ROOSTING HABITAT OF MERRIAM'S TURKEYS IN THE BLACK HILLS, SOUTH DAKOTA

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Abstract: Lack of roost habitat (trees ≥40 cm diameter breast height [dbh] and ≥ 18 m^2/ha basal area) can limit populations of Merriam's turkeys *(Meleagris gallopavo merriami).* The Black Hills region has relatively large populations of Merriam's turkeys, yet trees ≥40 cm dbh are uncommon. Consequently, I studied roosting habitat of this subspecies in a hierarchical manner to quantify roost habitat requirements in an area of apparent limited suitable roost habitat. Little or no selection for roosts occurred among macrohabitats. Basal area at roost sites averaged 19 - 25 m^2/ha. Winter and summer (excluding hens with poult) roost sites were more similar than roost sites selected by hens with poults or random sites. Vegetative characteristics at roost plots showed trends toward trees with larger dbh, lower tree density (stems/ha), and higher basal area (m^2/ha). Roost trees averaged 35 cm dbh, but trees ≥23 cm dbh were used. Roost trees had layered horizontal branches and often large dbh, but large dbh was not a prerequisite for roost trees. Timber management practices in the Black Hills that modify the forest below 21 m^2/ha and decrease the number of 25-35 cm dbh trees will reduce roosting habitat for Merriam's turkeys.

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Roosts are apparently important to sustaining populations of turkeys (Boeker and Scott 1969, Mackey 1984, Kilpatrick et al. 1988). Merriam's turkeys abandoned areas in Arizona where basal area at roost sites was reduced to 16.8 m^2/ha (73 ft^2/acre) (Scott and Boeker 1975). Bryant and Nish (1975) partially attributed nonuse of pinon-juniper *(Pinus edulis-Juniperus* spp.) habitats to the lack of suitable roost sites.

Roost trees selected by Merriam's turkeys typically have been large (≥40 cm dbh), mature, or overmature (large diameter old trees with flat tops and large horizontal branches) ponderosa pine *(P. ponderosa)* (Hoff man 1968, Boeker and Scott 1969, Phillips 1980). Narrowleaf cottonwood *(Populus agustifolia)*, Engelmann spruce *(Picea engelmannii)*, white fir (*Abies concolor*), and Douglas-fir *(Pseudostuga menziesii)* also are used for roosting (Hoff man 1968, Mackey 1984, Lutz and Crawford 1987). Trees ≥40 cm dbh are uncommon in the Black Hills, but the area supports large and sustaining turkey populations. My objective was to describe, in a hierarchical manner, the roosting habitat of Merriam's turkeys in an area where large (≥40 cm dbh) trees were in short supply.

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STUDY AREA AND METHODS

I conducted this study for 5 years (Mar 1986 - Jan 1991) in the central Black Hills of South Dakota. Elevation ranges from approximately 1,300 to 1,800 m above sea level. Most of the land was managed by the Black Hills National Forest, Pactola Ranger District. Private holdings associated with ranch operations occurred in some meadows and several private homes and cabins occurred within the study area.

Vegetation of the study area was pure ponderosa pine forest (84%), with meadows and aspen *(P. tremuloides)* - birch *(Betula papyrifera)* vegetation in drainages. Some monotypic aspen stands occurred on northern exposures. Bur oak *(Quercus macrocarpa)* and white spruce *(P. glauca)* comprised < 1% of the study area.

Some turkeys in the Black Hills used ranch feed lots and suburban housing developments for winter feeding; others remained in the forest throughout winter or until deep snow forced them to use ranches (Petersen and Richardson 1975). My research was conducted on birds in the latter category.

I trapped turkeys from late February to early March each year of the study using ralose (Williams 1966), drop nets, or rocket nets. Eighty-eight individual turkeys (63 females and 25 males) were fitted with back-pack mounted radio transmitters having a mass of approximately 108 g. The fewest number of marked birds in any year was 13. Actual number of birds in the field at any time was a function of survival (up to 4-5 yr) and annual mortality.

During the first 3 years, I located approximately 1 roost/month; during the last 2 years, approximately **1** roost/week was located. Turkeys are gregarious with some mingling and exchange among flocks. Usually > 1 radio-marked bird was located at a roost. During winter, birds occasionally used the same roost repeatedly. Individual roost sites were included in the sampling only once, and co-occurrence of radio-marked birds at a roost site was treated as 1 observation. I selected roosts from different flocks to ensure adequate representation of all radio-marked birds. Over the course of the study, 158 roosts were located.

Habitat Descriptions

Macrohabitats. -I determined turkey roosting habitat using a hierarchical approach to habitat selection (Johnson 1980). Macrohabitats were the lowest level of habitat delineation and corresponded to third-order habitats (Johnson 1980). Macrohabitats were numerically identified geographical units, the boundaries of which were defined by watershed topography (ridges and drainages) or distinct changes in vegetation type. Typically, these were 4- to 32-ha land units; although smaller size macrohabitats were delineated if distinct vegetation types such as aspen-birch or meadows could be identified on 1:24,000 aerial photographs. I assigned private lands in the study area to macrohabitats based on interpretation of aerial photographs; boundaries of adjacent macrohabitats were extended if the vegetation type was continuous, or new boundaries were assigned if changes in vegetation were apparent. I delineated 9 macrohabitat categories and 513 geographical units for my study. Macrohabitats were described vegetatively based on dominant species of vegetation, diameter breast height (dbh), and overstory canopy cover (Buttery and Gillam 1983). Dominant vegetation type included ponderosa pine, aspen-birch, oak, spruce, and meadows. Dbh categories included 2.5-22.9 cm and >22.9 cm; overstory canopy cover included 0-40, 41 - 70 and 71 - 100%. I estimated overstory canopy cover of macrohabitats from the following relationship developed for the Black Hills: overstory canopy cover (%) = 2.23*basal area (m^2/ha) – 1.94 (Bennett 1984). These procedures for describing macrohabitats are used by Rocky Mountain Region National Forests for modelling wildlife habitat relationships.

Microhabitats. -I evaluated microhabitat at roosts at 3 scales of resolution (roost site, roost plot, and roost tree), which represented fourth and higher orders of habitat selection (Johnson 1980). Vegetation measurements at microhabitats included basal area (m^2/ha), density of trees (stems/ha), average dbh, slope, aspect, and overstory canopy cover. Three plots were sampled at each roost site: one at the roost, and one 30 m in each direction on the contour. Basal area, tree density, and dbh were recorded for trees using a 10-factor prism to determine sample trees at each plot. Aspect was determined from a down-hill compass bearing, percent slope was estimated with a clinometer, and overstory canopy cover (%) was estimated with a spherical densiometer (Lemmon 1956, Griffing 1985).

During the last 2 years of the study, I expanded microhabitat data collection to include silvicultural prescription, time since cut, stand structure, location on the slope, fuels (tons [M]/ha), and roost tree characteristics. I classified prescriptions as: no cut, no evidence of past cutting at the roost site; clearcut, most or all trees removed in an area pattern (occasionally some small diameter trees would be left); commercial thin, evidence that past cutting had removed several to most mature trees (included past selective harvest); shelterwood seed cut, most trees harvested with remaining few trees of mature seed-producing size (basal area ≤ 9 m^2/ha); and precommercial thinning, small diameter trees cut and left in the forest. Time since cut was categorized as <2 years, 2-5 years, and > 5 years. I classified stand structure as multistory or not based on the presence of 2 or more layers to the tree canopy. Location of roost on the slope was determined among 6 exclusive categories; ridge, top 25% upper 25% lower 25% bottom 25% and bottom. I estimated fuels for 2.5 to 7.6-cm and >7.6-cm diameter categories based on pictorial guides developed for the Black Hills (USDA For. Serv., Rocky Mt. Reg. 1982). Roost tree height, roost height, and spacing between branches at roost height were determined from ocular estimates.

The same microhabitat sampling scheme was used at 220 random sites within the study area. Random sites were located based on stratified random sampling of macrohabitats (described above). Data pertaining to position on slope, tree height, roost height, and branch spacing were not collected at random sites.

Analyses

Habitat selection of hens with poults is distinct from other turkeys until poults are approximately 12 weeks old (Rumble 1990). Stratification of data by sex or age (subadult-adult) of turkeys during winter was impossible because mixed flocks frequently roosted together, and I could not correctly identify all birds. As a result, I used the following categories in analyses: winter, summer (excluding hens with poults), and hens with poults.

Macrohabitats. -Chi-square tests attempt to fit a specified model to a data set, and significance indicates deviations from the expected fit under the model. The model in each test was no interaction among factors of the contingency table, and hypotheses were stated in a positive sense (Steel and Torrie 1980: 496-499). I used Chi-square tests of independence to test hypotheses that macrohabitats used for roosting by turkeys (excluding hens with poults) were similar among seasons and that macrohabitats used for roosting by hens with poults were similar to other turkeys. Chi-square goodness-of-fit tests corrected for continuity (Cochran 1963: 57) were used to test hypotheses that selection of roosts by Merriam's turkeys among macrohabitats was similar to random expected use. In the overall Chi-square tests, I combined oak, spruce, and aspen habitats to reduce the number of cells with ≤ 5 expected observations. These, and other macrohabitats were considered separately with Bonferroni confidence intervals around proportional use to determine which macrohabitats were selected disproportionately from expected use (Neu et al. 1974, Byers et al. 1984).

Microhabitats. -I weighted random data to account for deviations from proportional sampling of macrohabitats in the analyses. Analysis of variance procedures were used to test the hypothesis that vegetative characteristics at roost sites did not differ from random sites. I analyzed data that did not adhere to homogeneity of variance assumptions among groups using Welch's test, which is recommended when variances and sample sizes are not equal (Milliken and Johnson 1984). Paired t-tests were used to test hypotheses that basal area, tree density, dbh, and overstory canopy cover did not differ between roost plots and plots 30 m away.

I used Chi-square tests for independence to test hypotheses that aspect, prescription, time since cut, and stand structure were similar among roosts selected during winter, summer, and by hens with poults. Chi-square goodness-of-fit tests were used to test hypotheses of independence of these variables at roosts from random sites. I used Bonferroni confidence intervals (Neu et al. 1974) and standardized Chi-square residuals with a Bonferroni correction to the Z-statistic (if observed use was zero; Mosteller and Parunak 1985) to determine categories of these variables that deviated from random.

Terminology used in this study follows Johnson (1980) and Thomas and Taylor (1990). Habitat use implies utilization that was not compared to availability. Habitat selection implies use that was not compared to availability. Habitat preference required differential selection of resources given equal availability. Tests of hypotheses for aspect, time since cut, and stand structure considered all possible responses and significant deviations from random inferred preference or avoidance for these variables.

Statistical significance in this study was determined at $\alpha \leq 0.10$. Costs of Type II errors in the analyses were weighed against attaining higher probability confidence intervals. Because this research was directed toward providing managers with information regarding the effects of forest management on turkeys, Type II errors would be equivalent to incorrectly suggesting turkeys use habitats randomly. Type II errors would result in lack of management in forest ecosystems to enhance or maintain turkey habitat.

RESULTS

Macrohabitats

The use of macrohabitats by turkeys did not differ ($P = 0.82$) between summer (excluding hens with poults) and winter. Therefore, these data were pooled for further tests. Macrohabitats used for roosting by hens with poults differed ($P = 0.03$) from those used by other turkeys. Selection of macrohabitats for roosting by turkeys during summer and winter differed from random ($P = 0.04$). However, few differences were apparent when proportional use of individual macrohabitats was compared to

Table 1. Selection of macrohabitats for roost sites by Merriam's turkeys in the Black Hills, South Dakota, 1986–91.

Habitat	Dbh	Percent canopy cover	Proportional area	Number of roosts: Hens with poults[a]	Number of roosts: Summer/winter[b]
Meadow			0.1016	2	1[c]
Pine	2.5–22.5 cm	0–40	0.0701	1	14
		41–70	0.1677	8	24
		>70	0.2173	4	24
Pine	>22.5 cm	0–40	0.0498	1	2
		41–70	0.2083	19	33
		>70	0.1239	1	18
Other[d]		0–100	0.0616	3	3

[a] Poults were ≤12 weeks old.
[b] Summer and winter were pooled because no differences ($P \geq 0.10$) occurred.
[c] Habitats selected less ($P < 0.10$) than expected.
[d] Includes all dbh and overstory categories of aspen, oak, and spruce vegetation types.

tional area, and selection of meadows less than available was the only statistically significant deviation (Table 1). Macrohabitats selected by hens with poults were not different from random ($P = 0.16$).

Microhabitats

Roost Sites.—During summer, basal area was higher ($P = 0.01$) at roost sites selected by hens with poults than at roost sites selected by other turkeys (Table 2). Basal area at winter and summer roosts and random sites did not differ ($P \geq 0.10$). Density of trees did not differ ($P \geq 0.10$) between summer and winter roost sites, but tree density at these roosts was lower ($P \leq 0.10$) than at roost sites of hens with poults and at random sites. Average dbh of trees at winter roost sites was greater ($P \leq 0.10$) than at roost sites selected by hens with poults; average dbh at summer roosts did not differ ($P \leq 0.10$) from that of winter or poult roosts. Average dbh at random sites was less ($P < 0.10$) than at all roost sites selected by turkeys. Slope was similar among all roost sites but greater ($P < 0.001$) than at random sites. Overstory canopy cover was greater ($P \leq 0.10$) at winter roosts than at random sites, or roosts selected by hens with poults. Small diameter fuels (2.5–7.6 cm) were not different ($P \leq 0.10$) among all roost sites, but were greater ($P = 0.02$) at random sites than at sites selected for winter roosts. No differences ($P = 0.27$) were found for large diameter fuels (>7.6-cm diameter).

Chi-square analysis indicated that aspect,

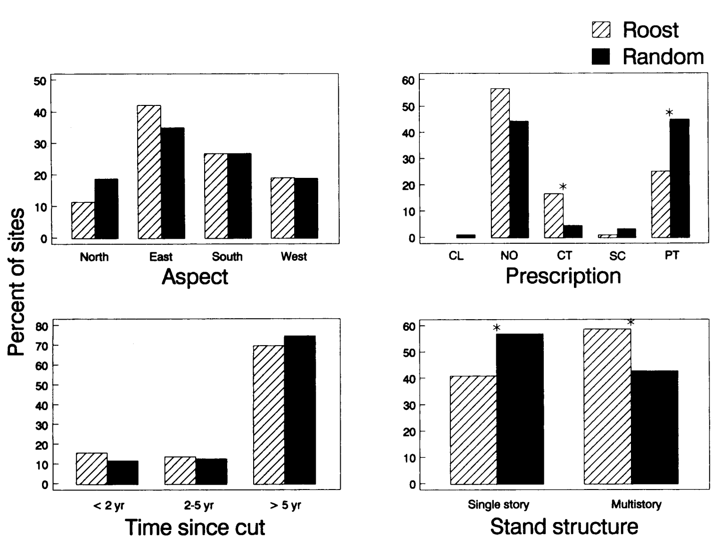

Fig. 1. Distribution of aspect ($n = 158$), prescription ($n = 95$), CL = clearcut, NO = no evidence of timber harvest, CT = commercial thin, SC = shelterwood seed cut, PT = precommercial thin), time since cut ($n = 44$) and stand structure ($n = 95$) at roost and random sites in the Black Hills, South Dakota, 1986–91. Asterisk indicates roost and random sites differed ($P \leq 0.10$).

Table 2. Microhabitat characteristics ($\bar{x} \pm$ SE) of roost sites and random sites in the Black Hills, South Dakota, 1986-91.[a]

Habitat characteristic[b]	Winter	Summer	Hens with poults	Random
Basal area (m^2/ha)	22.4 ± 1.1AB[c]	19.4 ± 1.1A	25.9 ± 1.7B	21.1 ± 0.8AB
Tree density (trees/ha)	598.2 ± 78.1A	534.4 ± 97.1A	973.3 ± 142.8B	1,001.6 ± 75.1B
Diameter breast height (cm)	26.9 ± 0.8A	26.6 ± 0.9AB	23.3 ± 1.1B	19.7 ± 1.6C
Slope (%)	28.2 ± 1.4A	30.3 ± 2.2A	29.4 ± 2.2A	22.9 ± 0.9B
Overstory canopy cover (%)	58.3 ± 1.4A	53.1 ± 2.0AB	52.6 ± 2.6AB	46.9 ± 1.5B
Fuels 2.5-7.6 cm [tons(M)/ha]	2.6 ± 0.5A	2.4 ± 0.4AB	2.4 ± 0.8AB	3.8 ± 0.2B
Fuels >7.6 cm [tons(M)/ha]	6.0 ± 0.9A	5.2 ± 0.9A	7.2 ± 2.5A	7.0 ± 0.3A

[a] n = 71, 48, and 39 for winter, summer, and broods, respectively, for basal area to overstory canopy cover. n = 49, 34, and 6 for winter, summer, and broods, respectively, for fuels variables. n = 220 for all variables from random sites. Different sample sizes occurred because variables were added after the first 2 years.
[b] Conversions from metric to English units are: basal area (m^2/ha) = 0.2291*ft^2/acre; density (trees/ha) = 2.471*trees/acre; dbh (cm) = 2.54*inch; and fuels (metric tons/ha) = 2.24*tons/acre.
[c] Row means with different letters differ ($P \leq 0.10$); ANOVA or Welch's test.

prescription, time since cut, and stand structure did not differ ($P \geq 0.40$) among roosts selected during summer, winter, or by hens with poults. Thus, these data were pooled for comparisons with random sites. Most (42%) roosts were located on slopes facing northeast to southeast (Fig. 1). However, no (P = 0.24) preference relative to aspect was noted. Of roosts located in areas of prior timber harvest activity, more occurred in stands that had been commercially thinned (selectively cut) and fewer occurred in precommercially thinned stands ($P \leq 0.10$) than at random. Turkeys tended to select roosts in stands with no evidence of timber harvest (57%) or that had been harvested at ≥5 years prior (78%). Neither of these latter variables differed from random ($P \geq 0.10$). Merriam's turkey avoided (P = 0.0008) roosting in even-aged or single story stands.

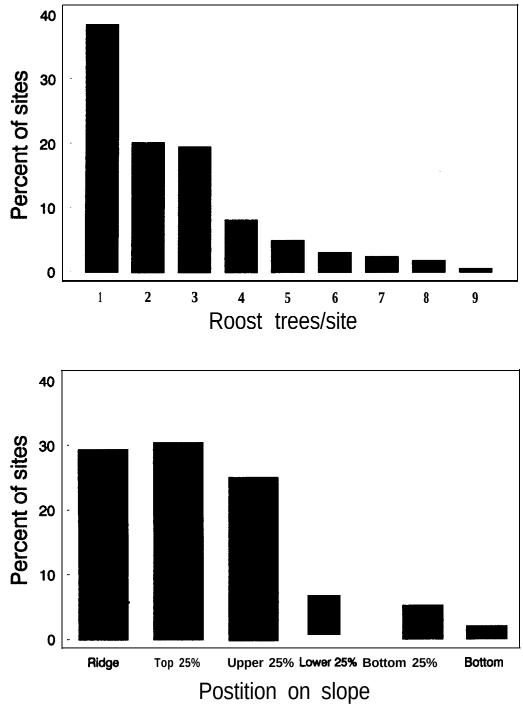

Fig. 2. Distribution of Merriam's turkey roost trees per site (n = 158) and location on slopes (n = 95) in the Black Hills, South Dakota, 1986-91.

The number of roost trees per site showed a significant negative exponential distribution (r^2 = 0.97, $P \leq 0.001$) (Fig. 2). Approximately 80% of the roost sites had ≤3 roost trees, with nearly 40% having only 1 roost tree. More ($P < 0.001$) roost trees/site were found at winter roosts ($\bar{x} \pm$ SE = 3.2 ± 0.2) than summer roosts ($\bar{x} \pm$ SE = 2.2 ± 0.3); both of which were greater than sites selected by hens with poults ($\bar{x} \pm$ SE = 1.5 ± 0.1). Eighty-five percent of all roosts were located on the upper half of slopes or on ridges.

Roost Plots.-There was a trend toward greater basal area, lower density of trees, and larger dbh at plots containing roosts versus those on adjacent plots (Table 3). Basal area was higher at plots containing the roost tree than plots 30 m away at summer roosts (P = 0.08) and roosts selected by hens with poults (P = 0.06). During winter, density of trees at roosts was lower (P = 0.03) than on adjacent areas. Dbh at roost plots during winter and summer was greater (P = 0.04) than on adjacent plots. Hens with poults selected roosts with greater (P = 0.002) overstory canopy cover than on adjacent plots. Otherwise no differences in overstory canopy cover were evident at roosts versus adjacent plots.

Roost Trees.-Mean dbh of roost trees ($\bar{x} \pm$ SE = 37 ± 0.5 cm) was not different among summer, winter, or hen with poult roosts (P =
However, the distribution of dbh for trees

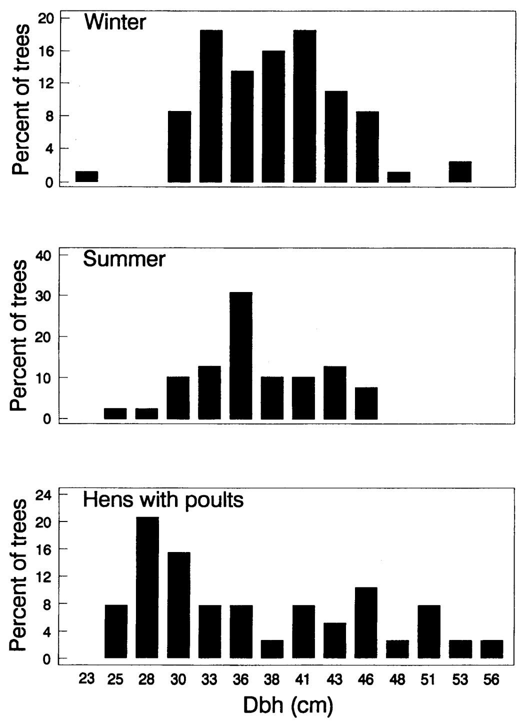

Fig. 3. Dbh of roost trees at winter (n = 80), summer (n = 39), and hen with poult (n = 39) roosting sites of Merriam's turkeys in the Black Hills, South Dakota, 1986–91.

selected for roosts was visibly different (Fig. 3). No differences in branch spacing (P = 0.80) or tree height (P = 0.13) occurred among roost categories. Mean (±SE) branch spacing and tree height were 0.9 ± 0.1 m and 27.0 ± 0.4 m, respectively. Hens with poults roosted higher (P = 0.03) in trees (13.4 ± 0.5 m) than other turkeys during winter (11.5 ± 0.5 m). Summer roosts averaged 12.6 ± 0.6 m from the ground.

DISCUSSION

Macrohabitats

Similar use of macrohabitats between summer and winter for roosting by turkeys in my study contrasted with results of Lutz and Crawford (1987) who reported decreased use of mixed conifer habitats for roosting from winter (92%) to summer (59%). These differences may have resulted from snow accumulations in the mountains of Oregon that would force turkeys to migrate to lower elevations during winter. Turkeys in my study did not demonstrate large elevational migrations, probably because snow accumulations over 20 cm were infrequent and

Table 3. Microhabitat characteristics ($\bar{x}$ ± SE) at Merriam's turkey roost plots and plots 30 m from roosts in the Black Hills, South Dakota, 1986–91.

Habitat characteristic	Winter[a]		Summer[a]		Hens with poults[a]	
	Roost	Away	Roost	Away	Roost	Away
Basal area (m^2/ha)	22.8 ± 1.1A[b]	21.7 ± 1.1A	20.4 ± 1.1A	18.9 ± 1.2B	28.9 ± 2.5A	24.5 ± 1.7B
Density (trees/ha)	435.1 ± 64.5A	681.9 ± 106.5B	485.9 ± 107.1A	558.7 ± 120.4A	913.6 ± 180.3A	1,003.1 ± 168.2A
Dbh (cm)	28.8 ± 0.7A	25.9 ± 0.9B	28.0 ± 1.1A	26.0 ± 0.9B	24.4 ± 1.3A	22.9 ± 1.0A
Canopy cover (%)	56.5 ± 1.7A	59.3 ± 1.7A	54.6 ± 2.1A	52.7 ± 2.5A	62.3 ± 3.5A	47.8 ± 3.1B

[a] n = 80, 39, and 39, respectively, for winter, summer, and broods roost sites.
[b] Row means with different letters within categories of winter, summer, or hens with poults differed ($P \leq 0.10$); paired t-test.

short term, and because only a 500-m change in elevation was possible.

Outside of infrequent use of isolated trees in meadows, no patterns of selection for roosting were evident at the macrohabitat scale of resolution. Lutz and Crawford (1987) and Mackey (1984) also reported few deviations from expected use of low resolution habitats for roosting by turkeys.

Microhabitats

Roost Sites.-The ability to relate vegetative characteristics of roosts among studies is difficult because of inconsistencies in the variables reported. Basal area at roost sites in my study was similar to that reported in Arizona (Scott and Boeker 1975), but was substantially less than the 33 m^2/ha reported for turkeys roosting in Douglas-fir in Washington (Mackey 1984). Overstory canopy cover was lower than reported by Mackey (1984), but was greater than reported by Lutz and Crawford (1987). Patterns of similarity or differences between basal area and overstory canopy cover are expected since these 2 variables are positively correlated (Bennett 1984, Hoover and Wills 1984:411). Densities of trees at roost sites in my study were greater than those reported by Hoffman (1968) for roost sites in Colorado.

Merriam's turkeys usually select roost sites on moderately steep (20-30%) slopes (Jonas 1966, Lutz and Crawford 1987, this study), but occasionally use relatively gentle slopes (5%) (Scott and Boeker 1975). No differences in percent slope were found at roost sites in my study. However, slopes at summer roosts have been reported to be more gentle than winter roosts (Hoffman 1968, Lutz and Crawford 1987).

Most turkeys in my study roosted near the top of slopes or on ridges, which was consistent with other studies (Lutz and Crawford 1987, Schemnitz et al. 1985). More roosts in my study had easterly aspects, but patterns did not deviate from random. Boeker and Scott (1969) postulated that first morning light was important in selection of easterly aspects at turkey roosts. Ponderosa pine, the most common tree selected for roosting by Merriam's turkeys, is associated with sites deficient in rainfall (Fowells 1965), typical of eastern slopes of mountain ranges in the western United States. As a result, easterly aspects would predominate in the landscape and could, in part, explain the selection of eastern aspects for roost sites. Northwestern winds and weather patterns also have been suggested as factors determining selection of easterly aspects for roosts (Jonas 1966, Boeker and Scott 1969). Weather may, in part, influence location of roosts relative to aspect. More roosts with western and northern aspects were located on lower portions of the slopes compared to roosts with eastern or southern aspects in my study, which would decrease exposure to prevailing northwest winds.

Turkeys in the Black Hills selected sites for roosts that had limited or no recent timber activity. The prescription at most sites selected for roosts with evidence of cutting was a commercial thin under current management, or selective cuts under previous management. The primary difference between these prescriptions is that a commercial thin is designed to release suppressed trees in a stand for increased growth. Typical timber harvest prescriptions for the Black Hills are more drastic (i.e., overstory removal or shelterwood seed cut). Seed cut prescriptions (about 9 m^2/ha basal area remaining) would be well below the average basal area at roost sites. Overstory removal, the final stage of 3-step shelterwood prescriptions, removes all the overstory if the stand has advanced regeneration (Hoover and Wills 1984:215).

Even-age management goals of ponderosa pine in the Black Hills are for stands of 14-18 m^2/ha (60-80 ft^2/acre) Growing Stock Levels (GSL). GSL are tree stocking levels in basal area corrected for future growth to a standard dbh of 25 cm (10 inches). GSL of 18 for trees 18 cm (7 inches) dbh would have less than 16 m^2/ha (70 ft^2/acre) basal area (Boldt and Van Duesen 1974). Moderate timber harvest activity in Arizona did not affect roost site selection by Merriam's turkeys, but timber harvest that left <18 m^2/ha basal area caused turkeys to abandon roosts (Scott and Boeker 1975). No roosts were located in second growth timber in Colorado (Hoffman 1968). There was a statistical preference for multistory stands for roosts in my study, and roosts in Oregon were primarily located in multistory stands (Lutz and Crawford 1987). However, the direct effects on turkey roosting behavior of even-age management are still unknown.

Fewer roost trees per site occurred in my study than reported elsewhere for Merriam's turkeys. Other regions of the west averaged 5-13 roost trees/site with up to 37/site, and winter roosts usually have more trees/site than summer roosts (Boeker and Scott 1969, Lutz and Crawford 1987, this study). The highest number of roost trees per site recorded in my study was 9. Large winter flocks, typical of most Merriam's turkey range did not occur in the population I studied and could account for reported differences in roost trees per site. Traditional roosts with large flocks occur in some areas of the Black Hills usually at low elevations and in association with ranch operations or housing developments where turkeys obtain domestic grains.

Roost Plots.-Vegetative characteristics surrounding the roosts demonstrated few statistical deviations from adjacent plots, but some patterns were evident: basal areas were higher, densities of trees were lower, and average dbh was greater. Turkeys usually enter roost trees directly from below (Mackey 1984), or from open areas on the uphill side (Hoff man 1968, Boeker and Scott 1969). These characteristics at roosts may represent a combination of larger diameter trees selected for roosting (see below) and the relative open areas from which turkeys fly into roosts.

Roost Trees.-Large diameter trees ($\geq$50-cm dbh) have been reported for turkey roosts in the literature (Boeker and Scott 1969, Mackey 1984, Lutz and Crawford 1987). This has led some managers and researchers to postulate that turkeys need large diameter trees for roosts. My data suggest that diameter is not the criterion for selection of roost trees by turkeys. Thirty-six percent of all roost sites had 1 or more trees 2.5 cm dbh larger than the tree selected for roosting and 16% had 1 or more trees 7.6 cm larger dbh than the tree selected for roosting within the roost plot. Trees selected for roosts in my study had layered horizontal branches spaced at intervals that allowed easy access by turkeys, and were typical of photographs accompanying previous research (Jonas 1966, Hoffman 1968, Boeker and Scott 1969). Easy access to roosts was a factor in selection of flat, layered configuration of roost trees by eastern wild turkeys (Kilpatrick et al. 1988). Layered horizontal branches are typical of trees in the Black Hills that are approximately 100 years old (G. Gire, Black Hills Nat. For., Rapid City, S.D., pers. commun.). Roost trees in Colorado averaged 160 years (Hoffman 1968) and those in Oregon were >300 years old (Lutz and Crawford 1987).

Reduced thermal expenditure has been suggested as a mechanism for the selection of certain roost tree characteristics by Merriam's turkeys (Mackey 1984). Thermoregulatory benefits of roosting in trees are more probable from reduced wind velocities than from reduced heat loss due to the overhead canopy (Kelty and Lustick 1977, Walsberg 1985). Location of roosts on easterly aspects would result in some protection from wind (Hoffman 1961) and roosting close to the tree trunk would maximize benefits of reduced wind velocity (Walsberg and King 1980, Pekins et al. 1991). However, many roosts of Merriam's turkeys were located on ridges (Boeker and Scott 1969, my study), and most turkeys observed in roost trees were on limbs away from the trunk.

The subject of thermoregulatory benefits from roosting in trees appears to be unresolved. Walsberg and King (1980) found no substantial energy conservation for American robins *(Turdus migratorius)* roosting 1-2 m from the trunk in Douglas-fir and suggested that protection from predators may be of greater importance than thermoregulatory economy. Thompson and Fritzell (1988) found thermoregulatory benefits to ruffed grouse (*Bonasa umbellus*) roosting in red-cedar *(Juniperus virginiana),* mostly due to improved radiative heat balance. Walsberg (1986) reported that night roosts in dense tree canopies improved the thermoregulatory balance of phainopepla *(Phainopepla nitens)*, mostly by reducing wind velocity.

Tree heights in my study were similar to other studies (with larger dbh trees) suggesting slower growth rates of trees in those areas, and probably closer spacing of branches. Natural limb pruning occurs slowly in ponderosa pine (Fowells 1965), and older trees may be required for roosting in regions where tree growth is slow.

MANAGEMENT IMPLICATIONS

Roost site selection by Merriam's turkeys was not evident at macrohabitat levels of resolution typical of current Forest Service monitoring plans. Habitat conditions necessary to meet roosting habitat requirements of Merriam's turkeys should come from active management. Timber management that results in stands with trees <25 cm dbh and Growing Stock Levels <22 m^2/ha will reduce the availability of roosting habitat for Merriam's turkeys. If management for Merriam's turkeys is considered a priority, silvicultural prescriptions that maintain portions of the forest at basal areas >21 m^2/ha (90 ft^2/acre with trees 25-35 cm average dbh will need to be developed. Roosting habitats should be dispersed throughout the forest and can be included in winter habitats (Rumble 1990). In terms of Forest Service management criteria, stands of ponderosa pine >22.5 cm dbh and 70-100% overstory canopy cover would meet these criteria. Timbered stands managed to provide roosting habitats for turkeys should include trees on the upper third of the slope with layered horizontal branches, spaced at 0.9-m intervals, in the upper half of the tree. These forest and tree characteristics may be partially related to dbh of the tree.

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