Sampling Forest Birds: Strip Transects Versus Time-area Circular Plots

R. Montague Whiting, Jr., *School of Forestry,*[1] *Stephen F. Austin State University, Nacogdoches, TX 75962*

Susan C. Baggett,[2] *School of Forestry, Stephen F. Austin State University, Nacogdoches, TX 75962*

Abstract: The strip transect and fixed-area circular plot methods of sampling birds were compared in 4 even-age pine-hardwood stands (seedling, sapling, pole and sawtimber tree-size classes) during winter and spring of 2 years. During spring the circular plot method resulted in more species and more individuals than the transect method. Most differences were significant ($P \leq 0.05$). Winter samples showed the same pattern, however most differences were not significant ($P > 0.05$). For selected species and species assemblages, fixed-area circular plots generally resulted in higher numbers during both seasons, except for high canopy inhabitants.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:358–367

Many methods are used to sample forest avifauna. Most studies translate bird abundance samples into estimates or indices of avian community parameters such as numbers of species and individuals and species diversity and equitability values. Some investigators have compared sampling methods to evaluate accuracy, time efficiency, and cost.

Amman and Baldwin (1960) compared fixed-area circular plots, fixed-width strips, and variable-width strips and found the variable-width strip to be the most accurate estimator of woodpecker numbers in spruce-fir forests. Jarvinen (1978) found point counts and transect counts were equally efficient, with point counts being more cost effective. Reynolds et al. (1980) supported the use of circular plots as more effective than transects. They found that stationary observers spent more time searching for birds than did slowly moving observers who needed to watch the path of travel; thus, stationary observers had a greater probability of observing birds in structurally complex vegetation. However, Anderson and Ohmart (1981) reported transect method detection rates as great or greater than variable-area circular plot

[1] In cooperation with the Wildlife Habitat and Silviculture Lab, Southern Forest Experiment Station, USDA Forest Service, Nacogdoches, TX 75962.

[2] Present address: USDA-Soil Conservation Service, P.O. Box 1037, Groveton, TX 75845.

rates. They found the transect method was time efficient, but the circular plot method was most effective where patches of different vegetation types were too small for transects.

In Louisiana bottomlands, Dickson (1978) recorded more bird species and individuals using spot-map counts than with transect counts. In East Texas, Conner et al. (1983) used strip transects and 2 intensities of spot mapping to compare to population estimates obtained using mist net capture-recapture data for 5 bird species in a sapling pine stand. Although estimated total bird numbers were higher with spot mapping than with the transect method, both methods yielded results similar to capture-recapture estimates.

It is logical to assume that a still, hidden observer would more effectively count some bird species than would an observer walking a transect line, although a moving observer might "flush" birds that otherwise would not be seen. Also, as forest industry converts to pine plantation management, islands and strips of non-plantation vegetation (e.g., riparian zones) are often too small to be sampled effectively using transect methods. Our objective was to compare the applicability of the fixed-area circular plot (FCP) method of sampling birds to the fixed-width strip transect (ST) method in pine forests of 4 different tree-size classes.

Dr. R. R. Fleet, G. Hiser, P. Head, K. VanDunk, S. Lower, T. Brigham, and G. Ramey aided in sampling birds. Drs. R. N. Conner, B. J. Gruver, R. B. Hamilton, J. E. Howard, R. J. Warren, and an anonymous reviewer provided valuable reviews of the manuscript. The research was conducted under Cooperative Agreement No. 19–330 between the U.S. Forest Service, Southern Forest Experiment Station, Range Management Research, and the School of Forestry at Stephen F. Austin State University. The project was endorsed by the U.S. Man and Biosphere Program (MAB-3) as contributing to grazing land management.

Methods

Four study units, each approximately 800 ha, were selected in the Angelina National Forest in San Augustine County, near Broaddus, Texas. Within each study unit, 4 even-age pine stands, classified by tree size as seedling, sapling, pole and sawtimber, were selected as study areas. Four of the 16 stands were used in the bird sampling-method comparison study, 1 from each tree-size class. As it was sometimes necessary for the FCP observer to walk between study areas, the 4 most proximate stands of the proper tree-size class were chosen.

Vegetation and soils of the 4 stands chosen have been described in detail elsewhere (Baggett 1983; Rakowitz 1983; Whiting and Fleet 1985, 1987). Briefly, the 36-ha seedling stand, which was on an extremely dry site, was harvested, site prepared by prescribed fire, and planted to pine seedlings in 1978. Due to drought-related seedling mortality, the stand was replanted during both winters of the study. Vegetation during the study was comprised of a variety of woody vegetation, herbs and grasses; except for a few scattered hardwood saplings, vegetation height did not exceed 1.0 m. The 15-ha sapling stand was planted to pine in 1968 and burned with a cool fire in March 1981. Height and dbh of the planted pines averaged 9.5 m and 13.4 cm, respectively. The 30-ha pole stand was regenerated to pine about 1940 and thinned in early 1979. Overstory pines averaged 19.8 m in height and 27.4 cm dbh. Hardwoods in the stand averaged 13.3 m tall and 16.6 cm dbh. Pines in the extensive sawtimber stand averaged 55 years of age; average values for pine height and dbh were 20.7 m and 28.2 cm respectively. Overstory hardwoods averaged 13.6 m tall and 15.2 cm dbh. Despite no significant difference (*t*-test, $t = 1.21$, 178 d.f., $P = 0.227$) in dbh of pines in the pole and sawtimber stands, other differences in mid-story and understory characteristics dictated that the stands be classified differently (Whiting and Fleet 1985, 1987). The only forest management activity in the stand during the previous 20 years was a prescribed fire in winter 1981.

Establishment of Transects and Plots

The ST method procedures closely resembled those outlined by Conner and Dickson (1980). Three transects, each 300 × 100 m, were established within each stand. This provided 3.0 ha per transect and 9.0 ha per study area. Center lines of the transects were >100 m apart and parallel where possible. Transect center lines and borders were well marked with plastic flagging.

Within each comparison stand, 4 FCP's were situated so as to maximize overlap of the plots and transects. Radius of each plot was 85 m, thus 2.25 ha per plot and 9.0 ha per study area. At the center of each plot a blind was constructed of on-site material. Plot borders were marked at regular intervals with plastic flagging. Mean distance between plot centers did not exceed 225 m in any study area.

Sampling Birds

Avifauna of the study areas were sampled for 2 consecutive winter (January and February) and spring (May and June) seasons during 1980 and 1981. Four observers were required for sampling the ST's, a fifth for the FCP's. To reduce weather-related bias, birds were sampled only on mornings when all 5 observers could work. Also, windy and/or rainy days were not used.

Original plans were to rotate the 5 observers among transects and plots. Due to an injury prior to the first season, this proved impossible, so 1 person was assigned the FCP's each season and the other 4 rotated among the ST's. All observers trained together before each season.

Each ST study area was sampled 8 times per season. On a sample-day, each observer sampled a pair of proximate study areas. Sampling of the first study area began about sunrise; the second about an hour later. Sampling normally was completed within 2.5 hours. The second time an observer sampled a pair of study areas, the order was reversed. Each study area was sampled every other sample-day.

The FCP observer followed the same procedures. Sampling of the first study area began about sunrise, the second slightly over an hour later. The next time the 2 study areas were sampled, the order was reversed. The FCP observer sampled each study area concurrently with a ST observer during 4 of the 8 seasonal samples.

Individual ST observers sampled each comparison stand concurrently with the FCP observer 1 day per season.

ST's were sampled using the guidelines of Conner and Dickson (1980). For the FCP's, the observer entered a blind and remained seated for a 15-minute observation period, but turned to face a different direction every 3–4 minutes. All birds seen or heard within the borders of the circular plot were recorded. After completing an observation period, the observer moved quietly to another plot within the same study area and repeated the procedure until all 4 plots were sampled.

Bird Community Values and Statistical Comparisons

For each avian sampling method, the daily count of a study area was considered a sample. For each sample, total numbers of bird species and individuals were determined. These data were combined by sampling method and season for each study area. For each season, numbers of species and individuals recorded by the stationary observer were compared to those recorded by the moving observer in each study area using sample methods and study areas in factors in 2-way ANOVA's. Data from the 4 study areas were then combined by season and tested between sample methods using *t*-tests.

Differences in numbers of individuals of selected species and species assemblages were tested by season with study areas combined using *t*-tests. Individual species selected were those recorded in relatively high numbers in at least 3 study areas. Species assemblages were formed by grouping several species with similar taxonomic or ecological characteristics. Grouping provided adequate sample sizes to examine differences in effectiveness of the sampling methods in detecting birds with the chosen characteristics.

During winter, the individual species selected for analyses were northern cardinals (*Cardinalis cardinalis*), Carolina wrens (*Thryothorus ludovicianus*), and hermit thrushes (*Catharus guttatus*). Selected assemblages were: 1) solitary arboreals, i.e., brown creepers (*Certhia americana*), hairy (*Picoides villosus*) and downy woodpeckers (*P. pubescens*), and yellow-bellied sapsuckers (*Sphyrapicus varius*); 2) foliage gleaners, i.e., yellow-rumped (*Dendroica coronata*) and pine (*D. pinus*) warblers, tufted titmice (*Parus bicolor*), Carolina chickadees (*P. carolinensis*), and golden-crowned (*Regulus satrapa*) and ruby-crowned kinglets (*R. calendula*); and 3) wintering sparrows, i.e., vesper (*Pooecetes gramineus*), savannah (*Passerculus sandwichensis*), white-crowned (*Zonotrichia leucophrys*), white-throated (*Z. albicollis*), and chipping sparrows (*Spizella passerina*), dark-eyed juncos (*Junco hyemalis*), and rufous-sided towhees (*Pipilo erythrophthalmus*).

During spring, the individual species tested were northern cardinals and Carolina wrens. Assemblages considered were: 1) vocal breeding warblers, i.e., northern parula (*Parula americana*), yellow-throated (*Dendroica dominica*), pine, prairie (*D. discolor*), Kentucky (*Oporornis formosus*), and hooded warblers (*Wilsonia citrina*), common yellowthroats (*Geothlypis trichas*), and yellow-breasted chats (*Icteria virens*); 2) breeding woodpeckers, i.e., hairy, downy, pileated (*Dryocopus pi-*

leatus), red-headed (*Melanerpes erythrocephalus*), and red-bellied woodpeckers (*M. carolinus*); and, 3) breeding flycatchers, i.e., eastern kingbirds (*Tyrannus tyrannus*), eastern wood pewees (*Contopus virens*), and great crested (*Myiarchus crinitus*) and Acadian flycatchers (*Empidonax virescens*).

Results and Discussion

Within Individual Study Areas

During winter, the FCP method yielded a significantly higher number of species in the pole stand than did the ST method; that was the only significant difference in avian community values of the individual study areas as detected using the 2 census methods (Table 1). Throughout the study areas, however, consistently more species and individuals were recorded when sampling the circular plots than the transects. The lack of significant differences is a result of wide fluctuations in winter bird activity and thus numbers. For example, numbers of species and individuals recorded per sample in the sapling stand ranged 5–14 and 20–424, respectively, for the FCP method, and 1–10 and 2–118, respectively, for the ST method. Other studies that have noted wide variations in numbers of winter birds recorded between sample days in East Texas include Dickson and Segelquist (1977) and Whiting (1978).

During spring, the FCP method resulted in higher numbers of species and individuals (Table 1). In the older, more complex stands, these differences were significant. Our results support the concept that a fixed observer can obtain a more complete sample of the avifauna in structurally complex habitats than can a moving observer (Reynolds et al. 1980).

Study Areas Grouped

When data from all study areas were combined, the FCP observer recorded more bird species and individuals than did the ST observer during both seasons (Table 2). With the exception of numbers of individuals during winter, differences were significant. Lack of significant difference in numbers of individuals during winter was a result of transitory flocks of wintering birds.

For selected species and assemblages, during winter the hidden, stationary observer recorded more northern cardinals, hermit thrushes, Carolina wrens, solitary arboreals, and wintering sparrows than did the moving observer (Table 3). Only foliage gleaners, which were very abundant in the upper canopy of the older stands, were recorded in higher numbers by the ST observer. Differences in numbers of cardinals and hermit thrushes were significant.

During spring, differences in numbers of cardinals and Carolina wrens recorded were minor (Table 3). However, the FCP observer recorded more individuals of each of the 3 assemblages than did the ST census-taker (Table 3). The difference in the vocal breeding warblers was significant.

Data from both seasons demonstrate several advantages of a stationary, hidden

Table 1. Avifaunal characteristics of each 9-ha study area as derived using strip transect (ST) and fixed-area circular plot (FCP) sample methods during winter and spring. Comparisons between methods were made using sample methods and study areas as factors in 2-way ANOVA's (N = 16 for each method).

Avifaunal characteristics	Seedling		Sapling		Pole		Sawtimber	
	ST	FCP	ST	FCP	ST	FCP	ST	FCP
Winter								
Avg. no. species/sample	5.50	9.00	7.00	10.94	8.63	13.00[a]	9.62	12.07
Standard error	0.75	0.65	1.02	1.03	0.77	1.05	0.80	0.90
Total different species	25	33	28	34	27	34	25	34
Avg. no. individuals/sample	56.25	100.23	25.69	32.35	40.81	43.00	28.13	32.27
Standard error	10.25	25.98	5.42	3.46	9.32	3.69	4.96	3.02
Total individuals	900	1504	411	550	653	731	450	484
Spring								
Avg. no. species/sample	8.25	10.50	7.81	12.44[a]	10.19	15.88[a]	10.94	15.38[a]
Standard error	0.66	0.65	0.57	0.94	0.37	0.80	0.61	0.99
Total different species	25	38	29	39	30	44	31	44
Avg. no. individuals/sample	24.75	34.00	15.75	26.63[a]	25.81	44.44[a]	25.75	32.31[a]
Standard error	2.25	2.93	1.60	1.90	2.24	1.83	3.19	2.34
Total individuals	396	544	252	426	413	711	412	517

[a]Significant ($P \leq 0.05$) difference between sample methods by study area.

Table 2. Avifaunal characteristics as derived using strip transect (ST) and fixed-area circular plot (FCP) methods during winter and spring. Data were combined among 4 9-ha study areas, *t*-tests were used to compare between sample methods (N = 64 for each method).

Avifaunal characteristics	Census method	
	ST	FCP
Winter		
Avg. no. species/sample	7.69	11.30[a]
Standard error	0.46	0.50
Total different species	46	56
Avg. no. individuals/sample	37.72	51.08
Standard error	4.12	7.03
Total individuals	2414	3269
Spring		
Avg. no. species/sample	9.30	13.55[a]
Standard error	0.32	0.50
Total different species	55	71
Avg. no. individuals/sample	23.02	34.34[a]
Standard error	1.28	1.38
Total individuals	1473	2198

[a]Significant ($P \leq 0.05$) difference between sample methods.

observer over a moving observer. Cardinals, hermit thrushes, and Carolina wrens are low vegetation or ground dwellers and are far more often recorded by sound than sight. During winter, the birds' sounds are low in volume and a walking observer is often relatively close to a bird before it is heard. This supports Verner and Ritter's (1985) suggestion that a moving observer silences some birds and as a result, may not record as many as a stationary observer. During spring, most cardinals and Carolina wrens recorded were singing loudly and thus were recorded at much greater distances than during winter. The intimidation of a moving observer on birds low in the canopy also could be the reason that the FCP observer recorded greater numbers of vocal breeding warblers in the seedling, sapling, and pole study areas than did the ST observer.

Our results support the conclusions of Reynolds et al. (1980), that stationary observers have less effect on bird activity than do moving observers. Our data also support the concept that a stationary observer is visually more effective than a moving observer, especially in younger, dense stands (Reynolds et al. 1980). In our study, the stationary observer recorded higher numbers of wintering sparrows than did the moving observer (Table 3). Over 80% of these birds were recorded in the seedling study area. This suggests that the stationary observer could estimate more accurately the size of ground-inhabiting flocks of birds than could the moving observer.

Table 3. Numbers of individuals of selected bird species and species assemblages as recorded in each 9-ha study area using the strip transect (ST) and fixed-area circular plot (FCP) sample methods ($N = 16$ for each method). Study area data were combined and differences between sample methods were evaluated using *t*-tests ($N = 64$ for each method).

Species or assemblage	Study area								Study areas combined			
	Seedling		Sapling		Pole		Sawtimber		Total		Average	
	ST	FCP	ST	FCP	ST	FCP	ST	FCP	ST	FCP	ST	FCP
Winter												
Cardinal	6	2	29	50	39	68	24	30	98	150	1.53	2.34[a]
Carolina wren	0	1	21	32	43	60	25	27	89	120	1.39	1.88
Hermit thrush	1	3	9	21	8	32	8	13	26	69	0.41	1.08[a]
Solitary arboreal	0	0	7	6	12	22	18	19	37	47	0.58	0.73
Foliage gleaners	8	23	140	150	416	340	254	228	818	741	12.78	11.58
Wintering sparrows	434	564	20	35	40	39	28	10	522	648	8.16	10.13
Spring												
Cardinal	5	1	55	51	72	88	47	36	179	176	2.80	2.75
Caroina wren	0	0	7	5	56	68	19	19	82	92	1.28	1.44
Vocal brd. warblers	111	171	33	56	110	171	83	73	337	471	5.27	7.36[a]
Breeding woodpecker	1	7	4	13	17	33	12	29	34	82	0.53	1.28
Breeding flycatchers	18	5	1	8	6	15	24	59	49	87	0.77	1.34

[a]Significant ($P \leq 0.05$) difference between sample methods.

Comparisons of Other Sample Features

Time is often a factor of critical importance in sampling birds. The mean detections per minute for the FCP observer (0.70) was significantly higher than that of the ST observer (0.53). These results are similar to those of other studies which have shown that samples using stationary observers to be time effective (Jarvinen 1978, Reynolds et al. 1980). Verner and Ritter (1985) discuss sample times of transects and variable-radius circular plots in detail.

It would be beneficial to investigate the optimum observation time for the FCP method. Our 60-minute observation period per study area was chosen arbitrarily in an attempt to estimate the time spent sampling a ST study area. Jarvinen (1978) reported a saturation effect occurred when conducting point counts in areas of high bird densities. He found large numbers of birds confused the observer, and that 5-minute sample periods were not long enough to sort by species and distances. In areas of high bird densities, too few records were made and bird abundances were underestimated. Conversely, Verner and Ritter (1985) recommended 6-minute counts for plots that are 100 m apart. We found that the 60-minute sample period was ample time to accurately distinguish species and was similar to the mean of 56 minutes required to sample a ST study area.

We also tested the effect of the disturbance of an observer on the number of birds recorded by the other observer. Avian values for days on which a study area was sampled by both methods were compared to values for days on which the study area was sampled by a single method. Differences were not significant, thus the moving observer did not affect the numbers of birds recorded by the stationary observer, nor did the stationary observer affect the numbers of birds recorded by the moving observer. R. N. Conner (pers. commun.) noted similar findings in several studies of forest birds in East Texas.

Finally, the FCP method required less field preparation time than the ST method. Although both methods required accurate marking of boundaries, establishing center lines of the ST's was often very time consuming, especially in study areas that did not have uniform vegetation. Alternatively, cold temperatures in winter and nuisance insects in spring were major disadvantages for the stationary observer.

Conclusions

Thus study supported the concept that a stationary observer records more bird species and individuals than does a moving observer. Numbers recorded by the FCP observer were regularly significantly higher than those recorded by the ST observer. We believe the FCP method of sampling birds has potential for use in the mixed pine-hardwood forests of the southeastern United States. The method would probably prove particularly utilitarian for sampling patchy vegetation, especially in predominantly young stands or areas with dense midstory or understory.

Literature Cited

Amman, G. D. and P. H. Baldwin. 1960. A comparison of methods for censusing woodpeckers in spruce-fir forests of Colorado. Ecology 41:699–706.

Anderson, B. W. and R. D. Ohmart. 1981. Comparisons of avian census results using variable distance transects and variable circular plot techniques. Pages 186–192 *in* C. J. Ralph and J. M. Scott, eds. Estimating numbers of terrestrial birds. Studies in Avian Biology No. 6. Allen Press, Lawrence, Kan.

Baggett, S. C. 1983. A comparison of two avian census methods: strip transect and fixed circular plot. M.S. Thesis, Stephen F. Austin State Univ., Nacogdoches, Tx. 69pp.

Conner, R. N. and J. G. Dickson. 1980. Strip transect sampling and analysis for avian habitat studies. Wildl. Soc. Bul. 8:4–10.

———, ———, and J. H. Williamson. 1983. A comparison of breeding bird census techniques with mist-netting results. Wilson Bul. 95:276–280.

Dickson, J. G. 1978. Seasonal bird populations in a south central Louisiana bottomland hardwood forest. J. Wildl. Manage. 42:875–883.

——— and C. A. Segelquist. 1977. Winter bird populations in pine and pine-hardwood forest stands in east Texas. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 31:134–137.

Jarvinen, O. 1978. Estimating relative densities of land birds by point counts. Annalas Zoologici Fennici 15:290–293.

Rakowitz, V. A. 1983. Comparison of the herpetofauna of four different-aged stands in the loblolly-shortleaf pine-hardwood ecosystem of east Texas. M.S. Thesis, Stephen F. Austin State Univ., Nacogdoches, Tx. 130pp.

Reynolds, R. T., J. M. Scott, and R. A. Nussbaum. 1980. A variable circular plot method for estimating bird numbers. Condor 82:309–313.

Verner, J. and L. V. Ritter. 1985. A comparison of transects and point counts in oak-pine woodlands of California. Condor 87:47–68.

Whiting, R. M. 1978. Avian diversity in various age pine forests in east Texas. Ph.D. Diss., Texas A&M Univ., College Station. 160pp.

——— and R. R. Fleet. 1985. Small animal population inventories on a mixed pine-hardwood forest of East Texas. U.S. Dep. Agric. For. Serv., South. For. Exp. Sta., Final Rep., FS-SO-1701-4.11, Alexandria, La. 396pp.

——— and ———. 1987. Bird and small mammal communities of loblolly-shortleaf pine stands in East Texas. Pages 49–66 *in* H. A. Pearson, F. E. Smeins, and R. E. Thill, Compilers. Ecological, physical, and socioeconomic relationships within southern national forests. U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. SO-68, New Orleans, La.