Ecology of the Common Snipe in Northern Utah

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ECOLOGY OF THE COMMON SNIPE IN NORTHERN UTAH

by

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Samuel C. Winegardner

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ABSTRACT

Ecology of the Common Snipe in Northern Utah

by

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Utah State University, 1976

Major Professor: Dr. Jessop B. Low
Department: Wildlife Science

The study addresses five areas relating to the biology and management of common snipe (Capella gallinago), including habitat requirements, food habits, breeding biology, sexing and aging and census techniques.

The primary habitat requirement of snipe was determined to be areas that were saturated or covered with shallow water. Secondary requirements were vegetation of less than 3 decimeters in height and between 30 and 50 percent density.

Food habit studies determined that snipe selected animal material with larger and more abundant organisms being preferred without regard to species. Plant material appeared to be ingested only incidentally.

Common snipe use winnowing as a courtship display, distraction device and a means of defining territory. Winnowing activity was most intense in periods of subdued light and cooler temperatures. A ground call emitted from a perch also was used to define territory. Snipe on the ground were observed to use the fanned, erect rectrices as a courtship display and as a distraction device.

No new techniques were developed for externally sexing snipe and previously used techniques were unreliable. Using the presence of a faint black terminal line on the rectrices as indication of an immature, 84.5 percent of 58 snipe were correctly aged. A previously suggested method using the characteristics of the upper wing coverts correctly aged 84.0 percent of snipe correctly. Discriminant functions developed for externally sexing and aging snipe are not considered reliable because of measurement difficulties and variations in samples.

Strip census methods and capture-recapture techniques tested were not effective in estimating snipe populations. The use of average territory size divided into the amount of suitable habitat and actual counts resulted in reliable estimates of the population.

(86 pages)

INTRODUCTION

In the nineteenth and early twentieth century, common snipe (Capella gallinago) hunting was a common sport (Erickson 1945). However, as the result of a 12 year closed season from 1941 through 1952, the interest in snipe hunting waned significantly, and participation in the sport was practically eliminated upon reopening of hunting seasons. Since 1952 there has been a rise in the popularity of the snipe as a game species. Arnold (1976) compiled a continent-wide annual estimate of snipe harvest based upon data provided by the states and concluded that the current annual harvest may approach 900,000 birds.

The common snipe is one of the more abundant and widespread game species in North America. It is possible, because of expanded wintering ranges created by agricultural practices and livestock grazing, that the common snipe population has never been more abundant in North America than it is today (Tuck 1969).

This project was initiated in order to provide knowledge to facilitate management of the common snipe. The following objectives were established with respect to the common snipe in Northern Utah:

1. To determine habitat requirements.
2. To determine food habits.
3. To investigate breeding biology.

4. To investigate aging and sexing techniques.

5. To evaluate census methods.

REVIEW OF LITERATURE

General

A monograph published by the Canadian Wildlife Service (Tuck 1972) describes many aspects of the biology of the common snipe in detail. Because this information is readily available in one volume it will be referenced but not repeated here.

Tuck (1972) describes snipe breeding and wintering range. Snipe are known to breed and winter in Utah. Wolfe (1931) described snipe as common breeders along the western slope of the Wasatch Mountains in northern Utah and in mountain parks up to elevations of 8000 feet. Wintering ground counts conducted in 1955-56 by the U. S. Fish and Wildlife Service indicated important wintering areas south of Provo, Utah near Utah Lake (Robbins 1956). An unpublished survey conducted by the Utah Division of Wildlife Resources and the Utah Cooperative Wildlife Research Unit indicates that snipe also winter in the southwestern corner of Utah along the Virgin River system south of St. George.

Habitat requirements

Tuck (1972) discussed the breeding habitat of the common snipe. In Minnesota, Erickson (1945) found nests built in cattails, rushes and humps of grass located in wet pastures. Robbins (1954) found breeding snipe consistently common in areas of forest-tundra transition in western Canada. Wolfe (1931) described well-pastured meadows with boggy spots as being preferred snipe breeding habitat in the Salt Lake Valley, Utah.

Neely (1959) mentioned that snipe wintering areas are not naturally abundant and suggested that the lack of such areas is a limiting factor for the species. He indicated that man-made, managed snipe fields can contribute to snipe abundance when vegetation is left in a closely cropped condition. Erickson (1945) emphasized that livestock grazing improved snipe habitat during the fall by keeping vegetation from becoming rank. Tuck (1972) described fall and winter habitat. Tuck (1965) mentioned burning marsh lands to create probing areas for migrating snipe. In northern California, White and Harris (1966) found wintering snipe preferred salt marsh and upland and lowland dairy pastures. Snipe fed in upland areas and used the closely cropped salt marshes and pastures for loafing and preening.

Food habits

Food habit studies have been conducted by Booth (1968), Owens (1967) and Whitehead (1965) in Louisiana; Erickson (1945) in Minnesota; White and Harris (1966) in northern California; Tuck (1972) in Canada; and Sperry (1940) in the eastern United States. Results of these studies have indicated that animal material amounts to more than one-half of the total diet. Annelids, insect larvae, Mollusca and Crustacea are the more important animal foods. Plants, seeds and grit, some of which may be ingested extraneously, comprised one-fourth to one-half of the diet. Field observations and volumetric analysis indicate that snipe feed during the early morning and late afternoon periods.

White and Harris (1966) consider that plant fibers and other extraneous material should not be considered as food items primarily because they remain unchanged by any digestive process and are finally regurgitated. Tuck (1972) concluded that neither seeds, plant fibers nor grit should be considered as food.

Breeding biology

Tuck (1972) discussed winnowing habits of the common snipe as well as the bird's territorial, courtship and breeding behavior. Tuck (1955) describes the winnowing activity of snipe on clear, moonlit nights.

Sexing and aging

General. Techniques for sexing and aging snipe that have been developed by different authorities have often proven unreliable when applied to populations in other locations or to the entire continental population. Whitehead (1965) and Oswald (1969) both state indications are that there are probably several different breeding populations of snipe in North America, each population having distinct variations. At this point sexing and aging techniques that have been developed appear to hold true only for those populations in which the technique was developed

Sexing. Tuck (1972) proposed that snipe could be externally sexed by a comparison of bill length and the length of the outer tail feather. Males generally have shorter bills and longer outer tail feathers than females. White (1963) was unable to determine any method for externally sexing snipe. The width of the first secondary was used by Whitehead (1965) to sex snipe. Snipe with a first secondary width of 14 mm or less are males and those with a width of 15 mm or more are females. Oswald (1969) determined that six characteristics were usable in externally distinguishing sex in snipe. The length of the third toe and the number of bars in the outer rectrix feather were significant at the 0.01 level while rectrix patterns, outer rectrix length, length of the fourth toe and the sum of the length of the third and fourth toes were significant at the 0.05 level. In this study it was found that males had more than seven bars on the outer rectrix while females had seven bars or fewer. Perry (1971) proposed the construction of a linear combination of body and feather measurements for the determination of sex of snipe. In this method the 25 most significant sexing variables were formulated into a discriminant function to obtain the minimum percent misclassification of sexes (28.38 percent). However, these possible misclassifications were considered excessive to accurately sex snipe. Hoffpauir (1969) had used a similar method using six feather measurements which resulted in only 2.78 percent overlap or misclassification. He concluded that the method was useful and practical.

Aging. Tuck (1972) has shown that in the juvenal plumage there is a faint marginal black line on the tip of most median, lesser, posterior marginal and tertial upper wing-coverts. This black line is often retained on some coverts until the following breeding season. Birds in the second year, or the second basic plumage and older, have a dark brown terminal shaft line at the tip of the median and lesser coverts. White (1963) was unable to find any effective means of externally determining age in snipe. Whitehead (1965) found that the upper, outer primary coverts permitted aging of all adult female snipe and 97.8 percent of immature female snipe. These coverts have a distinct broad white tip in the adults that may be absent, very narrow, incomplete or poorly defined in immature birds. Hoffpauir (1969) developed a linear combination using the four best feather measurements, which gave an overlap of 12 percent. He felt that the amount of misclassification did not take away from the effectiveness of the method. Perry (1971) used a similar method but found he had 22.64 percent misclassification using the 22 most significant measurements and he concluded that the resulting overlap was too great for the method to be of practical use.

Census techniques

Techniques for censusing snipe are limited. The use of winnowing counts as an indication of breeding populations have been reported by Solomon (1954), Burleigh (1952) and Tuck (1972). Results of these studies indicate that winnowing counts are only estimates of the number of breeding pairs within an area. White and Harris (1966) reported censusing wintering snipe by systematically walking fields and counting the number of snipe flushed. Winter counts conducted by the U. S. Fish and Wildlife Service computed population indexes based on the number of snipe flushed per hour afield (Robbins 1956). Tuck (1972)

discussed use of the King strip census method. Arnold (1976) recommends that in addition to the methods proposed by Tuck (1972) the Lincoln-Petersen index be utilized and that a snipe wing survey be established to examine and monitor annual productivity and hunter harvest.

METHODS AND MATERIALS

Study area

To assist in the accomplishment of the stated objectives, a study area was established in Cache County, Utah. This area is approximately two and a half kilometers square and is located between Mendon, Utah on the west and the Little Bear River on the east. Marshes, water courses and wet pastures are abundant within the area which is accessible by road systems throughout the year. The cover and feeding conditions provided by the combination of marsh and pasture attracts a population of snipe that remains in the area between March and December.

Habitat requirements

As an aid in the determination of common snipe habitat preferences and cover requirements, cover maps were constructed showing primary land use patterns, vegetation composition and soil moisture. Information for the cover maps was collected by physically walking over the study area, inspecting the various characteristics of each site and recording the data on a field map. This information was compared with aerial photographs as a cross check for accuracy.

In order to quantify the habitat requirements of the common snipe, the study area was systematically walked and data was collected by measuring a number of variables in conjunction with individual sightings of snipe. Information collected at each flushing point included vegetation type, vegetation dominant, vegetation density, mean height of overstory species, distance to standing water, land use, percent utilization by livestock and soil moisture.

A site was classified as one of seven vegetation types based upon a combination of factors including land use, vegetation, topography and soil moisture. An area was called a shallow marsh if the ground was completely saturated and/or water covered to a depth of one decimeter or less throughout most of the year. Vegetation cover was composed of typical marsh plants such as water cress (Rorippa nasturtium-aquaticum), speedwell (Veronica americana), common cattail (Typha latifolia) and sedge (Carex aquatilis). A deep marsh was possessed of similar characteristics with the exception that water cover exceeded one decimeter in depth throughout most of the year. Wet pasture represented an area which was grazed at least part of the year and in which the ground was wet to saturated. Dry pasture was also grazed, although the ground was normally dry or only moist. Lowland meadow was ungrazed land that was used to produce wild hay. In lowland meadows the ground was normally wet to saturated while in upland meadow the ground was dry to moist. Cultivated crops included all those areas in which farm crops were planted and subsequently harvested. These included areas planted to corn, wheat and alfalfa hay.

Density of vegetation was determined to the nearest 10 percent by visually estimating the amount of ground in a square meter that was covered by vegetation. This method is similar to those suggested by Stewart and Hutchings (1936) and Folks (1969). The vegetation that was visually dominant and covered the majority of the area immediately surrounding the flushing point was considered as the dominant vegetation.

Mean height of overstory species was determined by measuring the vegetation in the immediate vicinity of the flushing point. Data was recorded in categories as shown below:

0.0	-	3.0 decimeters	15.1	-	18.0 decimeters
3.1	-	6.0 decimeters	18.1	-	21.0 decimeters
6.1	-	9.0 decimeters	21.1	-	24.0 decimeters
9.1	-	12.0 decimeters	24.1	-	27.0 decimeters
12.1	-	15.0 decimeters	Beyond		27.0 decimeters

Distance to standing water was measured from the point at which the bird was flushed to the nearest standing water, even if that pool of water was only 4 to 5 centimeters in diameter. The measurements were recorded in the same categories as used for the mean height of overstory species.

Land use was determined on the basis of one of four categories including idle land, land which was harvested of wild hay, land which was grazed and land which was cultivated for crops. Soil moisture was visually and tactually estimated and recorded in one of five categories as being dry, moist, wet, saturated or water covered.

The location of each flushing point was plotted on a separate map to determine those areas most often frequented by common snipe. This information was compared with that shown on cover maps to determine possible associations.

The variables recorded at each flushing point were analyzed statistically by the use of a chi-square test. The number observed in each level of each variable was the number of snipe observed occupying that particular element of habitat. In order to determine the number of snipe expected to occupy each level of a variable, a percentage was estimated for the portion of the study area that was represented by each level. In some variables, such as density of vegetation where it was virtually impossible to estimate percentages, it was assumed that the percent of the study area represented by each level was the same. These percentages were applied to the total number of observations in each season to arrive at an expected number for use in the chi-square test. In addition to determining whether each variable was significant, the significance of each level within the variable was determined as each level was compared individually with all other levels of that variable considered as a single group.

Food habits

Analysis of stomach contents. A total of 80 common snipe were collected through the year so that approximately 25 were taken in each of three calendar seasons, spring, summer and fall. Snipe were collected with a shot gun and 7 1/2 shot. As the collected snipe were also being studied for age and sex characteristics it was impractical to remove and analyze stomach contents immediately. Therefore birds were injected with 10 percent formalin to retard digestion as suggested by Davis and Arnold (1972). A small wad of cotton was forced into the throat of each bird to prevent loss of food items. The snipe were then wrapped in a paper towel, placed in a plastic bag and frozen at the earliest possible opportunity after collection. The birds were tagged with the date collected, the time of day, the collection locality and any other pertinent information.

When the birds were dissected, items found in the mouth, esophagus, proventriculus and ventriculus were removed and placed into a vial with ten percent formalin. Because of the small quantities of food occurring in each stomach, it was necessary to combine the contents so as to obtain measurable amounts as stated by Whitehead (1965). The stomachs were grouped by season and area from which collected. An effort was made to place five stomachs in each group; however, one group had four while another contained six stomachs. Although stomachs were grouped the contents of each stomach in a group were examined separately. Stomachs were examined separately not only to obtain frequency of occurrence but also because of the difficulty in separating contents of several stomachs when mixed together.

The contents of each stomach were flushed into a petri dish and then pushed apart and stirred until all items were completely detached.

Samples were taken by the use of a metal cylinder 15.24 cm in diameter and 7.62 cm in depth similar to the one employed by Whitehead (1965) and Booth (1968). The cylinder was pushed into the soil until the top was flush with the surface. The sample was removed intact and placed in a metal can with a plastic lid for transport to the laboratory.

Soil samples were normally processed within 24 hours. Samples were washed with warm water through a sieve with a screen size of 20 meshes per inch in order to remove all soil. The remaining material was poured into a white porcelain tray to which warm water was added. The material was sorted carefully and all animal matter was removed with forceps and placed in vials with 10 percent formalin. The total number of organisms of each group was tabulated and a percent availability of food items was computed.

Calculation of food preferences. A chi-square test was made to compare the number of each organism found in snipe stomachs with the number expected. The number expected was obtained by determining a percentage of each organism that was seasonally available based upon the soil samples. This percentage was applied to the total number of organisms found in the snipe stomachs in each season to arrive at the number expected. To determine if any particular organism was preferred over all others, each organism was compared individually with all other food items consumed during the same season considered as a single group.

Breeding biology

Winnowing habits. Winnowing counts were conducted to determine if there were correlations or associations between the number of winnows produced by a bird and various weather and other environmental conditions. Counts were conducted through both the day and night for extended periods during the height of the winnowing season during the spring. The total number of winnows heard in a five minute period was recorded every 30 minutes throughout the listening day or night. Various weather and other environmental conditions were recorded at the time that each winnowing count was conducted. These included temperature, relative humidity, wind velocity, precipitation, cloud cover and light conditions.

Temperature was measured in degrees Centigrade in open air, shaded conditions utilizing a hand held thermometer. A sling psychrometer was used to measure the percent of relative humidity. Wind velocity was measured in miles per hour with a hand held wind meter and subsequently converted to kilometers per hour. Precipitation was recorded as either raining or not raining. The amount of cloud cover was estimated visually and recorded to the nearest tenth of sky coverage. Light conditions were recorded as bright daylight, dim daylight, bright night, dim night, moonlit night, dusk or dawn.

The information obtained was recorded on computer punch cards and analyzed statistically in a linear combination model in order to determine those factors that were most significant.

Territorial, courtship and brooding behavior. Common snipe were studied within the study area to determine their territorial habits as well as courtship and brooding behavior. To facilitate observation, snipe were trapped by the use of mist nets and marked on the light colored breast feathers with various colors and patterns of aniline dyes. These markings were easily observed, particularly when the birds were flying. Snipe were also banded with size 3 U. S. Fish and Wildlife Service numbered bands prior to release.

Sexing and aging

The common snipe collected for the food habits study were also utilized to determine possible external age and sex characteristics. Observations of the external appearance of the collected birds were carefully recorded to provide data for possible aging and sexing techniques. Measurements recorded included length and width of all primary, secondary and rectrix feathers. The purpose of the study was to develop a technique that could be used in the field by the manager and, therefore, measurements were taken under conditions similar to those that might be experienced by managers. Feathers were measured while still in place on the bird. Length was measured from the base of the feather to the tip and width was measured at the widest point on the feather from the midpoint to the tip. It was felt that those measurements could be duplicated with live birds. Other measurements were taken in addition to the feather measurements including depth and total length of the bill, bill length (tip to nostril), bill length (nostril to culmen), tarsus length and diameter, length of all toes, length from the base of the toes to the base of the tarsus, total length, length of the wing chord and total weight. Measurements were recorded to the nearest 0.1 mm or 1.0 g. All measurements were taken in the laboratory with the exception of total weight which was taken in the field immediately after the bird was taken. The recorded measurements were combined in a linear model for statistical analysis to determine those characteristics with significant differences between sex and age groups.

Common snipe were aged and sexed internally in the laboratory. Sex was determined by the presence of the gonads or an oviduct. Males and females were aged by the bursa of Fabricius as suggested by Perry (1971). The bursa was teased away from the cloaca and measured. A bursa of 3 mm or more was considered to be that of an immature whereas a bursa of less than 3 mm or no bursa was considered evidence of an adult (White 1963). Female birds in which the presence or absence of a bursa of Fabricius could not be detected as a result of damage oc-curred in collection were aged by measuring the width of the oviduct flattened over a probe. As used by Hoffpauir (1969) and Perry (1971), an oviduct width greater than 2.5 mm was considered to be that of an adult snipe. Male birds in which the presence of a bursa of Fabricius could not be detected were not aged.

Census techniques

Various census techniques were utilized to estimate the size of the snipe population within the study area. Of the two major types of census techniques that have been suggested, one capture-recapture and two strip census methods were selected for use.

The Lincoln-Petersen index (Seber 1973) was selected to determine if a capture-recapture census technique could be utilized with snipe. The two strip census methods used were the King strip census method (Overton 1969) and that of Hayne (1949) which is a modification of King's method.

In an attempt to develop a census technique for snipe, winnowing counts and territories were also utilized to arrive at an estimate of the size of the population. Winnowing counts were used in the determination of the number of breeding pairs in an area. An average territory size was determined and divided into the total amount of suitable snipe habitat. The figure obtained represented the total number of pairs in the area.

Results of these census methods were compared with an actual count of the snipe population in the study area. The actual count was obtained by systematically walking the study area and counting the number of snipe flushed. This method was used by White (1963) who felt that the count achieved represented at least 95 percent of the actual population. The snipe trapped and marked with aniline dyes in the territorial studies were utilized to determine population estimates using the Lincoln-Petersen index. Transects were established in the study area for obtaining information for use with the strip census methods. The transects were walked on five surveys and the number of snipe flushed and their flushing distance were tabulated.

RESULTS AND DISCUSSION

Habitat requirements

It can be readily seen from a comparison of Figures 1 through 4 that snipe were sighted primarily in areas that were grazed, water covered or saturated and vegetated by various sedges (Carex spp.). It can also be seen from Figure 4 that snipe occupy a smaller portion of the total study area as the year advances from spring to fall. A possible contribution to this phenomenon is that almost the entire study area is flooded in the spring which then becomes progressively drier with the advent of summer and fall. Another contributing cause is probably behavioral since snipe are spread through the area in territories in the spring while in the fall they exhibit a flocking behavior.

The results of chi-square tests indicate that all habitat variables measured in conjunction with snipe sightings were highly significant for common snipe and that there was an apparent difference in choice of habitat by season (Appendix A). In each case the hypothesis was rejected that the use of the different levels of the variable (rows) and season of use (columns) are independent.

Snipe displayed preference for wet pasture and shallow marsh through the year (Figure 5). Lowland meadows were also used in about the same percentage of instances in each season through the year.

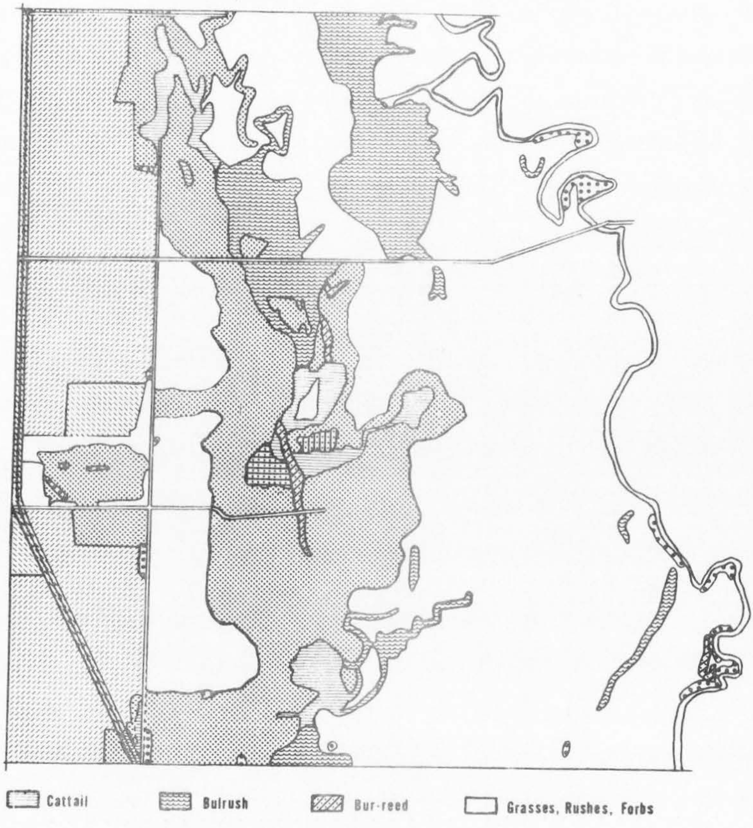

Figure 1. Composition of vegetation within the study area.

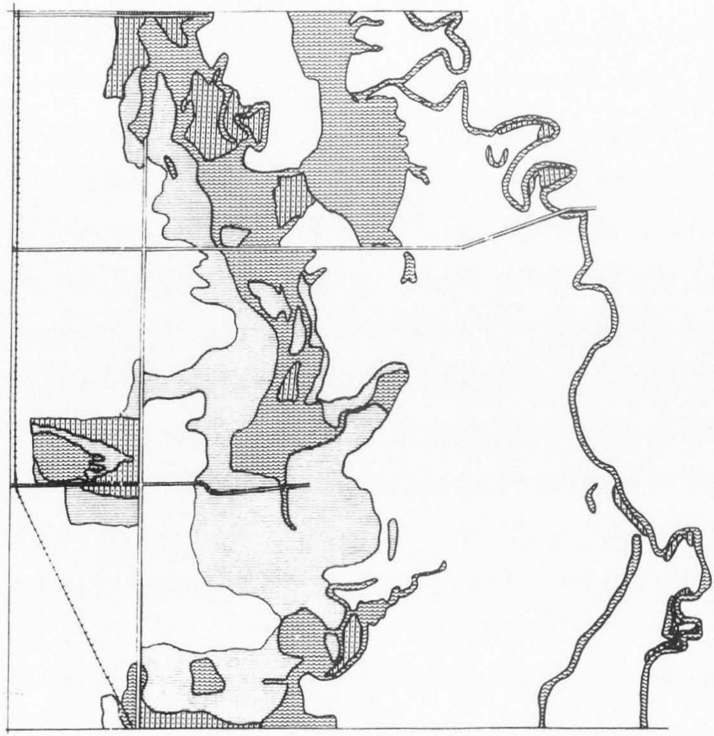

Figure 2. Soil moisture within the study area during late June and July.

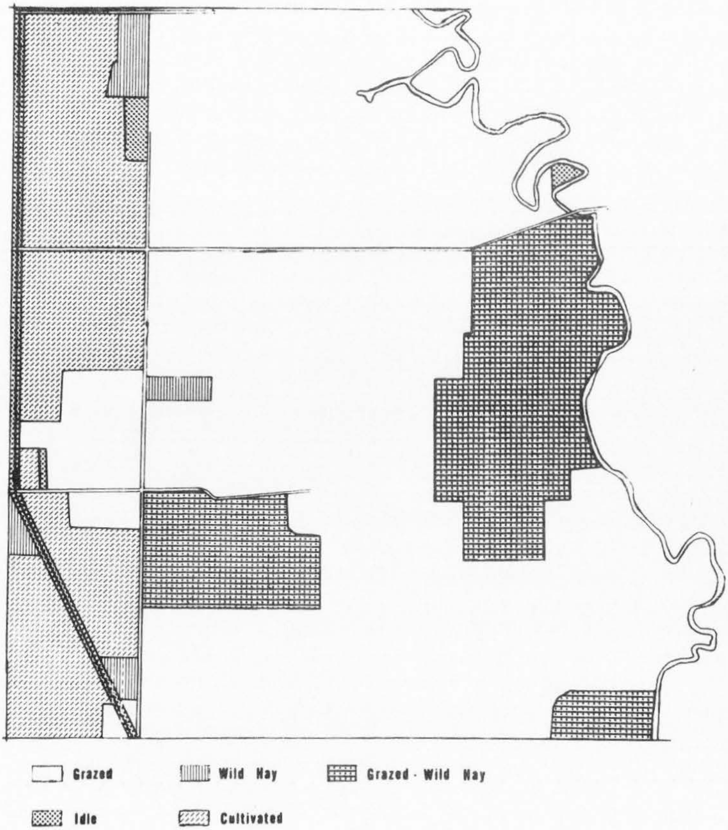

Figure 3. Land use patterns within the study area.

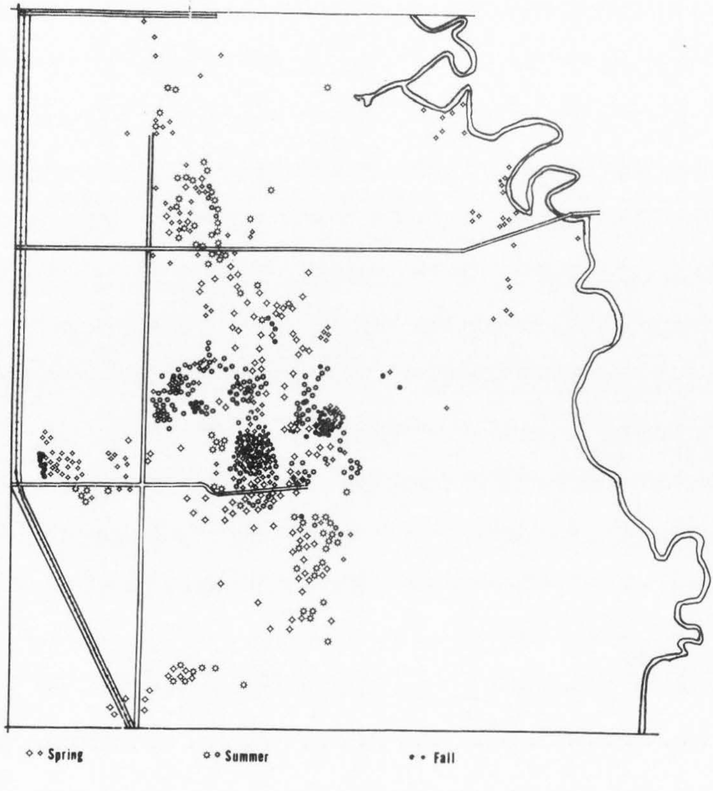

Figure 4. Distribution of common snipe sightings within the study area in spring, summer and fall.

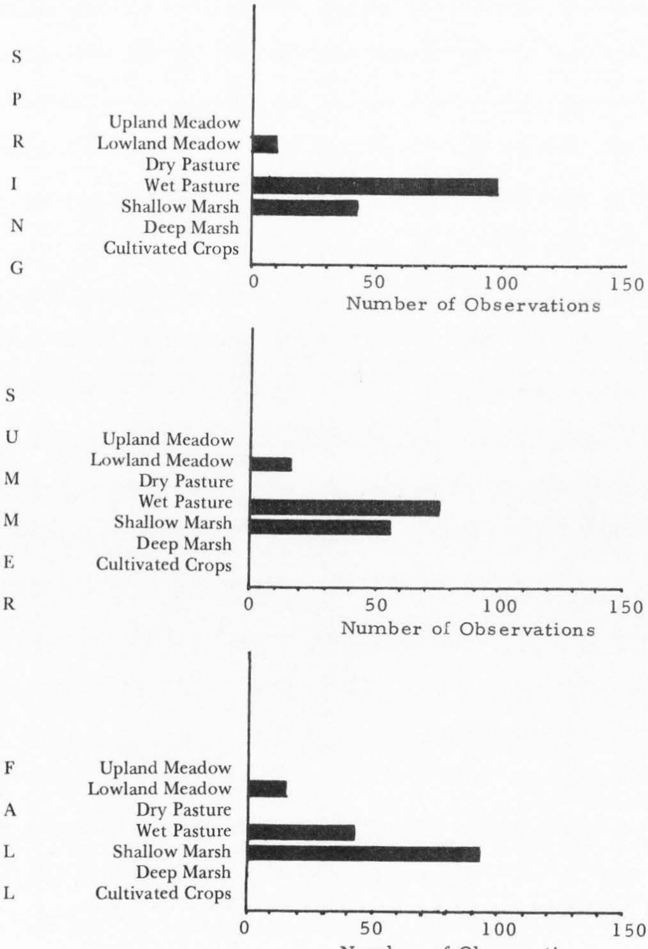

Figure 5. Vegetation type in relation to common snipe observations.

Snipe were found only in the vegetation types normally saturated or water covered and quite probably soil moisture was responsible for the seeming preference for these vegetation types. The shift from wet pastures to shallow marshes through the seasons probably resulted from the availability of water in the study area. Almost the entire area was flooded in the spring and a majority of the study area was then classified as wet pasture. The pastures began to dry with the coming of summer and the wet pasture area roughly equaled the shallow marsh area. In the fall most of the pastures were dry and the shallow marsh provided the great majority of the area with saturated or water covered soils. The small number of observations in lowland meadows was possibly due to the small amount of lowland meadow found in the study area. The statistical significance showing preference for wet pastures and shallow marshes could well be a reflection of the soil moisture.

The apparent preference of common snipe for sedges was also quite likely a reflection of soil moisture (Figure 6). Nearly all observations throughout the seasons were in areas where Carex species were dominant. When considered in conjunction with soil moisture the phenomenon was not surprising. Carex aquatilis was predominant in those areas that formed a transition between dry and flooded areas. This transition zone was normally saturated or shallowly covered with water. In the areas where snipe were observed in grasses, the ground was usually recently flooded as a result of either irrigation or precipitation runoff. In the areas where other plant species were dominant it

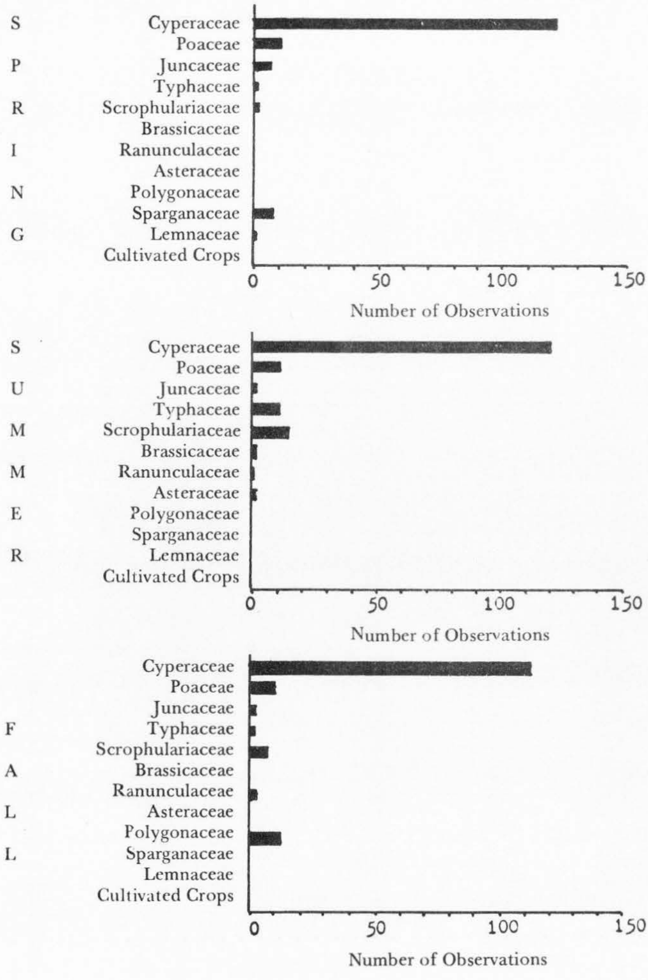

Figure 6. Vegetation dominant in relation to common snipe observations.

appeared that the requirements of the plant were specialized and normally they did not cover as extensive areas as did the sedges. The specialized requirements and more limited distribution of these plants probably accounted to a large extent for the smaller numbers of snipe observed in areas where these plants were located. Bur-reed (Sparganium spp.) and cattails (Typha spp.) were normally found in deeper water while most rushes (Juncus spp.) were usually noted in slightly drier areas, neither of which appeared to be favorable to snipe. The other plant species accounted for only a small part of the study area and were less likely to be used. No birds were observed in areas of cultivated crops. This probably was due to the irregularity of the water supply and the greater height and/or density of these plants.

Throughout the year approximately 80 percent of all observations of snipe occurred in areas where the density of vegetation was between 20 and 70 percent (Figure 7). The percentage of snipe observed in areas where the density of vegetation was between 30 and 50 percent varied from 40 percent in the spring to 60 percent in the fall. As can be seen from Figure 7 the largest number of observations in each season was in areas of 41 to 50 percent density of vegetation. The chi-square values comparing number of observations with the number expected in the areas where vegetation density was between 41 and 50 percent were consistently higher than for any other category, indicating that common snipe appeared to select these areas. Three separate areas that were used by snipe early in the spring were deserted as the

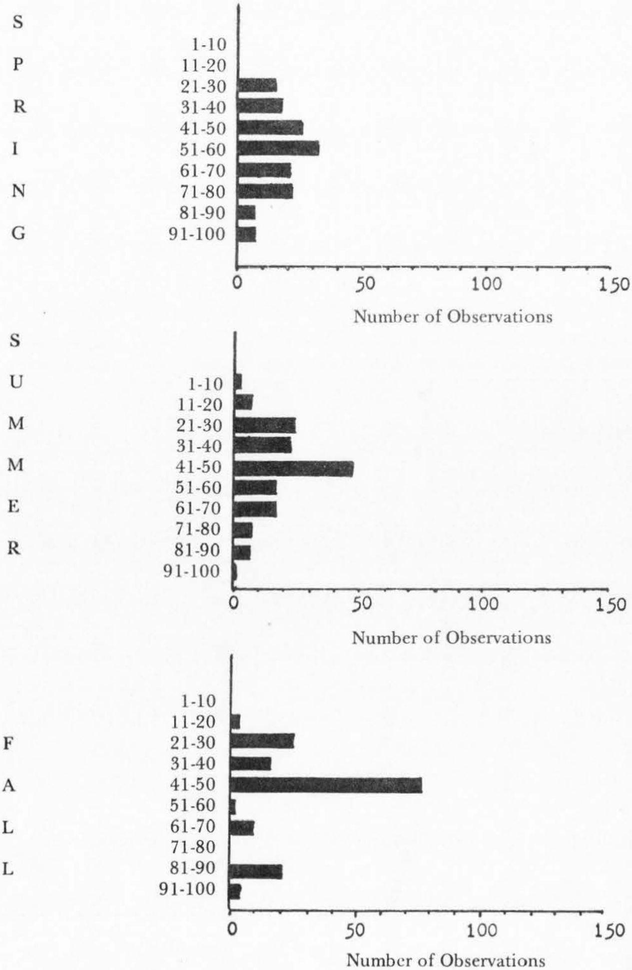

Figure 7. Density of vegetation in relation to common snipe observations (numbers represent percentage of vegetation density).

density and height of vegetation increased during the year. Conversely, areas of dense, tall vegetation that were seldom used by snipe were later used extensively as the height and density of vegetation were reduced by grazing or mowing. Snipe were rarely seen in areas that were completely or almost bare. Those birds that were seen in these areas appeared to be stealthy in their movements and usually moved rapidly into cover.

It is difficult to discuss density and height of vegetation separately since the two variables are so closely related. Many of the comments relating to the density of vegetation apply to the height of the vegetation overstory. Snipe tended to avoid areas where vegetation was higher than 3 dm and few were observed under such conditions (Figure 8). A number of areas were noted that appeared to be ideal for snipe yet no birds were observed in these areas. The only obvious differences from areas utilized by snipe were an increased height of vegetation beyond 3 dm and/or increased density of vegetation.

Only occasionally was a bird found more than 3 dm from standing water, even though that pool of water might be no larger than a cow's hoof print (Figure 9). In those observations where birds were sighted farther than 27 dm from standing water the ground was normally saturated or water soaked. A light pressure on the soil surface, which was often totally organic, would cause a small pool of water to form.

Snipe were consistently found in grazed areas throughout the year (Figure 10). This close association could exist because the areas where

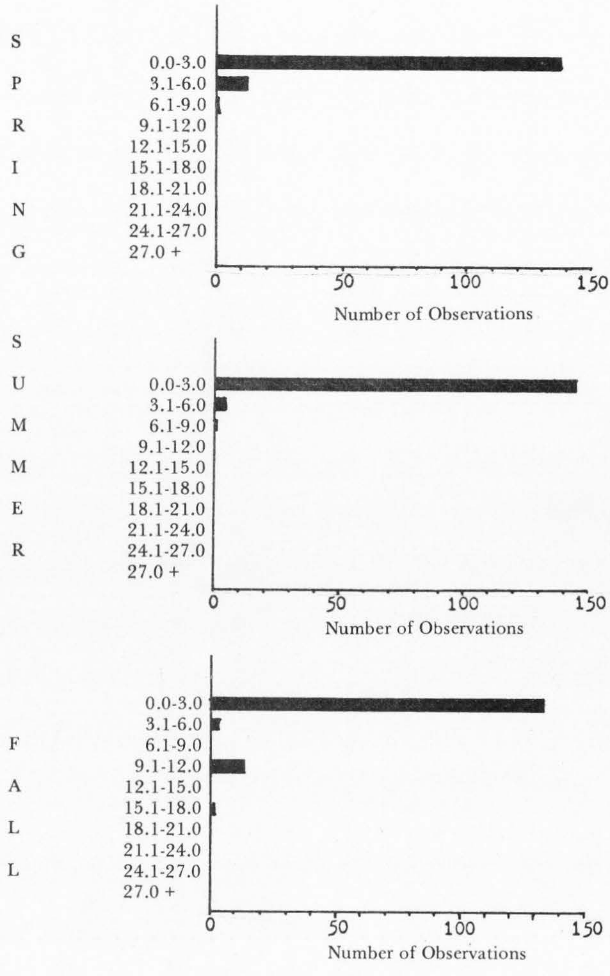

Figure 8. Mean height of overstory species in relation to common snipe observations (numbers represent mean height in decimeters).

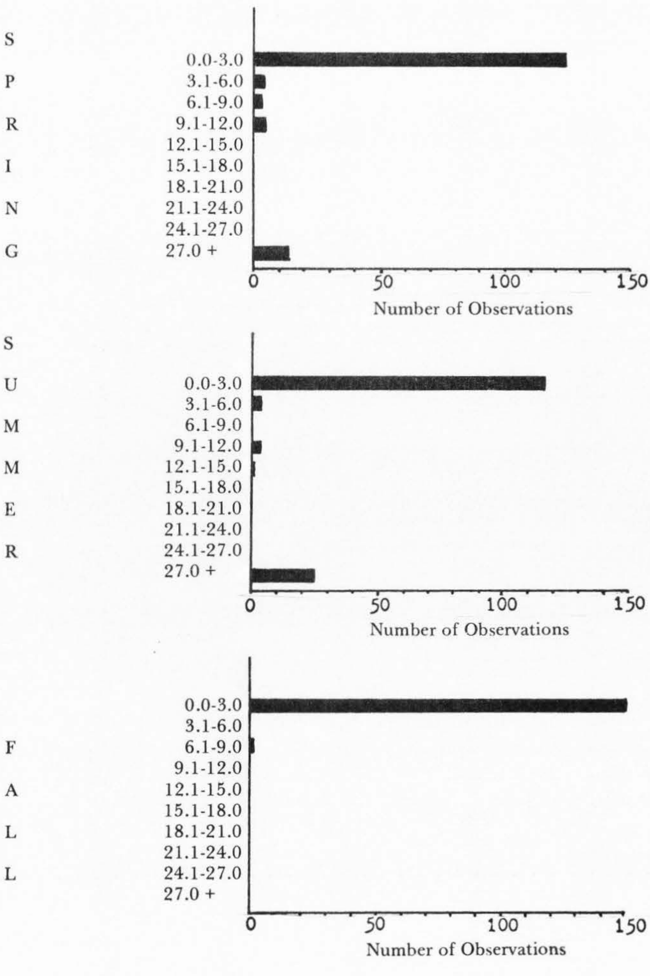

Figure 9. Distance to standing water in relation to common snipe observations (numbers represent distance in decimeters).

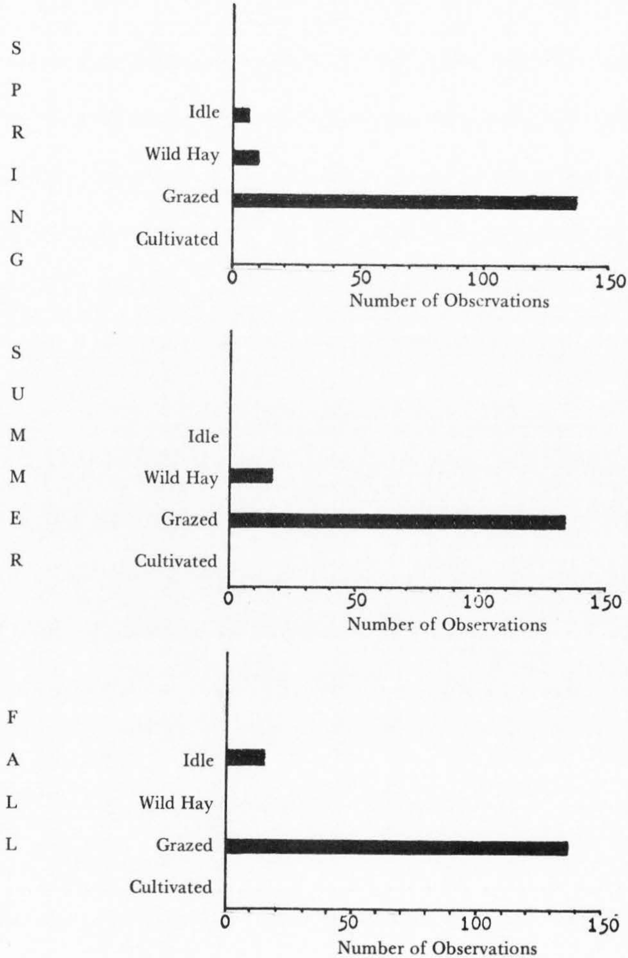

Figure 10. Land use in relation to common snipe observations.

snipe were found were normally saturated or water covered and were not suitable for economic purpose other than livestock grazing. It appeared that grazing was beneficial to snipe in decreasing the density and height of vegetation. An area that was grazed one year was used by numerous snipe but when it was excluded from grazing the following year it was not used at all by snipe as the height and density of vegetation increased. Where the taking of wild hay was the primary land use, snipe often were noted in the area after mowing. Mowing had the obvious effect of reducing vegetation height, although it did not decrease the density and some extremely dense meadows that were recently mowed were not utilized by snipe. Common snipe were not observed in fields of cultivated crops.

Although the chi-square test indicated that snipe showed a differential preference for certain areas based upon the percent utilization of the vegetation by livestock, the graphs in Figure 11 show that the nature of this preference is quite probably artificial. As the year progressed from spring through summer to fall, snipe used progressively more heavily grazed areas which were probably the result of cumulative use by livestock through the year. Grazing appeared to be important only as a device to reduce vegetation height and density to a point where snipe would utilize the area. In most instances, the intensity of livestock use required to meet minimum snipe needs was relatively little; beyond that livestock use appeared to have little effect.

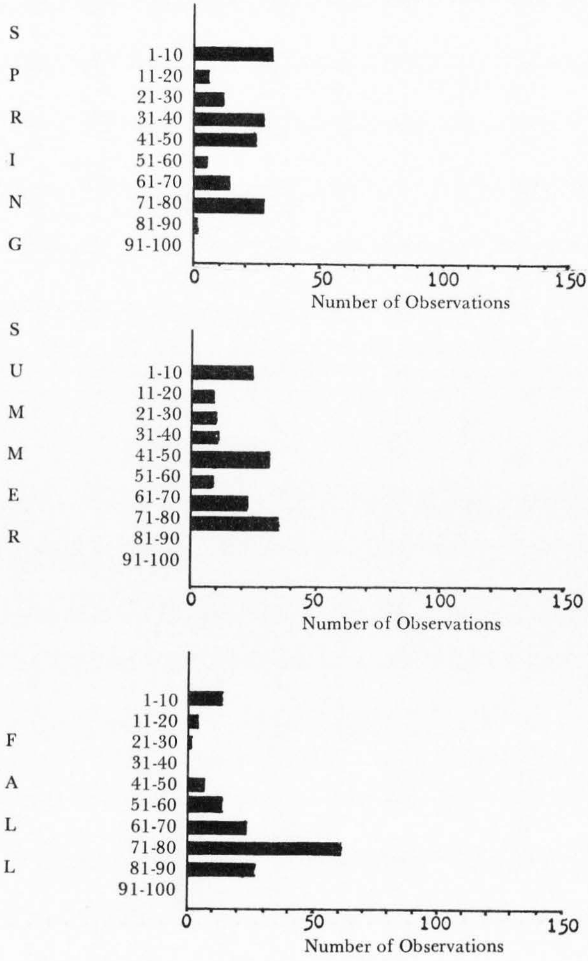

Figure 11. Percent utilization of vegetation by livestock in relation to common snipe observations (numbers represent percentage of vegetation use).

Soil moisture appeared to have the greatest influence upon the distribution of common snipe as virtually all observations were in water covered or saturated areas (Figure 12). There were no observations in those areas of dry or only moist soil. In those areas that were water covered the depth of water was always less than a decimeter. It was noted that if conditions for snipe appeared to be ideal with the exception of water then snipe were not present. If other conditions were not exactly ideal and the soil was saturated or water covered, snipe were often observed in that area.

Food habits

Items identified were placed into the three categories of animal material, plant material and grit (Table 1). All three categories were strongly represented when frequency of occurrence was considered. Grit and plant material were found in almost every stomach examined while animal material was found in almost 84 percent of the total stomachs. When the total volume of the items ingested in each of these major categories was considered animal material comprised an overwhelming 70 percent of the total while grit and plant material comprised approximately only 17 and 13 percent respectively. In this instance the percent of total volume is probably a better criterion for determining food preferences than is frequency of occurrance. The frequency of occurrence percentage for plant material is probably inflated by the presence of plant fibers that are particularly resistant to digestion.

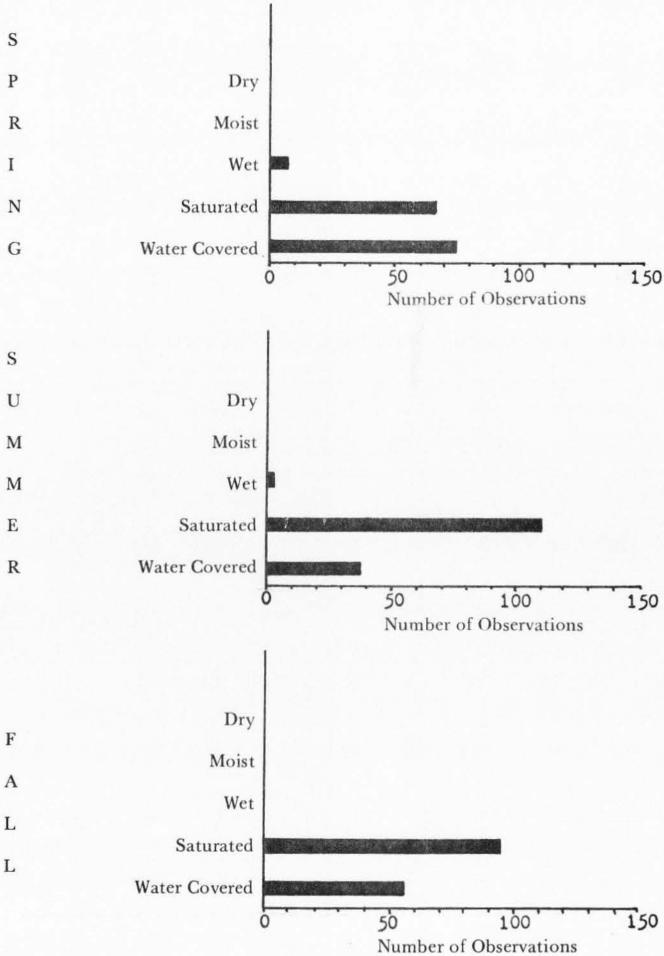

Figure 12. Soil moisture in relation to common snipe observations.

Table 1. Major items found in the stomachs of 80 snipe collected in northern Utah

Item	Percent of total volume	Percent frequency	Times occurring as trace
Animal material	(70.31)	(83.75)	(43)
Annelida			
Worms	19.79	30.00	1
Leaches	0.79	2.50	1
Insecta			
Odonata			
Libellulidae	0.48	2.50	0
Megaloptera			
Sialidae	0.24	10.00	6
Coleoptera			
Haliplidae	trace	1.25	1
Hydrophilidae	1.66	30.00	14
Carabidae	0.16	1.25	1
Diptera			
Tipulidae	1.74	5.00	0
Chironomidae	0.08	1.25	0
Ceratopogonidae	trace	1.25	1
Stratiomyidae	33.65	37.50	8
Dolichopodidae	1.19	12.50	4
Syrphidae	5.70	2.50	0
Ephydridae	0.79	1.25	0
Muscidae	trace	5.00	4
Culicidae	0.08	1.25	0
Arachnida			
Spiders	0.55	2.50	0
Mollusca			
Snails	3.56	18.75	1
Mussels	trace	1.25	1
Crustacea			
Fairy shrimp	0.16	1.25	0
Plant Material	(12.75)	(97.50)	(112)
Plant Fibers	9.58	95.00	17
Seeds			
Carex spp.	0.16	17.50	15
Ranunculus spp.	0.79	50.00	36
Polygonum spp.	1.50	52.50	30
Juncus spp.	0.08	15.00	11
Rumex spp.	trace	2.50	2
Sparganium spp.	0.63	1.25	0
Unidentified seed	trace	1.25	1
Grit	16.94	97.50	5

It was noted that seeds found in stomachs were always whole and never in a partially digested condition. In stomachs containing no animal matter plant fibers were found on a number of occasions to be compacted into tight masses or pellets. These pellets in several cases contained seeds and or particles of grit. Pellets of this nature are probably the same pellets noted by Tuck (1972). Plant fibers were also observed entwined about most animal matter that was collected from the soil samples indicating that these fibers could well have been ingested incidentally to the animal material.

Animal material appeared to be the more important part of the common snipe diet in that it comprised a greater percentage of the total volume of items ingested. The animal food items found in the snipe stomachs were compared with the available animal food that was removed from the soil samples collected in the study area. These comparisons indicate that snipe selected certain food items over others and that this preference was not independent of the season of the year as shown by a chi-square contingency table (Appendix B). Items that formed a statistically significant part of common snipe diet are displayed in Table 2. A number of these food items are significant in that they were selected against by snipe. Worms were the only group consistently in this category. This might be explained by the fact that the majority of the worms found in the soil were extremely small, usually less than three cm in length and one mm in diameter. Those worms

Table 2. Chi-square analysis of animal food items found to be significant in stomachs of common snipe collected in northern Utah (values represent a comparison of individual food items in each season to all other items in that season)

	Chi-square values		
	Spring	Summer	Fall
Annelida			
Worms	196.4**	748.6**	217.6**
Leeches	21.0**	> 0.1	0.1
Insecta			
Stratiomyidae	3240.1**	800.2**	118.9**
Dolichopodidae	63.1**	> 0.1	145.3**
Syrphidae	1.3	248.9**	0.0
Ephydridae	6.7**	21.1**	0.0
Muscidae	a	0.2	137.2**
Mollusca			
Snails	4.3*	81.7**	90.6**

* Significant at the 0.05 level
** Significant at the 0.01 level
Degrees of freedom = 1
[a] Undefined with an expected value of zero

found in snipe stomachs were normally larger or at least five times the diameter of the worms found in the soil. Size apparently had a great deal to do with the food items selected by snipe. Those items selected by snipe were as a class generally larger in size than those not selected. Seasonal differences in selection of food items in Table 2 is probably explained by seasonal availability of those food items. Several families of insects including Hydrophilidae and Sialidae were found in the stomachs of snipe but not in the collected soil samples. In some instances this was possibly the result of sampling error, while in other cases such as Hydrophilidae and Sialidae, the insects are normally found in habitats other than in the soil and would not have been collected in the soil samples. Another possibility is that snipe ingested the food items outside the study area and were subsequently collected in the study area.

Breeding biology

Winnowing habits. Common snipe began to winnow in northern Utah in mid-March and continued until about mid-July. Maximum winnowing activity took place in April, May and early June. In 1974 and 1975 winnowing began on 16 and 17 March respectively and was not heard after 20 July in either year. A multiple regression analysis of the effect of measured weather and environmental variables upon snipe winnowing activity is shown in Table 3. Two factors were found to be statistically significant. Temperature was significant at the 0.05 level and light conditions were significant at the 0.01 level. When a stepwise deletion of variables was conducted until only the two variables of temperature and light conditions remained a coefficient of determination (R^2) value of 0.39 was achieved.

Observations of winnowing activity supported the values in Table 3. Snipe winnowing activity was most intense in periods of subdued light and cooler temperatures. These conditions normally existed at both dawn and dusk although an overcast day would also increase winnowing activity. Snipe were also observed winnowing vigorously on a clear, moonlit night when the moon was one night past the full stage on 27 May 1975. Precipitation had little effect on winnowing activity since birds

Table 3. Analysis of variance table for variables associated with common snipe winnowing activity

Variable	Degrees of freedom	Mean square	F
Temperature	1	1764.659	5.691*
Relative humidity	1	176.329	0.569
Wind velocity	1	853.832	2.754
Precipitation	1	672.709	2.170
Cloud cover	1	996.237	3.213
Light conditions	6	5314.631	17.141**
Error	166	310.061	----
Total	177	----	----

* Significant at the 0.05 level
** Significant at the 0.01 level

were observed winnowing in both rain and snow storms. Wind velocity also had little effect on winnowing until the wind speed reached a point where snipe had difficulty maintaining their position in the air. Snipe would normally land and seek cover when wind velocities exceeded 20 km per hour. The amount of cloud cover appeared to have no effect on winnowing activity except as it influenced light conditions, while relative humidity apparently had no effect on winnowing.

Territorial behavior. Upon their arrival at the breeding grounds in mid-March common snipe could be observed moving about in loose flocks of from 5 to 20 birds. Although winnowing activity began at this time it did not reach its maximum intensity until about 1 April when snipe were observed to begin pair formation. Territories were established between 1 April and 15 April and occupied continually until about 15 June. A male snipe would normally establish a territory about nine hectares in area although the size varied slightly. Other results were in accordance with Tuck (1972).

Courtship and brooding behavior. The results of this study revealed no new information beyond that provided by Tuck (1972).

Sexing and aging

Sexing. In order to ascertain if an equation could be developed that would provide a means of externally determining the sex of common snipe, a stepwise discriminant function analysis was run using 43 different variables. These variables included total bill length, bill length (tip to nostril), bill length (nostril to culmen), bill depth, tarus length, length from base of tarsus to base of the toes, all toe lengths, length and width of the five outer primaries and five outer secondaries, length and width of the three outer and two inner rectrices, total length, length of the wind chord and total weight. Of these 43 variables, six were shown to differ significantly between males and females (Table 4). It should be noted that even though the means of these six variables were significantly different there was in each case a high percentage overlap, which is defined as the percentage of the values that are common to both distributions.

Table 4. Results of analysis of variance of the six measurements with significant differences between male and female snipe

Variable		Mean squares		$F_{1,37}$	Means & standard deviations		Percentage overlap
		Sex	Error		Males	Females	
Bill length total	(X_1)	42.3399	7.1420	5.928*	63.6 mm ±2.4	66.0 mm ±3.3	64
Bill length tip to nostril	(X_2)	46.4103	7.4291	6.247*	57.4 mm ±2.4	59.9 mm ±3.5	60
Width 1st secondary	(X_3)	2.2465	0.4479	5.016*	13.1 mm ±0.6	13.7 mm ±0.8	74
Length 3rd rectrix	(X_4)	28.9287	5.8848	4.916*	55.2 mm ±2.6	53.2 mm ±1.6	46
Width 7th rectrix	(X_5)	6.6963	1.1751	5.699*	12.3 mm ±1.0	11.2 mm ±1.3	72
Total weight	(X_6)	1929.1106	189.3962	10.186**	92.8 g ±12.8	108.9 g +16.4	33

* Significant at the 0.05 level

** Significant at the 0.01 level

The six variables listed in Table 4 were combined into a linear function which maximized the differences between sexes. The linear function is expressed as:

$$Z = 0.2456X_1 - 0.3363X_2 0.5950X_3 + 0.0659X_4 + 0.6832X_5 - 0.0379X_6$$

If the resulting Z value was greater than −3.866, the snipe was classified as a male. If the resulting Z value was less than −3.866 the bird was considered to be a female. Using this function 32 of 39, or 82.1 percent, of the common snipe were correctly sexed.

Two of the variables in the discriminant function designed to determine sex would be extremely difficult to measure in the field on a live bird. These two variables, the widths of the first secondary (X_3) and of the seventh rectrice (X_5), were deleted and another discriminant function was run using the four remaining variables. The resulting linear function is expressed as:

$$Z = 0.4241X_1 - 0.7740X_2 + 0.4568X_4 - 0.1112X_6$$

If the resulting Z value was greater than −4.685 the bird was classified as a male while if the Z value was less than −4.685 the bird was considered to be a female. Using this function 27 of 39, or 69.2 percent, of the snipe considered were correctly sexed.

Plumage characteristics were examined to determine if there were any means of externally sexing snipe. No new characteristics that had not been previously discussed by other authors were noted. The method developed by Oswald (1969) was applied to the snipe collected for the study. This method utilized the number of bars on the outer rectrix. By using this technique 66.1 percent, or 41 of 62 snipe were correctly sexed.

Aging. A stepwise discriminant function analysis was run using the same 43 variables used in the sexing study to determine if snipe could be aged using external body and feather measurements. Of the 43 variables, four were shown to differ significantly between adults and immatures (Table 5). It should be noted that even though the means of these four variables were significantly different there was a high percentage overlap in each case.

The four variables listed in Table 5 were combined in a linear function which maximized the differences between adults and immatures. The linear function is expressed as:

$$Z = 0.2970X_1 + 0.1666X_2 + 0.8096X_3 + 0.4782X_4$$

If the resulting Z value was greater than 29.549 the snipe was classified as an adult. If the resulting Z value was less than 29.549 the snipe was classified as an immature. Using this function 30 out of 39, or 76.9 percent of the common snipe considered were correctly aged.

Plumage characteristics were examined for a means of externally aging snipe. The method suggested by Tuck (1972) was applied to the collected snipe. Tuck's method relied upon the markings of the upper wing coverts. Results of using this technique showed that 84.0 percent

Table 5. Results of analysis of variance of the four measurements with significant differences between adult and immature snipe

		Mean squares			Mean & standard deviations		Per centage overlap
		Age	Error	$F_{1,37}$	Adults	Immatures	
Length 2nd rectrix	(X_1)	65.0563	8.3138	7.825**	53.1 mm ±2.9	50.3 mm ±3.0	60
Width 2nd rectrix	(X_2)	2.2173	0.4673	4.745*	9.5 mm ±0.7	8.9 mm ±0.6	62
Width 3rd rectrix	(X_3)	3.8339	0.6979	5.493*	10.3 mm ±0.9	9.6 mm ±0.7	49
Width 8th rectrix	(X_4)	5.0421	1.1064	4.557	11.6 mm ±1.2	10.8 mm ±0.5	49

* Significant at the 0.05 level

** Significant at the 0.01 level

of the snipe were correctly aged. Whitehead (1965) suggested that the upper, outer primary coverts were effective in aging snipe. Utilizing this technique 69.8 percent of the snipe collected were correctly aged.

In studying the plumage it was noted that the rectrices of immature snipe had a faint terminal black line which in some cases was only a black point at the distal end of the shaft. This marking was not present in adult snipe. The terminal marking is most apparent on rectrices of immature snipe that were collected in late August and September. The markings on those birds collected in October and November were not so clearly defined and the terminal marking was normally evident only on the central rectrices. By using this technique 49 of 58, or 84.5 percent of the snipe examined were correctly aged.

Census techniques

The results of the census methods utilized are shown in Table 6. The actual count numbers represent the total number of common snipe observed within a portion of the study area during the spring. Although systematic counts were conducted on only two occasions, observations while conducting other portions of the study confirmed that the number counted was indeed close to the actual population number and in all probability no more than a 10 percent error was incurred. The number obtained by this method probably represents a conservative estimate of the population size. The actual count and the other census techniques were all conducted during the spring while snipe were occupying

Table 6. Comparison of techniques used to census common snipe

Survey number	Actual count	King strip census	Hayne strip census	Territorial determination
1	24	218	246	25
2	26	112	141	--
3	--	121	134	--
4	--	79	117	--
5	--	48	49	--
Mean	25	116	137	25

territories and were relatively evenly spread through the habitat. After July when birds began to move in small flocks from one area to another the techniques began to break down completely.

The best result of all the techniques was obtained by using the average territory size. The average size of snipe territories was determined by observations in the spring to be 9 hectares. When this figure was divided into the amount of suitable habitat an estimate of the population of 12.5 pairs or 25 common snipe was obtained. This estimate compares favorably with the estimate obtained by an actual count.

The Kind strip census method and the Hayne modification of the method both resulted in estimates that were greatly inflated. The estimates were obviously in excess of actual numbers and the methods appear to be unworkable with common snipe in northern Utah. Moreover, the results of the censuses conducted by both methods show a wide range of values with only one value at the lower limit giving an estimate of the population that is at all reasonable. This could be the result of the small number of snipe observed and a large sampling variance. In addition the average flushing angle varied from 35 to 52 degrees. Seber (1973) points out that both the King and Hayne methods are sensitive to departures from an average flushing angle of 32.704 degrees and that the Hayne method in particular is positively biased when the flushing angle exceeds 40 degrees.

It was hoped that two additional methods could be employed to determine estimates of the population. The first of these was the Lincoln-Petersen index. No estimates were obtained using this method primarily because of the difficulty in capturing and marking enough birds in order that a detectable number could be counted at a later time. Seber (1973) states that if there are less than seven recaptures there is a high probability that the estimate of the population size will be biased. He goes on to point out that if the number of marked animals is much less than 10, the Lincoln-Peterson index may fail to give even the correct order of magnitude of the population.

The second method that offered a possibility for population estimates was based upon the winnowing activities of common snipe. It was hoped that winnowing counts would give an estimate of the number of breeding pairs in an area which could then be expanded to a larger area. This method broke down because of the difficulty of distinguishing the number of birds winnowing when more than three snipe were active.

In addition the number of snipe winnowing would vary greatly within short periods of time which made an estimate based upon this method unlikely to be useful.

CONCLUSIONS AND RECOMMENDATIONS FOR MANAGEMENT

Habitat requirements

Conclusions. Soil moisture appears to be the single most important element in the selection of a particular habitat by common snipe. This observation is substantiated by the fact that almost all sightings of snipe were in areas that were water covered or completely saturated. The importance of water is further demonstrated by the proximity of standing water to each snipe observation. After appropriate water conditions are provided, density and height of vegetation seem to be of great importance to snipe habitat. Common snipe appear to avoid open ground as well as heavily vegetated areas and select primarily those areas that are neither too dense nor too open, normally between 30 and 50 percent density of vegetation. Almost every observation of snipe took place in vegetation with an overstory height of three decimeters or less. In those instances where snipe were observed in higher vegetation, the vegetation was normally less dense.

The other variables in the habitat study can be related in some way to soil moisture and height and density of vegetation and are important primarily as they relate to these three variables. Obviously soil moisture has a great deal to do with determining vegetation type and snipe, preferring wet areas, were found in those vegetation types that are wet. Thus, wet pasture is an important vegetation type primarily because it is wet. The fact that more snipe were observed in wet pasture as opposed to lowland meadow with similar soil moisture is related to the greater amount of the study area devoted to pasture. The effects of grazing which tends to reduce tall, dense vegetation to the conditions preferred by snipe also accounts for this observation. The dominant vegetation in turn appears to be dictated by the soil moisture. The overwhelming number of observations in sedges, primarily Carex aquatilis, is a reflection of the soil moisture conditions more than anything else. Both snipe and sedges prefer saturated and shallow water covered soil.

Recommendations for management. Management should be centered on those elements of snipe habitat that are most important to snipe. A dependable supply of water is obviously most important. In areas where such a supply does not occur naturally, water would have to be supplied from another source such as irrigation or diversion of other waters. In northern Utah for example, waste irrigation water is normally diverted into pastures which are lower in elevation than most cultivated crops. Although not a deliberate management effort, this practice results in an area with ideal soil moisture conditions for common snipe.

There are several means of reducing height and density of vegetation. Grazing appears to be most effective because in addition to reduction of vegetation height, density of vegetation is also affected by hoof action. Mowing also appears to be effective in reducing vegetation height but the area must be recut periodically as the vegetation grows. Mowing has the disadvantage of not affecting the vegetation density. Disking the field might well be an effective means of decreasing vegetation density although the effects of this practice were not observed. Spring burns, where the water covered roots of plants would not be damaged, could also be effective in reducing vegetation height and perhaps density, although the area would have to be subsequently mowed or grazed to counteract vegetation growth. The effects of burning on snipe habitat have not been observed.

Food habits

The diet of common snipe consists primarily of animal material and plant material appears to be ingested only incidentally, since it is in close association in the soil with animal food items. The formation of pellets in the stomachs of snipe also indicate that plant material is not utilized. Within the broad category of animal material snipe seemed to prefer insect larvae, particularly those of the family Stratiomyidae. This preference appeared to be related more to the size and availability of the animal material than to a particular family or group. As an example the Stratiomyidae larvae were normally between two and three cm in length and five to seven mm in diameter and were generally the largest burrowing organism collected in the soil samples. Seasonal availability of insect larva changed with the life cycle of the insect and snipe appeared to select accordingly.

Breeding biology

Winnowing activity is most intense in periods of subdued light and cooler temperatures that exist primarily at dawn and dusk. Other conclusions regarding breeding biology coincide with the observations of Tuck (1972).

Sexing and aging

Conclusions. None of the techniques suggested in the literature is reliable in externally determing the sex of common snipe. Although a reasonably high percentage (82.1 percent) of the snipe considered were correctly sexed by the use of a discriminant function employing six variables (Table 4), the method is suspect because of the high percentage overlap of each of the variables and the difficulty that would be encountered in obtaining some of the measurements in the field from a live bird. In particular the width of feather measurements would be extremely difficult where the difference between sexes amounts to a millimeter or less. Additionally the method could give a lesser percentage of correctly sexed birds if applied to a sample of snipe other than those used to develop the function. A second discriminant function which considered the four variables of the six in the first function that could be easily measured in the field, correctly sexed only 69.2 percent of the snipe to which it was applied. The percent misclassification is probably too great for this function to be useful.

The same difficulties encountered with the first two functions would be experienced with the discriminant function developed to age snipe using the four variables in Table 5, even though 76.9 percent of the birds considered were correctly aged. Of the techniques suggested by other authors, the one determined by Tuck (1972) utilizing the characteristics of the upper wing coverts is the only one that consistently gave reliable results. Using this method 84.0 percent of the snipe considered were correctly aged. A technique using the faint black terminal marking of the rectrices as an indication of an immature bird was developed and proved to be effective 84.5 percent of the time in determining age.

Recommendations for management. There is a large variability in plumage characteristics of common snipe and to date an effective and usable technique to externally sex snipe has not been developed. None of the techniques developed for determining sex can be employed by the manager in the field with any degree of confidence. On the other hand, the method suggested by Tuck (1972) and the new technique set forth here both appear to be useful in determining age.

Census techniques

The King strip census method and the modification of this method suggested by Hayne both give estimates of the population that are inflated. The inflated estimates were probably a result of the very small numbers of snipe observed and the departure of the average flushing angle from 32.704 degrees. In addition, the estimates have a very large sampling variance. Although the methods might be usable in areas where greater concentrations of snipe are found they do not appear to be workable in northern Utah.

The Lincoln-Petersen index is useless in the census of common snipe populations of the size and nature of those encountered in northern Utah. The method is not effective because of the difficulty in capturing and marking enough birds so that a detectable number can be counted at a later time. Perhaps the method could be used in populations where there is a greater concentration of snipe, although the time and effort involved in applying the technique would be excessive to obtain what would be questionable results.

An actual count of the population can be accomplished in areas that are relatively small and during the breeding season when birds are spread through the area in territories. The resulting estimate should be within ten percent of the actual population number. An actual count is much more difficult when larger numbers of snipe are present and are moving about an area in loose flocks in late summer and fall. Difficulty is also encountered if the area to be censused is large.

Estimates of the population size determined by dividing the average territory size into the amount of total suitable habitat appear to give reliable results. Obviously this method is workable only during the breeding season. Difficulties arise if the suitable habitat is not completely occupied by snipe. The method also makes no provision for counting those birds not occupying territories.

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APPENDIXES

Appendix A

Chi-square Analysis of Habitat Variables

Table 7. Chi-square analysis of the number of common snipe observed in each vegetation type during the spring, summer and fall in northern Utah, 1974 and 1975

Vegetation type	Percent of study area	Number observed and chi-square values					
		Spring		Summer		Fall	
Upland meadow	5	0	7.5**	0	7.5**	0	7.5**
Lowland meadow	5	10	0.8	17	12.0**	13	4.0
Dry pasture	30	0	45.0**	0	45.0**	0	45.0**
Wet pasture	20	98	154.1**	77	73.6**	43	5.6*
Shallow marsh	7	42	94.5**	56	197.2**	94	664.0**
Deep marsh	13	0	19.5**	0	19.5**	0	19.5**
Cultivated crops	20	0	30.0**	0	30.0**	0	30.0**
		150	351.4**	150	384.8**	150	775.6**

* Significant at the 0.05 level

** Significant at the 0.01 level

Degrees of freedom = 6

Table 8. Chi-square contingency table analysis of the number of common snipe observed in each vegetation type during each season in northern Utah, 1974 and 1975

Vegetative type	Spring	Summer	Fall	Row totals
Upland meadow	0	0	0	0
Lowland meadow	10	17	13	40
Dry pasture	0	0	0	0
Wet pasture	98	77	43	218
Shallow marsh	42	56	94	192
Deep marsh	0	0	0	0
Cultivated crops	0	0	0	0
Column totals	150	150	150	450
	Chi-square = 45.67**			

**Significant at the 0.01 level

Degrees of freedom = 12

Table 9. Chi-square analysis of the number of common snipe observed in each vegetation dominant during the spring, summer and fall in northern Utah, 1974 and 1975

Vegetation dominant	Percent of study area	Number observed and chi-square values					
		Spring		Summer		Fall	
Cyperaceae	20	120	270.0**	108	202.8**	113	229.6**
Poaceae	35	10	34.4**	11	32.8**	10	34.4**
Juncaceae	5	7	> 0.1	1	5.6*	2	4.0
Typhaceae	5	2	4.0	11	1.6	2	4.0
Scrophulariaceae	2	3	0.0	14	40.3**	7	5.3*
Brassicaceae	1	0	1.5	2	0.2	0	1.5
Ranunculaceae	1	0	1.5	1	0.2	3	1.5
Asteraceae	1	0	1.5	2	0.2	0	1.5
Polygonaceae	3	0	4.5	0	4.5	13	16.1**
Sparganaceae	5	7	> 0.1	0	7.5**	0	7.5**
Lemnaceae	2	1	1.3	0	3.0	0	3.0
Cultivated crops	20	0	30.0**	0	30.0**	0	30.0**
		150	348.8**	150	328.7**	150	338.4**

* Significant at the 0.05 level
** Significant at the 0.01 level
Degrees of freedom = 11

Table 10. Chi-square contingency table analysis of the number of common snipe observed in each vegetation dominant during each season in northern Utah, 1974 and 1975

Vegetative dominant	Spring	Summer	Fall	Row totals
Cyperaceae	120	108	113	341
Poaceae	10	11	10	31
Juncaceae	7	1	2	10
Typhaceae	2	11	2	15
Scrophulariaceae	3	14	7	24
Brassicaceae	0	2	0	2
Ranunculaceae	0	1	3	4
Asteraceae	0	2	0	2
Polygonaceae	0	0	13	13
Sparganaceae	7	0	0	7
Lemnaceae	1	0	0	1
Cultivated crops	0	0	0	1
Column totals	150	150	150	450

Chi-square = 79.38**

**Significant at the 0.01 level
Degrees of freedom = 22

Table 11. Chi-square analysis of the number of common snipe observed in each level of density of vegetation during the spring, summer and fall in northern Utah, 1974 and 1975

Density of vegetation	Percent of study area	Number observed and chi-square values					
		Spring		Summer		Fall	
1-10 percent	10	0	15.0**	2	11.3**	0	15.0**
11-20 percent	10	15	0.0	7	4.3*	3	9.6**
21-30 percent	10	18	0.6	24	5.4*	24	5.4*
31-40 percent	10	27	9.6**	22	3.3	14	0.1
41-50 percent	10	33	21.6**	47	68.3**	76	248.1**
51-60 percent	10	20	1.6	17	0.3	1	13.1**
61-70 percent	10	21	2.4	17	0.3	9	2.4
71-80 percent	10	8	3.3	7	4.3*	0	15.0**
81-90 percent	10	8	3.3	6	5.4*	20	1.7
91-100percent	10	0	15.0**	1	13.1**	3	9.6**
		150	72.4**	150	116.0**	150	305.0**

* Significant at the 0.05 level
** Significant at the 0.01 level
Degrees of freedom = 9

Table 12. Chi-square contingency table analysis of the number of common snipe observed in each level of density of vegetation during each season in northern Utah, 1974 and 1975

Density of vegetation	Spring	Summer	Fall	Row totals
1-10 percent	0	2	0	2
11-20 percent	15	7	3	25
21-30 percent	18	24	24	66
31-40 percent	27	22	14	63
41-50 percent	33	47	76	156
51-60 percent	20	17	1	38
61-70 percent	21	17	9	47
71-80 percent	8	7	0	15
81-90 percent	8	6	20	34
91-100 percent.	0	1	3	4
	150	150	150	150

Chi-square = 79.02**

**Significant at the 0.01 level
Degrees of freedom = 18

Table 13. Chi-square analysis of the number of common snipe observed in each level of mean height of overstory species during the spring, summer and fall in northern Utah, 1974 and 1975

Mean height of overstory	Percent of study area	Number observed and chi-square values					
		Spring		Summer		Fall	
0.0-3.0 dm	15	137	992.3**	145	1126.6**	132	912.6**
3.1-6.0 dm	15	12	0.6	4	8.1**	3	9.6**
6.1-9.0 dm	15	1	13.1**	1	13.1**	0	15.0**
9.1-12.0 dm	15	0	15.0**	0	15.0**	13	0.3
12.1-15.0 dm	15	0	15.0**	0	15.0**	0	15.0**
15.1-18.0 dm	15	0	15.0**	0	15.0**	2	11.3**
18.1-21.0 dm	15	0	15.0**	0	15.0**	0	15.0**
21.1-24.0 dm	15	0	15.0**	0	15.0**	0	15.0**
24.1-27.0 dm	15	0	15.0**	0	15.0**	0	15.0**
27.0 + dm	15	0	15.0**	0	15.0**	0	15.0**
		150	1111.0**	150	1252.8**	150	1023.8**

** Significant at the 0.01 level
Degrees of freedom = 9

Table 14. Chi-square contingency table analysis of the number of common snipe observed in each level of mean height of overstory species during each season in northern Utah, 1974 and 1975

Mean height of overstory	Spring	Summer	Fall	Row totals
0.0-3.0 dm	137	145	132	414
3.1-6.0 dm	12	4	3	19
6.1-9.0 dm	1	1	0	2
9.1-12.0 dm	0	0	13	13
12.1-15.0 dm	0	0	0	0
15.1-18.0 dm	0	0	2	2
18.1-21.0 dm	0	0	0	0
21.1-24.0 dm	0	0	0	0
24.1-27.0 dm	0	0	0	0
27.0 + dm	0	0	0	0
Column totals	150	150	150	450

Chi-square = 39.32**

**Significant at the 0.01 level
Degrees of freedom = 18

Table 15. Chi-square analysis of the number of common snipe observed in each level of vegetation utilization by livestock during the spring, summer and fall in northern Utah, 1974 and 1975

Percent utilization	Percent of study area	Number observed and chi-square values					
		Spring		Summer		Fall	
1-10 percent	28	31	2.9	23	8.6**	13	20.0**
11-20 percent	8	6	3.0	9	0.8	3	6.8*
21-30 percent	8	11	0.1	10	0.3	1	10.1**
31-40 percent	8	28	21.3**	11	0.1	0	12.0**
41-50 percent	8	24	12.0**	31	30.1**	7	2.1
51-60 percent	8	6	3.0	9	0.8	13	0.1
61-70 percent	8	14	0.3	22	8.3**	23	10.1**
71-80 percent	8	29	24.1**	35	44.1**	62	208.3**
81-90 percent	8	1	10.1**	0	12.0**	28	21.3**
91-100 percent	8	0	12.0**	0	12.0**	0	12.0**
		150	88.8**	150	117.1**	150	302.8**

* Significant at the 0.05 level
** Significant at the 0.01 level
Degrees of freedom = 9

Table 16. Chi-square contingency table analysis of the number of common snipe observed in each level of vegetation utilization by livestock during each season in northern Utah, 1974 and 1975

Percent utilization	Spring	Summer	Fall	Row totals
1-10 percent	31	23	13	67
11-20 percent	6	9	3	18
21-30 percent	11	10	1	22
31-40 percent	28	11	0	39
41-50 percent	24	31	7	62
51-60 percent	6	9	13	28
61-70 percent	14	22	23	59
71-80 percent	29	35	62	126
81-90 percent	1	0	28	29
91-100 percent	0	0	0	0
Column totals	150	150	150	450

Chi-square = 135.80**

**Significant at the 0.01 level
Degrees of freedom = 18

Table 17. Chi-square analysis of the number of common snipe observed at varying distances to standing water during the spring, summer and fall in northern Utah, 1974 and 1975.

Distance to water	Percent of study area	Number observed and chi-square values					
		Spring		Summer		Fall	
0.0-3.0 dm	10	123	777.6**	117	693.5**	149	1197.1**
3.1-6.0 dm	10	4	8.1**	3	9.6**	0	15.0**
6.1-9.0 dm	10	3	9.6**	0	15.0**	1	13.1**
9.1-12.0 dm	10	5	6.7**	3	9.6**	0	15.0**
12.1-15.0 dm	10	0	15.0**	1	13.1**	0	15.0**
15.1-18.0 dm	10	0	15.0**	0	15.0**	0	15.0**
18.1-21.0 dm	10	0	15.0**	0	15.0**	0	15.0**
21.1-24.0 dm	10	0	15.0**	0	15.0**	0	15.0**
24.1-27.0 dm	10	0	15.0**	0	15.0**	0	15.0**
27.0 + dm	10	15	0.0	26	8.6**	0	15.0**
		150	877.0**	150	809.4**	150	1330.2**

** Significant at the 0.01 level
Degrees of freedom = 9

Table 18. Chi-square contingency table analysis of the number of common snipe observed at varying distances to standing water during each season in northern Utah, 1974 and 1975

Distance to water	Spring	Summer	Fall	Row totals
0.0-3.0 dm	123	117	149	389
3.1-6.0 dm	4	3	0	7
6.1-9.0 dm	3	0	1	4
9.1-12.0 dm	5	3	0	8
12.1-15.0 dm	0	1	0	1
15.1-18.0 dm	0	0	0	0
18.1-21.0 dm	0	0	0	0
21.1-24.0 dm	0	0	0	0
24.1-27.0 dm	0	0	0	0
27.0 + dm	15	26	0	41
Column totals	150	150	150	450
	Chi-square = 43.62**			

**Significant at the 0.01 level
Degrees of freedom = 18

Table 19. Chi-square analysis of the number of common snipe observed in each land use during the spring, summer and fall, 1974 and 1975

Land use	Percent of study area	Number observed and chi-square values					
		Spring		Summer		Fall	
Idle	5	4	1.6	0	7.5**	13	4.0
Wild hay	5	9	0.3	17	12.0**	0	7.5**
Grazed	70	137	9.8**	133	7.5**	137	9.8**
Cultivated	20	0	30.0**	0	30.0**	0	30.0**
		150	41.7**	150	57.0**	150	51.3**

** Significant at the 0.01 level
Degrees of freedom = 3

Table 20. Chi-square contingency table analysis of the number of common snipe observed in each land use during each season in northern Utah, 1974 and 1975

Land use	Spring	Summer	Fall	Row totals
Idle	4	0	13	17
Wild hay	9	17	0	26
Grazed	137	133	137	407
Cultivated	0	0	0	0
Column totals	150	150	150	450

Chi-square = 32.26**

**Significant at the 0.01 level
Degrees of freedom = 6

Table 21. Chi-square analysis of the number of common snipe observed in each soil moisture condition during the spring, summer and fall in northern Utah, 1974 and 1975

Soil moisture	Percent of study area	Number observed and chi-square values					
		Spring		Summer		Fall	
Dry	30	0	45.0**	0	45.0**	0	45.0**
Moist	10	0	15.0**	0	15.0**	0	15.0**
Wet	10	7	4.3	2	11.3**	0	15.0**
Saturated	30	67	10.8**	110	93.9**	94	53.4**
Water covered	20	76	70.5**	38	2.1	56	22.5**
		150	145.6**	150	167.3**	150	150.9**

**Significant at the 0.01 level
Degrees of freedom = 4

Table 22. Chi-square contingency table analysis of the number of common snipe observed in each soil moisture condition during each season in northern Utah, 1974 and 1975

Soil moisture	Spring	Summer	Fall	Row totals
Dry	0	0	0	0
Moist	0	0	0	0
Wet	7	2	0	9
Saturated	67	110	94	271
Water covered	76	38	56	170
Column totals	150	150	150	450

Chi-square = 31.87**

**Significant at the 0.01 level
Degrees of freedom = 8

Appendix B

Analysis of Food Habits Study

Table 23. Chi-square analysis of animal material found in stomachs of common snipe collected during the spring in northern Utah, 1975

Animal material	Number observed	Available in soil Percent(Number)	Number expected	Chi-square
Annelida				
Worms	21	69.96(319)	97.244	59.8**
Leeches	9	1.54(7)	2.141	22.0**
Insecta				
Odonata				
Libellulidae	1	0.22(1)	0.306	1.6
Megaloptera				
Sialidae	3	0.00(0)	0.000	a
Coleoptera				
Haliplidae	0	0.22(1)	0.306	0.3
Hydrophilidae	13	7.24(33)	10.064	0.9
Carabidae	0	0.00(0)	0.000	0.0
Diptera				
Tipulidae	5	0.00(0)	0.000	a
Chironomidae	0	1.75(8)	2.433	2.4
Ceratopogonidae	0	1.32(6)	1.835	1.8
Stratiomyidae	72	1.10(5)	1.529	3248.0**
Dolichopodidae	9	0.66(3)	0.917	71.2**
Syrphidae	0	1.54(7)	2.141	2.1
Ephydridae	0	5.26(24)	7.311	7.3*
Muscidea	2	0.00(0)	0.000	a
Culicidae	0	0.00(0)	0.000	0.0
Arachnida				
Spiders	1	0.00(0)	0.000	a
Mollusca				
Snails	2	5.92(27)	8.229	4.7*
Mussels	1	3.29(15)	4.573	2.8
Crustacea				
Fairy shrimp	0	0.00(0)	0.000	0.0
				3424.9**

*Significant at the 0.05 level

**Significant at the 0.01 level

Degrees of freedom = 13

[a] Undefined with an expected value of zero

Table 24. Chi-square analysis of animal material found in stomachs of common snipe collected during the summer in northern Utah, 1975

Animal material	Number observed	Available in soil Percent(Number)	Number expected	Chi-square
Annelida				
Worms	23	91.62(2089)	104.447	63.5**
Leeches	0	0.57(13)	0.650	0.7
Insecta				
Odonata				
Libellulidae	0	0.00(0)	0.000	0.0
Megaloptera				
Sialidae	8	0.00(0)	0.000	a
Coleoptera				
Haliplidae	1	0.00(0)	0.000	a
Hydrophilidae	14	0.00(0)	0.000	a
Carabidae	1	0.00(0)	0.000	a
Diptera				
Tipulidae	1	0.22(5)	0.251	2.2
Chironomidae	1	0.09(2)	0.103	0.1
Ceratopogonidae	1	3.33(76)	3.796	2.1
Stratiomyidae	21	0.44(10)	0.502	837.0**
Dolichopodidae	1	0.44(10)	0.502	0.5
Syrphidae	23	1.54(35)	1.756	257.0**
Ephydridae	4	0.39(9)	0.445	28.4**
Muscidae	0	0.22(5)	0.251	0.3
Culicidae	1	0.00(0)	0.000	a
Arachnida				
Spiders	1	0.00(0)	0.000	a
Mollusca				
Snails	11	0.96(22)	1.094	89.7**
Mussels	0	0.00(0)	0.000	0.0
Crustacea				
Fairy shrimp	2	0.00(0)	0.000	a
				1281.7**

**Significant at the 0.01 level

Degrees of freedom = 11

[a]Undefined with an expected value of zero

Table 25. Chi-square analysis of animal material found in stomachs of common snipe collected during the fall in northern Utah, 1974

Animal material	Number observed	Available in soil Percent(Number)	Number expected	Chi-square
Annelida				
Worms	28	90.25(1417)	65.883	21.8**
Leeches	0	0.96(15)	0.701	0.7
Insecta				
Odonata				
Libellulidae	1	0.00(0)	0.000	a
Megaloptera				
Sialidae	0	0.00(0)	0.000	0.0
Coleoptera				
Haliplidae	0	0.06(1)	0.044	> 0.1
Hydrophilidae	2	0.00(0)	0.000	a
Carabidae	0	0.00(0)	0.000	0.0
Diptera				
Tipulidae	0	0.06(1)	0.044	> 0.1
Chironomidae	0	0.57(9)	0.416	0.4
Ceratopogonidae	0	0.45(7)	0.329	0.3
Stratiomyidae	6	0.32(5)	0.234	142.1**
Dolichopodidae	10	0.76(12)	0.555	160.7**
Syrphidae	0	0.00(0)	0.000	0.0
Ephydridae	0	0.00(0)	0.000	0.0
Muscidae	3	0.06(1)	0.044	198.6**
Culicidae	0	0.00(0)	0.000	0.0
Arachnida				
Spiders	0	0.19(3)	0.139	0.1
Mollusca				
Snails	23	5.48(86)	4.000	90.3**
Mussels	0	0.13(2)	0.095	0.1
Crustacae				
Fairy shrimp	0	0.38(6)	0.277	0.3
				615.9**

**Significant at the 0.01 level

Degrees of freedom = 13

[a]Undefined with an expected value of zero

Table 26. Chi-square contingency table analysis of animal material found in stomachs of common snipe collected during each season in northern Utah, 1974 and 1975

Animal material	Spring	Summer	Fall	Row totals
Annelida				
Worms	21	23	28	72
Leeches	9	0	0	9
Insecta				
Odonata				
Libellulidae	1	0	1	2
Megaloptera				
Sialiade	3	8	0	11
Coleoptera				
Haliplidae	0	1	0	1
Hydrophilidae	13	14	2	29
Carabidae	0	1	0	1
Diptera				
Tipulidae	5	1	0	6
Chironomidae	0	1	0	1
Ceratopogonidae	0	1	0	1
Stratiomyidae	72	21	6	99
Dolichopodidae	9	1	10	20
Syrphidae	0	23	0	23
Ephydridae	0	4	0	4
Muscidae	2	0	3	5
Culicidae	0	1	0	1
Arachnida				
Spiders	1	1	2	2
Mollusca				
Snails	2	11	23	36
Mussels	1	0	0	1
Crustacea				
Fairy shrimp	0	2	0	2
	139	114	73	326

Chi-square = 204.02**

**Significant at the 0.01 level
Degrees of freedom = 46

VITA

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