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SUMMARIZING REMARKS: SPECIES VARIABILITY

ROBERT E. RICKLEFS[1]

Biologists have been using census techniques for years without fully understanding the potential errors in estimating relative or absolute abundances of populations. The papers in this session demonstrate some of the inefficiencies and biases of standard census techniques and, more importantly, suggest some of the underlying bases for these difficulties. The papers have restated a theme heard frequently during this symposium concerning the reliability of bird censuses. The detectability of birds on transect or singing male counts is extremely variable with respect to season, species, individual variation, time of nest cycle, and perhaps other variables not explicitly dealt with in this session (e.g., habitat, weather, interobserver variation). The overall efficiency of observing individual birds or pairs of birds on single transects was found to average 40% (range, 0–90%) in deciduous forest in Ohio (Mayfield 1981), and about 50% for the Red-backed Shrike and two warblers in old-field habitat in Poland (Diehl 1981). Moreover, on small census areas, or for species with low population densities, the efficiency of sampling species can be quite poor. During each of his transects, Mayfield recorded only between 6 and 13 of 20 species present. This inability to sample species fully in brief periods has important implications for the comparative study of bird communities, in which large numbers of censuses are required.

Detectability clearly is an important factor in estimating the abundance of populations and the composition of communities. But the factors influencing detectability appear to be so numerous and complexly interrelated that it is not yet possible to judge the detectability of particular species under particular conditions simply by generalizing past experience. Therefore, the error inherent in the census techniques employed in a particular study can be estimated accurately only by direct validation.

The papers presented in this session have revealed some of the factors that influence detectability of birds, and they have implicitly pointed future research in some useful directions. Census techniques are usually validated by comparing their results with thorough, exhaustive censuses, often incorporating nest finding (Diehl 1981, Mayfield 1981), or with unbiased procedures (e.g., capture-recapture method used by Ekman 1981). Comparisons of these techniques are not the main topic of this session and have been treated in detail elsewhere in the symposium.

The speakers in this session have left no doubt that there are major differences between species and individuals in detectability, but they have provided us with few clues to the particular characteristics that make some species and individuals conspicuous and others cryptic. The speakers have provided more details concerning the influence of season and stage of nesting cycle on detectability. For example, Ekman (1981) determined that the detectability of Willow Tits on transects varied seasonally by as much as two- to three-fold relative to population densities estimated by the capture-recapture method. In his presentation, Ralph (1981) demonstrated for the 'Elepaio seasonal fluctuations in the number of individuals observed. In six of 10 Hawaiian species, the effective detection distances exhibited seasonal patterns of variation, presumably related to behavior or habitat cycles. Diehl (1981) showed a strong correlation between detectability and stage of the nesting cycle, it being highest during the prelaying period and, in the Red-backed Shrike, lowest during the incubation and nestling periods.

For me, the most interesting observations in this session related detectability directly to the behavior of individual birds or to seasonal variation in behavior patterns. In winter flocks of Willow Tits of known composition, Ekman (1981) showed that females, especially adults, are less detectable than males and younger birds because they feed higher in the trees and are thus more frequently hidden from the view of observers. Diehl's (1981) observation on the Red-backed Shrike that successful breeders were more detectable than unsuccessful ones was intriguing, and suggests that there are behavioral changes associated with nest failure. Ralph (1981) applied a correlation analysis to determine the relationship of census results to seasonal changes in patterns of vocalizations and movements. This summary is not the proper place to discuss the application of multivariate techniques to the detectability problem except to note their potential for sorting out many interrelated variables and to urge others to follow Ralph's example. In his study, several species, including the 'Elepaio, revealed correlations between behavior and census results.

The papers in this session seem to me a good start toward understanding the biological bases

[1] Department of Biology, University of Pennsylvania, Philadelphia, Pennsylvania 19104.

of biases and errors involved in estimating the numbers of birds. It is reasonable that additional effort be directed to more detailed validation studies of census techniques, and especially to studies of individual activity patterns, in order to devise a general theory of census efficiency and to improve our ability to estimate errors associated with particular censuses. I suspect that detectability can be related to such factors as foraging behavior, mating system, season, stage of nesting cycle, weather, time of day, and habitat. But whether knowledge of these factors and either their "experimental" control or entry into analyses as covariates can substantially improve estimates of numbers will be determined only by extensive comparative study. It may be possible to relate detectability to such indirect measures as plumage brightness and complexity or to certain morphological characteristics that are related to behavior and movement patterns. But suitable correction factors for census data that take into account such considerations will probably accumulate only through the experience gained in systematic attempts to relate detectability coefficients to other easily measured attributes of the species.