

exceptionally favorable circumstances that it is very rarely possible for even the best-trained field ornithologist to identify positively, by the use of glasses, a Bronzed Grackle in the range of the Purple. Also we have grave doubts as to the "Wilson's Warblers" Mr. Kohler records as breeding in New Jersey ("The Oölogist," vol. xxxiii., No. 6, p. 104), as Wilson's Warbler has not been found in New York in summer and is rare in the nesting season even in northern New England.

THE CORRELATION BETWEEN THE MIGRATORY FLIGHTS OF BIRDS AND CERTAIN ACCOMPANYING METEOROLOGICAL CONDITIONS.¹

FRANK SMITH.

The purpose of this paper is to call attention to the correlation between the principal migration activities of birds in Spring in Central Illinois and certain types of weather conditions. The existence of such correlation is shown by an examination of the migration records which have been made during the past fourteen years (1903-1916) at the University of Illinois.

The region in the vicinity of Urbana, where the greater part of these records have been made, is an elevated prairie, without marshes or swamps; the streams are mere ditches; and the natural timber is but a thin woodland tract skirting one of these ditches and a nearby artificial pond. The most complete data are from a cemetery adjacent to the campus; an artificial forest of about 18 acres and over 40 years old which is on the campus; and a few rapidly disappearing hedges and brushy patches in the outskirts of the city. More extensive streams and woodlands twelve to twenty miles distant, have been visited very frequently but not daily and hence the data from them have not been used in this discussion.

¹ Contribution from the Zoölogical Laboratory, University of Illinois, No. 87.

Daily records have been made each year from early in February until late in May for the past fourteen years and each record includes a list of all the species seen, with approximate numbers of each, together with memoranda concerning nests and songs. During the season of migration activity these records include results of early morning trips by the writer and others; trips of sections of a class in Ornithology at 8-10 a. m. or 3-5 p. m. taken with an instructor; and individual work of a few experienced students taking more advanced work who are assigned special territory for regular observations. In addition to these records there are nearly always some members of the University Staff and other citizens, often former students, who contribute results of frequent trips and help materially in the adequacy of the data. The great superiority of such composite data over that possible by a single observer has already been discussed by Cooke (*Auk*. 1907: 346) and Stone (*Proc. Acad. Sci. Phila.* 1908: 128).

The combined results of a number of observers makes a list of dates of "first seen" conform much more closely with a list of dates of first arrivals than is possible with a single observer. A comparison of the records of the writer with those of the other observers during the years of 1912-1916 shows the following relations between his list of dates of "first seen" and those of the other observers. 43.5% of the "firsts" were recorded on earlier dates by others; 26.5% were recorded earlier by the writer; and 30% were recorded on the same dates by both. This is a decidedly better showing than that of Mr. Cooke and his collaborators at Washington who only recorded about 8.5% of the "firsts" on the same days.

In the problem under discussion we must determine what measurable phenomenon we shall use as an evidence of migration having taken place. We may use the appearance of species which have not previously been recorded for the season; or we may use obvious increases of numbers of individuals or bulk movements; or we may use the non-appearance of birds which have been recorded on the next preceding lists. For the purposes of this paper I shall deal with records containing

the larger numbers of "firsts" and in doing so it becomes very obvious that in the data studied we are at the same time dealing with records showing important bulk movements.

The data of "firsts" shows a great lack of uniformity of distribution throughout the season. The average season has had 89 days and the number of "firsts" has averaged 120 but these have been so bunched that 61 of them have been recorded on 9 days. The extremes are found in the season of 1907 when it took 14 days to record one half of the "firsts," and in 1912 when one half of them were bunched on 5 days. This lack of uniformity in distribution is still more apparent when we examine the records of the last 30 days of each season, during which three fifths of all of the arrivals make their appearance. On the average, 74 "firsts" are recorded in these 30 days and 39 of them are bunched on 4 or 5 days. Extremes occurred in the years 1915 in which it took 8 days to record one half of the "firsts" of the last 30 days, and in the years 1909 and 1916 in each of which it took but 2 days. One half of all the "firsts" of those 14 seasons of 30 days each were recorded on a total of 63 days and we have now to examine the weather conditions which existed on those days.

For such comparison weather maps are of course desirable and preferably a series of the Washington maps which appear daily including Sundays and holidays.

An examination of the weather maps for the 63 days on which are recorded a half of all the "firsts" of the last 30 days of each of the 14 seasons shows that on 54 of those days there were approaching areas of low pressure, with south winds which had been effective during the preceding night. On 5 days there were southerly winds, or had been at points further south in the state during the preceding night, although an approaching "low" was not well defined. On 3 days the winds were light and either due East or West. On one night, April 30, 1907, there was a rather light northerly wind and yet 5 "firsts" were recorded on the morning of May 1st where none of them had been found on the preceding day.

A study of the records of these 63 days readily shows that they include the heaviest of the bulk movements of many species as well as the "firsts" of others.

In view of what has preceded there seems to me ample justification for the statement that in Central Illinois there is a high degree of correlation between the flights of night migrants and the meteorological conditions involved in the near approach from the West of an area of low barometric pressure with the accompanying rise in temperature and southerly winds.

A preparation of graphs showing temperature changes and migration activities would doubtless show marked correlation, as have those prepared by Stone at Philadelphia. So also would graphs showing changes in the wind and migration activities. The determination of the relative importance of temperature and wind direction in the initiation of the separate migratory flights is yet to be made.