Drumming Log Habitat Selection by Male Ruffed Grouse in North Carolina

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Abstract: We evaluated ruffed grouse *Bonasa umbellus* drumming logs in western North Carolina to determine criteria used by male grouse in selecting drumming sites. For every drumming log found (N = 34), we selected a random log within the same stand type and with a similar topographic position. We collected data on drumming log characteristics and on vegetation surrounding the drumming site. We found 85% (N = 29) of drumming logs on or near a ridge top in a mature (>40 years old) oak/hickory *(Quercus/Carya)* or northern hardwood forest stand with a dense mid-story of mountain laurel *(Kalmia latifolia)* and or flame azalea *(Rhododendron calendulaceum).* There was no difference in physical characteristics of logs, basal area, or woody understory density between drumming logs and random logs ($P>0.05$). Mid-story density and vertical vegetation density were greater at drumming logs than at random logs ($P > 0.01$). Retaining mature stands on ridge tops that contain a dense mid-story of mountain laurel and flame azalea, while harvesting timber on mid- and lower-slopes will improve interspersion of habitats used by male and female ruffed grouse during the breeding season in the southern Appalachians.

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Male ruffed grouse attract females during spring by drumming. Although males drum to attract females, the primary function of drumming is to define territories among neighboring males (Archibald 1975) and deter intruding males (Gullion

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1970). Drumming is initiated during late March in the southern Appalachians and peaks during the first 2 weeks in April (Stafford unpubl. rep., Epperson 1988, Boyd 1990). Fall drumming by established males also may occur during October and November on sunny afternoons to deter dispersing juvenile males from settling in their territory (McBurney 1989).

Several studies have reported that males select drumming sites on upper slopes or ridge tops with varying aspects and slopes (Stoll et al. 1979, Hale et al. 1982, Thompson et al. 1987). Drumming sites are usually located in stands with a dense mid-story and open under-story (Eng 1959, Gullion et al. 1962, Boag and Sumanik 1969). Physical characteristics of drumming logs are not thought to be significant in selection (Taylor 1976, Hale et al. 1982, Thompson et al. 1987).

The drumming log is the focal point for year-round movements of male grouse (Gullion et al. 1962). Males become sedentary once a territory is established (Palmer 1956) and rarely move more than 0.4 km from the drumming site (Johnsgard 1989). Thus, all habitat requirements for male grouse must be met within a relatively small area based on selection of a drumming site. Drumming site selection, therefore, becomes important in determining male grouse distribution. Hale et al. (1982) found most drumming logs in Georgia were located on ridge tops in mature forests; however, Boyd (1990) and Pelren (1991) reported female grouse in Tennessee preferred regenerating stands in late winter and early spring. If this is the case, mating opportunities may decrease if males remain on ridge tops in mature forests while females use regenerating stands. An interspersion of younger and older stands should facilitate interaction of males and females given their habitat preference during this time of year.

It is important to determine preferred drumming habitat in North Carolina. Land managers could use this information to ensure quality grouse habitat is being provided in sufficient amounts. To determine criteria used by male grouse in selecting drumming sites in the mountains of North Carolina, we measured vegetation and topographic parameters surrounding drumming logs detected during drumming surveys.

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Methods

The study was conducted on the Wine Spring Creek Ecosystem Management Area and surrounding compartments located on the Wayah Ranger District of the Nantahala National Forest in western Macon County, North Carolina. The 4,900-ha area is within the Blue Ridge Physiographic Province, part of the Nantahala Mountains within the Unaka Range.

The Wine Spring area is located approximately 110 km southwest of Asheville, North Carolina, and 29 km south of the Great Smoky Mountains National Park. Elevation ranged from 915 to 1,644 m. Mean annual temperature was 10 C and mean annual precipitation was 192 cm. Forest types within the study included northern hardwood forests, mixed mesophytic hardwood forests, upland oak-hickory forests, and mixed hardwood-pine forests. Acquired by the Forest Service in 1912, timber was harvested on a regular rotation, making it representative of most Forest Service lands within the southern Appalachians.

We located drumming sites by approaching all drumming males heard during drumming surveys or other research activities in spring 1999 and 2000. A log was determined to be a drumming log by presence of accumulated fecal droppings and/or feathers. A random direction was chosen and the first log encountered at least 30 m from the drumming log (so plots would not overlap) was deemed the random log. Only random logs with similar topographic position within the same forest stand were selected (Hale et al. 1982). We made attempts to select random logs equal to or larger than the smallest drumming log—at least 23 cm in height, 25 cm in diameter, and 3 m in length. If habitat or physical condition criteria were not met, another log was chosen. Elevation at each site was determined using a Global Positioning System (GPS) remote unit. Topographic position of logs was recorded as ridge top, upper slope, mid-slope, or lower slope. We determined slope and aspect using a clinometer and compass, and the direction each log was lying in relation to the contour (i.e., perpendicular or parallel) was recorded. We measured length of each log from the butt end to the first major branching (when present), height, diameter. Moss coverage was estimated visually as percentage cover. The condition of each log was recorded as sound (bark still intact), worn (sound with no bark), or well worn (varying degrees of rotting). Distance to the nearest road, water source, and edge (considered a distinct change in forest type or stand age) $\leq$100 m was recorded. We measured basal area using a 2.5 m^2/ha factor prism, and vegetation surrounding drumming logs was identified and measure using nested, circular plots with drumming stage as plot center. We counted woody understory, consisting of stems $<$1.4 m tall within a 3.6-m radius plot. Mid-story vegetation, consisting of stems $<$11.4 cm diameter at breast height (dbh) and $>$1.4 m tall, was counted within a 5.7-m radius plot. We tallied stems based on dbh categories of $\leq$2.5, 2.6–5.0 cm, 5.1–7.5 cm, and $\geq$7.6 cm. Vertical vegetation density was estimated using a 2.0- $\times$ 0.4-m density board (Nudds 1977) placed 15 m up slope, down slope, and perpendicular to slope in both direction from plot center. Stand age and forest type were identified using U.S. Forest Service Continuous Inventory of Stand Condition (CISC) data. We spatially referenced all sites with a GPS remote unit.

Data were analyzed using logistic regression because the dependent variable was categorical with only 2 possible values—drumming log or random log (coded as 1 and 0, respectively). Explanatory variables included drumming stage height and diameter, log length, slope, moss cover, vertical vegetation density, basal area, understory density, and mid-story density. The final model was chosen using backward selection and the SCORE statistic. Significance of individual variables was tested at α

Table 1. Variable means (± SE) for drumming logs and random logs on the Wine Spring Creek Ecosystem Management Area, North Carolina, 1999–2001.

Variables	Drumming logs	Random logs
Height (cm)	50.0 (2.0)A[a]	51.9 (2.9)A
Diameter (cm)	50.5 (2.1)A	52.8 (3.0)A
Length (m)	8.3 (0.5)A	7.6 (0.4)A
Slope(%)	26.9 (2.5)A	28.3 (1.8)A
Moss cover (%)	34.8 (5.8)A	44.6 (6.5)A
Vertical vegetation density (%)	41.4 (3.8)A	25.7 (3.1)B
Basal area (m^2/ha)	15.4 (1.4)A	18.1 (1.2)A
Understory density (stems/ha)	12,433 (1,858)A	10,302 (1,795)A
Mid-story density (stems/ha)	6,805 (629)A	3,438 (429)B

a. Same letter denotes no significant difference ($P > 0.05$) based on logistic regression analysis.

= 0.05. The Hosmer-Lemeshow goodness-of-fit test was used to assess the model fit ($P>0.05$ was acceptable; SAS 2000). Stand type, age, topographic position, and elevation were not analyzed for significance because random logs were located within the same parameters.

Results

We identified 33 drumming logs and 1 drumming rock. Physical dimensions of the rock could not be compared with another rock; however, vegetation and topographic data surrounding the rock were collected. We used log length, diameter, and height means to replace the rock means in the analysis.

Drumming sites were found in stands varying from 10–137 years old; however, 28 sites were in stands >40 years old. Seventy-four percent ($N = 25$) of drumming sites were located in white oak *(Q. alba)*/northern red oak *(Q. rubra)*/hickory (*Cana* spp.) stands (For. Serv. type 53) and 26% ($N = 9$) were located in northern hardwood stands (For. Serv. type 81; For. Serv. Handb. 1986). These 2 forest types make up 73% of the study site.

Average height, diameter, and length (Table 1) of drumming logs did not differ ($\chi^2_1 = 0.31$, $P = 0.58$; $\chi^2_1 = 0.40$, $P = 0.53$, $\chi^2_1 = 1.31$; $P = 0.25$ respectively) from random logs. Height ranged from 23–75 cm, diameter ranged from 25–101 cm, and length ranged from 3–17 m. Logs over 10 m ($N = 8$) were used as often as logs only 3–6 m long ($N = 7$). Eighteen logs were 6–10 m. One drumming log was sound, 22 were worn, and 10 were well worn. Moss cover on drumming logs was similar ($\chi^2_1 = 1.25$, $P = 0.26$) to random logs.

Drumming sites and random sites were located on all aspects. There was no difference ($\chi^2_1 = 0.69$, $P = 0.35$) in use of logs according to the direction they were lying. Eighty-five percent ($N = 29$) of drumming sites were located on ridge tops or upper slopes. Drumming sites were located on a wide range of slopes and did not dif-

Table 2. Parameter estimates for selection of drumming logs by male ruffed grouse on the Wine Spring Creek Ecosystem Management Area, North Carolina, 1999–2001.

Variables	Parameter estimates
Height (cm)	-0.009
Diameter (cm)	-0.010
Length (m)	-0.108
Slope (%)	-0.009
Moss cover (%)	0.008
Vertical vegetation density	-0.040
Basal area (m^2/ha)	0.048
Understory density (stems/ha)	-0.0002
Mid-story density (stems/ha)	-0.0003

fer ($\chi^2_1 = 0.19$, $P = 0.66$) from random sites. Distances from drumming sites to nearest road, edge, and water varied from a few to >100 m. Only 5 logs were located <100 m from the nearest water source.

There was no difference ($\chi^2_1 = 2.01$, $P = 0.16$) in basal area between drumming and random sites. Visibility was lower at drumming sites ($\chi^2_1 = 8.15$, $P < 0.01$; Table 1,2). Average woody understory density surrounding drumming sites did not differ ($\chi^2_1 = 0.68$, $P = 0.41$) from random sites; however, mid-story density was greater ($\chi^2_1 = 11.43$, $P < 0.01$) at drumming sites. Mid-story vegetation usually consisted of mountain laurel or flame azalea; however, rhododendron (*Rhododendron* spp.) and highbush blueberry *(Vaccinium corymbosum)* often were present. Backward selection identified a model with only mid-story density remaining. The SCORE statistic supported the model. There was a positive relationship between mid-story density and drumming use. The model had a max-rescaled R^2 value of 0.28. The final model (Hosmer-Lemeshow goodness-of-fit statistic = 9.68, $P = 0.29$) indicates a difference between drumming and random logs. There was a 72.1% correct classification rate. Twenty-one percent ($N = 7$) of random logs were classified as drumming and 38% ($N = 13$) drumming logs were classified as random.

Discussion

Male grouse primarily used mature stands located on an upper slope or ridge top with a dense mid-story for drumming. Preference for upper slopes and ridges may be associated with vegetative structure found at these sites. At Wine Spring, mountain laurel and flame azalea are abundant on ridges that receive full sun exposure and have shallow soils–stands with a relatively low site index. These shrubs provide excellent overhead protection from avian predators via a canopy of dense limbs. This structure, coupled with a drumming stage approximately 50 cm above the ground, affords males a better vantage to identify incoming females, as well as approaching mammalian predators. In addition, mountain laurel is used as a food source in winter months when little else is available (Stafford and Dimmick 1979). Hale et al. (1982) reported habitats containing mountain laurel and flame azalea were used by drumming grouse in north Georgia and Gullion (1977) reported 14,000–20,000 stems/ha of aspen (*Populus* spp.) regeneration as optimal cover for drumming grouse. There were equivalent stem densities present at Wine Spring (Harper 1998); however, they existed only in stands 0–12 years old, not in stands >40 years old where most of our logs were located.

Although grouse tend to prefer upper slopes and ridge tops for drumming, the vegetation structure found there seems beneficial for protection from avian predators only. Gullion and Marshall (1968) reported avian predators killed male grouse in boreal forests only after leaving their logs. During spring 2000, 4 of 17 radio-collared males at Wine Spring were killed by mammalian predators near their drumming logs based on evidence found at the site (i.e., chewed calamus, broken bones, viscera remains; Schumacher, unpubl. data).

Understory stem density did not appear to influence drumming site selection. During the drumming season (mid-March through mid-April), the deciduous understory (i.e., primarily blueberries [*Vaccinium* spp.] and huckleberries *[Gaylussacia]*) at Wine Spring had not leafed out. Without leaves, the understory vegetation provided little additional cover for drumming males. Studies in similar and dissimilar (e.g., aspen and spruce [*Picea* spp.]) habitat types also have reported understory density did not influence drumming site selection (Palmer 1963, Boag and Sumanik 1969, Hale et al. 1982, Thompson et al. 1987).

Physical characteristics (i.e., height, diameter, length) of drumming logs at Wine Spring were comparable to those found elsewhere (Table 3) and did not determine drumming site use. Although diameter was not significant, there must be a minimum log diameter for grouse to select a log (>25 cm in this study). The grouse using a rock as a platform had roughly 8 cm on which to balance. He remained at the site throughout the drumming season even though several logs were found in the vicinity. The higher drumming stage (65 cm) may have been more beneficial than a wider stage.

Most drumming logs at Wine Spring were sound and without bark. Stoll et al. (1979) found 76% of logs in Ohio were sound and without bark and log condition varied from sound to rotten. They reported the lack of bark "probably reflects time

Table 3. Comparison of drumming log dimensions at North Carolina, Georgia, Tennessee, and Missouri.

Variable	NC	GA[a]	TN[b]	MO[c]
Height (cm)	50.0	43.0	30.0/44.0[d]	41.9
Diameter (cm)	50.5	—	37.0	46.5
Length (m)	8.3	10.6	9.3	8.6

a. Hale et al. 1982.

b. Taylor 1976.

c. Thompson et al. 1987.

d. Reported as height on the up-hill and down-hill side of log.

required for vegetational succession to provide suitable habitat around a log rather than a preference for logs without bark." This suggests that habitat conditions (i.e., mid-story stem density) surrounding the log are more important in site selection than log condition.

Aspect, slope, and direction the log was lying did not influence drumming site selection at Wine Spring. Stoll et al. (1979), Hale et al. (1982), and Thompson et al. (1987) found similar results. Boag and Sumanik (1969) claimed male grouse rarely used logs parallel to the slope. One male at Wine Spring drummed on a log parallel to a 55% slope, but the log had a large curve in the trunk providing a flat drumming stage. As long as the drumming stage was relatively level, position of the log in relation to contour seemed irrelevant.

Wine Spring has been logged regularly over the last century and a network of logging roads (in various conditions and ages) existed on the study site. As a result, there were few places >100 m from some type of road. Therefore, the fact that 74% of drumming sites were located <100 m from a logging road or some type of edge is not surprising.

Proximity to a water source was not an important factor in drumming site selection at Wine Spring. Grouse obtain water primarily through dew and their food, not from permanent or temporary water sources (Bump et al. 1947). In addition, streams may actually deter males from selecting a log because of associated noise (Hale et al. 1982). For instance, the ability of a male to be heard by other grouse would be reduced by the rushing water and the potential for a male to deter approaching predators would be limited.

Bergerud and Gratson (1988) discussed a theory of Bradbury (1981) and Oring (1982) that male ruffed grouse spaced themselves to increase encounters with females and therefore "males should attempt to display near areas where females will later nest." This theory opposed Gullion's opinion (1967) that males select activity centers based on availability of cover. Our research supports Gullion. According to Bergerud and Gratson (1988), males should drum on ridge tops because females nest there. However, only 17% ($N = 3$) of females at Wine Spring nested on ridge tops in 2000–2001 (Fettinger, unpubl. data), whereas 65% ($N = 22$) of males drummed on ridge tops. Bergerud and Gratson (1988) also claimed southern grouse chose conspicuous sites on "exposed hilltops" and were able to do so because they were below the range of northern goshawks *(Accipiter gentilis).* The sites used for drumming at Wine Spring, however, were not exposed. In the southern Appalachians, northern goshawks are replaced by broad-winged *(Buteo lineatus),* Cooper's *(A. cooperii),* and red-tailed *(B. jamaicensis)* hawks, and their presence may prompt male grouse to use dense habitats for drumming sites.

Studies investigating sites used for drumming by male grouse have resulted in few management implications. In most areas, availability of potential drumming logs is not a problem, and, at Wine Spring, there were usually several other "suitable" logs available within sight of drumming logs. However, it does appear that ridge tops within mature stands containing a dense mid-story offered preferable conditions for drumming sites. This does not mean mature stands, per se, offer the best conditions for drumming. In the southern Appalachians, stands located on relatively poor sites seemed to offer the best habitat for drumming because of the prevalence of a dense shrub mid-story. Potential drumming sites were not limited at Wine Spring because these stands were available throughout the area.

Retaining mature stands with a dense mid-story along ridge tops while implementing timber harvests on mid- and lower slopes seems warranted when making forest management decisions directed toward improving habitat conditions for ruffed grouse in the southern Appalachians. Increasing the interspersion of young and mature stands would enhance habitat conditions for both male and female grouse during the mating season and possibly reduce travel necessary for females when locating males.

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