Use of Spring Drumming Counts to Index Ruffed Grouse Populations in the Southern Appalachians

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Abstract: We studied ruffed grouse (*Bonasa umbellus*) drumming behavior in the southern Appalachian Mountains of North Carolina. We conducted drumming counts from late March through mid-April 2002–2004. Concurrent with drumming counts, radio-tagged males (N = 30) were monitored to determine proportion of males drumming. Drumming activity increased from late March (20% of males drumming) to a peak in mid-April (56%–69% of males drumming). Consistent drumming coincided with mean nest initiation date by females (12 April, N = 44). Drumming count results were related to fall trapping success on the study area. Drumming counts appear to be an effective tool to monitor grouse population trends in the southern Appalachians. In our area, we recommend planning drumming counts during the peak drumming period of 9–16 April.

Key words: Appalachians, *Bonasa umbellus*, drumming, North Carolina, population index, ruffed grouse.

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In the southeastern United States, ruffed grouse are distributed across 190,000 km^2 of forest in the Appalachian Mountains of Alabama, Georgia, Kentucky, Maryland, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia (Cole and Dimmick 1991). Ruffed grouse are associated with a mosaic of early, mid, and late successional habitats. During the past decade, forest maturation and reduced forest management have resulted in contiguous areas lacking early successional components, causing population declines (Dessecker 2001).

Because of their close association with early seral stages, ruffed grouse (hereafter, grouse) are a Management Indicator Species (MIS) on many National Forests. The National Forest Land and Resource Management Plan requires that MIS be monitored to index population responses to habitat management (USDA Forest Service 1982). State wildlife agencies often work in cooperation with the Forest Service on such monitoring efforts. Further, as grouse have gained popularity among hunters following a regional decline in northern bobwhite (*Colinus virginianus*), state agencies are interested in monitoring grouse population trends to assist in setting seasons and bag limits (Cole and Dimmick 1991).

Drumming behavior of male grouse provides a basis for estimating their numbers. From telephone surveys with state agency personnel in the southern portion of grouse range, we determined spring drumming counts were used to varying extents in Georgia, Kentucky, North Carolina, Ohio, Virginia, and West Virginia and a proposal for their use has been drafted in Tennessee. Drumming count methodology has been well described (Petraborg et al. 1953, Dorney et al. 1958, Gullion 1966). In short, number of grouse heard drumming along survey routes is recorded and reported as density per unit area sampled. Frequently, results are extrapolated to a population estimate with assumptions made regarding sex ratio, sampling area, and proportion of males drumming over time. Although these assumptions have been studied in the Great Lakes States (Gullion 1981, Rodgers 1981), to our knowledge none have explored chronology of spring drumming and efficacy of drumming counts to index grouse populations in the Southeast. Our objectives were to: (1) estimate drumming intensity from late March through April, (2) determine period of peak drumming activity, and (3) examine efficacy of drumming counts as a population index in the southern Appalachians.

Study Area

We conducted our research on Wine Spring Creek Ecosystem Management Area (WSC) within the Nantahala National Forest in Macon County, North Carolina. The area was within the Blue Ridge Physiographic Province and was part of the southern Nantahala Mountain Range. Elevation ranged from 915 to 1644 m. Terrain was typical of the southern Blue Ridge with broad ridges, steep valleys, and long connecting slopes (McNab and Browning 1993). Mean annual temperature was 10.4 C, and mean annual precipitation was 192 cm. Mixed deciduous hardwood, primarily oak (*Quercus* spp.) with some northern hardwoods on north and east aspects above 1219 m elevation dominated (>99%) the area. Rhododendron (*Rhododendron maximum*) was a primary midstory component along stream drainages while mountain laurel (*Kalmia* spp.) and huckleberry (*Gaylussacia* spp.) were present on drier upland sites. The U.S. Forest Service purchased the Wine Spring area in 1912. Since then, timber has been harvested on an 80- to 100-year rotation, making it representative of most Forest Service lands within the southern Appalachians. Approximately 9% of the area was in the 5–20 year age class.

Methods

We captured grouse using intercept traps (Liscinsky and Bailey 1955) during August–November and March–April 1999–2003. We fitted captured grouse (*N* = 276) with 12 g necklace-style radiotransmitters (Advanced Telemetry Systems, Isanti, Minnesota) and released them at capture sites.

We conducted spring drumming counts 24 March to 30 April 2001–2004. Observers walked designated routes (i.e., gated forest roads) on two consecutive mornings beginning 30 minutes before sunrise and ending three hours after sunrise. The starting point on the second morning was the endpoint from the first morning. Routes were selected across the area such that approximately 20% of the study area was sampled. We cancelled drumming counts when winds were >13 km/h because of reduced ability of observers to hear drumming. Observers listened for drumming while walking continuously at a steady pace. When a drumming male was heard, distance to drummer, time, and an azimuth to the bird were recorded. We plotted an approximate location for each drumming grouse on a GIS. Drumming male locations were buffered by 150 m because grouse may use alternate drumming sites (Lovallo et al. 2000). If two locations from consecutive days fell within the same 150 m buffer, they were considered the same bird.

Population estimates (grouse/100 ha) were calculated by doubling number of drumming males heard to account for females under the assumption of a 1:1 sex ratio. For these density estimates, it was necessary to determine effective sampling area for our study. We achieved this by estimating radius of audibility (the maximum distance at which drumming grouse could be heard; Petraborg et al. 1953). Audibility trials ($N = 10$) were conducted opportunistically during routine fieldwork. When a drumming grouse was located, one observer remained close to the drumming site and raised a flag when drumming occurred. A second observer moved away from the drumming site in 25 m increments until drumming could no longer be heard. Consistent with Petraborg et al. (1953), we determined 200 m as the maximum distance; therefore, 400 m buffers defined sampling area around each route (i.e., 200 m on each side). Differences in ability to hear may have created variability in effective sampling area among observers; however, we believe the difference was negligible.

In 2001, one drumming count was conducted during the week of 9–16 April (Period 3). During 2002–2004, we conducted counts during each of the weekly periods, 24–31 March (Period 1), 1–8 April (Period 2), and 9–16 April (Period 3). In 2004, we conducted additional counts 17–24 April (Period 4), and 25 April–2 May (Period 5). We calculated population estimates for each period to identify temporal changes in drumming. This allowed us to compare estimates among periods within the same year. Because grouse populations should not fluctuate greatly (especially increase) over four weeks in April, it was assumed variation within the same spring was a result of changes in drumming behavior.

Drumming intensity is percentage of radiotagged males heard drumming during a specific morning (Gullion 1966). To determine drumming intensity, we located radiotagged males and approached them within 50 m using care not to disturb the bird. After an initial quiet-down period of one minute, we recorded occurrence or non-occurrence of drumming during a five-minute interval. We used a distance of 50 m because it was well within the audible range of drumming, but not so close as to disturb the bird. Observations were concurrent with drumming count periods in 2002 and 2003, allowing us to examine within year changes in drumming intensity.

Porath and Vohs (1972) suggested peak of drumming in northeast Iowa corre-

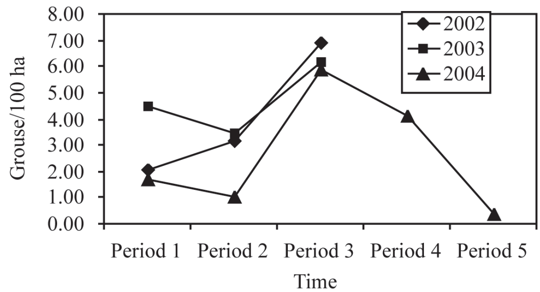

Figure 1. Ruffed grouse population estimates extrapolated from drumming counts conducted 24–31 March (Period 1), 1–8 April (Period 2), 9–16 April (Period 3), 17–24 April (Period 4), and 25 April–2 May (Period 5), 2002–2004, on Wine Spring Creek Ecosystem Management Area, Macon County, North Carolina.

sponded with copulation. To explore this relationship, we used telemetry data to estimate mean nest (N = 44) initiation date. Copulation occurs 3–7 days prior to laying of the first egg (Bump et al. 1947); therefore, we estimated copulation date by subtracting this range from mean nest initiation date. Estimated copulation range was then compared graphically to drumming chronology.

We compared across year population trends from Period 3 drumming counts to several data sources, including grouse hunter surveys, ancillary observations, and trapping success the following fall. North Carolina Wildlife Resources Commission collects grouse hunter surveys annually. To identify population trends from these data, we calculated number of grouse flushed per hunter hour on public lands within the southern mountain region of North Carolina during the 2001–2004 hunting seasons. The 16-county southern mountain region included our study area. Ancillary observations were recorded by research technicians on WSC. During routine radiotracking, technicians recorded kilometers driven and grouse observed along roads. We compared grouse seen per 100 km during the period, 15 March–30 April to drumming counts. We also compared fall trapping success on WSC, measured by grouse captured/100 trap-days, to drumming count data. We calculated Pearson correlation coefficients between drumming count population estimates and other indices using SAS (SAS 1999).

Results

Within each year, more drumming males were heard on counts during Period 3 than in Periods 1 and 2. In 2004, number of drumming males heard decreased through Periods 4 and 5, suggesting peak drumming activity in Period 3 (Fig. 1). Population estimates from Period 3 were 243%, 38%, and 242% greater than those from Period 1 in 2002, 2003, and 2004, respectively.

Drumming intensity generally increased from Period 1 through Period 3. In 2002, proportion of radiotagged males drumming was 20% in Period 1 (N = 15), 67% in Period 2 (N = 13), and 69% in Period 3 (N = 9). In 2003, proportion of radiotagged males drumming was 20% (N = 10), 18% (N = 11), and 56% (N = 9) in Periods 1, 2, and 3, respectively. Similar to drumming count data, drumming intensity was greatest during Period 3.

Table 1. Ruffed grouse population indices from drumming counts (grouse/100 ha), trapping success (grouse/100 trap-days), ancillary observations (grouse/100 km), and hunter surveys (flushes/hour), 2001–2004 on Wine Spring Creek Ecosystem Management Area, Macon County, North Carolina.

	Year			
Index	2001	2002	2003	2004
Drumming counts	11.40	6.93	6.20	5.88
Trapping success	0.73	0.49	0.20	NA
Ancillary observations	4.64	3.69	6.15	2.90
Hunter surveys	0.56	0.56	0.54	0.55

Estimated copulation was 5–9 April, just prior to annual peaks in drumming. Greatest drumming activity coincided more closely with nest initiation ($\bar{x}$ = 12 April, 10–14 April 95% CI) than copulation dates across years.

Fall trapping success and drumming counts suggested decreasing population trends from 2001–2003 (Table 1). Although Pearson's correlation coefficient between these methods was 0.867, the correlation was not significant (P = 0.332). Lack of significance was likely a function of small sample size (N = 3 years). Hunter flush rates were consistent across years, and did not indicate population change. Ancillary observations suggested overall decline from 2001–2004, with an apparent population increase in 2003. Drumming counts were not correlated with hunter flush rates (R = 0.351, P = 0.649) or ancillary observations (R = 0.225, P = 0.775).

Discussion and Management Implications

Of the four methods we examined, all but hunter flush rates indicated population decline. There may be several reasons hunter surveys did not indicate population change. First, surveys were conducted across 16 counties, and decreasing population trends may not have been as pronounced regionally as they were on our study area. However, conversations with hunters and U.S. Forest Service personnel suggested grouse numbers were decreasing across North Carolina's southern mountain region. Second, hunter surveys may be insensitive to population changes as hunters continually return to areas where they experience success, rather than "sampling" new or unproductive coverts. Perceived population changes from hunter surveys may reflect shifting hunter patterns as old coverts mature and new ones are discovered.

Ancillary observations suggested a decline in grouse numbers between 2001 and 2004 despite a population spike in 2003 that was not apparent in drumming counts or trapping success (Table 1). Ancillary observations can be sensitive to changes in observer travel patterns. While radiotracking a female grouse in 2003, we made frequent trips through an area where grouse were often observed along a forest road. These daily travels may have positively biased 2003 ancillary data. Ammann and Ryel (1963) reported grouse observations made by U.S. Postal Service employees were an effective population index because mail carriers traveled the same distances and routes over time. Such consistency in travel would seldom be achieved by wildlife agency personnel traveling during fieldwork.

Drumming counts have been used extensively to monitor population trends and responses to habitat management in the Appalachians and across ruffed grouse range (Kubisiak 1985, Wiggers et al. 1992, McCaffery et al. 1996, Dimmick et al. 1998, Storm et al. 2003). We believe drumming counts conducted in mid-April provide an effective means to monitor population trends in North Carolina. Due to variation in drumming activity, drumming surveys tend to underestimate number of birds on an area (Gullion 1966). The greatest proportion of males drumming on any morning during our study was 69%. Without a method to estimate proportion of males drumming concurrent with counts (i.e., radiotelemetry), it is not possible for managers to extrapolate accurate spring population estimates; therefore, drumming counts are best used as an index to population trends over time.

There are two main drumming count techniques; the walking method described for this study and others (Rodgers 1981, Dimmick et al. 1998), and roadside counts developed by Petraborg et al. (1953). Roadside counts involve driving a route and stopping at predefined listening points for 4–5 minutes before proceeding to the next point. Roadside counts are an effective method to determine population trends and allow coverage of a large area with relatively few observers (Petraborg et al. 1953, Stoll 1980). Walked routes are better suited to sampling smaller, specific areas of interest, such as wildlife management areas or research study sites. Utility of either technique to determine population trends depends on consistency of methods and timing of counts. Peaks of drumming activity occur at approximately the same time each spring (Gullion 1966); therefore, identifying peak periods and planning counts accordingly lends to consistency across years.

Earliest onset of spring drumming was recorded 9 March 2002. Ruffed grouse drumming activity on WSC peaked during the week of 9–16 April. Beyond the mid-April peak, drumming had nearly ceased by the first week in May. Studies in Minnesota and Wisconsin identified plateaus in drumming within seven days of 1 May (Dorney et al. 1958, Gullion 1966). In Ohio and Iowa, drumming peaked between 15 and 25 April (Donohoe 1965, Porath and Vohs 1972). Hale et al. (1982) reported drumming activity began in mid-March in northern Georgia. These data and ours support the contention of Bump et al. (1947) that onset and peak of drumming behavior occur earlier in southerly latitudes.

Because we conducted drumming counts once during each weekly period, within-period error could not be assessed; however, field observations provided insight into variability over time. During all years, drumming remained sporadic through the end of March and during that period, occurred only on clear days with no precipitation and little wind. By mid-April (Period 3), drumming became more consistent and males drummed despite overcast skies, precipitation and other inclement weather, including snow. Managers may not have flexibility to schedule drumming counts according to weather. Therefore, planning surveys during peak

Table 2. Nest initiation dates and associated 95% confidence intervals for ruffed grouse on Appalachian Cooperative Grouse Research Project study sites, 1997–2002. Data from Devers 2000.

State	County	Nest initiation	95% CI
Rhode Island	Washington	25 April	20–30 April
Pennsylvania	Clearfield	23 April	21–25 April
Ohio	Coshocton	10 April	4–15 April
Ohio	Athens	8 April	6–10 April
Maryland	Garrett	17 April	15–19 April
West Virginia	Randolph	16 April	13–19 April
West Virginia	Greenbrier	15 April	10–21 April
Kentucky	Lawrence	8 April	5–12 April
Virginia	Augusta	15 April	11–18 April
Virginia	Botetourt	14 April	11–16 April
Virginia	Smyth, Washington	17 April	15–19 April
North Carolina	Macon	12 April	10–14 April

drumming appears most advantageous. Nonetheless, high winds hinder hearing ability of observers to hear drumming, and counts should be suspended if winds exceed 13 km/h (Petraborg et al. 1953).

In our study, peak drumming coincided with nest initiation by females. Drumming behavior serves a dual purpose, to advertise territories and attract females (McBurney 1989). As females became preoccupied with nesting, males may have spent greater time on drumming logs attempting to attract mates. To estimate regional nest initiation dates, we backdated incubation chronology data compiled by Devers (2005) for the Appalachian Cooperative Grouse Research Project (Table 2). Regional nest initiation dates should provide insight to managers regarding peak drumming for their area of interest.

Prompted by population declines in the southern extent of ruffed grouse range, managers are developing strategic plans for grouse in the Appalachians. Monitoring population trends and response to habitat manipulation over time is an integral part of any strategy. With appropriate planning and consistency, spring drumming counts may provide an effective population index. Roadside counts and walked routes are equally viable techniques and choice of method depends on scale of area to be sampled (i.e., regional vs. management area). To reduce within and across year variability, we recommend planning surveys to coincide with peak drumming periods.

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