mother dressed in a night cap. Later on, when we saw them full grown, they got to be more owl like and dignified.

An owl spreads terror among the small ground folk as a ghost among negroes. It is the owl's shadow-silent wings, his sharp, sound-catching ear and his night-piercing eyes that make him the superior of the mouse, the mole, the gopher and the rat. He fans over the field with an ominous screech that sets a mouse scampering to his hole, but his ear has caught the foot-steps; those wings are swift; those steel trap claws are always ready; his drop is sure, his grip is death.

From an economic standpoint, it would be difficult to point out a more useful bird in any farming community. Like many other birds, the barn owl deserves the fullest protection, but man is often his worst enemy.

Santa Monica, Cal.

The Percentage of Error in Bird Migration Records [1]

BY WITMER STONE

IN no branch of ornithology is it more difficult to obtain reliable data than in the study of bird migration.

It is seldom that we see the actual migration in progress, and then it is but a small fraction of the movement that comes under our observation and that often under abnormal conditions.

Consequently we are thrown back upon a comparison of the records of the occurrence, or the dates of arrival and departure of birds at various points, in any deductions that we may make as to the direction and rapidity of their migratory flights.

Without considering the possibility of error on the part of the observer there are many conditions which tend to impair the accuracy of such records, such as inability to be in the field every day during the migratory season, inability to cover the same amount of territory each day, and the recording by some observers of early stragglers which were not noted by others.

To obviate the last, suggestions have been made to record the arrival of the bulk of the species; but this at once admits the personal equation into the problem, and I find that nearly all observers differ in their interpretation of the bulk arrival, especially in the case of species which are subject to a constant increase in numbers from the first day that they are observed.

The average date of arrival based on several years' observation is more accurate as a basis of comparison, but even then there is a large probability of error.

Now most of the published tables of migration consist of the records of single observers at scattered points along the route of travel with generally large intervals between their stations.

Scarcity of competent observers made it practically impossible to secure a large number of migration records from a limited area; but the wonderful increase in the popular interest in bird study which we have recently witnessed has developed many able observers and renders the accumulation of this sort of data quite feasible.

It has been my privilege to study a series of local records of this sort kept at from 30 to 40 stations each year, all within 15 or 20 miles of Philadelphia, by a corps of observers organized by the Delaware Valley Ornithological Club.

These records are suggestive both in the apparent reduction of the percent-

[1] Read at the Twenty-third Congress of the A. O. U. in New York City, November, 1905.

age of error by a combination of many local reports and in the light which they seem to throw upon the general nature of migratory arrivals.

I have, moreover, a peculiar pleasure in presenting some of the results of my study on this occasion in as much as the first paper that I ever read before the A. O. U., fifteen years ago, dealt with the migration records kept at Philadelphia by the seven founders of the Delaware Valley Ornithological Club which had then just been organized.

The plan of recording migration which is now followed by our migration corps, as well as the detailed results of the work, have been published each year in *Cassinia*, the annual publication of the Club; but, as many of you probably have not had an opportunity of consulting it, I shall give a brief outline of the plan.

The work is confined to the spring migration, as the study of the fall movement has proved impracticable except in the case of a very few observers.

Schedules are mailed in February to all former observers and to probable recruits, and contain the printed names of 90 migrants, with blanks for the date of arrival after each, and a blank column for the entry of additonal species, while remarks and supplementary data are to be written on the back. The convenience of having each species in exactly the same position on every schedule can be appreciated by any one who has done any compiling from such records. The *first* date of observation *only* is entered in the arrival column but others may be given under remarks, especially when the first arrival was an advance straggler. The schedules are returned in June, and as soon as the report for the year is prepared and published, each observer receives a separate, thus keeping up his interest in the study and keeping him in touch with his fellow workers.

From the records of the past four years I have selected the dates of arrival of a few of the most common and easily recognized species as reported by some of the most reliable observers, that is, those who were most constantly in the field. From these we may draw some interesting deductions.

In the first place the diversity of dates is considerable; even the average of arrival for four years is by no means uniform, and one can readily see that any calculation on the speed of migration in a general study would vary considerably according to which station we should quote as indicating the date of arrival at Philadelphia. Indeed the diversity is sometimes as great as that between points separated 200 miles or more, as given in some of the published records. [See Table I.]

Tabulating the records in another way and using the whole series we find that there are usually scattering reports of arrival from one or two stations. And then on one or two days the species reaches nearly all of the other stations. In other words the bulk of the arrivals are massed on one or two days. [See Table II.]

It seems to me that the indications are that early arrivals drop down here and there thruout the area covered by our observers, sometimes being first recorded from the stations farthest up the river or farthest back on the uplands; then comes the bulk movement some days later which marks the advent of the species at all the other stations.

In other cases there is no well marked bulk movement, and the species is reported arriving day after day at one station or another until it is spread over the whole area. In such instances it may be seen regularly by one man some days before it appears in the territory covered by his neighbor only a short distance away.

This method of tabulating our data is probably the most satisfactory, but as an illustration of how the combination of several records reduces the percentage of error, take sixteen stations within ten miles of Philadelphia in 1903, and we find a range of a week, or more, variation in the reports of arrival of six common species;

combining the same records into four centers or clusters of observers, north, south, east and west of the city, and selecting the earliest date for each species in each of the four groups, we find the range of variation reduced to a day or two. [See also Table III.]

In this way it can readily be seen that every report, no matter how fragmentary, is of value. It may contain one or two observations not noted at any other of the neighboring stations, while its deficiencies are made up in their records.

I do not propose to quote a host of dates and figures, which are uninteresting and hard to follow, but I trust I may have made clear to you the value of combined local records and also the probability that the correct statement of migration at any given point will not be the citation of a single date but by some such statement as follows: "Stragglers of a certain species were arriving at Philadelphia from April 23 to 27 and the bulk movement occurred on April 28 and 29."

Migration constantly invites us to theorize and generally we find that we are working with very slender chains of evidence. What we need in the future, it seems to me, is more detailed and accurate data; and the plan of organizing large corps of observers at several important centers, as above described, is suggested as a means toward that end.

TABLE I. Showing average (4 years) date of arrival at four stations within ten miles of Philadelphia and three stations over twenty miles distant.

Station	A	B	C	D	E	F	G
DISTANCE FROM PHILADELPHIA	6 mi.	8 mi.	10 mi.	10 mi.	21 mi.	22 mi.	33 mi.
Chætura pelagica	Apr. 19	Apr. 22	Apr. 23	Apr. 23	Apr. 18	Apr. 21	Apr. 23
Piranga erythromelas	May 6	May 9	May 8	May 6	May 9	May 9	May 8
Seiurus aurocapillus	Apr. 30	May 3	May 2	Apr. 28	Apr. 29	Apr. 30	May 4
Hylocichla mustelina	Apr. 27	May 3	Apr. 30	Apr. 29	May 1	Apr. 30	Apr. 30
Sayornis phœbe	Mch. 14	Mch. 20	Mch. 27	Mch. 18	Mch. 24	Mch. 20	Mch. 27

TABLE II. Showing how first arrival reports from stations about Philadelphia are massed on certain days.

Chimney Swift (*Chætura pelagica*).

1903	1904	1905
April 12 arrived at 1 station	April 15 arr. at 2 sta.	April 13 arr. at 1 sta.
17 " " 1 "	21 " " 1 "	18 " " 2 "
19 " " **6** "	22 " " 2 "	20 " " **9** "
20 " " **6** "	23 " " 1 "	21 " " **16** "
21 " " 2 "	24 " " **8** "	22 " " 2 "
22 " " 3 "	25 " " **16** "	23 " " 3 "
23 " " 3 "		24 " " 4 "

Wood Thrush (*Hylocichla mustelina*).

1903	1904	1905
April 23 arr. at 1 sta.	April 22 arr. at 2 sta.	April 23 arr. at 1 sta.
30 " " **6** "	26 " " 1 "	24 " " 2 "
May 1 " " **1** "	28 " " 1 "	25 " " 2 "
2 " " **6** "	29 " " **6** "	26 " " 1 "
3 " " 2 "	30 " " **7** "	27 " " 1 "
4 " " 2 "	May 1 " " **6** "	28 " " **5** "
5 " " 4 "		29 " " **2** "
		30 " " **9** "
		May 1 " " 2 "

TABLE III. Illustrating method of combining data from 12 local observers into several "centers."

Chætura pelagica, 1902: April 19 (1 sta.), April 21 (1), April 22 (5), April 23 (1), April 24 (2), April 26 (1), April 27 (1). Grouping the stations in four sections, or "centers," and taking the earliest date for each section, we have: Section A, April 21; B, April 22; C, April 19; D, April 22.

Toxostoma rufum, 1902: April 22 (2), April 23 (1), April 24 (4), April 25 (1), April 26 (2), April 27 (1), May 1 (1). Grouping them we have: Sect. A, April 22; B, April 22; C, April 23; D, April 24.

Philadelphia, Pa.