THE COOPERATIVE ORGANIZATION IN WILDLIFE STATISTICS

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Has anyone in the audience had the frustrating and somewhat frightening experience of being asked by your high school son how to take the first derivative of a quadratic function and then find the maximum point on the curve it represents? Do you realize that within ten years this will be a commonplace experience? Do you further realize that ten years from now unless he can do this kind of math, a high school graduate may not even be able to get into a college to study in your particular area of fish or game management? If this is true, and I believe it is, what will your wildlife research and your literature be like in ten years? Undoubtedly the research will call upon more powerful and efficient techniques than are in use today and the literature will contain many papers written in the shortland language of mathematics. This is quite a contrast to the situation that existed when most of us went to college. We probably got very little training in mathematics, and we have had little need to use our math in such things as statistics. Does this mean then that in ten short years most of us will be regarded as useless antiquated hangers-on in science? My guess is that it could, but it probably won't!

The complexity and rapid pace of today's society requires quick adaptation to avoid obsolescence, and this is particularly true for those of us who work in scientific disciplines. In your work in the Southeast you have hit upon a novel and apparently effective method of coping with this situation. You have developed a cooperative research and consulting service which will keep you abreast of new developments. It is my pleasure to describe this service this morning and to report to you on its performance to date.

Almost your entire efforts of research, of management or of control, hinge upon the estimation of certain properties of populations. These may be populations of fish, game, insects, hunters, or licenses. The business of interpreting the

value and meaning of these population estimates lies in the domain of the biologist. However, the business of developing the methods for obtaining these estimates efficiently, without bias, with desired precision, but within a specified time and at a cost that can be tolerated, is the domain of the statistician. For many years a few highly competent and mathematically trained biologists have worked on statistical procedures for wildlife problems. Often, their contributions were not fully understood or were ignored by the general biologist. In recent years, however, it has been generally realized that a large portion of the fish or game research and management dollar is invested annually in collecting estimates. Therefore, it has been inevitable that more and more attention be given to the statistical procedures undergirding wildlife activities in an effort to get more information from every dollar spent.

Two important facts need to be called to your attention in this connection. First, modern statistics is based on pretty sophisticated mathematics, and research in statistical procedures themselves requires a strong background in math. It does not necessarily follow however that one must be an expert mathematician in order to use the techniques effectively. Secondly, most of the statistical techniques developed for other scientific fields cannot be adopted directly in fish and game problems without alteration. This means on the one hand that some mathematically capable people are now needed in this area to develop more basic tools. On the other hand it means that wildlife biologists who have little math training must be able to communicate effectively with those highly trained statisticians to set up problems and to give adequate biological interpretations to the statistical results.

What I have just described to you has been clearly seen and understood by your administrative leaders. After several years of studying this problem, they developed last year an organization which has the primary objectives and responsibilities of doing two things:

1) undertaking research on important statistical problems arising in the wildlife research and management activities of the region, and
2) assisting the biologists of the region in setting up their research and sampling activities in the most efficient manner and in analyzing the data they collect.

A very important by-product of the organization will be the training of more biologists in the basic statistical skills.

This organization was established by a cooperative agreement among nine of the Southeastern states, in which they provide for a five-year period of research and service such as I have described. The basic agreement which these states signed is supplemented annually to establish the budgetary level of activity of the organization, and the financial contribution of the participating states.

The organization was set up at the Institute of Statistics at North Carolina State College to insure adequate statistical backstopping and resources. By locating the wildlife organization here the Southeastern states automatically have call on the abilities and the interest of the 22 professional staff and the 60 graduate students who make up this center. The Institute has made a concerted effort over the years to tie their statistical activities closely to the research of the users of statistics. Thus you will find there strong programs already in the development of techniques for pastures and forage work. There is an outstanding quantitative genetics group, the animal nutrition laboratory has a basic research program that is very productive, and the plant and animal disease groups work intimately with statistics in their research. For you, this means that if a particular problem has already been worked on somewhere, one of the staff will surely know of it. Ideas on how best to approach a particular situation are sharpened by discussions in seminars and "bull sessions" among experts in statistical theory. The ideas and potential answers to problems are kept in the realm of reality and practicality by

having a wildlife biologist as your major contact. He acts as the funnel through which this all passes into the Institute. He is a man with a Master's degree in wildlife management and with eight years of field experience. He has subsequently spent three years in adding mathematics and statistical theory to his training. He can now understand and communicate very well with the theoretical statisticians on one hand and with the field biologists on the other. In addition to the wildlife statistician, the organization provides for one or two graduate students to supplement and extend the efforts of the principal wildlife statistician. This fall a student joined us whose undergraduate work was in Wildlife and the Master's degree in Statistics at Michigan State. He, too, will add mathematics and statistical theory to his bag of tools, and during the next couple of years he will be working on problems of interest to you.

We have just completed a year of operation with this new organization, and it is of interest to look back over its performance and see if it has measured up to expectations. A brief summary of activities was presented to the participating states and copies of that report are available here after this session. However, let me briefly and candidly evaluate for you the performance of the organization last year as I see it. As I do this, I would urge you to form some judgement of how its usefulness may be enhanced in the future.

We have found during the 20 years that the statistics program has been operating at North Carolina, that communication is the first major problem in assisting any group with statistical needs. The statistician is accustomed to thinking in terms of idealized situations, because these are the situations for which mathematical or statistical solutions exist or can be readily developed. The biologist on the other hand finds it extremely difficult to understand the reasons why observations must be random, why a complicated design may provide cheaper information even though it may cost more to use it, why messy mathematical formulae

are used instead of simple arithmetic, etc. In view of this it was decided that establishing rapport and understanding between these groups was and continues to be the first order of business for the new organization. A second hurdle to be overcome is the stimulation of the imagination and interest of the biologist in using newer and more efficient approaches. In view of the fact that both of these problems were common to almost all the biologists of the area, a mass approach appeared advisable and a one-week short course was organized last February. This session provided some basic instruction in statistical methods and designs, it illustrated ways in which these ideas could be put to effective use in wildlife problems, and it held workshop discussions on specific problems brought in by participants. Those who attended felt that they learned enough statistics to see that many things they were now doing could be improved upon greatly, and many activities that were in the planning stage became much clearer with respect to efficient procedures. Perhaps, more important than all else, they saw new possibilities of resolving their problems through this newly developed service. This short course will be continued as an annual affair as long as it appears to be effective for the area.

You have brought many problems to us during the year, asking for ways of estimating certain populations. Almost without exception, there was no patent answer. We developed, in the time allotted, the best answer we know. Then, in the case of many of these problems, further statistical research was done. Results of these further inquiries into theory must necessarily be recorded first in very technical language and presented to theoretical statisticians to undergo severe scrutiny and criticism by those best qualified to do so. Later, these results will be presented in more biological contexts and with the necessary practical details spelled out.

There are three papers in manuscript form ready for submission to journals.

They are:

1. Random road block method of estimating hunting pressure.
2. Testing differences in population level when the Schnabel method of estimation is used.
3. The mean square alternate difference in certain wildlife applications.

Some of you have seen these reports. They are written in rather mathematical terminology and are currently receiving the "baptism by fire" from statisticians. Your turn will soon come to give them similar review and criticism from the biological viewpoint. In the meantime, if you wish to see this work summarized against a background of other statistical research, I have with me a few copies of the recent "Record of Research" for the Institute of Statistics for distribution.

In addition, the staff have developed techniques that are being used in the field by one or more states in the region, but which are not yet written up in publishable form. These are:

1. A creel census design with flexible size of sampling unit.
2. More efficient estimation of fishing pressure by numerical integration methods.
3. A technique for estimating duplication in licensing under a generalized pattern of duplication in any number of license categories.

In my estimation, some of these pieces of research represent real break-throughs on problems you have faced, and they are developments that you can be proud to be a part of.

Consulting activities are difficult to appraise. Their value depends on the technical skill of the biologist as well as the statistician, on proper timing, on personalities, and on other intangibles. There has been an increased flow of questions and problems, particularly following the short course. There is every indication that this portion of the organization's activities will soon swamp us.

Several innovations are planned now to extend the usefulness of these personal consultations. Many of the problems resolved are of rather wide interest, and therefore, we plan a periodic reporting to you on problems sent in and the solutions developed. We also expect to use many of these problems as the basis of afternoon workshop discussions in the short courses where methods of arriving at answers can be spelled out in more detail. It is expected that new ideas and techniques developed from the above activities will soon be appearing in your literature, although this form of reporting will usually await the availability of actual results.

In summary, I should like to emphasize three points.

1) In order to maintain leadership, your administrators have provided you with a statistical organization through which you can effectively call upon statistical theory and mathematics now in your own work.
2) During its first year of operation, this organization concentrated on developing good communication between biologists and statisticians and in stimulating an awareness of the potential of statistical tools. It also made significant contributions in basic methodology in wildlife research and it provided very worthwhile consulting services.
3) This is your organization and we invite you to use it to the fullest, not only in research, but also in administration and in educational programs.

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240. Bose, R. C. and Ray-Chaudhuri. On a class of error correcting binary groups of codes. September, 1959.

242. Corsten, L. C. A. Note on triangular partially balanced incomplete block designs. October, 1959.

243. Quade, Dana E. A. The asymptotic power of the Kolmogorov Tests of goodness-of-fit. December, 1959.

244. Durbin, James. Fitting of time-series models. December, 1959.

245. Bose, R. C., S. S. Shrikhande and E. J. Parker. Orthogonal Latin-squares and Euler's conjecture. January, 1960.

246. Roy, S. N., B. G. Greenberg, A. E. Sarhan. Evaluation of determinants, characteristic equations and their roots for a class of pattern matrices. December, 1959.

247. Hannan, E. J. A central limit theorem for systems of regression. March, 1960.

248. Rawlings, J. O. and C. C. Cockerham. Theoretical analyses of double-cross and three-way hybrid populations. March 1960.

249. Durbin, James. Efficient fitting of linear models for a continuous stationary time series on discrete data. March, 1960.

250. Hannan, E. J. The canonical correlation of functions of a random vector.

251. Grizzle, J. E. Application of the logistic model to analyzing categorical data. April, 1960.

252. Finkner, A. L., John Monroe, and Jack Fleischer. The Nashville morbidity survey. April, 1960.

253. Hafley, William. Some comparisons of sensitivities for two methods of measurement. April, 1960.

254. Roy, S. N. On a new derivation of a well-known distribution. April, 1960.

255. Smith, W. L. A note on the renewal function when the mean renewal is infinite. April, 1960.

256. Gaylor, D. W. and R. L. Anderson. The construction and evaluation of some designs for the estimation of parameters in random models. April, 1960.

257. Richardson, Wyman. Asymptotic methods of evaluating $\int_a^\infty f(x)dx$. May, 1960.

258. Hoeffding, Wassily. On sequences of sums of independent random vectors.

259. Webster, J. T., A. H. E. Grandage, R. J. Hader, R. L. Anderson. A decision procedure for the inclusion of an independent variate in a linear estimator. June, 1960.

260. Chakravarti, I. M. On some methods of construction of partially balanced arrays. July, 1960.

261. Roy, S. N. and R. Gnanadesikan. On certain alternative hypotheses on dispersion matrices. August, 1960.

262. Murthy, V. K. On the distribution of averages over the various lags of certain statistics related to the serial correlation coefficients. August, 1960.

263. Anderson, R. L. Some needed developments in multivariate analysis. August, 1960.

264. Chapman, D. G., W. S. Overton and A. L. Finkner. Methods of estimating dove kill. October, 1959.

265. Eicker, Friedhelm. Consistency of parameter-estimates in a linear time-series model. October, 1960.

266. Eicker, Friedhelm. A necessary and sufficient condition for consistency of the LS estimates in linear regression. October, 1960.

267. Smith, W. L. On some general renewal theorems for nonidentically distributed variables. October, 1960.