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NEST HABITAT USE OF RIO GRANDE WILD TURKEYS

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ABSTRACT.—Nest habitat use of Rio Grande Wild Turkeys (*Meleagris gallopavo intermedia*) was studied along the South Platte River in northeast Colorado in 1986–87. Thirty-three of 35 nests were in riparian habitats. Nests were either in western snowberry (*Symphoricarpos occidentalis*) (67%) or mixed forbs and grasses (33%). Early season nests were more likely to be in snowberry than late season nests. Nest sites were characterized by greater overstory canopy cover, more shrubs, fewer grasses, and greater understory cover and height than surrounding areas. These areas had more shrubs, fewer large trees, and greater understory cover and height than riparian habitats throughout the study area. Phenology of understory vegetation and the effect of such vegetation on nest predation may influence temporal patterns of nest habitat use. *Received 19 Dec. 1988, accepted 25 March 1989.*

Avian nest habitat selection may be influenced by many factors including predation (Martin and Roper 1988), inter- and intraspecific competition (Orians 1980), and the thermal environment (Walsberg 1985). To understand habitat selection and the effect of such factors, patterns of nest habitat use must first be documented. For Wild Turkeys (*Meleagris gallopavo*), several investigators have recently reported quantitative data on nest habitat use (Lazarus and Porter 1985, Ransom et al. 1987, Wertz and Flake 1988). The varied habitats used for nesting and low sample sizes of these studies precluded elucidation of what criteria Wild Turkeys may use in choosing nest sites. Nest predation has been implicated as a major limiting factor of Wild Turkey populations (Reagan and Morgan 1980, Speake 1980, Ransom et al. 1987), but the influence of predation on habitat choice is not clear.

The objective of our study was to document quantitatively nest habitats used by an introduced population of Rio Grande Wild Turkeys (*M. g. intermedia*). We investigated nest-site selection by: (1) comparing nest sites to random sites at several levels or scales, and (2) comparing the chronology and success of nests in different vegetative types.

STUDY AREA

The study was conducted along the South Platte River in Logan, Morgan, and Washington counties in northeast Colorado. This riverbottom community extended to 1.0 km in width

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and was dominated by an open-canopied plains cottonwood (*Populus sargentii*) forest. Boxelder maple (*Acer negundo*), red ash (*Fraxinus pennsylvanica*), and Russian-olive (*Eleagnus angustifolia*) occurred in low but increasing frequencies. Common forbs included pepperweed (*Lepidium latifolium*), poison hemlock (*Conium maculatum*), ragweed (*Ambrosia* spp.), sunflower (*Helianthus* spp.), and thistle (*Cirsium* spp.). Common grasses included cheatgrass brome (*Bromus tectorum*), prairie cordgrass (*Spartina pectinata*), inland saltgrass (*Distichlis stricta*), sand dropseed (*Sporobolus cryptandrus*), and wheatgrass (*Agropyron* spp.). Shrubs occurred in discrete patches and were predominately western snowberry, although willows (*Salix* spp.) were common in mesic areas (plant names follow Scott and Wasser [1980]). Lindauer (1983) provided a complete vegetative description of this particular community.

Private lands adjacent to the riverbottom were primarily used for production of alfalfa, corn, wheat, and other small grains and row crops. Cattle were grazed at varying intensities both in and adjacent to the riverbottom. The Colorado Division of Wildlife owned approximately one-third of the riverbottom in the study area. These lands were not grazed and were used for both consumptive and nonconsumptive recreation.

Sixty Rio Grande Wild Turkeys from Kansas and Texas were introduced into the study area during 1980–83. No Wild Turkeys had previously existed in northeast Colorado.

METHODS

Wild Turkeys were trapped in February 1986–87 with drop-nets and clover traps. Captured birds were classified as yearlings (< one year of age) or adults (> one year of age) based on characteristics of primaries IX and X (Petrides 1942). Females were fitted with transmitters mounted on ponchos (Amstrup 1980) or attached to the central pair of rectrices (Bray and Corner 1972). Poncho and tail-clip transmitters weighed 29–32 and 26–29 g, respectively, and had expected battery lives of six months.

Habitat measurements.—Hens were monitored daily, when possible, to ascertain nest initiation. Date of initiation was estimated by calculating number of eggs laid and incubation period (Schmutz and Braun 1989). Nest habitat variables were measured within two days after eggs hatched or were abandoned or depredated. Measurements of random habitat plots were distributed over the same periods as measurements of nest plots to minimize phenological differences. Eight nest plots and 31 associated random plots from 1986 were remeasured in April 1987 at the approximate date of nest initiation the previous year.

All plots were 0.04-ha circles with 22.5-m diameters. Nest plots were centered on nest sites. Up to four adjacent random (AR) plots were selected within 79 m of each nest at random distances and directions. Study area random (SAR) plots were spaced at 2.5-km intervals throughout the linear study area. At each interval, SAR plots were established in the riverbottom at a random percentage of the riverbottom's width from the river at that interval. No SAR plots were within 300 m of a nest.

Variables measured at nest and random plots were: overstory canopy cover, understory cover, understory height, amount of shrubs, forbs, grasses, and bare ground, distance to nearest tree >30 cm in diameter at breast height (DBH), and basal area of all trees and small (<25 cm DBH), medium (≥25 and <45 cm DBH), and large (≥45 cm DBH) trees. Canopy cover was measured with a densiometer. A vegetation profile board (Nudds 1977) was used to estimate percent understory cover to one of six classes (<2.5, 2.5–25, 26–50, 51–75, 76–95, and >95%) in each of three height categories (<0.5, 0.5–1.0, and 1.1–2.0 m). The profile board was placed at the plot center and read from the plot perimeter in the four cardinal directions. Understory height was measured at these four perimeter locations and the plot center. Both understory height and basal area were measured in 5-cm increments.

Coverage of shrubs, forbs, grasses, and ground was estimated in meters along two perpendicular, but randomly oriented, transects, each equal to the plot diameter of 22.5 m.

In 1987, egg visibility was measured concurrent with habitat measurements at all 22 nests of radio-marked hens. Ten Wild Turkey eggs were placed in the nest bowl. The number of visible eggs was counted while standing above the nest, and while standing and crouching 2 and 5 m away in the four cardinal directions. The four directional measurements were then averaged.

Statistical analyses.—Habitat measurements in AR plots for each nest site were averaged and then paired with associated nest plot data for analysis with Wilcoxon signed ranks tests. If <2 AR plots were measured at a nest site, then the nest and associated AR plots were excluded from this analysis. Likewise, the eight nests measured in April 1987 were paired with 1986 habitat data and analyzed with Wilcoxon signed ranks tests. Habitat differences between nest and SAR plots were tested with median tests because the distributional differences between these two groups prevented analysis with more powerful Mann-Whitney tests (Conover 1980). Habitat and egg visibility differences between nests of different age hens, fates (successful vs unsuccessful), and vegetation types (snowberry vs other) were tested with Mann-Whitney tests as were differences between AR and SAR plots. Nesting in snowberry versus other vegetation as a function of nest initiation date was examined with logistic regression. Wilcoxon signed ranks tests were conducted using SPSS (Norusis 1986). The Statistical Analysis System was used for all other analyses (SAS 1987).

RESULTS

Thirty radio-marked hens initiated a known total of 35 nests. Thirty nests were in ungrazed riverbottom, three were in riverbottom lightly grazed within the past year, and the two latest initiated nests (>1.5 months after median nest initiation date [Schmutz and Braun 1989]) were approximately 200 m from the riverbottom edge in currently grazed pastures. For first nest attempts (including an unmarked adult), early nesting hens were more likely to nest in snowberry than late nesting hens ($P = 0.067$) (Fig. 1). Three hens were known to renest once and one hen renested twice. Excluding the hen that renested after laying a single egg, all four renests were in the opposite vegetation type (snowberry vs other) from the hens' previous attempts.

Nest plots measured at hatch (late May–Jun 1986) had greater canopy and understory cover in all three height classes than the same plots measured the following year during the nest initiation period (mid-Apr 1987) ($P < 0.05$ for all tests). Live grasses and forbs were much shorter at nest initiation ($\bar{x} = 9 \pm 1$ [SE] cm) than at hatch ($\bar{x} = 56 \pm 3$ cm; $P < 0.001$), but height of live shrubs did not vary between nest initiation ($\bar{x} = 100 \pm 8$ cm) and hatch ($\bar{x} = 106 \pm 9$ cm; $P = 0.722$). Adjacent random plots also had greater canopy and understory (≤ 1 m) cover at hatch than at nest initiation ($P < 0.05$ for all tests).

Thirty-one nest plots (including one nest of an unmarked adult) were compared with their associated AR plots. Nest plots were characterized by greater canopy cover, more shrubs, fewer grasses, and greater under-

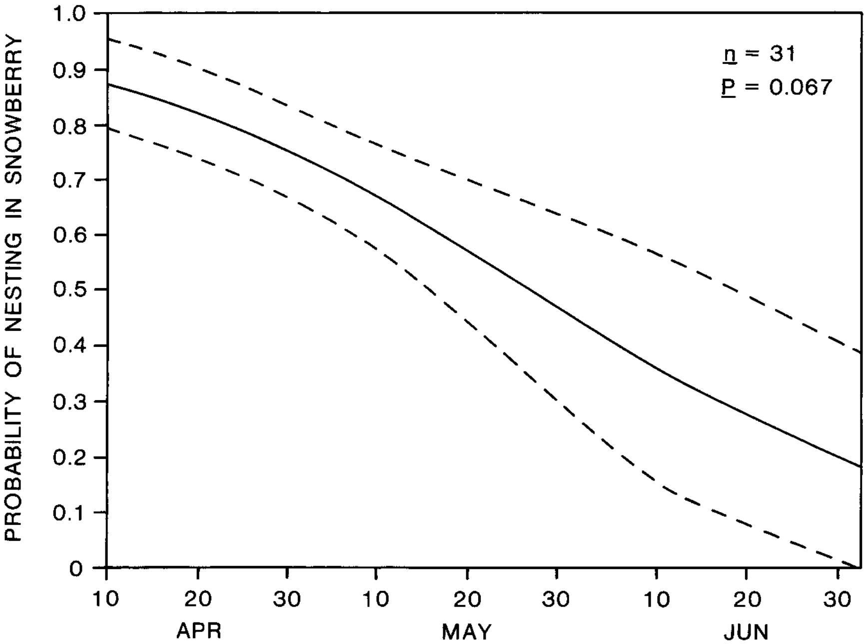

FIG. 1. Probability of Wild Turkeys nesting in snowberry as a function of nest initiation date in northeast Colorado, 1986–87. Logistic regression was used to predict values ± SE from $y = 0.041x - 6.051$, where initiation date was the Julian date.

story cover (≤1 m) and height than AR plots ($P < 0.01$ for all tests) (Table 1). Distance to large tree, basal area of trees, amount of forbs and bare ground, and understory cover >1 m did not differ ($P > 0.05$) between nest and AR plots. Comparing the 31 first nest attempts to the SAR plots (N = 36), the same characteristics were different except that canopy cover and grass abundance did not differ. Additionally, AR plots had greater understory cover (>0.5 and ≤1.0 m) and height, more shrubs, and fewer large trees than SAR plots ($P < 0.05$). Other habitat variables did not differ ($P > 0.10$), but understory cover ≤0.5 m tended to be greater at AR plots ($P = 0.068$).

Nest plots centered in snowberry (N = 24) were closer to a large tree and had greater canopy cover, more large trees, more shrubs, and fewer forbs than nests in other vegetation (Table 2). Many snowberry clumps contained 1–5 large cottonwoods resulting in many of these differences. Nest failure due to predation was independent of habitat type (snowberry vs other) when examined across entire seasons (G test, $G = 0.502$, $P = 0.479$). After dividing the data set into early (N = 16) and late (N = 17) seasons and excluding three abandonments, early nests in snowberry tend-

TABLE 1
HABITAT VARIABLES AT WILD TURKEY NESTS AND RANDOM PLOTS IN NORTHEAST COLORADO, 1986–87

Variable	Nest (N = 31) $\bar{x}$	Nest (N = 31) SE	Adjacent random (N = 31) $\bar{x}$	Adjacent random (N = 31) SE	Study area random (N = 36) $\bar{x}$	Study area random (N = 36) SE
Canopy, %	33.3	6.1	14.9[a]	2.5	29.8	5.9
Shrubs, m	6.6	1.0	2.5[a]	0.5	2.2[bc]	0.7
Forbs, m	6.4	1.0	5.8	0.7	4.6	0.8
Grasses, m	8.6	0.9	12.4[a]	0.7	11.9	1.1
Ground, m	0.5	0.2	1.3[a]	0.3	3.3[b]	0.7
Understory cover, %						
<0.5 m	96.6	0.4	68.0[a]	3.5	51.4[b]	5.7
0.5–1.0 m	60.3	4.9	29.6[a]	3.7	22.6[bc]	4.2
1.1–2.0 m	8.5	1.6	6.0	0.7	10.7	2.5
Understory height, cm						
Plot center	94	6	57[a]	4	36[bc]	5
Total plot	70	4	54[a]	3	41[bc]	3
Distance to large tree, m	24.7	7.6	27.5	6.9	25.1	5.7
Basal area, m^2/ha						
Small trees	0.7	0.3	0.3	0.1	2.2	0.8
Medium trees	2.8	0.9	1.8	0.5	2.1	0.5
Large trees	6.3	1.9	3.5	0.6	3.7[c]	1.3
Total trees	9.9	2.1	5.6	0.8	7.9	1.6

[a] $P < 0.05$ for nest vs AR plots.
[b] $P < 0.05$ for nest vs SAR plots.
[c] $P < 0.05$ for AR vs SAR plots.

ed to be more successful than late nests in snowberry ($P = 0.027$) (Table 3). Among late nests, those in snowberry were less successful than those in forbs and grasses ($P = 0.026$). A greater proportion of nests in 1986 (11 of 13) were in snowberry than in 1987 (13 of 23). Nests in 1986 had greater understory cover (>0.5 and ≤1.0 m) than 1987 nests ($P = 0.041$), but other habitat variables did not differ.

Habitat variables within adult nest plots (N = 14) did not differ ($P > 0.05$) from those of yearlings (N = 22) nor did successful nests (N = 18) differ from unsuccessful nests (N = 16, excluding two observer-induced abandonments). Egg visibility from all angles did not differ between age classes, nest fates, or vegetation types. An average of 5.4 eggs was visible from above the nest, <3 eggs were visible from a distance of 2 m, and <1 egg was visible from 5 m.

DISCUSSION

Whereas floristic composition at nest sites varies greatly across the Wild Turkey's geographic range, most investigators have observed similar

TABLE 2
HABITAT VARIABLES AT WILD TURKEY NESTS IN SNOWBERRY AND OTHER VEGETATION IN NORTHEAST COLORADO, 1986–87

Variable	Snowberry (N = 24)		Other (N = 12)	
	$\bar{x}$	SE	$\bar{x}$	SE
Canopy, %	40.2	7.2	14.1[a]	7.2
Shrubs, m	9.3	1.0	0.5[a]	0.3
Forbs, m	4.4	0.9	10.6[a]	1.8
Grasses, m	7.9	1.2	10.6	1.8
Ground, m	0.4	0.2	0.5	0.2
Understory cover, %				
<0.5 m	97.0	0.2	93.9	2.3
0.5–1.0 m	61.7	5.1	51.0	2.3
1.1–2.0 m	7.4	1.4	8.3	3.3
Understory height, cm				
Plot center	92	6	97	9
Total plot	70	5	60	10
Distance to large tree, m	11.5	2.2	59.5[a]	19.4
Basal area, m^2/ha				
Small trees	0.9	0.4	0.1[a]	0.1
Medium trees	3.3	1.1	0.8	0.5
Large trees	8.6	2.3	0.5[a]	0.5
Total trees	12.8	2.5	1.3[a]	1.0

[a] $P < 0.05$.

structural patterns in nest site vegetation. Nests are characterized by concealment in dense herbaceous or woody vegetation, both around and above the nest (Williams et al. 1968, Lazarus and Porter 1985, Wertz and Flake 1988). Similarly, we found that nests of Rio Grande Wild Turkeys were in understory vegetation denser and taller than the surrounding environment. Low visibility of eggs and incubating hens substantiated the concealing effect of these understory characteristics.

The relative cover value of snowberry strongly influenced temporal and spatial aspects of nest-site selection. Many of the observed differences (e.g., distance to large tree, grass abundance) were likely artifacts of their correlation with the presence of snowberry clumps. In mid-April, when hens were first initiating nests, the amount of cover provided by snowberry was much greater than that provided by herbaceous vegetation, and thus, snowberry was probably more effective at deterring nest predators (Bowman and Harris 1980). As the season progressed, the cover value of forbs and grasses approached that of snowberry, and correspondingly, these types were used more as nesting cover. Why nesting success between these

TABLE 3
NUMBERS OF SUCCESSFUL AND DEPREDATED WILD TURKEY NESTS IN SNOWBERRY AND MIXED FORBS AND GRASSES IN EARLY AND LATE SEASON IN NORTHEAST COLORADO, 1986–87

		Vegetation	
Season	Fate	Snowberry	Forbs and grasses
Early	Successful	9	1
	Depredated	4	2
Late	Successful	2	6
	Depredated	6	3

two habitats changed with respect to time is not as clear. The greater abundance of forbs and grasses (as compared to shrubs) may result in lower probabilities of nest predation in these habitats due to the increased amount of area (potential nest sites) a predator would need to search (Martin and Roper 1988). The observation that all renests after nest depredation occurred in the opposite vegetation type further suggests that reducing potential nest predation influenced nest-site selection by these Wild Turkeys.

Although these data support the belief that Wild Turkeys select nest sites in dense, concealing understory vegetation, definition of what specific structural characteristics they may cue on is not yet possible. Differences between the two spatial scales of random plots (SAR vs AR) and between both types of random plots and nest plots suggests that without an experimental approach, it is difficult to interpret at what scale(s) nest habitat selection is operating. Interpretation of descriptive studies that compare use with non-use or random sites is potentially biased by the spatial scale(s) one chooses for measurement.

Tall, dense understory vegetation, possibly because of its moderation of nest predation, may be a primary cue used by Wild Turkeys in northeast Colorado for selecting nesting habitat. Whether or not potential nest sites can be defined by specific structural variables awaits further study. This study demonstrates the need for avian nest habitat studies to consider both spatial and temporal (phenological) scales of habitat measurement.

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