SOME REPEAT DATA ON THE CARDINAL

BY HOWARD YOUNG

The establishment of a banding station in a previously untrapped area doubtless produces various changes in the behavior of the exposed population. As a persistent source of food it may alter the movement patterns of some individuals, and as a location where there is a frequent concentration of birds it may attract predators and thus modify the local mortality rate. Capture in a trap produces differing reactions among the victims, which will affect the probability of their being recaptured.

Where banding data are used to gain information about local movements, survival, etc., attempts should be made to determine the effects of such factors. The following material is an effort in this direction, concerned particularly with the trap-reactions of individuals after initial capture.

During the period Jan. 4, 1953 to May 24, 1953, a total of 88 cardinals (35 males, 53 females) was captured at Fayetteville, Arkansas. The traps were single-cell potters, and scratch feed was used as bait. In this period of time (141 days), traps were set on 133 days. There was a constant total of 15 traps, each permanently located at its own spot within the approximately one-half acre trapping area. This resulted in 225 captures of cardinals, the original 88 captures, and 137 repeats (1,995 trap-days).

Prior to the time of this study, trapping had been carried on in the same area; but a varying number of traps, shiftings of locations, and irregular trapping periods prevented the accumulation of useful data. Eighty cardinals (33 males, 47 females) had been captured during this period of intermittent banding.

Of the 88 birds included in the following discussion, 34 (16 males, 18 females) are birds which had been banded during the period last described, and prior to Jan. 4, 1953. Their date of banding varied from 20 to 66 days before the beginning of the study, with an average of 38 days. Since these birds constituted nearly 40% of the sample available for the present work, it was desirable to include them, providing their repeating history did not vary significantly from those first caught after the project had been organized.

To consider this problem, the birds were divided into two groups: A (banded prior to Jan. 4, 1953), and B (banded on or after Jan. 4, 1953). Statistical tests indicated that the groups did not vary significantly in any of the following respects: sex ratio, no. males repeating, total no. male repeats, total no. female repeats, days elapsing to first recapture (either sex). In comparing the number of females repeating, a X^2 value of 4.750 was obtained, which exceeds the level of probability at 5%, comparatively more females repeating in the A group than in the B group. Since the tests on all other characteristics indicated that variations such as were found would be frequently expected from chance alone, and since some variations exceeding the 5% X^2 level can of course also be ascribed to chance, it was felt that pooling of the two sets of data was permissible.

Consequently these 34 cardinals banded prior to Jan. 4, 1953 were included; their first trapping after Jan. 4th was considered as the original capture for use in this analysis, and all subsequent captures were considered as repeats.

One purpose of the study was to observe the variation, if any, in trap response (trap addiction vs trap aversion) among the individual cardinals. Since the species shows a marked sexual dimorphism, it was also possible to note and measure any difference in trap reaction between the sexes. It may be stated at this point that much confidence was placed in the sedentary habits of the cardinal, the problem of length of stay being lessened by choosing a non-migratory species as a subject of study.

There were no other banding stations within 50 miles, and there were no foreign recoveries; all repeats referring to recapture at the home station. Previous to the establishment of this station, 49 cardinals had been banded the preceding spring about 1 mile distant. Two of these birds appeared at the new station, one male and one female. As in all banding studies, the error introduced by movement, and whether it is equally distributed between the sexes, is an unknown factor.

In this study a bird was considered as present only until its last capture. This perhaps introduces an error, since some birds present will probably refuse to re-enter the traps. At the same time we eliminate those birds which have permanently moved from the area.

Data bearing on the points above are presented in Table 1. The sex ratio at the time of first capture does not vary significantly from 100:100 as tested by X^2, and the proportion of birds repeating is almost exactly even between the sexes. However, in the total number of recaptures (which reflects the frequency with which individuals repeated) a marked difference between the sexes appears. The recaptured males repeated at about 175% the frequency of recaptured females, and this apparently reflects a real difference between the group ($P<1\%$). Since the birds were recaptured at various times in the study, those first captured early in the program had more opportunity to repeat than those captured later. With this point in mind, the average number of trap days that the repeating males and females were known to be exposed to was computed, to see if this explained the difference.

When this analysis was made, it was found that the average known exposure was the same for each sex—34 days. The discrepancy in repeats is thus expressed more accurately in Table 1 under the column entitled "Ave. No. Recaps./Day." However, one male repeated 25 times

TABLE 1—CARDINAL BANDING DATA

	Captured		Recaptured		Total Recaptures		Ave. No.* Recaps.	Ave. Recaps. Per Day	Ave. No. Days to 1st Recap.
	No.	%	No.	%	No.	%			
Males	35	40	16	46	77	57	4.8	.14	8.6
Females	53	60	23	43	60	43	2.6	.08	14.7
Totals and Averages	88	100	39	44	137	100	3.5	.11	12.2

*Omits non-recaptured birds.

during a known exposure of 92 days; this may possibly reflect a "position effect" of a bird rather permanently settled in the immediate vicinity, which would tend to be caught more frequently than those visiting the area at irregular intervals. When the data are recomputed, with this male omitted, the variation between the two sexes is of a degree that could well be ascribed to chance ($5\% < P < 10\%$).

Hundley (1953) reported on two trapping periods for the cardinal. From November 5, 1950 to April 20, 1951, 44% of 52 males repeated, while 56% of 48 females repeated. From October 17, 1951 to February 14, 1952, 56% of 75 males repeated, while 55% of 77 females repeated. Neither difference is significant.

The possibility of differential trap vulnerability may also be examined by considering the days elapsing before the first recapture, on the logical assumption that a bird which had acquired a wariness towards traps would take longer to repeat than one not so conditioned. Despite the fact that females on an average waited six days longer than males before re-entering traps, the difference does not appear to be significant. ($t = 1.142$, $P > 30\%$).

In monogamous species an approximately 100:100 sex ratio is usually assumed. The small sample in the present report does not vary significantly from this ratio. Also Hundley (op. cit.) in two larger samples found 52% males in 100 birds trapped ('50-'51) and 49% males in 152 birds trapped ('51-'52). Variation here from 100:100 is obviously insignificant.

With the possible exception of the frequency of repeating, a sex difference in behavior towards traps is not demonstrable in this species with the data available. Unless one hypothesizes a sexual variation in the initial contact with traps it would appear that the sex ratios of the cited samples accurately reflected those of the cardinal populations in the areas.

The use of banding data to compute population levels, length of stay, etc., is dependent upon the assumption (among others) that the banded birds are all equally susceptible to retrapping. Such was not the case in the studies of Borror (1948) and Hundley (op. cit.). Though the problem is seldom mentioned in bird-banding literature, it has been considered in other vertebrate studies, and many banders have had

TABLE 2

Distribution of first repeats compared with that expected from a p value of .11.

p	day	exp.	obs.
.110	0	3.08	2
.098	1	2.74	0
.087	2	2.44	3
.078	3	2.18	1
.069	4	1.93	2
.061	5	1.71	2
.055	6	1.54	0
.049	7	1.33	2
.043	8	1.20	0
.039	9	1.09	1
.034	10	.95	0

experience with "trap-happy" individuals, while others are identifiable in the area, but repeat only at rare intervals, or not at all.

As mentioned before, we may measure this "retrappability" of individuals by observing the number of days elapsing before a bird is recaptured for the first time. Here we make use of the data to determine p, the probability of a bird being recaptured on any given day. This is computed by use of the formula: $p = n/t$, where n equals the number of days on which a bird repeats, and t equals the time (no. days) exposed to traps. The upper limit of p obviously is 1.0. In the case of the present data, a p value of .14 is obtained for the males, of .08 for the females. Computed for the entire group, the weighted average is .11. The same formula could be computed using n to represent the total number of repeats (including multiple repeats on a single day). In the present case the change in the value of p would be a negligible increase. See Young, Neess and Emlen (1952) for further consideration of this expression.

Since p represents the probability of being recaptured on any day following banding, then 1-p equals the probability of escaping traps on any given day. It follows that p (1-p) is the probability of escaping traps the first day but repeating on the second. Similarly $p\ (1\text{-}p)^2$ represents the chance of a bird first repeating on the third day, and $p\ (1\text{-}p)^{n-1}$ of a bird first repeating on the nth day.

Twenty-eight cardinals (10 males, 18 females) had repeat records indicating that they had exposures of 10 days or more to the traps. Table 2 shows the distribution of first repeats during the first ten days which actually occurred in this group, compared with that expected from the stated p value.

It is clear that the two have little similarity. A p value of .11 should result in the first recapture of 20 birds within the first ten days after banding, while actually only 13 repeated. One of these cardinals did not repeat until 55 days after the initial capture. Although the sample is not large for statistical purposes, a X^2 test (using small sample adjustments) on the total of 28 birds indicates a non-chance variation from the expected ratio. Retrapping therefore does not seem to have been random, and the distribution of the repeats suggests that trap-shyness was a major factor operating. Actually of the entire cohort (88 birds), 56% never repeated, although trapping continued for an average of 94 days after their original capture.

TABLE 3—TRAP SUCCESS

Period	Success*
Jan. 4 - Jan. 29	.21
Jan. 30 - Feb. 24	.13
Feb. 25 - Mar. 23	.09
Mar. 24 - Apr. 23	.11
Apr. 27 - May 24	.02

*no. captures/no. trap days

Banding activities tend to produce both trap-shy and trap-addicted individuals, but it is not safe to assume with Borror (1948) that the two reactions cancel each other out. While these responses produce compensating errors, numerically they are not necessarily equal, and the intensity of the individual reactions is variable.

Further trouble arises when the trapping period extends over any considerable period of time, since trap-success varies with changing weather and seasonal changes in the bird's activities. Table 3 summarizes such data for this study.

Comparable problems exist in retrapping programs for small mammals (Young, Neess, Emlen, op. cit.). Banding studies on such topics as populations, stay-over period, survival, etc., will be strengthened if records are reported in such a way that efforts can be made to evaluate these difficulties. With large samples it might be possible to measure the variations in trap-reaction with enough precision that appropriate mathematical adjustments could be made where necessary.

To accumulate data of this type, several features seem mandatory in the banding program:

1) Number and type of traps should be fixed
2) Position of traps should be fixed
3) Bait should not be varied
4) Records should be kept of trap-days
5) All repeats should be recorded

Change in any of these features results in unmeasurable variations in the probability of retrapping, or leaves gaps in the needed data.

SUMMARY

1) Trapping activities in Arkansas from Jan. 4, 1953, to May 24, 1953, resulted in 225 captures of 88 cardinals.

2) The sex ratio of the trapped sample did not vary significantly from 100:100, and the trap-reactions of the sexes were similar.

3) Analysis of the recapture data indicates that the individuals repeated in a non-random fashion.

4) Seasonal changes in trap success were noted.

5) It is suggested that trap reaction be given consideration where studies involve the use of banding data.

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Wisconsin State College, La Crosse, Wisc.