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Optimizing the Duration of Point Counts for Monitoring Trends in Bird Populations

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Minute-by-minute analysis of point counts of birds in mixed-conifer forests in the Sierra National Forest, central California, showed that cumulative counts of species and individuals increased in a curvilinear fashion but did not reach asymptotes after 10 minutes of counting. Comparison of the expected number of individuals counted per hour with various combinations of counting time and noncounting times (for record keeping and travel between counting stations) showed that 10-minute counts were most efficient in most cases. Counting longer than 10 minutes is not recommended, because of the increased risk of double counting some individuals.

Retrieval Terms: birds, monitoring, point counts, count duration, Sierra Nevada

Three basic methods—spot mapping, transects, and point counts—have been developed to estimate numbers of birds.[1,2] Spot mapping is applicable to relatively small areas, but it is too labor intensive to use for monitoring trends in bird numbers on areas larger than about 200 ha. Both transects and point counts can be used for monitoring on a larger scale, but transects are not as suitable as point counts because the time spent on a transect cannot be so rigidly controlled as that on a point count. Depending on the number of birds detected along a transect, an observer will stop for varying amounts of time to record observations. The time stopped may be enough for some undetected birds to come within range of detection by the observer, although they would have remained undetected had the observer not stopped to record prior detections. Thus, the presence of more birds along a transect may cause an upward bias in the numbers detected, relative to a transect with fewer birds. This bias cannot be separated later from the real difference in numbers of birds along any two transects, or along the same transect on different occasions.

Unlike the case with transects, the effort given to actual counting of birds during point counts can be precisely controlled by standardizing the duration of the counts. This makes point counting the method of choice for monitoring trends in bird numbers on land areas larger than appropriate for spot mapping. The method has been described elsewhere, especially in reference to estimating densities.[2,3]

This note recommends an optimum duration for point counts when used to monitor trends in bird populations. Results are probably applicable to a variety of habitats other than those studied because efficiency, as affected by the ratio of counting to noncounting time, is a function of the mean cumulative counts of individual birds. Thus, other habitats that generate counts comparable to or higher than those obtained in this study—e.g., many wetland and riparian sites—could safely follow the same guidelines.

STUDY AREAS

Point counts were done at two locations in the Sierra National Forest. The "Markwood" site was situated on a southwest-facing slope, from 1830 to 1950 m elevation, between Markwood Meadow and Bald Mountain Lookout, 12 km east of Shaver Lake (37°6'N, 119°W, Huntington Lake SW Quadrangle, USGS). The site, lightly logged in the 1960's, was in a heterogeneous area of old-growth mixed-conifer forest interspersed with patches of mountain chaparral. Dominant canopy trees were white fir (*Abies concolor*), incense-cedar (*Libocedrus decurrens*), and sugar pine (*Pinus lambertiana).* Total shrub cover was 30.5 pct, largely in dense stands between 1 and 2 m in height.

The "Teakettle" site was located on a south-facing slope, from 2040 to 2130 m elevation, on the Teakettle Experimental Forest, 13 km south of Wishon Reservoir (36°57'N, 119°02'W, Patterson Mountain NE Quadrangle, USGS). The site was in old-growth coniferous forest, never logged except for minimal sanitation purposes, construction of a narrow access road, and clearing for a cabin site. Dominant canopy trees were red fir (*Abies magnifica)*, white fir, sugar pine, Jeffrey pine (*Pinus jeffreyi*), and incense-cedar. Total shrub cover was 31.8 pct. Unlike the shrub cover at Markwood, much of that at Teakettle was generally sparse and less than 1 m in height.

METHODS

Three observers at Markwood and four at Teakettle completed 10-minute point counts during the first, third, and fifth hours of the morning, with the "first hour" commencing 10 minutes after official sunrise time. Four counting stations were established at the corners of a square, 250 m on a side, at each location. Each observer counted at all stations during 1 hour on 2 days per week for 6 weeks, beginning the last week of May 1986. All observers at each site counted during the same hour of the same day, rotating observers among the counting stations. With the constraint that each hour be sampled in any set of three successive counting days, the hour of counting was randomly determined, as were the assignments of observers to their initial counting stations on a given day, and the direction the observers rotated among the stations (clockwise or counterclockwise). Distances were estimated from the counting station to all birds detected, and all birds detected were tallied, regardless of their distance from the station. The total sample for each observer consisted of four replicate counts of each station during each hourly interval (48 counts/observer; 144-count total at Markwood, 192-count total at Teakettle).

During each count, observers kept a separate tally by minute, endeavoring to avoid counting the same individual more than once during the full 10-minute count. These data were used to generate cumulative counts of species and individuals, by minute. I empirically estimated the number of new individuals expected per hour of total effort for various combinations of counting and noncounting time (e.g., for record keeping and travel between counting stations), using the formula:

$$E = \frac{60}{C + N}(I)$$

in which

E = the expected cumulative count of individuals per hour for a given combination of counting and noncounting times,

C = count duration in minutes,

N = noncounting time in minutes,

and

I = the mean cumulative count of individuals after 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 minutes of counting.

Statistical significance has been arbitrarily set at a probability level of 0.05.

RESULTS

At both sites, counts of species (*fig. 1*) and individuals (*fig. 2*) did not reach asymptotes after 10 minutes of counting, and mean counts of both were significantly higher at Markwood than at Teakettle, commencing with the second minute (t = 3.68; 0.02>P>0.01) for species (*fig. 1*) and the second minute (t = 2.93; 0.05>P>0.02) for individuals (*fig. 2*).

Estimated counts of individuals for different combinations of counting and noncounting time showed that unless noncounting time was relatively short—on the order of 5 to 10 minutes—counts of 10 minutes were more efficient than any of shorter duration (*fig. 3*). Although calculated confidence intervals indicated significant differences in efficiency only between counts differing in duration by 6 or 7 minutes, little reason exists to doubt the validity of the observed trends: (1) The trends were the same for all seven observers, and (2) every observer detected new individuals with each additional minute of sampling.

With noncounting time of 5 minutes, peak counting efficiency occurred with 4-minute counts at both sites; with noncounting time of 10 minutes, peak efficiency occurred with 8-minute counts at the Markwood site and 7-minute counts at the Teakettle site. For all other noncounting times (15, 20, 25, and 30 minutes), peak efficiency occurred with 10-minute counts. The proportional gain in efficiency with 10-minute counts compared to 5-minute counts increased with increasing noncounting time.

Differences in noncounting time had considerably more effect on count efficiency than differences in counting time (*fig. 3*). For example, with a 5-minute increase in counting time, from 5 to 10 minutes, expected counts increased only 2.2 pct and 0.8 pct at the Markwood and Teakettle sites, respectively, when noncounting time was 10 minutes. Comparable gains were 9.1 pct and 7.4 pct with a noncounting time of 15 minutes. On the other hand, reducing the noncounting time the same amount, from 15 to 10 minutes, gave 33.4 pct and 33.2 pct higher totals

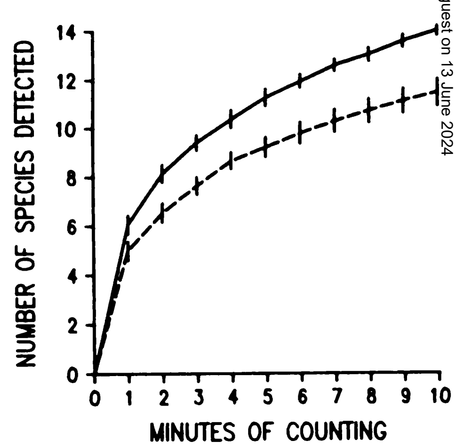

Figure 1—Mean species-accumulation curves for the Markwood (solid line) and Teakettle (dashed line) sites in the Sierra National Forest, California. Vertical lines indicate 95 percent confidence intervals.

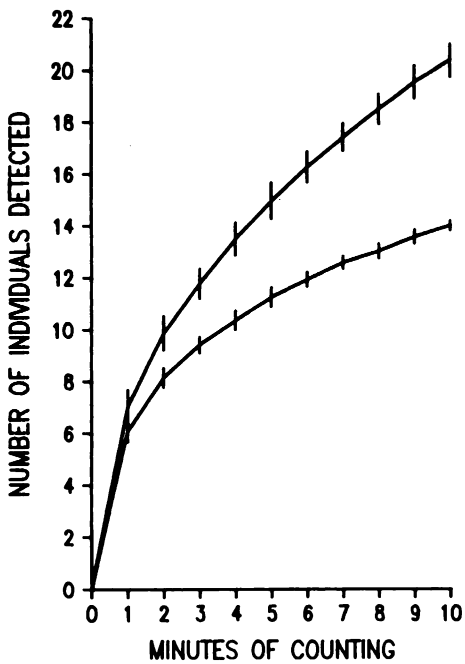

Figure 2—Mean individual-accumulation curves for the Markwood (solid line) and Teakettle (dashed line) sites. Vertical lines indicate 95 percent confidence intervals.

with 5-minute counts and 24.9 pct and 25.1 pct higher totals with 10-minute counts at Markwood and Teakettle, respectively. This general result held for all comparisons of this sort, and in general the loss in efficiency with increasing noncounting time was proportionally the least with counts lasting 10 minutes, and the rate of gain in efficiency accelerated with decreasing noncounting times.

A final decision on the optimum duration of point counts for a monitoring system must balance count efficiency in relation to noncounting time with other considerations. Results of this analysis suggest that counts even longer than 10 minutes would probably be more efficient, so long as noncounting time exceeded counting time by 20 pct to 30 pct. However, the longer an observer counts at the same station, the more likely he or she is to count certain individuals more than once,[2] violating a key assumption of the statistical analysis appropriate to results of such counts.

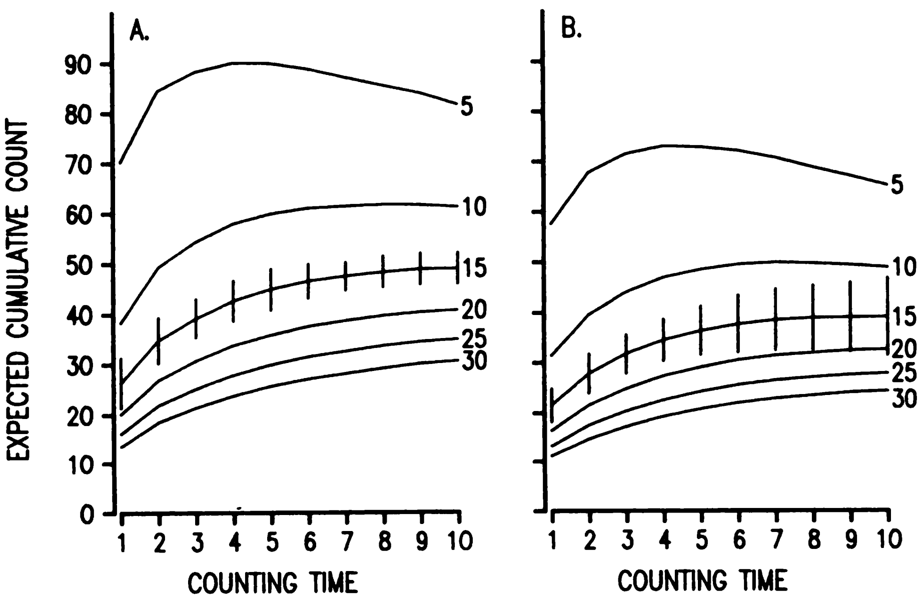

Figure 3—Expected cumulative counts of individuals per hour of effort for different combinations of counting and noncounting times, based on data from the Markwood (A) and Teakettle (B) sites. The duration of noncounting time is noted at the end of each curve. Ninety-five percent confidence intervals are shown only for the 15-minute noncounting times, as an example of the expected magnitude of variability.

RECOMMENDATIONS

Because the power of statistical tests increases with increasing total counts of individuals, noncounting time should be kept as short as possible to increase the total number of stations counted by an observer in a given morning. The most efficient design would exclude noncounting time, of course, but that would preclude counting at more than one station. Even the combination of 5-minute counts with 5 minutes of noncounting time—the most efficient of the various combinations examined—is unfeasible. The optimum design for a monitoring system would scatter numerous counting stations (I recommend at least 200) randomly throughout the geographic area to be monitored. In addition, no station should be nearer than 300 m to any other station, to assure that individual birds are not counted from different stations. This means that most stations would be too far apart to allow an observer to move from one to another in only 5 minutes. (Field personnel in a study in oak-pine woodlands in Madera County, Calif., sometimes had difficulty finishing up data recording at the end of a count and walking just 200 m between counting stations in 5 minutes.)

For use of point counts in habitats that give counts similar to those reported here, I recommend a counting period no longer than 10 minutes. This represents a compromise between counting longer for increased efficiency (this study) and not counting so long that the risk of double-counting individuals is unacceptably high.[2] In addition, I recommend that field data sheets provide a way for observers to record time at the end of 5 minutes of counting, to increase the potential for using frequency (number of stations at which a species is detected/total number of stations) as a measure of abundance.[4] (Certain species may be regularly detected at all stations during 10-minute counts but may be missed occasionally with a 5-minute count.) Frequency, of course, loses its comparative value among species that are detected at all stations (frequency = 1.0).[2]

I further recommend, subject to the constraint that assumptions of statistical tests be satisfied, that counting stations used for monitoring be located so an observer can travel between all stations to be sampled in a given morning with an average of no more