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Variation in Selection of Microhabitats by Merriam's Turkey Brood Hens

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ABSTRACT -- We studied microhabitats of Merriam's turkey (*Meleagris gallopavo merriami*) brood hens in a ponderosa pine (*Pinus ponderosa*) ecosystem in South Dakota from 1986 to 1988. Cluster analysis indicated three groups of microhabitats, open-shrub, open-grass/forb and forest, based on vegetation characteristics at sites selected by brood hens. Poults of brood hen that selected open-shrub microhabitats were younger than those that selected forest microhabitats. Open-shrub and open grass/forb microhabitats had high herbaceous cover. Herbaceous vegetation provides habitat for invertebrates required in diets of poults and was selected by brood hens for feeding. Brood hens selected forest microhabitats more often when temperatures were high, or when precipitation and herbaceous biomass was low. Management for Merriam's turkeys should ensure 126 g/m² of herbaceous vegetation along forest/meadow edges until poults are more than seven weeks old.

Key words: Merriam's turkey, *Meleagris gallopavo merriami*, microhabitats, hens, poults, South Dakota.

Merriam's turkeys (*Meleagris gallopavo merriami*) occur throughout the western United States (Kenamer and Kenamer 1990) in coniferous forests (Shaw and Mollohan 1992). Macrohabitats, large areas described by dominant vegetation patterns, of Merriam's turkey brood hens include forest openings, forest/grassland edges, and forests with low overstory canopy cover (McCabe and Flake 1985, Mackey 1986). Previously, we described the habitat selection of Merriam's turkey brood hens in 4 to 32-ha macrohabitats of the Black Hills (Rumble and Anderson 1993). However, understanding habitats of Merriam's turkeys at the macrohabitat level of resolution is insufficient to predict changes

in ecosystems that do not alter the dominant vegetation type or affect the forest structure. Studies of microhabitats provide understanding of how animals use habitats (Johnson 1980) and allow examination of animal responses to subtle changes in vegetative conditions.

Microhabitats of Merriam's turkey brood hens in grassland/deciduous forest of the Great Plains include high abundance of forbs, soft-mast plants, and arthropods (Day et al. 1991). In contrast, Mackey (1986) suggested Merriam's turkey broods selected microhabitats with less understory vegetation and lower vegetation height than occurred randomly in mixed conifer forests of Washington. Microhabitats of Merriam's turkey brood hens have not been described in forest ecosystems dominated by ponderosa pine (*Pinus ponderosa*). Thus, our objectives were to identify patterns of microhabitat selection by Merriam's turkey brood hens in a ponderosa pine ecosystem and to examine variation in microhabitats associated with age and behavior of poults.

STUDY AREA

We studied microhabitats of Merriam's turkey brood hens from 1986 to 1988 in the central Black Hills 16 km west of Rapid City, South Dakota. The area is in the Black Hills National Forest, but includes private lands associated with ranches, homes, and cabins. Elevation of the area is between 1300 to 1800 m and 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 (unpubl. doc., Climatography of the U.S., No. 20-39, No. 6, U.S. Superintendent of Documents, Washington, D.C.). Climate and soils in the Black Hills are ideal for ponderosa pine (Boldt and Van Duesen 1974), which comprised 84% of the area. Other vegetation communities include quaking aspen (*Populus tremuloides*)/paper birch (*Betula papyrifera*), white spruce (*Picea glauca*), and bur oak (*Quercus macrocarpa*).

METHODS

During the winters of 1986-88, we captured and radio-marked 36 hen turkeys. Following successful nesting by hens, we obtained one or more precise locations each week for each of 18 brood hens that remained in the study area. We obtained locations of brood hens from 8 June to 29 September or until poults were greater than 12 weeks of age. During each of three daily time periods, sunrise to 1000, 1001 to 1400, and 1401 to sunset, precise locations of brood hens were obtained by visual observations or close-range telemetry with a hand-held antenna. Locations of undisturbed birds were marked and we returned within one week to sample microhabitats.

Merriam's turkey brood hens typically move along forest-meadow ecotones in a linear pattern (Day et al. 1991, Gobielle 1992). We measured microhabitat characteristics along a 60-m transect centered on the location of the radio-marked bird and oriented along the meadow/forest edge or along the contour if the location occurred within the forest. This allowed us to consistently sample the vegetation community where the birds occurred. Tree basal area (BA), tree density, average diameter at breast height (DBH), and percent overstory canopy cover (%OCC) were measured at 0-, 30-, and 60-m points along each transect. We used a 10-factor prism to identify trees to be sampled (Sharpe et al. 1976) and measured DBH with calipers. We measured %OCC with a spherical densiometer (Griffing 1985) and percent slope with a clinometer. We estimated percent canopy cover (%C) of each of the following understory, less than 1.0 m tall, categories or plants: grasses, forbs, shrubs, shrub species, total vegetation, and logs, greater than 2.5 cm diameter, from 30, 0.10-m² quadrats (Daubenmire 1959) at 2-m intervals along the transect. We calculated the number of shrub species and number of soft-mast shrub species in each microhabitat from %C data. At 5-m intervals along the transect, we estimated height of visual obstruction (VOR) and height of vegetation by using a pole marked in 0.5 dm intervals (Robel et al. 1970). For microhabitats with little or no shrub cover, we estimated herbaceous vegetation by:

$$\text{Herbaceous vegetation}(g/m^2) = 125 \times \ln(\text{VOR}[cm]) - 114.9, R^2 = 0.72$$

(unpubl. data, Rocky Mountain Research Station, Rapid City, South Dakota) where $\ln(\text{VOR})$ is the natural logarithm of the visual obstruction measured in cm and R^2 represents the proportion of the variance in vegetation weight accounted for by the equation.

We used the same procedures described for brood-hen microhabitats (above) to sample 240 random sites in a stratified random design. Samples were stratified based on 12 vegetation categories described by dominant vegetation type, %OCC, and DBH (Buttery and Gillam 1983). Five-hundred and twelve land units approximately 4 to 32 ha in size were assigned to these vegetation categories. During 1987 and 1988, we randomly selected 10 land units from each of the 12 vegetation categories then randomly selected a site to sample from the intersections of a 100-m grid overlaid on each land unit. These random sites were marked on 1:24,000 U.S. Geological Survey maps and relocated in the field. These random sites were measured from June to August, which coincided with sampling of most brood-hen microhabitats.

We obtained 114 locations from 18 brood hens that remained within the study area. Successive samples from individual radio-marked brood hens

averaged 7.4 ± 5.3 ($\bar{x} \pm SD$) days apart; 91% were 3 or more days apart. We considered these locations biologically independent (e.g., Carey et al. 1989, Reynolds and Laundré 1990).

We excluded variables that occurred at less than 5% of brood hen microhabitats and shrub species that comprised less than 1% canopy cover (Stephenson and Cook 1980, Uresk 1990). We then tested for homogeneity of variances and normal distributions. Because these assumptions for parametric statistics were usually violated, we used analytical methods that did not require these assumptions.

Because habitats and diets of turkey poults vary as poults age (Healy et al. 1975, Hurst and Stringer 1975, Day et al. 1991), we assigned microhabitats to the following age categories of poults: 0-3, 4-7, and 8-12 weeks of age. Using a multiresponse permutation procedure (MRPP, Mielke 1984), we tested null hypotheses that vegetation characteristics at microhabitats of brood hens did not differ among age categories of poults.

We used cluster analysis (del Moral 1975), to explore patterns of microhabitat selection by brood hens that were not identified by testing averages within age categories of poults. To eliminate the effects of trivial variables in cluster analysis, we used principal component analysis (Everitt 1977:69) to reduce our data to nine variables that captured the majority of the variation in the microhabitat data. These variables included %C forbs, %C grasses, %C shrubs, %C western snowberry (*Symphoricarpos occidentalis*), number of shrub species, ponderosa pine BA, tree density, and %OCC. We used standardized vector means from the cluster analysis to interpret these results.

We used Welch's tests under the assumption of heterogeneous variances (Milliken and Johnson 1984) and Dunnett's T3 multiple comparison procedure (Dunnett 1980) to evaluate all variables at brood-hen microhabitats among cluster analysis groups and random sites. Random samples in these analyses were weighted to account for deviations from proportional random sampling.

Terminology of use, selection, and preference of habitats follows recommendations of Thomas and Taylor (1990). We accepted statistical significance at $\alpha \leq 0.05$. All tests used preserved experimentwise error rates at the preset α level. Scientific names of plants follow the Great Plains Flora Association (1986).

RESULTS

Only five of 24 variables differed among age categories of poults (Table 1). Microhabitats of brood hens with poults 0-3 weeks of age had greater %C total vegetation, %C forbs, and VOR than microhabitats of brood hens with poults 8-12 weeks of age ($P \leq 0.03$). Percent cover of bearberry

(*Arctostaphylos uva-ursi*) was greater at microhabitats of brood hens 8-12 weeks of age than microhabitats of brood hens with poults ≤ 3 weeks of age ($P \leq 0.02$). These variables at microhabitats of poults 4-7 weeks of age were intermediate between and did not differ from microhabitats of poults younger or older. Percent cover of logs did not differ between microhabitats of brood hens with poults 0-3 and 4-7 weeks of age, but was less than at microhabitats of brood hens with poults 8-12 weeks of age ($P \leq 0.01$).

Cluster analysis showed three groups of brood-hen microhabitats. Standardized vector means led us to interpret these groups of microhabitats as openings with grasses and forbs, openings with shrubs comprised mostly of western snowberry, and pine forest. Hereafter, these groups of microhabitats are referred to as open-grass/forb, open-shrub, and forest microhabitats, respectively.

Percent cover of total understory vegetation was greater ($P \leq 0.05$) at brood-hen microhabitats than random sites (Table 2). Forest microhabitats were more similar to random sites than open-grass/forb or open-shrub microhabitats. Percent cover of western snowberry was four to six times greater ($P < 0.05$) at open-shrub microhabitats than open-grass/forb, forest microhabitats or random sites. Visual obstruction was higher ($P \leq 0.05$) at open-shrub microhabitats than open-grass/forb microhabitats, both of which had higher VOR ($P \leq 0.05$) than forest microhabitats or random sites. Vegetation height was similar at open-shrub and open-grass/forb microhabitats, but greater than forest microhabitats and random sites ($P \leq 0.05$). Percent cover of bearberry and Wood's rose (*Rosa woodsii*) comprised more of the understory in forest microhabitats than open-grass/forb or open-shrub microhabitats ($P < 0.05$). Open-shrub and forest microhabitats had less slope ($P < 0.05$) than random sites; open-grass/forb microhabitats had marginally less slope ($P \leq 0.10$) than random sites.

There were no differences ($P = 0.12$, χ^2 test) in the frequency that brood hens selected open-shrub microhabitats and forest microhabitats when categorized by age classes of poults (Fig. 1). Nevertheless, average age of poults in open-microhabitats was marginally less (3.5 ± 0.7 weeks, $P = 0.07$, MRPP test) than poults in forest microhabitats (5.1 ± 0.5 weeks). Average age of poults in open-grass/forb microhabitats (4.3 ± 0.5 weeks) was not different from age of poults in open-shrub or forest microhabitats. Brood hens used forest microhabitats less ($P = 0.04$) in 1986 and marginally more ($P = 0.10$) in 1988.

Table 1. Variables at Merriam's turkey brood-hen microhabitats that differed among age categories of poults in the Black Hills, South Dakota, 1986-88.

Variable	<u>Age of Poults</u>					
	<u>0-3 weeks</u>		<u>4-7 weeks</u>		<u>8-12 weeks</u>	
	<u>(N = 56)</u>		<u>(N = 35)</u>		<u>(N = 23)</u>	
	<u>\bar{x}</u>	\pm SE ^a	<u>\bar{x}</u>	\pm SE	<u>\bar{x}</u>	\pm SE
%C Bearberry (<u>Arctostaphylos uva-ursi</u>)	0.9	0.5A	1.4	1.0AB	4.9	2.1B
%C Log	0.8	0.2A	1.2	0.3A	3.5	0.8B
%C Total vegetation	68.5	2.9A	64.6	4.0AB	54.5	4.1B
%C Forbs	24.4	1.7A	23.4	3.0AB	15.9	2.1B
VOR (dm)	1.2	0.1A	0.9	0.1AB	0.6	0.1B

^a Averages and standard errors followed by different letters within rows are different $\alpha \leq 0.05$, Welch's test.

Table 2. Variables from microhabitat groups identified by cluster analysis of sites selected by Merriam's turkey brood hens and random sites in the Black Hills, South Dakota, 1986-88.

Variable	Random		Open-shrub		Open-grass/forb		Forest	
	\bar{X}	SE ^a	\bar{X}	SE	\bar{X}	SE	\bar{X}	SE
%C Serviceberry (<i>Amelanchier alnifolia</i>)	0.6	0.1	0.9	0.4	0.6	0.2	1.1	0.3
%C Bearberry (<i>Arctostaphylos uva-ursi</i>)	6.5	0.8A	0.9	0.4BC	0.6	0.2BC	4.2	1.4AC
%C Wood's rose (<i>Rosa woodsii</i>)	4.4	0.4A	0.0B		0.8	0.5B	1.1	0.4B
%C Raspberry (<i>Rubus idaeus</i>)	1.1	0.1	3.0	0.8	1.5	0.3	1.4	0.5
%C Wild spiraea (<i>Spiraea lucida</i>)	0.3	0.1	0.0		0.4	0.3	0.2	0.1
%C Snowberry (<i>Symphoricarpos occidentalis</i>)	3.1	0.4A	24.7	1.7B	5.3	0.7C	4.1	0.7AC
%C Juniper (<i>Juniperus communis</i>)	0.4	0.1A	0.0B		0.6	0.1B	0.1	0.1B
%C Ninebark (<i>Physocarpus monogynus</i>)	0.5	0.1A	0.9	0.8AB	0.2	0.1AB	0.1	0.1B
%C Chokecherry (<i>Prunus virginiana</i>)	0.6	0.1	1.1	0.4	1.1	0.4	0.3	0.1
%C Total vegetation	33.8	1.6A	86.4	2.3B	70.4	2.1C	44.2	2.9D
%C Grasses	15.4	1.4A	55.2	4.5B	50.5	2.8B	22.9	2.3C
%C Forbs	7.8	0.6A	33.6	3.3B	24.8	1.7B	12.9	1.6C
%C Shrubs	14.9	0.9A	36.1	2.2B	12.1	1.3A	14.4	1.8A
%C Logs	2.0	0.1A	0.2	0.1B	0.8	0.2B	3.1	0.6A
\bar{N} shrubs	4.2	0.2	4.5	1.1	3.6	0.4	4.4	0.4
\bar{N} soft-mast shrubs	3.1	0.1	3.4	0.5	2.8	0.2	3.2	0.2
VOR, dm	0.4	0.1A	1.9	0.3B	1.0	0.1C	0.5	0.1A
Vegetation height, dm	3.4	0.1A	5.3	0.3B	4.3	0.2B	3.4	0.2A
Overstory canopy cover, %	47.3	1.5A	25.5	4.8B	11.3	1.5C	40.6	2.7AB
Percent slope	27.4	1.1A	11.5	1.6B	16.3	2.2AB	17.9	3.3B
DBH ponderosa pine, cm	16.5	0.5A	24.9	2.5B	28.4	2.4B	18.8	1.2A
Ponderosa pine BA, m ² /ha	21.0	0.7A	6.1	1.1B	6.5	0.7B	17.3	1.9A
Density of trees \bar{n} /ha	1566	108A	314	73B	223	52B	1178	218A

^a Averages and standard errors followed by different letters within rows are different $\alpha \leq 0.05$, Welch's test.

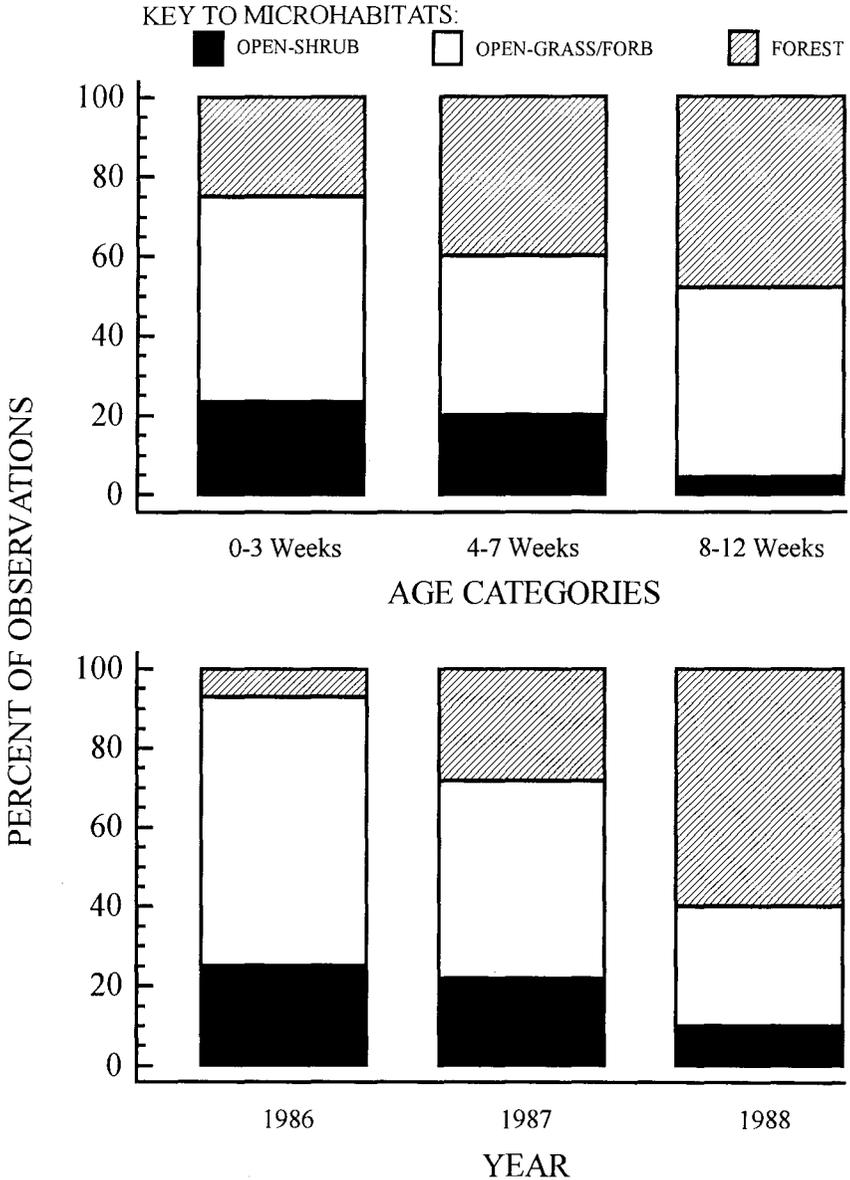


Figure 1. Frequency of Merriam's turkey brood hen selection of open-shrub, open-grass/forb, and forest microhabitats among age categories of poults (top) and years (bottom) in the Black Hills, South Dakota, 1986-88.

DISCUSSION

Poults of all ages used edges of meadows for feeding and forests for escape and loafing. Thus, few differences were evident when brood-hen microhabitats were stratified by age of poults.

Open-grass/forb and open-shrub microhabitats occurred in meadows within 5 m of the adjacent forest. Both had high amounts of herbaceous vegetation. Poults less than seven weeks of age require high levels of dietary protein for growth and development (Natl. Res. Counc. 1977), which they obtain by consuming arthropods (Hurst and Poe 1985). Arthropods are more abundant at sites with greater herbaceous biomass (Healy 1985, Rumble and Anderson 1996). The primary difference between open-grass/forb and open-shrub microhabitats was the greater amounts of western snowberry in the latter. We observed young poults using western snowberry for hiding cover, while older poults usually fled into the forest when disturbed. Young Merriam's turkey poults in southeastern Montana also used western snowberry for cover (Jonas 1966). Despite greater use of forest microhabitats by brood hens as poults aged, more than 50% of microhabitats selected by brood hens with poults more than seven weeks of age were open-grass/forb or open-shrub microhabitats.

We estimated that less than 25% of the area sampled for trees encompassed adjacent forest at open-grass/forb and open-shrub microhabitats. Ponderosa pine BA at these microhabitats averaged 6.1 m²/ha and 6.5 m²/ha, respectively. However, because these microhabitats occurred in openings near the forest/meadow ecotone, we estimated that trees occupied < 25% of the plots and thus BA in adjacent forests probably exceeded 25 m²/ha. Dense forest stands provide protection from raptors, terrestrial predators, and shade for loafing. Poults of all ages were observed loafing in the shade beneath the tree canopy. High BA and overstory canopy cover are typical of loafing sites for Merriam's turkey poults in Arizona (C. Mollohan and D. R. Patton, Development of a habitat suitability model for Merriam's turkey, unpubl. rep. KR87-0374, Ariz. Game and Fish Dept., Phoenix; Gobielle 1992).

Eastern turkey (*M. g. silvestris*) poults require 40 to 300 g/m² of herbaceous vegetation at feeding sites (Healy 1985). We used the lower limit of the 80% confidence interval for average herbaceous vegetation at open-grass/forb microhabitats as an approximation of the minimum requirements of poults. Thus, the herbaceous vegetation requirements of Merriam's turkey poults exceeded 126 g/m². A similar estimate for vegetation height was greater than 40 cm. This measurement included seed heads of grasses and unmeasured leaf height averaged 25-30 cm.

Variation in precipitation and temperature affected habitat conditions of

brood-hen microhabitats. Precipitation declined from 1986 to 1988. June-August average daily maximum temperature was 3° C higher during 1988 than during 1986 or 1987 (unpubl. monthly summaries, South Dakota Climatological Summary, U. S. Dept. Commerce, Asheville, N.C.). Lower precipitation and higher temperatures in 1988 resulted in lower herbaceous vegetation in meadows ($146 \pm 43 \text{ g/m}^2$, $\bar{x} \pm \text{SE}$) compared with 1987 ($212 \pm 43 \text{ g/m}^2$). Poult to hen ratios during 1988 (4.1) were lower than in 1986 (5.7) or 1988 (5.7) (R. W. Hauk, unpubl. Game Rep. 90-18, South Dakota Game, Fish, and Parks, Pierre). Herbaceous productivity and hot temperatures affect poult survival (Hurst and Owen 1980, Metzler and Speake 1985, Schmutz et al. 1990). Maintaining thermoneutrality can be difficult for poults (Schmutz et al. 1990). Ambient temperature would be lower beneath the tree canopy of forest microhabitats. Increased selection of forest microhabitats by older poults during late July and August may reflect thermoregulation requirements of poults, as well as reduced dietary protein requirements.

CONCLUSIONS

Microhabitats selected by brood hens included open habitats with abundant herbaceous vegetation and forest habitats. Open habitats provided feeding areas where poults could obtain diets rich in protein from the abundant invertebrates (Rumble and Anderson 1996) adjacent to dense forests. Herbaceous biomass in open habitats should exceed 126 g/m^2 . Selection of forest habitats increased in older poults and coincided with reduce dietary protein requirements, low herbaceous biomass, and higher temperatures.

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