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THE NEST SITE SELECTION BEHAVIOR OF THE LARK BUNTING, *CALAMOSPIZA MELANOCORYS*

by

THOMAS GREGORY SHANE

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Introduction

Throughout the areas inhabited by man, organisms have been confronted with a changing environment. There is a long list of recent species that no longer exist because they could not adapt to changes as fast as man was making them. However, many species have adapted to the various subseres created by man and have done so quite rapidly.

The Lark Bunting (Calamospiza melanocorys) is one of the most abundant birds breeding in the short grass prairie region of central North America (Robbins and Van Velzen, 1969). It ranges through the high plains from northern Texas to Saskatchewan, and utilizes a wide variety of man-modified habitats or subseres for nesting purposes (Benckeser, 1957; Cameron, 1908; Cary, 1902; Cody, 1968; Quillin, 1935; Reed, 1904; Rice, 1965; Sclater, 1912; Walcheck, 1970; and Whittle, 1922). Its ground nesting behavior in short vegetation reduces the complexity of the structural dimensions in its habitat, making most mensuration and their analyses easy. The simplicity of the habitat and the distinct epigamic plumage of the male Lark Bunting facilitate censusing and locating nests.

Little is known about the Lark Bunting beyond the usual descriptions of various early naturalists (Langdon, 1933). These have been summarized by Baumgarten (Bent, 1968).

For species occupying unnatural habitats Lack (1968) has considered the following possibilities of adaptation:

(1) "In evaluating survival value it is important to remember that the features under consideration were normally evolved as adaptations to the natural habitat of the species concerned. Hence they are not necessarily those most advantageous at the present day in habitats modified by man, and in some cases it may even be difficult nowadays to see that they are adaptations at all."

(2) "It might be argued that changes in the environment due to man should not affect the interpretation of adaptations, because the latter can quickly be modified."

(3) "Further, birds living in man-modified habitats may not be genetically isolated from others of their kind living under nearly natural conditions."

(4) "Another factor tending to retard adaptive modifications to new conditions is that each breeding adaptation is linked with others. Hence while a modification in one feature might be advantageous in the (recently) changed circumstances, it might on balance be harmful through upsetting associated adaptations."

Furthermore, as Tinbergen (1965) stresses, "Would the animal be less successful if it did not possess this behavior?"

The present study is concerned with the nesting habitat and nest sites of the Lark Bunting. Does the Lark Bunting predominantly nest in man-modified areas now, or is it still associated with the native vegetation? What are the characteristics of the Lark Bunting nest site and can their survival value be identified?

Methods

Habitat Selection

An index of Lark Bunting densities was determined by a 41 mile, 51 stop census route in Wallace County (Figure 1) on 18 and 30 May, 12 and 22 June, 5, 19 and 28 July and 6 August, 1969. Each stop was chosen prior to the arrival of the Lark Buntings. Four types of habitat were available: (1) grazed short grass prairie, (2) Sandhill Sage (*Artemisia filifolia* Torr.) dominated habitat, (3) oldfields (fallow fields), and (4) cultivated fields (agriculture). Twelve stops for each habitat plus an additional 3 for the oldfield group were made. The additional oldfield stops were made in case some of the fields were to be plowed during the summer. All Lark Buntings were counted for a two-minute period at each stop. Since windy weather would affect the results, calm weather usually determined the starting time and the day of a census.

Additional roadside censuses were made along two different roads during the period 18-29 June to determine activity of Lark Buntings at various times of the day (Figure 2).

Study Areas

The Smoky Hill area, 700 meters by 400 meters (28 hectares) was located in the NW 1/4 of section 19, T13S, R42W; Wallace County, Kansas (Figure 3). It comprised an oldfield about 35 years old, the northwest half was dominated by Sandhill Sage with patches of various grasses between and a few forbs such as sunflowers (*Helianthus annus* L.) and spiderwort (*Tradescantia occidentalis* (Britton) Smyth). The southeast half was dominated by Red Triple-awn grass (*Aristida longiseta* Steud.), with an occasional sage, or yucca (*Yucca glauca* Nutt.), a few patches of slow growing forbs containing sunflowers, scurfpea

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Figure 1. Map showing the 51 stop census route. Small case letters indicate the stops and habitat type.

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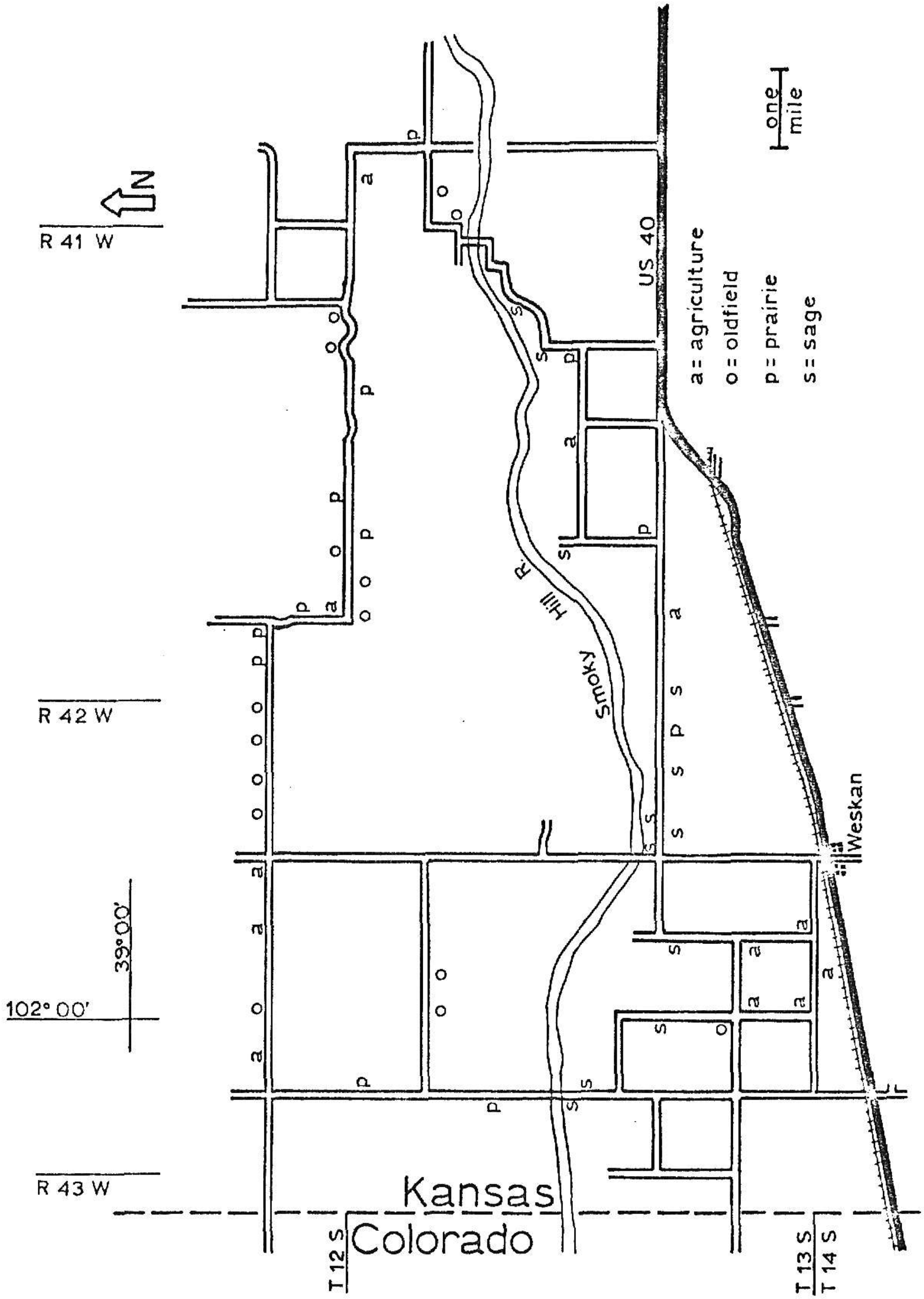

N
R 41 W
R 42 W
R 43 W
102° 00'
39°00'
Smoky Hill R.
US 40
Weskan
Kansas
Colorado
T 12 S
T 13 S
T 14 S
one mile
a = agriculture
o = oldfield
p = prairie
s = sage

Figure 2. Map showing the areas covered in the roadside count. Lark Buntings were counted along the shaded areas.

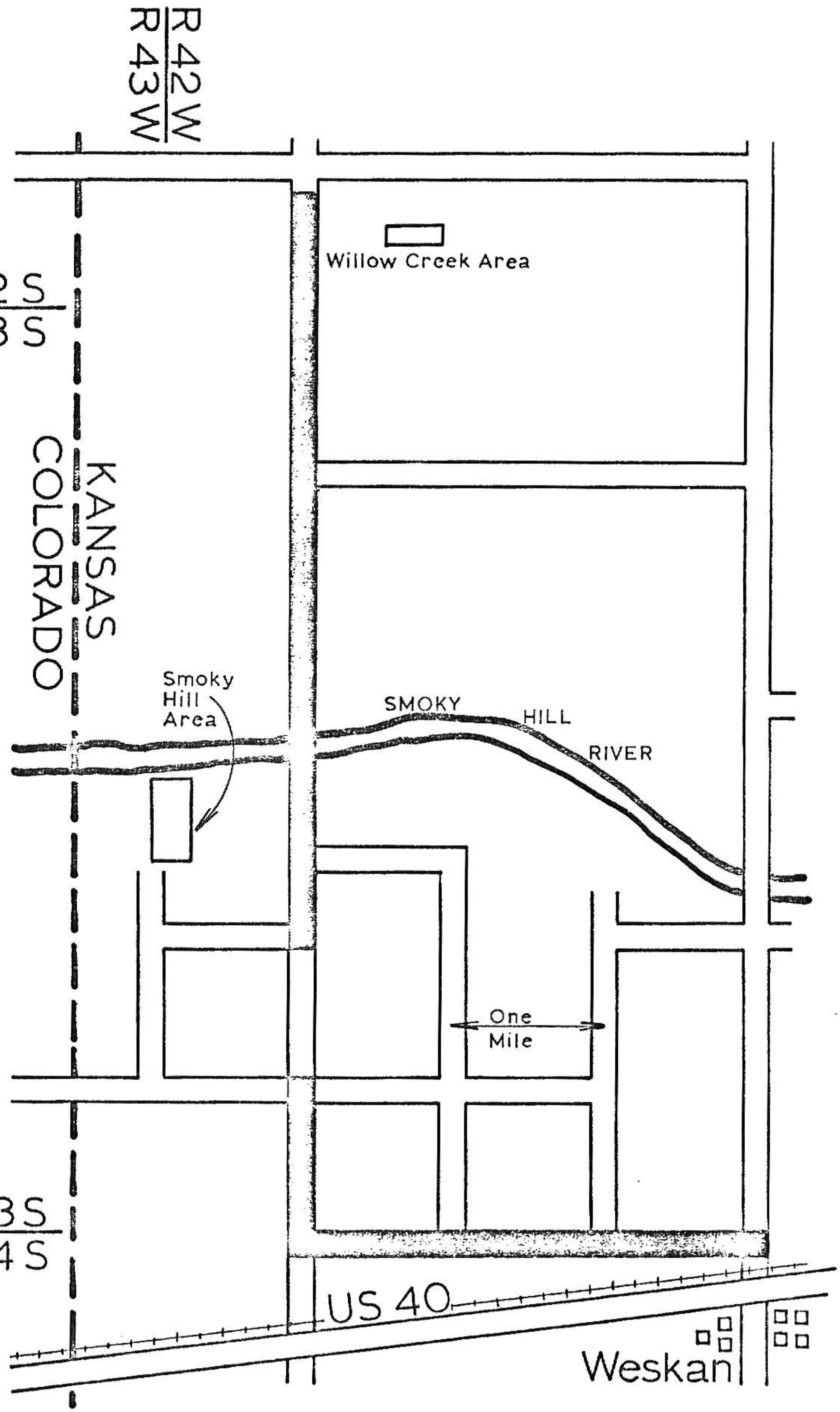
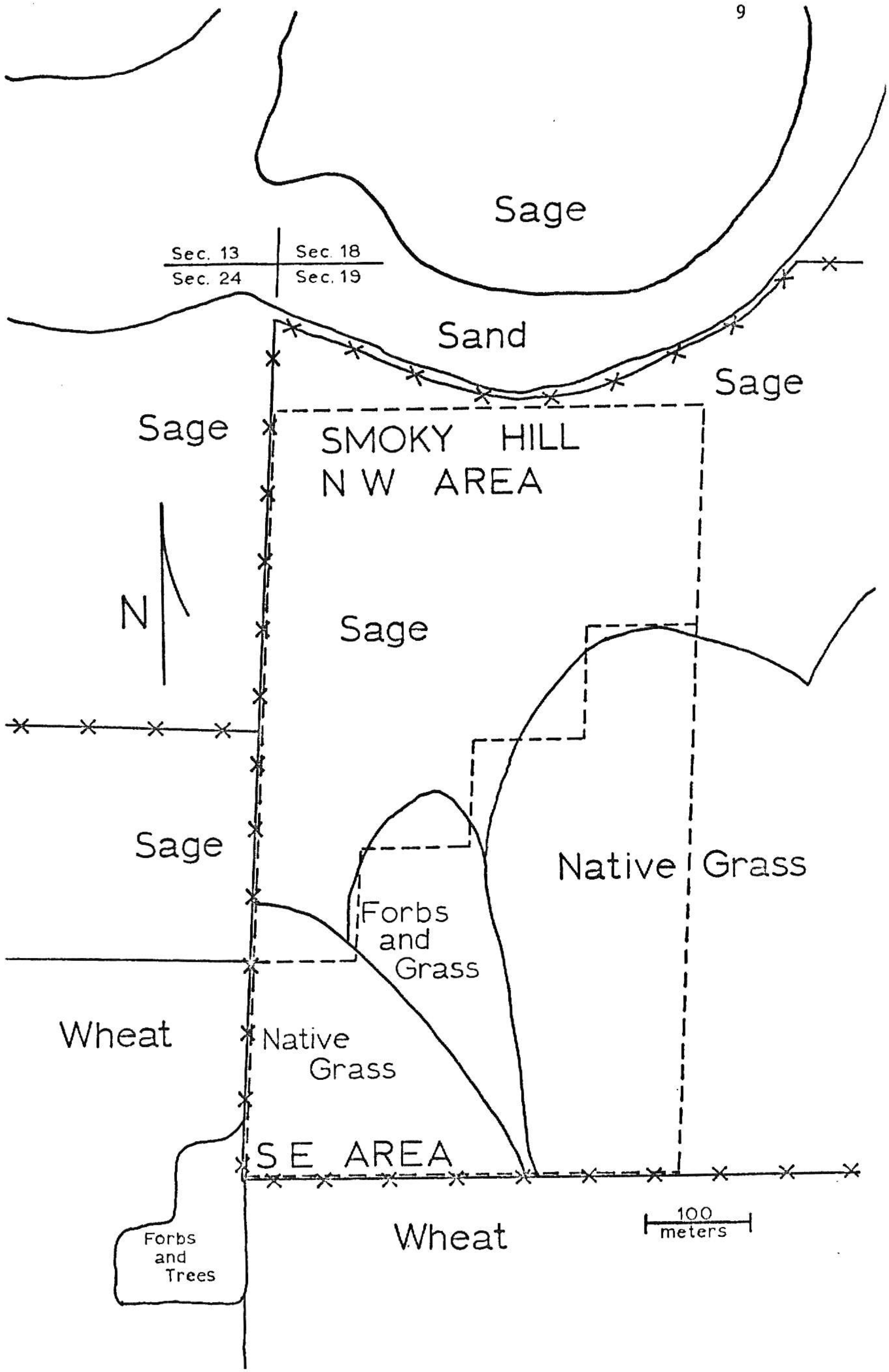

R 42 W
R 43 W
T 12 S
T 13 S
Willow Creek Area
KANSAS
COLORADO
Smoky Hill Area
SMOKY HILL RIVER
One Mile
T 13 S
T 14 S
US 40
Weskan

Figure 3. Map showing the Smoky Hill Study Areas (dashed lines) and the surrounding area.


Sage
Sec. 13
Sec. 18
Sec. 24
Sec. 19
Sand
Sage
Sage
SMOKY HILL
N W AREA
N
Sage
Sage
Native Grass
Forbs
and
Grass
Wheat
Native
Grass
S E AREA
100
meters
Wheat
Forbs
and
Trees

(*Psoralea tenuiflora* Pursh.) and ragweed (*Ambrosia artemisiifolia* L.). The north end of the area was on the flood plain of the Smoky Hill River, the south end gradually sloped from the river bottom. The soil was sandy, almost pure sand at the north end adjacent to the river. This area was further divided equally into 14 hectare areas, the Northwest Smoky Hill area and the Southeast Smoky Hill area, to minimize the variation in particular parameters being considered (Figure 3).

The Willow Creek area, 800 meters by 185 meters (14.8 hectares) was located in the southeast 1/4 of section 32, T12S, R42W: Wallace County, Kansas (Figure 4). This area was dominated by slow growing Mexican Fireweed (*Kochia scoparia* (L.) Schrad.) with some introduced tall grass and occasional sunflowers. The area had been cultivated 10 to 15 years ago. The soil varied from sand to gravel. Nomenclature for the vascular plants is according to Barkley (1968).

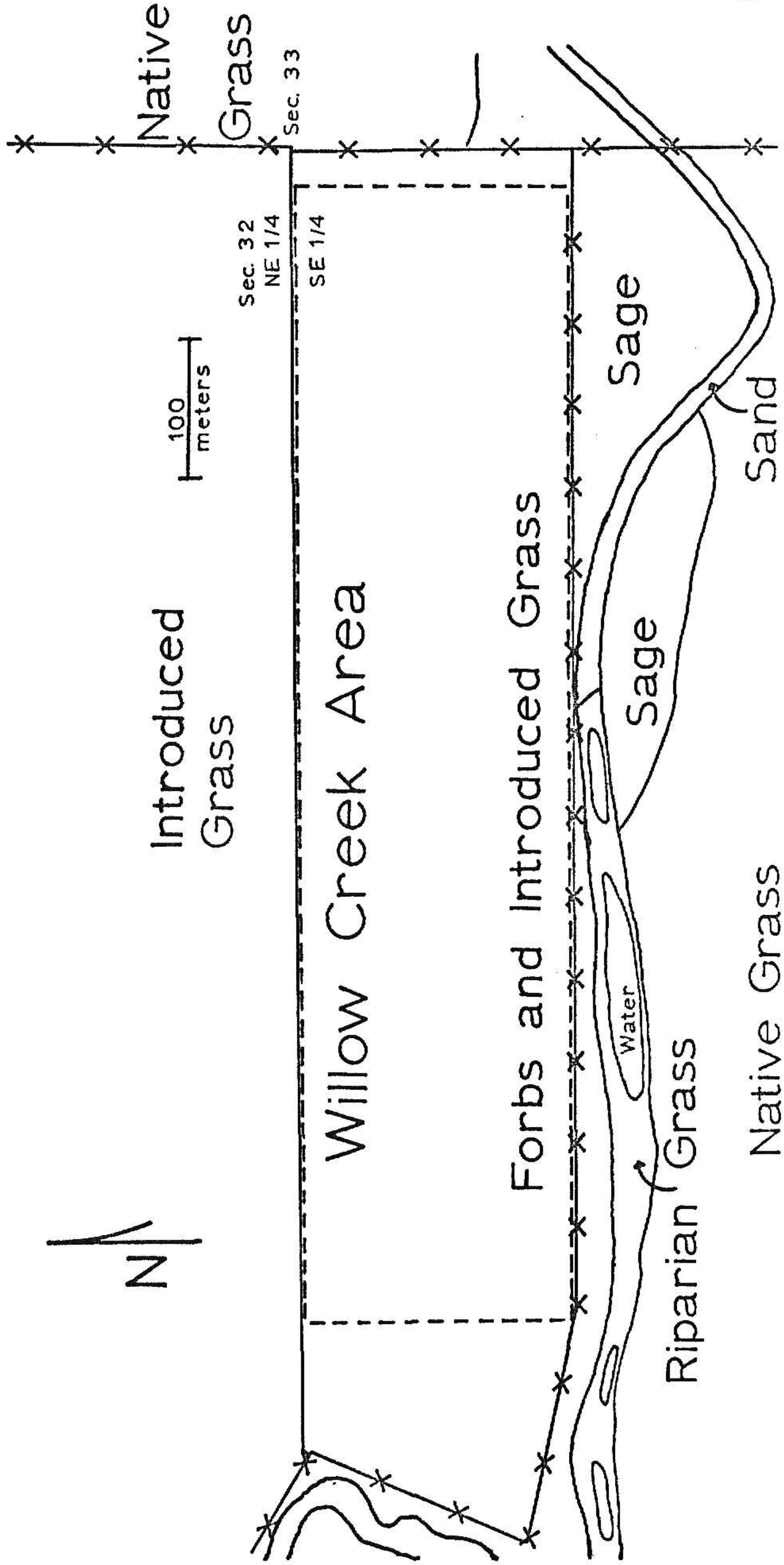
Territories of Males

The Smoky Hill areas were marked off in one hectare quadrats by means of plastic flags. On 12 days between 18 May and 24 July censuses of territorial male Lark Buntings were made by recording their locations on maps of the study area. All censuses were summed for each quadrat giving an index to the number of males for each quadrat. These quadrats were divided into two nearly equal groups, one group of low density quadrats (0-2 territorial males/quadrat) and a second group of high density quadrats (3-6 territorial males/quadrat).

Nests

Nests were found by observing females returning to the nest, by accidentally flushing and by dragging ropes over open areas. Nests were checked

Figure 4. Map showing the Willow Creek Study Area (dashed lines) and the surrounding area.


Native Grass
Sec. 33
Sec. 32
NE 1/4
SE 1/4
100 meters
Introduced Grass
Willow Creek Area
Forbs and Introduced Grass
Sage
Sage
Sand
Water
Riparian Grass
Native Grass
N

daily to determine their status. A nest was considered successful if young were still present 6 days after hatching.

Vegetation

After a nest was no longer active the surrounding vegetation was identified and measured. The height and the type of vegetation were determined at 5 points, 5cm apart along each of eight lines as indicated in Figure 5. Each nest was then classified according to the dominant life form (plant type) around that nest. The height and type of vegetation was measured at 10 cm intervals 10 times along a meter stick laid 1 meter from the nest in each of 4 directions from the nest as indicated in Figure 6.

Vegetation was sampled in each hectare quadrat on the Smoky Hill area along a diagonal transect marked by a rope (Figure 7) from the southwest corner of each quadrat. A set of six points at 9.14 meter (30 ft) intervals started at the southwest corner and a second set of six started 64 meters from the southwest corner (Figure 7). At each of these points the percent coverage and average height of grass, woody and forb vegetation was sampled along a meter stick laid in four directions from the point, starting with 0° and rotating 90° for each successive measurement.

The Willow Creek vegetation was measured with the same transect rope. Since no grid system was set up on the Willow Creek area, a series of plastic flags was placed along the southern boundary of the study area at 50 meter intervals starting 25 meters from the east border and ending 25 meters from the west border. The vegetation was then measured by starting a perpendicular transect at the south or north border. The first transect started at the north border, then the starting point was alternated between the north and south border for the remaining 15 transects at 50 meter intervals (Figure 8).

Figure 5. Diagram showing the vegetation sampling points (small open circles) adjacent to the nest.

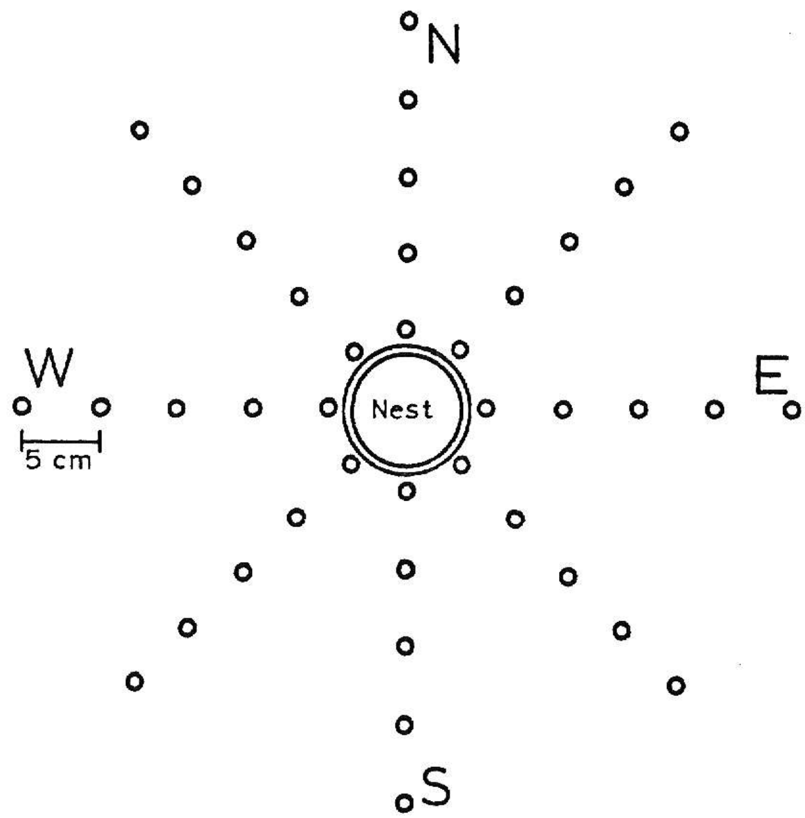

N
W
E
S
Nest
5 cm

Figure 6. Diagram showing the vegetation sampling points (small open circles) one meter from the nest.

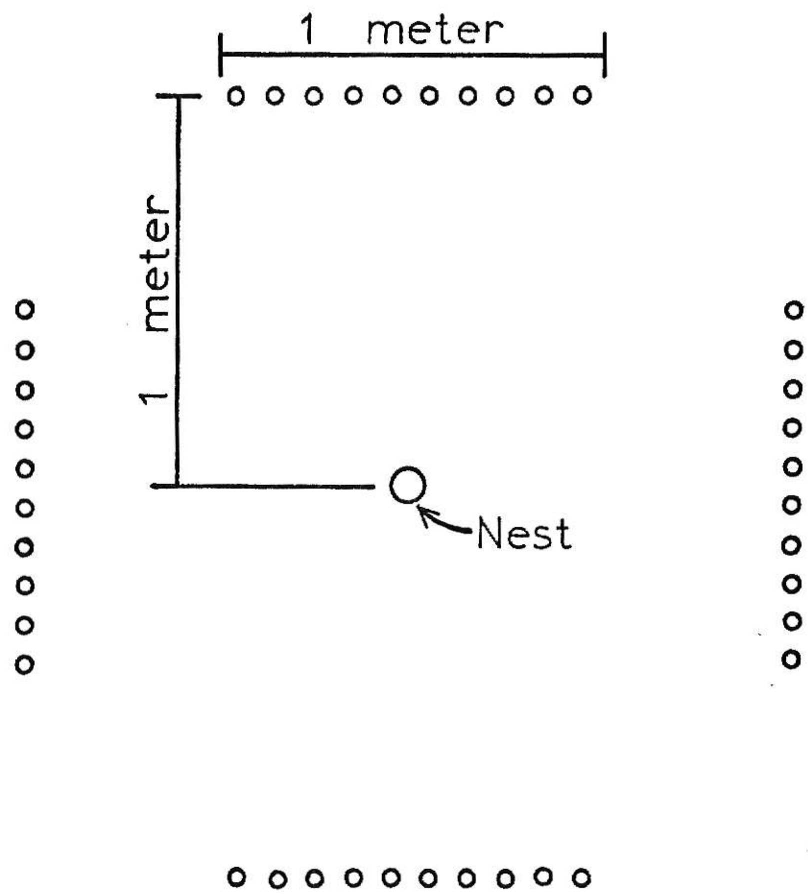

1 meter
1 meter
Nest

Figure 7. (a) Map showing the location of transects (dashed lines) on the Smoky Hill Area. (b) Diagram showing the location of sampling points (solid dots) on the transect rope used.

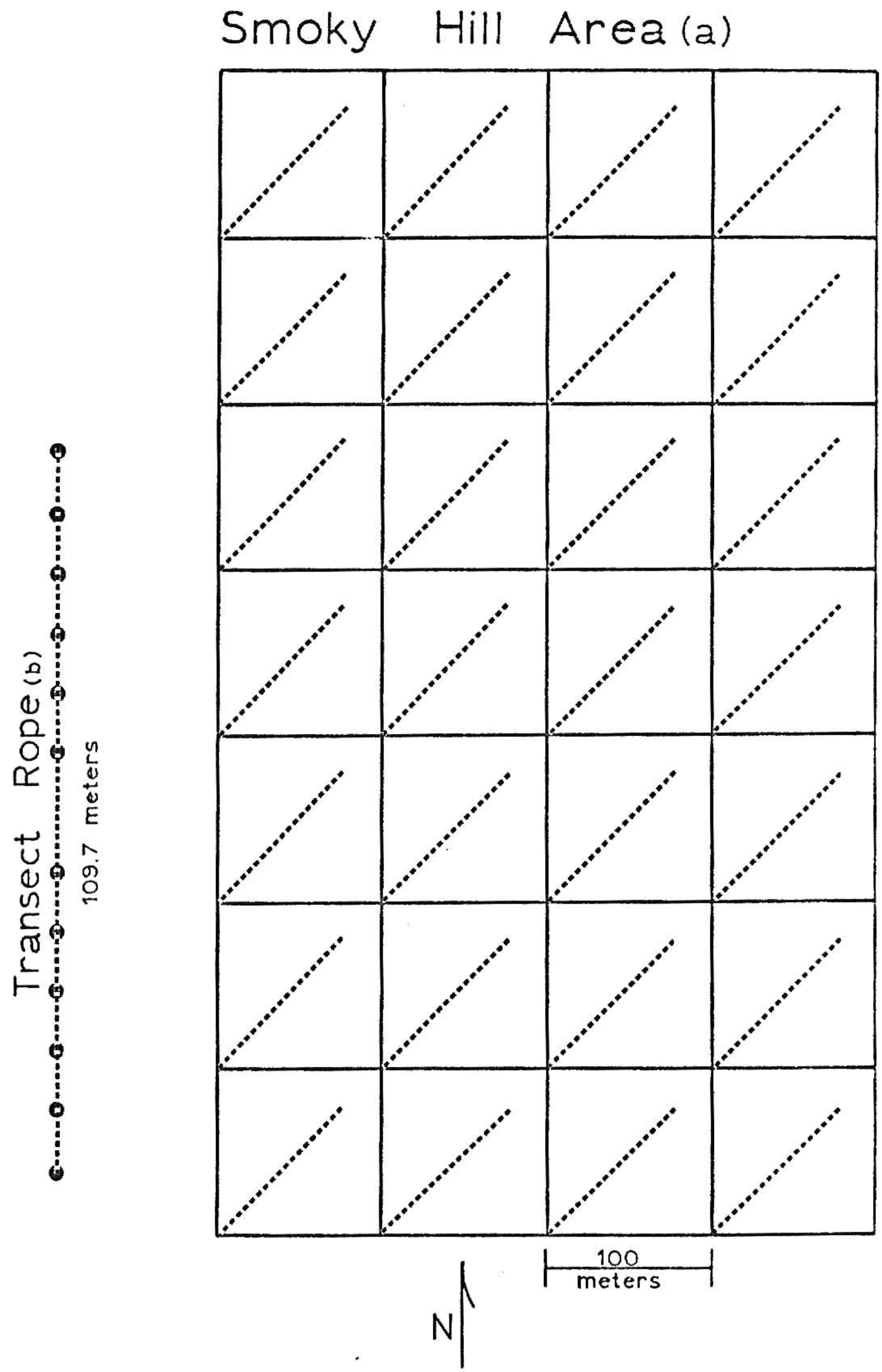
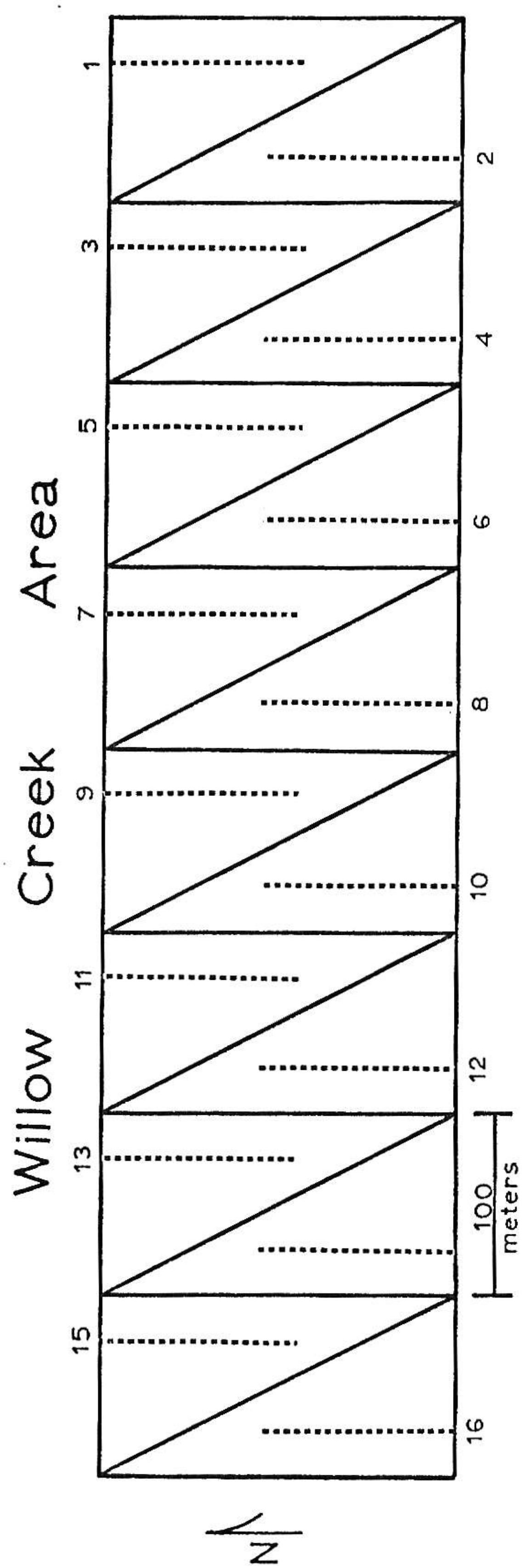

Smoky Hill Area (a)
Transect Rope (b)
109.7 meters
100 meters
N

Figure 8. Map showing the location of transects (dashed lines) on the Willow Creek Area.


Willow Creek Area
1
2
3
4
5
6
7
8
9
10
11
12
13
15
16
100
meters
N

From the data collected in this way the mean percent coverage and height of each life form was calculated for each quadrat on the Smoky Hill area and for the triangles all of equal size plotted on a map of the Willow Creek area (Figure 8).

Results

Habitat Selection

The average number of Lark Buntings per stop observed in each type of habitat for each census is shown in Figure 9. No significant differences were found between habitat types for any census date except May 30 ($F = 3.19$, $df = (3, 47)$, $P < .05$). This occurred between the oldfields (mean of 3.33 birds/stop) and the prairie and sage habitats (means of 1.67 and 1.08 birds/stop) ($LSD_{.05} = 1.55$). No differences were found between the total census means of each habitat type ($F = 0.34$, $df = (3, 27)$, $P > .75$).

The numbers of Lark Buntings along the roadsides were not different between three time periods (8 am - noon, noon - 4 pm, and 4 pm - 8 pm) for which the roadside counts were made ($F = 1.90$, $df = (2, 21)$, $P > .15$). The time of day the above 51 stop census was conducted should then have no particular effect on the results.

The vegetation structure of the three study areas exhibited a marked difference in percent coverage of the life forms (Figure 10).

The number of territorial males on the 2 Smoky Hill areas was not significantly different. Each hectare contained an average of 2.86 males for the 12 censuses in the northwest half and 2.21 males in the southeast half ($t = 1.052$, $N = 28$, $P > .30$).

A comparison of the vegetation in hectares that contained a high number of territorial males throughout the courting season with those that contained a low number of males was made for the Smoky Hill area. No significant differences were found in the height or percent coverage of any life form for the 2 groups.

Eleven nests were found on the Willow Creek Area, the Smoky Hill area

Figure 9. Mean number of Lark Buntings observed for each census in each habitat.

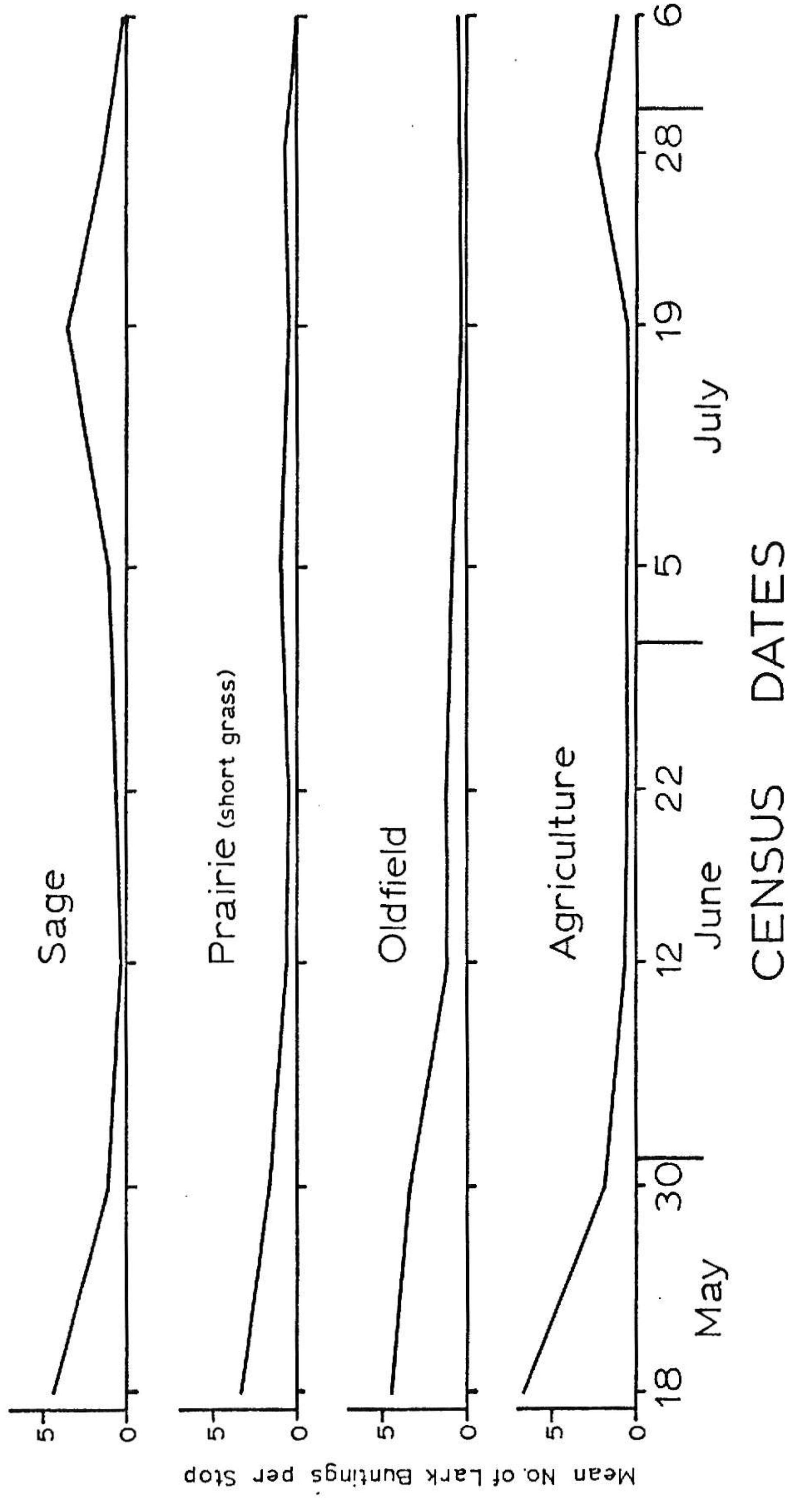
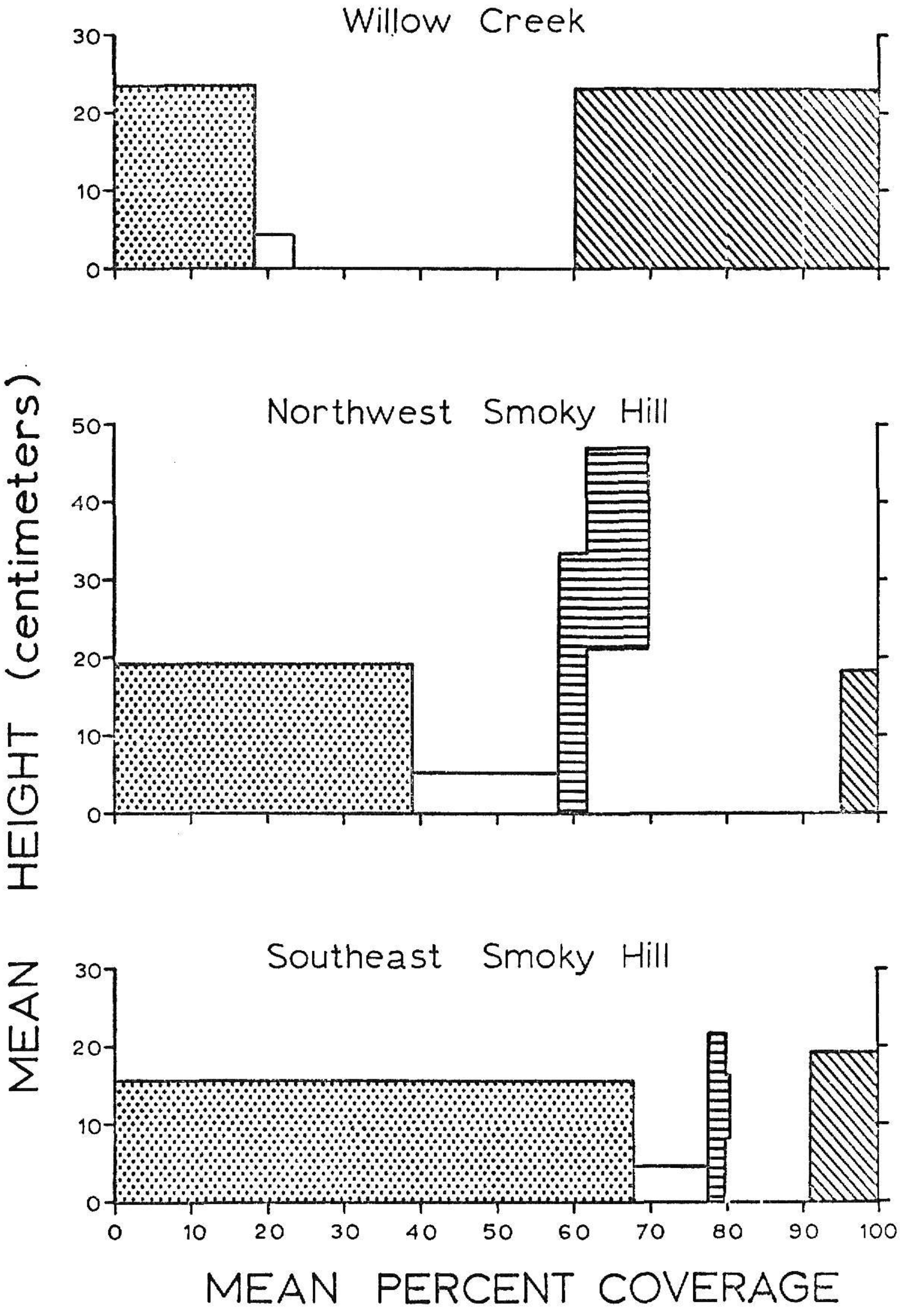

Sage
Prairie (short grass)
Oldfield
Agriculture
Mean No. of Lark Buntings per Stop
5
0
18
30
12
22
5
19
28
6
May
June
July
CENSUS DATES

Figure 10. The mean vegetation height and percent coverage for each study area; tall grass (stippled), short grass (unshaded), sage (horizontal lines) and forbs (diagonal lines).



Willow Creek
Northwest Smoky Hill
Southeast Smoky Hill
MEAN HEIGHT (centimeters)
MEAN PERCENT COVERAGE
0
10
20
30
40
50
60
70
80
90
100

contained 9 on the northwest half and 4 on the southeast half (Figure 11). The number of nests on the 3 areas was not significantly different if equal distribution was expected (χ^2 = 3.25, df = 2, P > .20).

A comparison of the vegetation of the Smoky Hill areas was made between hectares that contained nests and adjacent hectares that did not contain nests. No vegetation differences were found on the southeast area, but on the northwest area, hectares with nests had less and shorter sage (Table 1). A comparison of sections with and without nests for the Willow Creek Area showed that sections with nests were less open and had a higher percent coverage of forbs (Table 2).

Nest Site Selection

The mean plant height adjacent (5 - 25 cm) to each nest was compared to the mean plant height 1 meter from each nest. Adjacent vegetation averaged 25.2 centimeters, while at 1 meter from the nest the mean plant height was 12.9 centimeters (t = 5.818, N = 58, P < .001).

Nests that were successful had higher vegetation, both adjacent and at 1 meter, than the unsuccessful nests (Table 3).

Heights of the life forms were compared at successful and unsuccessful nests if the vegetation around the nest was covered by 25 percent or more of the particular life form being considered. The only difference occurred between the height of forbs adjacent and at 1 meter. The successful nests were surrounded by higher forbs than were the unsuccessful nests (Table 4).

Nest orientation was determined by considering all the vegetation around the nest rather than just looking at the dominant plant or the tallest plants. A vegetation center for each nest was determined by a height-distance relationship which converted each of the 40 polar coordinates (Figure 5) sampled

Figure 11. Outline of each study area showing the position of all nests (open circles) on the areas and several nests just off the areas.

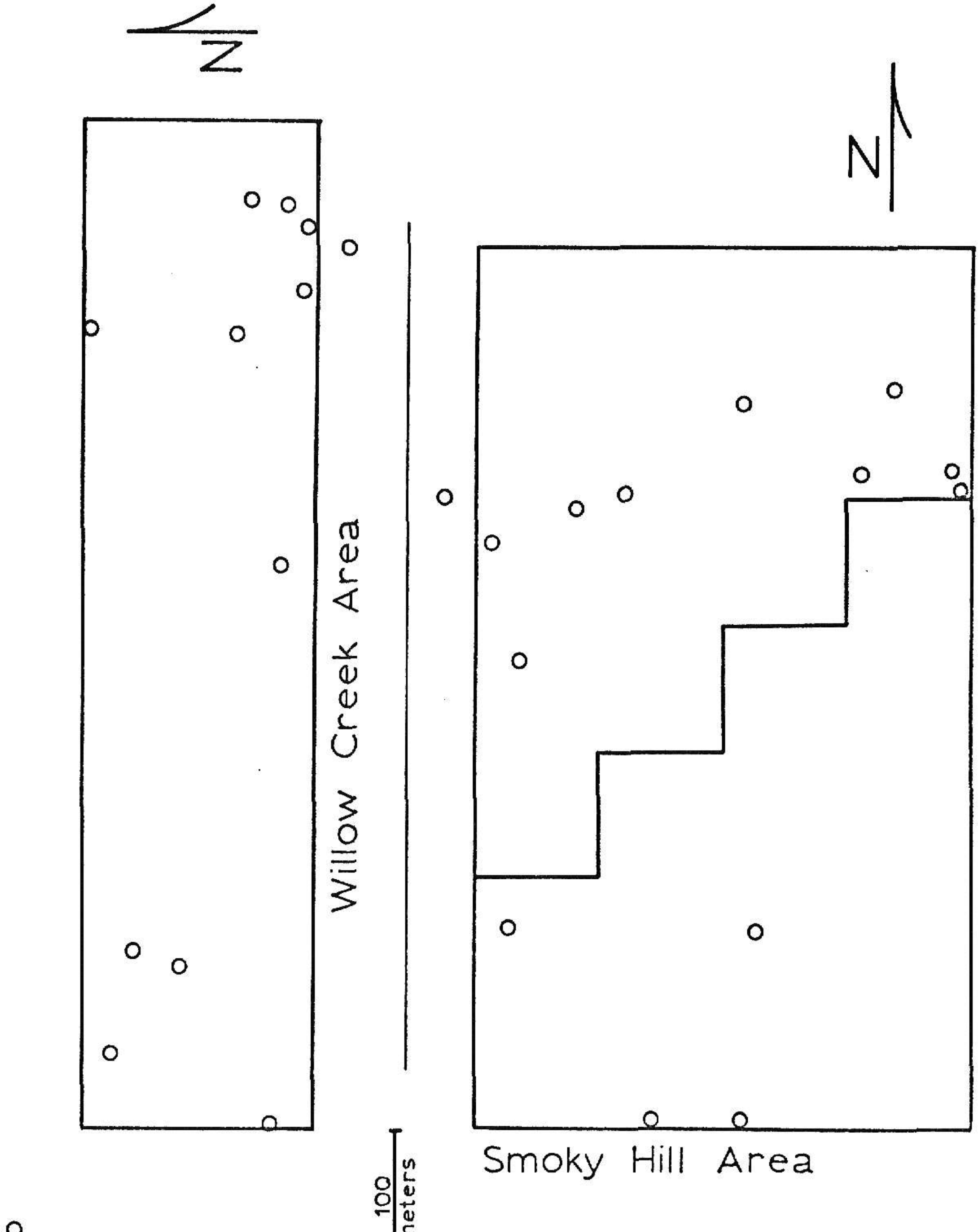

N
N
Willow Creek Area
Smoky Hill Area
100
meters

TABLE I

Vegetation in the Areas of Nests on the Northwest Smoky Hill Area.

	Total Sage Coverage			
Hectares with Nests	5.3%			
		N = 18	"t" = 3.291	P < 0.007
Hectares without Nests	12.9%			
	Total Sage Height			
Hectares with Nests	23.26cm			
		N = 18	"t" = 4.481	P < 0.001
Hectares without Nests	42.04cm			

TABLE 2

Vegetation in the Areas of Nests on the Willow Creek Area.

	Percent Coverage of Open Areas			
Sections with Nests	29.9%			
		N = 19	"t" = 3.397	P < 0.006
Sections without Nests	44.4%			
	Percent Forb Coverage			
Sections with Nests	48.2%			
		N = 19	"t" = 2.330	P < 0.04
Sections without Nests	29.9%			

TABLE 3

Nesting Success and Nest Site Plant Height.

	Mean Plant Height Adjacent to the Nests (5–25cm)			
Successful Nests	30.64cm			
		N = 29	"t" = 1.955	P < 0.07
Unsuccessful Nests	22.79cm			
	Mean Plant Height One Meter from the Nests			
Successful Nests	17.56cm			
		N = 29	"t" = 2.639	P < 0.02
Unsuccessful Nests	10.80cm			

TABLE 4

Nesting Success of All Nests with 25% or more Forb Coverage Adjacent to the Nest.

	Comparison of Heights of Forbs Adjacent to the Nests			
Successful Nests	41.87cm			
		N = 13	"t" = 6.031	P < 0.001
Unsuccessful Nests	25.12cm			
	Comparison of Heights of Forbs One Meter from the Nest			
Successful Nests	24.87cm			
		N = 13	"t" = 4.711	P < 0.001
Unsuccessful Nests	11.96cm			

within a 25 cm radius of the nest, into rectangular coordinates and then determined the average coordinates which were height dependent for each nest. The coordinates for the vegetation centers of each nest were determined by the following equations:

(Equation 1) $$X = \frac{\sum_i \left[\sin \Theta_i \left(\sum_j (H_{ij} \times D_{ij})_j \right) \right]_i}{\sum_{ij} H_{ij}}$$

(Equation 2) $$Y = \frac{\sum_i \left[\cos \Theta_i \left(\sum_j (H_{ij} \times D_{ij}) j \right) \right]_i}{\sum_{ij} H_{ij}}$$

where:

Θ_i = the angle between a particular 25 cm transect and 0° or north.

H_{ij} = the height of the vegetation at the various sampling points.

D_{ij} = the distance the various sampling points are from the center of the nest.

i represents a particular transect 1-8.

j represents a particular point on a transect 1-5.

The multivariate analysis for uncorrelated variables described by Li (1964) was used in the comparison of the vegetation centers of the nests. For the exact vegetation centers for all nests of each life form, the mean coordinates for all nests, successful and unsuccessful nests, see Figures 12a, b and c.

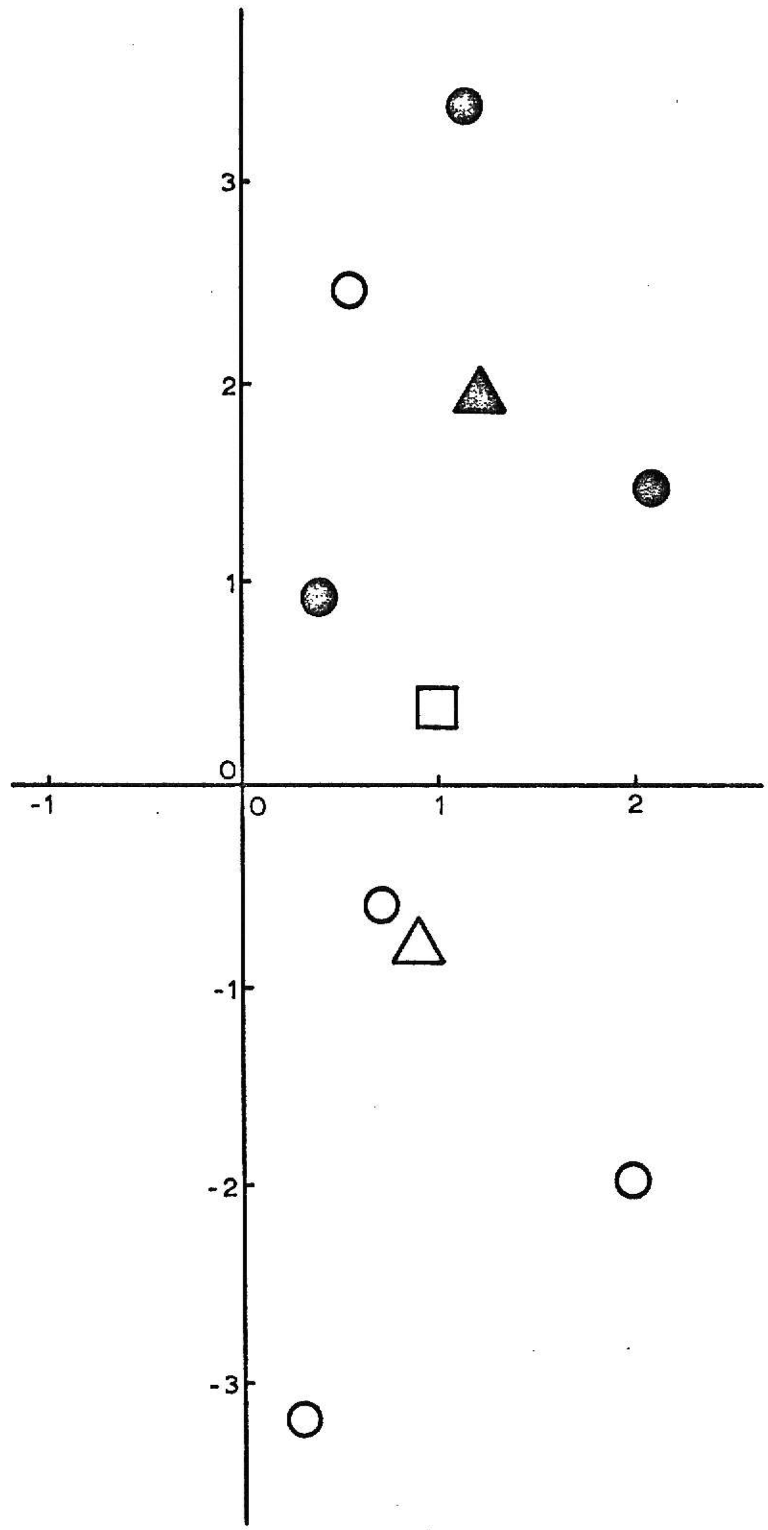
There were significant differences in the mean vegetation centers for the 3 dominant life forms (Table 5, Figure 12a, b and c).

Three nests of 7 in sage were successful (43%), 3 of 11 in forbs (27%) and 3 of the 11 grass dominated nests were successful (27%). The differences were not significant ($\chi^2 = 0.77$, df = 2, P > .50).

EXPLANATION OF FIGURE 12

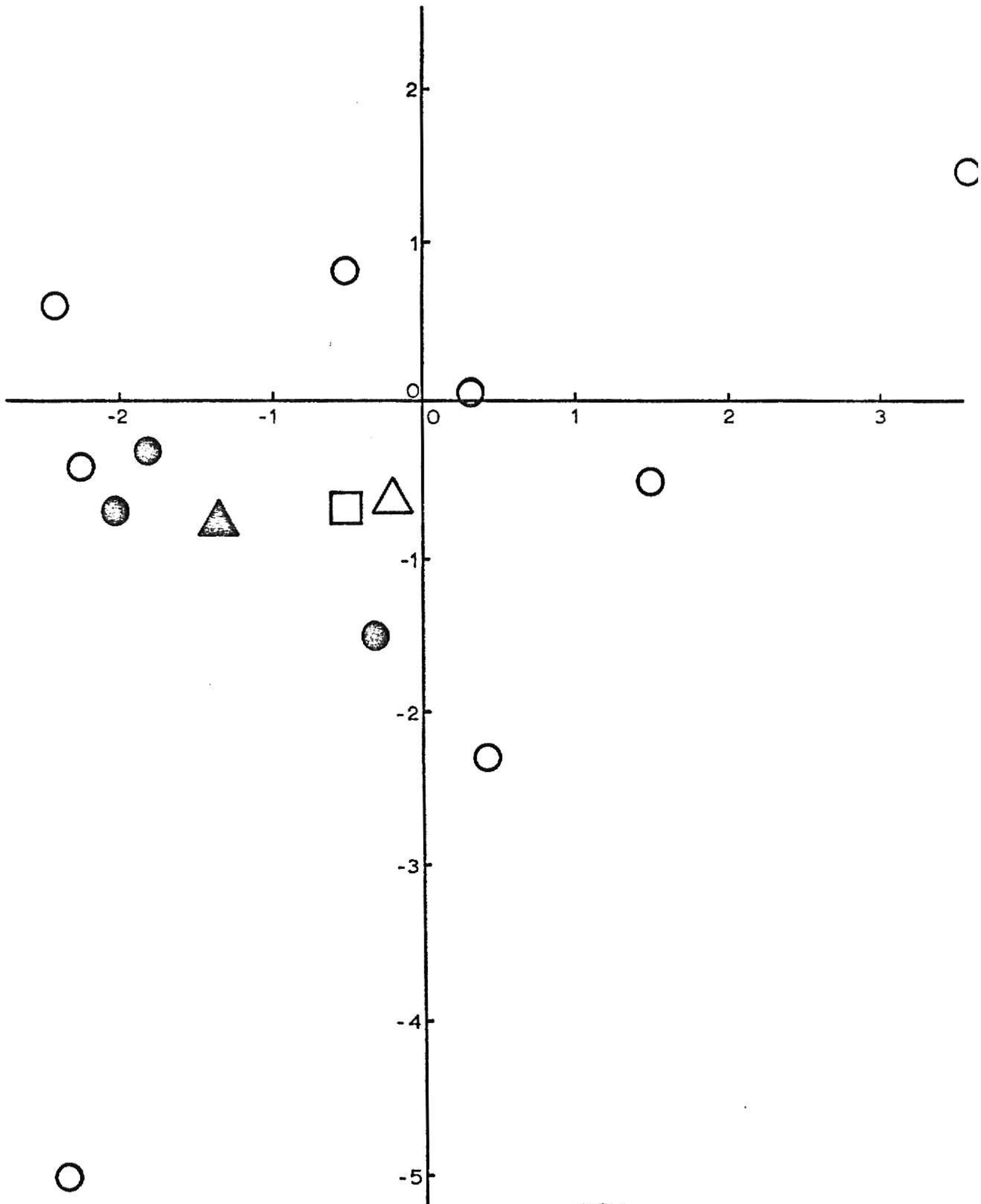
The coordinates (as determined by equations 1 and 2) are shown for the vegetation center of each nest, successful nests (shaded circles), and unsuccessful nests (open circles). The mean vegetation center for all nests dominated by a particular life form is represented by the open square. Mean vegetation centers for successful nests (shaded triangle) and unsuccessful nests (open triangle) are shown. The coordinates (0,0) represent the nest center. Each unit equals 1cm.

Figure 12a. Sage Dominated Nests.



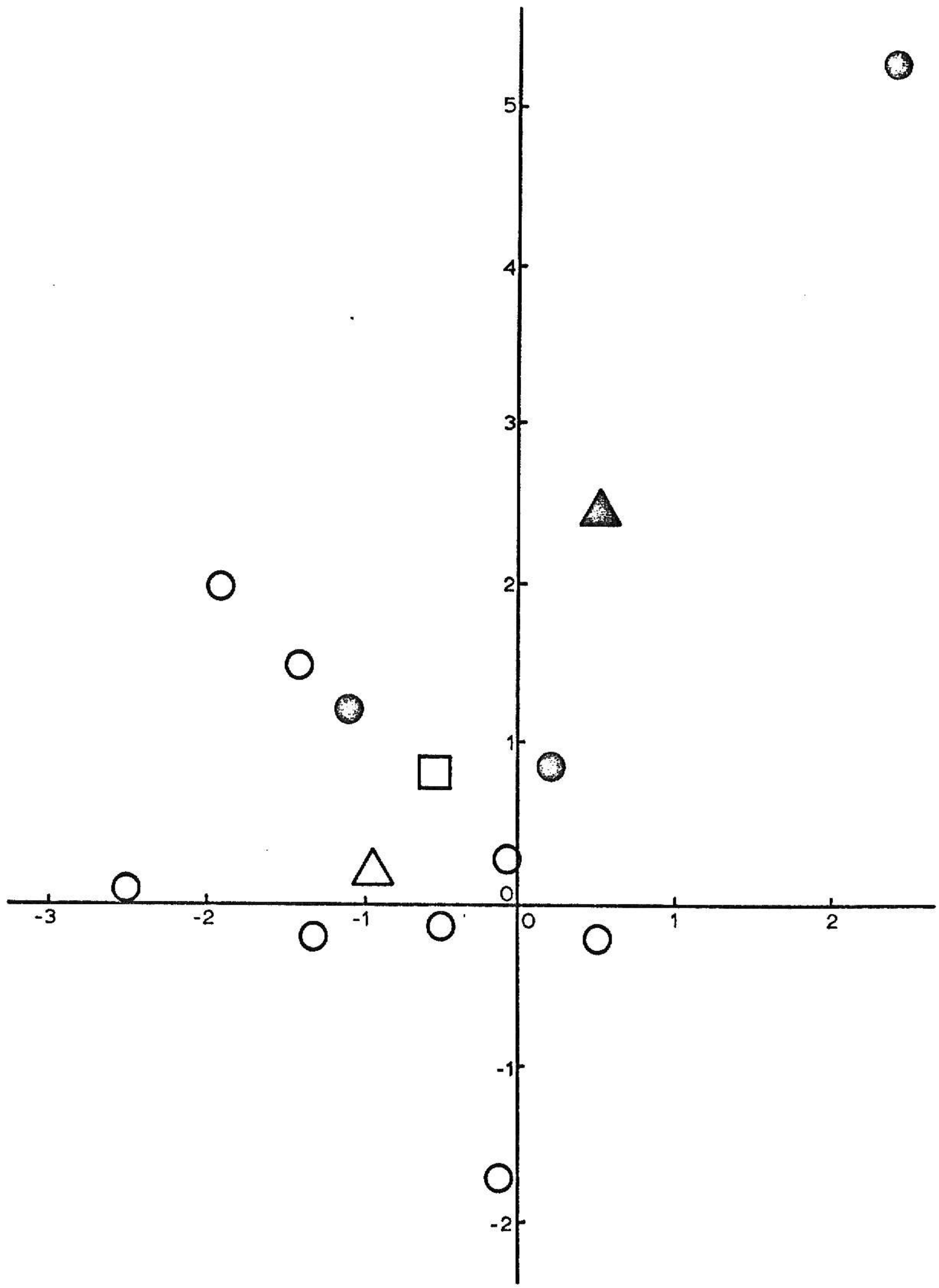
12a

Figure 12b. Grass Dominated Nests.



12b

Figure 12c. Forb Dominated Nests.



12c

TABLE 5

Multivariate Analysis of Variance Comparing the Mean Vegetation Centers of all Forb, Sage, and Grass Dominated Nests

	Analysis of Variance		
All Plant Forms	$F = 4.63$	$df = (2,27)$	$P < 0.019$
	Two by Two Analysis		
Sage vs. Forbs	$F = 7.80$	$df = (1,16)$	$P < 0.013$
Sage vs. Grass	$F = 5.35$	$df = (1,16)$	$P < 0.035$
Grass vs. Forbs	$F = 3.99$	$df = (1,20)$	$P < 0.049$

Discussion

Habitat Selection

Overall, no particular habitat is favored by the Lark Bunting, although structurally these habitats are quite different (Figure 10). Willow Creek is a recent oldfield, northwest Smoky Hill is sage dominated habitat and the southeast Smoky Hill area is short grass prairie habitat. The greatest number of birds in the oldfields on May 30 may have been due to a higher number of unmated or courting males which were more apparent. The oldfields also may have been more attractive to the late migrants. The number of nests and territorial males on the study areas appear to be somewhat different, however if equal distribution is expected these differences are not significant. Even locally the territorial males did not favor any particular type of vegetation. Therefore it seems that no habitat utilized by the Lark Bunting can be called optimal at this time.

The Dickcissel (*Spiza americana*) can be considered the successional counterpart to the Lark Bunting in tall-grass prairies. In this species the habitat type as well as the structure of the vegetation have significant effects on its density (Zimmerman, 1971), and also affects the success of the male Dickcissel in attracting females (Zimmerman, 1966).

The Nesting Areas

The idea of Lark Buntings nesting in colonies has previously been mentioned by Rice (1965) and Whittle (1922). The distribution of nests shown in Figure 11 may suggest this, but cannot be statistically shown at this time. If the birds are somewhat gregarious in their nesting behavior this could force certain individuals to utilize less optimal nest sites which may account for some birds nesting in shorter vegetation and having lowered success (Table 3). Within the oldfield and the sage habitat certain vegetation structures were preferred for a nesting area (Tables 1 and 2). Females may mate with males territorial in these areas. Once they are mated no territory is defended, and a second male may move in and start courting in the vicinity of the first pair's nest. The actual function of the male's territory, other than courtship, and its relationship to the nesting area used by a mated pair, is not known. The birds apparently do not like tall dense vegetation for nesting purposes (Table 1). Visibility at the nest site may be an important factor. The preference for greater forb coverage on the Willow Creek area (Table 2), possibly resulted from a greater number of nest sites available; there was no difference in the overall vegetation height.

Wiens (1969) also found that the vegetation in the nesting areas is different than in the areas used as territories for several grassland species.

Nest Site Selection and Orientation

Within the nesting area, the Lark Bunting places its nest in vegetation that is taller than the surrounding vegetation. This is also characteristic of other grassland birds such as the Bobolink (*Dolichonyx oryzivorus*), Eastern Meadowlark (*Sturnella magna*), Savannah Sparrow (*Passerculus sandwichensis*) and the Grasshopper Sparrow (*Ammodramus savannarum*) (Wiens, 1969). The Dickcissel likewise occasionally nests in similar situations (Blankespoor, 1970).

Predation appears to be the greatest mortality-producing factor for open nesting birds (Ricklefs, 1969). This would lead one to believe that nests are placed in dense vegetation to conceal them from predators. In his studies of the Dickcissel, Zimmerman (1971) states, "Covert nest placement to escape predators may not be the only effect that gives dense vegetation survival value. An alternate (or concomitant) hypothesis for the role of the height and density of the vegetation as an ultimate factor in the environment may be its ameliorating effect on the microclimate of the nest site." This becomes somewhat more evident when certain climatic conditions become "harsh" or possibly account for a higher percentage of the nest failures of certain species. McGahan (1968) noted that the Golden Eagle (Aquila chrysaetos) placed its nest on a cliff so that it would receive sunlight some part of the day, only 2 of 22 nests faced north. He contributes this to the early nesting of the bird where it is occasionally exposed to below freezing temperatures.

Baily (1953) in recording nest orientation for the Red Crossbill (Loxia curvirostra) found the majority facing a southerly direction. Since the birds are found nesting in January this would suggest that having the nest exposed to the sunlight would have survival value.

Interestingly, Dorst (1963) found that the hummingbird (Oreotrochilus estella) in the Andes of South America has adapted to 2 extreme climatic conditions. Here the temperatures get very low in the early morning and high during the day. The bird usually places its nest on the side of a large boulder. Dorst found that about 70% of the nests were placed on the east side of the boulder. Here the bird could take advantage of the early morning sun but would be shaded during the latter part of the day.

Four nests of the Desert Lark (Ammomanes deserti) observed by Orr (1970) faced north, had some protective feature such as a bush or overhanging rock shading them, and were on north facing slopes. He states, "The nest is interesting because its orientation and structure seem helpful in avoiding high mid-day temperature extremes in the nest, and also appear adjusted to take advantage of early morning sun and late afternoon wind to provide favorable incubation conditions while the female is absent for foraging."

Blankespoor (1970) showed that Dickcissel nestlings receiving more sunlight had slower growth rates. He hypothesized that this could increase the chances of predation.

Nest orientation in relation to cold prevailing winds has been observed in several species. Nests of the Horned Lark (Eremophila alpestris) and Water Pipit (Anthus spinoletta) observed by DuBois (1935), Verbeck (1967), Wynne-Edwards (1952) and Verbeek (1970) were constructed so that there was some protective feature on the prevailing windward side.

The importance of nest orientation and ventilation was observed in the Cactus Wren (Campylorhynchus brunneicapillus) (Ricklefs and Hainsworth, 1969). Early breeding wrens faced the nest away from the strong cool winds while the late breeders faced the nest into the winds which occurred during the hot part of the day.

The most moderate microclimate for nests of the Dickcissel are those located in "isolated type" vegetation (Blankespoor, 1970). That is a nest located in a different and usually taller plant than the surrounding vegetation. He suggests that the most probable cause for the observed moderation of temperature microclimate relates to increased ventilation.

In his studies of the Mallard (Anas platyrhynchos) Caldwell (1971) also found that wind was important in modifying the nest microclimate. He states, "When ambient temperatures rose above 27°C, with slight or no wind speed, females were observed panting. However, increasing wind speed had an expected cooling effect, decreasing the occurrences of panting at any given ambient temperature."

The meadowlarks (Sturnella sp.) do exhibit nest orientation (Sandborn and Goelitz, 1915; Lanyon, 1957; and Roseberry and Klimstra, 1970), however several of these studies suggest that the prevailing winds and storms depress the vegetation in the same direction which encourages the same orientation during nesting.

Another factor affecting orientation was considered by Hann (1937). He found that 86% of the ovenbird (Seiurus aurocapillus) nests on his study area faced down slope possibly to avoid runoff during heavy rains.

Temperature microclimates are more severe in "grass type" vegetation (Blankespoor, 1970 and Francis, 1968) which is due to a larger part of the incident radiation being intercepted by the forbs. Blankespoor also stated that wind usually penetrates more deeply into grass type vegetation.

Considering the climatic factors affecting nest orientation in other species as well as the vegetation type some hypotheses can be made about the resulting orientations of the Lark Bunting nests.

All nests were in "isolated type" vegetation described by Blankespoor (1970). Ventilation may be an important factor in Lark Bunting nest site selection.

Low nighttime temperatures characteristic of an arid environment were frequently encountered during the nesting season of the Lark Bunting. Night time temperatures within a few degrees of freezing were recorded several times at nearby weather stations during the summer of 1969. Nest exposure to early morning sunlight may have survival value for the Lark Bunting as has been hypothesized for Oreotrochilus estella and the Desert Lark.

High daytime temperatures are prevalent during the Lark Bunting nesting season. During the nesting season of 1969 temperatures exceeded 100°F on 7 days with a maximum temperature of 107°F for the Northwest Kansas area

(Climatological Data, Kansas, 1969). Protection from the hot afternoon sun is undoubtedly important and is probably the most severe climatic factor affecting nesting success.

If indeed grass sites have greater microclimatic fluctuations, then the most advantageous orientation of the nest would be such that the vegetation would be utilized for shading purposes during the afternoon. As shown in Figure 12b the average Lark Bunting grass nest site does have more vegetation to the southwest of the nest, thus supporting this hypothesis.

According to Blankespoor (1970) and Francis (1968) forb nest sites should have a less severely fluctuating temperature microclimate. Therefore orientation in regard to increased ventilation and morning sun may have greater survival value.

A nest on the east side of a clump of forbs would give the best protection from the afternoon sun, and would also allow more morning sun to reach the nest. A nest on the south side of a clump of forbs would obtain more ventilation from the prevailing south winds. Considering the forb nest sites (Figure 12c) the 1 nest with the vegetation center to the southeast would be at a disadvantage in regard to all 3 factors. The 2 nests with the vegetation centers to the northeast would have a ventilation advantage only. The 3 nests with vegetation centers to the southwest would have the best afternoon shade and early morning sun. In order to receive the benefits of afternoon shade, morning sun and the prevailing south wind ventilation the vegetation center should be to the northwest. Five of the nests were oriented in this manner.

Sage dominated nests have the most consistent orientation (Figure 12a) but the results appear to contradict the previous protection from afternoon sun hypothesis. It appears now that a type of bi-level orientation may be taking place in relation to this life form. There were usually clumps of grass associated with these small sage plants, and in most cases, the nests appear to have had some of this grass to the southwest just as in the grass dominated type nests. When these 2 plant forms are considered simultaneously the resulting sage orientation indeed does appear most advantageous. Due to the structure of the sage plant low angle insolation passes beneath the plant. This should be advantageous in the early morning but detrimental in the late afternoon, so a grass clump or possibly some other structure southwest of the nest would be of distinct advantage.

Nesting Success

The effects of differences in relative heights of vegetation at successful and unsuccessful nests is not at all clear (Table 3). Most of the predation on nests was attributed to snakes for the following reasons: (1) snakes were frequently observed throughout the area, (2) no eggshells were ever left in or around the nest, (3) no Lark Bunting nest (nest material) was ever disturbed or out of place, while some of the nests of other species on the area were torn up which appeared to be the work of mammals, (4) mammalian predators, aerial predators, and corvids were not at all common.

Effective differences in adjacent vegetation appear to be due to the forbs when present (Table 4). Forbs are the most effective in shading or modifying temperature microclimates but to ascribe selection pressures of this magnitude to a single factor is somewhat questionable. The greater amount of vegetation around these nests may also be effective in detouring a foraging snake far enough from the nest to avoid detection.

Although some trends do appear the number of nests is not large enough to compare the vegetation centers of the successful and unsuccessful nests of each life form.

As Lack (1968) emphasized, adaptations may be made very rapidly as is probably the case in regard to nest orientation. Many of these adaptations were probably developed prior to man's modifications, but there have been many recent changes in the habitat and minor adaptations have undoubtedly resulted to meet them.

Distinct nest site strategies have evolved with the utilization of the 3 life forms (grass, forb and woody vegetation) by the Western Kansas Lark Bunting population and these appear to have equivalent success. This suggests that an equal number of ecotypes may be present in the Lark Bunting population and other distinct behavioral and morphological characteristics may be present to maintain the genetic information necessary for these nest site behaviors.

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SUMMARY

The nest site selection behavior of the Lark Bunting was studied during the summer of 1969. Although structurally different the four major habitat types in Wallace County, Kansas seemed to be equally utilized by the breeding Lark Bunting. However, the vegetation in the actual nesting areas was different than the surrounding areas in an oldfield and in a sage dominated area but not in the prairie habitat. Nests do not seem to be placed in the males territory but are either placed in a colony, or are placed in the most suitable vegetation which tends to clump nests giving the appearance of a colony.

Nests are always placed in a clump of vegetation that is taller than the surrounding vegetation. The maximum vegetation (nest vegetation center) around forb dominated nests is to the northwest; to the southwest is grass dominated nests and to the east is sage dominated nests. It has been hypothesized that these orientations have been selected for because of the various and different microclimate modifying properties each of these life forms may exhibit.

There was higher vegetation around the successful nests which was usually due to the forbs present. Success was not enhanced by any particular life form dominating the nest sites.

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THE NEST SITE SELECTION BEHAVIOR OF THE LARK BUNTING, *CALAMOSPIZA MELANOCORYS*

by

THOMAS GREGORY SHANE

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The nest site selection behavior of the Lark Bunting (Calamospiza melanocorys) was studied in Wallace County, Kansas during the summer of 1969. A 51-stop census of Lark Buntings was made in four major habitat types: (1) short grass prairie, (2) sandhill sage dominated areas, (3) oldfields (fallow fields) and (4) cultivated fields. These four habitats appeared to be equally utilized by the breeding Lark Buntings.

The percent coverage and average height of the vegetation was measured on two study areas. The oldfield nesting area had a higher percent coverage of forbs and was less open than the surrounding areas, while the sage dominated nesting area had shorter and less percent coverage of sage than the surrounding areas. No difference between the immediate nesting area and the surrounding vegetation was shown for a grass dominated area.

Nests are not necessarily placed in the males' territory, but are either grouped in a colony or are placed in the most suitable vegetation which may occasionally clump nests giving the appearance of a colony. The exact relationship of territory and nest site was not determined.

The height of the vegetation and the life form present (i.e., grass, forb and woody) were determined at 80 points around each Lark Bunting nest. Forty of the sampling points were within 25 cm of the nest and the other 40 were located 1 meter from the nest. Nests are always placed in a clump of vegetation that is taller than the surrounding vegetation.

A nest vegetation center was determined by a height-distance relationship, which averaged the 40 sampling points adjacent to the nest. The mean vegetation center at forb dominated nests is to the northwest, to the southwest in grass dominated nests, and to the east in sage dominated nests. I hypothesize that these orientations have been evolutionarily selected because of the various and different microclimate modifying properties exhibited by each of these life forms.

There was higher vegetation around the successful nests than around unsuccessful nests. This was not due to the dominant life form, but was attributed to forbs when present.

Nesting success was not enhanced by any particular life form dominating the nest site.