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STRATIFICATION OF HABITATS FOR IDENTIFYING HABITAT SELECTION BY MERRIAM'S TURKEYS

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ABSTRACT.--Habitat selection patterns of Merriam's Turkeys were compared in hierarchical analyses of three levels of habitat stratification. Habitat descriptions in first-level analyses were based on dominant species of vegetation. Habitat descriptions in second-level analyses were based on dominant species of vegetation and overstory canopy cover. Habitat descriptions in third-level analyses were based on dominant species of vegetation, overstory canopy cover, and structural stages (dbh categories). First-level analyses showed turkeys selected for ponderosa pine and selected against meadow habitats. No conclusions could be drawn regarding forest management on habitat selection of turkeys at this level of habitat stratification. Second-level analyses showed that selection of ponderosa pine and aspen/birch habitats varied among seasons. Implications for forest management activities on turkeys at this level of habitat stratification could be made. Third-level analyses added little to conclusions of habitat selection patterns drawn from second-level analyses and increased chances for Type II errors. Habitat selection patterns of Merriam's Turkeys were best described when habitats were stratified by dominant species of vegetation and overstory canopy cover.

Key words: ***Merriam's Wild Turkeys,*** Meleagris gallopavo merriami, ***habitat descriptions, forest management, habitat selection.***

Habitat use and management of Merriam's Turkeys ***(Meleagris gallopavo merriami)*** in northern latitudes have been studied in South Dakota (Petersen and Richardson 1975) and Montana (Rose 1956, Jonas 1966). These early studies were limited to direct observation of birds when assessing habitat use, and data contained biases in the assessment of the birds' habitat needs (e.g., Jonas 1966, Bryant and Nish 1975, Petersen and Richardson 1975, Shaw and Smith 1977). Telemetry has allowed collection of data on habitat use patterns in an unbiased manner, but few studies have addressed the detailed stratification habitats.

Studies of habitat use and selection patterns by Merriam's Turkeys have delineated habitats based primarily on the dominant species of vegetation (DSV) (Jonas 1966, Bryant and Nish 1975, Scott and Boeker 1975, Mackey 1982, 1986, Lutz and Crawford 1989). Because timber management activities seldom result in conversions of vegetation types, understanding habitat selection patterns at this level precludes understanding the effects of forest management activities such as logging or thinning on Merriam's Turkeys. Increased value of ponderosa pine timber resources, emphasis on old-growth resource values, and improved technology for harvesting timber have potential to impact Merriam's Turkey habitat (Shaw 1986). Therefore, stratification beyond dominant species of vegetation is necessary to elucidate the effects of forest management on turkeys. Merriam's Turkeys in southeastern Montana demonstrated an apparent preference for pole-size (<23 cm dbh) ponderosa pine habitats (Jonas 1966). Merriam's Turkeys in Oregon avoided habitats that had been logged by clear-cut or shelterwood methods (Lutz and Crawford 1989). To our knowledge, no researchers have stratified habitats in terms of size and density categories of tree species. However, on lands managed by the USDA Forest Service and other public agencies, methods of habitat stratification that include structural stages (SS) and overstory canopy cover categories (OCC) have been described (Thomas 1979) to further stratify habitats.

The objective of this study was to determine the level of habitat stratification that best described habitat use and selection patterns of Merriam's Turkeys in the Black Hills.

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METHODS

Study Area

This study was conducted in the central Black Hills of South Dakota, 16 km west of Rapid City. Most of the land is under management by the Black Hills National Forest, Pactola Ranger District. Some private holdings associated with ranch operations are present in the meadows, and several private homes and cabins are located in the study area.

Vegetation of the study area is primarily pure ponderosa pine forest (84%). Meadows and aspen/birch *(Populus tremuloides/Betula papyrifera)* habitats occur in drainages.

This study was conducted over a three-year period beginning March 1986 and ending January 1989. Because analytical methods used to make statistical tests were goodness-of-fit tests and nonsignificance indicates fit by the proposed model, hypotheses tested have been stated appropriately. The hypotheses tested relative to Merriam's Turkeys in the Black Hills of South Dakota were that each of the following habitats depict patterns of use and selection by Merriam's Turkeys: (1) habitats stratified by DSV, (2) habitats stratified by DSV and OCC, (3) habitats stratified by DSV and SS, and (4) habitats stratified by DSV, SS, and OCC.

TRAPPING AND LOCATIONS.-Turkeys were trapped in late February or early March of each year of the study with rocket nets and drop nets over corn bait. This study was primarily concerned with hens since they are the reproductive segment of the population. Forty-four (36 females and 8 males) of 82 turkeys trapped were fitted with backpack radio transmitters weighing approximately 108 g.

Locating birds began after a one-week period of adjustment to the radio transmitters (Nenno and Healy 1979). Each bird in the study area was located three times each week, once during each of the following time periods: sunrise-1000 hr, 1001-1400 hr, and 1401 hr-sunset. Birds that emigrated from the defined study area were located at least monthly to monitor their activities and determine if they had moved back into the study area. Locations were determined by plotting 2+ bearings (frequently 5+) from known locations on USGS 1:24,000 contour maps in the field using a hand-held, two-element yagi antenna. Bearings were usually taken from positions within 300 m of the estimated location. Each location was assigned to a habitat unit (see below) based on maps and Universal Transverse Mercator coordinates recorded to the nearest 100 m in the field. To achieve independence of observations (Alldredge and Ratti 1986), only one location was recorded for each bird on any given day and most were two days apart.

Habitat Descriptions

Habitats were numerically identified geographical units approximately 4-32 ha (10-80 acres) in size. Boundaries were usually defined by watershed topography such as ridges and drainages. Obvious changes in vegetation type also were used to define boundaries of habitats. In all, 513 habitat units were delineated.

Vegetative descriptions of habitats were determined from five plots located within each defined habitat unit. These plots were marked on unit 1:24,000 contour maps in the lab and distributed evenly across each habitat. Some habitats were too small to effectively place five plots, so fewer plots were used. Each plot was then located in the field and sampled to determine tree basal area.

Habitat descriptions were made based on DSV, SS, and OCC according to criteria developed by the USDA Forest Service, Region 2 (Buttery and Gillam 1983). DSV categories were ponderosa pine, aspen/birch, oak, spruce, and meadows. SS categories were pole timber (trees 2.5-22.8 cm dbh) and sawtimber (trees greater than 22.8 cm dbh). OCC categories were 0-40%, 41-70% and 71-100%. OCC was estimated based on the following equation: OCC(%) = 0.51*BASAL AREA (FT^2/AC) – 1.94 (Bennett 1984). Depending on the level of stratification included in the analyses, 5-12 habitats were delineated.

Analyses

Data pertaining to use of habitats described above were stratified into seasons: December-February (winter), March-May (spring), June-August (summer), and September-November (fall). Chi-square test of independence was used to test the hypothesis that habitat use patterns of Merriam's Turkeys were similar among seasons. Because this test was significant ($P < .001$), tests of habitat selection at different levels of habitat stratification were made within seasons.

Chi-square goodness-of-fit tests with correction for continuity (Cochran 1963) were used to test hypotheses regarding the level of habitat

stratification that best depicted habitat selection patterns of Merriam's Turkeys in a hierarchical structure. Bonferroni confidence intervals around proportion of use (Neu et al. 1974, Byers et al. 1984) were used to determine habitat selection patterns that deviated from expected use. We determined differences from expected use of habitats for which utilization was 0 by examining chi-square residuals with G-standardization and Bonferroni correction to the Z-statistic (Mosteller and Parunak 1985). An array of structural stages occurred only for ponderosa pine habitats. Therefore, the test for DSV x SS level of habitat stratification was analyzed using data from ponderosa pine habitats.

Initial chi-square tests of use versus availability for DSV x SS, DSV x OCC, and DSV x SS x OCC were made with oak, aspen, and spruce habitats pooled to reduce as much as possible the number of cells with fewer than five expected observations. Selection of these habitats by turkeys was evaluated individually with Bonferroni confidence intervals for comparison tests. The significance of confidence intervals holds regardless of the overall chi-square test (Neu et al. 1974).

RESULTS

Habitats Determined by DSV

The hypothesis that habitats stratified by DSV depict patterns of habitat use and selection by Merriam's Turkeys was rejected (P = .06). Meadows were selected less than expected across all seasons (Table 1). Ponderosa pine habitats were selected more than expected during winter, spring, and fall; they were equal to what was expected during summer. Aspen habitats were selected more than expected during summer. Oak habitats were selected less than expected during spring, while spruce habitats were selected less than expected during winter and spring.

Habitats Determined by DSV and OCC

The hypothesis that habitats stratified by DSV and OCC depict patterns of habitat use and selection by Merriam's Turkeys was rejected for all seasons (P = .04). Stratifying habitats by DSV and OCC did not alter the results for meadow, oak, or spruce habitats (Table 2). Oak and spruce were not represented across all overstory canopy cover categories on this study area.

Aspen/birch habitats with 41-70% OCC were selected more than expected during spring and summer by turkeys in the Black Hills. Infrequent use of aspen/birch habitats with 71-100% OCC was noted over all seasons. But statistically, this was less than expected only during spring. Open ponderosa pine habitats (0-40% OCC) were selected less than expected during the winter and spring. Turkeys selected ponderosa pine habitats 41-70% OCC more than expected during spring. Dense ponderosa pine habitats (71-100% OCC) were selected more than expected during fall and winter and less than expected during summer.

Habitats Determined by DSV and SS

The hypothesis that habitats stratified by DSV and SS depicted patterns of habitat use and selection by Merriam's Turkeys was not rejected for winter, summer, and fall. During spring, ponderosa pine habitats with stems greater than 23 cm dbh were selected more than expected. Otherwise, no differences were apparent in the habitat selection patterns of turkeys when pine habitats were stratified based on dbh. Aspen/birch, oak, and spruce habitats were not adequately represented across structural stages to make comparisons.

Habitats Determined by DSV, SS, and OCC

The hypothesis that habitats stratified by DSV, SS, and OCC depict patterns of habitat use and selection by turkeys was rejected (P = .03) during winter, spring, and summer (Table 3). Data from fall indicated observed differences from expected at P = .11. Since several habitat categories were pooled to achieve minimum sample size in the overall chi square test, P = .11 was considered sufficient indication of difference from expected to proceed with the Bonferroni confidence intervals.

Use patterns of meadow, oak, and spruce habitats by Merriam's Turkeys were unchanged from previous levels of habitat stratification. However, because more habitats were included in the analyses, selection of spruce during winter and aspen/birch habitats with 41-70% overstory canopy cover during summer no longer differed from expected.

Turkeys selected open ponderosa pine habitats in both structural stages less than expected during winter, and the 2.5-22.8 cm dbh structural

TABLE 1. Seasonal utilization by Merriam's Turkeys of habitats described by dominant species of vegetation in the Black Hills of South Dakota.[a,b]

Habitat	Proportional area	Winter (205)	Spring (878)	Summer (126)	Fall (218)
Aspen	0.0516	4—	61	17++	14
Meadow	0.1016	11—	9—	5—	7—
Pine	0.8371	186++	807++	100	195++
Oak	0.0044	4	0—	1	1
Spruce	0.0056	0—	1—	3	1

[a]Sample sizes (telemetry fixes) are in parentheses. Expected use can be calculated from proportional use × sample size.
[b]Differences ($P \leq .10$) among habitats selected versus available are indicated by — if used less than expected and ++ if used more than expected.

TABLE 2. Seasonal utilization by Merriam's Turkeys of habitats described by dominant species and overstory canopy cover of vegetation in the Black Hills of South Dakota.[a,b]

Habitat	Percent canopy cover	Proportional area	Winter (205)	Spring (878)	Summer (126)	Fall (218)
Aspen/birch	0–40	0.0148	2	14	4	1
Aspen/birch	41–70	0.0191	0	46++	11++	12
Aspen/birch	71–100	0.0177	2	1—	2	1
Ponderosa pine	0–40	0.1199	3—	63—	26	29
Ponderosa pine	41–70	0.3760	65	430++	45	71
Ponderosa pine	71–100	0.3412	118++	314	29—	95++
Meadows		0.1016	11—	9—	5—	7—
Oak	0–100	0.0044	4	0	1	1
Spruce	0–100	0.0056	0	1—	3	1

[a]Sample sizes (telemetry fixes) are in parentheses. Expected use can be calculated from proportional use × sample size.
[b]Differences ($P \leq .10$) among habitats selected versus available are indicated by — if used less than expected and ++ if used more than expected.

TABLE 3. Seasonal utilization by Merriam's Turkeys of habitats determined by dominant species, overstory canopy cover, and structural stage in the Black Hills of South Dakota.[a,b]

Habitat	Structural stage	Percent canopy cover	Proportional area	Winter (205)	Spring (878)	Summer (126)	Fall (218)
Aspen/birch	2.5–22.8 cm	0–40	0.0148	2	14	4	1
Aspen/birch	2.5–22.8 cm	41–70	0.0191	0	46++	11	12
Aspen/birch	2.5–22.8 cm	71–100	0.0177	2	1—	2	1
Ponderosa pine	2.5–22.8 cm	0–40	0.0701	1—	9—	20++	18
Ponderosa pine	2.5–22.8 cm	41–70	0.1677	32	143	25	33
Ponderosa pine	2.5–22.8 cm	71–100	0.2173	85++	222	16—	62
Ponderosa pine	>22.8 cm	0–40	0.0498	2—	54	6	11
Ponderosa pine	>22.8 cm	41–70	0.2083	33	287++	20	38
Ponderosa pine	>22.8 cm	71–100	0.1239	33	92	13	33
Meadows			0.1016	11—	9—	5—	7—
Oak		0–100	0.0044	4	0	1	1
Spruce		0–100	0.0056	0	1—	3	1

[a]Sample sizes (telemetry fixes) are in parentheses. Expected use can be calculated from proportional use × sample size.
[b]Differences ($P \leq .10$) among habitats selected versus available are indicated by — if used less than expected and ++ if used more than expected.

stage was selected less than expected during spring. No differences were noted for ponderosa pine with 41–70% overstory canopy cover and 2.5–22.8 cm dbh across seasons. However, the structural stage greater than 22.8 cm dbh and 41–70% overstory canopy cover was selected more than expected during spring. Dense ponderosa pine (>71% overstory canopy cover) 2.5–22.8 cm dbh was selected more than expected during winter and less than expected during summer. No differences were noted for dense ponderosa pine >22.8 cm dbh.

DISCUSSION

The highest level of stratification of habitats that added new information to use and selection patterns of Merriam's Turkeys in this study area was by DSV and OCC. Despite statistical significance of differences when habitats were stratified by DSV, SS, and OCC, trends in habitat selection were similar to analyses for which data were pooled across SS categories. Shaw and Smith (1977) noted apparent habitat selection by Merriam's Turkeys in Arizona when ponderosa pine habitats based on diameter classes were ignored. However, pole-size ponderosa pine habitats were used more than other size classes by turkeys in Montana (Jonas 1966). Within our study area, 12 of the 372 ponderosa pine habitats had an average dbh of less than 15 cm (6 in); the lowest average dbh was 10.7 cm (4.2 in). Thirty-seven of the ponderosa pine habitats in the study area had dbh greater than 30 cm (12 in), of which the majority were in the 0-40% OCC category indicative of large overmature trees. Most of the study area had been logged in the past one hundred years. Because excellent germination conditions for ponderosa pine in the Black Hills result in overstocked stands with reduced growth rates (Boldt and Van Duesen 1974), ponderosa pine habitats larger than 30 cm dbh were rare. Ponderosa pine habitats in this study were representative of a narrow range of the potential tree dbh classes for ponderosa pine. However, they did represent the size classes of ponderosa pine throughout the Black Hills.

The tests of the model for DSV x SS suggested good agreement between the model and observed use by turkeys from a statistical point of view. These results suggest random selection of habitats when stratified by DSV x SS. Nonrandom selection of habitats had already been demonstrated. We also believe that stratification of habitats by DSV x SS obscured biological patterns already demonstrated by the test of DSV x OCC. Many of the relationships of OCC were contrasted between high and low OCC. These results were pooled, resulting in the apparently good fit of the DSV x SS model.

Our approach to these analyses was hierarchical in nature; and since patterns of habitat selection by turkeys had been demonstrated at higher levels, it would not be prudent to ignore those biological patterns. However, to ensure that no oversights were made, we made tests of habitat selection based on habitats stratified by SS, OCC, and SS x OCC. The test of the model for SS was not rejected. Tests of the model for OCC and SS x OCC were rejected, but were influenced by the preponderance of the study occupied by ponderosa pine (84%) and the range of dbh classes in the Black Hills. Interpretations of results from these latter tests were similar to tests of DSV x SS and DSV x OCC.

Stratification of habitats beyond that necessary to depict the dispersion patterns of the animal decreases the sensitivity of tests and increases the probability of Type II error in the analyses (Alldredge and Ratti 1986). The effect of adding stratification factors is to dilute the sample sizes in individual cells, thus increasing the chance of Type II error. Apparent Type II errors occurred in the determination of habitat selection patterns when habitats were stratified by DSV x SS x OCC. At the highest level of habitat stratification, apparent differences from expected use for three habitat categories disappeared from the analyses.

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