A TEST FOR RANDOMNESS IN TRAPPING[1]

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When certain information, such as sex-ratio, comparative abundance, age distribution, etc., is sought from a trapping program, the investigator desires what is commonly referred to as a random sample. In general this is taken to mean that there are no artificial distortions of the data—that the trapped sample is an accurate representation of the population being studied.

Where only single captures are required, such as in some bird-banding programs, or in small mammal snap-trapping studies, the problem is simpler than in programs where individuals are marked and released for recapture attempts. In the latter case one has to have information about the randomness of recaptures as well as original captures (Young, Neess, Emlen, 1952; Young, 1958).

This paper concerns itself with the randomness of original captures, and makes use of a technique first described by Mood (1940), which may be described as the "theory of runs." For a particularly lucid discussion, see Freund (1952). In brief, this relates to the internal structure of the sample, i.e., the sequence in which the data occur.

The use of this technique can be described by taking some material from the author's bird-trapping records. From January 29, 1958 to April 21, 1958, a ten trap banding station was in operation in a local cemetery. All the traps were single-cell Potter-type traps, permanently located, and uniformly baited with scratch feed. The Slate-colored Junco, *Junco hyemalis,* was one of the species captured. The data were first organized by designating as A any day on which at least one junco was caught, and as B any day on which no juncos were captured. These were then arranged in their natural chronological sequence, giving the pattern shown below:

BB A B AA B AA B AAA B A BBB A BB A B A BBBBBB AAAA BBB A BB A BBBB A BBBBB A

Field biologists are frequently plagued by small samples, such as this one, and in these cases it is particularly desirable to have information about the randomness of the sample. The technique here described is applicable as long as A and B each equal at least ten. The question to be answered is whether or not this is a random arrangement of A's and B's. Simple counting shows that there are twenty A's and thirty-two B's, and that there are twenty-six runs of either A or B. A run is a sequence of one letter followed and preceded by the other letter, or by none at all. We may designate the runs by the symbol u.

This test helps us decide whether the runs are too numerous or too few to constitute a random sample. To do this we make use of the following formulae:

1) $mu = 2AB/A + B + 1$

and

2) $\sigma u = \sqrt{2AB(2AB - A - B)/(A + B)^2\ (A + B - 1)}$

If the total number of runs is less than $mu - 1.96\sigma u$, or greater than $mu + 1.96\sigma u$, the sample probably is non-random. If it falls between these two limits the sample does not show any significant (5% level) deviation from randomness.

In the particular case here considered, $mu = 25.62$, $\sigma u = 11.33$. Therefore $mu + 1.96\sigma u$ is 47.83 and $mu - 1.96\sigma u$ is 3.41. Since $u = 26$ falls within these limits, there seems to be no apparent deviation from randomness. This gives the investigator a certain amount of confidence in completing more detailed analyses, such as sex-ratios, recapture ratios, etc.

From January 29, 1958 to March 26, 1958, Chickadees, *Parus atricapillus,* were also captured at the same station. The original data can be examined in the same way as that for the junco. For the chickadee the results are $A = 30$, $B = 19$, and $u = 23$. Using the preceding formulae we obtain $mu + 1.96\sigma u = 25.56$, $mu - 1.96\sigma u = 20.28$, and u again falls within the indicated range of randomness.

During 1958-1959, traps were operated for 103 days during the period from Nov. 3, 1958 to April 3, 1959. English Sparrows, *Passeres domesticus,* were abundant in the area, and often seen in the immediate vicinity of traps. Examination of the trapping data on these birds gives the following: $A = 21$, $B = 82$, $u = 21$. It can be seen that sparrows were caught on about 1 day out of 5. Analysis shows that $mu + 1.96\sigma u$ is 40.83, $mu - 1.96\sigma u$ is 28.05. As u fails to fall within these limits, it appears that capture was not random.

Where definite suggestions of a non-random behavior are present, the application of more advanced statistical procedure must be carried out with distinct reservations, if at all.

Another situation might arise in which captures were made every day the traps were set, or almost every day. Where trapping success has been this good it is still possible to apply the "runs" test by computing the average number caught per day, and then designating as A those days on which more than the average were caught, and as B those days when fewer than the average were caught.

The author is not this efficient a trapper. However, data approaching this condition are available from the trapping of juncos during the winter of 1958-1959. From Dec. 18, 1958 to April 3, 1959, juncos were caught on 49 (79%) of the 62 days on which traps were set. Initial analysis showed that the capture-non-capture days produced a non-random pattern. During this period there was a total of 105 captures of juncos, an average of 1.7 per day. Days on which 2 or more juncos were caught were designated as A, those on which 1 or zero juncos were caught were designated as B. On this basis, $A = 30$, $B = 32$, $u = 29$. Computations show that $mu + 1.96\sigma u = 60.76$, $mu - 1.96\sigma u = 1.18$, and u falls well within the limits of randomness. This indicates a lack of significant "bunching" of captures.

Establishment that the original captures followed a random pattern of course does not release the investigator from further statistical responsibility. For example, suppose one were investigating the length of the residence period of a migratory species. It should be clear that this would not necessarily coincide with the period during which the birds were captured. There might well be a time-lag after arrival in the area before the first individual was caught, and again, some might remain in the area for some time after the last capture. Evidence that they were captured in random fashion during the period in which they entered the traps would not give information on this point.

The test thus applies specifically to those individuals which are vulnerable to trapping, and provides no information about those which refuse to enter the traps for any one of various reasons.

For another example we may consider trapping reports on the Cardinal, *Richmondena cardinalis*, for a period extending from Jan. 4, 1953 to May 24, 1953. During this time the average number of cardinals caught per day was 1.6. Analysis by this "runs" method showed a random pattern of captures. However, further analysis (Young, 1958), which considered recaptures, showed that the individual birds did not repeat in random fashion.

The techniques here described would seem to be of value in preliminary consideration of small sample data. Where indications are that the sampling technique *per se* was selective, i.e., non-random (and this is often the case), the use of data drawn from the sample must be made with due caution.

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REPORT ON THE CAUSE OF MORTALITY AND THE MORPHOMETRY OF SEVENTY RUBY-CROWNED KINGLETS KILLED AT THE WENH-TV TOWER IN DEERFIELD, NEW HAMPSHIRE

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The University of New Hampshire began use of the educational TV channel 11 in 1959 in conjunction with other educational institutions in New Hampshire. Part of the installations constructed to activate the station consist of a supported tower 360 feet high topped by a 12 bay antenna, one foot in diameter and 76 feet high. This structure was erected at a point about 1100 feet in elevation on Saddleback Mountain in Deerfield, N. H. The tower is guyed at three points equi-