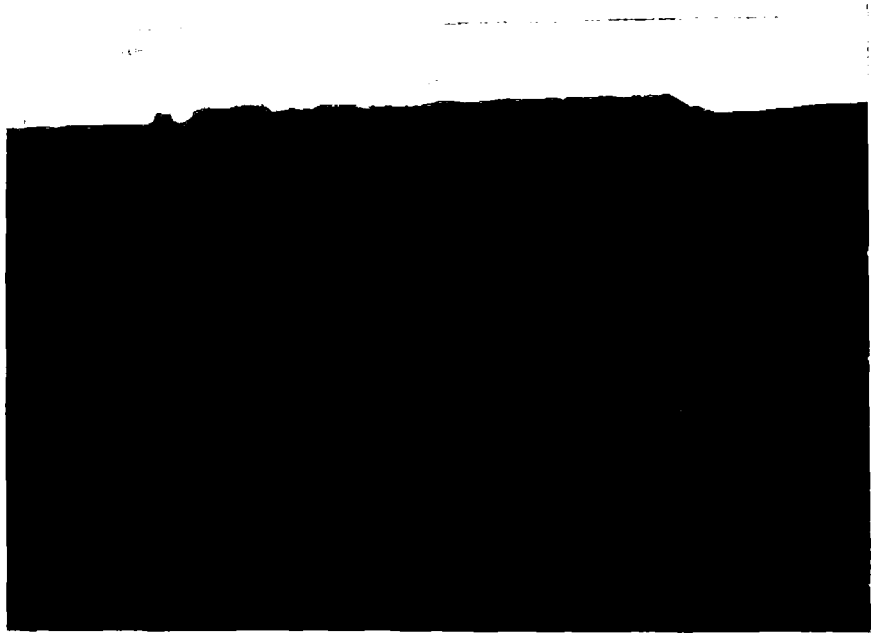

Fig. 4. Brushy draw type in Unit I dominated by American elm, boxelder, rose, and wolfberry.

Fig. 5. Brushy draw type in Unit I showing ground cover and tree canopy.

study plot in this unit. Small grains made up 12.8 percent of cropland acreage in Jackson County and 3.1 percent was alfalfa (U. S. Dept. of Agriculture, 1966).

Unit III (badlands grass area) was 80 square miles, most of which was in Pass Creek and Red Stone Basins. It contained mid grass (Fig. 2), cropland, and brushy draw (Fig. 6) habitat types. Soils in the basins are of the Badlands Association. Erosion has carved barren badlands in sedimentary formations of soft silt and clay. Small grassed tables and mesas, badlands walls, and scattered eroded buttes are prominent in the area. The study plot was on the edge of the Kadoka-Epping soil association. Topography is gently sloping to rolling above the Badlands Association. Kadoka soils are silty and overlie silty-clay-loam siltstones. They are found on the gentler slopes. Epping soils, which are shallow silty soils over siltstones, are found on ridges and steeper sideslopes (Konrad and Potas 1967). Characteristic grassland vegetation included annual bromes, needle-and-thread, sedges, blue grama, western wheatgrass, six weeks fescue (Festuca octoflora), sand dropseed, prairie sandreed (Calamovilfa longifolia), wooly plantain, rose, and prairie birds-foot trefoil (Lotus americanus). Brushy draws were characterized by chokecherry (Prunus virginiana), skunkbush sumac (Rhus trilobata), Rocky Mountain red cedar (Juniperus scopulorum), Rosa spp., and wolfberry (Fig. 7).

Fig. 6. Brushy draw type in Unit III dominated by ponderosa pine, Rocky Mountain red cedar, and skunkbush sumac.

Fig. 7. Brushy draw type in Unit III showing preponderance of evergreens.

Unit IV, an area of 35 square miles along the White River, contained mid grass, brushy draw, cropland, and tree (Fig. 8) habitat types. Soils are deep calcareous loams and silt loams over stratified alluvium of very fine sand, silt, and clay (Konrad and Potas 1967). Understory vegetation consisted of western wheatgrass, sideoats grama, annual bromes, green needlegrass, prairie sandreed, red threeawn, blue grama, needle-and-thread, yellow sweet clover (Melilotus officinalis), wolf-berry, Rosa spp., and skunkbush sumac. Dominant trees were cottonwood (Populus deltoides), willow (Salix spp.), and American elm (Fig. 9).

Fig. 8. Tree type in Unit IV dominated by cottonwood and willow.

Fig. 9. Typical bottomland in Unit IV showing interspersion of trees.

METHODS AND MATERIALS

Vegetation and Insect Analysis

Vegetation analyses were conducted on six sample study plots (Fig. 1) during the summer of 1967 only, as it was concluded vegetation would not change appreciably between 1966 and 1967. Sample plots were four square miles in area and, where possible, contained two or more basic grouse habitat types. Selection of the plots was influenced by the accessibility of vehicles. Preliminary field work showed one square mile of grassland type could be adequately sampled using four transects.

Transects were established by dividing each section of a sample plot into quarter sections and using a table of random numbers to select two quarter sections per section. Two transects were established in each quarter section with a starting point for the first transect on the western edge 300 yards north of the southwest corner. A second transect, 300 yards north of the first transect, was run back to the western edge of the quarter section.

Grasses and forbs were sampled by placing a square-foot quadrat (one hundred quadrats constituted a transect) down every two steps. Presence of plant species was recorded. The quadrat size of $0.047m^2$ established by Wiegert (1962) adequately sampled grasses and forbs; however, since all grassland transects were

standardized as to location, no consideration was given to plant distribution. This may have been the cause for differences among species in similar appearing areas. Vegetation analysis was started in early June when many species were represented by only a few leaves. Results may have been different for many species had identification been possible at this time.

Number of transects required for brushy draw and tree habitats was calculated from the number of acres of each type present in a sample plot (based on four transects for 640 acres of grassland). The Quarter Method (Cottam and Curtis 1956) was used to sample trees and shrubs. One hundred points were used per transect. Penfound (1963) stated that this method provided excellent data on frequency.

A sweep net was used to sample insects in grassland types during summer. Three transects, ten sweeps per transect, were run twice a month in the grassland types of Units I, II, and III. Ground-dwelling insects were sampled using trap methods described by Peterson (1964:33), with three traps located along each sweeping transect.

Grouse Collection

Twenty sharp-tailed grouse, five from each unit, were shot per month for two years for use in the food preference study. Some grouse were also collected from areas around the Missouri

River. Crops and gizzards were collected at hunter check stations during the hunting seasons of 1966 and 1967. Seasons were described according to availability of food to the birds and are as follows: spring, March 15 to May 31; summer, June 1 to October 31; fall, November 1 to December 14; winter, December 15 to March 14.

Crop and Gizzard Analysis

Crop and gizzard contents were examined to determine foods eaten. Since the study areas included many diverse habitats, gizzards (Korschgen 1965) allowed sampling hard seeds that were retained and that would have gone unnoticed if only crops were used.

Birds collected were frozen and kept in locker plants. Crops and gizzards were later removed, put into plastic bags, then refrozen for later analysis. After thawing, contents were separated and air dried. Food items were listed by frequency of occurrence and volume (cubic centimeters) as suggested by Swanson (1940). Volume was read to a tenth of a cubic centimeter and an item measuring less than one tenth was listed as a trace. Young prairie chickens were aged using descriptions by Baker (1953) for Kansas prairie chickens; immature sharptails were aged using methods developed by Janson (1955) and Ruos (1967).

To correlate results of crop analysis and availability studies, the technique employed by Ward and Keith (1962) and Bellrose and Anderson (1943) was used. It is based on the ratio of food consumption to food availability and results in an index value for a particular food item. The larger the figure, the greater the value of the plant or animal species as a food item.

RESULTS AND DISCUSSION

Vegetation Analysis

Thirty-two transects were run in the grassland type of Unit I (16 per replication). Analysis of variance between replications showed significant differences ($P < .05$) for annual bromes (85.2 percent replication 1, 40.7 rep. 2), scurf pea (15.6 rep. 1, 6.8 rep. 2), green sage (22.6 rep. 1, 3.8 rep. 2), and daisy fleabane (20.0 rep. 1, 3.1 rep. 2) (Table 1). The two sample plots were adjacent to one another and no differences between plots could be detected visually. A possible explanation for these differences could be the "patchy" distribution of these species. An example of this is buffalo grass, a low stoloniferous plant, which did not occur at all in rep. 1 but occurred approximately 17 percent in rep. 2. It was present in only four transects but with rather high frequencies. Since only four species of the 21 present on the plots were significantly different the study plots were called similar (J. K. Lewis, personal communication).

To detect differences between grassland types, Duncan's (1955) new multiple-range test, with Kramer's (1956) modification, was used. Eleven species (4 grasses, 6 forbs, 1 shrub) showed no significant difference between units (Table 2). Study plots in Units I and III were most comparable, having 15 species (5 grasses, 9 forbs, 1 shrub) with non-significant differences. Study plots

Table 1. Means of species with frequencies five percent or more and five important grouse foods in Unit I (based on 16 values for each replication).

Species	Means (% frequency) Rep. 1	Rep. 2	F value
Western wheatgrass (Agropyron Smithii)	75.5	65.1	.30
Annual bromes (Bromus tectorum, B. japonicus)	85.2	40.7	6.69*
Blue grama (Bouteloua gracilis)	34.0	34.0	.01
Sedges (Carex spp.)	33.8	31.0	.02
Needle-and-thread (Stipa comata)	28.1	17.6	1.81
Sand dropseed (Sporobolus cryptandrus)	16.0	18.3	.08
Scribner's panic (Panicum Scribnerianum)	15.0	13.9	.02
Buffalo grass (Buchloe dactyloides)	0.0	17.1	3.35
Green needlegrass (Stipa viridula)	6.1	10.7	.43
Wooly plantain (Plantago Purshii)	20.9	20.7	.02
Long-headed coneflower (Ratibida columnifera)	22.4	23.0	.03
Blue stickseed (Lappula echinata)	4.6	12.3	2.52
Scurf pea (Psoralea tenuiflora)	15.6	6.8	6.52*
Green sage (Artemisia Dracunculus)	22.6	3.8	8.86**
Daisy fleabane (Erigeron strigosus)	20.0	3.1	6.29*
Hoary vervain (Verbena stricta)	9.3	4.4	1.54
Goatsbeard (Tragopogon major)@	2.3	2.0	.03
Prickly lettuce (Lactuca Serriola)@	1.9	1.0	.60
Wild rose (Rosa arkansana)@	0.0	0.1	.01
Common dandelion (Taraxacum officinale)@	0.2	3.0	1.03
Wolfberry (Symphoricarpos occidentalis)@	1.1	0.0	1.66

* significant ($P < .05$)
** highly significant ($P < .01$)
@ important grouse food species

Table 2. Means of species in Units I, II, and III with frequencies five percent or more, and five important grouse foods based on 32 values for Unit I, 16 for Unit II, and 9 for Unit III. (first four F values are based on original means, the remainder are based on transformed data)

Species	Means (% frequency)			F value
	Unit I	Unit II	Unit III	
Western wheatgrass (Agropyron Smithii)	70.4^{a}	66.0^{a}	40.3^{a}	1.64
Annual bromes (Bromus spp.)	64.6^{a}	15.3^{b}	82.1^{c}	18.79**
Blue grama (Bouteloua gracilis)	43.0^{a}	49.7^{a}	46.3^{a}	.80
Sedges (Carex spp.)	40.8^{a}	27.3^{b}	48.6^{a}	1.00
Needle-and-thread (Stipa comata)	24.1^{a}	1.8^{b}	57.2^{c}	33.15**
Sand dropseed (Sporobolus cryptandrus)	16.0^{a}	0.3^{b}	10.6^{c}	17.32**
Scribner's panic (Panicum Scribnerianum)	14.1^{a}	0.0^{b}	3.9^{c}	9.30**
Buffalo grass (Buchloe dactyloides)	10.0^{a}	45.4^{b}	7.4^{a}	33.04**
Green needlegrass (Stipa viridula)	6.2^{a}	15.7^{b}	0.6^{c}	9.85**
Sideoats grama (Bouteloua curtipendula)	0.2^{a}	36.8^{b}	0.1^{a}	217.63**
Red threeawn (Aristida longiseta)	1.0^{a}	12.1^{b}	3.0^{c}	39.88**
Six weeks fescue (Festuca octoflora)	4.6^{a}	9.2^{b}	27.3^{c}	12.93**
Prairie sandreed (Calamovilfa longifolia)	2.7^{a}	0.0^{b}	10.4^{c}	3.32
Prairie junegrass (Koeleria cristata)	1.7^{a}	0.3^{b}	7.0^{c}	10.53**
Wooly plantain (Plantago Purshii)	27.0^{a}	27.2^{a}	29.1^{a}	.65
Long-headed coneflower (Ratibida columnifera)	21.5^{a}	3.3^{b}	4.8^{b}	7.92**
Blue stickseed (Lappula echinata)	12.0^{a}	5.8^{a}	7.1^{a}	1.61
Scurf pea (Psoralea tenuifloria)	12.2^{a}	4.3^{b}	3.6^{b}	3.05
Green sage (Artemisia Dracunculus)	13.0^{a}	0.0^{b}	5.6^{c}	11.79**
Daisy fleabane (Erigeron strigosus)	11.7^{a}	0.4^{b}	1.0^{b}	8.22**
Hoary vervain (Verbena stricta)	7.0^{a}	0.0^{b}	0.3^{b}	10.62**
Gumweed (Grindelia squarrosa)	0.0^{a}	42.8^{b}	0.1^{a}	554.05**
Phlox (Phlox andicola)	0.1^{a}	16.4^{b}	1.2^{c}	60.95**

Table 2. (continued)

Species	Means (% frequency) Unit I	Unit II	Unit III	F value
Wild vetch (Vicia americana)	0.0^{a}	17.8^{b}	0.0^{a}	40.47**
Stiffstem flax (Linum rigidum)	0.8^{a}	15.5^{b}	1.0^{a}	66.45**
Red mallow (Sphaeralcea coccinea)	1.2^{a}	11.1^{b}	7.3^{c}	38.39**
Milkvetch (Astragalus spp.)	1.9^{a}	8.8^{b}	0.4^{c}	7.96**
Rough Pennyroyal (Hedeoma hispida)	2.6^{a}	9.1^{b}	9.1^{b}	1.87
Peppergrass (Lepidium spp.)	1.6^{a}	8.1^{b}	0.9^{a}	17.86**
Venus's lookingglass (Specularia leptocarpa)	0.0^{a}	6.3^{b}	0.0^{a}	14.97**
Spurge (Euphorbia spp.)	1.4^{a}	6.0^{b}	0.3^{a}	12.55**
Fringed sage (Artemisia frigida)	0.0^{a}	5.3^{b}	2.9^{c}	8.40**
Prairie birds-foot trefoil (Lotus americanus)	2.1^{a}	1.7^{a}	10.2^{b}	5.22*
White sage (Artemisia ludoviciana)	1.4^{a}	2.6^{b}	8.0^{c}	7.17**
White prairie aster (Aster ericoides)	0.0^{a}	0.0^{a}	7.2^{b}	28.78**
Goatsbeard (Tragopogon major)@	2.0^{a}	0.6^{b}	1.8^{a}	2.68
Prickly lettuce (Lactuca Serriola)@	1.5^{a}	0.2^{b}	0.0^{b}	6.27**
Common dandelion (Taraxacum officinale)@	1.2^{a}	1.1^{a}	0.0^{b}	1.23
Rose (Rosa arkansana)@	0.2^{a}	0.6^{b}	12.0^{c}	34.64**
Wolfberry (Symphoricarpos occidentalis)@	0.4^{a}	0.8^{a}	1.2^{a}	.05

small letters following the means show results of Duncan's (1955) new multiple range test

* significant ($P < .05$)
** highly significant ($P < .01$)
@ important grouse food species

in Units I and II differed the most, having only eight species (2 grasses, 5 forbs, 1 shrub) with non-significant differences. Five of ten major plant foods were present in the grassland types, however, prickly lettuce (Lactuca Serriola) and common dandelion (Taraxacum officinale) were absent from the study plot in Unit III. The absence of prickly lettuce could be explained by the lack of cropland or waste areas with which this species is associated. It also would have had a higher frequency of occurrence in all study plots had transects been run along the perimeter of cropland or through road ditches, being quite common there.

The clayey soils of Unit II supported relatively high frequencies of western wheatgrass, green needlegrass, and sideoats grama. Indication that over-grazing occurred here was the abundance of gumweed (42.8 percent) and the presence of prickly pear cactus (Opuntia spp., 5 percent). Abundance in Units I and III of needle-and-thread (24.1 percent; 57.2 percent), prairie sandreed (2.7 percent; 10.4 percent), western wheatgrass (70.4 percent; 40.3 percent), blue grama (43.0 percent; 46.3 percent), and green needlegrass (6.2 percent; 0.6 percent) reflects the sandy to silty soils found in Washabaugh County.

Comparison of brushy draws, between Units I and III, showed significant differences ($P < .05$) for all species except rose, green ash, dandelion, western wheatgrass, annual bromes, and

green needlegrass (Table 3). Brushy draws in Unit I were associated with rolling grassland and those in Unit III were associated with badlands topography. Means for brushy draws were based on relative frequencies and would likely have differed had figures been based on density. Plant densities and numbers were greater in brushy draws in Unit III than in Unit I. Draws in Unit III were also much deeper than those in Unit I. Hawthorn (Crateagus sp.) in Unit III was very scattered and none was recorded on the transects. None were found or seen in Unit I.

Replications in Unit IV were highly variable (Table 4) with regard to grasses, trees, and shrubs because tree density was less in rep. 1 and required running the transect through much open area where species such as annual bromes, red threeawn, blue grama, and buffalo grass were abundant. Yellow sweet clover was completely absent in rep. 2, yet was present 59 percent in rep. 1 because the transect was run through a field reseeded to sweet clover. Two trees, box elder and cottonwood, and three shrubs, rose, chokecherry, and wolfberry, differed significantly ($P < .05$) between replications. Here again, tree and shrub means were based on relative frequencies and would likely have differed had figures been based on density.

Insect Analysis

Sixty-three transects (24 in each of Units I and II, 15 in Unit III) were run in grassland types to sample insect populations

Table 3. Means for species in brushy draws of Units I and III with frequencies five percent or more.

Species	Means (% frequency) Unit I	Unit III	X^2 values
Wolfberry (Symphoricarpos occidentalis)	39.0	10.0	22.72**
Boxelder (Acer Negundo)	10.0	0.2	9.92**
American elm (Ulmus americana)	20.0	7.0	7.24**
Chokecherry (Prunus virginiana)	0.0	37.6	46.30**
Skunkbush sumac (Rhus trilobata)	0.0	19.2	21.22**
Rocky mountain red cedar (Juniperus scopulorum)	0.0	10.2	10.74**
Wild plum (Prunus americana)	0.0	5.2	5.34*
Rose (Rosa spp.)	8.0	10.0	.24
Green ash (Fraxinus pennsylvanica)	16.0	8.0	3.02
Long-headed coneflower (Ratibida columnifera)	30.0	0.0	35.30**
False Solomon's-seal (Smilacina stellata)	0.0	23.0	25.98**
Poison ivy (Rhus radicans)	0.0	15.0	16.22**
Hoary vervain (Verbena stricta)	14.0	1.0	12.16**
White sage (Artemisia ludoviciana)	0.0	11.0	11.64**
Horsemint (Monarda fistulosa)	10.0	0.0	10.52**
Thistle (Cirsium spp.)	7.0	0.0	7.26**
Common dandelion (Taraxacum officinale)	8.0	2.0	3.78

Table 3. (continued)

Species	Means (% frequency) Unit I	Unit III	X^2 values
Kentucky bluegrass (Poa pratensis)	92.0	2.0	162.56**
Sideoats grama (Bouteloua curtipendula)	2.0	29.0	27.84**
Sedges (Carex spp.)	20.0	42.0	11.30**
Little bluestem (Andropogon scoparius)	0.0	8.0	8.34**
Canada wildrye (Elymus canadensis)	15.0	4.0	7.02**
Foxtail barley (Hordeum jubatum)	6.0	0.0	6.18*
Needle-and-thread (Stipa comata)	0.0	6.0	6.18*
Western wheatgrass (Agropyron Smithii)	26.0	18.0	1.88
Annual bromes (Bromus japonicus, B. tectorum)	5.0	10.0	1.80
Green needlegrass (Stipa viridula)	3.0	5.0	.52

* significant ($P < .05$)
** highly significant ($P < .01$)

Table 4. Means for replications in Unit IV for species with frequencies five percent or more, and for three important grouse food species.

Species	Means (% frequency) Rep. 1	Rep. 2	X^2 values
Annual bromes (Bromus japonicus, B. tectorum)	48.6	10.0	35.94**
Red threeawn (Aristida longiseta)	30.0	0.0	35.30**
Blue grama (Bouteloua gracilis)	28.0	1.0	29.38**
Green needlegrass (Stipa viridula)	14.3	42.0	18.80**
Buffalo grass (Buchloe dactyloides)	17.0	0.0	18.58**
Sideoats grama (Bouteloua curtipendula)	33.0	62.0	16.84**
Needle-and-thread (Stipa comata)	3.6	22.0	15.16**
Prairie sandreed (Calamovilfa longifolia)	25.6	12.0	6.06*
Canada wildrye (Elymus canadensis)	10.6	5.0	2.20
Western wheatgrass (Agropyron Smithii)	59.0	67.0	1.36
Yellow sweet clover (Melilotus officinalis)	59.0	0.0	83.68**
Stiffstem flax (Linum rigidum)	16.0	0.0	17.40**
Prickly lettuce (Lactuca Serriola)	1.0	5.0	2.82
Common dandelion (Taraxacum officinale)@	2.3	0.0	2.04
Goatsbeard (Tragopogon major)@	1.0	0.0	1.00
Blue lettuce (Lactuca pulchella)	5.3	6.0	.06

Table 4. (continued)

Species	Means (% frequency) Rep. 1	Rep. 2	X^2 values
Boxelder (Acer Negundo)	0.0	34.6	41.82**
Rose (Rosa spp.)	24.0	57.0	22.60**
Cottonwood (Populus deltoides)	76.6	46.0	18.92**
Chokecherry (Prunus virginiana)	10.0	0.0	10.52**
Wolfberry (Symphoricarpos occidentalis)	46.0	31.5	4.10*
Willow (Salix spp.)	14.3	6.0	3.56
American elm (Ulmus americana)	5.0	11.5	3.14
Wild grape (Vitus rupestris)	6.0	1.9	2.08
Russian olive (Elaeagnus angustifolia)@	0.3	0.0	.30
Skunkbush sumac (Rhus trilobata)	9.0	6.8	.28

* significant ($P < .05$)
** highly significant ($P < .01$)
@ important grouse food species under 5 percent

(Table 5). No transects were located in Unit IV because it was important to grouse only during winter when insects were not available. Only the family Tettigoniidae, represented by Conocephalus saltans, differed significantly ($P < .05$) between units. This species, according to Shelford (1963), is generally associated with the grass Andropogon common to the tall and mixed-grass prairies. Many of the insect species listed in Appendix A are mentioned as being associated with mixed and short grass prairies (Shelford 1963).

Tumble-in traps used during June to sample ground-dwelling insects were biased for certain groups (ants and dung and carrion beetles) and were discontinued. Many species of ground-dwelling insects (Gryllidae, Carabidae, Tenebrionidae) found in grouse crops were not present in insect sweepings.

Crop and Gizzard Analysis

Crops and gizzards of 742 prairie grouse (667 sharptails, 75 prairie chickens) were analyzed for food contents. Figure 10 shows the number and distribution of prairie grouse taken.

Cultivated crops (corn, oats, wheat, barley, sorghum) made up 34.2 percent and short-horned grasshoppers 24.0 percent of the total volume of 659 crops (Table 6). Plant material accounted for 73 percent of the total food volume.

Table 5. Means for insects for Units I, II, and III (means are averages for summer months June-October, 1967).

Family	Means (% frequency)			F values
	Unit I	Unit II	Unit III	
Long-horned grasshoppers (Tettigoniidae)	7.0[a]	1.0[b]	6.0[a]	4.68*
Stink bugs (Pentatomidae)	0.0[a]	3.0[b]	0.1[a]	3.04
Walking sticks (Phasmidae)	2.0[a]	0.1[b]	0.0[b]	1.74
Robber flies (Asilidae)	0.0[a]	0.6[a]	0.0[a]	1.20
Short-horned grasshoppers (Acrididae)	47.0[a]	53.0[a]	50.0[a]	.72
Crickets (Gryllidae)	0.6[a]	2.0[b]	0.0[a]	.72
Noctuid moths (Noctuidae)	0.7[a]	2.0[b]	0.8[a]	.63
Leaf beetles (Chrysomelidae)	4.0[a]	5.0[a]	4.1[a]	.12
Beetles (Carabidae)	0.2[a]	0.1[a]	0.2[a]	.01
Tiger moths & Footman moths (Arctiidae)	0.0[a]	0.0[a]	0.1[a]	.01

* significant ($P < .05$)

small letters following means are results of Duncan's (1955) new multiple range test

Table 6. Average volumes of 20 major food items for 659 prairie grouse.

Food Item	Average volume cc.	Percent
Cultivated crops (corn, oats, wheat, barley, sorghum)	1.38	34.2
Rose (Rosa arkansana)	.44	10.9
Wolfberry (Symphoricarpos occidentalis)	.25	6.2
Common dandelion (Taraxacum officinale)	.24	5.9
Prickly lettuce (Lactuca Serriola)	.19	4.7
Grass	.11	2.7
Alfalfa (Medicago sativa)	.10	2.5
Goatsbeard (Tragopogon major)	.10	2.5
Hawthorn (Crateagus spp.)	.08	2.0
Russian olive (Elaeagnus angustifolia)	.06	1.5
Short-horned grasshoppers (Acrididae)	.97	24.0
Noctuid moths (Noctuidae)	.04	1.0
Long-horned grasshoppers (Tettigoniidae)	.03	0.7
Leaf beetles (Chrysomelidae)	.01	0.2
Beetles (Carabidae)	.01	0.2
Crickets (Gryllidae)	.01	0.2
Tiger moths and Footman moths (Arctiidae)	.01	0.2
Stink bugs (Pentatomidae)	.01	0.2
Robber flies (Asilidae)	trace	0.1
Walking sticks (Phasmidae)	trace	0.1
Totals	4.04	100.0

Percent total volume:

Plant	73.0
Animal	27.0

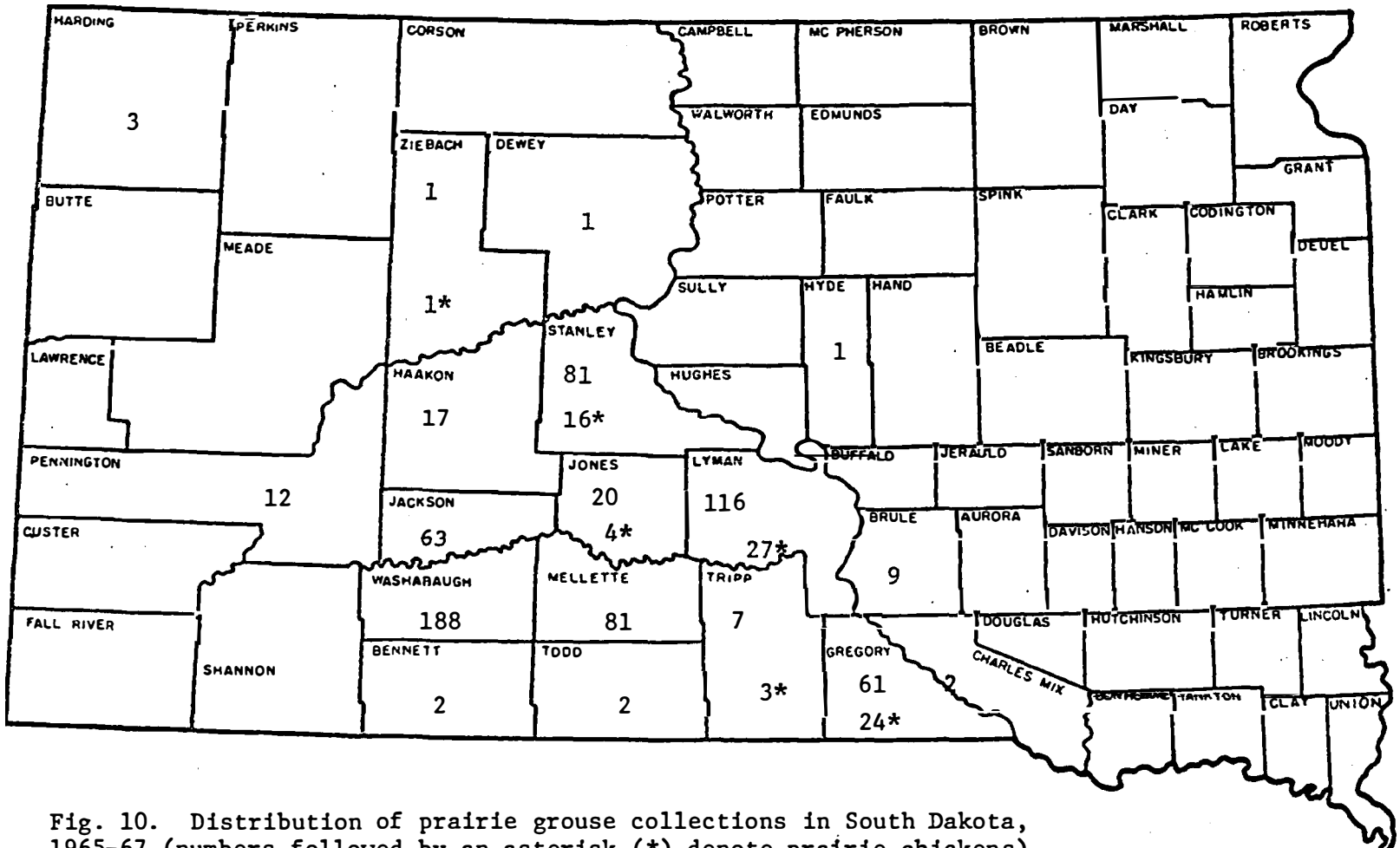

Fig. 10. Distribution of prairie grouse collections in South Dakota, 1965-67 (numbers followed by an asterisk (*) denote prairie chickens).

Of the 268 sharp-tailed grouse from Haakon, Jackson, and Washabaugh Counties, 85 birds came from Unit I, 19 from Unit II, none from Unit III, and four from Unit IV.

When compared to habitat type, cultivated crops accounted for 67.2 percent of the total volume for sharptails from cropland (Table 7). Short-horned grasshoppers made up 74 percent of the diet of birds from river bottom types. Alfalfa and cultivated crops each accounted for 22.6 percent of the total food volume of sharptails from alfalfa type. Dandelion ranked first (46.2 percent) in birds from brushy draw types in Unit I and hawthorn ranked number one (82.7 percent) in the diet of birds from Unit IV. Only 12.2 percent of the diet of sharptails from Unit IV consisted of cultivated crops.

Cultivated crops were most important in the diet of prairie chickens collected from cropland, grassland, and alfalfa (Table 8). The majority of prairie chicken crops came from hunter check stations during opening weekend of the hunting season in late summer.

Importance of the twenty major food items according to season for prairie grouse of all ages is shown in Table 9. Dandelion accounted for 72.2 percent of the food volume of sharp-tailed grouse during spring. It made up 57 percent of the diet of 45 sharptails from eight western counties (Appendix B) and 50.9

Table 7. Percent volume of 20 major food items for 594 sharp-tailed grouse according to habitat (computed from average volumes).

Food Item	Habitat Type (No. of birds)				
	Unknown(77)	Unit I(87)	Unit II(27)	Unit IV(4)	Cropland(90)
Cultivated crops (corn, oats, wheat, barley, sorghum)	37.8	27.0	61.6	12.2	67.2
Grass	.9	4.4	0.7	0.6	2.6
Hawthorn (Crateagus sp.)	2.2	*	*	82.7	3.0
Goatsbeard (Tragopogon major)	0.2	0.9	*	*	0.4
Prickly lettuce (Lactuca Serriola)	6.3	13.2	2.9	*	2.4
Rose (Rosa arkansana)	24.4	7.8	13.2	*	2.6
Alfalfa (Medicago sativa)	1.3	3.8	*	*	0.9
Common dandelion (Taraxacum officinale)	1.1	14.6	3.5	*	1.5
Wolfberry (Symphoricarpos occidentalis)	3.3	18.7	*	*	1.0
Russian olive (Elaeagnus angustifolia)	4.8	*	*	*	2.6
Short-horned grasshoppers (Acrididae)	16.0	9.0	16.2	1.4	14.7
Noctuid moths (Noctuidae)	0.6	tr	0.5	0.8	0.2
Long-horned grasshoppers (Tettigoniidae)	0.3	0.1	*	*	0.5
Beetles (Carabidae)	tr	*	0.2	*	0.1
Crickets (Gryllidae)	0.7	*	*	*	tr
Stink bugs (Pentatomidae)	0.1	0.2	0.8	*	0.1
Leaf beetles (Chrysomelidae)	tr	*	*	2.3	0.1
Robber flies (Asilidae)	tr	*	*	*	*
Walking sticks (Phasmidae)	tr	0.3	*	*	0.1
Tiger moths & Footman moths (Arctiidae)	*	*	*	*	*
Percent total volume: Plant	82.3	90.4	81.9	95.5	84.2
Animal	17.7	9.6	18.1	4.5	15.8

* not present

Table 7. (continued)

Food Item	Habitat Type (No. of birds)				
	Brushy Draw in Unit I(4)	Other Grass-land(224)	Alfalfa(56)	Other Brushy Draw(21)	River Bottom(4)
Cultivated crops (corn, oats, wheat, barley, sorghum)	21.2	17.9	22.6	25.4	*
Grass	0.2	4.0	4.9	5.8	*
Hawthorn (Crateagus sp.)	*	*	*	0.4	*
Goatsbeard (Tragopogon major)	*	4.6	17.8	0.6	*
Prickly lettuce (Lactuca Serriola)	*	4.2	1.1	16.3	3.0
Rose (Rosa arkansana)	0.4	11.2	0.4	8.2	16.1
Alfalfa (Medicago sativa)	8.1	1.3	22.6	1.8	*
Common dandelion (Taraxacum officinale)	46.2	9.1	2.8	7.2	*
Wolfberry (Symphoricarpos occidentalis)	*	9.8	*	15.4	0.9
Russian olive (Elaeagnus angustifolia)	*	0.1	*	*	*
Short-horned grasshoppers (Acrididae)	22.9	33.1	24.2	15.4	74.0
Noctuid moths (Noctuidae)	*	1.9	1.0	2.8	*
Long-horned grasshoppers (Tettigoniidae)	1.0	1.2	0.8	*	2.4
Beetles (Carabidae)	*	0.2	0.8	*	*
Crickets (Gryllidae)	*	tr	0.1	*	3.6
Stink bugs (Pentatomidae)	*	0.2	*	0.4	*
Leaf beetles (Chrysomelidae)	*	0.5	0.2	0.3	*
Robber flies (Asilidae)	*	0.3	*	*	*
Walking sticks (Phasmidae)	*	0.1	0.7	*	*
Tiger moths & Footman moths (Arctiidae)	*	0.3	*	*	*
Percent total volume: Plant	76.1	62.2	72.2	81.1	20.0
Animal	23.9	37.8	27.8	18.9	80.0

* not present

Table 8. Percent volume of 20 major food items for 66 prairie chickens in summer according to habitat (computed from average volumes).

Food Items	Habitat Type (No. of birds)			
	Unknown(38)	Cropland(12)	Grassland(23)	Alfalfa(2)
Cultivated crops (corn, oats, wheat, barley, sorghum)	25.1	39.4	44.5	47.6
Grass	0.4	5.5	*	4.8
Hawthorn (Crateagus sp.)	*	*	*	*
Goatsbeard (Tragopogon major)	*	9.2	*	*
Prickly lettuce (Lactuca Serriola)	0.5	10.1	24.9	23.8
Rose (Rosa arkansana)	6.1	*	*	*
Alfalfa (Medicago sativa)	3.0	1.8	14.1	23.8
Common dandelion (Taraxacum officinale)	*	*	7.9	*
Wolfberry (Symphoricarpos occidentalis)	*	*	*	*
Russian olive (Elaeagnus angustifolia)	*	*	*	*
Short-horned grasshoppers (Acrididae)	61.2	15.6	0.5	*
Noctuid moths (Noctuidae)	0.1	18.4	2.6	*
Long-horned grasshoppers (Tettigoniidae)	0.6	*	*	*
Beetles (Carabidae)	2.3	*	*	*
Crickets (Gryllidae)	*	*	0.3	*
Stink bugs (Pentatomidae)	*	*	0.8	*
Leaf beetles (Chrysomelidae)	0.3	*	4.4	*
Robber flies (Asilidae)	*	*	*	*
Walking sticks (Phasmidae)	*	*	*	*
Tiger moths & Footman moths (Arctiidae)	0.1	*	*	*
Percent total volume: Plant	35.1	66.0	91.4	100.0
Animal	64.9	34.0	8.6	0.0

* not present

Table 9. Average percent volume of 20 major food items for 659 prairie grouse by season (computed from average volumes).

Food Item	Spring ST (63)[1]	Summer ST(463)	Summer PC(64)	Fall ST(26)	Fall PC(1)	Winter ST(45)
Cultivated crops (corn, oats, wheat, barley, sorghum)	15.3	23.1	28.8	54.8	100.0	63.9
Grass	0.7	1.9	0.6	6.9		5.9
Hawthorn (Crateagus spp.)	*	2.2	*	10.7	*	*
Goatsbeard (Tragopogon major)	0.3	4.9	0.5	*	*	*
Prickly lettuce (Lactuca Serriola)	0.1	6.8	6.3	*	*	*
Rose (Rosa arkansana)	1.6	14.7	4.6	0.2	*	5.0
Alfalfa (Medicago sativa)	6.5	3.5	5.4	*	*	*
Common dandelion (Taraxacum officinale)	72.2	3.5	1.6	2.0	*	*
Wolfberry (Symphoricarpos occidentalis)	0.2	3.0	*	7.4	*	19.0
Russian olive (Elaeagnus angustifolia)	*	0.1	*	15.4	*	4.9
Short-horned grasshoppers (Acrididae)	0.9	32.1	46.6	1.8	*	0.7
Noctuid moths (Noctuidae)	0.1	1.7	1.8	*	*	*
Long-horned grasshoppers (Tettigoniidae)	*	1.0	0.4	0.6	*	*
Beetles (Carabidae)	*	0.2	1.7	*	*	*
Crickets (Gryllidae)	2.0	0.2	0.1	*	*	*
Stink bugs (Pentatomidae)	*	0.2	0.2	*	*	*
Leaf beetles (Chrysomelidae)	0.1	0.4	1.3	0.2	*	*
Robber flies (Asilidae)	*	0.2	*	*	*	*
Walking sticks (Phasmidae)	*	0.3	*	*	*	*
Tiger moths & Footman moths (Arctiidae)	*	tr	0.1	*	*	0.6
Totals	100.0	100.0	100.0	100.0	100.0	100.0

* not present
1 number of birds

percent of the total food volume of 18 sharptails from Unit I (Appendix C). Cultivated crops (15.3 percent) were second in importance (Table 9). Insects, mainly crickets and short-horned grasshoppers made up 68 and 26 percent, respectively, of the total insect volume.

Insects became important in diets of both sharptails (36.2 percent) and prairie chickens (52.2 percent) during summer with short-horned grasshoppers ranking first (32.1 and 46.6 percent respectively). Animal material constituted 61.8 percent of the diet of 120 young sharp-tailed grouse from eight western counties (Appendix D) and 39.7 percent of the total food volume of 43 young sharptails from Units I and II (Appendix E). Cultivated crops ranked second in importance for both species (Table 9). Rose was third in importance for sharptails (14.7 percent) and fifth (4.6 percent) for prairie chickens. Goatsbeard (Tragopogon major) ranked fifth (4.9 percent) for sharp-tailed grouse and eleventh (0.5 percent) for prairie chickens. It accounted for 6.9 percent of the diet of 48 sharptails from Unit I (Appendix F) and 14.8 percent of the food volume of 68 sharptails from ten western counties (Appendix G).

Gizzard analysis of 81 sharp-tailed grouse from summer (Appendix H) revealed that rose seeds made up 31.4 percent of the total volume and 19.6 percent for prairie chicken gizzards

(Appendix I). Weeds seeds accounted for a very small percentage of the contents for both species.

During fall, cultivated crops ranked first in importance for sharptails and prairie chickens (54.8 and 100.0 percent respectively). Fruits of Russian olive (Elaeagnus angustifolia), hawthorn, and wolfberry became important. Russian olive was third (14.8 percent), hawthorn fourth (10.3 percent) and wolfberry seventh (4.4 percent) in the diet of 24 sharptails from five western counties (Appendix J). Wolfberry was most important (58.1 percent) for three sharptails from Units I and II (Appendix K). Short-horned grasshoppers consitituted 69.8 percent of the total insect volume for sharp-tailed grouse, and long-horned grasshoppers (Tettigoniidae) were second in importance (22.9 percent).

Cultivated crops made up 63.9 percent of the total food volume for sharptails during winter. Wolfberry was second in importance (19.0 percent) and grass was third (5.9 percent). Much of the material identified as grass leaves was probably winter wheat. Little budding was in evidence during winter. Of six sharp-tailed grouse taken from Jackson and Washabaugh Counties, cottonwood buds ranked fifth (6.5 percent) in total food volume (Appendix L). Buds of western buffaloberry (Shepherdia argentea), skunkbush sumac, chokecherry, and American elm were also taken (Appendix M). However,

amounts were less than 1.5 percent of the total plant food volume. Absence of appreciable budding could be explained by the warm temperatures and lack of snow cover. Temperatures were quite mild for 1966 and 1967: highs of 66 degrees were recorded for February 28 and March 1, 1967 (U. S. Weather Bureau Records from Interior, South Dakota). There were also five readings above 50 for the period February 24-March 10, 1967. This would also explain the appearance of insects in three sharptails taken in eastern Pennington County (Appendix M).

The proportion of plant and animal matter in young prairie grouse is represented in Table 10. The diet of young grouse to 13 weeks of age averaged 91.5 percent animal material, ranging from 64 percent at three weeks to 100 percent at four weeks of age. At 17 weeks of age animal material constituted only ten percent of the diet. The general pattern of animal food in the diet of young grouse in this study (Fig. 11) follows that found by Kobriger (1965). Differences in percentages between my study and Kobrigers, regarding the various age groups, can be attributed to weather, insect availability, and hatching periods for the two states. Only the ten major plant foods were considered in my study, many of which would not be available to young grouse.

Both prairie chickens and sharp-tailed grouse feed in early morning and late afternoon (Baker 1953, Hart et al. 1950). The

Table 10. Volume of food material in prairie grouse crops according to age (based on 20 major food items).

Age in weeks	No. of birds	Plant Avg. vol. cc.	Plant Percent	Animal Avg. vol. cc.	Animal Percent	Total avg. vol. cc.
3	5	.44	36	.78	64	1.22
4	3	*	*	.13	100	.13
5	15	.14	9	1.34	91	1.48
6	14	.11	6	1.75	94	1.86
7	10	.12	11	.97	89	1.09
8	6	.25	6	3.78	94	4.03
9	20	.35	9	3.37	91	3.72
10	16	.08	1	9.82	99	9.90
11	13	.25	6	4.06	94	4.31
12	6	.08	1	11.74	99	11.82
13	9	.53	8	6.46	92	6.99
14	9	3.70	35	6.82	65	10.52
15	34	2.95	48	3.15	52	6.10
16	30	1.44	32	3.08	68	4.52
17	28	10.68	90	1.19	10	11.87
18	23	5.71	83	1.16	17	6.87
Unknown age	127	4.03	68	1.86	32	5.89
Adult	399	4.92	69	2.20	31	7.12

* no figures

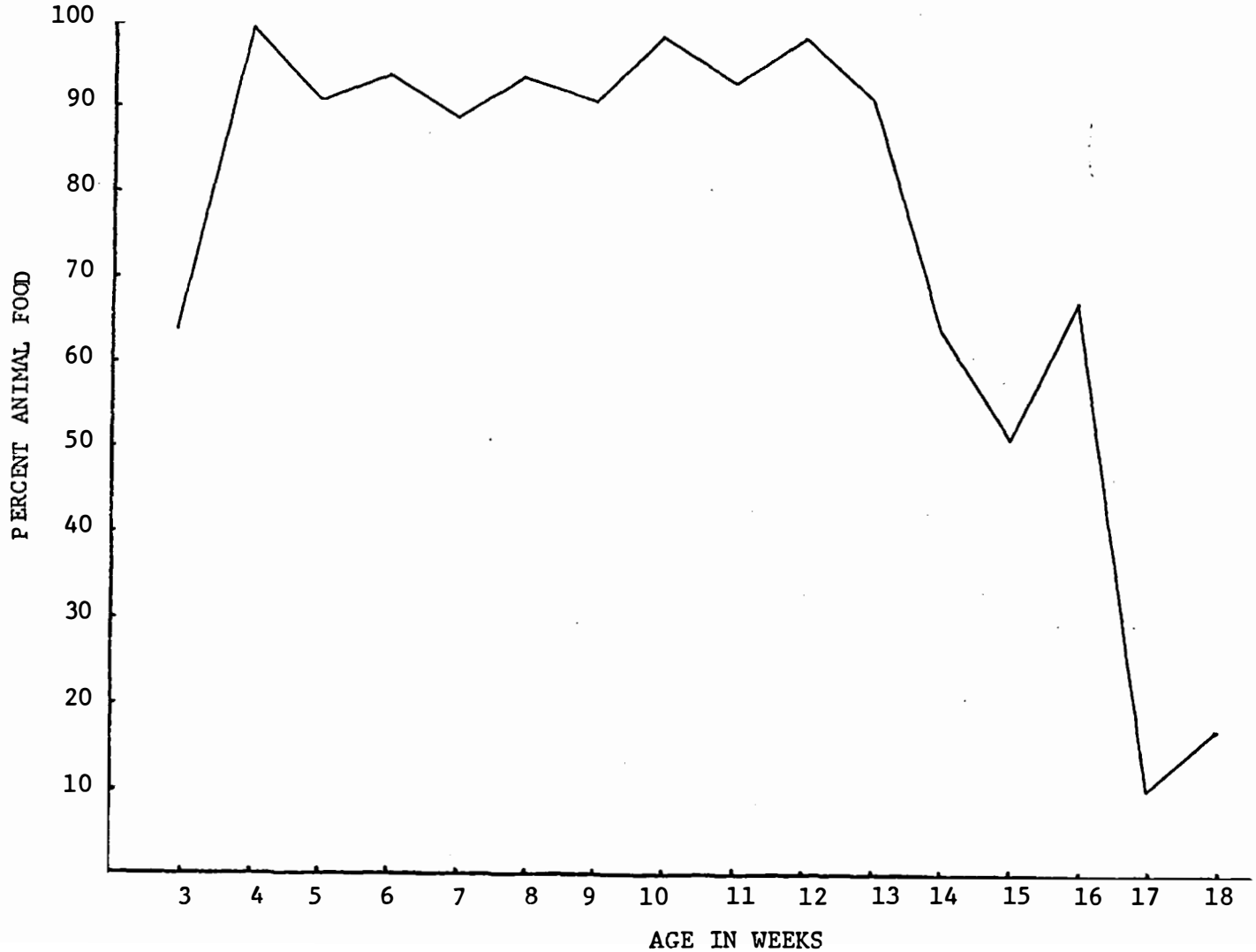

Fig. 11. Percent animal food of young prairie grouse, western South Dakota, 1966-67.

majority of birds were collected between 5:00 a.m. and 10:00 a.m. but average food volume was greatest between 9:00 a.m. and noon (Table 11). The high percentage of animal material in the diet at 6:00 a.m. could be due to quiescence of insects making them easier prey, or because approximately 37 percent of the birds were young. Over half of birds taken at 9:00 a.m. were from three to 13 weeks of age. Average percent animal material for this age range is 91.5 percent (Table 10).

Food Preferences

Food-preference indices for 48 adult sharp-tailed grouse were based upon birds collected during summer 1966 and 1967 and availability figures from summer 1967 in Unit I (Table 12). Rose hips were the most important food item for adult sharptails followed by wolfberry fruits, and clovers (Trifolium spp.) There seemed to be some selectivity for walking sticks (Phasmidae) by adult sharptails.

Although it may not be valid to base index values from all seasons on availability figures from only one season, general importance for the twenty major food items for sharptails in Units I and II can be seen. Index values for the 20 major food items in these units are shown in Table 13. Consumption figures are for all birds from 1966 and 1967. The majority of birds were

Table 11. Volume of food material in sharp-tailed grouse crops according to time of day (based on 20 major food items).

No. of birds (No. young)	Hour of Day	Plant		Animal		Avg. Total Vol. cc.
		Avg. vol. cc.	Percent vol.	Avg. vol. cc.	Percent vol.	
2	3	*	---	*	---	*
9	4	*	---	*	---	*
38 (1)	5	0.22	100	*	---	0.22
46 (17)	6	0.31	16	1.60	84	1.91
61 (26)	7	1.58	63	0.93	37	2.51
61 (30)	8	2.16	59	1.48	41	3.64
30 (17)	9	3.20	46	3.75	54	6.95
22 (17)	10	5.53	77	1.67	23	7.20
9 (3)	11	5.02	85	0.90	15	5.92
9 (2)	12	9.00	100	0.03	trace	9.03
7 (2)	13	2.14	100	*	---	2.14
6	14	2.29	100	*	---	2.29
7	15	6.83	100	0.03	trace	6.86
8 (2)	16	0.58	82	0.13	18	0.71
11 (2)	17	3.37	94	0.20	6	3.57
14 (5)	18	2.76	63	1.60	37	4.36
5 (2)	19	8.46	68	3.94	32	12.40
2 (1)	20	1.80	100	*	---	1.80

* not present

Table 12. Percent availability, percent consumption, and index value of food items in Unit I (for 48 adult sharp-tailed grouse collected in summer).

Food Item	Availability percent	Consumption percent	Index Value
Rose (Rosa arkansana)	0.2	15.4	77.00
Wolfberry (Symphoricarpos occidentalis)	0.4	5.5	13.76
Clovers (Trifolium spp.)	0.1	1.2	12.00
Prickly lettuce (Lactuca Serriola)	1.5	14.7	9.80
Cultivated crops (wheat, oats, barley)	8.7	37.9	4.35
Goatsbeard (Tragopogon major)	2.0	7.2	3.60
Alfalfa (Medicago sativa)	3.5	4.4	1.25
Dandelion (Taraxacum officinale)	1.2	0.2	0.17
Peppergrass (Lepidium spp.)	1.6	0.1	0.06
Grass	100.0	3.9	0.04
Annual sunflower (Helianthus annuus)	*	7.7	-----
Yellow sweet clover (Melilotus officinalis)	*	0.6	-----
Wild buckwheat (Polygonum convolvulus)	*	0.6	-----
Small-seeded false flax (Camelina microcarpa)	*	0.2	-----
Poison ivy (Rhus radicans)	*	0.2	-----
Green foxtail (Setaria viridis)	*	0.1	-----
Walking sticks (Phasmidae)	2.0	8.3	4.15
Short-horned grasshoppers (Acrididae)	47.0	75.9	1.61
Noctuid moths (Noctuidae)	0.7	0.9	1.29
Long-horned grasshoppers (Tettigoniidae)	7.0	1.9	0.27
Leaf beetles (Chrysomelidae)	4.0	0.9	0.23
Crickets (Gryllidae)	0.6	0.0	very low
Beetles (Carabidae)	0.2	0.0	very low

* not available

Table 13. Percent availability, percent consumption, and index value of the 20 major food items for sharp-tailed grouse from Units I and II (based on summer availability).

Food Item	Unit I			Unit II		
	Availability %	Consumption %	Index Value	Availability %	Consumption %	Index Value
Wolfberry (Symphoricarpos occidentalis)	0.4	20.7	51.75	0.8	**	-----
Rose (Rosa arkansana)	0.2	8.7	43.50	0.6	16.2	27.00
Common dandelion (Taraxacum officinale)	1.2	16.1	13.42	1.1	4.3	3.91
Prickly lettuce (Lactuca Serriola)	1.5	14.5	9.67	0.2	3.6	18.00
Cultivated crops (corn, oats, wheat, barley, sorghum)	8.7	29.7	3.41	12.8	75.9	5.93
Alfalfa (Medicago sativa)	3.5	4.2	1.20	3.1	**	-----
Goatsbeard (Tragopogon major)	2.0	0.9	0.45	0.6	**	-----
Grass	100.0	4.8	0.05	100.0	0.9	0.01
Hawthorn (Crateagus sp.)	*	**	----	*	**	-----
Russian olive (Elaeagnus angustifolia)	*	**	----	*	**	-----
Short-horned grasshoppers (Acrididae)	47.0	92.4	1.97	53.0	92.7	1.75
Walking sticks (Phasmidae)	2.0	3.6	1.80	0.1	**	-----
Noctuid moths (Noctuidae)	0.7	0.4	0.57	2.0	2.5	1.25
Long-horned grasshoppers (Tettigoniidae)	7.0	1.2	0.17	1.0	**	-----
Beetles (Carabidae)	0.2	**	----	0.1	0.8	8.00
Stink bugs (Pentatomidae)	*	1.6	----	3.0	4.2	1.40
Crickets (Gryllidae)	0.6	**	----	2.0	**	-----
Leaf beetles (Chrysomelidae)	4.0	**	----	5.0	**	-----
Robber flies (Asilidae)	*	**	----	0.6	**	-----
Tiger moths & Footman moths (Arctiidae)	*	**	----	*	**	-----

* no availability
** no consumption

obtained in summer with 65 collected in Unit I and 24 from Unit II. Additional birds from Unit I represent spring (17), fall (3), and winter (2), and from Unit II three more birds (one from spring, two from winter). Wolfberry and rose were most important and there appeared to be a high selectivity for these species. They appeared in quantities below one percent for both units yet ranked one and two, respectively, as to importance. Although cultivated crops rated number one on the basis of crop analysis by volumetric comparison, they were fifth and third for Units I and II respectively based on index values. Short-horned grasshoppers rated first (Unit I) and second (Unit II) by volume but their index values indicated that their consumption was approximately in proportion to their abundance. No apparent selectivity was observed for insects; their use being determined by availability.

Using summer availability data, index values for 18 sharptails from spring (Unit I) indicated a preference for succulent green material (dandelion, clovers, alfalfa, Anemone sp., and grasses).

CONCLUSIONS

Significant differences ($P < .05$) were found for most species of vegetation in grassland types of Units I, II, and III. Although grassland in Units I and III were the most comparable, they could not be called similar. Grassland in Unit II, short-grass area, differed the most from grassland in Unit I. The abundance of gumweed (42.8 percent) indicated that over-grazing occurred in Unit II.

Brushy draws in Units I and III differed significantly ($P < .05$). Draws in Unit III were characterized by coniferous species, whereas, draws in Unit I contained all broadleaf deciduous trees and shrubs. There was a total lack of brushy draws on the study plot in Unit II. Hawthorn, an important food item in late fall and winter, was very scattered throughout Unit III.

Variability between replications in Unit IV was attributed to density. Tree and shrub densities in rep. 2 were greater than in rep. 1.

Although frequency determination for vegetation was carried out rapidly perhaps the clip-and-weigh method for grasses and forbs and density figures for trees and shrubs would have yielded more adequate figures. Differences in habitats sampled indicate that plant availability should be determined for the specific area on

which habitat improvements are to be made. There are certain groups of foods which are mutually replaceable by others in terms of availability, as suggested by Hungerford (1957). Determination of these groups would prevent costly attempts at habitat improvement in areas where these species occur.

Insect data showed that only long-horned grasshoppers (Tettigoniidae) differed significantly ($P < .05$) between grassland types.

Food analysis of 659 prairie grouse showed that dandelion ranked first in importance for sharptails during spring, with cultivated crops second. Insects became important in the diet during summer for adults as well as young of both grouse species, and cultivated crops were second in importance. During fall, cultivated crops ranked first for both grouse species, with fruits and berries also being taken more often. Little budding was in evidence during winter and cultivated crops ranked first in the diet of sharp-tailed grouse. The appearance of insects in the winter diet was attributed to warm weather.

Adequate numbers of sharptails were collected during summer, but spring, fall, and winter collections were not substantial. Since availability of food items is limited during spring and winter, a true picture of their diet is probably represented in

this study. Because few prairie chickens were collected during spring, winter and fall, their diet was not adequately determined during the seasons.

Summer food preferences for 48 adult sharp-tailed grouse indicated selectivity for rose hips, wolfberry fruits, and clovers. There was some selectivity for walking sticks but most index values indicated that insect consumption was in approximate proportion to their abundance. Food-preference indices for all seasons would have been arrived at if vegetation had been sampled during all seasons.

Sharptail habitat is characterized by brushland, used as nesting cover, during molting, and as fall and winter approaches for fruits and greens. On overgrazed ranges, draws were devoid of woody species and grouse populations were correspondingly low. Essential habitat requirements for sharp-tailed grouse, grassland and brushy draws, are present in nearly all of western South Dakota. These habitats, however, are often overgrazed. Suggested management practices to effectively increase sharptail populations are : (1) exclosures around key sites, mainly brushy draws, to prevent trampling and overuse of important species by cattle, (2) reduction in number of cattle on overgrazed ranges, and (3) possible planting of hawthorn, Russian olive, and western buffaloberry where none of these exist.

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APPENDICES

Appendix A. Insects encountered in sweeping transects.

Odonata
- Lestidae
  - *Lestes* sp.
- Coenagrionidae

Orthoptera
- Acrididae
  - *Melanoplus femur-rubrum*
  - *M. dawsoni*
  - *M. sanguinipes sanguinipes*
  - *M. keeleri luridus*
  - *M. differentialis*
  - *M. fasciatus*
  - *M. bivittatus*
  - *M. packardii*
  - *M.* sp. (nymph)
  - *Trachyrhachys kiowa kiowa*
  - *Phoetaliotes nebrascensis*
  - *Opeia obscura*
  - *Arphia pseudonietana*
  - *Camnula pellucida*
  - *Orphulella speciosa*
  - *Spharagemon collare*
  - *Mermiria maculipennis macclungi*
  - *Brachystola magna*
  - *Dactylotum pictum*
  - *Daihinia brevipes*
  - *Amphitornus coloradus coloradus*
  - *Hesperottetix speciosus*
- Tettigoniidae
  - *Conocephalus saltans*
- Gryllidae
  - *Oecanthus quadrimaculatus*
- Phasmidae
  - *Diapheroma velii*

Hemiptera
- Miridae
  - *Phytocoris* sp.
  - *Adelphocoris* sp.
  - *Polymerus* sp.

Appendix A. (continued)

Hemiptera
- Reduviidae
- Nabidae
  - *Nabis ferus*
  - *N. alternatus*
- Lygaeidae
  - *Nysisus* sp.
  - *Lygaeus* spp.
  - *L. kalmii*
- Corimelaenidae
  - *Allocoris pulicaria*
- Scutelleridae
  - *Homaenus parvulus*
  - *H. bijugis*
- Pentatomidae
  - *Thyanta custator*
  - *T.* sp.
  - *Peribalus limbolarius*
  - *Neottiglossa humidifrons*

Homoptera
- Membracidae
  - *Campylenchia latipes*
  - *C. bubalus*
  - *Ceratolobus inermis*
  - *Stictocephala bubalus*
- Cercopidae
  - *Lepyronia gibbosa*
  - *Philaronia bilineata nigricans*
- Cicadellidae
  - *Keonolla dolebrata*
  - *Macropsis trivialis*
- Fulgoridae
  - *Scoleps sulipes*
- Acanaloniidae
  - *Acanalonia bivattata*

Neuroptera
- Chrysopidae
  - *Chrysopa* sp.

Appendix A. (continued)

Coleoptera
- Carabidae
  - *Pterostichus corvus*
  - *Cratacanthus dubius*
  - *Amara impuneticollis*
  - *Lebia atriventris*
  - *Pasimachus elongatus*
- Histeridae
  - *Spilodiscus militaris*
- Melyridae
  - *Collops quadromaculatus*
- Elateridae
  - *Limonius ursinus*
  - *Ludius inflatus*
- Coccinellidae
  - *Hippodamia* spp.
- Meloidae
  - *Epicauta maculata*
- Tenebrionidae
  - *Eleodes opaca*
  - *E. tricostata*
- Scarabaeidae
  - *Phyllophaga portoricensis*
- Cerambycidae
  - *Tetraopes femoralus*
- Chrysomelidae
  - *Delyola guttata*
  - *Jonthonata nigripes*
  - *J. ellipsis*
  - *Agroiconata bivittata*
  - *Disonycha punctigera*
  - *D. admirabilis*
  - *D. triangularis*
  - *Leptinotarsa lineolata*
  - *Monoxia inornata*
  - *Cryptocephala venustus*
  - *Paria thoracica*
  - *Zygogramma suturalis casta*
  - *Systena elongata*
  - *Blepharida rhois*
  - *Nodonota tristis*
  - *Graphops beryllinus*
  - *Ophraella americana*
  - *O. cribrata*

Appendix A. (continued)

Coleoptera
  Curculionidae
    Bradyrhynchoides constrictus
    Thecesternus humeralis
    Tanymecus confusus
    Sphenophorus placidus
    Ophryastes vittatus
    Pantomorus elegans elegans
    Brachyrhinus sulcatus

Lepidoptera
  Pieridae
    Pieris rapae
  Nymphalidae
  Hesperiidae
  Sphingidae
  Nolidae
  Arctiidae
  Noctuidae
  Geometridae
  Pyralidae
  Pterophoridae
  Ethmiidae

Diptera
  Tabanidae
  Asilidae
    Protacanthus milbertii
  Tephritidae
    Tephritis bella
  Anthomyiidae
    Proboscimyia sp.
    Allomyella sp.

Hymenoptera
  Tenthredinidae
  Ichneumonidae
  Formicidae
    Formica fusca
    F. obscuripes

Diplopoda (Millipedes)

Chilopoda (Centipedes)

Araneida (Spiders)

Appendix B. Spring foods of 45 sharp-tailed grouse from eight western South Dakota counties, 1965-67.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Common dandelion (Taraxacum officinale) heads & leaves	26	57.8	92.0	57.0
Yellow sweet clover (Melilotus officinalis) leaves	2	4.4	19.0	11.4
Corn (Zea mays)	4	8.9	12.2	7.6
Small-seeded false flax (Camelina microcarpa) pods	1	2.2	11.0	6.8
Wind-flower (Anemone sp.) flowers	1	2.2	4.3	2.7
Rose (Rosa arkansana) hips	4	8.9	2.8	1.7
Grass	11	24.4	2.2	1.4
Alfalfa (Medicago sativa)	7	15.6	1.7	1.1
Green leaf material	5	11.1	1.7	1.1
Wheat (Triticum aestivum)	1	2.2	1.7	1.1
Clovers (Trifolium spp.)	2	4.4	1.3	0.8
Oats (Avena sativa)	2	4.4	1.0	0.6
Western buffaloberry (Shepherdia argentea) leaves	2	4.4	1.0	0.6
Sorghum (Sorghum vulgare)	2	4.4	0.8	0.5
Wild buckwheat (Polygonum convolvulus) leaves	3	6.7	0.7	0.4
Sedge (Carex spp.) spikes	2	4.4	0.6	0.4
Goatsbeard (Tragopogon major)	1	2.2	0.5	0.3
Barley (Hordeum vulgare)	2	4.4	0.4	0.3
Wolfberry (Symphoricarpos occidentalis) fruit	2	4.4	0.4	0.3
Umbelliferae sp. umbel	1	2.2	0.1	0.1
Horsetail (Equisetum sp.) stems	1	2.2	0.1	0.1
Prickly lettuce (Lactuca Serriola) leaves	1	2.2	0.1	0.1
Yellow wild parsley (Lomatium foeniculaceum) seeds	1	2.2	tr	tr

Appendix B. (continued)

Food Item	Frequency		Volume	
	No.	%	cc.	%
Crickets (Gryllidae)	1	2.2	3.5	2.2
Short-horned grasshoppers (Acrididae)	1	2.2	1.5	0.9
Ants (Formicidae)	2	4.4	0.3	0.2
Snails	1	2.2	0.2	0.1
Noctuid moth (Noctuidae) larvae	1	2.2	0.1	0.1
Leaf beetles (Chrysomelidae)	3	6.7	0.1	0.1
Millipede	1	2.2	tr	tr
Beetles (Carabidae)	1	2.2	tr	tr
Ladybird beetles (Coccinellidae)	2	4.4	tr	tr
White, sulfur, orange-tip (Pieridae) larvae	1	2.2	tr	tr
Totals			161.3	100.0

Appendix C. Spring foods of 18 sharp-tailed grouse from Unit I, 1966-67.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Common dandelion (Taraxacum officinale) heads	13	72.2	39.1	50.9
Clovers (Trifolium spp.)	1	5.6	15.0	19.5
Alfalfa (Medicago sativa)	5	27.8	9.6	12.5
Wheat (Triticum aestivum)	1	5.6	5.5	7.1
Oats (Avena sativa)	2	11.1	3.2	4.2
Corn (Zea mays)	4	22.2	1.9	2.5
Wind-flower (Anemone sp.) flowers	1	5.6	1.5	2.0
Grass	5	27.8	0.4	0.5
Sow thistle (Sonchus arvensis) leaves	1	5.6	0.3	0.4
Green leaf material	2	11.1	tr	tr
Barley (Hordeum vulgare)	1	5.6	tr	tr
Noctuid moth (Noctuidae) larvae	1	5.6	0.2	0.3
Ants (Formicidae)	1	5.6	0.1	0.1
Click beetles (Elateridae)	1	5.6	tr	tr
Short-horned grasshoppers (Acrididae)	1	5.6	tr	tr
Totals			76.8	100.0

Appendix D. Summer foods of 120 young (3 weeks - 18 weeks) sharp-tailed grouse from eight western South Dakota counties, 1965-67.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Rose (Rosa arkansana) hips	10	8.3	39.8	5.9
Barley (Hordeum vulgare)	4	3.3	37.6	5.5
Wheat (Triticum aestivum)	8	6.7	32.4	4.8
Skunkbush sumac (Rhus trilobata) fruit	12	10.0	22.1	3.3
Wolfberry (Symphoricarpos occidentalis) fruit	11	9.2	18.3	2.7
Prostrate knotweed (Polygonum aviculare) flowers	2	1.7	17.0	2.5
Prickly lettuce (Lactuca Serriola) heads	17	14.2	15.2	2.2
Green leaf material	15	12.5	13.2	1.9
Hawthorn (Crateagus sp.) fruit	3	2.5	11.9	1.8
Goatsbeard (Tragopogon major) heads	19	15.8	10.4	1.5
Common dandelion (Taraxacum officinale) heads	4	3.3	6.4	0.9
Willow (Salix sp.) leaves	1	0.8	6.0	0.9
Yellow sweet clover (Melilotus officinalis) leaves	8	6.7	5.8	0.9
Grass	9	7.5	5.4	0.8
Clovers (Trifolium spp.)	1	0.8	4.0	0.6
Chokecherry (Prunus virginiana) fruit	2	1.7	3.6	0.5
Alfalfa (Medicago sativa)	4	3.3	3.1	0.5
Buffalo grass (Buchloe dactyloides) female spikes	3	2.5	1.2	0.2
Russian olive (Elaeagnus angustifolia) fruit	1	0.8	1.0	0.1
Poison ivy (Rhus radicans) fruit	1	0.8	0.7	0.1
Wild buckwheat (Polygonum convolvulus) seeds	2	1.7	0.7	0.1
Bushy knotweed (Polygonum ramosissimum) leaves	2	1.7	0.6	0.1
Annual sunflower (Helianthus annuus) seeds	2	1.7	0.5	0.1
Insect galls	1	0.8	0.5	0.1
Blue lettuce (Lactuca pulchella) heads	1	0.8	0.4	0.1
Small-seeded false flax (Camelina microcarpa) pods	3	2.5	0.3	tr

Appendix D. (continued)

Food Item	Frequency		Volume	
	No.	%	cc.	%
Lepidoptera pupae	3	2.5	0.5	0.1
Snails	8	6.7	0.4	0.1
Hymenoptera sp.	2	1.7	0.4	0.1
Treehoppers (Membracidae)	8	6.7	0.4	0.1
Lygaeid bugs (Lygaeidae)	3	2.5	0.3	tr
Measuringworm (Geometridae) larvae	1	0.8	0.2	tr
Shield-backed bugs (Scutelleridae)	6	5.0	0.2	tr
Snout beetles (Curculionidae)	5	4.2	0.2	tr
Narrow-winged damselflies (Coenagrionidae)	3	2.5	0.2	tr
Homoptera sp. nymph	1	0.8	0.1	tr
Ants (Formicidae)	15	12.5	0.1	tr
Typical sawfly (Tenthredinidae) larvae	1	0.8	tr	tr
Centipede	1	0.8	tr	tr
Deer flies (Tabanidae)	1	0.8	tr	tr
Tiger moth (Arctiidae) larvae	1	0.8	tr	tr
Soft-winged flower beetles (Melyridae)	2	1.7	tr	tr
Planthoppers (Fulgoridae)	1	0.8	tr	tr
Negro bugs (Corimelaenidae)	2	1.7	tr	tr
Ladybird beetles (Coccinellidae)	7	5.8	tr	tr
Leafhoppers (Cicadellidae)	10	8.3	tr	tr
Neuroptera sp.	1	0.8	tr	tr
Totals			419.5	100.0

Appendix D. (continued)

Food Item	Frequency		Volume	
	No.	%	cc.	%
Green foxtail (Setaria viridis) spikes	2	1.7	0.3	tr
Yellow foxtail (Setaria lutescens) spikes	2	1.7	0.2	tr
Oats (Avena sativa)	2	1.7	0.1	tr
Corn (Zea mays)	1	0.8	0.1	tr
Wild vetch (Vicia americana) leaves	1	0.8	tr	tr
Low stickseed (Lappula Redowskii) flowers	1	0.8	tr	tr
Unidentified buds	1	0.8	tr	tr
Puccoon (Lithospermum canescens) seeds	1	0.8	tr	tr
Unidentified plant material	1	0.8	tr	tr
Short-horned grasshoppers (Acrididae)	86	71.7	377.6	55.7
Long-horned grasshoppers (Tettigoniidae)	36	30.0	14.3	2.1
Noctuid moth (Noctuidae) larvae	21	17.5	7.7	1.1
Robber flies (Asilidae)	8	6.7	3.2	0.5
Stink bugs (Pentatomidae)	14	11.7	2.2	0.3
Beetles (Carabidae)	8	6.7	1.9	0.3
Leaf beetles (Chrysomelidae)	30	25.0	1.8	0.3
White, sulfur, orange-tip (Pieridae) larvae	5	4.2	1.5	0.2
Crickets (Gryllidae)	4	3.3	1.5	0.2
Hornworm (Sphingidae) larvae	2	1.7	1.1	0.2
Spiders	7	5.8	0.7	0.1
Planthoppers (Acanaloniidae)	7	5.8	0.7	0.1
Walking sticks (Phasmidae)	1	0.8	0.7	0.1
Darkling beetles (Tenebrionidae)	4	3.3	0.6	0.1
Ethmiid moth (Ethmiidae) larvae	1	0.8	0.5	0.1
Brush-footed butterfly (Nymphalidae) larvae	1	0.8	0.5	0.1

Appendix E. Summer foods of 43 young sharp-tailed grouse (3 weeks - 18 weeks) from Units I and II, 1966-67.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Oats (Avena sativa)	4	9.3	37.5	16.2
Hawthorn (Crateagus sp.) fruit	2	4.7	29.5	12.7
Green foxtail (Setaria viridis) spikes	8	18.6	17.0	7.3
Wheat (Triticum aestivum)	5	11.6	16.6	7.2
Barley (Hordeum vulgare)	3	7.0	13.6	5.9
Rose (Rosa arkansana) hips	4	9.3	10.2	4.4
Alfalfa (Medicago sativa)	3	7.0	4.4	1.9
Prickly lettuce (Lactuca Serriola) heads	2	4.7	2.4	1.0
Wolfberry (Symphoricarpos occidentalis) fruit	1	2.3	2.0	0.9
Unidentified flower heads	1	2.3	2.0	0.9
Common dandelion (Taraxacum officinale) heads	1	2.3	0.9	0.4
Yellow sweet clover (Melilotus officinalis) leaves	1	2.3	0.9	0.4
Grass	3	7.0	0.7	0.3
Insect galls	2	4.7	0.5	0.2
Chokecherry (Prunus virginiana) leaves	1	2.3	0.5	0.2
Goatsbeard (Tragopogon major) heads	1	2.3	0.4	0.2
Unidentified plant material	2	4.7	0.3	0.1
Skunkbush sumac (Rhus trilobata) fruit	2	4.7	0.3	0.1
Blue lettuce (Lactuca pulchella) heads	1	2.3	0.1	tr
Ridge-seeded spurge (Euphorbia glyptosperma) head	1	2.3	0.1	tr
Wild buckwheat (Polygonum convolvulus) seeds	2	4.7	0.1	tr
Silverberry (Elaeagnus commutata) leaf	1	2.3	tr	tr
Unidentified green leaf	2	4.7	tr	tr

Appendix E. (continued)

Food Item	Frequency No.	Frequency %	Volume cc.	Volume %
Buffalo grass (Buchloe dactyloides) female spike	1	2.3	tr	tr
Common dandelion leaves	1	2.3	tr	tr
Small-seeded false flax (Camelina microcarpa) pods	1	2.3	tr	tr
Short-horned grasshoppers (Acrididae)	29	67.4	78.1	33.6
Ethmiid moth (Ethmiidae) larvae	2	4.7	1.9	0.8
Darkling beetles (Tenebrionidae)	2	4.7	1.5	0.6
Unidentified insects	2	4.7	1.5	0.6
Stink bugs (Pentatomidae)	9	20.9	1.3	0.6
Lepidoptera pupae	4	9.3	1.2	0.5
Long-horned grasshoppers (Tettigoniidae)	3	7.0	1.2	0.5
Hornworm (Sphingidae) larvae	2	4.7	1.0	0.4
Noctuid moth (Noctuidae) larvae	5	11.6	0.9	0.4
Leaf beetles (Chrysomelidae)	8	18.6	0.9	0.4
Measuringworm (Geometridae) larvae	2	4.7	0.8	0.3
Typical sawfly (Tenthreninidae) larvae	1	2.3	0.4	0.2
White, sulfur, orange-tip (Pieridae) larvae	2	4.7	0.4	0.2
Spiders	2	4.7	0.3	0.1
Walking sticks (Phasmidae)	1	2.3	0.3	0.1
Ichneumon flies (Ichneumonidae)	1	2.3	0.1	tr
Snout beetles (Curculionidae)	1	2.3	0.1	tr
Crickets (Gryllidae)	1	2.3	0.1	tr
Beetles (Carabidae)	6	14.0	0.1	tr

Appendix E. (continued)

Food Item	Frequency		Volume	
	No.	%	cc.	%
Damsel bugs (Nabidae)	2	4.7	tr	tr
Planthoppers (Acanaloniidae)	1	2.3	tr	tr
Treehoppers (Membracidae)	1	2.3	tr	tr
Ladybird beetles (Coccinellidae)	2	4.7	tr	tr
Ants (Formicidae)	7	16.3	tr	tr
Skipper (Hesperiidae) larvae	1	2.3	tr	tr
Leaf bugs (Miridae)	1	2.3	tr	tr
Totals			232.1	99.6

Appendix F. Summer foods of 48 adult sharp-tailed grouse from Unit I, 1966-67.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Wheat (Triticum aestivum)	18	37.5	74.5	27.0
Rose (Rosa arkansana) hips	11	22.9	40.6	14.7
Prickly lettuce (Lactuca Serriola) heads	20	41.7	38.2	13.9
Annual sunflower (Helianthus annuus) seeds	3	6.3	20.5	7.4
Goatsbeard (Tragopogon major) heads	7	14.6	19.0	6.9
Oats (Avena sativa)	1	2.1	17.0	6.2
Wolfberry (Symphoricarpos occidentalis) fruit	9	18.8	14.4	5.2
Alfalfa (Medicago sativa)	8	16.7	11.7	4.2
Grass	17	35.4	10.2	3.7
Barley (Hordeum vulgare)	1	2.1	9.0	3.3
Clovers (Trifolium spp.)	3	6.3	3.3	1.2
Yellow sweet clover (Melilotus officinalis) leaves	2	4.2	1.7	0.6
Wild buckwheat (Polygonum convolvulus) seeds	9	18.8	1.7	0.6
Common dandelion (Taraxacum officinale) heads	2	4.2	0.6	0.2
Small-seeded false flax (Camelina microcarpa) pods	2	4.2	0.5	0.2
Prickly lettuce leaves	3	6.3	0.5	0.2
Poison ivy (Rhus radicans) fruit	1	2.1	0.4	0.1
Green foxtail (Setaria viridis) spikes	5	10.4	0.3	0.1
Unidentified plant material	2	4.2	0.3	0.1
Rose leaves	2	4.2	0.3	0.1
Peppergrass (Lepidium sp.) pods	1	2.1	0.2	0.1
Green leaf material	2	4.2	tr	tr

Appendix F. (continued)

Food Item	Frequency		Volume	
	No.	%	cc.	%
Short-horned grasshoppers (Acrididae)	11	22.9	8.2	3.0
Walking sticks (Phasmidae)	1	2.1	0.9	0.3
Spiders	2	4.2	0.8	0.3
Long-horned grasshoppers (Tettigoniidae)	1	2.1	0.2	0.1
Noctuid moth (Noctuidae) larvae	1	2.1	0.1	tr
Plume moth (Pterophoridae) larvae	1	2.1	0.1	tr
Lygaeid bugs (Lygaeidae)	1	2.1	0.1	tr
Shield-backed bugs (Scutelleridae)	2	4.2	0.1	tr
Leaf bugs (Miridae)	1	2.1	0.1	tr
Treehoppers (Membracidae)	1	2.1	0.1	tr
Leaf beetles (Chrysomelidae)	1	2.1	0.1	tr
Stink bugs (Pentatomidae)	1	2.1	tr	tr
Damsel bugs (Nabidae)	1	2.1	tr	tr
Ladybird beetles (Coccinellidae)	1	2.1	tr	tr
Ants (Formicidae)	1	2.1	tr	tr
Hemiptera nymphs	1	2.1	tr	tr
Totals			275.7	99.7

Appendix G. Summer foods of 68 adult sharp-tailed grouse and one adult prairie chicken from ten western South Dakota counties, 1966-67.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Goatsbeard (Tragopogon major) heads	18	26.5	45.0	14.8
Common dandelion (Taraxacum officinale) heads	11	16.2	40.8	13.4
Alfalfa (Medicago sativa)	16	23.5	19.6	6.4
Rose (Rosa arkansana) hips	3	4.4	18.9	6.2
Serviceberry (Amelanchier sp.) fruit	1	1.5	16.0	5.3
Wheat (Triticum aestivum)	9	13.2	15.7	5.2
Prickly lettuce (Lactuca Serriola) heads & leaves	9	13.2	13.2	4.3
Wolfberry (Symphoricarpos occidentalis) fruit	3	4.4	12.0	3.9
Hawthorn (Crateagus sp.) fruit	1	1.5	11.0	3.6
Skunkbush sumac (Rhus trilobata) fruit & buds	2	2.9	6.1	2.0
Small-seeded false flax (Camelina microcarpa) pods	3	4.4	5.9	1.9
Yellow sweet clover (Melilotus officinalis) leaves	5	7.4	5.8	1.9
Green leaf material	13	19.1	4.7	1.5
Chokecherry (Prunus virginiana) fruit	1	1.5	4.2	1.4
Wild buckwheat (Polygonum convolvulus) flowers & leaves	4	5.9	2.6	0.9
Barley (Hordeum vulgare)	1	1.5	2.5	0.8
Blue lettuce (Lactuca pulchella) leaves	1	1.5	2.0	0.7
Bur oak (Quercus macrocarpa) acorn	1	1.5	1.5	0.5
Oats (Avena sativa)	2	2.9	1.4	0.5
Bushy knotweed (Polygonum ramosissimum) flowers	2	2.9	0.9	0.3
Field bindweed (Convolvulus arvensis) pods	1	1.5	0.9	0.3
Grass	5	7.4	0.7	0.2

Appendix G. (continued)

Food Item	Frequency No.	Frequency %	Volume cc.	Volume %
Peppergrass (Lepidium sp.) pods	1	1.5	0.7	0.2
Marsh vetchling (Lathyrus palustris) leaves	1	1.5	0.3	0.1
Insect galls	1	1.5	0.3	0.1
Annual sunflower (Helianthus annuus) seeds	1	1.5	0.1	tr
Green foxtail (Setaria viridis) spikes	1	1.5	0.1	tr
Clovers (Trifolium spp.)	1	1.5	0.1	tr
Buffalo grass (Buchloe dactyloides) female spikes	1	1.5	tr	tr
Gaura (Gaura coccinea) seeds	1	1.5	tr	tr
Short-horned grasshoppers (Acrididae)	20	29.4	60.9	20.0
Leaf beetles (Chrysomelidae)	15	22.1	4.0	1.3
Walking sticks (Phasmidae)	1	1.5	1.5	0.5
Crickets (Gryllidae)	3	4.4	1.1	0.4
Beetles (Carabidae)	2	2.9	0.9	0.3
Noctuid moths (Noctuidae)	6	8.8	0.9	0.3
Long-horned grasshoppers (Tettigoniidae)	1	1.5	0.4	0.1
Lepidoptera pupae	1	1.5	0.4	0.1
White, sulfur, orange-tip (Pieridae) larvae	1	1.5	0.4	0.1
Robber flies (Asilidae)	2	2.9	0.4	0.1
Shield-backed bugs (Scutelleridae)	1	1.5	0.2	0.1
Neuroptera sp.	1	1.5	0.1	tr
Stink bugs (Pentatomidae)	1	1.5	0.1	tr
Lygaeid bugs (Lygaeidae)	2	2.9	0.1	tr
Treehoppers (Membracidae)	2	2.9	0.1	tr

Appendix 3. (continued)

Food Item	Frequency No.	Frequency %	Volume cc.	Volume %
Ladybird beetles (Coccinellidae)	6	8.8	0.1	tr
Hemiptera nymphs	2	2.9	tr	tr
Leaf bugs (Miridae)	2	2.9	tr	tr
Leafhoppers (Cicadellidae)	3	4.4	tr	tr
Snout beetles (Curculionidae)	1	1.5	tr	tr
Fruit flies (Trupaneidae)	1	1.5	tr	tr
Centipede	1	1.5	tr	tr
Spiders	2	2.9	tr	tr
Totals			304.6	100.0

Appendix H. Gizzard contents of 81 adult and young sharp-tailed grouse from summer, 1966-67.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Rose (Rosa spp.) seeds	78	96	102.6	31.4
Unidentified plant material	66	81	81.9	25.1
Corn (Zea mays)	15	19	18.3	5.6
Miscellaneous items	81	100	15.3	4.7
Poison ivy (Rhus radicans) seeds	23	28	15.2	4.7
Sorghum (Sorghum vulgare)	7	9	11.9	3.6
Wolfberry (Symphoricarpos occidentalis) seeds	56	69	11.6	3.6
Wheat (Triticum aestivum)	11	14	10.5	3.2
Oats (Avena sativa)	7	9	9.2	2.8
Western buffaloberry (Shepherdia argentea) seeds	3	4	6.6	2.0
Green foxtail (Setaria viridis) seeds	17	21	6.0	1.8
Hawthorn (Crateagus spp.) seeds	5	6	5.2	1.6
Wild buckwheat (Polygonum convolvulus) seeds	17	21	4.0	1.2
Yellow sweet clover (Melilotus officinalis) seeds	29	36	3.9	1.2
Skunkbush sumac (Rhus trilobata) seeds	12	15	3.0	0.9
Unidentified animal material	44	54	9.3	2.8
Short-horned grasshoppers (Acrididae)	18	22	5.1	1.6
Noctuid moth (Noctuidae) larvae	1	1	0.5	0.2
Beetles (Carabidae)	4	5	0.3	0.1
Walking sticks (Phasmidae)	1	1	0.2	0.1
Miscellaneous items	6	7	0.1	tr
Grit	41	51	5.8	1.8
Totals			326.5	100.0

Appendix I. Gizzard contents of 20 adult and young prairie chickens from summer, 1966-67.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Unidentified plant material	16	80	15.7	19.6
Rose (Rosa spp.) seeds	14	70	15.7	19.6
Yellow sweet clover (Melilotus officinalis) seeds	7	35	7.6	9.5
Sorghum (Sorghum vulgare)	6	30	7.5	9.4
Wheat (Triticum aestivum)	4	20	6.6	8.2
Wild buckwheat (Polygonum convolvulus) seeds	9	45	4.4	5.5
Wild grape (Vitis rupestris) seeds	2	10	2.9	3.6
Miscellaneous items	20	100	2.0	2.5
Oats (Avena sativa)	2	10	1.9	2.4
Poison ivy (Rhus radicans) seeds	4	20	1.3	1.6
Unidentified animal material	10	50	5.4	6.7
Short-horned grasshoppers (Acrididae)	5	25	5.1	6.4
Beetles (Carabidae)	1	5	0.1	tr
Grit	10	50	4.0	5.0
Totals			80.2	100.0

Appendix J. Fall foods of 24 sharp-tailed grouse from five western South Dakota counties, 1965-66.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Corn (Zea mays)	10	43.5	34.3	33.4
Sorghum (Sorghum vulgare)	5	21.7	15.8	15.5
Russian olive (Elaeagnus angustifolia) fruit	2	8.7	15.1	14.8
Hawthorn (Crateagus sp.) fruit	1	4.3	10.5	10.3
Barley (Hordeum vulgare)	1	4.3	5.7	5.6
Grass	10	43.5	5.3	5.2
Wolfberry (Symphoricarpos occidentalis) fruit & buds	4	17.4	4.5	4.4
Western buffaloberry (Shepherdia argentea) fruit & leaves	4	17.4	4.2	4.1
Common dandelion (Taraxacum officinale) leaves	1	4.3	2.0	2.0
Chokecherry (Prunus virginiana) fruit	1	4.3	1.0	1.0
Silverberry (Elaeagnus commutata) fruit	1	4.3	0.8	0.8
Wheat (Triticum aestivum)	1	4.3	0.3	0.3
Oats (Avena sativa)	1	4.3	0.2	0.2
Rose (Rosa arkansana) hips	2	8.7	0.2	0.2
Prickly lettuce (Lactuca Serriola) leaf	1	4.3	tr	tr
Green leaf material	1	4.3	tr	tr
Short-horned grasshoppers (Acrididae)	1	4.3	1.4	1.4
Long-horned grasshoppers (Tettigoniidae)	1	4.3	0.6	0.6
Leaf beetles (Chrysomelidae)	1	4.3	0.2	0.2
Ants (Formicidae)	1	4.3	tr	tr
Click beetles (Elateridae)	1	4.3	tr	tr
Snout beetles (Curculionidae)	1	4.3	tr	tr
Totals			102.1	100.0

Appendix K. Fall foods of three sharp-tailed grouse from Units I and II, 1966-67.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Wolfberry (Symphoricarpos occidentalis) fruit	2	66.7	2.5	58.1
Grass	1	33.3	1.5	34.9
Wolfberry leaves	1	33.3	0.2	4.7
Wolfberry buds	1	33.3	0.1	2.3
Unidentified leaves	1	33.3	trace	trace
Totals			4.3	100.0

Appendix L. Winter foods of six sharp-tailed grouse from Units I and II, 1966-67.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Russian olive (Elaeagnus angustifolia) fruit	1	16.7	32.2	31.6
Wolfberry (Symphoricarpos occidentalis) fruit	3	50.0	22.8	22.4
Rose (Rosa arkansana) hips	2	33.3	14.3	14.0
Barley (Hordeum vulgare)	3	50.0	13.4	13.1
Cottonwood (Populus deltoides) buds	1	16.7	6.6	6.5
Wheat (Triticum aestivum)	3	50.0	6.3	6.2
Skunkbush sumac (Rhus trilobata) buds	1	16.7	3.0	2.9
Poison ivy (Rhus radicans) fruit	1	16.7	2.6	2.5
Skunkbush sumac fruit	1	16.7	0.4	0.4
Oats (Avena sativa)	1	16.7	0.3	0.3
Unidentified buds	1	16.7	0.1	0.1
Grass	1	16.7	tr	tr
Yellow sweet clover (Melilotus officinalis) seeds	1	16.7	tr	tr
Grit	1	16.7	0.2	0.2
Totals			102.0	100.0

Appendix M. Winter foods of 39 sharp-tailed grouse from six western South Dakota counties, 1966-67.

Food Item	Frequency		Volume	
	No.	%	cc.	%
Corn (Zea mays)	11	28.2	170.8	27.9
Sorghum (Sorghum vulgare)	14	35.9	110.8	18.2
Wolfberry (Symphoricarpos occidentalis) fruit & buds	10	25.6	88.7	14.5
Oats (Avena sativa)	8	20.5	58.1	9.5
Wheat (Triticum aestivum)	4	10.3	45.0	7.4
Grass	8	20.5	36.3	5.9
Rose (Rosa arkansana) hips	2	5.1	32.7	5.3
Wild buckwheat (Polygonum convolvulus) seeds	4	10.3	28.5	4.7
Green leaf material	4	10.3	14.1	2.3
Western buffaloberry (Shepherdia argentea) buds	1	2.6	7.0	1.1
Cottonwood (Populus deltoides) buds	3	7.7	3.8	0.6
Skunkbush sumac (Rhus trilobata) fruit & buds	3	7.7	2.3	0.4
Serviceberry (Amelanchier sp.) fruit	2	5.1	1.1	0.2
Chokecherry (Prunus virginiana) buds	1	2.6	1.0	0.2
Yellow sweet clover (Melilotus officinalis) seeds	4	10.3	0.7	0.1
Scurf pea (Psoralea tenuiflora) seeds	1	2.6	0.5	0.1
Unidentified buds	1	2.6	0.5	0.1
Green foxtail (Setaria viridis) spikes	1	2.6	0.2	tr
American elm (Ulmus americana) buds	1	2.6	0.2	tr
Mud-plantain (Alisma subcordatum) seeds	2	5.1	0.1	tr
Annual sunflower (Helianthus annuus) seeds	1	2.6	tr	tr
Short-horned grasshoppers (Acrididae)	3	7.7	4.7	0.8
Tiger moth (Arctiidae) larvae	2	5.1	4.4	0.7
Nolidae larvae	1	2.6	tr	tr
Totals			611.5	100.0