So far I have used seed in a small tray as bait and hung the trap from a lower limb of a tree by the ring in the bail. The list of captures from 10 April to 31 December, 1950 is: Downy Woodpecker 1, Black-capped Chickadee 72, White-breasted Nuthatch 2, House Wren 1, Ruby-crowned Kinglet 1, Rose-breasted Grosbeak 6, Goldfinch 3. At least one Chickadee learned to go in and out without using the perch. Lateral twigs left on the perch would help.

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ON THE PROBLEM OF THE RETURN OF MIGRATORY BIRDS

By CHARLES H. BLAKE

It seems clear from observation that certain migratory birds return with good accuracy to their nesting sites and to their winter quarters. It is usually supposed that the failure of some of these species to show returns to intermediate banding stations may be ascribed to their using a somewhat different route on each migratory trip. Such an explanation is only credible if we assume that the departures from the previous route are merely large enough so that the bird passes beyond the area of attraction of the trapping station and that these deviations are not cumulative during any one trip. Otherwise, the bird would stand a strong chance of passing into unfamiliar territory from which it could not find its way to its destination. We are here discussing only those cases where a bird is making a migration in a direction previously travelled. The problem of the first fall and spring migrations of a young bird may be entirely distinct. It will be noted that I am assuming virtually contact navigation. As an *obiter dictum* drift or abmigration will yield no returns and the case of instrument navigation, although it would give the same sort of result as contact navigation, is still too obscure to be profitably considered.

A still more unlikely answer is that the bird has solved the problem of going between two fixed points by a path which is known as a "random walk." If we are satisfied with a statistical distribution of the returns around the fixed point this solution is possible, but the bird's solution seems to be an absolute one rather than statistically random.

Later I expect to consider the problem of the direction of flight line and of individual migratory flights (here called jumps). Each jump is an uninterrupted flight from one feeding or resting stop to another. Here I intend only to consider the problem of the statistical distribution of the lengths of jumps and its bearing on the likelihood of return to a given stop on the migratory path of the individual.

We may start with the assumption that a bird feels no special attachment to any one migratory stop. This seems intuitively reasonable

although we have no proof of it for small land birds. The situation
may well be quite otherwise for birds that require some restricted type
of feeding or resting area.

The actual statistical distribution of the lengths of jumps is not
known. We may say with some assurance that all jumps will be of
more than infinitesimal length and will rarely be indefinitely long. For
the present we may ignore the question of the exact physical meaning
to be attached to a jump of zero length. Unless the average jump is
very long and the lengths very uniform the distribution will tend to
be skewed. The distribution can only be symmetrical if the range of
possible deviations above and below the mean is the same. As a first
approximation we will assume that the individual lengths exhibit a
Poisson distribution. This choice is motivated not alone by considera-
tions of the parameters of the distribution but by the practical reason
that extensive tables (Molina, 1942) are available for the Poisson dis-
tribution. Certain skewed Gaussian distributions would yield practically
the same qualitative results.

Let us define our unit of distance as that distance from a banding
station at which a bird may alight from a jump and still be attracted
into the station. We further make the simplifying assumption that the
direction of the jump passes through the center of the banding station.
Under these conditions, if the average jump length is l then the maxi-
mum and minimum lengths which will yield arrivals at the station
are $l + 1$ and $l - 1$.

We may now consider what will happen if the starting point of the
jump and the banding station are separated by a distance d. The nu-
merical value of the probability of arrival (p) at the station will
depend on the absolute values of l and d as well as on the ratio l/d.
I have computed numerical values of the probability in some detail
only for the case $d = 100$ over the range $l = 0.01$ to $l = 100$ (Fig. 1).
Together with a more cursory examination of other values of d over
the same range of l this suffices for a general picture of the relation
between the probability of arrival and the ratio l/d. If l is equal to
or less than 1, then p tends to approach 1, that is, certainty of arrival.
For values of l lying between 1 and d, the situation varies in detail with
the size of d, but generally the curve will show one or more peaks
(maxima) in this span. The higher maximum will occur at $l = d$ and
another and lower one may occur near $l = d/2$. For l greater than d,
the value of p diminishes as l/d becomes greater.

The effect of our simplifying assumption that the direction of the
jump is through the center of the banding station is to increase p for
all values of l greater than about 1.

We conclude that the chance of a bird returning on another migration
in the same direction as the first to a banding station at which it was
originally banded as a migrant is small except in the cases where the
bird migrates by very short jumps or where the distance from starting
point to banding station is, on the average, made in one jump or a
very few jumps of almost equal length.

Now the question arises as to how a station gets any birds to band
if it gets very few returns. Let us again assume a case similar to the
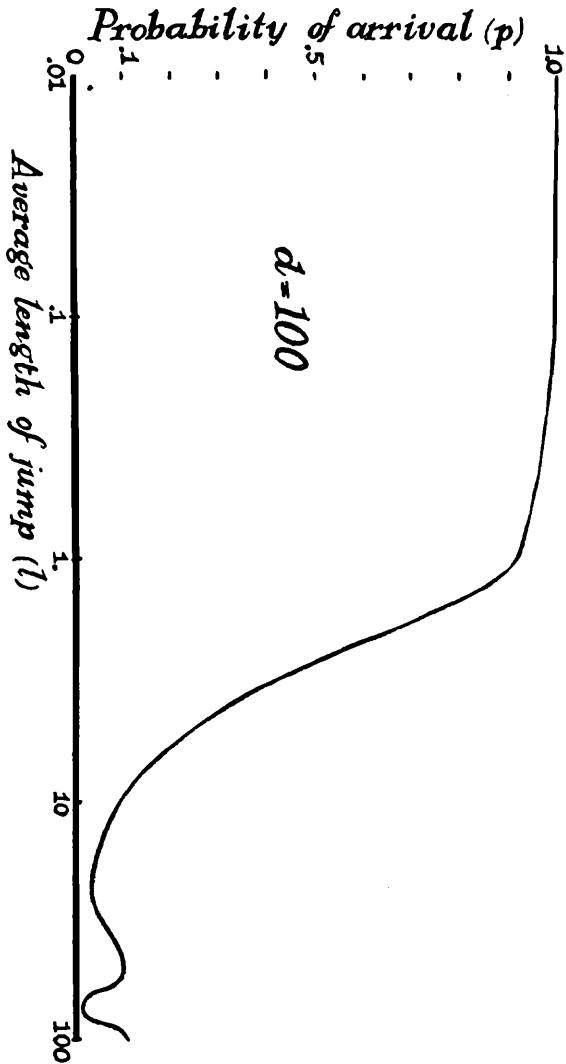
precding, namely an average jump of 100 units of distance and a
uniformly distributed population distant 90 to 110 units from the
station. We make a further simplifying assumption that birds must
alight at the station to be available for banding. This assumption
somewhat reduces the population available for trapping and also our
arithmetic, but is evidently more stringent for the birds. The overall
chance for birds starting from any one unit of distance is 0.033 or a

little more than 3 birds per 100 of population. The chance of a return a year later is the square of the chance of the first arrival which is 0.0011 on the average. Under the stated assumptions a bird once captured has only one chance in 31 of returning. It would be easy to pick cases giving much lower rates of return. Our example makes no allowance for deaths which will decrease the chance of any designated bird returning without appreciably altering the chance of its being banded.

We may summarize our conclusions in another way by distinguishing four classes of passages from one place to another.

Class A — The distance is covered in one jump. Ex. 100.

Class B — The distance is covered in very few jumps of equal or nearly equal length. Ex. 49 + 51.

Class C — The distance is covered in few jumps of very unequal length. Ex. 98 + 2.

Class D — The distance is covered in several jumps of nearly equal length. Ex. 25 + 25 + 25 + 25.

If the distance to be covered is the same as the average length of the jump then Class A is the most favorable, with Class B generally next most favorable to a return.

If the distance is some small multiple of the average jump length, then Class B will be most favorable.

If the distance is a large multiple of the average jump length, then Class D is the most favorable.

There will be no cases in which Class C will be most favorable.

It is unfortunate that, at the moment, we can advance only a theoretical solution. Such a solution, although unsatisfactory in some respects, tells us what we need to know in order to convert the theory into an actual solution for a given species. Even if the theory ultimately needs alteration and refinement it is the best guide we have to formulate methods for solution of the problem. For any species we need to know the length of the migratory jump, its variation, the unit of distance, and the points of origin of the birds arriving at a given station.

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AN EXAMPLE OF SEXUAL BIAS IN TRAPPING

BY CHARLES H. BLAKE

Farner (1949: 68-69) has pointed out the question of bias in trapping birds. Years ago, this was specifically noted for the towhee by Whittle (1928) and Wharton (1928). It was early apparent to me that the Red-eyed Towhee *(Pipilo e. erythrophthalmus)* shows a strong sexual bias with adult males trapping much more readily than adult