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Ground nest predation and Ruffed Grouse densities in southwest Virginia.—Densities of Ruffed Grouse (*Bonasa umbellus*) are lower in the southern Appalachians than in northern portions of the species' range (Bump et al. 1947). Bergerud (1988) proposed that this resulted from greater southern nest predation. Furthermore, he contended that nest predation is density-dependent in that the proportion of nests destroyed by predators increases as density of nests increases. Because nest predation is believed to be greater southward and density-dependent, hens in the South should space their nests farther apart than hens in the North to achieve nesting success sufficient to maintain a stable population. To test this hypothesis, we measured predation rates on artificial ground nests in southwest Virginia and tested whether this predation was density-dependent.

Study areas and methods.—Three study sites within the ridge and valley province of the Appalachian hardwood subregion (Smith and Linnartz 1980) were selected in the Jefferson National Forest in Montgomery and Craig counties, Virginia. All sites were characterized by oak (*Quercus* spp.)-hickory (*Carya* spp.) forests, with pine (*Pinus* spp.), red maple (*Acer rubrum*), and yellow poplar (*Liriodendron tulipifera*) common in the overstory. Mountain laurel (*Kalmia latifolia*), vaccinium (*Vaccinium* spp.), flowering dogwood (*Cornus florida*), rhododendron (*Rhododendron* spp.), and saplings of overstory species were common in the understory. All three sites contained small (<5 ha) clear-cuts less than 25 years of age, with heavy regeneration of overstory species. Ruffed Grouse were observed and heard drumming on or near all three sites.

Two areas were delineated at each of the three study sites and were assigned high and low nest densities. High density areas were 500 × 500 m and low density areas were 500 × 2000 m. High and low density areas were separated by at least 1 km and were >100 m from any road open to vehicular use. Sites for nest placement were located using two random numbers, one was the number of meters along a transect that bisected the area (ranging from 1 to 500 for high density areas and 1 to 2000 for low density areas) and the other was

the number of meters perpendicular to this baseline transect (ranging from 1 to 250 for both areas). The direction perpendicular to the baseline transect was randomly determined. To aid in relocating artificial nests, colored flagging was placed in trees at approximately 50 m intervals along the baseline transect and on the perpendicular lines leading to the nests. Flagging was placed 8–15 m from the nest and explicit directions from the flagging to the nest site were recorded. Twenty artificial nests were placed in each of the six areas, resulting in nest densities of 0.8 and 0.2 nests/ha for the high and low density areas, respectively. Although these nest densities are probably higher than those of Ruffed Grouse in the South, they are lower than those used in other artificial nest studies. Lower densities were not chosen because areas containing an adequate number of nests at a lower density would have been prohibitively large.

Nests consisted of five fresh brown domestic fowl (*Gallus domesticus*) eggs placed in small depressions in leaf litter at the base of trees, stumps, or logs to simulate a Ruffed Grouse nest (Bump et al. 1947). We wore rubber boots when placing and checking nests and handled eggs with plastic or rubber gloves to minimize human odors. Nests were made using a 2.4 m pole with a shallow dish at the end so that we remained >2 m from the nest. Artificial nests were established in mid-April to coincide with laying and incubating schedules of grouse in the area (Servello and Kirkpatrick 1988). Nests were placed at the John's Creek study site on 13–14 April 1992, at Poverty Creek on 15–17 April, and at Craig Creek on 21–22 April. A random drawing determined which density of nests at a given site was established first. All nests were checked 10 and 20 days after placement, and any disturbance was noted. A 20-day exposure period was chosen to avoid egg spoilage (which has been reported with longer exposure periods [Matschke 1965, Henry 1969]) and to approximate the 17 day laying or 23 day incubation (Bump et al. 1947) periods of Ruffed Grouse. A nest was considered depredated if one or more eggs were broken or missing. Predation was classified as avian or mammalian following Rearden (1951). Nests were classified as disturbed if they had been depredated or if one or more eggs, although intact, were found displaced from the nest. At the end of the 20-day exposure period, all eggs were broken and inspected for spoilage.

Paired *t*-tests were used to compare percent of nests depredated or disturbed between high and low density areas, pairing on sites. The test was one sided because density-dependent nest predation capable of controlling the population would be supported only if predation rates on the high density area were greater.

Results.—Predation rates for all six areas combined averaged $19.2\% \pm 4.2$ ($\bar{x} \pm SE$) after 20 days of exposure with no difference ($t = 1.00$, $P = 0.211$) in number of nests depredated between high and low density areas (Table 1). Percentage of nests classified as disturbed averaged $25.8\% \pm 7.0$ and was not different between high and low density areas ($t = 0.96$, $P = 0.219$) (Table 1). The difference in number of nests classified as depredated and disturbed was due to nests in which one or more eggs had been displaced from the nest but were found intact near the nest. The nine nests in this category had an average of 3.0 ± 0.43 eggs displaced an average of 28.8 ± 3.15 cm. The class of predator was not evident for 39% of depredated nests, and the remainder (61%) was attributed to mammals.

Discussion.—Ground nest predation rates in this study were lower than those from comparable studies (e.g., 30% after 21 days of exposure [Matschke 1965], 56% after 43 days of exposure [Henry 1969], and 25 to 83% after 5–6 days of exposure [Yahner and Morrell 1991]). The present study offers weak evidence against density-dependent ground nest predation in southwest Virginia. The power (Cohen 1988) of the statistical tests used in this study was <30%. This was due in part to the small magnitude (5–10%) of mean difference in predation and disturbance rates between high and low density areas. The biological significance of this difference is questionable, supporting the conclusion that density-dependent nest predation has not been demonstrated.

TABLE 1
ARTIFICIAL NESTS DEPREDATED AND DISTURBED AFTER 20 DAYS OF EXPOSURE AT TWO
NEST DENSITIES ON THREE STUDY SITES DURING APRIL–MAY 1992 IN SOUTHWEST
VIRGINIA^a

Area	Depredated				Disturbed			
	High		Low		High		Low	
	Percent	N	Percent	N	Percent	N	Percent	N
John's Creek	15	3	20	4	15	3	20	4
Poverty Creek	15	3	5	1	20	4	15	3
Craig Creek	35	7	25	5	60	12	30	6
Total	22	13	17	10	32	19	22	13

^a Twenty nests were placed at each density on each area.

The only solid evidence for greater Ruffed Grouse nest predation in the southern Appalachians is a study in which eggs in only three of 12 Ruffed Grouse nests hatched in Kentucky (Hardy 1950 cited in Bergerud 1988). The low nest predation rates of this study and the failure to demonstrate density-dependent nest predation suggest low predation pressure in early to mid-successional stage forest habitat. Ruffed Grouse nest predation rates in the Southwest need to be quantified to understand further the role of nest predation in the disparate densities of Ruffed Grouse across the species' range.

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Potential predatory attack by Common Ravens on porcupines.—Reports of Common Ravens (*Corvus corax*) attacking mammals are scarce. Several authors have documented corvids attacking (mainly immature) mammals and birds (Ostbye 1969, Rowley, 1970, Maser 1975, Mallory 1977, Long and Killingley 1983, Lawrence 1986, Kilham 1989). I report here an incidence of aggressive behavior exhibited by a group of ravens toward an adult porcupine and its young. I am unaware of any previous mention of such an event in the literature.

At 19:00 h CST on 21 June 1992, I observed four ravens attacking an adult and a young porcupine (*Erethizon dorsatum*). Two ravens consistently provoked the adult porcupine through vocalization and tail-pulling. In response, the adult porcupine displayed the typical defense mechanism of flaring its quills and turning its rump toward the ravens (Nowak 1991); however, it also charged at the ravens. As one raven stood in front of the adult porcupine, another pulled the porcupine's tail from behind. The adult porcupine often turned toward the "tail-pulling" raven and charged, thereby exposing its rump and tail to another raven. Several times the ravens appeared to prevent the adult porcupine from entering a hazelnut (*Corylus americana*) thicket. The ravens also prevented the porcupine from climbing a nearby jack pine (*Pinus banksiana*) by pulling its tail. I also observed two additional ravens vocalizing loudly, hopping, and flapping their wings in nearby shrubs. After approximately 15 min, the ravens became aware of my presence and flew away. As I approached the scene, the adult porcupine climbed approximately 3 m up a jack pine tree. I could not see any wounds on its tail or body. I noticed a young porcupine huddled in a hazelnut clump 5 m from the adult. Upon closer examination of the young, I noticed that quills were missing from a circular patch approximately 9 cm in diameter on the lower third of its back. The last 3 cm of its tail was also missing quills and had two cuts, approximately 1 cm wide. The end of the tail was void of fur and skin so that muscle tissue and vertebrae were visible. The young porcupine appeared to be in shock, as it was immobile and shaking. Due to lack of quill development, time of year, and body size (total length was 23–25 cm), I estimate that the young porcupine was 2–4 weeks old (Shadle 1948).

I believe that had I not interrupted this event, the ravens would have killed at least the young porcupine. I base this judgment on the physical condition of the young porcupine after the attack and its apparent inability to defend itself.

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