to obtain gross estimates over large areas. Consideration should be given to evaluating applicability to other precocial colonial ground-nesting species whose fledgling survival may be inaccurately estimated by "traditional" counts. Procedures may be especially applicable during future fieldwork designed to compile geographic summaries of waterbird nesting status like those of Erwin (Coastal Waterbird Colonies: Cape Elizabeth, Maine to Virginia, U.S. Fish and Wildl. Serv., FWS/OBS–79/10, 1979) and Sowls et al. (Catalog of California Seabird Colonies, U.S. Fish and Wildl. Serv., FWS/OBS–80/37, 1980). These procedures are not suggested for colonies where ongoing studies can provide more detailed data for production estimates and associated confidence limits.

In summary, the majority of juvenile Least Terns appear to depart colonies within 3 weeks after fledging. Single counts of fledged juveniles substantially underestimate cumulative production. Awareness of these phenomena will permit more accurate assessment of fledging rate for Least Terns. At a minimum, multiple counts should be made on a schedule timed with the breeding chronology in the survey area and should be corrected for juvenile departure. Observer familiarity with colonies is requisite to the appropriate timing of counts and examination of use areas. Counts using such procedures are not suggested as substitutes for estimates derived from more intensive studies of survival.

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Expanded use of the variable circular-plot census method.—Since its introduction by Reynolds et al. (Condor 82:309–313, 1980), the variable circular-plot method (VCPM) has become a popular means of censusing birds (Ralph and Scott, eds., Stud. Avian Biol. 6, 1981). Designed for use in rough terrain, the method has now been applied in a variety of vegetation types (e.g., DeSante, Stud. Avian Biol. 6:177–185, 1981; Morrison et al., Stud. Avian Biol. 6:405–408, 1981; Scott et al., Wildl. Soc. Bull. 9:190–200, 1981a). The method allows density estimates based on species-specific detection distances obtained by observers at fixed locations. The method assumes, however, that individual birds are located anywhere within the species-specific radius around the fixed point; that is, locations of individuals are not mapped as with the classic spot-map method (SMM; Williams, Ecol. Monogr. 6:317–408, 1936; Kendeigh, Ecol. Monogr. 14:67–106, 1944; see also Ralph and Scott 1981). The SMM provides an estimate of territorial bird density and is often used for assessing the accuracy of other methods (Franzreb, Stud. Avian Biol. 6:164–169, 1981; Szaro and Jakle, Wilson Bull. 94:546–550, 1982). The SMM, however, is usually applicable only to small areas of moderate terrain during the breeding season (Emlen, Auk 94:455–468, 1977). This paper describes a simple way to use the VCPM as a means of: (1) locating areas of highest use by birds, (2) rudimentarily delineating territories, and (3) assessing the problems of double-counting individuals.

The method.—The only information required in addition to that recorded for standard VCPM counts (Reynolds et al. 1980) is the direction of the bird from the census station. A compass can be hand-held or attached to a clipboard and the direction (azimuth) of each individual bird seen or heard can be recorded along with distance and other information of

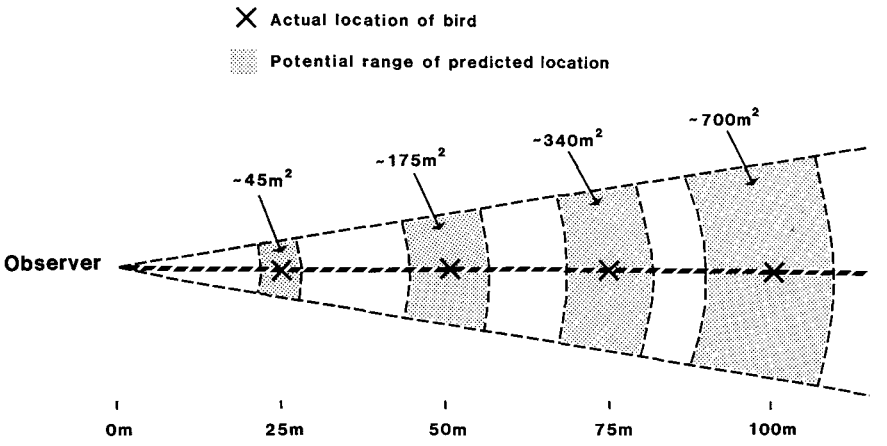

FIG. 1. Potential ranges of predicted locations of birds at four distances from observer, assuming 10% error in both direction and location.

interest. As direction is not required for calculating estimates of bird densities with the VCPM, missing data on directions would not affect density estimates. Direction and distance data can then be used to estimate the positions of the birds.

Given repeated censuses, territories may be roughly located as in the SMM using maps of the study area; sample sizes required for estimating density by the VCPM and SMM were described elsewhere (Robbins, Audubon Field-Notes 24:723–726, 1970; Reynolds et al. 1980; Franzreb 1981, Morrison et al. 1981). The use of direction estimates in the VCPM is offered not as a means of determining true territory boundaries and territory size, but rather for identifying areas of higher activity through a concentration of observations as plotted on maps. Birds could thus be located on a study area of any size without establishing a grid system, and densities could be calculated. With adequate numbers of observations of territorial species, density estimates derived from the VCPM could be compared with those obtained from mapping. Possible overlap (double-counting) of birds between adjacent stations could also be evaluated by mapping. Double-counting of individuals is a major problem with the VCPM (Reynolds et al. 1980) but has not been critically evaluated. Some of the problems of delineating territories using a mapping scheme were reviewed by Eagles (Stud. Avian Biol. 6:455–460, 1981), Franzreb (1981), and Oelke (Stud. Avian Biol. 6:114–118, 1981). Combining the recording of distance and direction would also allow calculation of densities on a year-round basis; densities of non-breeding species usually cannot be calculated using the SMM alone (Franzreb 1981).

Considerations of bias.—Incorporating direction into the VCPM requires an accurate estimation of both distance and direction. Errors in estimating these parameters increase with increasing distance from the census point. Methods of training observers to use the VCPM should be considered (e.g., Kepler and Scott, Stud. Avian Biol. 6:366–371, 1981; Scott et al., Stud. Avian Biol. 6:334–340, 1981b).

Scott et al. (1981b) noted that mean estimates of distances to birds heard were accurate within 10%, although the variance of distance estimates made by any one observer may be quite high. Our experience suggests that 10% is also a reasonable estimate of mean observer

error in determination of direction (unpubl.). Of course, the exact level of error may vary among observers, habitats, and with absolute distance of an observation. Assuming 10% error, errors in distance and direction estimation thus may be viewed as frustrums of wedges that increasé in area with increasing distance from the observer (Fig. 1). Accurate estimation of direction and distance may be difficult in extremely rough terrain, where across-ground direction and distance estimates are desirable. In such cases, however, mapping locations will still indicate general areas of higher use by birds.

Extensive evaluation followed the formal introduction of the VCPM (such as in Ralph and Scott 1981). The use of direction estimates to delineate territories must also be evaluated. We are using the addition of directional data to the VCPM to help assess habitat use; these results will be presented elsewhere.

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Evaluation of the road survey technique in determining flight activity of Red-tailed Hawks.—Road censusing, as described by Craighead and Craighead (Hawks, Owls and Wildlife, Stackpole Co., Harrisburg, Pennsylvania, 1956), has been used extensively in Christmas bird counts to assess raptor population densities. Observations of activity of raptors during such surveys have been used to indicate the overall activity pattern of a species (Craighead and Craighead 1956; Schnell, Auk 84:173–182, 1967; Bildstein, Ph.D. diss., Ohio State Univ., Columbus, Ohio, 1978; Preston, Wilson Bull. 93:350–356, 1981). However, there are no studies that verify that road censusing techniques provide an accurate estimate of the flight activity pattern of raptors. In this report I assess the applicability of the road survey technique for determining the amount of daily flight of the Red-tailed Hawk (*Buteo jamaicensis*) by comparing this method with results obtained from direct long-term observations of individuals. Red-tailed Hawks are good candidates for the census technique (Fuller and Mosher, Stud. Avian Biol. 6:235–248, 1981), since they tend to use open habitat and frequently hunt along roadsides.

In order to obtain an accurate estimate of the actual percentage of the day spent in flight, a bird must be equally visible during all activities. As raptors often change their activity patterns at certain periods of the day, it is also essential that all periods are equally represented in the sample. Seasonal changes in activity patterns and behavior of certain individuals occurring, for example, during breeding, migration, or fledging, should also be taken into account.

Methods.—Road surveys of Red-tailed Hawks were made during winter (5 December 1981–28 February 1982) and during summer (23 June–16 September 1982). Over 4000 km were driven (32–72 kmph [20–45 mph]) each season along roadway transect routes in central Missouri (38°49′N lat.). These intervals were chosen to minimize the possibility of observations of breeding or migratory hawks, but still at such times to enable me to compare activity patterns typical of summer and winter. Routes were travelled repeatedly, but only once per field day, by one to three observers. When a bird was first observed, the time of day and activity (either flying or perched) was recorded. The vehicle was stopped momentarily if a bird could not be identified. Only birds within approx. 0.4 km of either side of a road were included. When driving unfamiliar transects and/or ones along which topography