SUMMER HABITAT OF SHARP-TAILED GROUSE, *PEDIOECETES PHASIANELLUS* (LINNAEUS), IN THE NEBRASKA SANDHILLS

being

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by

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THESIS ABSTRACT

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The summer habitat of sharp-tailed grouse was studied in the Nebraska Sandhills during the summers of 1964 and 1965 to determine the importance of physiographic exposures, climatological factors, and vegetation to sharp-tailed grouse habitat preferences. Vegetation samples were taken where sharp-tailed grouse were observed and in areas of uniform vegetation on certain physiographic exposures. Climatological data were obtained from four stations during the summer of 1965.

Sharp-tailed grouse appear to select habitat types in the Sandhills that are most like their northern habitats. Displaying sharp-tailed grouse prefer open areas on relatively level ground; nesting sharp-tailed grouse pick rough topography with an abundance of previous years' vegetation; brooding sharp-tailed grouse select level or gentle terrain; and loafing sharp-tailed grouse choose steep slopes with half-shrubs in abundance.

This study is of value for formulating management plans concerning this upland game bird in an area of moderate sharp-tailed grouse population density.

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INTRODUCTION

A geographic contraction has occurred in the sharp-tailed grouse range during the twentieth century. This reduction has been brought about by man's misuse of the habitat through excessive grazing, cultivation, and forestation (Cahalane et al. 1942).

The objectives of the study are two-fold. First, characteristics of the summer habitat in the Nebraska Sandhills are evaluated. Secondly, the habitat actually used by the sharp-tailed grouse for their various activities is determined, and the type of habitat preferred by the grouse is delineated.

Much of the research concerning sharp-tailed grouse has been conducted in areas where sharp-tailed grouse are rare inhabitants (Ammann 1957; Grange 1948; Hamerstrom 1939; Hart, Lee, and Low 1950; Jones 1965). Habitat characteristics of sharp-tailed grouse that are recorded in most of these studies appear to be dissimilar to the habitat of the Nebraska Sandhills, and therefore, they may not be applicable to the Sandhills, a region of higher sharp-tailed grouse density.

This study, conducted in the Nebraska Sandhills, supplements the deficient information concerning sharp-tailed grouse in this area. It also provides additional information concerning desirable management measures for this upland game bird.

DESCRIPTION OF STUDY AREA

The area selected for study of sharp-tailed grouse habitat is located in Blaine and Thomas Counties, Nebraska (Figure 1). These counties are located in the north-central part of the state, lying near the center of the Nebraska Sandhills, which cover approximately one-fourth of the state (Bredemeier 1963) (Figure 2). The major portion of the data collected for this study was obtained in the Nebraska National Forest (Bessey Division). Environmental data were collected in a 13 year old Natural Area, with exact location SW¼, Sec. 3, T21N, R27W.

The Bessey Forest is composed of approximately 90,000 acres, an estimated 65,000 acres of which is native prairie. The remaining 25,000 acres are planted to coniferous trees of which more than half were destroyed by fire in May 1965.

The Sandhills are Pleistocene eolian dune sand derived from the Valentine and other Tertiary formations and from Pleistocene Grand Island and Holdrege sand and gravel sheets (Condra and Reed 1959). The Sandhills are underlain by impervious Oligocene Brule clay and Cretaceous Pierre shale formations that dip southeastward and promote the flowing of underground water and surface streams in a general southeastward direction (Burzlaff 1962; Condra and Reed 1959) (Figure 1). The hills and valleys, trending in a parallel northwest to southeast direction, are in many places irregular with the relief varying from a few feet to approximately 150 feet (Pool 1914; Weaver and Albertson 1956).

The summer climatic conditions in the Nebraska Sandhills are characterized by hot daytime temperatures, large daily temperature fluctuations, strong southerly winds, and a low relative humidity. The average annual precipitation recorded by the National Forest weather station is 19.89 inches, with approximately 40% of the yearly precipitation falling during the period of June through August (U. S. Weather Bureau 1964).

The dominant vegetation in the Sandhills is the bunch grass community (Weaver and Albertson 1956; Pool 1914). Jones (1964) states that the Sandhills, a unique grassland type in Nebraska, are composed of tall grasses, mid grasses, and species peculiar to sandy soils. The general appearance of the Sandhills is one of a homogeneous assemblage of grassland vegetation over large areas (Pound and Clements 1900). They note that every hill has the same general appearance as the next, and that the view may become monotonous to the observer.

REVIEW OF LITERATURE

Most research concerning the sharp-tailed grouse has been conducted in areas where these birds inhabit woody vegetation (Hamerstrom and Hamerstrom 1951a; Hamerstrom and Hamerstrom 1951b; Grange 1948; Ammann 1957). It is not known if their findings apply to the Nebraska Sandhills, as little research concerning sharp-tailed grouse ecology is available from this area. Viehmeyer (1941) states that the tall grass prairie in Nebraska is the only suitable sharp-tailed grouse habitat in the state. Mohler (1944) adds that few sharp-tailed grouse in Nebraska have been recorded outside the Sandhills.

Some work concerning the habitat of the sharp-tailed grouse in Nebraska was conducted by Kobriger (1965). He found that sharp-tailed grouse use wetland meadows to a large extent for breeding grounds and brooding habitat on the Valentine Wildlife Refuge. Another study concerning sharp-tailed grouse on a sandhills area was conducted by Aldous (1943) in North Dakota. Aldous concluded that sharp-tailed grouse apparently prefer shrubby vegetation and tall, relatively undisturbed, grassland. His habitat improvement suggestions for grouse in this area include a reduction of the grazing pressure on dune areas and a program for planting shrubs and trees on and around the dunes. Symington and Harper (n.d.) note that in

Saskatchewan, Canada, the best sharp-tailed grouse habitat occurs in the sandhills. They state that the topography of the Saskatchewan Sandhills prevents extensive agriculture, and the dry climate prevents intensive grazing; therefore, requisites for sharp-tailed grouse habitat prevail.

Hamerstrom and Hamerstrom (1951b) observed that sharp-tailed grouse require brushland to survive. Their studies in Wisconsin have shown that a combination of brush and open (non-woody) areas provide the best habitat for grouse. Grange (1948), in discussing Wisconsin's grouse problems, states that open areas are desired for grouse habitat. This type of arrangement includes grass, weed, and herbaceous cover over a broad expanse, with interspersed clumps of shrubby vegetation, saplings, and larger trees throughout the area. Ammann (1957) also records that prairie grouse [sharp-tailed grouse and greater prairie chickens, <u>Tympanuchus cupido</u> (Linnaeus)], are found primarily in open country. He found that sharp-tailed grouse inhabit every gradation in cover from treeless to wooded areas, but they are more prevalent in the treeless sites. Ammann notes that sharp-tailed grouse generally use a more brushy cover than prairie chickens.

Hamerstrom (1963) states that the habitat used for brooding by sharp-tailed grouse in Wisconsin is open areas rather than woody cover. Approximately 80% of the broods Hamerstrom encountered occurred in open areas, and another 14% were found in edge habitats, such as the outer 50-foot of woods, on roadsides passing through woods, openings in woods, or thickets in the open. He concluded that the ideal sharp-tailed grouse brooding habitat consists of grasslands with some shrubs and trees.

Jones (1963), in Oklahoma, studied specifically the habitat of the greater prairie chicken and the lesser prairie chicken, *Tympanuchus pallidicinctus* (Ridgeway). Jones (1965) also studied the sharp-tailed grouse habitat in Washington. The Du Rietz life form classification was utilized in both studies to analyze the habitats used by these species.

The vegetation, climate, and soils of the Nebraska Sandhills are well documented. Rydberg (1895) made an extensive survey of the vegetation of the Nebraska Sandhills, and Pool (1914) made the first descriptive study of vegetation and climatic factors in the Sandhills. Burzlaff (1962) described the Sandhill soils and discussed their effect on vegetation. Several other studies are of importance concerning the Sandhills prairie (Tolstead 1942; Frolick and Shepherd 1940; Bredemeier 1963; Jones 1964). None of these studies relates that sharp-tailed grouse inhabit the Sandhills.

METHODS

Environmental data were obtained from four climatological recording stations established at characteristic physiographic sites. A ridgetop, the adjacent valley floor to the south, and the north- and south-facing slopes of the valley were selected as typical physiographic sites. The two stations on the slopes were located near the midpoint of the slopes. Recordings were taken during June, July, and August of 1965.

Temperature and relative humidity were recorded by Bendix hygrothermographs. The hygrothermographs were placed in shelters that rested directly on the ground. Every Monday between 6:00 AM and 12:00 M the hygrothermograph charts were changed; the hygrothermograph temperature and relative humidity were checked by a thermometer and a Bendix hand aspirated psychrometer, respectively, and the proper adjustments were made to correct errors occurring in the hygrothermograph readings. At this time each hygrothermograph was moved to another station to minimize errors in the readings on any one site due to variations inherent in the hygrothermographs.

Evaporation rates were measured by Livingston atmometers placed approximately 24 inches above the soil surface. Approximately every three days each atmometer was checked, filled to a predetermined level, and the amount of water added was recorded. Each atmometer was checked occasionally against all others to calculate differences in evaporation rates.

Wind measurements were recorded by placing Bendix totalizing anemometers approximately 24 inches above the ground. Since only two anemometers were available, one anemometer was stationed on the ridgetop, and the other was placed on each of the other three stations for five-day periods. The wind on the ridgetop was given a 100% total wind movement value, and the readings obtained at each of the other stations were recorded as a per cent of the ridgetop value. Both anemometers were placed on the ridgetop periodically to compare and correct instrument recording differences.

Vegetation sampling was classified into three categories. First, homogeneous vegetational stands were sampled on various physiographic exposures characteristic of the Sandhills. Samples were categorized as occurring on north-facing slopes, south-facing slopes, ridgetops, and valley floors, which are the dominant physiographic exposures in the Sandhills. Secondly, shrubby vegetation environments were sampled for the purpose of comparing their habitat characteristics with those herbaceous environments. Thirdly, samples were taken on sharp-tailed grouse activity sites in an attempt to determine the preferred type of habitat for each sharp-tailed grouse activity, and to determine the importance of the specific components of the available habitat.

Herbaceous vegetation was sampled by the 3/4-inch loop method along a 50-foot line (Parker and Harris 1959). Because of the relatively sparse vegetation of the Sandhills, each loop was treated as a point in analyzing the vegetation. Height of plants hit along the transect was recorded, and at 5-foot intervals, incident light readings in foot candles were taken with a Brockway Model S exposure meter immediately above the vegetation and 4 inches above the ground so that per cent light intercepted by plants could be calculated. The range condition of each stand was calculated as described by Dyksterhuis (1949), and by Burzlaff (1961) for the Sandhills vegetation in the 20 to 24-inch rainfall belt. Other pertinent data recorded for each stand were physiographic exposure, degree of slope, soil type, and a list of plant species.

Shrubby vegetation was sampled by the line intercept method (Canfield 1941). Two transects of the line intercept method were taken on each shrub stand. One transect was placed 6 inches below the average height of the shrubs, and the other was placed at a level of half the average height of the shrubs. Height of shrubs was calculated by measuring the height at 5-foot intervals along the 50-foot transect and taking the mean of the 10 readings. Light readings were taken at 5-foot intervals using the previously described technique. The 3/4-inch loop method was used on the ground vegetation in shrubby stands. The procedure described previously for herbaceous vegetation sampling was employed on these stands except range condition was not calculated.

Herbage-mulch samples were collected by clipping the vegetation and picking up the litter in a one square foot plot and placing it in a paper sack. When the herbage-mulch had air dried, each sample was weighed and recorded.

The vegetation data of physiographic exposures and sharp-tailed grouse activity sites were summarized by calculating the per cent presence and the per cent composition of each plant species for each of the physiographic exposures and sharp-tailed grouse activities. Per cent presence (number of stands a species occurred / total number of stands sampled) (100) was calculated from a species list of each site. Per cent composition (number of individuals of a species recorded / total number of individuals recorded on all transects) (100) was calculated from the 3/4-inch loop data. These values, per cent presence and per cent composition, of each species were summed to give a relative importance index of each species for each sharp-tailed grouse activity and physiographic exposure. This index reveals the plants that are associated with a particular sharp-tailed grouse activity or a given physiographic exposure that may not be present in large quantities but, nevertheless, occur on a majority of the stands. Errors have been pointed out in the 3/4-inch loop sampling method (Hutchings and Holmgren 1959) which the relative importance index tends to minimize. A similar index was used in western North Dakota by Dix (1961), analyzing prairie vegetation with the point-centered quarter method.

Scientific names and authorities of plant species follow that of Winter (1936), Rydberg (1932), and Hitchcock and Chase (1950), and the scientific names of birds are authorized by the A.O.U. Checklist (1957).

RESULTS AND DISCUSSION

Climatological Factors

Data on four climatological factors--temperature, wind, relative humidity, and evaporation--were compiled to determine similarities and differences on physiographic exposures and possible effects on sharp-tailed grouse summer habitat selection in the Nebraska Sandhills. Temperature, wind, and evaporation normally reach their highest readings during the summer months. These are considered prime factors in influencing sharp-tailed grouse habitat preferences.

Precipitation on the National Forest during the study period was nearly normal. The long-term June average precipitation of 3.16 inches was exceeded by 1.20 inches. Precipitation during July exceeded the average of 2.28 inches by only 0.02 inches. August's precipitation was 0.25 inches below the mean precipitation of 2.72 inches (U. S. Weather Bureau 1965).

Temperature

A comparison of monthly temperatures during the summer (Figure 3) shows that the June temperatures were generally lower than those recorded during July and August. The average daily temperature range was less during June than during July and August. August had the highest average temperature and the highest daily temperature ranges. Comparable monthly temperature data were recorded at the weather station at the National Forest Headquarters (U. S. Weather Bureau 1965).

During August, the daily temperature minimums were considerably lower at the valley floor station than at the three other stations. Cold air drainage from the ridges into the valleys offers a possible explanation for this effect. The minimum temperatures recorded at the valley floor station during August were lower than the minimum temperatures recorded during same times of day at the other stations during June.

During the two warmest months (July and August), the ridgetop and south-facing slope had higher temperature readings than the valley floor and north-facing slope during the warmest part of the day (Figure 3). Throughout the study, the valley floor tended to be the coolest of the four stations during the highest daily temperature periods. During August, the maximum north-facing slope and valley floor temperatures were approximately the same, averaging about 2 to 4 F cooler than temperatures on the south-facing slope and ridgetop.

<u>Wind</u>

The wind velocity at the four physiographic stations maintained the same relationships during all three months of the study (Figure 4). The ridgetop received the greatest amount of wind; lesser quantities were recorded on the south-facing slope, valley floor, and north-facing slope in that order. Since the winds in the Sandhills are predominately southerly during the summer months (Weaver and Albertson 1956), the north-facing slope and valley floors are the most protected exposures from this environmental factor. Weaver and Albertson consider wind one of the most important factors affecting the vegetation in the Sandhills because originally it formed the hills, and through erosion is presently a constant menace.

Relative Humidity

During June, the mean monthly relative humidity minimums were higher than during July and August (Figure 5). During August the mean relative humidity minimum was lower than for June and July. The ridgetop and south-facing slope had the lowest relative humidity means of the four stations for all three months. In every month, the highest mean relative humidity minimum was attained on the north-facing slope.

Evaporation

The greatest amount of evaporation occurred on the ridgetop and the south-facing slope (Figure 6). A lesser amount of evaporation was recorded on the north-facing slope and the valley floor. Evaporation rates in the shrubs were greatly reduced being less than half that of the ridgetop and south-facing slope. Comparable data were recorded by Pool (1914) and Tolstead (1942) in the Sandhills.

Discussion

A summarization of data indicates that the four climatological factors are interrelated. The ridgetops and south-facing slopes receive the greatest amount of wind and have the highest temperatures of the four physiographic exposures. Associated with the higher temperatures and wind velocities on these exposures is a high rate of evaporation in comparison with the evaporation rates of the valley floors and north-facing slopes. Since there are lower relative humidity readings and higher temperature and wind values on the ridgetop and south-facing slope, the higher rates of evaporation on these exposures are expected.

Available Habitat

Herbaceous vegetation

The vegetation of the grassland communities in the Nebraska Sandhills is composed of a diversified flora; some species are characteristic of the True Prairie; others are representative of the Mixed Prairie, and many occur only in the sandy regions of the Central United States (Weaver and Albertson 1956). Bredemeier (1963) states that the soils of the Sandhills are homogeneous over broad areas and that the fine textured sandy soils absorb rainfall rapidly resulting in luxuriant vegetation. Weaver and Albertson (1956) state that vegetation gradually changes from dense stands in valleys to very sparsely covered areas on the hilltops; this is also represented in my data (Figure 7). They note that the vegetation density is associated with greater moisture content on areas of higher plant densities.

Burzlaff (1961; 1962) describes the soils and the characteristic range sites in the Sandhills. The three range sites that he classified that are related to this study are choppy sands, sands, and sandy sites. The choppy sands are stabilized dune sand with steep slopes on high hills. The sands range site is located on gentle, undulating hills without the steep slopes characteristic of the choppy sands, and the sandy range sites are positioned in the flat valleys between the choppy sands or sands range sites. The range sites of my sample areas are as follows: the ridgetops and approximately one-half of the north- and south-facing slopes were choppy sands; the sands range site was represented in samples taken on the other north- and south-facing slopes and on some valley floor sites; and sandy range sites occurred in low valley floors in the area.

The range condition of sands and sandy sites is significantly lower than the choppy sands. The range condition on the various physiographic exposures has this same relationship with the valley floors having significantly lower range condition than the ridgetops, north- and south-facing slopes (Figure 8). The effect of cattle grazing more extensively on the gentle terrain and their avoiding the steep slopes probably accounts for this lower range condition. Approximately half of the samples used for this analysis were taken in the Natural Area of the Nebraska National Forest (Bessey Division) that has been protected since 1952. Evidently, the areas presently exhibiting low range condition in this area have not had ample time to recover and return to climax condition.

The plant cover decreased from sandy to sands range sites, and from sands to choppy sands range sites (Figure 7). Ridgetops and south-facing slopes exhibit significantly lower plant cover than north-facing slopes, but the ridgetops and south-facing slopes are not significantly different from one another. In turn, north-facing slopes have a significantly lower plant cover index than valley floors.

Quantities of herbage-mulch vary significantly between the valley floors and the remaining three physiographic exposures; however, no significant differences arise among the latter sites (Figure 9).

Variations in height of plants and the per cent light intercepted are nonsignificant on the four physiographic exposures. Large variations of height and per cent light intercepted are found on each exposure, but the general uniformity of the bunch grass community (Pound and Clements 1900) may account for these nonsignificant variations on these exposures.

Burzlaff (1962) gives a detailed analysis of the soils in the Nebraska Sandhills. The silt-clay fraction of the soil is significantly greater in the sandy range site than on the sands range site. Organic matter contents of the soils are as follows: greatest in the sandy site, intermediate on the sands site, and smallest on the choppy sandhills site. Moisture constants, measured at tensions of 1/10 to 15 atmospheres (1/10 atmosphere representing field capacity and 15 atmospheres the lower limit at which moisture is available to plants), indicate that the water holding capacity in the sandy site is greater than that of the sands site, and the sands site has greater water holding capacity than choppy sandhills (Burzlaff 1962).

The luxuriant type of vegetation supported by the Sandhills soils is thought to be associated with the soil-moisture relationships. The high infiltration rate and approximately 70% of the precipitation falling during the growing season, in addition to little or no runoff, may account for this True Prairie flora in a climate that normally supports mixed grasses on areas of finer textured soils (Burzlaff 1962).

A comparison of exposures (Figure 10) indicates that the relative importance index of grasses on south- and north-facing slopes is greater than on the ridgetops and on valley floors. The greater per cent of forbs on the ridgetops and valley floors may be the result of overgrazing by cattle on the valley floors and the disturbing factor of stronger winds on the top of a stabilized dune. Shrub species are more prevalent on north-facing slopes than on any other exposure. The valley floors and south-facing slopes are characterized by a sparsity of shrubs.

Several differences in vegetation composition and relative importance of plant species exist on the physiographic exposures (Tables 1-4). On north-facing slopes, little bluestem (Andropogon scoparius) is the most important plant species, while on the south-facing slopes, it is the second most important. Little bluestem constitutes about one-third of the vegetation on north-facing slopes, and on the south-facing slopes this value is only approximately one-tenth of the composition. Tolstead (1942) states that little bluestem is a bunch grass growing predominately in the more favorable sandhills habitats.

Shrubby vegetation, prevailing on north-facing slopes, include Arkansas rose (Rosa pratincola), soap-weed (Yucca glauca), sandcherry (Prunus besseyi), lead plant (Amorpha canescens), and red-root (Ceonothus ovatus).

Other physiographic exposures support species more or less conspicuous to their particular area. The valley floors, having an abundance of forb species, commonly support large amounts of gray sagewort (Artemisia gnaphalodes). Several sedges (Carex spp. and Cyperus schweinitzii), comprising about one-third of the vegetation on this exposure, are important on this area, and switch grass (Panicum virgatum) reaches its greatest relative importance on the valley floors. Sand bluestem (Andropogon hallii) reaches its maximum importance on south-facing slopes and ridgetops. Since these physiographic exposures receive the greatest amount of desiccating wind during the summer, encounter highest temperatures and evaporation rates, and the lowest relative humidity, the relative importance of sand bluestem, a pioneer in successional areas between shifting sand to mature communities on protected slopes (Weaver and Albertson 1956), is expected.

Shrubby vegetation

The vegetation of the Sandhills consists primarily of the bunch grass community with a small per cent of shrub cover; however, shrubs must be considered as they may be of importance as loafing areas to sharp-tailed grouse during the summer months.

Shrubs, those woody plants possessing heights of 0.8 to 2 meters (Jones 1963, from Du Rietz 1931) are sometimes utilized by sharp-tailed grouse. The shrub composition and their influence on environmental factors is unknown in this area. Most vegetation studies of the Sandhills do not reveal the presence of shrub stands. However, Tolstead (1942) notes that shrubs sometimes form stands of several acres on the steep north-facing slopes of dunes, but no quantitative data are included.

Dominating shrub species in the Sandhills are eastern chokecherry (Prunus virginiana), buckbrush (Symphoricarpos occidentalis), and wild yellow plum (Prunus americana) (Table 5). Two willows, sandbar willow (Salix interior) and prairie willow (Salix humilis), also constitute definite stands in certain areas of the Sandhills.

Most shrubby stands are located on steep inclines (Table 6) and are positioned on north-facing slopes. Fifteen of 21 samples were obtained on this exposure.

No significant differences exist between per cent canopy cover of foliage 6 inches below the average height of the shrubs and at half the average height of the shrubs. However, the amount of light intercepted by the shrubs at various heights is significantly different at the two levels (Table 6). This vegetation type also intercepts a greater per cent of light than herbaceous vegetation on the various physiographic exposures.

The ground vegetation in shrubs is composed of several plant species that are often associated with woodland areas (Table 7). Several sedges compose approximately one-third of the per cent composition on the ground flora and maintain dominance on the importance index. Poison ivy (*Toxicodendron radicans*) constitutes the second most abundant species of the ground cover in shrubs.

The plant cover on the floor of shrub stands, being similar to herbaceous cover on ridgetops and south-facing slopes and significantly less than on north-facing slopes and valley floors, is relatively sparse (Figure 7).

Discussion of Available Habitat

The two distinct types of vegetation present in the Sandhills, herbaceous vegetation with interspersed half-shrubs and shrubby vegetation, vary considerably on the different physiographic exposures in the area. The north-facing slopes, and to some extent, the valley floors support a more mesic type of vegetation than ridgetops and south-facing slopes.

The soil-vegetation relationships (Burzlaff 1962) and the influence of wind on vegetation (Weaver and Albertson 1956) may account for some of the vegetational variations on the various physiographic exposures. Other climatological factors--temperature, relative humidity, and evaporation--may also influence the distribution of vegetation.

In grassland areas, rainfall influences the vegetation greatly (Weaver and Albertson 1956), and those areas that are adapted to conserve moisture support a more mesic type of vegetation. North-facing slopes and valley floors support vegetation of more moist climates than ridgetops and south-facing slopes. The north-facing slopes and valley floors receive less wind, experience lower temperatures and evaporation rates, and encounter higher average relative humidity values than the south-facing slopes and ridgetops. Certain plants are adapted to take advantage of this mesic habitat, and through competition they are able to inhabit these areas.

The preceding sections characterize the habitat available for sharp-tailed grouse in a region of the Sandhills where lakes and wetland meadows are practically nonexistent. Both climatic factors and vegetational composition vary considerably on the various physiographic exposures, and in the following section, consideration of portions of available habitat actually used by sharp-tailed grouse are delineated.

Sharp-tailed Grouse Summer Habitat

The sharp-tailed grouse activities that are considered in this study are displaying, nesting, brooding, and loafing. Displaying activities by male sharp-tailed grouse occur on areas established permanently for this activity, and re-used for many breeding seasons. Displaying occurs in the spring, beginning in March and continuing until mid-June, and again in the fall, from September into November. During the spring displaying period, female sharp-tailed grouse visit the display grounds, mate, and leave to begin nesting activities.

Sharp-tailed grouse nesting activities normally occur during May and June. The nesting period is followed in the reproductive sequence by a brooding period that involves the hen and her young. This relationship between the hen and young lasts until late August or early September. The adult male sharp-tailed grouse do not enter into the nesting and brooding activities. Instead, they spend much of the time during the summer months in groups of one to six individuals in areas that are categorized in this paper as loafing sites. As re-nesting is not a common occurrence, the males are probably joined in this activity by females that do not breed in the spring or encounter unsuccessful nesting attempts.

Habitat samples of the four sharp-tailed grouse activities were taken in areas where birds were encountered and flushed. The following is an attempt to describe and interpret the habitat for each of the activities.

Display grounds

The display grounds of the sharp-tailed grouse in the Nebraska National Forest (Bessey Division) are located on disturbed grassland areas that are usually on level or gentle rolling topography in the sands range site. Twenty-nine of the 30 display grounds sampled are on small hills that are surrounded by relatively level ground. The range condition of the display ground sites is fair and is significantly lower than the range condition used for any other sharp-tailed grouse activity considered in this study (Figure 8). Ammann (1957) found comparable display ground habitats of sharp-tailed grouse in Michigan. He notes that display grounds are usually located in unobstructed areas of the habitat that are not characteristic of the vegetation in the area as a whole.

Plant cover on display grounds is not significantly different than plant cover on the other activity sites (Figure 7). However, height of the plants on display grounds is characteristically short (Figure 11); consequently, the amount of light intercepted by these plants is also significantly lower than on the other sites (Figure 12). Also, display grounds, due to a reduction of litter, are characterized by significantly less ground cover than the other activity sites (Figure 13).

Vegetational aspects of the sharp-tailed grouse display grounds are characterized by relatively few shrubby plants and an abundance of grasses and forbs that invade and increase in response to grazing by cattle (Burzlaff 1961) (Figure 14). Sedges, sand drop-seed (Sporobolus cryptandrus), a variety of forbs, and hairy grama (Bouteloua hirsuta) contribute the greatest per cent composition of the vegetation. Other plant species having high relative importance indices on displaying areas are western ragweed (Ambrosia psilostachya), prairie sandreed (Calamovilfa longifolia), little bluestem, and western prickly pear (Opuntia humifusa) (Table 8).

Nesting Habitat

Nesting sharp-tailed grouse tend to perform this activity on the north- or east-facing slopes of large hills. Approximately 75% of the 33 nests observed and sampled were located on these physiographic exposures. The actual nest is a scratched, hollow form in the ground lined with grasses, litter, and feathers. The slope inclination for sharp-tailed grouse nesting sites is significantly greater than the slopes used for displaying (Figure 15). The steep, sloping topography used by nesting sharp-tailed grouse is usually located in excellent condition range.

The amount of ground covered with vegetation and litter on nesting areas is significantly greater than the ground cover index of display grounds and is similar to the ground cover values obtained on the other activity sites (Figure 13). Grazing by domestic livestock apparently does not affect the sharp-tailed grouse nesting habitat as most nests are located in range where current grazing is slight or moderate.

By comparing vegetation of the activity sites, this suggests that sharp-tailed grouse nesting sites are characterized by a large per cent of grass, a relatively low per cent of forbs, and a moderate per cent of shrubs (Figure 14). Vegetation of previous years is an important component of the nesting cover as approximately 19% of the total vegetation composition encountered in sampling was previous years' growth. Little bluestem, a bunch grass, appears to be an important species around nesting sites. The data indicate that this grass constitutes approximately one-fifth of the total vegetation composition on the nesting areas. Other important species around nesting areas are prairie sandreed, several sedges, sand lovegrass (Eragrostis trichodes), and sand bluestem (Table 9). Two shrubs, Arkansas rose and soap-weed, provide additional cover and are characteristic and important components of sharp-tailed grouse nesting areas.

Brooding habitat

Sharp-tailed grouse brood activities are performed in areas characterized by level or gently rolling terrain in predominately herbaceous vegetation (Figure 14). Most of the 41 brooding sites examined are located in or near valley floors, usually situated in the sands range site where the range is in good condition (Figure 8). Kobriger (1965) found broods utilizing wetland meadows on the Valentine Wildlife Refuge in the Nebraska Sandhills. The study area in Blaine and Thomas Counties is practically void of wetland meadows, but the valley and gently rolling low areas of this region may provide similar habitat requisites for sharp-tailed grouse brooding as do the wetland meadows in the Valentine Wildlife Refuge.

A comparison of the habitat of brooding sites with other sharp-tailed grouse activity habitats indicates certain similarities and differences. The steepness of slope used for brooding activities is significantly less than nesting and similar to the displaying areas (Figure 15). Plant cover on brooding areas is significantly greater than on nesting areas, but it is similar to plant cover on other activity sites (Figure 7). The height of plants and light interception are significantly greater than on nesting and displaying habitats (Figures 11 and 12). Ground cover on this site (Figure 13) does not deviate from ground cover values on nesting sites but does differ significantly from the displaying areas which are on similar topography.

A comparison of the general vegetation characteristics of brooding sites with other activity areas, indicates that brooding sites contain a relatively low per cent of grasses, a relatively high per cent of forbs, and a low to moderate amount of shrubs (Figure 14). Sedges rank highest in relative importance while prairie sandreed, western ragweed, Arkansas rose, and needle-and-thread (*Stipa comata*) are also prominent (Table 10). Forbs, comprising approximately 42% of the relative importance index of the vegetation on brooding sites, are an important component of sharp-tailed grouse brooding habitat.

Loafing habitat

Adult sharp-tailed grouse that are not actively raising a brood during the summer apparently spend much of their time in loafing areas. They select areas that have moderate climatological characteristics. These birds are inactive, unless flushed, and spend most of the daylight period resting and dusting.

Loafing sharp-tailed grouse activity sites are topographically similar to nesting areas. They tend to loaf on the steeper slopes of the Sandhills, and of the 51 loafing sites encountered, over 60% faced a northerly direction on both choppy sands and sands range sites.

The range condition on loafing areas is most generally in high-good or excellent condition. Both range condition and steepness of slope are significantly greater than brooding and displaying habitats (Figures 8 and 15).

The height of the vegetation and the amount of light it intercepts on loafing areas are significantly greater than on nesting sites, even though similar topography and range conditions are used for both activities (Figures 11 and 12). On loafing areas, approximately 11% of the vegetation is growth of previous seasons; whereas, on nesting sites the previous seasons' growth accounts for about 19% of the vegetation composition.

The vegetation of the loafing sites, compared to other activity sites, is characterized by relatively low to moderate percentages of grasses and forbs, and a relatively large percentage of shrubby vegetation (Figure 14). Several sedges and little bluestem constitute over one-third of the total composition of loafing sites (Table 11). Shrub species that are extremely important on loafing areas include, Arkansas rose, lead plant, sand cherry, soap-weed, poison ivy, and red-root.

<u>Discussion</u>

Displaying habitats are located in areas that provide the sharp-tailed grouse with maximum visual opportunities while they are engrossed in displaying and in a state of unwariness. This type of habitat gives the sharp-tailed grouse a clear view of the surrounding country so that a predator would have to appear in the open before arriving on the display ground. The short vegetation on the display ground is also probably important because no hinderance of movement is experienced by displaying males.

Climatological factors in the Nebraska Sandhills may influence sharp-tailed grouse brooding, loafing, and possibly nesting habitat preferences. This region is near the southern extension of the sharp-tailed grouse range, and it is conceivable that sharp-tailed grouse would select habitat locations that resemble habitats in their northern ranges. The valley floors and north-facing slopes are locations, where sharp-tailed grouse activities occur, that have environmental conditions similar to their northern range. These two exposures offer a greater amount of protection from hot temperatures, high evaporation rates, high wind velocities, and low relative humidity that occur on the ridgetops and south-facing slopes.

Nesting habitat, characterized by relatively large percentages of old growth, provides concealment for the incubating hen. Since little current season's vegetation growth has occurred at this stage in the growing season, the presence of previous seasons' vegetation on steep slopes appears to be a factor in sharp-tailed grouse nesting success in the Sandhills.

The low, gentle terrain of the brooding habitat may be less hazardous to the young sharp-tailed grouse than the steep and relatively high physiographic exposures. Also, Hamerstrom (1963), working with the sharp-tailed grouse broods in Wisconsin, and Jones (1963), dealing with greater prairie chicken habitat in Oklahoma, indicate that forbs are important components of prairie grouse habitat because they support an abundance of insect life. These authorities suggest that a plentiful insect supply is a food requirement for the young sharp-tailed grouse and prairie chicken.

It is evident that sharp-tailed grouse are directed to the shrub component of the Sandhills vegetation for their loafing activities. Almost all shrub species occurring in herbaceous vegetation in the Sandhills could be placed in the half-shrub category of the Du Rietz life form classification used by Jones (1963; 1965) in evaluating prairie chicken habitat in Oklahoma and sharp-tailed grouse habitat in Washington, respectively. The loafing grouse appear to take advantage of the microclimate in the half-shrub and shrub areas to a greater extent than do sharp-tailed grouse for any of the other summer activities considered in this study. The shrub areas, most generally located on north-facing slopes, provide the greatest amount of shade and appear to buffer climatological factors more than any other type of area in the Sandhills prairie.

SUMMARY

Sharp-tailed grouse summer habitat characteristics were studied in the Nebraska Sandhills in Blaine and Thomas Counties, Nebraska. This area, composed of Pleistocene eolian dune sand, supports a luxuriant type of grassland vegetation that is unusual in areas of similar climate. The physiography of the Sandhills is characterized by northwest-southeast trending ridges and valleys with the relief ranging from a few feet to about 150 feet.

Climatological factors typical in the Sandhills are hot summers with large fluctuations between the daily high and low, strong southerly winds, high evaporation, low relative humidity, and the bulk of the precipitation falling during the growing season. Ridgetops and south-facing slopes exhibit higher temperatures and evaporation rates, greater wind movement, and lower relative humidity than the valley floors and north-facing slopes.

The Sandhills vegetation is characterized by a general uniformity of the bunch grass community over large areas. The valley floors usually support an abundance of forbs, and the north-facing slopes are characterized by the predominance of shrub and half-

shrub species. The dominant species on all exposures are the grasses that constitute the bunch grass community.

Sharp-tailed grouse displaying, nesting, brooding, and loafing habitats are similar in some respects and unique in others. Displaying sharp-tailed grouse use disturbed, open types of habitat that do not appear to be characteristic of the bunch grass community as a whole. Most display grounds are located on gentle terrain on small hills. Nesting sharp-tailed grouse use steep slopes that support an abundance of vegetation of previous growing seasons. Brooding occurs on gentle terrain characterized by plentiful forb occurrence. Loafing habitats are usually found on steep slopes with substantial amounts of shrubs and half-shrubs.

In general, north-facing slopes and valley floors are utilized by sharp-tailed grouse to a greater extent than ridgetop and south-facing slopes. Since most of the range of sharp-tailed grouse is in cooler climates with a greater occurrence of shrubs than occurs in the Sandhills, their utilization of valley floors and north-facing slopes is expected.

Table 1. Presence and composition percentages, and the relative importance index of the flora of ridge top exposures.[a]

Species	Per cent Presence	Per cent Composition	Relative Importance
Carex spp.[b]	100.0	20.2	120.2
Eragrostis trichodes	88.9	25.8	114.7
Andropogon scoparius	100.0	11.2	111.2
Andopogon hallii	100.0	7.6	107.6
Ambrosia psilostachya	100.0	2.8	102.8
Calamovilfa longifolia	88.9	5.1	94.0
Eriogonum annuum	88.9	0.8	89.7
Yucca glauce	88.9	0.0	88.9
Helianthus petiolaris	77.8	0.6	78.4
Tradescantia occidentalis	77.8	0.6	78.4
Bouteloua hirsuta	66.7	6.7	73.4
Laythrus ornatus	66.7	3.1	69.8
Prunus besseyi	66.7	1.1	67.8
Opuntia humifusa	66.7	0.0	66.7
Ceanothus ovatus	55.6	0.6	56.2
Rosa pratincola	55.6	0.0	55.6
Sporobolus cryptandrus	44.4	7.6	52.0

[a]A complete listing of plant species is not included for each exposure and sharp-tail activity classification.
[b]Carex spp. includes Cyperus schweinitzii, Carex heliophila, and C. eleocharis

Table 2. Presence and composition percentages, and the relative importance index of the flora of south-facing slopes.

Species	Per cent Presence	Per cent Composition	Relative Importance
Carex spp.	93.8	20.6	114.4
Andropogon scoparius	100.0	11.4	111.4
Eragrostis trichodes	93.8	16.3	110.1
Andropogon hallii	100.0	8.9	108.9
Calamovilfa longifolia	90.6	13.0	103.6
Ambrosia psilostachya	96.9	3.2	100.1
Opuntia humifusa	84.4	0.0	84.4
Rosa pratincola	78.1	3.2	81.3
Panicum scribnerianum	71.9	1.9	73.8
Eriogonum annuum	71.9	0.3	72.2
Helianthus petiolaris	59.4	0.4	59.8
Sporobolus cryptandrus	56.2	3.5	59.7
Commelina virginica	56.2	0.8	57.0
[illegible]	53.1	0.0	53.1

Table 3. Presence and composition percentages, and the relative importance index of the flora of valley floors.

Species	Per cent Presence	Per cent Composition	Relative Importance
Carex spp.	100.0	36.6	136.6
Ambrosia psilostachya	100.0	3.3	103.3
Calamovilfa longifolia	88.9	3.8	92.7
Sporobolus cryptandrus	66.7	8.8	75.5
Artemisia gnaphalodes	66.7	6.4	73.1
Eragrostis trichodes	66.7	5.1	71.8
Andropogon scoparius	55.6	10.5	66.1
Opuntia humifusa	66.7	0.3	67.0
Panicum virgatum	55.6	5.1	60.7
Plantago purshii	55.6	2.1	57.7
Lepedium densiflorum	55.6	1.9	57.5
Chenopodium leptophyllum	55.6	0.3	55.9
Eriogonum annuum	55.6	0.0	55.6
Rosa pratincola	55.6	0.0	55.6

Table 4. Presence and composition percentages, and the relative importance index of the flora of north-facing slopes.

Species	Per cent Presence	Per cent Composition	Relative Importance
Andropogon scoparius	96.9	32.3	129.2
Eragrostis trichodes	93.8	20.6	114.4
Carex spp.	96.9	10.5	107.4
Ambrosia psilostachya	96.9	3.1	100.0
Andropogon hallii	84.4	2.9	87.3
Calamovilfa longifolia	71.9	7.0	78.9
Rosa pratincola	75.0	1.2	76.2
Opuntia humifusa	75.0	0.0	75.0
Eriogonum annuum	75.0	0.0	75.0
Panicum scribnerianum	68.8	1.5	70.3
Sorghastrum nutans	65.6	1.9	67.5
Yucca glauca	65.6	0.1	65.7
Prunus besseyi	62.5	0.7	63.2
Helianthus rigidus	59.4	1.7	61.1
Sporobolus cryptandrus	50.0	2.1	52.1

Table 5. Per cent composition of shrubs at two height levels based on line interception data.

Species	6 inches below average shrub height	One-half shrub height
Prunus virginianus	56.1	46.0
Symphoricarpos occidentalis	31.2	36.0
Prunus americana	11.0	8.5
Amorpha canescens	0.5	3.4
Rosa pratincola	0.5	1.8
Toxicodendron radicans	---	1.6
Salix spp.	0.4	1.1
Others	0.3	1.6

Table 6. Confidence intervals of various factors from the analysis of shrubby vegetation.

Factor	$\bar{x} \pm s_{\bar{x}} \cdot 2$
Degree Slope	16.81 ± 3.97
Height of Shrubs	39.95 ± 4.68
Per cent canopy cover 6" below average shrub height	14.61 ± 3.28
Per cent canopy cover one-half average shrub height	21.87 ± 4.47
Per cent light intercepted 6" below average shrub height	18.61 ± 3.80
Per cent light intercepted one-half shrub height	40.52 ± 5.83

Table 7. Presence and composition percentages, and the relative importance index of the ground flora of shrubby stands.

Species	Per cent Presence	Per cent Composition	Relative Importance
Carex spp.	90.5	36.4	126.9
Ambrosia psilostachya	100.0	5.0	105.0
Rosa pratincola	81.0	2.2	83.2
Andropogon scoparius	66.7	6.9	73.6
Chenopodium leptophyllum	71.4	0.6	72.0
Toxicodendron radicans	61.9	7.7	69.6
Prunus virginianus	57.1	5.2	62.3
Eragrostis trichodes	57.1	3.5	60.6
Physalis heterophylla	52.4	1.2	53.6
Artemisia gnaphalodes	52.4	0.3	52.7
Commelina virginiana	47.6	3.5	51.1
Panicum scribnerianum	47.6	1.9	49.5
Helianthus petiolaris	47.6	0.6	48.2
Amorpha canescens	42.9	1.2	44.1
Prunus besseyi	42.9	0.0	42.9

Table 8. Presence and composition percentages, and the relative importance index of the flora of sharp-tailed grouse display grounds.

Species	Per cent Presence	Per cent Composition	Relative Importance
Carex spp.	90.0	21.9	111.9
Ambrosia psilostachya	80.0	4.9	84.9
Sporobolus cryptandrus	70.0	10.8	80.8
Andropogon scoparius	70.0	4.7	74.7
Calamovilfa longifolia	70.0	4.6	74.6
Opuntia humifusa	70.0	0.4	70.4
Amorpha canescens	50.0	1.1	51.1
Bouteloua hirsuta	40.0	8.3	48.3

Table 9. Presence and composition percentages, and the relative importance index of the flora of sharp-tailed grouse nesting sites.

Species	Per cent Presence	Per cent Composition	Relative Importance
Andropogon scoparius	100.0	18.9	118.9
Calamovilfa longifolia	97.0	14.2	111.2
Carex spp.	97.0	13.1	110.1
Eragrostis trichodes	90.9	13.0	103.9
Andropogon hallii	93.9	5.1	99.0
Sporobolus cryptandrus	84.8	7.4	92.2
Ambrosia psilostachya	81.8	3.0	84.8
Rosa pratincola	75.8	1.1	76.9
Opuntia humifusa	69.7	0.0	69.7
Bouteloua hirsuta	60.6	4.7	65.3
Yucca glauca	63.6	0.2	63.8
Helianthus rigidus	57.6	1.1	58.7
Stipa comata	54.6	3.1	57.7
Lithospermum gmelini	54.6	0.0	54.6

Table 10. Presence and composition percentages, and the relative importance index of the flora of sharp-tailed grouse brooding sites.

Species	Per cent Presence	Per cent Composition	Relative Importance
Carex spp.	97.5	21.2	118.7
Calamovilfa longifolia	85.3	10.9	96.2
Ambrosia psilostachya	90.2	3.5	93.7
Rosa pratincola	73.1	2.4	75.5
Stipa comata	65.8	9.0	74.8
Panicum scribnerianum	70.7	2.4	73.1
Andropogon scoparius	65.8	4.4	70.2
Sporobolus cryptandrus	58.5	6.3	64.8
Eragrostis trichodes	51.2	5.9	57.1
Panicum virgatum	53.6	2.0	55.6
Amorpha canescens	51.2	3.6	54.8
Opuntia humifusa	53.7	0.1	53.8
Erigeron canadensis	51.2	1.6	52.8
Artemisia gnaphalodes	48.8	1.2	50.0

Table 11. Presence and composition percentages, and the relative importance index of the flora of sharp-tailed grouse loafing sites.

Species	Per Cent Presence	Per Cent Composition	Relative Importance
Carex spp.	86.3	21.1	107.4
Andropogon scoparius	78.4	14.0	92.0
Ambrosia psilostachya	88.2	2.6	90.8
Rosa pratincola	82.4	3.0	85.4
Calamovilfa longifolia	72.6	8.1	80.7
Eragrostis trichodes	70.6	8.2	78.8
Andropogon hallii	68.6	3.2	71.8
Sporobolus cryptandrus	60.8	6.1	66.9
Amorpha canescens	52.9	2.4	55.3
Stipa comata	49.0	5.0	54.0
Panicum scribnerianum	49.0	3.8	52.8
Panicum virgatum	49.0	2.9	51.9

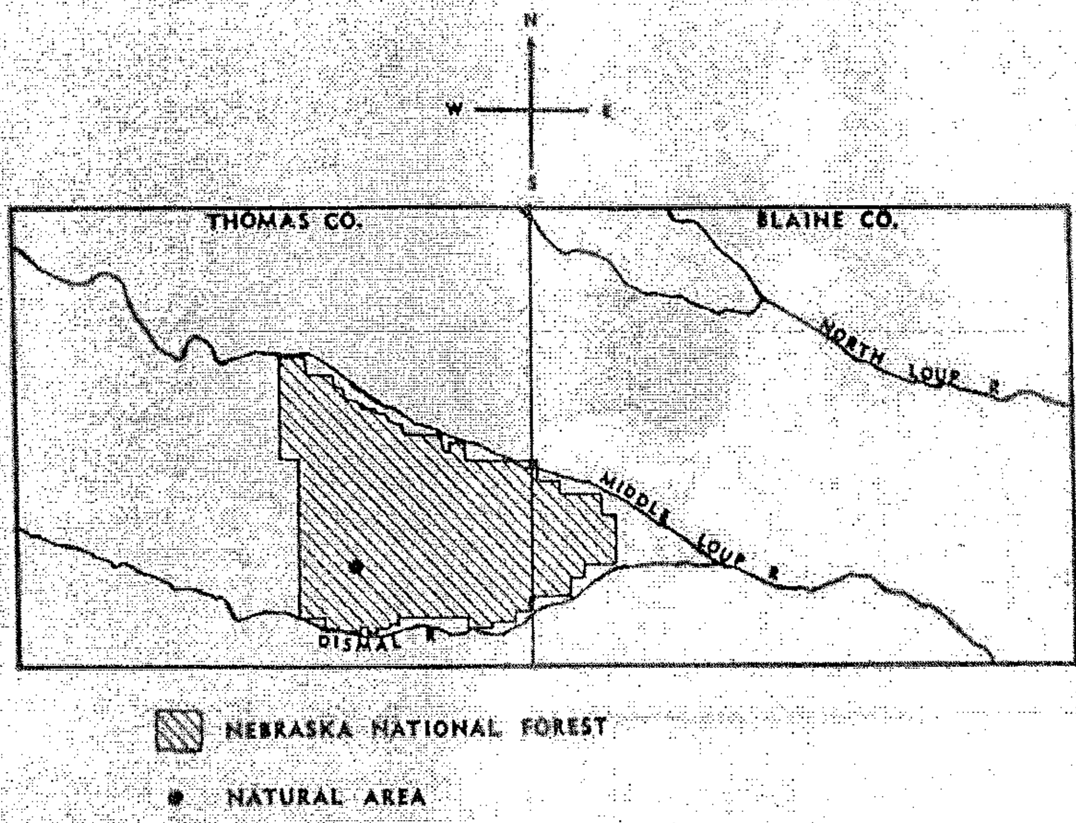

Figure 1. Diagram of study area showing position of the Nebraska National Forest, Natural Area, and directions in which rivers flow.

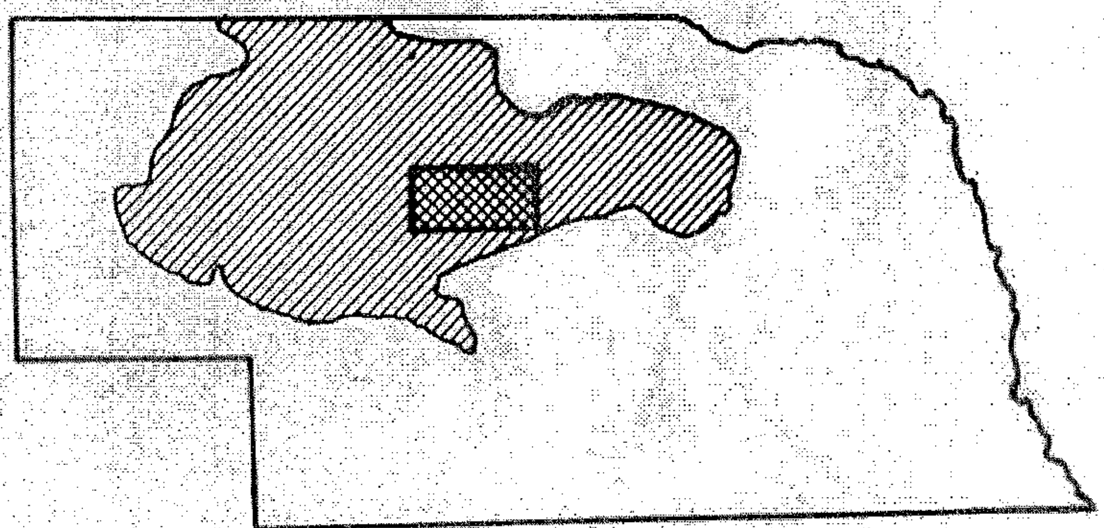

Figure 2, Diagram of Nebraska showing approximate area of the Sandhills and location of study area within the sandhills.

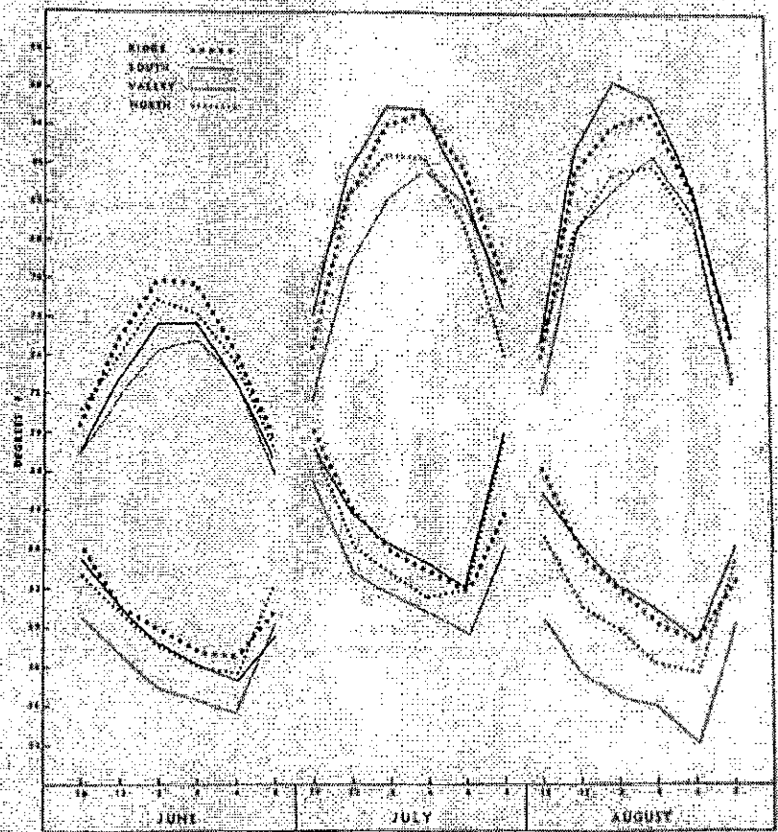

Figure 3. Summary of monthly temperature means at 2-hour intervals at four climatological stations. Upper series of four lines indicate time period between 10:00 A.M. and 8:00 P.M. Lower series of lines are for the time period occurring from 10:00 P.M. until 8:00 A.M. Ridge-ridgetop, south - south-facing slope, valley - valley floor, and north - north-facing slope.

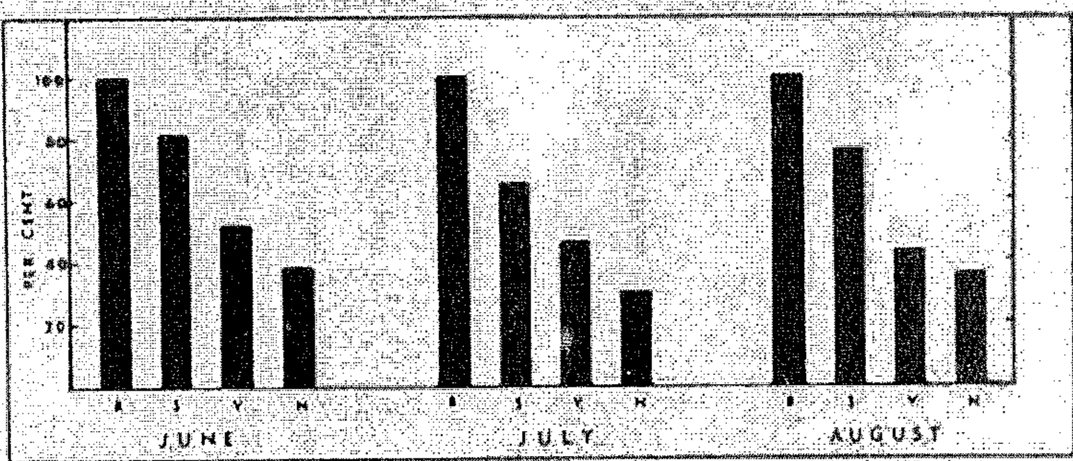

Figure 4. Relative wind movement at four climatological stations. R-ridgetop, s - south-facing slope, v - valley floor, and n - north-facing slope.

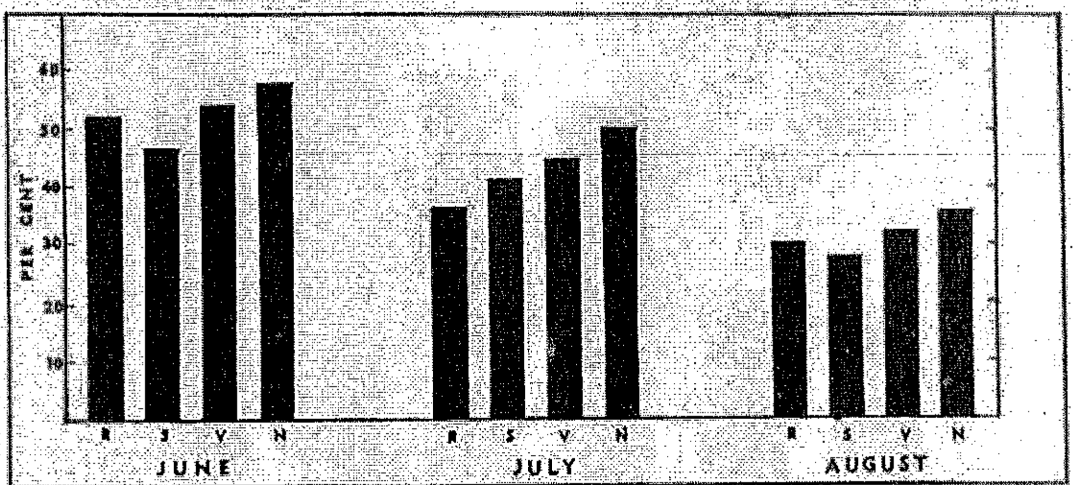

Figure 5. Mean monthly relative humidity minimum at four climatological stations. R-ridgetop, s - south-facing slope, v - valley floor, n - north-facing slope.

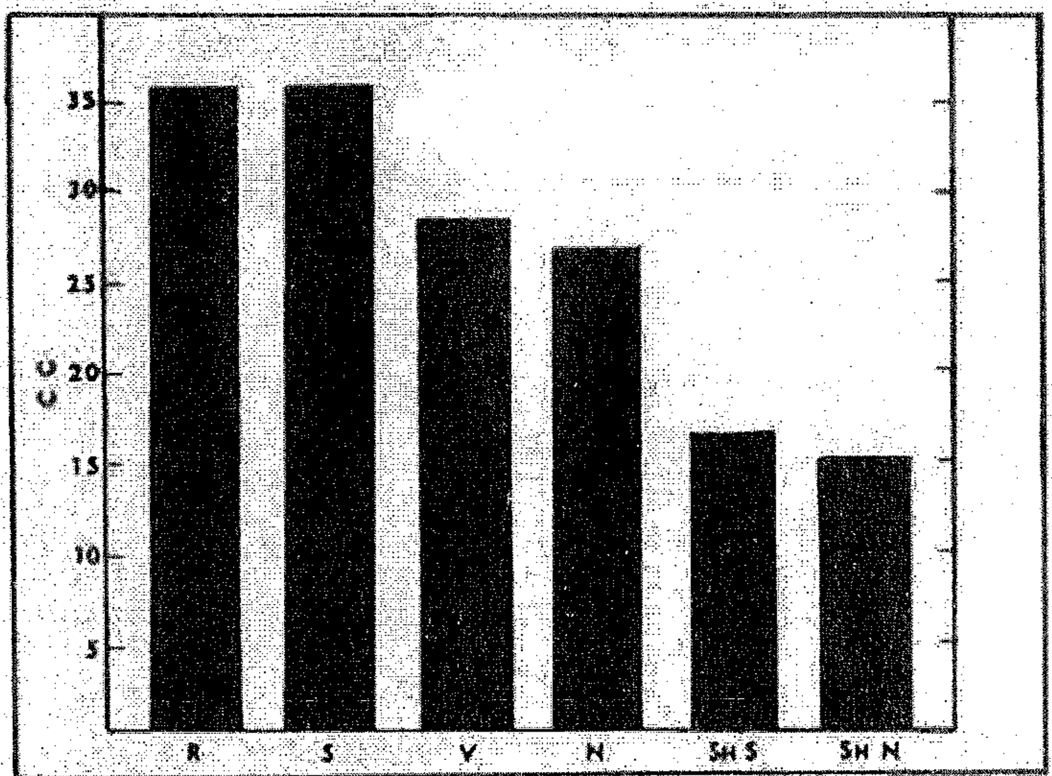

Figure 6. Daily evaporation means on several climatological stations. R-ridgetop, s - south-facing slope, v - valley floor, n - north-facing slope, shs - shrubs on south-facing slope, shn - shrubs on north-facing slope.

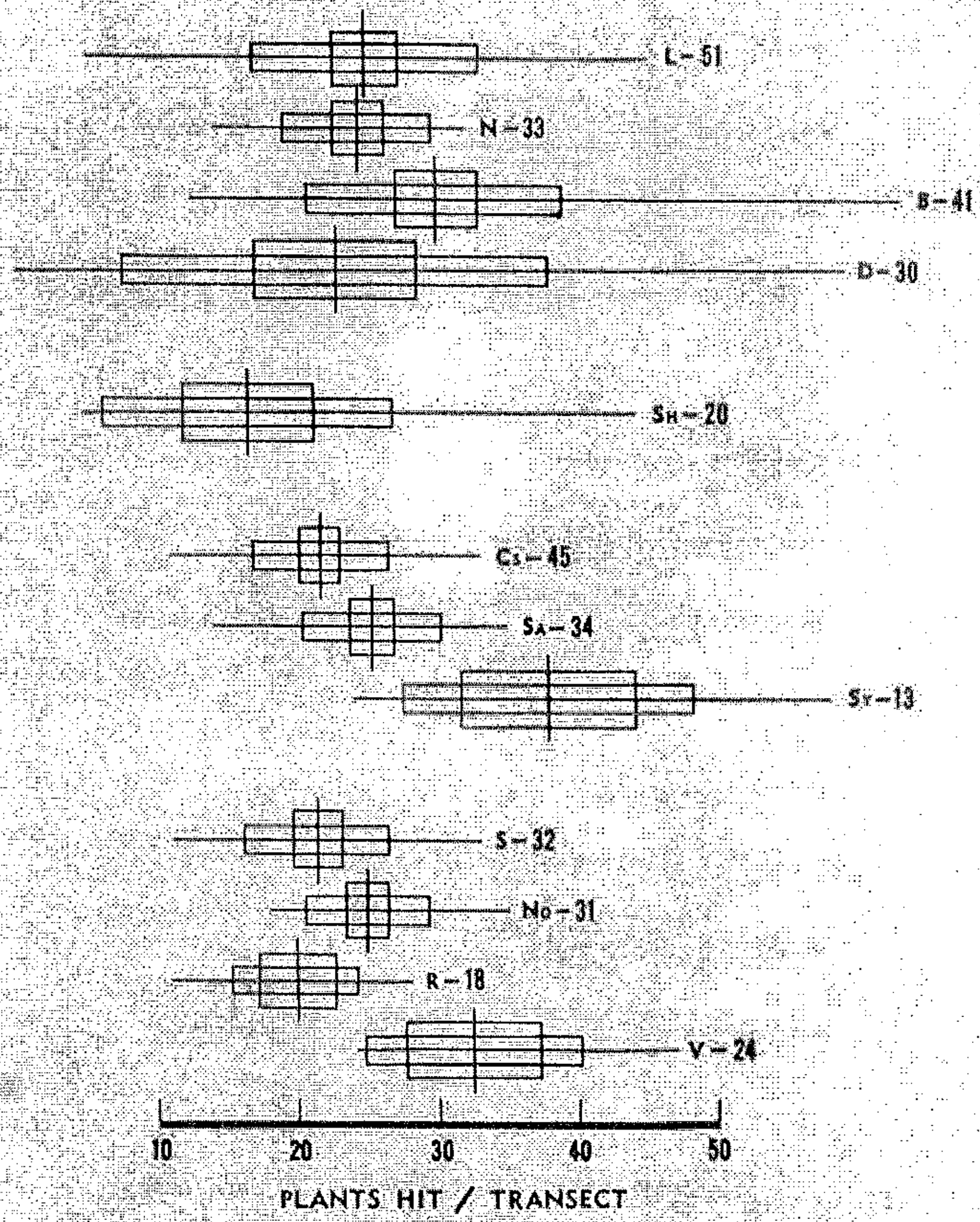

Figure 7. Plant cover. The horizontal line represents the range; the vertical midline is the mean; the vertical lines closest to the mean enclose plus and minus 2 standard errors of the mean; and the vertical lines furthest from the mean enclose plus and minus 1 standard deviation of the mean. Symbols are as follows; V-valley floor, R-ridgetop, No-north-facing slope, S-south-facing slope, Sy-sandy soils, Sa-sands soils, Cs-choppy sands soils, Sh-shrubs, D-display grounds, B-brooding, N-nesting, L-loafing. The numbers following the letters are the number of samples taken.

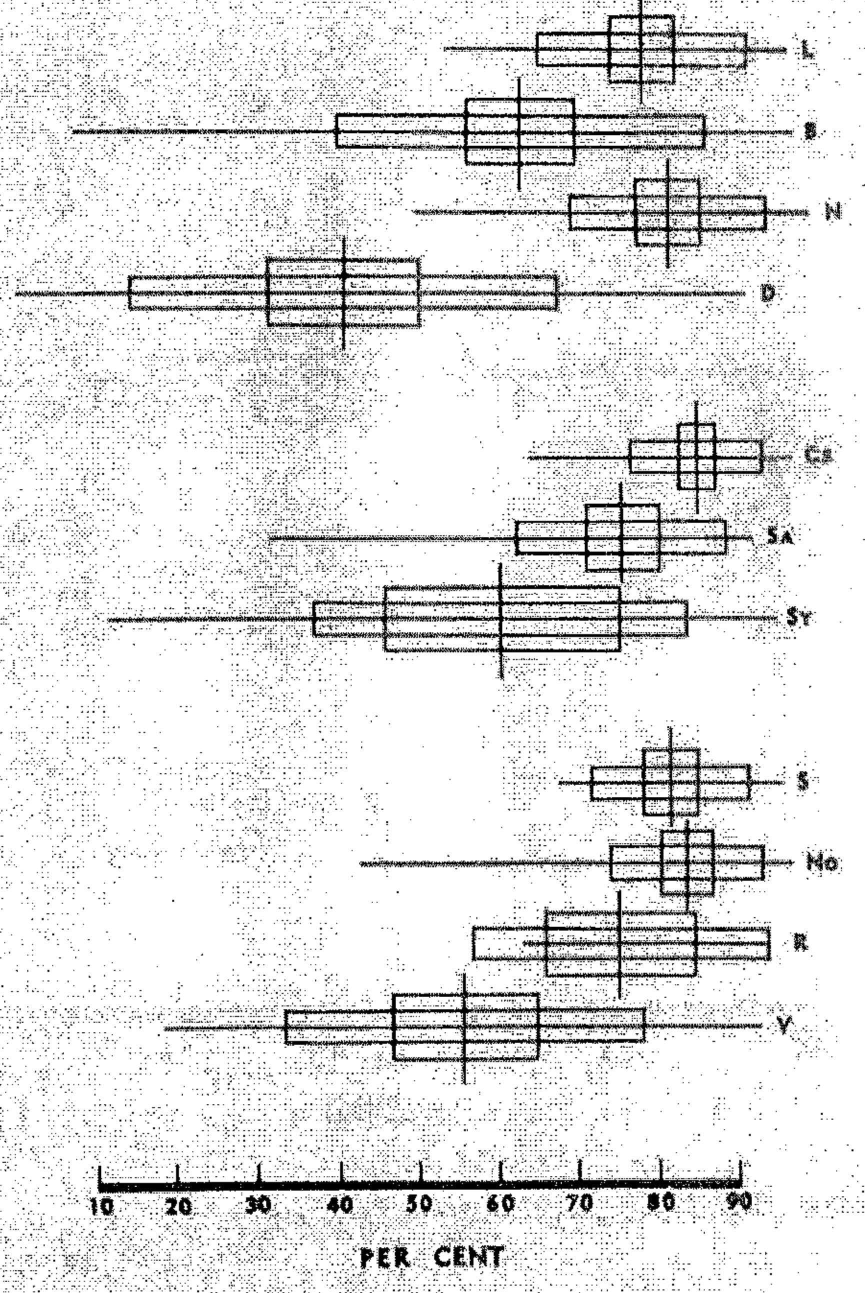

Figure 8. Range condition. Symbols and number of samples same as Figure 7.

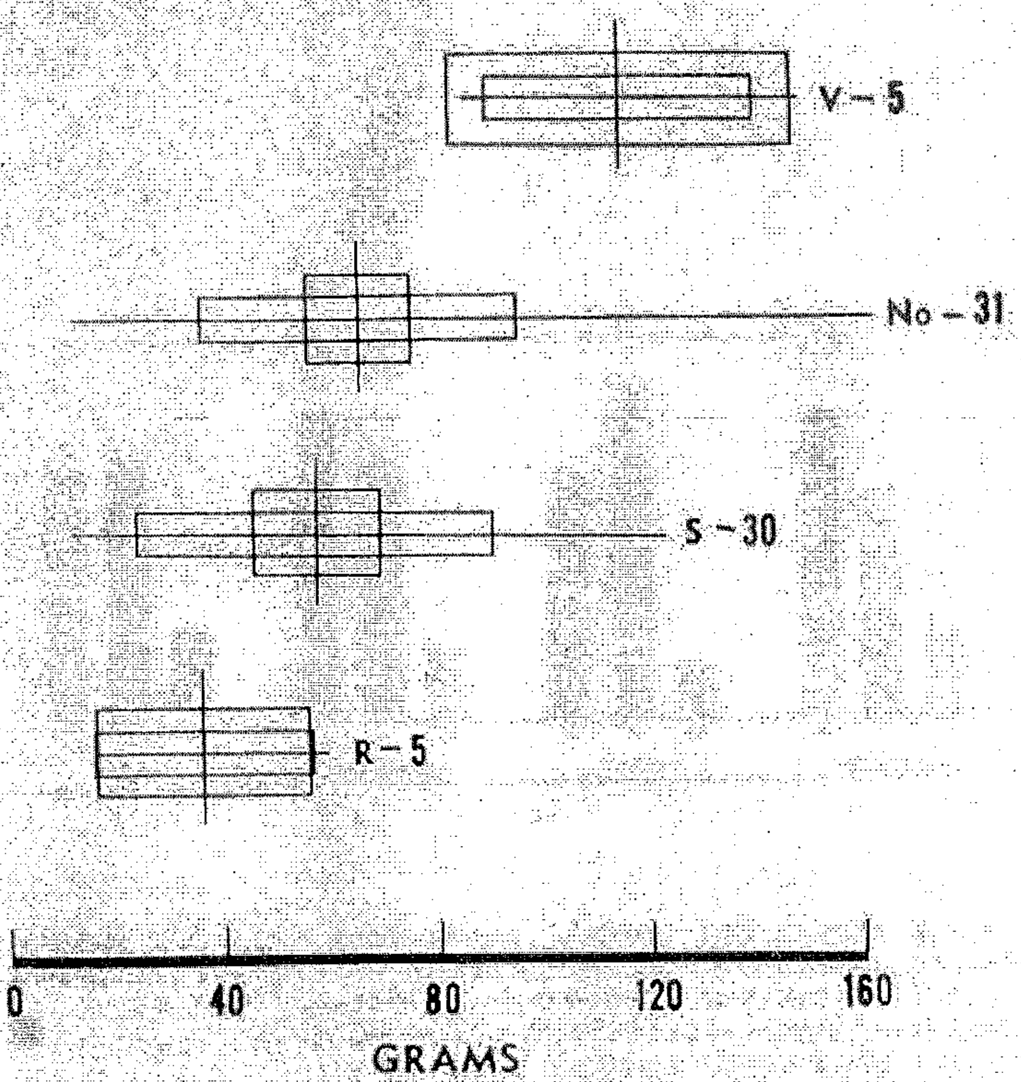

Figure 9. Herbage-mulch per square foot. Symbols same as Figure 7.

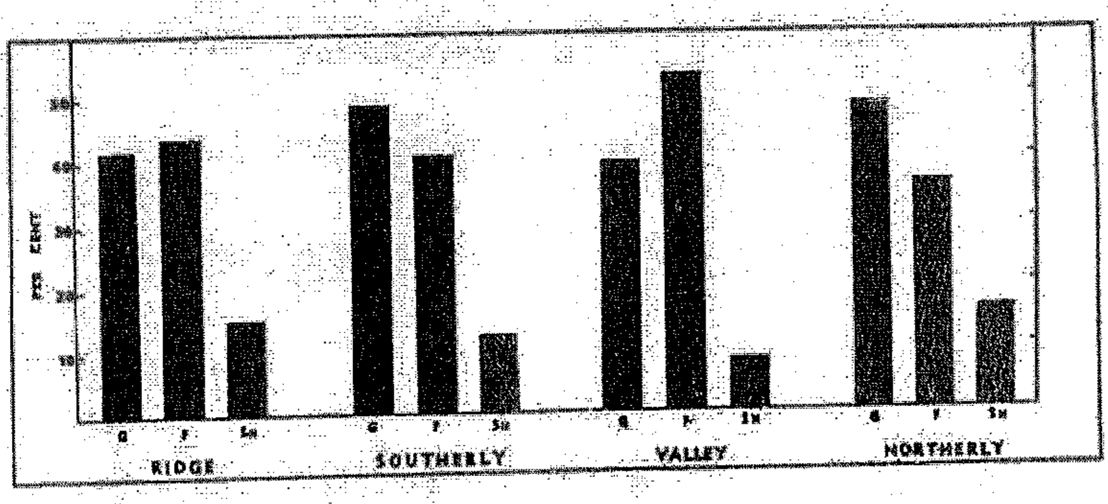

Figure 10. Per cent grass, forbs, and shrubs based on relative importance index of plant species on characteristic physiographic exposures. G-grasses, F-forbs, Sh-shrubs. Physiographic exposures--ridge, southerly, valley, and northerly--are samples taken from ridgetops, south-facing slopes, valley floors, and north-facing slopes, respectively.

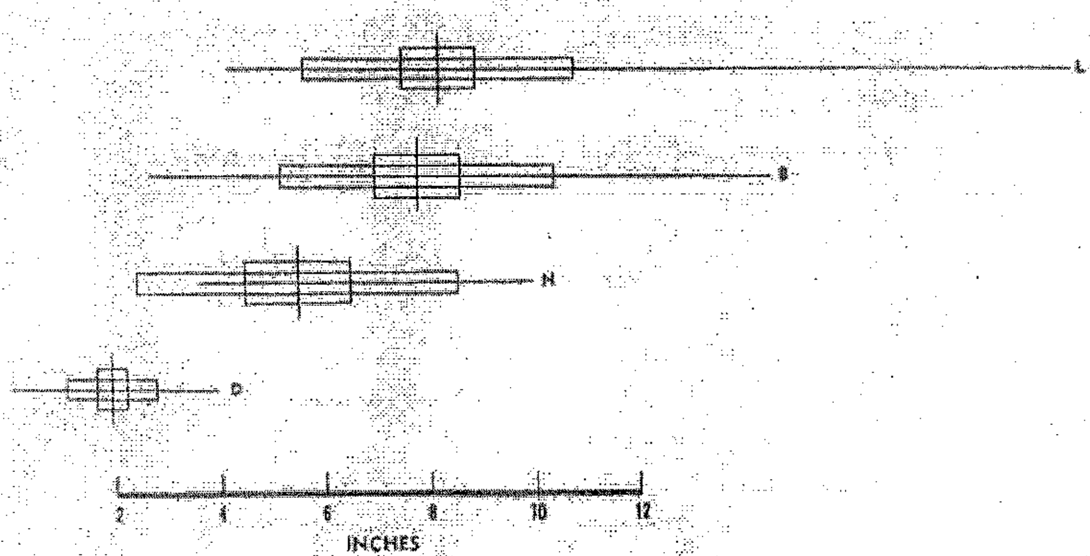

Figure 11. Height of vegetation. Symbols and number of samples same as Figure 7.

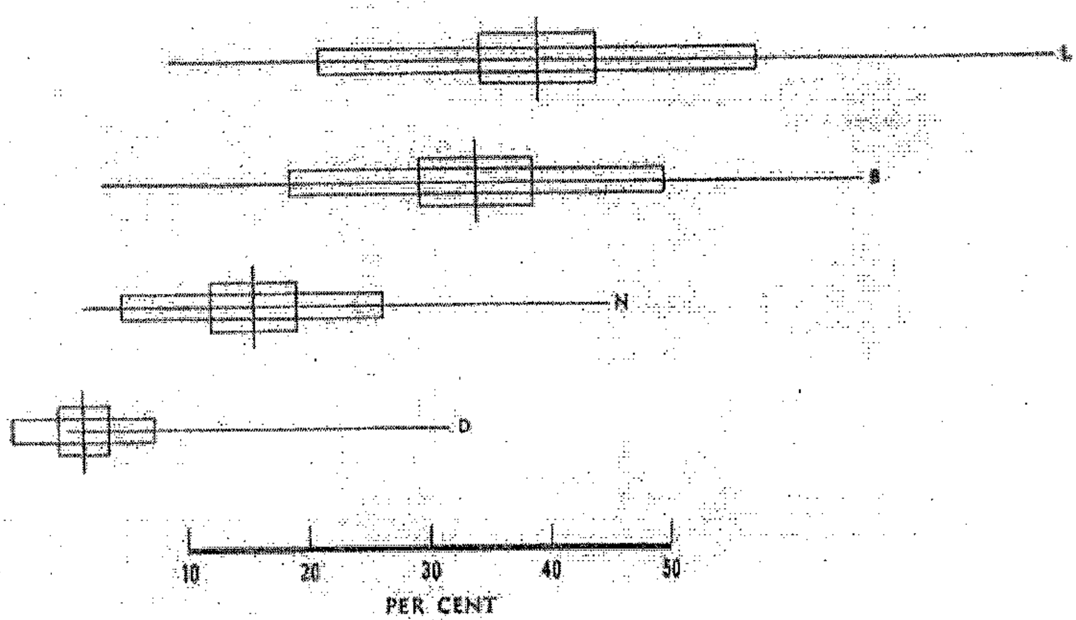

Figure 12. Per cent of light intercepted by vegetation over four inches above the ground. Symbols and number of samples same as Figure 7.

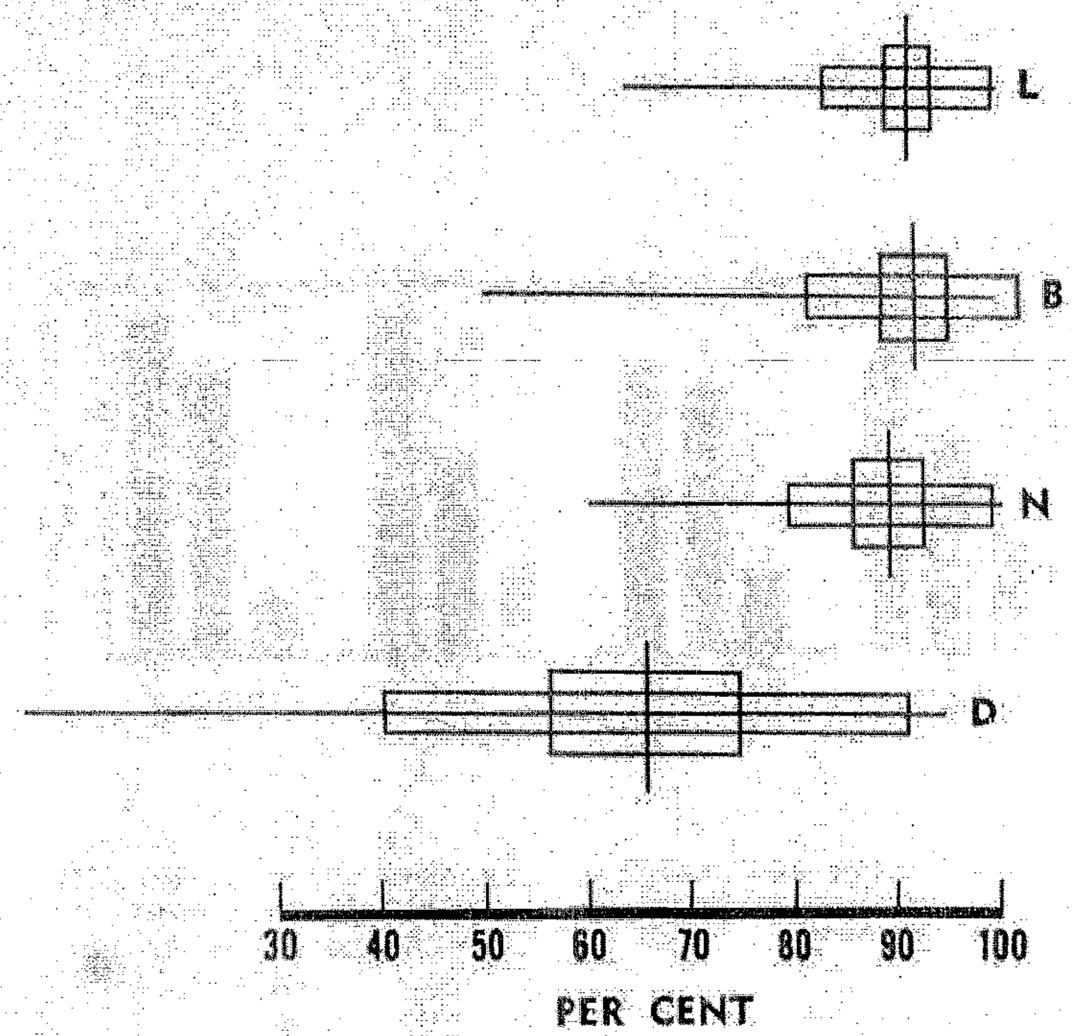

Figure 13. Per cent of ground covered with vegetation and litter. Symbols and number of samples same as Figure 7.

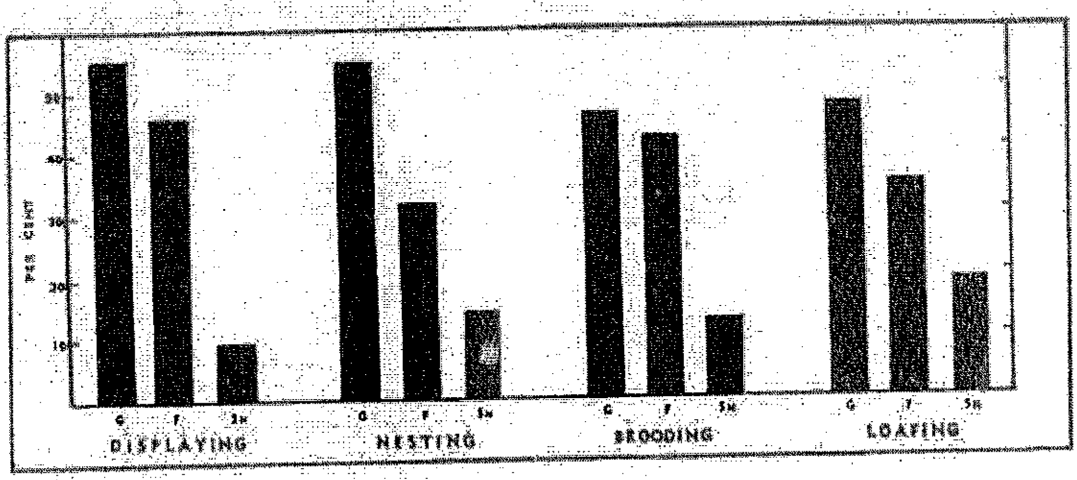

Figure 14. Per cent grass, forbs, and shrubs based on relative importance index of plant species on sharp-tailed grouse activity sites. Symbols same as Figure 10.

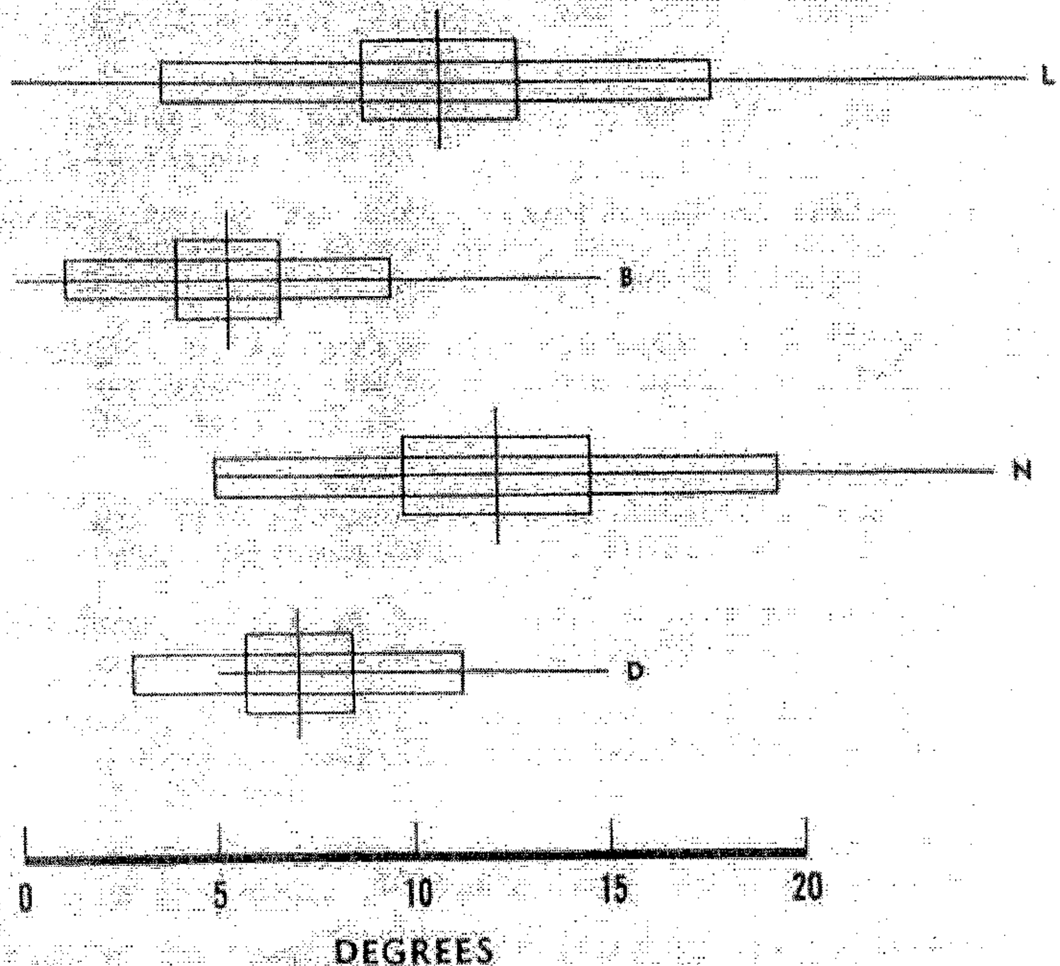

Figure 15. Slope inclination. Symbols and numbers of samples same as Figure 7.

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