Ruffed Grouse Food Availability in Southwestern Virginia

David G. Hewitt, *Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061*

Fredrick A. Servello,[1] *Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061*

Roy L. Kirkpatrick, *Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061*

Abstract: We initiated a pilot study of fall and winter ruffed grouse (*Bonasa umbellus*) habitat use, forage availability, and forage-based carrying capacities for an area in southwestern Virginia. Flush counts indicated grouse densities were low and that grouse preferred clearcuts in the fall. Fall forages appeared adequate to support moderate grouse populations. High quality forages (mast and herbaceous leaves) were scarce during the winter and resulted in low carrying capacity estimates. Evergreen forages were abundant in both seasons but toxic properties likely limited their utility.

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Ruffed grouse densities in the southeastern United States are lower than in the northern parts of the species range (Bump et al. 1947, Rusch and DeStefano 1989). Until recently, food resources of ruffed grouse in the Southeast have received little attention as a limiting factor, in part because low snowfall had led to the impression that food is abundant (Gullion 1984). Servello and Kirkpatrick (1987) reported that the winter diet of ruffed grouse in the Southeast contains greater proportions of leaves from evergreen plants than found in the diets of northern populations. Evergreen leaves have high levels of tannins and other phenolics and low levels of protein. Servello and Kirkpatrick (1987) hypothesized that grouse in the Southeast must consume evergreen plants in winter because better quality forages, such as herbaceous leaves and hard and soft mast, are scarce. The objectives of this study were to measure ruffed grouse habitat use (flush counts), measure the biomass of

[1] Present address: Department of Wildlife, University of Maine, Orono, ME 04469

known grouse foods, and determine forage based carrying capacities in an area of good grouse habitat in southwestern Virginia.

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Methods

Our study was conducted in the 235-ha Kelly Flats area of the Jefferson National Forest in Giles County, Virginia. The site was believed to consistently have an above average ruffed grouse density for southwestern Virginia (W. A. Guthrie, pers. commun.) and contain a variety of adjacent habitat types. Ruffed grouse densities in the area were sufficient to provide grouse for a 1985 relocation program (Coggin 1986). The study area lies within the Ridge and Valley Province of the Appalachian hardwood subregion (Smith and Linnartz 1980) and ranges in elevation from 800 to 1,000 m. Approximately 70% of the study area was even-aged mixed-oak hardwood stands 51–78 years old. The remaining 30% had been clearcut in the previous 4 to 18 years. Overstory species included white oak (*Quercus alba*), red oak (*Q. rubra*), black oak (*Q. velutina*), scarlet oak (*Q. coccinea*), chestnut oak (*Q. prinus*), hickory (*Carya* spp.), pitch pine (*Pinus rigida*), and Virginia pine (*P. virginianus*). Yellow poplar (*Liriodendron tulipifera*) was dominant in hardwood coves. Understory vegetation included saplings of overstory species, blueberry (*Vaccinium* spp.), huckleberry (*Gaylussacia* spp.), red maple (*Acer rubrum*), flowering dogwood (*Cornus florida*), and white pine (*P. strobus*). Mountain laurel (*Kalmia latifolia*) was an important component of the understory only in the northwest portion of the study area. Ground vegetation was dominated by wintergreen (*Gaultheria procumbens*), trailing arbutus (*Epigaea repens*), and galax (*Galax aphylla*). Oak regeneration characterized clearcuts except along a small stream that traversed 1 clearcut where white pine and hemlock (*Tsuga canadensis*) were common in the overstory and speckled alder (*Alnus incana*) and sedges (*Carex* spp.) were common in the understory.

The study area was initially divided into 10 stands based on age and plant species composition. Because of similarities, stands were combined to create 6 habitat types: (1) 4-year-old upland clearcut, (2) 16- to 18-year-old clearcut, (3) clearcut bottom, (4) sawtimber-general, (5) sawtimber-white pine, and (6) sawtimber thinned. The 4-year-old clearcut was 11 ha in size. The 16- to 18-year-old clearcut upland habitat consisted of 2 areas which had been cut 16 and 18 years previously and were 11 and 45 ha, respectively. The clearcut bottom was a 7-ha drainage bottom in the 18-year-old clearcut. The sawtimber-general type was 148 ha in size and represented 4 stands of 51- to 78-year-old mixed-oak hardwoods (Servello 1985). Two hardwood coves, treated as 1 stand, were characterized by large overstory stem diameters and an absence of understory vegetation. Two other stands had sparse understories and 1 had a mountain laurel understory. Sawtimber-white pine was a 12-ha stand on the southeastern corner of the study area that had a white oak overstory with white pine common in the understory. Sawtimber-thinned was an 8-ha stand that had recently been thinned of most stems <19 cm in diameter.

Forages were sampled from 1 October to 7 November 1982 and from 1 February to 10 March 1983 at randomly selected points in each of the 6 habitat types. Green leaves <0.5 m above the ground were collected from a 1-m^2 quadrat at each sampling point. Leaves from the following species were excluded from biomass data because they are rarely eaten by grouse: *Pinus* spp., galax, pyrola (*Pyrola* spp.), partridge-berry (*Mitchella repens*), dewberry (*Rubus* spp.), flowering dogwood, and all oaks, grasses and sedges (Nelson et al. 1938, Smith 1977, Stafford and Dimmick 1979, Servello and Kirkpatrick 1987). A 16 m^2 quadrat, centered on each sampling point, was searched for acorns and soft mast on the ground. Soft mast fruits above the ground were counted by species in the same quadrat, and a representative sample was collected to determine average dry mass of fruits by species. Total dry mass of soft mast was calculated by multiplying counts by average dry mass. Availability of tree buds and twigs was not measured because these foods are not common in the diet of grouse in the Southeast (Stafford and Dimmick 1979, Servello and Kirkpatrick 1987), and because tree species fed upon by grouse such as aspen (*Populus* spp.), cherry (*Prunus* spp.), and birch (*Betula* spp.) were rare or nonexistent in the study area. Similar numbers of plots were measured in each stand each week during the sampling period to minimize temporal biases. Stands were sampled until the variance of the total mass of fresh forage per plot stabilized.

Plant samples were freeze-dried and weighed by forage class and by species for common forages. Forage classes were leaves of evergreen woody plants, leaves of deciduous woody plants, leaves of nonwoody herbaceous plants, ferns, hard mast, and soft mast.

Nine permanent and parallel east-west transects which crossed the entire study area were established at 150-m intervals to estimate relative use of stands by grouse. The total length of transect within each stand is shown in Table 1. All transects were walked once per week during each sampling period (7 times in the fall and 5 times in the winter) when winds were light to none and there was no precipitation. Either odd- or even-numbered transects (randomly selected) were walked in random order the first sampling day of the week and the remaining set the second sampling day of the week. Half the transects walked each day were walked in the morning (randomly selected), starting 1 hour after sunrise, and the other half were walked in the afternoon, finishing 1 hour before sunset. An index of relative stand use was calculated as the number of grouse flushed per km of transect.

We calculated forage based carrying capacities using the biomass of herbaceous, deciduous, and evergreen leaves in the study area, estimates of the metabolizable energy (ME) in these forages, and ruffed grouse energy requirements. Captive grouse housed outdoors in sheltered cages and fed commercial diets consume 0.655 kcal of ME per gram of metabolic bodyweight ($g^{0.75}$) per day in the fall and winter (Servello 1985). With a winter body mass in Virginia of 630 g (Norman and Kirkpatrick 1984), a typical captive grouse would require 82 kcal ME/day. We used

Table 1. Number of ruffed grouse flushed per km of transect walked[a] from forest stands in southwestern Virginia during 1 October to 7 November 1982 (fall) and 1 February to 10 March 1983 (winter).

Stand	Transect length (km)	Flushes/km	
		Fall	Winter
4-year-old clearcut	1.33	0.97	0.0
16- to 18-year-old clearcut-upland	2.81	0.51	0.14
18-year-old clearcut-bottom	0.49	0.88	0.41
Sawtimber-general	9.90	0.06	0.02
Sawtimber-white pine	0.75	0.57	1.33
Sawtimber-thinned	0.63	0.0	0.0

[a]Transects walked 7 and 5 times in the fall and winter, respectively.

ME values of 2.78 kcal/g for deciduous and herbaceous leaves (Servello and Kirkpatrick 1987) and 2.04 kcal/g (Servello 1985) for evergreen leaves.

A Wilcoxon ranked sum (Hollander and Wolfe 1973) was used to test for differences between clearcut and sawtimber stands in the number of grouse flushed per km of transect. An alpha level of 0.05 was used in all tests.

Results

During the fall, 29 grouse were flushed on 113 km of transects (Table 1). Flushing rates were greater in clearcut stands than sawtimber stands ($W = 15$, $P = 0.05$). No grouse were flushed in the sawtimber-thinned stand. Of 24 flushes observed in the fall while sampling forage, all were in the clearcut stands.

Only 9 flushes were recorded in the winter for 79.5 km of transects (Table 1). Three flushes occurred from clearcut stands and 6 from sawtimber stands although the number of flushes per km of transect was not significantly different ($W = 10.5$, $P > 0.50$). Five of these flushes were from the sawtimber-white pine stand. Nine flushes were recorded during plot sampling in winter, 3 from clearcuts and 6 from sawtimber stands, 4 of which were from the sawtimber-white pine stand.

Woody evergreen leaves were more abundant than herbaceous leaves for both seasons in all stands, except for the fall clearcut-bottom (Table 2). During the fall, herbaceous leaf biomass was relatively abundant in most stands, but decreased during winter to no more than 1.5 kg/ha (Table 2). Hard and soft mast and ferns were rarely found in greater than trace amounts (<0.1 kg/ha) in any stand (Table 2). The acorn crop was below average on the study site during 1982 (Dutton 1987). The area scored a 7 on the Virginia Department of Game and Inland Fisheries' oak mast survey in 1982, while the average for the area from 1973 to 1986 was 15.0 (range = 1–44). Greenbrier was the only deciduous leaf and its biomass was 0.1 to 1.2 kg/ha in the fall and was no greater than trace amounts during the winter.

Table 2. Leaf biomass ($\bar{x}$ ± SE, kg/ha) of ruffed grouse foods[a] from forest stands in southwestern Virginia during fall (1 October to 7 November 1982) and late winter (1 February to 10 March 1983).

			Evergreen[b]		Deciduous[c]		Herbaceous	
Stand	Season	N	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
4-year-old	Fall	18	156.8	27.5	0.0		4.1	1.5
clearcut	Winter	18	48.7	8.5	0.0		0.5	0.2
16- to 18-year-old	Fall	33	70.2	9.7	1.2	0.6	2.4	0.6
clearcut-upland	Winter	36	26.2	3.7	t[d]		0.2	0.1
18-year-old	Fall	18	2.2	1.7	0.1	0.1	5.9	3.6
clearcut-bottom	Winter	18	2.7	1.6	0.0		0.5	0.2
Sawtimber-general	Fall	64	52.5	5.2	1.0	0.3	0.3	0.1
	Winter	63	28.2	5.6	t		t	
Sawtimber-white	Fall	15	21.1	5.3	0.1	0.1	2.6	0.8
pine	Winter	15	13.2	5.4	t		1.5	0.7
Sawtimber-thinned	Fall	14	92.5	17.0	0.4	0.2	5.2	1.6
	Winter	15	50.7	9.5	t		1.1	0.5

[a]Ferns and hard and soft mast were only found in trace amounts (<0.1 kg/ha) in all stands and seasons, except for clearcut-bottom which had 3.2 ± 2.5 kg/ha soft mast and sawtimber-thinned which had 0.3 ± 0.3 kg/ha soft mast, both in the fall.

[b]Wintergreen, trailing arbutus, and mountain laurel.

[c]Greenbrier

[d]t = trace (<0.1 kg/ha)

Discussion

Flush count data suggested that ruffed grouse densities on the study site were relatively low (0.26 and 0.11 flushes/km in the fall and winter, respectively). Low grouse densities in Idaho yielded 0.34 flushes/km (D. F. Stauffer, unpubl. data). Ruffed grouse populations in Alberta, increasing from a cyclic low 2 to 3 years previously, had flush rates of 0.35 and 0.22 flushes/km in the fall and winter, respectively (Rusch and Keith 1971). Flush count data indicated that ruffed grouse in our study area used clearcuts preferentially in the fall. The biomass of herbaceous leaves was generally greater in these stands (Table 2) which may have influenced the habitat selection. Although our sample size was small, it appeared that grouse were not using clearcuts as frequently during the winter.

Fall forages appeared adequate to support moderate grouse populations (Table 3). In contrast, high quality forage, specifically mast and herbaceous leaves, were scarce during the winter and only evergreen leaves remained abundant. Thus, ruffed grouse apparently must consume evergreen leaves during late winter, although it is unlikely grouse can subsist on them alone. Captive grouse died when fed only mountain laurel leaves (Bump et al. 1947) and were unable to maintain body mass on a diet of 50% dried mountain laurel leaves and 50% commercial feed (Servello 1985). However, captive grouse maintained body mass when fed 30% dried mountain laurel leaves and 70% commercial feed (F. A. Servello, unpubl. data). In most ruffed grouse food habits studies from the Southeast, woody evergreen forages have been <30% of the diet (Nelson et al. 1938, Smith 1977, Stafford and Dimmick 1979,

Table 3. Forage-based carrying capacity (grouse/10 ha/60 days) estimates for ruffed grouse during the fall and winter in southwestern Virginia forest stands. Using data from Table 2, 3 diets were considered: (1) no evergreen leaves were included in the diet, (2) the diet contained no more than 30% evergreen leaves, and (3) all forage available to grouse was consumed.

Stand	Herbaceous and deciduous leaves		70% Herbaceous and deciduous; 30% evergreen		All forage	
	Fall	Winter	Fall	Winter	Fall	Winter
4-year-old clearcut	22.9	2.8	30.1	3.7	665.2	202.3
16- to 18-year-old clearcut-upland	20.1	1.4	26.4	1.8	307.7	108.7
18-year-old clearcut-bottom	33.5	2.8	42.5	3.7	42.5	13.9
Sawtimber-general	7.3	0.6	9.5	0.7	222.3	116.1
Sawtimber-white pine	15.1	8.7	19.8	11.4	101.5	62.7
Sawtimber-thinned	31.3	6.4	41.1	8.4	410.2	214.1

Seehorn et al. 1981, Servello and Kirkpatrick 1987). Harlow and Guthrie (1972) and Servello and Kirkpatrick (1987) found circumstances when woody evergreen plants were >30% of the diet. Because the amount of evergreen leaves that can be consumed appears limited, the nutritional quality of the winter habitat is likely determined by the biomass of herbaceous leaves and mast.

The ME content of herbaceous and deciduous leaf forage in the clearcuts could support 1.4 to 2.8 grouse/10 ha for a 60-day period from 15 January to 15 March (Table 3). Herbaceous and deciduous material in the sawtimber-white pine and sawtimber-thinned stands could support 8.7 and 6.4 grouse/10 ha, respectively, during the same period (Table 3). No grouse could be supported in the sawtimber-general stand if limited to consuming only deciduous and herbaceous leaves. These forage-based carrying capacities are likely overestimates for several reasons: (1) the energetic cost of daily activity for wild grouse is likely greater than that of captive grouse, (2) the 2.78 kcal/g value for herbaceous leaves is likely an overestimate of the average ME of the available herbaceous forage because this value is from crop contents and grouse likely select forages higher in ME than the average, (3) some of the sampled herbaceous plants may not be eaten by grouse, (4) the herbaceous leaves in these stands are widely dispersed and may be unobtainable because of foraging efficiency limitations, and (5) portions of the forage may be consumed by other herbivores, e.g., white-tailed deer (*Odocoileus virginianus*). Therefore, we believe that in winter these habitats support only small numbers of grouse when the diet is limited to deciduous and herbaceous leaves. If 30% of the diet is evergreen leaves, clearcut areas may support 1.8 to 3.7 grouse/10 ha and the sawtimber stands 0.7 to 11.4 grouse/10 ha during the 15 January to 15 March period (Table 3). Diet quality will decrease when evergreen plants are consumed due to their lower ME and protein and greater tannin content.

Carrying capacities calculated when all potential grouse forage is included greatly increases forage-based carrying capacity estimates (Table 3) and suggests that grouse would not be food limited. However, it is increasingly apparent that all potential forages are not available to herbivores and that carrying capacities based on total forage are unrealistic (Hobbs and Swift 1985). Plant toxins appear to limit the amount of evergreen forage that may be consumed by grouse on our study area. Thus, despite an abundance of plant species that grouse are known to eat, food seems to be limited.

Widely dispersed high quality forages may increase the daily foraging time of ruffed grouse in the Southeast, resulting in greater energy expenditure and exposure to predation (Thompson and Fritzell 1989). Grouse in the Southeast also must compete with other herbivores, such as white-tailed deer and wild turkeys (*Meleagris gallopavo*), for the limited high quality forage available in the winter. Ruffed grouse in northern portions of the range may experience less competition for the arboreal buds that are a major component of their winter diet.

The biomass of forage available to ruffed grouse in northern portions of the range has never been fully documented. Huempfner and Tester (1988) estimated the amount of male flower and vegetative buds and twigs consumed by ruffed grouse from aspen trees during the winter in Minnesota. The estimates vary with snow conditions and averaged 0.284 kg dry matter/tree in a year with deep soft snow and 0.082 kg/tree in a winter with shallow crusted snow. Stem densities of aspen trees fed upon by ruffed grouse were not reported, so the forage consumed per ha cannot be calculated. Comparisons of food resources in Minnesota with those from our study area are further complicated by the significant differences in ME and protein of the various forages (Servello and Kirkpatrick 1987).

Ruffed grouse in this study area must include evergreen leaves in their late winter diets because of the low biomass of high quality forages. This may not be the case in years of exceptional mast production. Diet quality (ME and protein) and the ability of habitats in the study area to support ruffed grouse appear to be related to the availability of high quality herbaceous and mast forages. Calculated forage based carrying capacities are in general agreement with the low densities of grouse on the area as indicated by low flushing rates.

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