A method for evaluating quality of coverage in Breeding Bird Atlas projects

In computing species richness, diversity, or for any other uses of atlas data, adequacy of coverage must be considered for meaningful interpretation

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INTRODUCTION

FOLLOWING THE LEAD OF the successful breeding bird atlas project in Great Britain (Sharrock, 1976), atlas projects have been completed, are in progress or are being planned in a number of states and Canadian provinces as well as in most European and many African countries, Australia and New Zealand. A survey of atlas projects and their methods was recently given by Laughlin *et al.* (1982).

Atlas projects are designed to map the distribution of all breeding bird species in a selected area such as a state or a country. The area is divided into numbered blocks which are surveyed individually, usually by volunteer observers. Individual birds are not counted and no measure of abundance is recorded in a typical atlas project. Species are listed on the basis of observed breeding behavior which is usually grouped into three classes: possible, probable and confirmed, depending on the strength of the evidence obtained. A theoretical goal is to list and confirm all species present in all blocks but experience has shown that listing 70% to 90% of the species present and confirming 50% or more of those found is a more realistic expectation. Most atlas projects have been planned for a 5-year period so that some blocks, at least, are surveyed during more than one year. The final product of an atlas project is a publication with a map of the area for each species showing its range by indicating the class of evidence obtained in each block. The map is usually accompanied by a brief text describing the species and its breeding history in the area covered.

Basic methods such as mapping, establishment of individual blocks or squares, selection of breeding criteria, codes and reporting forms have been standardized. Block sizes, however, have varied widely depending on the size of the altas area, accessibility and the number of workers available.

NEED FOR EVALUATION

EVEN IN A PROJECT using uniformly-sized blocks, a wide range in numbers of breeding species can exist from one block to another depending on the habitat diversity, human modification of the original ecosystems and, in coastal areas, the amount of land area within the block. In the Marine Region of New York state, for instance, potential breeding species range from one or two in blocks containing only small areas of sandy beach and 10-12 in some inner city areas and offshore islands to about 100 in a few blocks with diverse and relatively undisturbed habitats. Well over 100 species per block have been found in other portions of the state.

The amount and quality of effort expended by observers assigned to individual blocks are equally diverse. Volunteers range from inexperienced bird watchers to veteran observers, professional ornithologists and wildlife experts. Time spent per block also varies from completely inadequate (*i.e.*, a few hours/season) to more than adequate (*i.e.*, 100-150 hours/season). Thus, the quality of coverage is a function of observer ability, interest, available time and, in some regions, accessibility.

Although most atlas projects seem carefully planned, well organized and conducted with energy and enthusiasm by large numbers of volunteers, the diversity in species composition and in actual coverage from block to block make it imperative that some method be used to evaluate carefully and critically the quality of coverage. The evaluation procedure has both scientific and operational uses. At the scientific level, it gives the user of the data some measure of the confidence that can be placed in the results for each block. At the operational level, it permits a Regional Coordinator or another person in charge of deploying survey personnel to determine when a block has had adequate coverage and how to use available observers most efficiently. Atlas projects are not exempt from the law of diminishing returns and it may be more useful to find 90% of the species in several blocks than to spend time finding 100% in one block while only 50% are discovered in the others. An observer who has achieved good coverage in one block can be assigned in subsequent years to blocks not previously or inadequately covered.

METHODS OF EVALUATING QUALITY OF COVERAGE

IN MOST ATLAS PROJECTS, no formal method of evaluating the quality of coverage or of judging when coverage is satisfactory has been adopted (Robbins, 1982). In some cases, the need for a method did not become apparent until the project was underway.

No absolute, quantitative, pre-determined standard exists by which coverage can be evaluated. If the number and kinds of species in each block were known, there would be no need for an atlas project. Although it is unrealistic to expect that all species in every block could even be listed, much less confirmed, 100% confirmation is a goal and a standard against which results must be judged. The only way to be sure of nearly complete coverage is to saturate a block with teams of expert observers. This method can be applied in only a very small number of blocks.

In some projects, finding some preselected number of species in a block was considered adequate coverage even though some blocks might not have contained that many and others might have produced many more. Thus, this method although easy to apply and in current use, cannot be considered satisfactory from either an operational or scientific viewpoint.

Another method that has been suggested (Smith, 1982) is to plot the number of species either listed or confirmed as a function of time, either hours within a season or years. The resulting curve tends to rise steeply at first, then bends over and approaches a limit asymptotically. When the curve becomes nearly horizontal, further effort becomes too great for gained results and is not warranted. This is a useful method but if used on an hourly basis, must be applied by each individual observer who must keep accurate records of both time and species added per increment of time. The observer must also have the interest and understanding to plot and interpret his results. It is unlikely that the majority of atlas workers would be willing to adopt this method. If a block is covered over years, the plot may be drawn by a Regional Coordinator. However, several years may be needed to establish the shape of the curve. Coverage of single blocks seldom lasts that long.

METHOD OF ESTIMATING AN EXPECTED NUMBER

THE MOST FEASIBLE alternative to the methods described above, and the one presented here, is to make an informed estimate of the number of breeding species probably present in each block. This can be refined and updated yearly if coverage continues. Results each year can be both evaluated against the estimate and used to improve the estimate. Assuming good coverage, the count and the estimate will tend to converge by the end of the period. If coverage is not adequate, the difference between the count and the estimate can be used to define the quality of coverage.

This method was first devised and tested in the Marine Region of New York State during the first year (1980) of the New York State Breeding Bird Atlas project. A preliminary version was presented by Raynor (1982). Estimates of the expected number of species in each block were made only after a block had been covered during one breeding season. The list of species actually found gave a minimum expected number. The following additional information was used to arrive at a total expected number:

1. Identification of the habitats in the block either from maps or other available data.
2. Knowledge of the expected breeding species in each habitat in the region either from the literature or personal experience.
3. Lists of species in nearby blocks with similar habitats.
4. Personal knowledge of the block or of similar habitats in the same area, if available.

Using all of this information, species that were missing from the list but that might reasonably be expected to be present were identified. If, for instance, the block contained deciduous woodland and a number of regular woodland species was listed but one or two others usually associated with them were lacking, a reasonable assumption is that they should be present also. Using this line of reasoning, a list of missing species is obtained and that number added to the number actually found. The sum is the estimate of the number of species expected. Such estimates have some margin of error but an experienced Regional Coordinator should obtain estimates within 10-20% of the true total in well-studied areas.

In remote and less well known regions, the expected numbers would have larger margins of error and, in some relatively unworked tropical countries, these may be quite large. However, the estimates can be refined as coverage and knowledge increase and they provide some standard against which to evaluate results.

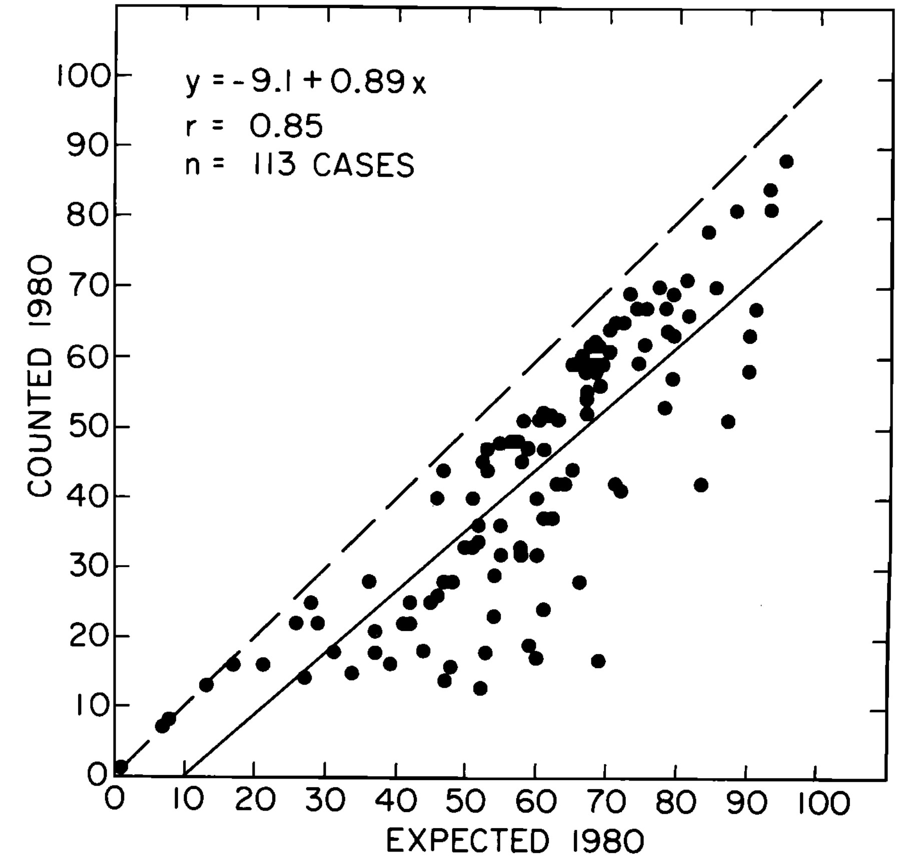

Figure 1. Number of species counted per block in 1980 compared to the expected number with the least squares line of best fit (solid), its equation and the correlation coefficient (r). The line of perfect agreement (dashed) is shown as a reference.

ESTIMATES MADE AFTER a year of coverage will always equal or exceed the number actually counted. As an example, Fig. 1 shows the number counted in each block in 1980 compared to the expected number calculated after the end of the season. Also shown is the least squares line of best fit (solid) with its slope and intercept, the number of cases (n) and the correlation coefficient (r) As a reference, the line of perfect agreement (dashed) is also plotted. Note that many counts are not far below the expected number. These represent good coverage for one year. On the other hand, points well below the line indicate inadequate coverage. However, the high value of r indicates a generally good agreement between count and estimate.

Note also the wide range in both the counts and the estimates. These show that the species present/block in the region range over nearly two orders of magnitude, from one to ninety or more. This demonstrates the futility of adopting an arbitrary number to define adequate coverage.

After a second year of coverage (1981), numbers counted were compared to the estimates made after 1980, as shown in Fig. 2. Note that many cases fall quite close to the line of perfect agreement and that some counts are above the expectation, indicating that the potential of those blocks was underestimated. This graph includes only those blocks which were covered in both years because, up to this time, estimates had been made only for those covered in 1980. A fair number of blocks with poor coverage are still evident but results are generally better and closer to the expected numbers than in 1980.

After the 1981 season, expected numbers were revised based on the combined results of the two season's work. The comparison shown in Fig. 3 shows that approximately 50% of the counts were within about ten species of the revised estimates and the rest were lower. The correlation coefficient (r = 0.93) is higher than those for the two previous comparisons. These results also include some for blocks not assigned to specific observers in which only minimal coverage was obtained during the course of other activities. If these had been omitted, the agreement would have been somewhat better. Continued improvement in agreement between counted and expected numbers is anticipated for the duration of the

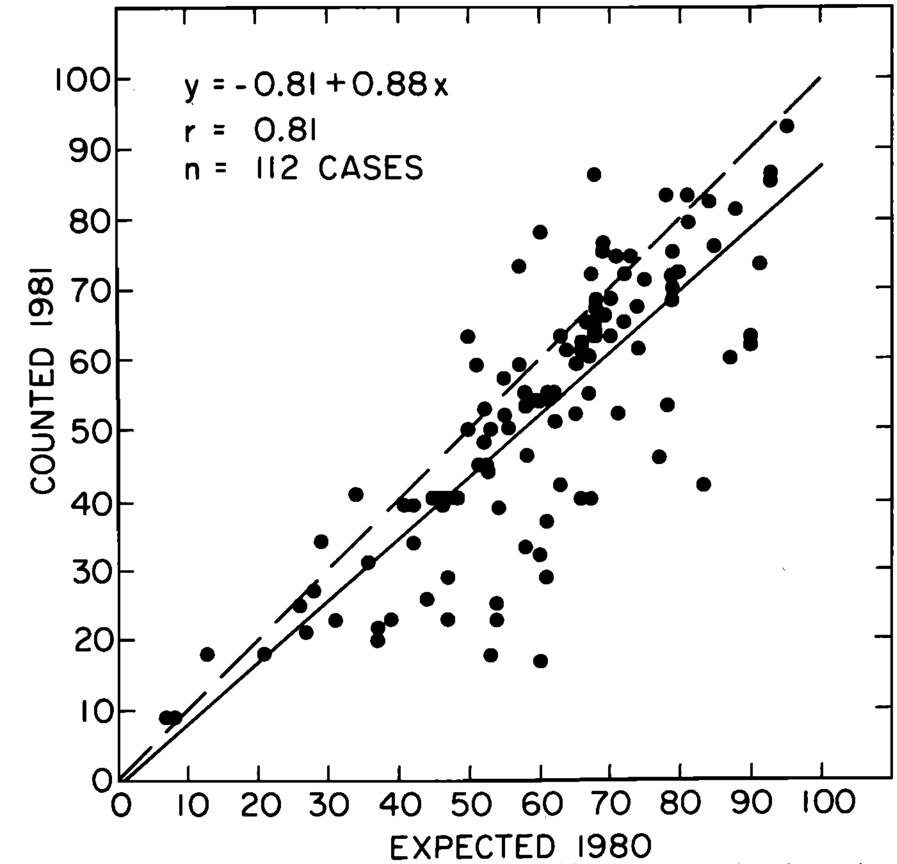

Figure 2. As Figure 1 except number of species counted in 1981 compared to the number expected after 1980.

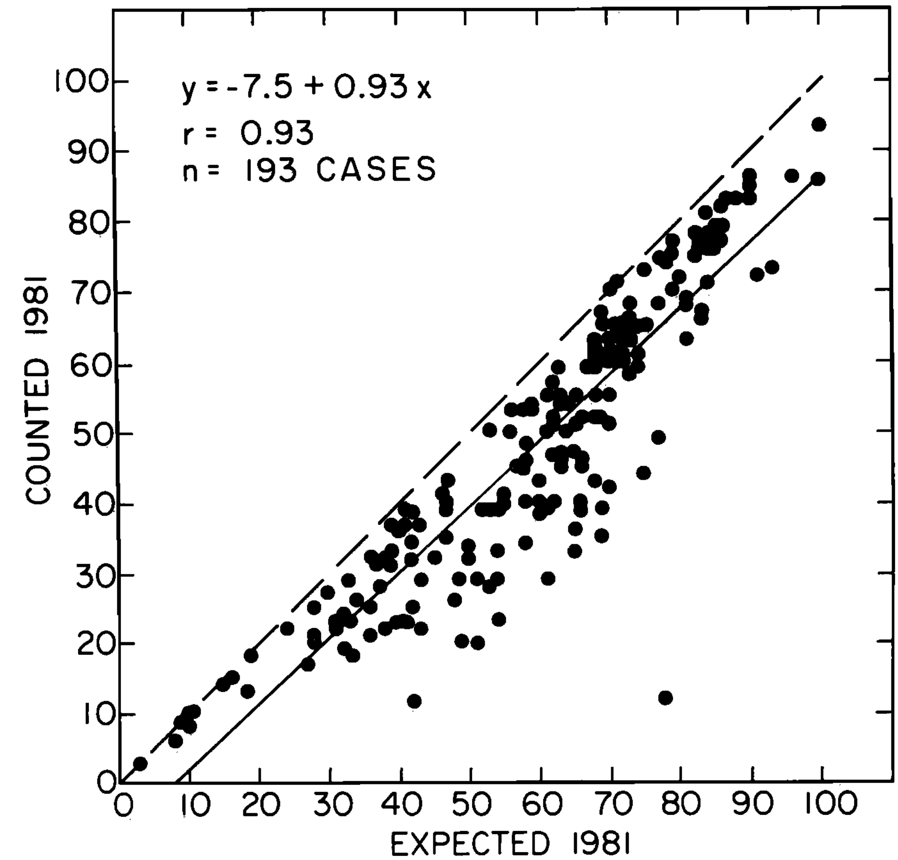

Figure 3. As Figure 1 except number of species counted in 1981 compared to the number expected after 1981.

project which, at this writing, is at the beginning of the third year.

CALCULATION OF RATIOS

NOW THAT THE FEASIBILITY of estimating an expected number of species in each block has been demonstrated, application to evaluation of survey data and operational use will be described.

Three statistics are particularly useful in evaluation results: the ratio of the number confirmed to the total number counted (CO/T), the ratio of the total number counted to the number expected (T/EX), and the product of these two, which is the ratio of the number confirmed to the number expected (CO/EX). The latter is the single most significant number. However, the first two ratios also describe the quality of coverage. Some observers, for instance, find most of the expected species in their block but confirm few while others find a smaller percentage but confirm a larger proportion of those found.

Once the expected numbers have been estimated, the counts and the calculated ratios can be tabulated on a form similar to that shown in Fig. 4. The number of each block in the region is listed with the name of the observer. The number of species found in each category, possible (PO), probable (PR) and confirmed (CO) and the total number (T) are listed next followed by the expected number (EX). Ratios are then calculated and listed on the right hand side of the page with the number of hours spent on the project, the number of years of coverage and finally a rating of good, fair or poor. After more than one year of work in a block, all statistics and the rating are based on the accumulated results and would be expected to improve from year to year. An evaluation form is filled out and results evaluated after each year of work.

EVALUATION OF COVERAGE

ONCE THE RATIOS HAVE been tabulated, a method is needed to rate the results. This may be done subjectively or specific values of one or more of the ratios may be chosen arbitrarily to separate good, fair and poor coverage. If either method is used, the class limits should be modified upward for each year of work until limits which are judged satisfactory are reached. Up to this point, good results for one year, for instance, might be considered only fair for two years of effort.

A more objective method based on the actual results obtained in the project is suggested. On the assumption that the better and more dedicated observers will obtain the best results reasonably possible, the T/EX and the CO/EX ratios were ranked and grouped into thirds. Those results in the upper third of each ranking could be considered good, those in the middle third fair and those in the lower third poor. The dividing lines between the lower, middle and upper third of the T/EX and CO/EX ratios actually achieved by observers in the Marine Region of New York during the first and second years of the project are shown as solid lines in Fig. 5. Projections of these curves for the final three years of the project are shown as dashed lines and represent expected results. Figure 5 shows that one-third of all observers listed 85% and confirmed 50% or more of the expected species in the first year and 90% and 53% respectively after two years of work. These are rated good. Another third listed between 60% and 85% and confirmed from 30% to 50% in the first year. These are rated fair. The lower third listed less than 60% and confirmed less than 30% of the species expected and their results are rated poor. The projected lower limits for the upper third after the fifth year, 99% listed and 62% confirmed, are not likely to be achieved in more than a few blocks because few blocks will be worked intensively for five years. The third year projected limits, 95% listed and 57% confirmed are suggested as goals after which coverage of a block can be discontinued.

Calculation of both a T/EX and a CO/EX ratio sometimes requires a decision as to which should be used for rating purposes. In most cases, both fall into the same third of the rankings. However, it is possible that results in some blocks may rate good on the T/EX but only fair on the CO/EX evaluation or fair on T/EX and poor on the CO/EX scale. Several courses of action are possible. The higher of the two rankings can be accepted, both may be required to reach the dividing line in which case the lower is governing or only one of the two, preferably the CO/EX ratio, can be used for definitive evaluation. Thus, the designers of each atlas project using the expected number evaluation system, must select the criterion to be used.

APPLICATION

AS AN AID IN DISCUSSING results with observers and in assigning additional blocks, the numbers and ratios on the evaluation form may be tabulated on small adhesive labels and placed on the appropriate blocks on a map of the region. For added convenience, the numbers or the labels may be color coded, i.e., red for good coverage, green for fair and blue for poor. Thus, the Regional Coordinator and others can see at a glance which areas are well covered, which need more work and which have not been assigned at all. The observer can also see how his results compare with those of others or which blocks are available if he is ready for an additional block. These labels can be updated after each year of work.

Experience with this method has been encouraging and no adverse reaction has been received, even from those observers whose results were rated poor. However, it is desirable to emphasize that the evaluation is not designed

Figure 4. Sample evaluation form. See text for detailed description. *Year 1981*

		No. Species					*PO/T*	*PR/T*	*CO/T*	*T/EX*	*CO/EX*			
Block	*Observer*	*PO*	*PR*	*CO*	*T*	*EX*						*HRS.*	*YRS.*	*RATING*
6955A	John Wilson	9	34	33	76	85	12	45	43	89	39	33	2	Fair
6955B	Richard Bachman	5	15	65	85	90	6	18	76	94	72	126	2	Good
6955C	Alex. Thayer	6	25	7	38	65	16	67	18	58	11	33	2	Poor

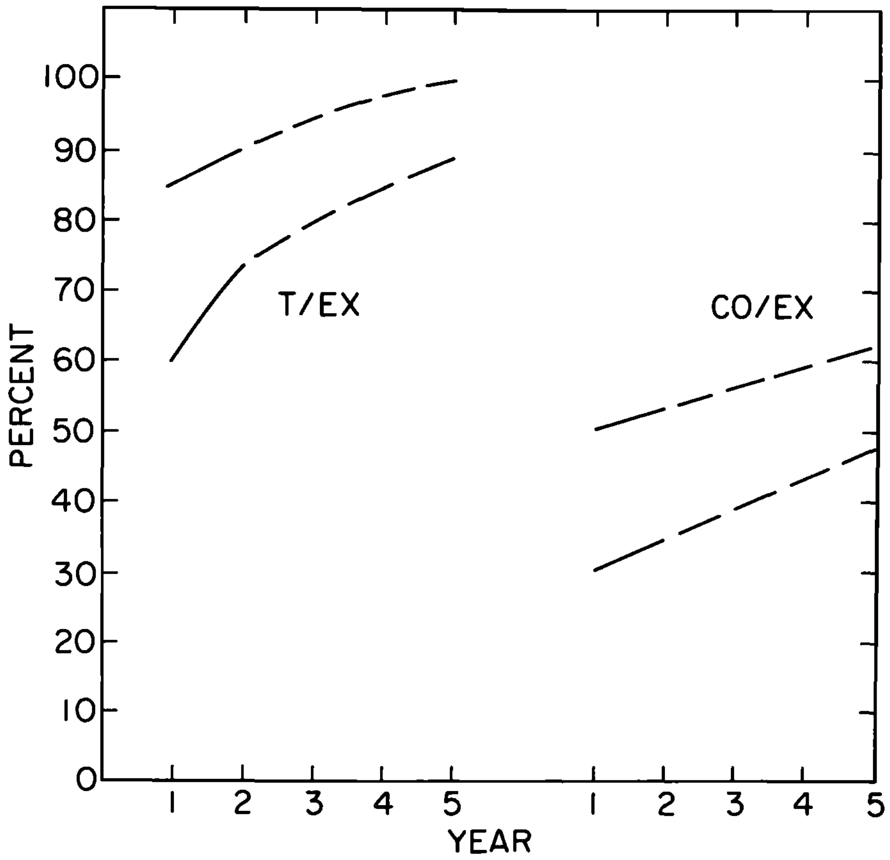

Figure 5. Dividing lines (solid) between the lower, middle and upper third of the T/EX and CO/EX ratios actually achieved by observers in the Marine Region of New York in the first two years of the project with projections (dashed) for the final three years. One-third of all observers achieved results above the upper curves, one-third between the curves and one-third below the lower curves.

to be critical of an observer or of his efforts but only as a sincere attempt to evaluate the *results*. There are many reasons why an observer may not do a good job in any one year: sickness, travel, less time than expected, etc. Thus, the Coordinator should be appreciative of even minimal results and encourage further work as needed. If an observer is clearly incapable or not interested, his block should be assigned to someone else but this situation has proven very rare. On the contrary, most observers who did poorly seem eager to do a better job next year and with proper support and encouragement can be expected to succeed.

These evaluations should also prove useful to users of the final atlas results. The absence of a species in a poorly covered block may be discounted if it is found in adjacent blocks with similar habitat but an absence in a well covered block would probably be real and should be considered significant in mapping the species' range. Similarly, in computing species richness or species diversity or in other uses of the data, the adequacy of coverage *must* be considered for meaningful results.

SUMMARY

A METHOD OF EVALUATING breeding bird atlas results has been presented based on an informed estimate of the number of species present in each block. The estimate is updated each year as coverage continues, so that the number estimated and the number counted tends to converge. Ratios of the number of species listed and the number confirmed to the number expected are classified either subjectively or objectively to define the quality of coverage. The method has both an operational and a scientific value and has worked well when applied to data from one atlas region. It is recommended for more general application.

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