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Characteristics and Use of Wild Turkey Roost Sites in Southcentral South Dakota

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CHARACTERISTICS AND USE OF WILD TURKEY ROOST SITES

IN SOUTHCENTRAL SOUTH DAKOTA

BY

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CHARACTERISTICS AND USE OF WILD TURKEY ROOST SITES IN SOUTHCENTRAL SOUTH DAKOTA

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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Abstract

Ten radio-tagged wild turkeys <u>(Meleagris gallopavo)</u> were monitored to document roost site use and bird movements in the Missouri River breaks complex of southcentral South Dakota during the summer of 1984. Distances between roost sites used by wild turkeys ranged from 0.55 km to 3.09 km. Primary and secondary roost sites were identified. Turkeys used one primary roost site consistently every night during periods ranging from a few days to 2 months, then moved to other primary roost sites. Secondary roost sites were used inconsistently by only a few birds that occupied the roost one night, and did not return on subsequent nights. Vegetative characteristics were sampled in roost plots and compared to control plots using discriminant analysis and analysis of variance. Total basal area explained the most variation between all roost plots and all control plots. Wild turkeys selected forested regions with relatively large basal areas. Roost plots averaged 30.2 m /ha while control plots averaged 13.12 m^2/ha. American basswood <u>(Tilia americana)</u> and eastern cottonwood <u>(Populus deltoides)</u> classifications comprised 81% of roost plots sampled and chi-square analysis indicated strong selection by turkeys for these 2 tree species.

Key words: wild turkey, roosting, telemetry, timber, South Dakota

INTRODUCTION

Oak forest/grassland habitat in southcentral South Dakota once supported indigenous eastern wild turkey (Meleagris gallopavo silvestris) (Schorger 1966); however, increased human activity caused local extinction of this woodland game bird. The South Dakota Department of Game, Fish and Parks, and private landowners, have successfully reintroduced Merriam's (M. g_ merriami) and Rio Grande (M. g_ intermedia) subspecies, establishing a harvestable turkey population in this region; some private releases of M. g_ silvestris also have occurred.

Wild turkeys generally inhabit areas associated with woodlands that provide protective cover, food sources, and roosting cover. Roost sites are considered a necessary habitat requirement for wild turkey, especially during winter when turkeys are subjected to greater environmental stress than during the rest of the year (Crockett 1973). Phillips (1980) claimed that turkeys need a sufficient number of accessible roost sites to utilize their habitats efficiently. Lack of available roosting cover may limit wild turkey distribution in areas that otherwise provide suitable habitat (Boeker and Scott 1969). Although several researchers (Hoffman 1968, Boeker and Scott 1969, Tzilkowski 1971, Crockett 1973, Kothmann and Litton 1975, Haucke 1975, Phillips 1980, Mackey 1984) have studied turkey roost sites, data on roosting habitat pertinent to southcentral South Dakota is lacking. The intent of this study was to assess roost site characteristics and to describe wild turkey movements in relation to roost sites in wooded areas of southcentral South Dakota.

The primary objective of this research was to determine whether roost site tree species composition and structural characteristics differed from other available forested areas. Two null hypotheses were developed to test for physical differences between roost sites and the rest of the forest habitat:

1) Physical roost site characteristics (e.g. tree species composition and height) are not significantly different ($P > 0.05$) from non-roost site areas dominated by the same tree species.
2) Tree species composition of roost sites does not significantly differ ($P > 0.05$) from that expected, based on overall tree species composition for the study area.

The first hypothesis was formulated to determine if wild turkeys select for particular vegetation characteristics, while the second tested for tree species selection by turkeys at roost sites. Another objective was to describe turkey movements in relation to roost site locations.

STUDY AREA

The study area was located in Gregory County, approximately 5 km north-northeast of St. Charles, South Dakota, and consisted of 7,200 ha of privately owned land lying within the Warm, Dry Plain (Typic Ustolls) of southcentral South Dakota. Soils vary from silt loam to clay loam. The area physiographically represents part of the Missouri River breaks complex in the Pierre Hills division of the Missouri Plateau (Westin and Malo 1978). The breaks complex is characterized by a dendritic drainage pattern where enclosing slopes of major drainages are bisected by secondary drainages creating a series of shallow valleys and ridges. Grasses dominate upland areas, while shrubs and woody vegetation grow along primary and secondary drainages. Dominant tree species found included American basswood (*Tilia americana*), American elm (*Ulmus americana*), bur oak (*Quercus macrocarpa*), eastern cottonwood (*Populus deltoides*), and green ash (*Fraxinus pennsylvanica*). Average annual precipitation is 56 cm and average annual air temperature is 9.4 C (Westin and Malo 1978). Cattle graze more than 90% of the area (McCabe 1984) and many flat to gently rolling upland areas are farmed for hay and small grains.

METHODS AND MATERIALS

Capture and Marking

Turkeys were trapped from January 1982 through July 1984. Capture techniques included cannon nets (Austin 1965), and walk-in traps (Petersen and Richardson 1975) located at sites prebaited with whole corn. Captured birds were aged, weighed, and sexed. Each bird was marked with 2 numbered patagial tags (Knowlton et al. 1964). An aluminum, butt-end leg band (National Band and Tag Company, Newport, KY), size 24 for females and size 28 for males, was attached to a leg of each bird.

Telemetry

Juvenile and adult male turkeys were selected for radio-tagging to insure that non-nesting/non-brooding birds would be used for roost usage monitoring. No more than 2 individuals of an identifiable group were radio-tagged, because these birds would yield similar telemetry information. Non-nesting/non-brooding females, radio-tagged for a concurrent nesting study, also were monitored.

A backpack style radio transmitter (Advanced Telemetry Systems, Inc. [ATS], Bethel, MN) was attached dorsally to the proximal end of the neck and each wing with a loop of parachute cord or plastic coated steel cable. Transmitters were thought not to adversely affect the birds (Nenno and Healy 1979).

ATS Challenger 200 programmable scanning receivers were used for monitoring radioed birds. Each receiver had a 2 MHz band width (150.00-151.999 MHz) and a programmable memory into which all telemetry radio frequencies were entered.

Radio-tagged turkeys were monitored from 3 telemetry stations located 1.2-2.4 km apart. Stations were established on the highest land forms recognizable on topographic maps, enabling the greatest possible number of birds to be monitored simultaneously. A guyed, 14-m tall Rohn 25G general purpose communications tower (UNR-Rohn, Peoria, IL) was placed at each station. Two 4-element Yagi antennas were mounted parallel to each other, 2 m apart, on a horizontal boom which was attached to a rotating mast protruding from the tower frame. An ATS combiner system was used to link the Yagi antennas to the receiver located at the tower base. The azimuth of each radioed bird was determined via a compass rose and indicator needle.

Accuracy of the telemetry system was unknown. However, based on plotted nocturnal locations in relation to known roost sites, the error of the telemetry system was subjectively estimated to be a minimum of +4 degrees. The system was calibrated daily to reduce error and the data are believed to adequately represent turkey movements on the study area.

Monitoring ocurred from mid-May to mid-September, 1984. Diurnal monitoring sessions were conducted 1-2 days per week, usually starting at sunrise and ending at sunset, depending on weather conditions. Nocturnal readings generally were obtained every other night throughout the study period. To locate new roost sites, nocturnal locations were plotted on topographic maps by intersection of azimuths from at least 2 of the tower stations. Roost site locations were confirmed using hand-held telemetry equipment.

Additional roost sites were located by observing turkeys roosting in trees or by checking potential roost sites for droppings beneath trees (Hoffman 1968, Boeker and Scott 1969, Tzilkowski 1971, Haucke 1975, Mackey 1984).

Telemetry Analysis

Diurnal and nocturnal locations were determined from telemetry azimuths using the TELEM computer program (Koeln 1980) and a Model 8 IBM 3031 computer. Each location was calculated as an average of all possible combinations of simultaneous azimuths for each bird. Since azimuths that approach a parallel configuration cause an increase in the error polygon area (Heezen and Tester 1967, Koeln 1980), TELEM was programmed to eliminate intersecting azimuths that created angles of either less than 20 degrees or greater than 160 degrees.

TELEM compatible X-Y coordinate grid overlays encompassing the portion of the study area being monitored were produced by a CALCOMP 1051 line-printer. Overlays were placed over topographic maps on a light table, so that roost sites used by each bird could be identified.

To evaluate use of roost sites, known roost sites were pinpointed on the topographic maps. Error polygons (+4 degrees) were then drawn, on overlays, around each roost site (Heezen and Tester 1967, Springer 1979). If polygons of individual roost sites overlapped with adjacent polygons, the affected polygons were combined into one larger polygon encompassing the roost sites involved. Use of delineated roost sites by each radio-tagged bird was then determined by placing the location overlays on the error polygon overlays and then tallying the number of bird locations within and outside of the error polygons.

Minimum and maximum distances between roost sites used by each bird were estimated by measuring the distances between roost sites around which error polygons were established. In instances where error polygons contained more than one roost site, a mid-point was established between the roost sites involved. Distance measurements were then taken from the mid-points to other roost sites used by each bird.

TELEM calculated home range estimates using the convex polygon method (Mohr 1947) for each of the radio-tagged birds. These estimates were used to study the relationship between number of roost sites used, and the home range size of each bird.

Roost Vegetation

A roost site was defined as the immediate forested area containing trees in which wild turkeys were known to roost. To sample roost site vegetation characteristics, a 25-m diameter circular plot was centered around a randomly selected roost tree within the site boundaries. If specific roost trees could not be identified within the roost site, a tree with a diameter-at-breast-height (dbh) of >15 cm was randomly selected as the center tree of the plot. Additional plots were established within a roost site if the area of the roost exceeded 55 m in length or width. Plots were established in such a manner as not to lie within 5 m of each other. Vegetation information recorded within each plot included dbh, height of first limb >5 cm diameter, and species of each tree having a dbh >15 cm. A diameter tape was used to measure dbh, and tree height was measured using a RANGING 120 OPTI-METER (Ranging, Inc.) rangefinder. Height of first limb was measured with the range finder or by ocular estimation.

Horizontal vegetation profile measurements were obtained using a 2-m x 30.4-cm vegetation profile board (Nudds 1977). Horizontal cover was recorded as the percent of the board obstructed when viewed at a distance of 15 m and a height of 1 m. Profile measurements were recorded from June to August, while vegetation was in leaf, to minimize variation due to change of season.

To determine if roost site tree species composition and structural characteristics were significantly different ($P < 0.05$) from other forested areas dominated by the same tree species, a matching control plot was established on the study area for each roost plot sampled in the roost sites. The center tree species within each roost plot was the species selected as center tree for each matching control plot. The dbh of the center tree of each control plot was equal to or greater than the minimium dbh observed for center trees of the same species within the roost plots. If a specific roost tree could not be identified within a roost plot, the center tree of the respective control plot was selected in the same manner used within the roost plot. The species of the tallest tree within the roost and control plots determined the classification of those plots for statistical analyses.

Point-centered-quarter transects (Cottam and Curtis 1956) were used to calculate estimates of tree species frequency in the overall forest community. Twenty, 100-m transects were established beginning at randomly selected points and extended in randomly selected compass directions. Every 20 m along the transect, a center point was established, and the adjacent area was divided into four quarters. Within each quarter, species and distance from the center point of the nearest tree was recorded.

Statistical Analyses

The relative importance of independent variables derived from plot data (Table 1) for discriminating between roost plots and control plots was ascertained using stepwise discriminant analysis (Kleinbaum and Kupper 1978:431-433, Parrish 1981). Three 2-group (roost plots vs. control plots) discriminant analyses were performed. The first analysis compared all roost plots to all control plots. The second analysis compared cottonwood roost plots to cottonwood control plots, and the third analysis compared basswood/ash roost plots to basswood/ash control plots. Discriminant analysis was not conducted comparing elm roost plots to elm control plots due to small sample size. Analysis of variance (ANOVA) was used to determine if vegetation characteristics differed between roost plots and control plots. Chi-square analysis (Neu et al. 1974) was used to compare forest composition within roost plots to expected composition which was derived from the transect data.

Table 1. Independent variables used in discriminant analysis of 25-m diameter wild turkey roost plots and control plots on a study area in Gregory County, South Dakota, during the summer of 1984. All trees sampled were a minimum of 15 cm diameter-at-breast-height.

Variables	Units of Measurement
Total basal area per plot	m^2
Average basal area per tree within plot	m^2
Average tree height per plot	Nearest 1.0 m
Average 1st limb height per plot	Nearest 1.0 m
Tree frequency per plot	# of trees per plot
DBH of tallest tree per plot	Nearest 1.0 cm
Height of tallest tree per plot	Nearest 1.0 m
1st limb height of tallest tree per plot	Nearest 1.0 m
Vegetation profile 0-1 m above ground	% Visual obstruction
Vegetation profile 1-2 m above ground	% Visual obstruction
% Composition basswood/plot	# Basswood/total # trees x 100
Composition elm/plot	# Elm/total # trees x 100
% Composition oak/plot	# Oak/total # trees x 100
% Composition cottonwood/plot	# Cottonwood/total # trees x 100
% Composition ash/plot	# Ash/total # trees x 100

RESULTS

Telemetry

Fifty-one turkeys were trapped and fitted with radio transmitters. An adequate number (>20) of telemetry locations for analysis were obtained for 10 of these birds (Table 2). Five of these birds were present on the monitored area through the entire 4 month study period. The 5 remaining birds either died or were not radioed until later in the study. Forty-one birds did not provide telemetry information because they were out of telemetry receiving range, died before an adequate number of locations could be recorded, or lost their transmitters.

Twelve error polygons were drawn around 17 roost sites located on the monitored portion of the study area (Fig. 1). Four of these polygons encompassed 2 or 3 roost sites due to polygon overlap and subsequent polygon combination. Five polygons fell entirely within the monitored area, the smallest being 7.8 ha and the largest 43.9 ha.

Sixty percent of the nocturnal locations fell within the polygons (Fig. 2). The total number of polygons in which nocturnal telemetry locations were found ranged from 1 to 4 per bird. Four of the 5 birds present on the monitored area throughout the entire monitoring period provided nocturnal telemetry locations in 4 of the error polygons (Table 3). Distances between roost sites used ranged from 0.55 to 3.09 km (Table 3). The most consecutive nights (11) a bird spent at the same roost site was recorded for a juvenile male. This was considered to be a minimum, since it was the maximum number of consecutive nights the bird was monitored.

Table 2. Capture data and telemetry location information for 10 radio-tagged turkeys on a study area in Gregory County, South Dakota, during the summer of 1984.

Band #	Sex/Age	# diurnal locations	# nocturnal locations	max. # potential monitoring days
[a] 136	m/adult	60	17	40
137	m/adult	222	44	117
[b] 142	m/juv.	170	32	75
[a] 151	m/juv.	211	43	91
276	f/juv.	219	48	117
277	f/juv.	23	18	113
[a] 280	f/adult	12	11	50
401	f/juv.	113	40	117
403	f/juv.	67	40	117
[a] 419	f/adult	31	17	50

[a] Died before monitoring period concluded
[b] Radio-tagged after monitoring period began

Fig. 1. Wild turkey roost site locations on a study area in Gregory County, South Dakota, during the summer of 1984. Error polygons were established using a +4° telemetry system error factor. Polygons 1, 2, 3, 7, and 12 contained primary roost sites.

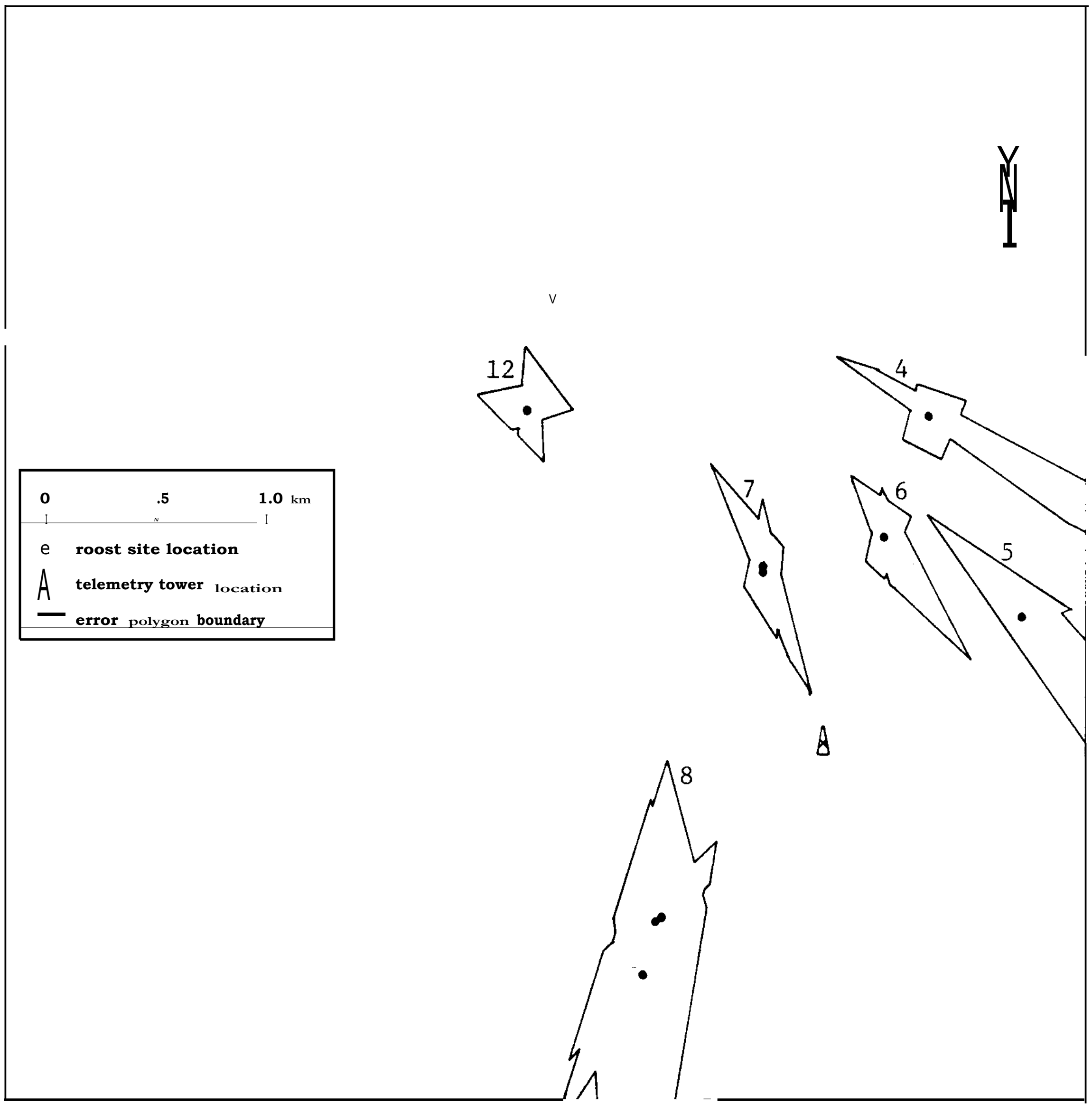

Fig. 2. Nocturnal telemetry locations of roosting wild turkeys in Gregory County, South Dakota, during the summer of 1984. Error polygons were established using a +4° telemetry system error factor. Polygons 1, 2, 3, 7, and 12 contained primary roost sites.

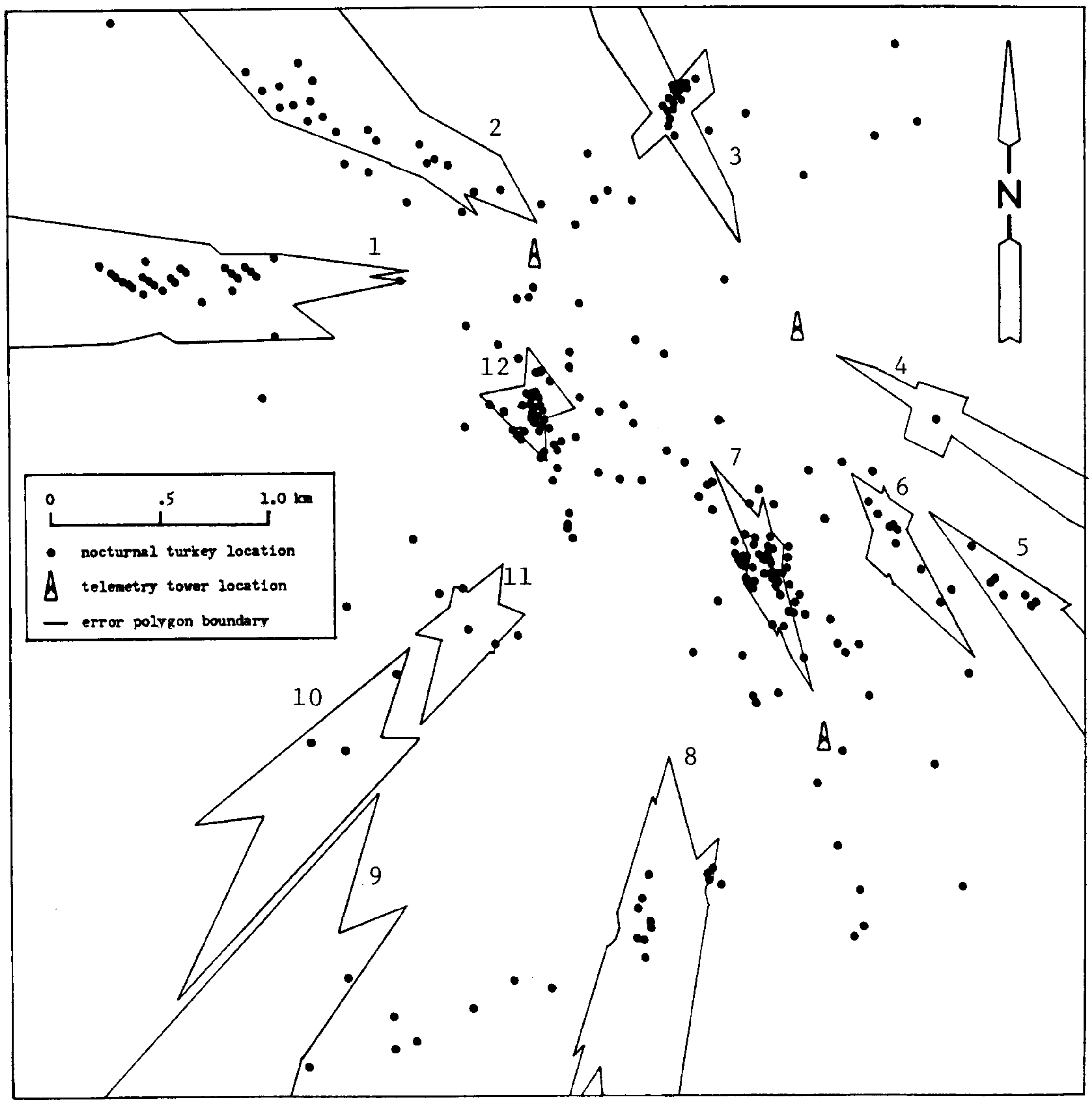

Table 3. Home range and roost site use of 10 radio—tagged wild turkeys on a study area in Gregory County, South Dakota, during the summer of 1984.

Band #	Home range area (ha)	Minimum # of roost sites used	Distance between roost sites used (km) min.	max.	[a] Max. # consecutive nocturnal locations in any one polygon
136	47.4	1			3
137	650.3	4	1.16	3.09	2
142	242.1	2	1.80	1.80	7
151	163.0	2	1.28	1.28	11
276	337.8	4	1.26	2.56	7
277	19.0	1			8
280	38.0	1			1
401	271.2	4	0.55	1.18	6
403	312.4	4	1.26	2.56	8
419	73.0	1			3

[a] Maximum number of consecutive nocturnal locations in any one error polygon is considered to be a conservative figure since it could be no greater than the number of consecutive nights the birds were monitored

Home range determined for the radio-tagged birds varied from 19.0 to 650.3 ha (Table 3), averaging 215.4 ha. Of the 5 birds that were radio-tracked for only a portion of the monitoring period, none had a home range greater than 163.0 ha, while the remaining 5 birds had an average of 318.1 ha.

Roost Vegetation and Analyses

Thirty roost sites were located, providing 36 roost plots for analysis (Table 4). Forty-five control plots were established and sampled for comparison. The discriminant function selected a combination of 4 variables (total basal area, percent bur oak, vegetation profile 1-2 m above ground level, and percent green ash) to discriminate between all roost plots and all control plots (Table 5). These variables combined, explained 53% of the variance between roost plots and control plots. The discriminant function correctly classified 88.9% of the roost plots and control plots.

Only 1 variable, total basal area, discriminated between cottonwood roost plots and cottonwood control plots, explaining 45% of the variation between them. The discriminant function correctly classified 88.2% of both roost plots and control plots.

A 2-variable combination discriminated between basswood/ash roost plots and basswood/ash control plots. Total basal area and percent composition of green ash explained 70% of the variation between roost and control plots. The discriminant function correctly classified 87.5% of the roost plots and 95.0% of the control plots.

ANOVA indicated significant differences ($P < 0.05$) between 8 of the 15 vegetation variables when all roost plots were compared to

Table 4. Number and tree species classification of wild turkey roost plots and control plots in Gregory County, South Dakota, during the summer of 1984. The tallest tree species of each plot determined the classification of the plot.

Species classification	[a] # of roost plots	[a] # of control plots
Eastern cottonwood (*Populus deltoides*)	[b] 17	[b] 17
American basswood (*Tilia americana*) and Green ash (*Fraxinus pennsylvanica*)	16	20
American elm (*Ulmus americana*)	3	8
Total	36	45

[a] The circular roost plots contained an area of 490 m^2 and were centered around randomly selected roost trees or trees with >15 cm diameter-at-breast-height (dbh) within the roost sites. Control plots were the same size and were established based on species and dbh of center trees within the roost plots.

[b] Includes one narrowleaf cottonwood (*Populus angustifolia*) plot.

Table 5. Independent variables used to discriminate between wild turkey roost plots and control plots in Gregory County, South Dakota, during the summer of 1984.

Group (# of cases)	% correctly classified	Major variable	(cumulative R^2)	Within-group means Roosts	Within-group means Controls	
All						
Roosts (36)	88.9	[a]TOBA	(.4112)	1.48 m^2	0.65 m^2	*
vs.		[b]oBO	(.4639)	22.1 %	46.5 %	*
All		[c]VEGP2	(.5014)	61.6 %	78.3 %	**
Controls (45)	88.9	[d]%ASH	(.5297)	18.5 0	11.0 %	
Cottonwood						
Roosts (17)	88.2					
vs.		TOBA	(.4471)	1.52 m^2	0.56 m^2	
Cottonwood						
Controls (17)	88.2					
Basswood/Ash						
Roosts (16)	87.5					
vs.		TOBA	(.5309)	1.58 m^2	0.67 m^2	*
Basswood/Ash		%ASH	(.7048)	20.2 7	17.1 %	
Controls (20)	95.0					

[a]Total basal area per plot
[b]Percent composition of bur oak per plot
[c]Vegetation profile 1-2 m above ground level per plot
[d]Percent composition of green ash per plot

* $P < 0.05$
** $P < 0.01$

all control plots. Six of the above 8 variables were significantly different at the $P < 0.01$ level (Table 6).

Cottonwood roost plots and control plots differed significantly ($P < 0.05$) in total basal area, average basal area per tree within plot, dbh of tallest tree, height of tallest tree, and vegetation profile measurements at 1-2 m above ground level. Basswood/ash roost plots and control plots differed significantly ($P < 0.05$) in percent composition of eastern. cottonwood, and percent composition of green ash.

Analysis of the transect data (Table 7) indicated that bur oak was the most abundant tree species on the study area, with green ash and American basswood the second and third most abundant tree species, respectively. American elm and eastern cottonwood, combined, accounted for less than 10% of the trees present. Chi-square analysis indicated that occurance of the 6 tree species categories within roost plots was significantly different ($P < 0.05$) than expected. Eastern cottonwood, American basswood, American elm, and other trees constituted larger proportions of trees found within roost sites than expected, while bur oak and green ash made up smaller proportions than expected.

Table 6. Least-squares means (X) and standard errors (S.E.) from analysis of variance of independent variables recorded at 36 wild turkey roost plots and 45 control plots on a study area in Gregory County, South Dakota, during the summer of 1984. All plots were circular with a diameter of 25 m.

Independent Variable	Roost plots X	Roost plots S.E.	Control plots X	Control plots S.E.	F-value
total basal area per plot (m^2)	1.27	0.11	0.67	0.08	20.10 *
average basal area per tree (m^2) within plot	0.12	0.01	0.05	0.01	17.63 **
average tree height per plot (m)	10.43	0.42	8.98	0.30	7.86 **
average 1st limb height per plot (m)	2.98	0.22	2.49	0.16	3.36
tree frequency per plot	16.19	1.68	15.59	1.21	0.08
dbh of tallest tree per plot (cm)	60.64	4.95	35.29	3.55	17.35 **
height of tallest tree per plot (m)	16.32	0.69	12.94	0.49	15.83
1st limb height of tallest tree per plot (m)	5.02	0.52	3.39	0.37	6.42
vegetation profile 0-1 m above ground per plot (%)	81.10	2.81	87.75	2.01	3.71

Table 6. (continued)

vegetation profile 1-2 m above ground per plot (%)	63.00	3.87	77.32	2.78	9.05	**
composition of American basswood (Tilia americana) per plot	17.57	5.08	11.57	3.64	0.92	
% composition of American elm (Ulmus americana) per plot	21.86	3.35	15.66	2.40	2.27	
% composition of bur oak (Quercus macrocarpa) per plot	21.42	5.96	46.74	4.28	11.91	**
composition of eastern cottonwood (Populus deltoides) per plot	8.55	4.76	12.51	3.41	0.46	
composition of green ash (Fraxinus pennsylvanica) per plot	13.45	4.62	9.75	3.32	0.42	

* P < 0.05
*4 P < 0.01

Table 7. Chi-square analysis of **observed** tree species frequencies and **proportions** within wild turkey roost plots **vs.** expected frequencies and **proportions** derived from transect data on a study area in Gregory County, South Dakota, during the summer of 1984.

Tree species	Observed		Expected		Chi-square value	CI on observed proportion
	freq.	prop.	freq.	prop.		
Eastern cottonwood	47.00	0.068	8.62	0.012	170.88 **	0.043-0.093
American basswood	232.00	0.336	86.25	0.125	246.30 **	0.289-0.383
American elm	61.00	0.088	36.22	0.052	16.94 **	0.060-0.116
Bur oak	186.00	0.270	384.68	0.558	102.61 **	0.225-0.315
Green ash	127.00	0.184	158.70	0.230	6.33 *	0.145-0.223
Other species	37.00	0.054	15.53	0.023	29.68 **	0.031-0.077
Total	690.00	1.000	690.00	1.000		

* P < 0.05
** P < 0.01

DISCUSSION

Telemetry

Twelve error polygons (Fig. 1) encompassed roost sites that received frequent use from as many as 25 birds per night. Of the 310 nocturnal locations recorded, 186 (60%) fell within the polygons. Based on the number of telemetry locations and observed use, roost sites found within polygons 1, 2, 3, 7, and 12 were considered to be primary roost sites. Turkeys generally used any one primary roost site consistently every night during periods from a few days to 2 months long. The birds then moved to other primary roost sites or to what were considered to be secondary roost sites. Use of secondary roost sites was indicated by locations falling within polygons 4-6, 8-11, and by the 124 (40%) locations falling outside the polygons. Secondary sites were used inconsistently by only a few birds that entered a roost one night, used it only that night, and usually did not return to it on subsequent nights. These same birds also used the primary roost sites when not in the secondary sites. Interpretation of nocturnal locations probably was conservative since the large polygons may have contained roost sites not found by the author. Therefore, a greater number of roost sites may have existed than indicated by telemetry.

All 10 birds used at least 1 primary roost site. Six of these birds used from 2 to 4 individual primary roost sites that ranged from 0.55-3.09 km apart (Table 3). This compares with findings by Fleming and Webb (1975) where a minimum and maximum distance of 0.6 km and 2.4 km, respectively, was found between roost sites used by any one bird.

Logan (1974) found the distances between 1 main roost site and 2 alternate roost sites to be 0.34 km and 1.61 km. Smith (1975) observed satellite roost sites located 0.4-2.4 km from primary roost sites.

There are several possible reasons why turkeys use multiple roost sites. Human and natural disturbances may cause the birds to abandon a roost site that would otherwise receive use. Landowners on and near the study area claimed that hunting turkeys at roost sites would cause immediate abandonment of the sites. Predators, such as great-horned owls (*Bubo virginianus*) also may cause turkeys to abandon roost sites (Latham 1956:64-71). Under these circumstances, it would benefit the birds to have available alternate (primary and secondary) roost sites, should they be forced from a particular site.

Increased efficiency of habitat utilization may be another reason wild turkeys used multiple roost sites. During this study, turkeys using the greatest number of primary roost sites had the largest home ranges (Table 3). If the birds were to return to a roost on subsequent nights, the habitat utilized was restricted by normal traveling distance and time factors. However, birds using 2 or more roost sites properly juxtaposed within suitable habitat could extend their home ranges and thus have access to more habitat resources.

Multiple roost behavior also may relieve conflict between flocks by allowing one flock to select alternate roost sites when prevented from roosting at a site by a second flock. Multiple roost sites have minimized encounters between male flocks when the roost sites were spaced at greater distances than the birds traveled (Watts and Stokes 1971). My data did not indicate displacement of turkeys from roost sites by birds from other flocks. This may be due to absense of flock conflict which would cause displacement, or it may reflect the inability of the telemetry system to pinpoint bird locations and distinguish nearby alternate (primary or secondary) roost sites.

A fourth possible explanation for multiple roost behavior would occur if the birds were unable to return to a preferred roost site late in the day and, therefore, selected any available roost site in the vicinity at roosting time. Although the predictable manner by which the turkeys on the study area behaved lends little support to this possibility, visual observations indicated that some opportunistic roost site selection occurred.

Another possible explanation for multiple roost behavior may be based on flock size. Small winter flocks of turkeys use more satellite roost sites than larger flocks (Smith 1975). The smaller turkey flocks had a greater choice of roost sites large enough to hold their entire group than did the larger flocks.

Roost Vegetation and Analyses

In each discriminant analysis group comparison (Table 5), total basal area per plot was the first variable entered into the discriminant function and singly explained the most variation between all roost plots and all control plots. Wild turkeys selected forested regions with significantly larger ($P < 0.05$) total basal areas

(30.20 m^2/ha) compared to control plots (13.12 m^2/ha). ANOVA (Table 6, Appendix 1) indicated a significant difference ($P < 0.05$) in average basal area between roost and control plots, showing that roost plots were comprised of fewer, larger individual trees than control plots. This infers selection by turkeys for large, mature trees in which to roost. Based on general observations, such trees provide large, spread-out canopies containing many nearly horizontal limbs for perching and allow easy access for turkeys, since less vegetation is present to impede flight while entering roost sites. Near-horizontal limbs provide better perches for roosting birds, as it would be difficult for birds to roost on severely inclined limbs. The larger the tree, the more limbs available for perching, therefore, more birds could be accomodated.

The smallest total basal area found in a secondary roost site during this study was 9.98 m^2/ha, while the smallest comparable basal area found in a primary roost site was 21.39 m^2/ha. Other studies have found basal area to be an important characteristic of roost sites, the reduction of which may cause disrupted roosting activity. Scott and Boeker (1975), and Phillips (1980), reported that turkeys ceased using sites in which logging had reduced basal area to below 16.8 m^2/ha and 16.1 m^2/ha, respectively. However, the former study reported that turkeys continued to use roost sites that were reduced to 20.7 m^2/ha. Mackey (1984) observed that roost sites in Washington had relatively high basal areas compared to control sites. The roost sites he sampled averaged 33.9 m^2/ha and only 12% of the roost sites had basal areas under 18.4 m^2/ha. The results of my study and the above suggest a threshold of approximately 20.0 m^2/ha total basal area for primary roost sites. Woodlots maintained at or above this level should provide an adequate number of primary roost sites that are able to accomodate flocks of 25 or more turkeys on a year-round basis.

Roost plots contained a significantly smaller ($P < 0.01$) proportion of bur oak than did control plots (Table 5). This negative association between roost sites and bur oak composition may be due to the relatively small size of bur oak compared to other dominant tree species on the study area. Turkeys were never observed roosting in bur oak trees during the 4 months (May-Aug.) of the telemetry study. Turkeys were observed roosting in bur oak. sites during the winter of 1983. However, this behavior was considered irregular. Extreme weather conditions prevalent at that time forced birds to roost within 100 m of a farmstead corn pile, presumably to have close access to food. Bur oak on the study area were too small to produce roosting cover comparable to that provided by eastern cottonwood, American basswood, green ash, and American elm. Bur oak is not a suitable roost tree species and its presence at some sites may be detrimental to growth of seedlings or saplings of other tree species that could develop into roosting trees. Crockett (1973) indicated that turkeys used bur oak as winter roost trees in Oklahoma. However, bur oak found within his roost sites averaged 14.9 m tall and 52.3 cm dbh as compared to 8.3 m tall and 18.7 cm dbh within roost plots sampled in this study.

Vegetation profile measurements at the 1-2 m level was the third function variable used when discriminating between all roost plots-and all control plots. Discriminant analysis and ANOVA indicated significantly less ($P < 0.01$) visual obstruction of the vegetation profile board within roost plots (Tables 5 and 6), suggesting a more open understory at this level. This may be due to greater shading by the larger trees within roost plots, thus limiting understory vegetation growth. Based on visual observations, turkeys most often flew to roost sites from clearings located 10-30 m from roost sites. Birds preparing to roost would be better able to detect potential predators hiding in more open understory. Furthermore, a more open understory would cause less obstruction to flight for turkeys entering a roost.

Percent composition of green ash was the fourth variable used to discriminate between all roost plots and all control plots and the second variable entered into the basswood/ash discriminant function. ANOVA did not detect a significant difference ($P > 0.05$) in composition between roost plots and control plots. Since percent composition of green ash was a discriminating variable with no significant difference between roost and control plots, a possible statistical interaction with one or more of the variables previously entered into the discriminant function may have existed. Turkeys were observed roosting in green ash, however, field observations indicated that only 1-3 birds used any particular green ash roost site during any one night. Green ash is a principle tree species found in secondary roost sites.

Only one variable, total basal area, was entered into the discriminant function of cottonwood roost plots vs cottonwood control plots. Within-group means indicated that turkeys selected cottonwood roost sites with greater total basal area than was found in cottonwood control plots (Table 5). Cottonwood trees in roost sites were taller and had a more spread out canopy which provided more limbs available as perches than did the cottonwood trees in the control plots.

Eastern cottonwood, American basswood, American elm, and other trees were found in larger proportions within roost plots than expected, while bur oak and green ash made up smaller proportions than expected (Table 7). The birds selected for areas dominated by eastern cottonwood and American basswood.

In conclusion, physical roost site characteristics are significantly different ($P < 0.05$) from non-roost site areas dominated by the same tree species. Wild turkeys selected roost sites with relatively large total basal areas. Such sites were dominated by large trees having large spread-out canopies. Total basal area and average basal area per tree are indirect measures of canopy size and can be used to evaluate turkey roost cover. Tree species composition of roost sites does significantly differ ($P < 0.05$) from overall tree species composition of the study area. The birds selected roost areas dominated primarily by eastern cottonwood and American basswood.

Management Implications

American basswood and eastern cottonwood were the principle tree species found in roost sites and together these 2 species classifications made up 81% (29) of the roost plots sampled (Table 4).

All 5 primary roost sites were dominated by 1 of these 2 species. It is apparent that basswood and cottonwood trees are very important for providing roost cover for wild turkeys in the Gregory County area. Turkey flocks would benefit from identification of primary roost sites and protection from unnecessary disturbance.

Cottonwood trees on the study area were usually situated along drainage bottoms, singly or in small groups of less than 10, with mature cottonwoods having large, tall boles. Basswood trees were usually found in groups of 10 or more, and generally had tall, slender boles. Cottonwood trees, by virtue of their large size, and Basswood trees, by virtue of their long bole length and clumped distribution, may be potential sources of harvestable timber (Naughton et al. 1979, Elias 1980:436—438). Excessive timber harvest would reduce roost site availability and could negatively impact turkey flocks in the area.

General observations revealed that several cottonwood roost sites contained large, mature cottonwood trees, the oldest of which had particularly open canopies with advancing decadence. As decay and limb loss increases, these trees become less desirable for roosting. To compensate for eventual roost tree loss, roost site management should include preservation of middle—age stands of cottonwoods to provide future roost sites.

This study also revealed that turkeys on the Gregory County study area used any one of several roost sites. Primary sites sheltered several birds on any given night and were used consistently, while secondary sites were used sporadically by only a few birds. The multiple sites used by any one bird were located within 3.09 km (Table 3) of each other. This indicates a need to preserve several roost sites within reasonable distance of each other to allow the birds a choice of roost sites and more efficient use of habitat.

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Appendix 1. Analysis of variance of independent variables recorded at 36 wild turkey roost plots (R) and 45 control plots (C) on a study area in Gregory County, South Dakota, during the summer of 1984. All plots were circular with a diameter of 25 m.

Independent Variable	Source of Variation	df	Mean Squares	F-value
total basal area per plot	TRT (R vs C)	1	4.7349	20.10
	Species	2	0.5139	2.18
	TRT x species	2	0.9931	4.22 *
	Error	75	0.2355	
average basal area per tree within plot	TRT (R vs C)	1	0.0664	17.63 *m
	Species	2	0.0437	11.60 **
	TRT x species	2	0.0148	3.92 *
	Error	75	0.0038	
average tree height per plot	TRT (R vs C)	1	27.5148	7.86 **
	Species	2	6.5321	1.86
	TRT x species	2	17.5714	5.02 **
	Error	75	3.5026	
average 1st limb height per plot	TRT (R vs C)	1	3.1553	3.36
	Species	2	6.0983	6.49 **
	TRT x species	2	3.9866	4.25
	Error	75	0.9390	
tree frequency per plot	TRT (R **vs** C)	1	4.5939	0.08
	Species	2	1667.4076	29.67 xM
	TRT x species	2	309.3740	5.50
	Error	75	56.1891	
dbh of tallest tree per plot	TRT (R vs C)	1	8401.9954	17.35 gym
	Species	2	13150.0240	27.16 **
	TRT x species	2	3024.9411	6.25 **
	Error	75	484.2350	

Appendix 1. (continued)

height of tallest tree per plot	TRT (R vs C)	1	149.0311	15.83	**
	Species	2	97.6194	10.37	**
	TRT x species	2	4.2605	0.45	
	Error	75	9.4173		
1st limb height of tallest tree per plot	TRT (R vs C)	1	34.6336	6.42	*
	Species	2	6.4572	1.20	
	TRT x species	2	1.3597	0.25	
	Error	75	5.3947		
vegetation profile 0-1 m above ground per plot	TRT (R vs C)	1	578.0600	3.71	
	Species	2	276.4393	1.77	
	TRT x species	2	90.2024	0.58	
	Error	75	155.8394		
vegetation profile 1-2 m above ground per plot	TRT (R vs C)	1	2685.1962	9.05	
	Species	2	22.8694	0.08	
	TRT x species	2	137.0634	0.46	
	Error	75	296.7809		
composition of American basswood _(Tilia americana)_ per plot	TRT (R vs C)	1	0.0470	0.92	
	Species	2	0.7352	14.40	**
	TRT x species	2	0.2467	4.83	
	Error	75	0.0511		
composition of American elm _(Ulmus americana)_ per plot	TRT (R vs C)	1	0.0503	2.27	
	Species	2	0.5337	24.03	*M
	TRT x species	2	0.0011	0.05	
	Error	75	0.0222		
composition of bur oak _(Quercus macrocarpa)_ per plot	TRT (R vs C)	1	0.8383	11.91	
	Species	2	0.2728	3.88	
	TRT x species	2	0.1899	2.70	
	Error	75	0.0704		

Appendix 1. (continued)

composition of eastern cottonwood (Populus deltoides) per plot	TRT (R **vs** C)	1	0.0204	0.46
	Species	2	0.9277	20.73 **
	TRT x species	2	0.0402	0.90
	Error	75	0.0448	
composition of green ash (Fraxinus pennsylvanica) per plot	TRT (R vs C)	1	0.0179	0.42
	Species	2	0.0919	2.17
	TRT x species	2	0.0445	1.05
	Error	75	0.0423	

* P < 0.05
** P < 0.01