THE VALUE OF THE CHRISTMAS BIRD COUNTS

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At the turn of the twentieth century the late Frank M. Chapman initiated Christmas bird "censuses" as a substitute for the old time "Christmas hunt" which was an organized effort to kill hawks, crows, and other "vermin." For many years the censuses were published in *Bird-Lore.* They have since appeared in *Audubon Magazine* and are now being published annually in *Audubon Field Notes.* Similar lists are also published in *Canadian Field Naturalist* and in several state and local journals. Only 27 persons made the 25 lists of the first year. Participation in these censuses (now known as counts) has since made a spectacular growth, and the number of observers taking part each year has increased almost two hundred fold; 5,151 observers took part in 433 separate counts in 1951.

The increase of participation in Christmas bird counts bespeaks their great popularity. The desire to contribute something to science, the wish to see one's name in print, the rivalry for best lists, sport, and recreation are some of the considerations which prompt observers to go afield in all sorts of weather to make the counts. Whatever the personal motives for making them, these counts have proven to be a highly effective means of collecting raw data on early winter bird populations.

In our constant probing into animal population problems, many specialized techniques have been developed. Most methods of censusing have undergone constant revision throughout their development, and many of these revisions are increasing the accuracy of the information collected. Although this is true of numerous methods of censusing, in certain fields the techniques employed have not kept abreast of the times. It is proper to ask: of what value are the Christmas bird counts? Can we enhance their value and still hold the interest of the many who make them?

Some Opinions on the Value of the Counts

Except for the stimulus for finding unusual birds, and for charting the invasions of northern birds, many ornithologists think that about the only value of the counts comes from the recreation furnished and the popularizing of bird study through the attention focused on it by the published lists. Perhaps these are the greatest values of the counts, but others think that they hold neglected possibilities. Their present limitation has been well expressed by L. S. Putnam (personal conversation). He stated: "The great number of variables inherent in the data derived through Christmas counts render them practically useless in the furtherance of scientific knowledge." On the other side, Wing and Jenks (1939:343) stated: "Among all the activities of amateurs, none is a greater contribution to science than the taking of Christmas

censuses," and Odum (1950:227) wrote: "One has the feeling that there is more gold buried in the mass of data than has yet been uncovered." Because of the large number and scattered distribution of the participants, which results in extensive sampling from a large area in a short period of time, I think that the method holds vast potentialities. However, its fullest possibilities are now being lost.

Some Attempts to Analyze the Count Data

The data at present are of limited application. Considering the large number of data amassed, relatively limited attempts have been made to analyze them. An early attempt to use the data as a basis for curves of population fluctuations in 10 species was made by Perkins (1914:14–15). The values plotted were derived by dividing the total number of individuals of a species by the total number of lists for the year. Even the important variable of extent of the total coverage was neglected. Nichols (1937:430–433) used a closely similar method of analysis.

Ganier (1938:89–93) used counts from Nashville, Tennessee, to determine the relative abundance of the "Christmas" birds in that area. Hicks and Chapman (1933:135–150) analyzed the counts made in Ohio during the first 32 years. Relative frequency of occurrence and the relative abundance of species were the principal items considered. Such attempts at determination of the relative abundance and comparative frequency of occurrence of various species, however, do not give ample consideration to the differences in coverage of various habitats and differences in conspicuousness of different species. Wing (1947:1–270) analyzed all available counts up to 1939 and presented the calculations in tabular form. No interpretation of results was attempted. With the use of Christmas count data, Wing and Jenks (1939:343–350) plotted the relative abundance of the Downy Woodpecker throughout its range. They also appraised trends in populations of the Bob-white in 26 states, the District of Columbia, and one Canadian province. Kendeigh (1944:82) plotted a curve showing yearly fluctuations of the Bob-white population in Ohio. Several additional statewide and area analyses have been made and reported in local publications. A partial list of these reports occurs in *Audubon Field Notes* (Anon., 1950b:187).

Some analysts took unjustifiable liberties with the data; in all cases they left the reader with questions which should have been answerable by analyses of counts. The simple question of whether birds have increased or decreased during the period covered cannot be conclusively answered by analyses of the counts. In an analysis (unpublished) of 48 years of Christmas counts from Youngstown, Ohio, I found that the total number of birds noted per mile of travel increased from 12 (1904) to 123 (1950). I also found a markedly lower level in the numbers of Black-capped Chickadees found per mile of

travel each year since 1920 as compared with the eight-year period immediately before that date. To what extent these changes were caused by actual changes in the populations is hidden by the many variables.

Slow Trend Toward Improved Methods

While there is still much to be desired, considerable improvement has been made in the techniques employed during recent years. Modern lists include a much more complete account of weather conditions than was included in the earlier lists. Weather may have a profound influence on the results. The recent practice of reporting the extent of coverage of different habitats is also highly commendable. These two innovations indicate a trend toward improved method of the counts, but further refinement is desirable. Perhaps future improvement will be more of a qualitative than a quantitative nature.

Spread of interest has been part of the improvement achieved, and there has been a gradual increase in the number of observers. This has been paralleled by gradual extension of the routes covered. The continuous change of itineraries forestalls direct comparison of lists from successive years. There must ultimately come a time when further expansion of coverage will not increase the numbers of species found. This point may be near in some of the larger counts. If this is true, it is extremely desirable that the counts be continued without further modification of the routes covered, as successive lists are more readily comparable if the same routes are followed each year.

More Exact Information Needed On Extent of Coverage In Different Habitats

Additional precautions are desirable if lists from different areas are to be comparable. There is need for information on the extent of coverage of different habitats. Fortunately, this information has been included in many lists of recent years. Coverage in different habitats, however, has been reported as percentages of total time spent, and the figures are usually derived from guesses. If the method is to be sufficiently sensitive to give the desired indication of small changes in bird populations, all pertinent information must be given with scientific exactness.

The Mixing of Data Obtained by Different Methods of Travel

There has been improvement in certain phases of the method of making the counts but marked deterioration in other phases. Increasing use of the automobile, coupled with competition for long lists, has lowered the scientific value of the counts. Most counts incorporate data collected by use of automobiles to scout through areas to list additional species otherwise overlooked. This practice unjustifiably accentuates the apparent abundance

of such conspicuous birds as hawks. In most cases the main count should include only birds listed by observers on foot. This is not to say that counting should never be done except on foot. Some counting is best done from an automobile or boat, and such counts are entirely acceptable for special conditions if a standard procedure is followed. Likewise, it is entirely fitting for the observer to use an automobile for visiting favored habitats, but a reasonable distance should be covered on foot in the habitats visited. The important thing is to segregate observations made by different methods of travel. It is clearly unscientific to compare observations made from an automobile with those made on foot, on a per mile or per hour basis. Published reports could distinguish between types of observations by enclosing in parentheses those numbers which do not properly belong in the main list made on foot.

The Need for Complete Honesty in Identifications

In addition to encouraging undesirable use of the automobile, the competitive desire for long lists sometimes induces dishonesty. I have been told of a case where an accipitrine hawk was seen but not identified. Since the list contained Cooper's Hawk, this unidentified bird was counted as a Sharp-shinned Hawk. In all fairness, however, such incidents are unusual. There is probably a high degree of accuracy in identification of the common birds. Observers should recognize that there is no particular value in long lists as such. Long lists, however, will usually result as by-products of the extensive coverage necessary to insure adequacy of the samples.

Numbers of Birds Observed per Spatial Unit More Meaningful than Numbers per Time Unit

The raw data which appear in the published reports must be translated into common values, such as the numbers of birds found per hour or per mile, before different lists can be compared. The present practice of reporting the extent of coverage of different habitats as percentages of total time spent assumes that the analyst will be interested only in the numbers of birds found per time unit of observation. In most lists time spent has probably been reported more accurately than mileage. Accordingly, in his analysis, Wing (1939) translated the data into terms of the numbers of birds found per hour. Actually, numbers of birds found per mile of travel is much more meaningful than numbers found per hour of observation. The total number of individual birds found is more nearly a function of the distance traveled than of time spent in the field. The walking speeds of observers must vary considerably. Colquhoun (1940:67) varied his walking speed from 1 to 2.3 miles per hour and found that the slow-fast ratio for the numbers of birds noted per hour was 1 to 1.7. The rate of travel is not entirely without signi-

ficance even when the observations are considered on the basis of numbers of birds found per mile but is relatively unimportant. Ideally, a reasonably uniform rate should be used on all counts even when the observations are to be considered on the basis of the numbers of birds found per mile. If a uniform rate of travel were always used the units of time and of distance would be equally satisfactory for comparative purposes. Such uniformity is obviously impossible. It is also more logical to refer to bird density in terms of space than in terms of the observer's time.

While the present practice of reporting the coverage of the different habitats in terms of percentage of total time, rather than actual time, is probably not worth quibbling about, there is a slight advantage in having the information given in units of actual time. The compiler is thus relieved of calculating a figure which must be reconverted by the analyst.

Selection of a Route and Determination of the Mileage Covered

If the count is properly planned and conducted, it is relatively easy to determine very nearly the actual distance traveled. Use of a fairly straight course will facilitate determination of mileage. In selecting a route, an itinerary which can be covered each year in spite of possible temporary shortages of observers should be chosen. This route should adequately represent the various habitats in the region. Reference should be made to aerial photographs and the route thoroughly planned in advance. The distances to be covered in the different habitats should be carefully computed from the photographs and supplementary knowledge of the region. Aerial photographs are usually available at the local offices of the Soil Conservation Service and the Production Marketing Administration. In the absence of an aerial photograph, U. S. Geological Survey topographic maps can be used. The use of a pedometer furnishes a possible alternative. The mileage need be computed only the first year, for the same route should be faithfully followed each subsequent year. Thereafter, only distances in changed habitats need to be determined. If possible, several persons should be familiar with each route so that its proper coverage is assured each year.

Variation Due to Non-Standard Use of Special Attracting Devices

In selecting a route, care should be exercised to avoid factors which artifically influence bird movements, such as bird feeders. Some observers are now spending as much as one fifth or more of their total count time around bird feeders. Observations thus made are not comparable with those from areas where no attracting devices are used.

It is questionable, too, whether devices such as the "squeak" and the "screech" should be used to attract birds unless their use is standardized. If

a chosen lure call is used at a standard frequency by all observers, it should produce reasonably uniform results. Unless their use is standardized, the various lures had best not be used. Likewise, the use of a dog in finding certain species of birds is undesirable.

Subdividing of Groups Objectionable

In many larger counts there is a rather prevalent practice of periodic subdividing and rejoining of groups of observers in making more thorough coverages of certain habitats. This adds little more than objectionable complications. Cooperative effort in spotting birds is thus varied along the route. If a group of three observers spreads out so that individuals are 500 feet apart as they cross a weed-covered field, the distance traveled by each observer would be important in considering the number of Bob-whites found per mile. If Marsh Hawks were being considered, however, the distance which one person walked would be more nearly the thing to take into account. The matter of proper spacing of observers to give uniform lateral coverage of different species in various habitats is difficult and complicated. Greater uniformity will be achieved if subdividing groups is avoided.

A possible exception is represented by a practice used by the Wheaton Club at Sugar Grove, Ohio. Many observers are available, and various habitats are traversed by a long line of observers separated by short distances and moving abreast. In many cases a complete parcel of habitat can be covered in one sweep. The size of the tract covered can then be determined with reasonable accuracy from a map or aerial photograph. A simple hatchet planimeter (Dickerson, 1942:19–22) can be conveniently used for determining the areas of habitats with irregular boundaries. Fewer of the birds occupying a given area are missed and fewer counted twice, presumably, when this method is used than when a single observer walks back and forth through the same area. The numbers of birds found per mile should not be directly compared with the numbers found by a single observer or by a group of observers following essentially the same path. The number of observers needed and the nature of the terrain to be worked limit the availability of this method for some counts, but the data yielded are much more valuable than those obtained by the standard method.

The Human Variable

There are striking differences in the proficiency in finding birds of different observers. This is related to total field experience, recent field activity, keenness of vision, and acuity of hearing. The proficiency of a single observer may vary. For instance, his hearing may be dulled by a head cold or may deteriorate with age. The influence of the human variable can be greatly

reduced by several observers working together. At least one thoroughly experienced observer should be in each group.

Another important human variable is involved in personal estimates of the numbers of birds in flocks. With small flocks, reasonable accuracy is probably assured by the combined efforts of several persons in a group, and actual counts can often be made. Estimates made by different observers of large flocks frequently vary widely and the count figures for large flocks of birds must be considered as only relative.

Special Problems Imposed by Flocking Habits of Birds

The flocking of birds presents a major problem to the count analyst. Large flocks frequently include all the birds of a given species present in a considerable area. Perhaps a flock of 5,000 Black Ducks is seen on a lake from one position. If we assume that the observer moves a distance of one foot, he is seeing 5,280 $\times$ 5,000 birds per mile of travel. Clearly, a figure thus obtained has no meaning, and another method must be used. There is no point in translating the count observations of such species into terms of numbers per mile. Analysis of the status of a species forming large flocks is most meaningful if it is made on a range-wide basis. Perhaps the best that can be done with the data on such species is to consider the total individuals included in the various lists. Supposed population trends based on these data would be meaningless unless an extremely large sample were represented. If the comparative abundance of different species is to be determined, the relative frequency of occurrence should also be considered.

All types of winter flocking are represented in different species of birds, and calculations of percentages of the total bird population made up of various species are seriously distorted if species forming large flocks are involved in the total. Just when a flock can be considered large is difficult to decide, and the decision is necessarily arbitrary. The important consideration is whether the local distribution of the birds is affected sufficiently by flocking to distort the results of the count. Probably the local distribution of the Bob-white in Ohio is such that the number of birds found per mile of travel gives an index to its relative abundance somewhat similar to that for a nonflocking species, while the Horned Lark should certainly be treated as a flocking species. Because of flocking and peculiarities in the movement of Horned Larks, the exact number of birds found probably has little meaning. This is also true of waterfowl, doves and crows.

Differences of Conspicuousness in Different Species

It would seem that counts of two nonflocking species such as Red-tailed and Red-shouldered Hawks should be fairly comparable. There may be factors in

the birds' behavior, however, which cause a differential frequency of observations. For example, perhaps one species calls more often than the other. There are many differences in conspicuousness among birds, and these differences are sometimes hard to detect and measure. Calculations of relative frequency do not give proper consideration to many differences in conspicuousness among the various species. The count analyst should make interspecific comparisons with extreme caution.

Variation in Conspicuousness of Birds at Different Times of Day

Grinnell and Storer (1924:25) listed the numbers of birds found during each hour of observation and noted that more were found in the early morning and late afternoon than at mid-day. Dice (1930:23) also pointed out that differences in bird movements at different times of day should be considered. Dice properly recommended that the numbers of individuals found during each hour or half hour should be noted. Unfortunately, it is probably impracticable to record these details in the Christmas counts, but perhaps this does not justify a serious objection, as a fairly constant average probably results when all counts represent all-day walks. It is a practical though not entirely satisfactory alternative to have coverage in the various habitats equally distributed through different hours of the day. An approximation of this probably results without special effort because of the varied habitats found in much of the country. The lists should always cover entire days as is usual for the counts. If a single habitat is worked during the entire day, approximately the average condition is shown in the results.

Variation in Results Imposed by Weather Variables

The efficiency of observers varies with different weather conditions. For instance, if the temperature is so low that the observer's ears are kept covered, acuity of hearing is probably reduced.

It is apparent, also, that the behavior and local movement of birds is influenced by weather factors. The weather on the count day is closely related to the results obtained. The details of how different species respond to given weather conditions are not now known. If information were available it might be possible to use a weather correction factor in analysis, but the problem is so highly involved that its exact details cannot be known for many years to come.

A simpler method of reducing the weather variable would be to try to make weather a constant factor. Unfortunately, most count days are selected with regard to convenience rather than weather. When many persons make a single count, a day must probably continue to be chosen for convenience. When possible, observers should allow their choice to be guided by weather

forecasts. Weather should be chosen which is normal for the locality during the period. This should be reasonably pleasant if possible. If the forecast is in error it might be desirable to discontinue the count and make a second try for a day with appropriate weather. It is, of course, wholly unrealistic to expect complete standardization of the weather factor.

The weather and other factors which preceded the count day may also have an important effect on the counts of certain species. Suppose fewer birds of a species are found in an area during a given year than is usual. A range-wide analysis of the species would indicate whether the unusual scarcity is local or represents a low for the species. In migratory species, a range-wide analysis would show if scarcity in the southern part of the range of a species were caused by less southward movement than usual. The counts now contain so many variables that such an analysis is not practicable.

Use of Counts for Calculating the Absolute Density of Birds Per Unit of Area

The application of Christmas counts should be restricted to the indication of trends in populations rather than the yielding of exact data on absolute density of birds per unit of area. A reasonable estimate of the numbers of birds occurring per unit of area can be made, however, if the width of the strip covered by the observer can be determined for the individual species and the different habitats. Unfortunately this strip usually lacks a well defined boundary, and the best that can be done is to determine its average width. Kendeigh (1944:77) presented a table showing the average distances at which 24 species of birds were first observed. With this information the average width of the strip covered could be calculated, and the density of various species per unit of area approximated. But the width of the strip varies with observers, habitats, and weather conditions. Kendeigh concluded that scientific use of Christmas count data for measurement of population size is not generally practical (personal correspondence, 1953).

If the counts are to be used to estimate densities in different habitats, the need for truly random samples is accentuated. But routes are usually planned to cover the richest bird habitats in the region. This is fairly satisfactory if standardized, and if only trends in populations are to be determined. But random samples from each habitat are essential for an unbiased picture of the average densities in different habitats. Requiring these, however, would probably complicate techniques so much that participation would be seriously reduced.

Exact Measurements Needed of Effect of Different Variables on Results of the Counts

Some of the suggestions in this paper merely represent repetition of needs pointed out by earlier writers, and some are a part of the official require-

ments for Christmas bird counts (Anon., 1950a:183–4). There seems to be some laxity in application and enforcement of improved counting techniques, and this may be unavoidable in such a large-scale volunteer enterprise. I hope that a number of observers will review their methods and apply an improved technique which might serve as a check on the reliability of adjacent counts using the prevailing method. A more desirable check could be made if the same area were covered with both methods through a series of different conditions. A worthwhile project for an enterprising bird club would be the study of the influence of the different variables (particularly the influence of variation in observer proficiency and weather) on the results obtained in the counts. A study should be made, also, to determine the minimum size of the area required for a satisfactory sample. Lack (1937:375) has already pointed out that a relatively large area should be covered if the sample is restricted to a single day.

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Summary and Conclusion

The Christmas bird count could be a highly effective method of collecting data on early winter bird populations, but the techniques now used are in need of refinement if the data are to have the maximum, or even much, scientific usefulness. There are so many variables involved that the lists from different years and localities are seldom comparable. An increased standardization of methods is needed.

The data are best compared on the basis of the numbers of birds found per unit of distance, and the distance traveled in each habitat should be reported with scientific exactness.

Observations made from automobiles must be separable from those made on foot.

Efforts should be made to avoid bias of the data from use of artificial attracting devices such as bird feeders and the "squeak" or "screech." Likewise, dogs should not be used.

Alternate subdividing and rejoining of groups of observers should be avoided.

Proficiency in finding birds varies widely among different observers and

to some extent in the same observer at different time. For the reduction of the influence of the human variable, several persons should work together on each route.

The flocking habit of birds introduces a serious problem to the count analyst, and the data for species forming large flocks should be considered as only relative. Species forming large flocks should be considered by the analyst on a range-wide basis. Percentages of the total local population which various species make up cannot be computed when large flocks of birds are involved in the total because such flocks may represent concentrations from a much larger area than that covered for nonflocking species.

Calculations of relative frequency of occurrence derived from the totals for all species do not give due recognition to the differences of conspicuousness among the various species.

Observers should attempt to make weather a constant factor. This could be done by selecting a type of weather which annually occurs during the prescribed period and by making the choice of a day with regard to forecasts of this standard condition.

If the numerous variables were properly controlled, a range-wide analysis of the status of a species during a given year would indicate the extent of a locally observed scarcity or abundance.

The Christmas counts cannot be used to determine absolute bird densities.

To provide a more exact appraisal of the value of the Christmas counts, studies are needed of the influence on the counts of the many related variables.

As a scientific method for collecting data on natural populations of wild birds, the Christmas count promises to be of vast utility, and is, indeed, the broadest available to science. The method will presumably always contain some flaws, but this should not discourage efforts toward needed improvement. The scientific value of the counts can be enhanced without serious infringement of their popular appeal.

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