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MICROHABITATS OF MERRIAM'S TURKEYS IN THE BLACK HILLS, SOUTH DAKOTA[1]

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Abstract. Merriam's Turkeys *(Meleagris gallopavo merriami)* are associated with ponderosa pine *(Pinus ponderosa)* forests in the western United States, but are not native to the ponderosa pine forest of the Black Hills, South Dakota. The Black Hills population was established by transplanting birds from New Mexico and Colorado between 1948 and *195* 1. Despite being outside its original range, this population provides a unique opportunity to assess mechanisms of habitat selection because the age of the population is known and literature indicates that it is more productive than other populations. We studied microhabitats of Merriam's Turkeys in the Black Hills, South Dakota between 1986 and 1991. We found few differences in microhabitats among diurnal time periods or between sexes. Cluster analysis of variables at turkey microhabitats indicated two groups, broadly interpreted as summer and winter microhabitats. Winter microhabitats of turkeys had less understory vegetation and more overstory cover than random sites, which in turn had less understory and more overstory cover than summer microhabitats. Both random sites and winter microhabitats had higher basal area of ponderosa pine than summer microhabitats. Summer microhabitats had trees with the largest dbh. Random sites had more small and large woody debris than sites used by turkeys. Tree density at random sites was more than two times greater than at winter microhabitats and more than three times greater than at summer microhabitats. Turkeys preferred southern exposures during winter. Production of pine seed, a major food item of turkeys, differed among years. There was a strong relationship between abundance of pine seeds and microhabitats selected by turkeys. Basal area of microhabitats between October and March was positively correlated with annual ponderosa pine seed production. Abundance of ponderosa pine seeds at turkey microhabitats during this period was at least four times the estimated average annual production. Management prescriptions for ponderosa pine of basal area ≤ 18 m^2/ha will reduce winter habitat for turkeys. Summer habitats are more compatible with timber management goals for ponderosa pine in the Black Hills.

Key words: food resources; forest management; habitat selection; Meleagris gallopavo merriami; *Merriam 's Turkeys; microhabitat relationships.*

INTRODUCTION

Ponderosa pine *(Pinus ponderosa)* is associated with habitat of Merriam's Turkey *(Meleagris gallopavo merriami)* throughout the species' range (MacDonald and Jantzen 1967). Merriam's Turkeys were transplanted to South Dakota between 1948 and 195 1 (Petersen and Richardson 1973). Despite being outside of the subspecies' original range (MacDonald and Jantzen 1967), turkeys in the Black Hills are more productive (Rumble and Hodorff 1993) and sustain higher annual harvests than other populations of Merriam's Turkey (Kennamer et al. 1992). These population characteristics, when linked to habitat selection and vegetation patterns, provide a unique opportunity to examine habitat selection and explore its mechanisms in Merriam's Turkey.

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During the past 10 years, commercial cutting of ponderosa pine in the Black Hills has increased 55% and the sale value has increased more than eight-fold *(unpublished manuscripts:* Land and Resource Management Plan 1983, Draft Land and Resource Management Plan 1994, Black Hills National Forest, Custer, South Dakota). This level of cutting presents unknown impacts on South Dakota's largest turkey population. Currently, 11 forest management plans identify Merriam's Turkey as a Management Indicator Species. Yet, data for most elements of Merriam's Turkey ecology are lacking to develop management standards and guidelines.

Early studies of habitat use and management of Merriam's Turkey outside the original range (Jonas 1966, Petersen and Richardson 1973) were biased because they depended on visual observations and,
ly, may have overemphasized open habitats where birds

were more visible. Recent studies have focused on unique aspects of Merriam's Turkey habitat selection by use, such as roosting (Mackey 1984, Lutz and Crawford 1987a, Rumble 1992), brood-rearing (Mackey 1986, Day et al. 1991a, Rumble and Anderson 1993a), and nesting (Lutz and Crawford 1987b, Day et al. 1991b, Rumble and Hodorff 1993).

Macrohabitats (habitats delineated from dominant vegetation types or land units ranging from 4 to 32 ha in size) of Merriam's Turkey have been studied (Lutz and Crawford 1989, Rumble and Anderson 1993b). Broad effects of land management activities, such as logging, can be hypothesized at the macrohabitat scale if habitats are stratified properly (Rumble and Anderson 1992). However, understanding the character and magnitude of impacts from timber harvest and mechanisms of habitat selection requires precise knowledge of how birds use forested habitats. Microhabitats, or fourth-order habitat selection (Johnson 1980), provide this level of resolution. To our knowledge, no previous studies have evaluated microhabitats of Merriam's Turkey in ponderosa pine forests.

We studied microhabitat selection patterns of Merriam's Turkeys in a ponderosa pine ecosystem and evaluated the relationships between microhabitat selection and food resources. We tested hypotheses that (1) microhabitat of Merriam's Turkeys did not differ among daily time periods, between sexes, or among seasons; (2) microhabitat did not differ between available conditions and conditions at sites used by Merriam's Turkeys; and (3) microhabitat selection by Merriam's Turkeys was not attributable to the distribution and abundance of food resources.

STUDY AREA AND METHODS

We studied Merriam's Turkey habitats on 4380 ha in the central Black Hills of South Dakota from February 1986 to December 1991. Geologic material is predominantly Precambrian and Cambrian granite, schists, and metasediments (Hoffman and Alexander 1987). Climate is continental, with cold winters and warm summers (Orr 1959). Temperature extremes range from -34 to 38°C and precipitation averages 50-55 cm (South Dakota Climatological Summary, Number 20-39-6, U.S. Weather Bureau). Climate and soils in the Black Hills are ideally suited for ponderosa pine (Boldt and Van Duesen 1974), which comprises 84% of the area. Rumble and Anderson (1993a) provide detailed descriptions of the study area vegetation.

Some turkeys in the Black Hills use ranch feedlots and/or suburban housing developments for winter feeding; others remain in the forest throughout the winter unless deep snow forces them to use these unnatural food sources. Our research focused on a population in natural forest.

We trapped Merriam's Turkeys during late February or early March with alpha-chloralose (Williams 1966), rocket nets, and drop nets. Radio transmitters were attached with 0.6 or 0.9-cm bungee cord looped under the wings. We radio-marked 111 turkeys, 80 females and 33 males; most males were radio-marked after 1988.

We began locating turkeys 1 wk after attaching the radio transmitters (Nenno and Healy 1979). We attempted to locate each bird three times a week, once each during morning (sunrise-l 000), midday (1001-1400), and afternoon (140 1 to sunset). One location each week was a precise location determined by direct observation or close-range telemetry with a hand-held two-element yagi antenna. Close-range telemetry locations were later confirmed by droppings or scatchings by wild turkeys.

Microhabitat descriptions

Vegetation characteristics (microhabitats) were sampled at each precise location, usually $\leq$ 1 wk following the location date. We sampled microhabitats along a 60-m transect centered over the bird's location and oriented along the contour. This transect was constrained to be within the same vegetation type in which the birds were observed. At the midpoint of the transect, we estimated percent slope using a clinometer and aspect as the downhill compass bearing. At the beginning, midpoint, and end of the transect, we used a 10-factor prism (Sharpe et al. 1976) to estimate tree basal area (BA) and to determine trees from which to measure diameter at breast height (dbh). Tree density was calculated from these data. We also estimated percent overstory canopy cover using a spherical densiometer (Griffing 1985) at these three points along the transect. Data from the beginning, midpoint, and end were averaged for estimates of variables at each microhabitat.

We estimated percent canopy cover (Daubenmire 1959) of total vegetative cover, grasses, forbs, shrubs, and shrub species at l-m intervals along the transect. Following abscission of shrubs, coverage was estimated from the outer extent of woody material. Following senescence of grasses and forbs, we estimated coverage of these categories from plant material of the previous growing season. Numbers of shrub species and soft mast-producing shrubs were tallied from these data.

Beginning in January 1989, additional measurements were collected at turkey microhabitats. We estimated the quantity of downed woody debris at each site for small (2.5-7.5 cm) and large (>7.5 cm) diameter logs (Photo series for quantifying forest residues in the Black Hills, USDA Forest Service, Rocky Mountain Region, AFM 831, 1982). Timber management prescription was classified as: not cut (no evidence of past timber management); clear-cut (most or all trees removed in an area pattern); commercially thinned (evidence that past cutting had removed several-to-most mature trees, including selective cutting); shelterwood-seedtree (most trees harvested, with remaining trees of mature, seed-producing size, BA $\leq 9\ m^2/ha$); and commercially thinned (small diameter trees cut and left in the forest). Time since cutting was estimated as <2 yr, 2-5 yr, and >5 yr. We also subjectively categorized each site as having a single- or multilayered canopy. Multilayered stands had one or more age classes of trees beneath the canopy of the tallest tree class.

Beginning in January 1989, we estimated the abundance of ponderosa pine seeds at each turkey microhabitat sampled between October and April. Litter was collected from three 0. 1-m^2 quadrats at the beginning, midpoint, and end of the transect and the pine seeds were counted.

Twelve macrohabitat categories based on dominant vegetation type, dbh, and overstory canopy cover (Buttery and Gillam 1983) were identified in our study area. These included meadows, three overstory canopy cover categories of aspen/birch *(Populus tremuloides/Betula papyrifera)*, two dbh categories of ponderosa pine with three overstory canopy cover categories in each (six total), bur oak *(Quercus macrocarpa)*, and white spruce *(Picea glauca)*. Using forest inventory maps from the Black Hills National Forest and interpreting aerial photographs, we delineated 5 12 macrohabitat land units (4 to 32 ha in size) in our study area. Each fall, from 1987 to 1991, we placed three 0.5-m^2 circular plots with nylon screen in three replicates of each of the six ponderosa pine macrohabitat categories to estimate annual pine seed production. We placed the plots in the field during the 1st wk of September and removed them the last week of October. Because these plots were not animal-proof, we counted seed wings with bracts indicative of a mature seed as an estimate of seed production.

We sampled 572 random sites using the same procedures as at turkey microhabitats between 1987 and 1991. Random sites were selected from a stratified random sampling of the macrohabitats described above. Ten sites in each of 11 macrohabitat categories and five sites in bur oak were marked on 1:24,000 US Geological Survey contour maps in the laboratory and relocated in the field each year. Incomplete data caused us to eliminate three sites.

Analyses

Microhabitat variables of trees and shrubs with < % frequency of occurrence at turkey sites or comprising < 1% canopy cover were excluded from analyses. Data from uncommon species are highly variable and often cannot be interpreted (Uresk 1990).

We tested for homogeneity of variance and normality in our data and these assumptions were seldom met. When possible, the procedures used for analyses did not make these assumptions of parametric statistics, or included adjustments for violations. We tested hypotheses that microhabitat variables did not differ among the three daily time periods with Welch's test (Milliken and Johnson 1984), and used Dunnett's T3 procedure for heterogeneous variances (Dunnett 1980) to make multiple range comparisons. For data collected after 1988, we tested hypotheses that microhabitat variables at sites selected by male and female turkeys did not differ, using separate variance estimate t tests.

We then used an iterative cluster procedure based on Euclidean distance (del Moral 1975) to explore patterns of microhabitat selection by Merriam's Turkeys. Inclusion of trivial variables in cluster analysis can produce spurious clusters (Everitt 1977:69). Therefore, we used principal component analysis (PCA; Everitt 1977) to reduce our data to nine variables that captured the majority of the variation in the microhabitat data. These variables included percent total vegetative cover, percent forb cover, percent grass cover, percent shrub cover, percent kinnikinnick *(Arctostaphylos uva-ursi)* cover, number of shrub species, percent overstory canopy cover, ponderosa pine BA, and tree density. To ensure that all variables received equal weight in the cluster analysis, variables were standardized to unit standard deviations.

We then conducted analyses to compare microhabitat characteristics among sites grouped by the cluster analysis and random sites. These analyses are not confirmatory of the cluster analysis, but evaluate variables important to the cluster solution and patterns relative to random availability. A priori review of the literature before conducting the cluster analysis suggested many variables were important in Merriam's Turkey habitat selection (Scott and Boeker 1973, 1975, 1977; Habitat Suitability Index Models: Merriam's Turkey, USDI Fish and Wildlife Service, Fort Collins, Colorado, *unpublished manuscript)*. Therefore, we considered all variables that met the initial 5% frequency and 1% cover criteria (prior to PCA) and variables added after January 1977 in these analyses (Tables 1 and 2). We used Welch's test and Dunnett's T3 multiple range procedure to test hypotheses that microhabitat variables at random sites did not differ from turkey sites. Random data were weighted to account for deviations from proportional sampling. Values of each variable at each site were multiplied by $p_i 572/n_i$, where p_i represents the proportion of the area in the i^{th} macrohabitat category, and n_i represents the number of random samples in the i^{th} macrohabitat.

We categorized aspect as north (316-450°), east (46-135°), south (136-225°), and west (226-315°). Chi-square goodness-of-fit was used to test hypotheses that random sites and sites used by turkeys had the same aspect (Batschelet 1965), timber management prescription, time since harvest, and stand structure. We used confidence intervals with a Bonferroni correction to preserve the experimentwise error (Neu et al. 1974) around proportional use of groups from cluster analysis to determine categories at turkey microhabitats that differed from random.

We tested hypotheses that ponderosa pine seed production did not differ among years using multiresponse permutation procedure (Mielke 1984), and used

TABLE 1. Habitat characteristics at Merriam's Turkey microhabitats and random sites in the Black Hills, South Dakota, 1986–1991.*,†

Variable name	Random $\bar{X}$	Random 1 SE	Summer $\bar{X}$	Summer 1 SE	Winter $\bar{X}$	Winter 1 SE
Percent canopy cover variables						
Amelanchier alnifolia	0.7 A	<0.1	0.7 A	<0.1	0.2 B	<0.1
Arctostaphylos uva-ursi	4.4 A	0.4	6.9 B	0.9	2.7 C	0.3
Rubus strigosus	0.7 A	0.1	1.0 A	0.1	0.1 B	<0.1
Spirea lucida	0.5 A	<0.1	0.5 A	<0.1	0.3 B	<0.1
Symphoricarpos occidentalis	3.1 A	0.2	4.9 B	0.4	2.9 A	0.6
Juniperus communis	0.4 A	<0.1	0.1 B	<0.1	0.3 A	<0.1
Physocarpos monogynus	0.5 A	0.1	0.2 B	<0.1	0.1 A	<0.1
Prunus virginiana	0.8 A	0.1	0.5 A	<0.1	0.3 B	<0.1
Total vegetative cover	33.7 A	1.0	54.6 B	1.0	18.8 C	0.6
Total grasses	16.5 A	0.9	29.5 B	1.4	8.8 C	0.4
Total forbs	9.4 A	0.4	12.0 B	0.8	2.5 C	0.2
Total shrubs	13.0 A	0.5	18.2 B	0.9	7.0 C	0.4
Number of shrub species	4.3 A	0.1	5.0 B	0.2	3.9 C	0.1
Number of soft mast shrub species	2.9 A	<0.1	2.8 A	0.1	1.7 B	<0.1B
Percent overstory cover	46.9 A	0.9	38.9 B	1.5	52.4 C	0.9
Ponderosa pine dbh (cm)	18.1 A	0.4	23.1 B	0.6	21.3 C	0.4
Ponderosa pine basal area (m^2/ha)	20.7 A	0.5	12.9 B	0.6	20.7 A	0.5
Small diameter (2.5–7.5 cm) fuels (kg/ha × 1000)	4.0 A	0.2	2.7 B	0.3	2.9 B	0.2
Large diameter (>7.5 cm) fuels (kg/ha × 1000)	7.7 A	0.3	6.2 AB	0.6	6.5 B	0.4
Percent slope	26.3 A	0.7	19.3 B	1.1	23.3 C	0.9
Density of trees (stems/ha)	2134 A	150	644 B	49	898 C	51

* Means followed by different letters across rows differ at $\alpha \leq 0.05$, Welch's test.
† $n = 572$ for random sites, $n = 216$ for summer turkey microhabitats, and $n = 413$ for winter turkey microhabitats. Small and large diameter fuels; $n = 317$ for random sites, $n = 115$ for summer turkey microhabitats, and $n = 269$ for winter turkey microhabitats.

rate variance t tests to compare pine seed abundance at turkey microhabitats from October to March with pine seed production beneath ponderosa pine stands during the previous fall. Regression analysis was used to examine the relationship between annual production of ponderosa pine seeds and abundance of pine seeds at microhabitats selected by turkeys during the subsequent winter (October–March). We also used regression analysis to examine the relationship between ponderosa pine seed production and BA at microhabitats selected by turkeys during the subsequent winter (October–March).

Significance for all tests was accepted at the $P \leq 0.05$ level. In this paper, "habitat selection" implies use by turkeys compared to local availability; "habitat preference" implies use by turkeys compared to all possible availability (Thomas and Taylor 1990). Scientific names of plants follow the Great Plains Flora Association (1986).

RESULTS

One microhabitat variable, percent slope, differed among diurnal time periods ($P < 0.01$). Microhabitats used by turkeys in the morning had more gentle slopes than those used midday or afternoon. We did not believe that differences among time periods for only one variable justified stratifying turkey microhabitats by time periods. Data were pooled across time periods in subsequent analyses.

Two variables differed between microhabitats used by male and female turkeys. Overstory canopy cover at sites used by females ($54 \pm 1.1\%$, $\bar{X} \pm 1$ SE) was greater ($P = 0.02$) than at sites used by males ($49 \pm 1.7\%$). Cover of ninebark (*Physocarpus monogynus*) was greater ($P = 0.02$) at sites used by females ($0.2 \pm 0.03\%$) than sites used by males ($0.04 \pm 0.02\%$).

The hypothesis that microhabitat selection by turkeys would not show seasonal patterns was rejected. Cluster analysis resulted in two groups based on microhabitat characteristics. The frequency of use by turkeys of different microhabitat groups was not equal among months ($P < 0.01$; Fig. 1). Microhabitats in group 1 were used by turkeys mostly between October and March. Microhabitats in group 2 were used mostly between April and September. We broadly interpreted these groups from cluster analysis as winter-like (group 1) and summer-like (group 2) microhabitats; they are referred to as winter and summer microhabitats in the text.

Summer microhabitats of turkeys generally had greater ($P < 0.05$) understory vegetation and less overstory canopy cover than random sites, which in turn tended toward more ($P < 0.05$) understory vegetation and less overstory canopy cover than winter microhabitats (Table 1). Total shrub cover and number of shrub species was greater ($P \leq 0.05$) at summer microhabitats than random sites; winter microhabitats had the lowest ($P \leq 0.05$) shrub cover and fewest shrub species. Snowberry (*Symphoricarpos occidentalis*), the most common shrub, was more abundant ($P < 0.05$) at random sites than at summer or winter microhabitats. Fewer ($P < 0.05$) soft mast shrub species occurred at winter microhabitats than at summer microhabitats or random sites. Ponderosa pine BA at winter microhabitats and random sites was greater ($P < 0.05$) than at summer microhabitats. Tree density at random sites was more than three times greater than at summer microhabitats and more than two times greater ($P < 0.05$) than at winter microhabitats. Random sites had trees with smaller dbh than summer or winter microhabitats; the largest ($P < 0.05$) trees occurred at summer microhabitats. Random sites had more ($P < 0.05$) small diameter (2.5–7.5 cm) woody debris than summer or winter microhabitats; large diameter woody debris was more abundant ($P \leq 0.05$) at random sites than winter microhabitats. Random sites had the steepest slopes ($P \leq 0.05$), followed by winter microhabitats, then summer microhabitats. Turkeys preferred south aspects and avoided north aspects ($P < 0.05$) at winter microhabitats (Table 2). Timber management prescription, time since harvest, and stand structure did not differ among random sites and the two groups of turkey microhabitats.

Ponderosa pine seed production was greater ($P < 0.01$) during the fall of 1987 than during any other year of the study (Table 3). Pine seed production did not differ from 1988 to 1990. Production of pine seeds in the fall of 1991 did not differ from 1989 or 1990, but was greater ($P < 0.01$) than during 1988.

Abundance of ponderosa pine seeds at October–March turkey microhabitats differed little among years. During this same period, turkey microhabitats had at least four times more ($P < 0.01$ for 1988–1989 to 1990–1991; $P = 0.10$ for 1991–1992) pine seeds than the average under pine stands. Average annual pine seed abundance at microhabitats selected by turkeys was weakly correlated with annual production ($r = 0.7$, df = 3, $P = 0.28$). Yet, birds selected microhabitats with higher BA when annual production of pine seed increased ($r = 0.91$, df = 4, $P < 0.03$).

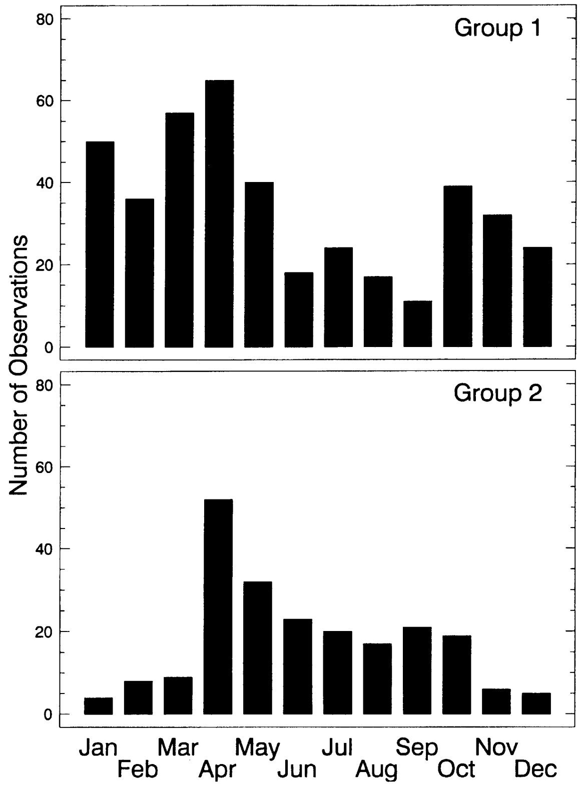

FIG. 1. Monthly frequency of use by Merriam's Turkeys of two microhabitat groups, based on cluster analysis of microhabitat characteristics in the Black Hills, South Dakota 1986–1991. Observations in group 1 were interpreted to represent microhabitats typical of winter; those in group 2 were interpreted to represent microhabitats typical of summer.

TABLE 2. Percent occurrences for categorical variables from microhabitats selected by turkeys and from random sites in the Black Hills, South Dakota, 1986–1991.*

Variable name	Random $n = 317$	Summer $n = 115$	Winter $n = 269$
Aspect†			
North	20 A	27 A	16 B
East	36	32	39
South	24 A	25 A	29 B
West	20	17	16
Prescription			
Clearcut	2	0	1
Commercial thin	18	21	18
Seedtree cut	2	4	1
Pre-commercial thin	35	31	44
No evidence of cutting	43	44	38
Estimated time since harvest			
<2 yr	9	4	8
2–5 yr	17	22	11
>5 yr	74	74	81
Multilayered canopy‡	43	42	47

* Entries followed by different letters in a row differ at $\alpha \leq 0.05$, chi-square test.

† North 316–45°; East 46–135°; South 136–225°; and West 226–315°.

‡ Positive response reported for multilayered canopy stands.

DISCUSSION

Habitat selection by sexes

Spatial or habitat segregation of sexes is common and has been suggested as a means to reduce competition within species (Geist and Petocz 1977), improve foraging efficiency (Shine 1986), or both (Austin 1976). We found few differences between microhabitats of male and female turkeys. Low cover by ninebark and overstory canopy cover differences of 4% are probably not biologically meaningful. Mature males were spatially separated from females except during breeding. Blue Grouse in Colorado (*Dendragapus obscurus*) partially segregate outside the breeding season (Cade

TABLE 3. Average ponderosa pine seed availability (seeds/m*) beneath the ponderosa pine stands and October-March turkey microhabitats in the Black Hills, South Dakota, 1987-1991.*

	1987-1989			1988-1989			1989-1990			1990-1991			1991-1992**		
	$\bar{X}$		SE	$\bar{X}$		SE	$\bar{X}$		SE	$\bar{X}$		SE	$\bar{X}$		SE
Ponderosa pine stands	30.1	A	3.6	2.0	c	0.3	3.2	BC	0.5	2.8	BC	0.5	5.3	B	0.7
Turkey microhabitats	NA			15.2	AB	3.3	11.5	A	1.6	18.6	AB	1.9	24.0	B	10.7

* Means with different letters across rows differ at $\alpha \leq 0.05$, MRPP (multiple random permutation procedure).
** The study was completed in December 199 1.

and Hoffman 1993), but habitats of both sexes are similar (Cade and Hoffman 1990).

Seasonal patterns of habitat selection

Merriam's Turkeys in the Black Hills used two groups of microhabitats that differed in vegetation and represented microhabitats typically selected during summer and winter. Turkeys selected both groups nearly equally during the spring and to a lesser extent in fall. Patterns of macrohabitat selection (land units 4-32 ha) also were less apparent during spring and fall (Rumble and Anderson 1993b). The spring and fall seasons in this region seldom blend gradually from winter to summer or vice versa. Weather conditions typical of both summer and winter commonly occur during spring. Snow storms with accumulations up to 30 cm are often followed by temperatures above 16oC, but with decreasing frequency, during March and April. Patterns of microhabitat selection by turkeys reflected these conditions. During fall, microhabitat selection patterns changed rapidly; by November, microhabitats typical of winter were predominately selected.

Winter.-Winter microhabitats of Merriam's Turkeys in the Black Hills were characterized by ponderosa pine with little or no understory vegetation, high BA, and high overstory canopy cover. Selection of macrohabitats during winter reflected similar patterns (Rumble and Anderson 1993b). An open understory is characteristic of winter turkey habitats in the southeastern United States (Exum et al. 1987).

Ponderosa pine seed, when available, is the primary winter food item of Merriam's Turkeys (Jonas 1966, Scott and Boeker 1973, Rumble 1990). The turkeys' selection of microhabitats reflected their search for pine seed. Similarly, Capercaillie *(Tetrao urogallus)* habitat selection is determined by the abundance of billberry *(Vaccinium myrtillus)* (Storch 1993). Turkeys foraged for pine seed in stands with high BA and little understory vegetation. Pine seed abundance increases asymptotically with BA of ponderosa pine up to ≈27 m2/ha; during years of low pine seed production, this relationship is not evident (Rumble 1990). BA and understory vegetation are inversely related (Uresk and Severson 1989), which could account for the low understory vegetation at winter turkey microhabitats. Birds would find it more difficult to search for pine seeds in pine stands with low BA because of the greater amounts of understory vegetation. Also, more pine seeds occur in stands with high BA. Average BA of microhabitats selected from October to March corresponded with annual production of ponderosa pine seed.

Drought and high temperatures between May and August 1988 (South Dakota Climatological Summary, U.S. Department of Commerce, Asheville, North Carolina) were followed by decreased production of pine seeds in the fall. Pine seed was uncommon in turkey diets after October 1988; kinnikinnick seeds and grass leaves and seeds comprised the majority of turkey diets throughout the winter (Rumble 1990), and birds selected microhabitats with BA more typical of summer microhabitats. We observed turkeys pecking at cones from previous years on several occasions and, despite a mild winter, 25% of our radio-marked birds, all subadult females, succumbed to predators 1 wk following a spring storm with 31 cm of snow. In Pennsylvania, turkeys starved when snow exceeded 0.5 m for >2 wk (Wunz and Hayden 1975). With the absence of adequate nutrition, snowfall >25 cm resulted in increased mortality (Austin and DeGraff 1975, Porter et al. 1980) and reduced reproductive performance (Porter et al. 1983) in Eastern Turkeys (M. g. *silvestris).* Effects of severe winter weather were more pronounced on juveniles than adults (Porter et al. 1980).

Habitat selection is, in part, an expression of foraging behavior and dietary need and, therefore, is predictable using foraging theory (Rosensweig 1985). We cannot draw conclusions as to whether or not these microhabitats maximized energy intake rate (Pyke 1984) for birds. Munger (1984) concluded that selecting optimal habitats may be less important than selecting habitats that are better than random. Turkeys in our study selected winter microhabitats where pine seeds were more abundant than random.

Merriam's Turkeys in the Black Hills preferred winter microhabitats with southern aspects. Turkeys in Oklahoma preferred south-facing habitats and avoided north-facing habitats despite greater mast production on them (Bidwell et al. 1989). We believe that turkeys selected southern aspects because these sites were warmer and snow melted sooner. South slopes were used by turkeys in New York because they have less snow for shorter periods (Austin and DeGraff 1975). Feeding behavior and daily movements of turkeys were adversely affected by snow depths > 15 cm (Austin and DeGraff 1975, Good 1982), and birds were incapacitated by >30 cm of fresh snow (Austin and DeGraff 1975). During and immediately after snow storms, turkeys stayed in roosts or were inactive on the ground throughout the day. Eastern Turkeys were inactive and remained in roosts during the day periods when snow was deep and there were inadequate food supplies (Porter et al. 1980).

Winter is a stress period for Merriam's Turkeys in the Black Hills. The average median daily temperature between December and February during our study was -4°C. Given the average range of daily temperature (14.2°C), ambient temperatures were often near or below the lower critical thermoneutral temperature (T_{lc}) of Eastern turkeys during this period. Merriam's Turkeys are similar in size to Eastern Turkeys (Stangel et al. 1992), and would be expected to have a similar T_{lc} of -15°C (Oberlag 1989).

Annual variation in production of the primary food (ponderosa pine seed) influenced the microhabitats selected. We attempted to study a turkey population that did not depend on unnatural foods. However, birds used trap bait, livestock feedlots, and bird feeders at private residences following fresh snowfall of > 15 cm, regardless of annual pine seed production. During winters of low pine seed availability, radio-marked birds used unnatural food sources regularly. Deep snow prevents turkeys from scratching for food (Austin and DeGraff 1975). Turkeys depend on agriculture fields or other unnatural foods during periods of deep snow and the absence of natural foods (Austin and DeGraff 1975, Porter et al. 1980).

Summer. -Summer microhabitats of turkeys(excluding females with poults) included ponderosa pine habitats with less BA than winter habitats and greater understory cover of grasses, forbs, and shrubs. During this period, turkeys primarily consumed seeds from grasses and other vegetative materials (Rumble 1990). For loafing and escape cover, birds chose microhabitats with high BA, which partially accounts for selection of microhabitats with winter characteristics during summer. Merriam's Turkeys in Montana used dense sapling pine stands for loafing (Jonas 1966). Hoffman et al. (1993) recommended stands with BA >23 m^2/ha as loafing cover for Merriam's Turkeys.

MANAGEMENT IMPLICATIONS

Timber management goals for the Black Hills National Forest are to manage BA to ≤ 18 m^2/ha (Land and Resource Management Plan 1983, Black Hills National Forest, Custer, South Dakota). These timber management goals are usually attained through commercial timber cutting or pre-commercial thinning. Management that reduces BA to ≤ 18 m^2/ha will reduce the quality of winter microhabitats. If turkey populations that are not completely dependent on artificial food sources during winter are a goal, management will need to ensure adequate abundance and distribution of winter habitats. Precise estimates of how much winter habitat is required for sustainable turkey populations are not available. However, Hoffman et al. (1993) recommended that 25% of ponderosa pine habitats should have BA >23 m^2/ha, 15% of which should have BA >30 m^2/ha. Some winter habitats should occur on southern aspects (135-225°).

Summer microhabitats are mostly compatible with timber management in the Black Hills. Seedtree cuts typically have BA <9 m^2/ha, less than birds selected for at summer microhabitats, and are used to regenerate stands (a necessary part of multiple use management). Because seedtree harvest methods are not the only timber management prescription used in the Black Hills, their prudent use should not impact summer microhabitats of turkeys.

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