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GENERAL NOTES

Comparison of variable circular-plot and spot-map methods in desert riparian and scrub habitats.—Accurately censusing bird populations has been a major concern of avian ecologists for many years (Kendeigh, Ecol. Monogr.14:67–106, 1944; Enemar, Var Fagelvarld Suppl. 2, 1959; Berthold, J. Orn. 117:1–69, 1976). Two methods are in extensive use in the United States: (1) the spot-map method (referred to as SMM) (Williams, Ecol. Monogr. 6:317–408, 1936) and (2) the variable-width transect method (Emlen, Auk 88:323–342, 1971; Emlen, Auk 94:455–468, 1977). Transects, spot-mapping, and point counts are heavily used in European countries (Blondel et al., Alauda 389:55–71, 1970; Järvinen and Väisänen, Oikos 26:316–322, 1975; Bournaud and Corbille, Terre Vie Rev. Ecol. 33:71–94, 1979). Most methods present problems in censusing small discrete areas of habitat.

In most riparian situations in the southwest it is difficult to find areas of homogeneous vegetation either 1–1.5 km in length for transects and/or greater than 10 ha in size for a SMM grid. Spot-mapping is also limited to the breeding season when the birds are defending and holding territories. Point counts are useable in small habitat "islands," but they fail to define the area censused.

Reynolds et al. (Condor 82:309–313, 1980) have recently proposed a variable circular-plot method (referred to as VCPM) that should be useful for counting birds in small habitat patches. With this method birds are counted around selected points; the distance from each point to the bird is estimated, which permits results to be expressed in terms of number of birds per unit area. This method would be useful in riparian situations in the southwest as well as other small areas of habitat, particularly if it could be demonstrated that it produces results comparable to the more established methodologies. Ideally, the method should be comparable both in riparian and in adjacent areas which might affect bird community structure in riparian habitats (Carothers et al., Am. Zool. 14:97–108, 1974; Szaro, pp. 403–418 *in* Management of western forests and grasslands for nongame birds, R. M. Degraff, tech. coord., USDA For. Serv. Gen. Tech. Rept. INT–86, Ogden, Utah, 1980). The purposes of this study, therefore, were (1) to assess the applicability of the VCPM to riparian and desert scrub habitats, and (2) to assess the comparability of the VCPM to the SMM.

Study areas.—The study was conducted on the Tonto National Forest, on Queen Creek, about 3.7 km upstream from the mouth of Whitlow Canyon and about 16 km west of Superior, Pinal Co., Gila River Basin, Arizona. We selected two study plots, one in a riparian area at 620 m elevation and the other in the adjacent desert scrub at 630 m elevation. The riparian plot, located immediately behind Whitlow Ranch Dam, was 250 × 450 m minus a 100 × 100-m square in the northwest corner (10.25 ha). The adjacent desert scrub plot was a 400 × 400-m square (16.0 ha). Both plots were gridded in a pattern of 50-m squares. The riparian area consisted of approximately 15 ha with a central core of even-aged Goodding willow (*Salix gooddingii*) surrounded by dense salt cedar (*Tamarix pentandra*) thickets. The desert plot was dominated by foothill paloverde (*Cercidium microphyllum*) and saguaro cactus (*Cercus giganteus*).

Methods.—Breeding bird counts were made using both the SMM (Kendeigh 1944) and the VCPM (Reynolds et al. 1980). For the SMM, nine visits were made to each plot from 15 April–29 June 1980. For the VCPM, four visits were made to each plot from 8 May–5 June 1980. For the VCPM, 14 stations were selected (within the grid pattern) in both habitats so that each point was at least 100 m from the nearest point. During the period when both methods were used, sampling was done on consecutive days with the order reversing for each sequence. Consecutive SMM counts began at opposite ends of the study areas. Similarly, VCPM counts began at stations 1 or 14. All counts began at approximately 06:20.

For the VCPM, the observer waited at each point for a 1-min "rest period" to allow for equilibration of bird activity. During the 8-min count period recommended by Reynolds et al. (1980) for closed canopy forests, the observer recorded all birds seen or heard and their distances from the point. Distances were determined with the aid of an optical rangefinder. Bird densities were plotted for each 5-m band from 0–100 m from the point and for each 10-m band from 100–200 m from the point. The inflection point was determined by choosing the edge of band where density of individuals of a given species in the next outermost band was less than 50% of the previous band. The effective detection distance, the distance from the center point to the inflection point, was determined by pooling all observations for a species within a habitat type over the entire sampling period. Individual point densities for each species for the entire study period were then determined using this effective detection distance. Mean species-densities and standard errors for each study plot were then calculated from the individual point densities.

Density estimates were determined for all species with a minimum of 10 records during the study period. The number of singing males and "all other observations" were recorded separately (Emlen 1971). The density of singing males was then doubled to account for the females of the territorial males unless that number was less than the number of singing males plus the number of "all other observations." In the latter case the total number of observations was used for density purposes (Franzreb, Condor 78:260–262, 1976; Reynolds et al. 1980). In our study all densities were determined with the total number of observations except for those of the Cardinal (see Table 1 for scientific names), Bell's Vireo, and Yellow-breasted Chat on the riparian plot only which were determined by doubling the number of singing males.

Results.—Density estimates from the SMM for all species except the White-winged Dove on the riparian area were within the 95% confidence limits around the mean for the VCPM estimates (Table 1). Total density for the 13 species nesting on the riparian area estimated by the VCPM was 323 pairs/40 ha, compared to the estimate of 388 pairs/40 ha for the same species by the SMM. In the desert scrub habitat, the total density estimate, again for 13 species, was 98 pairs/40 ha by the VCPM and 105 pairs/40 ha by the SMM. All SMM density estimates on the desert plot were within the 95% confidence limits for the VCPM estimates.

Total effort expended for the SMM was 34.5 h on the riparian area and 32.5 h on the desert scrub area divided among nine visits to each plot. Total effort expended (count and equilibration periods plus walking time) for the VCPM estimate was 13.5 h on the riparian area and 10.8 h on the desert scrub area divided among four visits to each plot. The actual time spent counting (8 min × 14 stations × 4 visits) was 7.5 h on both areas using the VCPM.

Discussion.—The close agreement in density estimates determined from the two methods shows the potential of the VCPM for censusing bird populations in small habitat "islands." The density estimates were significantly different for only one species, the White-winged Dove that maintains a Type B territory (Nice, Am. Midl. Nat. 26:441–487, 1941).

The agreement in density estimates between methods tested here would probably increase with an increased VCPM sample for the rarer species. There were minimal differences (less than 17%) in density estimates for the most abundant species (Lucy's Warbler, Abert's Towhee, Black-throated Sparrow, Yellow Warbler). These species were also the most frequently observed during the VCPM counts. Reynolds et al. (1980) showed that a species' abundance and distribution (variably or uniformly distributed) will affect the number of stations and/or visits required to count a species adequately. To maximize the number of density estimates, such estimates were calculated for all species that were observed 10 times or more in either the riparian or desert areas. However, only the Ash-throated Flycatcher, Wied's Flycatcher, Gila Woodpecker, and Abert's Towhee, all on the desert plot, were estimated with fewer than 15 observations.

TABLE 1

BREEDING BIRD DENSITIES (PAIRS/40 HA) IN GOODDING WILLOW-SALT CEDAR AND PALOVERDE-SAGUARO ASSOCIATIONS DETERMINED BY BOTH THE VARIABLE CIRCULAR-PLOT AND SPOT-MAP METHODS

Species	Riparian plot		Desert scrub plot	
	Variable circle	Spot-map	Variable circle	Spot-map
Gambel's Quail (*Lophortyx gambelii*)	—	—	10 ± 1.2	9
White-winged Dove (*Zenaida asiatica*)	44 ± 7.4[a]	70	7 ± 1.9	10
Mourning Dove (*Zenaida macroura*)	15 ± 5.3	23	7 ± 2.0	10
Black-chinned Hummingbird (*Archilochus alexandri*)	21 ± 5.0	20	7 ± 2.9	5
Gila Woodpecker (*Centurus uropygialis*)	—	—	3 ± 1.2	3
Ladder-backed Woodpecker (*Picoides scalaris*)	11 ± 4.0	12	N.E.[b]	2
Wied's Crested Flycatcher (*Myiarchus tyrannulus*)	9 ± 4.4	15	6 ± 3.2	5
Ash-throated Flycatcher (*Myiarchus cinerascens*)	—	—	4 ± 1.2	4
Verdin (*Auriparus flaviceps*)	—	—	10 ± 5.8	7
Cactus Wren (*Campylorhynchus brunneicapillus*)	—	—	5 ± 2.6	6
Bell's Vireo (*Vireo bellii*)	8 ± 2.5	9	N.E.	1
Lucy's Warbler (*Vermivora luciae*)	109 ± 12.9	125	11 ± 3.4	15
Yellow Warbler (*Dendroica petechia*)	24 ± 7.3	29	—	—
Yellow-breasted Chat (*Icteria virens*)	19 ± 3.8	16	N.E.	1
Brown-headed Cowbird (*Molothrus ater*)	13 ± 5.8	12	N.E.	4
Summer Tanager (*Piranga rubra*)	10 ± 3.8	10	—	—
Cardinal (*Cardinalis cardinalis*)	10 ± 4.6	12	5 ± 1.7	5

TABLE 1
CONTINUED

Species	Riparian plot: Variable circle	Riparian plot: Spot-map	Desert scrub plot: Variable circle	Desert scrub plot: Spot-map
Abert's Towhee (*Pipilo aberti*)	30 ± 7.4	35	5 ± 2.2	5
Black-throated Sparrow (*Amphispiza bilineata*)	—	—	18 ± 6.2	16
Total density	323	388	98	105
Species richness	13	19[c]	13	22[c]

[a] Mean density ± SE.
[b] Species observed but not enough data for a density estimate.
[c] Includes all species, i.e., those not estimated by both methods on a single site.

We found the VCPM underestimated total bird density as compared to the SMM by 17% on the riparian plot and by 7% on the desert plot. In contrast to DeSante (Stud. Avian Biol. 6:177–185, 1981), all bird densities in our study were not underestimated by the VCPM. On the riparian plot, the Yellow-breasted Chat, Brown-headed Cowbird, and Black-chinned Hummingbird had higher densities with the VCPM. On the desert plot we found an even distribution of our estimates with four species underestimated, five species overestimated, and four species with no difference in density (Table 1).

All species recorded by the SMM were also observed during the VCPM sampling. However, ten were not observed with high enough frequencies during VCPM sampling to calculate a density estimate. For less common and rare species, the VCPM may require as many sampling periods as the SMM for density estimation. For common species, the method requires substantially fewer visits to an area to obtain comparable density estimates.

However, once an effective detection distance for a rarer species is determined in a given habitat type, the number of sampling visits necessary to calculate density estimates for these species would decrease. Thus, repeated sampling of the same site in subsequent years by the VCPM would require substantially fewer visits than by the SMM.

The determination of band size is potentially a problem in the use of the VCPM. As suggested by Reynolds et al. (1980), band width should be 5-m widths from 0–100 m, and 10-m widths from 100–200 m from the station. DeSante (1981) used 30-foot bands from 0–600 feet and then 60-foot bands from 600–1200 feet. Anderson and Ohmart (Stud. Avian Biol. 6:186–192, 1981) recommended that the first band have a width of 30 m. This recommendation might be useful in the more open habitats along the lower Colorado River but in our dense riparian habitat the effective detection distance averaged only 37.3 ± 3.5 m. If we had used a first band of 30 m then for most species we would have used only the first and second bands in our density determinations. We feel that band width probably should be determined by habitat density.

Distance estimation is the major factor affecting accurate bird-density estimates with both the VCPM and line transect methods. The bias in density estimates from measurement errors can be reduced by training observers, flagging known distances, and using rangefinders (Scott et al., Stud. Avian Biol. 6:334–340, 1981). We had the advantage of having a previously gridded SMM plot to use as a guide for distance estimation. However, the flagging of a few known distances from each point should not require any more effort than setting up a SMM grid.

The VCPM has the same advantage over the SMM as Emlen's (1971) line transect method, that of being applicable for year-round studies. It has the added advantage of eliminating the bias involved in estimating the sighting angles needed for line transect density estimates (Burnham et al., Wildl. Monogr. 72:2–202, 1980). Moreover, the VCPM combines the usefulness of point counts in small habitats while defining the area censused.

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Use of prairie wetlands by selected bird species in South Dakota.—Most studies of prairie wetlands have concentrated on waterfowl; however, wetland habitat in the prairies is also important to other kinds of birds. Our purpose is to report use of natural and man-made wetlands by 13 selected bird species other than waterfowl to provide information useful for management of these wetland birds, as well as for management of prairie wetlands. Quantification of the use of wetlands by all avian species will allow managers a more comprehensive view of the importance of such areas.

Study area and methods.—We surveyed sample wetlands within 476 legal quarter-sections (0.65 km^2) chosen by a combination of stratified random and two-stage cluster sampling (Steel and Torrie, Principles and Procedures of Statistics, McGraw-Hill Co., Inc., New York, New York, 1960). Study plots and wetlands were representative of South Dakota, exclusive of the Black Hills region. A detailed description of the study area and sampling scheme was presented in Brewster et al. (J. Wildl. Manage. 40:50–59, 1976).

Wetland birds were censused from 12–24 May and 10–21 June 1975 and from 10–23 May and 7–12 June 1976. Censuses were conducted by three two-person teams equipped with binoculars and waders. Counts were made from 30 min after sunrise until 30 min before sunset.

Selection of target species for inclusion in the study was based on anticipated abundance of a species on the study areas and the ease with which species could be observed and censused. Species selected for study included Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*), Red-winged Blackbird (*Agelaius phoeniceus*), Lesser Yellowlegs (*Tringa flavipes*), Marbled Godwit (*Limosa fedoa*), Willet (*Catoptrophorus semipalmatus*), American Avocet (*Recurvirostra americana*), American Bittern (*Botaurus lentiginosus*), Black Tern (*Chlidonias niger*), Great Blue Heron (*Ardea herodias*), Black-crowned Night-Heron (*Nycticorax nycticorax*), Green-backed Heron (*Butorides striatus*), Wilson's Phalarope (*Phalaropus tricolor*), and Sora (*Porzana carolina*).

The total number of individuals seen of each species was recorded for each wetland visited. Only territorial male Yellow-headed and Red-winged blackbirds were counted because of the inconspicuousness of the females of these species. Of the target species, the Sora was the most difficult to census. Based on densities of Soras observed in other studies (Pospichal and Marshall, Flicker 26:2–32, 1954; Griese et al., Wilson Bull. 92:96–102, 1980), we believe our counts recorded only a small percentage of those present. Use of taped calls to census rails was not feasible due to the extensive area covered in our survey, the necessity of simultaneously censusing waterfowl, and limited manpower.