Experimental Relocation of Ruffed Grouse to the Georgia Piedmont

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Abstract: Forty-five ruffed grouse (*Bonasa umbellus*) were relocated in late summer 1984 from the Blue Ridge Mountains to the Piedmont of Georgia to assess the feasibility of establishing huntable populations. Nineteen radio-equipped birds survived 2 to 183 days ($\bar{x}$ = 82 days). Radio-monitored grouse preferred hardwood scrub habitats, sparse hardwood sawtimber, and bottomland hardwoods—all of which had high understory stem densities. Unradioed grouse were observed periodically from release until spring of 1985, but there was no evidence of reproduction. A grouse also was seen in the study area 2 years after the release (August 1986). Survival and moderate range sizes, dispersal, and daily movements indicated that the study area was capable of supporting grouse at least through early spring. However, heavy losses to predators occurred during late fall and winter. The number of grouse released may have been insufficient to sustain overwinter losses and reproduce successfully.

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Ruffed grouse reach the southern extent of their distribution in northern Georgia and northwestern South Carolina. From 1973 through 1984, however, grouse were reported from the Piedmont of Georgia—at least 90 and possibly 145 km south of ruffed grouse habitat in the Blue Ridge Mountains. Reports indicate a southerly expansion into areas not known to have supported grouse previously. Historical occurrence of ruffed grouse in the Piedmont is uncertain. The area was almost completely under cultivation by the mid-1800s (Vankat 1979), and there are few records of vegetation and wildlife before that time. Regrowth of forest following abandonment of croplands may have resulted in areas that are now suitable

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habitat. In addition, spread of thicket-forming exotic plants such as Japanese honeysuckle (*Lonicera japonica*), bush honeysuckle (*L. mackii*), privet (*Ligustrum sinense*), and autumn olive (*Elaeagnus umbellata*) added new sources of food and cover (Pursglove 1975, Hale et al. 1978, Wentworth 1986).

This study began in 1984 with the relocation of ruffed grouse from the mountains to the Piedmont. Objectives were to assess the feasibility of establishing ruffed grouse populations and to evaluate survival, movements, and habitat use.

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Methods

Trapping was conducted from 4 July through 13 September 1984 on the Chattahoochee National Forest in northeastern Georgia. Unbaited interception traps were used. We trapped birds from the southern portion of their range because origin of birds can be important in successfully establishing a population from relocated grouse (Hunyadi 1984, Woolf et al. 1984). The late summer trapping period was chosen to take advantage of simultaneous captures of hens and broods. Captured ruffed grouse were transported to the Piedmont release area within 16 hours (Wentworth 1986).

Release sites were located 8 km south of Athens, Clarke County, on Whitehall Forest, a 300-ha research and teaching area. The Forest is located at the confluence of the North and Middle Oconee rivers and bordered on 3 sides by forest lands that provided opportunities for dispersal by relocated grouse. The release area was chosen because of its protection from hunting and other human disturbances, its proximity to trapping areas, accessibility, presence of riparian habitats similar to those associated with most earlier Piedmont grouse reports, an abundance of privet, autumn olive, and honeysuckle, and presence of habitats structurally similar to those occupied in northern Georgia (Harris 1981, Hale et al. 1982). Ultimately, locations of radio-tagged grouse established boundaries of the study area.

Whitehall Forest and surrounding areas were representative of the Georgia Piedmont with gently rolling topography and forest lands interrupted by agricultural clearings. Riparian habitats associated with the Oconee River and its tributaries were composed of a bottomland hardwood overstory with understory thickets of privet and switchcane (*Arundinaria gigantea*). Upland habitats of pine, hardwood, and mixed pine-hardwood varied in species composition, age, size, and density. Much of the area was composed of oak (*Quercus* spp.)-hickory (*Carya* spp.) and oak-hickory-pine (*Pinus* spp.) sawtimber; however, early to mid-successional stages were present as a result of land abandonment, timber harvest, and fire. These areas and sparsely stocked mature forests contained dense mixtures of shrubs, saplings, and vines (Wentworth 1986). Thickets of autumn olive were common.

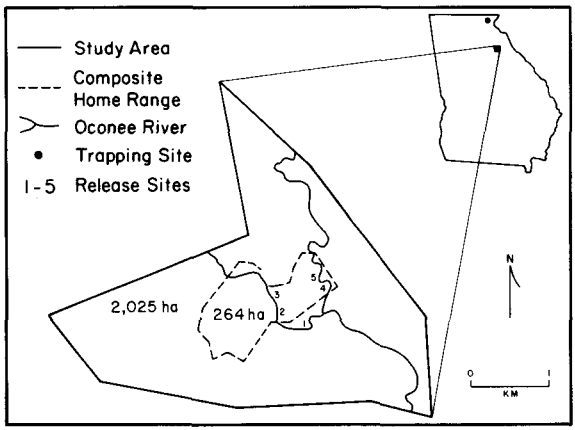

Figure 1. Study area boundaries as determined by outermost locations of 19 radio-equipped ruffed grouse relocated to the Georgia Piedmont, 1984–1985. The composite range for 13 grouse contains 96% of all telemetry locations.

Before being released, grouse were classified as adult or juvenile, and ages for juveniles were estimated by the pattern of feather replacement (Bump et al. 1947). Sex of adults was determined by the number of dots on rump feathers (Roussel and Ouellet 1975), and sex of juveniles was judged from age in relation to weight (Bump et al. 1947). Grouse were weighed and fitted with aluminum leg bands (adults) or wing tags (juveniles).

All 15 adults and 5 juveniles were fitted with 10-g battery-powered transmitter packages. Transmitters were attached to adults as back-pack mounts with elastic harnesses. Transmitters for 8- to 12-week-old juveniles were attached to vinyl-coated cloth as bibs (Amstrup 1980). One juvenile shed a bib transmitter and was not included in analysis. Grouse were released at midmorning or early afternoon at 1 of 5 sites on Whitehall Forest (Fig. 1). Birds captured as a group were released as a group. Radio-tagged birds released in a group quickly separated, and their subsequent telemetry locations were considered independent observations.

If possible, instrumented birds were located daily by triangulation, and locations were plotted on composite maps. Habitat types were delineated from aerial photographs and ground inspection. Contact was maintained with all radio-equipped grouse from release until death. Grouse located for 30 or more days are referred to as established and were included in analysis of change in daily location, range, and habitat use. All radio-tagged birds were considered in analysis of dispersal and survival. Survival was the number of days from release until recovery of carcass or transmitter.

Telemetric data were compared for sex and age groups—adult females, adult males, all adults, and all juveniles. The telemetric monitoring period of 10 July

1984 to 4 February 1985 was divided into seasons: summer—10 July to 17 September; fall—18 September to 26 November; winter—27 November to 4 February.

Mobility of relocated grouse was examined by determining ranges and change in daily location for each established bird, and maximum dispersal for all radio-tagged birds. Ranges were delineated by the minimum area method (Mohr 1947). Because of the short monitoring period, ranges are intended only as representations of the areas used most intensively by individual grouse. Change in daily location was the distance between locations on consecutive days. Maximum dispersal was the distance from the release site to the farthest location for each grouse. Survival and range sizes of juveniles vs. adults and adult females vs. adult males were compared with *t*-tests. One-way analysis of variance and Duncan's Multiple Range Tests were used to test differences in mean change in daily location and maximum dispersal among sex and age groups. Pearson correlation coefficients were used to determine the relationship between survival and mean change in daily location.

Habitat use was examined within circular regions containing the innermost 90% of locations for each established grouse. Area and number of locations in each habitat type were summed for adult females, adult males, juveniles, and all established grouse. Use and availability for each sex and age group were determined by the percentages of total locations and total area per habitat type. Chi-square tests were used to determine if there were differences between use and availability of habitats. A modification of the Bonferroni *z* statistic (Neu et al. 1974) was used to test if individual habitat types were used more or less than expected ($P < 0.05$) based on availability.

Results and Discussion

Forty-seven ruffed grouse were captured between 4 July and 13 September 1984 with an average trap success of 1 bird per 33 trap days. Injuries during trapping and handling were minimal. Forty-five grouse were released on Whitehall Forest—15 adults (10 females, 5 males) and 30 juveniles (20 females, 10 males). Juveniles were 6–13 weeks old.

Nineteen radio-tagged grouse supplied 1,153 locations for analysis. Total weight of transmitter packages was 2.0% of the mean adult weight and 2.6% of the mean weight of radio-equipped juveniles.

Survival of telemetered grouse ranged from 2 to 183 days and averaged 82 days (Table 1). Mean juvenile survival of 95 days was not different from mean adult survival of 78 days ($P > 0.05$). Survival also was not different for adult males (79 days) and females (77 days) ($P > 0.05$). Greatest mortality (47%) occurred between 12 October and 28 November 1984 and may have been related to reduction in cover after leaf fall. Change in daily location during this period was not greater than average, and survival was not correlated with mean change in daily location during the entire monitoring period ($r = -0.003$, $P > 0.05$). Although the last surviving telemetered grouse died on 4 February 1985, some of the 25 unradioed juveniles were seen until April 1985. One grouse was observed in the study area in August

Table 1. Survival, cause of death, range, and dispersal of radio-equipped ruffed grouse relocated to the Georgia Piedmont, 1984–1985.

Bird	Survival period	Survival (days)	Cause of death	Range size (ha)	Maximum dispersal (km)
Juveniles					
10 (8)[a]	27 Jul–31 Jul	4	Raptor		0.3
14 (9)	5 Aug–12 Dec	129	Mammal	61	5.3
22 (10)	24 Aug–4 Feb	163	Unknown	150	4.1
26 (12)	6 Sep–28 Nov	83	Unknown	44	1.6
Adult males					
4	24 Jul–23 Jan	183	Mammal	82	1.7
6	11 Aug–1 Nov	83	Raptor	115	1.8
8	14 Aug–30 Aug	16	Raptor		3.0
13	7 Sep–24 Nov	78	Unknown	11	1.0
15	7 Sep–12 Oct	35	Stress		5.3
Adult females					
1	10 Jul–12 Nov	125	Mammal	78	1.9
2	18 Jul–23 Oct	97	Mammal	93	1.8
3	23 Jul–22 Jan	183	Mammal	110	1.4
5	27 Jul–14 Oct	79	Mammal	40	2.0
7	12 Aug–15 Aug	4	Stress		0.9
9	22 Aug–27 Aug	5	Raptor		0.5
10	24 Aug–5 Nov	73	Unknown	43	0.9
11	26 Aug–28 Jan	154	Unknown	134	2.3
14	7 Sep–29 Oct	52	Human	8	2.1
16	9 Sep–11 Sep	2	Unknown		<0.1

[a]Age of juveniles in weeks.

1986 and was probably a result of the 1984 release. When possible, cause of death was determined based on evidence such as carcass location, tooth or beak marks on bones or transmitter, antenna damage, or presence of predators near the carcass. Mammalian and avian predators were suspected in most deaths (Table 1). Stress-related deaths included a hen that was emaciated when captured and released and an adult male that flew into a window after 35 days of erratic movements.

Observations, examination following recapture, survival, and stable movements of telemetered grouse indicated that the transmitter packages did not adversely affect the majority of the telemetered birds. Four radio-tagged birds that died or were killed by predators within 5 days after release, however, may have been influenced by capture, handling, and/or radio-tagging.

Outermost locations of the 19 telemetered birds encompassed 2,025 ha. Grouse activity was concentrated in a smaller central area delineated by the combined ranges of 13 established grouse. This composite range of 264 ha contained 96% of locations for all telemetered grouse (Fig. 1). Ranges varied from 8 to 150 ha with a mean of 74.5 ha(Table 1). Mean juvenile and adult ranges were 85.0 ha and 71.4 ha, respectively. Range sizes for adult females (72.3 ha) and males (69.0 ha) were similar ($P > 0.05$).

Range sizes in this study were similar to or smaller than those reported for other relocated grouse on the southern periphery of the range (White and Dimmick

1978, Jones 1979, Gudlin and Dimmick 1984, Woolf et al. 1984). Ranges in the Piedmont were similar to those of resident hens with broods in northern Georgia but were more than twice those of resident adult males and hens without broods (Harris 1981). Ranges for resident birds included the breeding season and are not directly comparable to those in this study.

Larger range size may be a result of poorer habitat quality (Harris 1981, Woolf 1985). Range size following relocation also may be an expression of exploratory behavior necessary to find suitable habitats. Comparisons of home ranges among studies and the significance of range size are confounded by number of locations, season monitored, regional variation, and method used to delineate range boundaries.

Telemetered grouse displayed no strong affinity for release sites and quickly dispersed. Only 3 of 13 established grouse included their release sites in their ranges. Mean maximum dispersal from release sites by radio-equipped grouse was 2.0 km and ranged from 0.04 to 5.3 km (Table 1). Mean dispersal of juveniles (2.8 km), adult males (2.6 km), and hens (1.4 km) was not different ($P > 0.05$).

Although dispersal by hens was similar to mean maximum dispersal by grouse relocated in western Tennessee (White and Dimmick 1978, Jones 1979, Gudlin and Dimmick 1984) and Illinois (Woolf et al. 1984), dispersal by juveniles and adult males was greater. Exaggerated dispersal by males in the Piedmont resulted from erratic movements shortly after release or during sallies from established ranges, whereas maximum dispersal by juveniles occurred during November and may have been an expression of typical fall behavior.

Based on the change in consecutive daily locations, mobility of relocated grouse was greater during summer than fall or winter ($P < 0.05$). Movement of adults was greater for males than females during summer ($P < 0.05$) but was similar for sexes during fall and winter. Mean juvenile daily movement (205 m/day) was greater ($P < 0.05$) than adult movement (175 m/day), and juveniles were particularly mobile during fall.

Juveniles and adults released in western Tennessee (White and Dimmick 1978, Jones 1979) were more mobile than those relocated in our study. In a relocation of ruffed grouse from Michigan to southern Iowa, juveniles were less mobile than adults, and hens were less mobile than adult males (Hanson 1985).

Habitat use by 13 established grouse differed from expected use based on availability ($X^2 = 196.6$, $P < 0.001$) (Table 2). Hardwood scrub habitat was used most frequently and consistently by grouse and was used more than expected ($P < 0.05$) by male and female adults and juveniles. This type accounted for 37%, 31%, and 58% of the locations for hens, adult males, and juveniles, respectively. Hardwood scrub habitat was the type used most often by hens and juveniles during each season. It was favored by adult males during summer and winter but was secondary to bottomland hardwoods during fall. At least 43% of locations in bottomlands were in privet thickets.

Other important habitat types that were used more than expected ($P < 0.05$) were sparsely stocked stands of hardwood sawtimber and pine sawtimber by hens

Table 2. Habitat availability and use by 13 radio-tagged ruffed grouse relocated to the Georgia Piedmont, 1984–1985.

Habitat type[a]	Percent available	Locations		95% CI[c]	Prefer[d]
		Exp[b]	Obs		
Hardwood scrub	17.4	174.7	388	342–433	+
Sp. hardwood sawtimber	4.6	46.2	112	83–142	+
D. pine sawtimber	11.8	118.5	84	58–110	−
D. hardwood sawtimber	11.8	118.5	83	57–109	−
Bottomland hardwood	3.6	36.1	67	44– 90	+
Sp. mixed sawtimber	12.8	128.5	55	34– 76	−
D. mixed sawtimber	14.0	140.6	54	33– 75	−
Sp. hardwood sawtimber and poletimber	2.9	29.1	40	22– 58	0
Sp. pine sawtimber	1.3	13.1	27	12– 42	0
D. hardwood saplings	2.4	24.1	23	18– 28	0
D. mixed poletimber	1.8	18.1	20	7– 33	0
Other hardwood	0.4	4.0	5	−1– 11	0
Other mixed	2.9	29.1	18	6– 30	0
Other pine	3.7	37.1	23	18– 28	−
Brush/open	8.5	85.3	5	−1– 11	−

[a]Sp = sparsely stocked, D = densely stocked; Mixed = pine-hardwood.
[b]Percent available × total observed telemetry locations (1,004).
[c]Confidence interval about observed telemetry locations (adapted from Neu et al. 1974).
[d]+ = used more than expected, − = used less than expected, 0 = used in proportion to availability.

and bottomland hardwood by adult males. Adults used pine-hardwood sawtimber less than expected ($P < 0.05$), and juveniles used pine sawtimber less than expected ($P < 0.05$).

In the Piedmont, grouse preferred habitats with high densities of small stems (Wentworth 1986), similar to those preferred in other areas by both native and relocated birds (White and Dimmick 1978, Jones 1979, Harris 1981, Hale et al. 1982, Backs 1984, Gudlin and Dimmick 1984, Hunyadi 1984, Woolf et al. 1984, Hanson 1985). These habitats such as dense hardwood saplings and evergreen shrubby thickets are produced by various management practices and natural phenomena. Hardwood scrub habitat and areas with comparable understory conditions apparently were the most suitable habitats encountered by relocated grouse. Saplings such as oaks, dogwood (*Cornus florida*), and red maple (*Acer rubrum*); shrubs such as deerberry (*Vaccinium stamineum*), hawthorn (*Crataegus* spp.), blackberry (*Rubus* spp.), and autumn olive; and vines such as greenbrier (*Smilax* spp.), honeysuckle, and muscadine (*Vitis rotundifolia*) were available as food and dense cover during all seasons monitored. Honeysuckle, greenbrier, and blackberry were important because they retained green foliage through most of the winter and, therefore, were available as food and cover when most shrub and sapling species were dormant. In bottomlands, privet, which is also semi-evergreen, was available as food and cover throughout the year.

Despite concentrated use of hardwood scrub and sparse hardwood sawtimber habitats, only 1 death occurred in these types. High stem densities of the woody understories of these habitats provided concealment and protective cover. Predation

frequently occurred following movement from these more secure habitats to those with sparse understories.

Conclusions

The study area in the Georgia Piedmont was capable of supporting grouse from summer through early spring. Thirteen of 19 telemetered grouse established ranges that were not unusually large compared to those of grouse relocated in other states, and they did not exhibit extreme dispersals or daily movements. Moderate mobility by established grouse may have indicated that the study area provided adequate food and cover. The number surviving was insufficient to establish a self-sustaining population. Telemetered grouse failed to survive through mid-winter, but several unradioed birds were observed in late winter and early spring. Either survival was very low or most juveniles had dispersed, and no evidence of breeding activity was obtained from searches for drumming males or attempts to locate hens and broods with a chick distress call (Healy et al. 1980).

Possible reasons for failure to establish a viable population include the number of grouse released, number and age of juveniles, unbalanced sex ratio, and inadequate extent of preferred habitats. Origin and condition of birds and release procedures were favorable. With high losses to predators, the release of 45 birds was insufficient to provide for successful reproduction. Unlike native grouse populations, this isolated population could not recover losses through immigration (Woolf et al. 1984).

Establishment of ruffed grouse in the Piedmont may be feasible; however, it would be expensive and labor-intensive. Suitable habitat is limited and future relocations should be preceded by a thorough inventory of release sites and consist of a larger number of birds per release site.

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