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SPREAD OF THE STARLING AND ENGLISH SPARROW

BY LEONARD WING

MY studies of the forty years of Bird-Lore (now Audubon Magazine) Christmas censuses have revealed much data on the spread and abundance of the Starling (*Sturnus vulgaris*), and it seems desirable to present some of the material in advance of a report covering the census studies as a whole.

The Starling is, of course, still spreading and likewise is still increasing in numbers in the area back of the advancing front. The increase will undoubtedly continue for two or three decades to come, though the spread should be substantially completed—if the past mirrors the future—within a decade.

It should be borne in mind that the census data are rough in character (as indeed most observational data must be). The published records of first arrivals given in this study may not always mark the actual first arrivals even though reported as such. This discussion and interpretation, therefore, will be confined to the broader and more general aspects of the Starling spread; hence, details of distribution will not be considered.

Many attempts were made to establish the Starling in America both before and after 1890,¹ but for the purposes of this discussion, its introduction will be considered to be the New York liberations of 1890. Its date of *establishment* is assumed as 1895.

The task of tracing the spread of the Starling proves to be a difficult one indeed. Many accidental movements have occurred through unusual winter wanderings and by wind transportation as well as by unknown causes. The early appearance of the species in Labrador and some southern states, for example, as well as recent appearances at Churchill and Moose Factory, should probably be considered as instances of accidental distribution rather than of true spreading.

The first appearance of the Starling in the Christmas-census reports for each state is shown in Text-figure 1A. Isopleth lines at five-year intervals indicate the progressive spread. In reading this map (as well as those that follow) it should be borne in mind that, as I have explained previously, only the general aspects of the spread are considered. From the broad view of continental geography, it is a minor matter whether an isopleth line is half a state one way or another. Although half a state seems a large area to a person living in it, yet from the standpoint of a continent of eight million square miles, it is rather small.

In order to compare the first appearance in each state as revealed by the census data with the first appearance as indicated by published reports, I mapped the Starling reports area by area as found in standard sources at my disposal. I have made no attempt to search the literature exhaustively; my purpose is served well by the standard publications, and I leave the refined search to others having access to more material. Upon averaging the dates of appearance shown

¹ Phillips, John C. 'Wild Birds Introduced or Transplanted in North America.' U. S. Dept. Agr., Technical Bulletin No. 61, 1928.

on the maps, I find that the census reports average slightly less than five years later than the published reports. From the standpoint of time, the difference is greatest in the early years, and from the standpoint of geography, greatest in the southern states. At the present time the dates of appearance as reported by the censuses lag little behind the published reports. The published reports indicate that the spread of the Starling is forecast by the arrival of winter stragglers; breeding lags behind by about five years. The Christmas-census reports of the earlier years probably can be taken as rough indicators of the spread of the Starling as a breeding bird.

The patterns indicate a more rapid spread through the southern and south-central states than through the northern states, though in recent years the spread has been about equal (Table 1). It also

TABLE 1
MILES OF AIR-LINE SPREAD OF THE STARLING AT SUCCESSIVE PENTADS

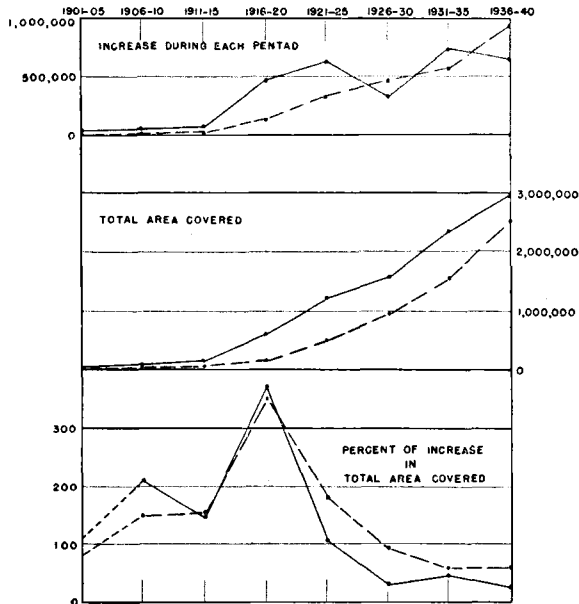
Direction	Pentad							
	1901-05	1906-10	1911-15	1916-20	1921-25	1926-30	1931-35	1936-40
<i>West:</i>								
<i>Census</i>	15	61	225	475	621	1059	1193	1917
<i>Published</i>	72	229	367	497	1159	1289	1748	2127
<i>West-Southwest:</i>								
<i>Census</i>	21	67	116	426	803	1390	1692	1898
<i>Published</i>	105	286	478	1015	1113	1558	1748	1983
<i>North-Northwest:</i>								
<i>Census</i>	78	140	201	243	304	383	487	727
<i>Published</i>	82	203	262	596	720	—	—	—

shows a more rapid progress during recent years than in earlier ones. The more open country of the prairie region and its fewer cities and towns would appear to reduce the number of suitable stopping places. In addition, the prairie country has fewer fruits in comparison with

TEXT-FIG. 1. A—Isopleths of the Starling spread as indicated by its appearance in the Bird-Lore Christmas censuses. The broken line indicates the known advance not yet revealed by the censuses. B—Isopleths of the English sparrow spread. The data previous to 1883 have been taken from Barrows's report supplemented by later evidence; data subsequent to 1883 have been obtained from published records. C—Average birds-per-hour for the Starling during 1937-1939. The concentration in a strip running northeast-southwest from New England to the Western Gulf Region is marked. Compare this with the first appearances as shown in map D. The figures for Missouri, Arkansas, Mississippi, and Alabama are probably low owing to the small number of reports. D—Average number of Starlings-per-hour for the initial year of appearance in the censuses. The high figure for Tennessee is undoubtedly the result of chance.

the timbered east. It is a general rule that birds and mammals wander more in 'marginal' than in optimum areas; this rule presumably applies to the Starling in its spread over new territory, for the prairie country, to all appearances, is more marginal than the timbered country. The Starling has certainly spread faster across the prairie.

In order to study the rate of spread on an area basis, I measured the amount of area enclosed by successive isopleths on the respective maps. These amounts (in square miles) are given in Table 2 and in Text-figure 2. The area has increased from zero in the year of



TEXT-FIG. 2. *Upper*—The spread of the Starling by five-year intervals. *Middle*—Total area covered by the Starling. *Lower*—Percentage of increase in the total area covered. (The solid lines are for published reports; the broken lines are for the census reports.)

establishment (assumed to have been 1895) to more than two and a half million square miles in 1940. The difference between the figures for the published reports and the census accounts is 464,904 square miles or 15.60%. The isopleths of Canada have been drawn farther north for the published accounts because of reports of stragglers in Labrador, Moose Factory, and Churchill; 200,000 square miles have been included by this. The published accounts indicate 171,261 square miles more territory covered in the West than do the censuses.

The unexplained difference between the two sets of figures is 93,643 square miles or 3.14%—a difference that is negligible indeed. If we split the difference between our respective results, we shall have a total of 2,717,161 square miles, a figure which is probably the best we can obtain at the present time.¹

That the census and published reports were not always so near to each other is clearly shown by Table 2. The difference was marked

TABLE 2
SPREAD OF THE STARLING AND ENGLISH SPARROW DURING SUCCESSIVE PENTADS
AFTER THE RESPECTIVE INTRODUCTIONS. THE DATA HAVE BEEN OBTAINED
BY MEASURING THE AREAS BOUNDED BY SUCCESSIVE ISOPLETHS.

Years after intro- duction	Starling						
	Actual years	Published accounts			Christmas census reports		
		Area of pentad	Area to date	Percent- age of increase	Area of pentad	Area to date	Percent- age of increase
1- 5	1891-95	—	—	—	—	—	—
6-10	1896-00	—	(500)	—	—	(500)	—
11-15	1901-05	(15,624)	16,124	—	(5,513)	6,013	—
16-20	1906-10	34,553	50,677	214.30	9,020	15,033	150.01
21-25	1911-15	76,016	126,693	150.00	23,053	38,086	153.35
26-30	1916-20	476,830	603,523	376.37	135,308	173,394	355.27
31-35	1921-25	621,953	1,225,476	103.05	331,753	505,147	191.33
36-40	1926-30	361,654	1,587,130	29.51	472,071	977,218	93.45
41-45	1931-35	747,495	2,334,625	47.10	582,322	1,559,540	59.59
46-50	1936-40	584,988	2,919,613	27.63	955,169	2,514,709	61.25

Years after introduction	English Sparrow			
	Actual years	Area of pentad	Area to date	Percentage of increase
1- 5	1854-58	—	—	—
6-10	1859-63	—	(300)	—
11-15	1864-68	(11,217)	11,517	—
16-20	1869-73	226,897	238,414	1970.11
21-25	1874-78	400,814	639,224	168.12
26-30	1879-83	679,535	1,318,763	106.31
31-35	1884-88	1,304,950	2,623,713	98.95
36-40	1889-93	—	—	—
41-45	1894-98	—	—	—
46-50	1899-03	—	(3,676,427)	—

¹ The Starling has been reported from eastern California (Condor, 44: 79, 1942) since this paper was sent to the Editor.

until the most recent pentad (1936-40). Although the difference may be the result of observational errors, it seems more likely that it reflects the difference between the progress of the *population front* and that of the pioneers that make up the *advancing front*. This is corroborated to some extent by the fact that the population front has overtaken the pioneer front only since the latter reached the non-forested country of the Midwest.

It has been stated in literature, principally on the basis of European authorities, that altitude governs the Starling and that it is a bird of lowlands. The altitudes of settled parts of Europe are low, mostly less than 2,000 feet. In contrast, the Great Plains of America rise to 7,000 feet at the continental divide, and much of this region exceeds 5,000 feet. Although the Starling doubtlessly spreads fastest through valleys, yet this can hardly be cited as an example of altitudinal influence, for the Starling follows settlement, and settlements are associated with valleys. The Starlings reported recently from Jackson, Wyoming, are already at 6,200 feet altitude.

The future spread of the Starling will doubtlessly continue, but it will probably be less rapid than the previous spread because of the mountainous terrain ahead, as well as the dry lands of the Southwest. The indications are clear that the Starling, like the sparrow, follows towns in its spread. This being so, the advance through the Rockies is likely to be through the passes which contain towns and farms. The belief that the sparrow was spread to some extent by riding in railroad cars hardly seems justifiable as an assumption for the Starling.

It is rather difficult to work out a satisfactory record of the spread of the English Sparrow (*Passer domesticus*), the other successful avian alien. The formal literature is singularly devoid of records of first arrivals of the sparrow, and the best study still is Barrows's monograph.¹ Today it is difficult to judge conditions as they were in 1883-1886 when Barrows gathered his data. Curiously enough, it is difficult to understand Barrows's interpretation of his own data; his writings do not explain how he reached many of his conclusions. It is probable that the many cases of transporting birds to locations ahead of the advancing front was the complicating factor. The data of Text-figure 1B prior to 1883 have been taken from Barrows's monograph with such supplements as subsequent reports indicate are necessary. The spread since 1883 has been obtained directly from available literature (though I must confess that data are rather

¹ Barrows, Walter B. 'The English Sparrow in America.' U. S. Dept. Agr., Division of Economic Ornithology and Mammalogy, Bull. No. 1, 1889.

meager). The mapping of the sparrow spread, like the mapping of the Starling spread, ignores all but the major trends.

We can assume from the data that forty years after its *introduction*, the sparrow had completed its conquest of America. Many areas were not completely overrun until later (such as southern California which was not overrun until after 1900), but the major outline of the sparrow range was substantially settled by 1893.

The spread of the sparrow, pentad by pentad, is given in Table 2 (area based upon the map), columns nine to twelve. It is obvious that the spread of the sparrow was much faster, pentad for pentad, than the spread of the Starling. The increase of the sparrow spread over the Starling spread for comparable pentads is given in Table 3.

TABLE 3

INCREASE OF THE AREA COVERED BY THE ENGLISH SPARROW IN COMPARISON WITH THE STARLING DURING COMPARABLE PENTADS. THE STARLING FIGURES USED ARE BASED UPON PUBLISHED REPORTS RATHER THAN THE CENSUS DATA.

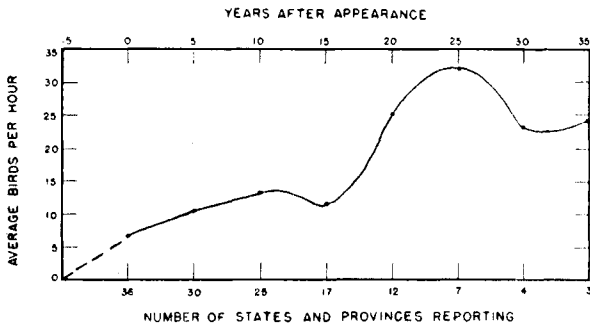
<i>Years after introduction</i>	<i>Sparrow area in excess of Starling area</i>	<i>Percentage increase of English Sparrow over Starling</i>	<i>Percentage of the sparrow range covered by Starling</i>
6-10	(-200)	-40.00	(-166.67)
11-15	-4,607	-28.57	140.00
16-20	187,737	370.46	21.26
21-25	512,535	404.55	19.81
26-30	715,240	118.51	45.76
31-35	1,398,237	114.10	46.70
36-40	—	—	—
41-45	—	—	—
46-50	756,814	25.92	79.41

Included also is the percentage of increase in the area covered by the sparrow and the percentage of the sparrow area covered by the Starling during the same pentad. The indication that the Starling spread faster in the initial years—in other words, became established more quickly—is probably not true. The accounts of the Starling's spread are more abundant than those for the sparrow, and they are not complicated by the transportation of birds ahead of the advancing front. Although a large portion of these transplants probably failed, nevertheless they throw doubt upon later data because it is not possible to tell whether many subsequent reports indicate the advancing front or transplants.

It would seem probable that the area covered by the 1859-63 pentad

was about a thousand square miles and the area covered during the following pentad nearly 35,000 square miles. We cannot tell from the present data, however, whether or not this is true though the evidence for it is strong.

Some very interesting things appear when attention is turned to the increase in numbers of the Starling as the years have gone by, but it must be remembered, of course, that the significance of the data may be lost when we come to specific details. Among the reasons for this should be mentioned the tendency of the starling to concentrate in winter (when the censuses were taken) near areas of human occupation, especially near cities and towns. Another reason is that



TEXT-FIG. 3.—The general increase in the abundance of the Starling (birds per hour of censusing) at five-year intervals after the first appearance in the censuses. The data have been averaged for all states and provinces.

the Starling migrates, and the migration, though real, is best considered as haphazard in comparison with the relatively well-ordered migration of native birds. We must not forget, too, that in recent years the mobility of the census takers has been increased by automobiles and good roads; thus more territory is now accessible.

The data for the censuses of each state or province have been combined to obtain a state figure of the average number of birds per hour of censusing for each year. The birds per hour for each state have been combined at five-year intervals after the first appearance in the respective states and provinces (Table 4 and Text-figure 3). The data are not complete for all areas and the reports as given by the censuses may not necessarily indicate the true first year of appearance; yet this does not appear sufficient to disqualify the data for study of general or mass trends. The general increase (the table is actually a table of general increase without regard to area) rises slowly for

TABLE 4
INCREASE OF THE STARLING POPULATION DURING SUCCESSIVE YEARS AFTER ITS
APPEARANCE IN EACH STATE OR PROVINCE

<i>Years after its appearance</i>	0	5	10	15	20	25	30	35	40
<i>Number reporting</i>	46	37	29	19	13	7	4	3	
<i>Number of areas for which data are available</i>	35	30	25	17	12	7	4	3	(1)
<i>Average birds per hour of censusing</i>	6.72	10.52	13.11	11.56	25.32	32.04	23.55	24.11	(42.47)

the first fourteen years followed by a sudden rise and fall. The rise of the 20–25 year period and the subsequent fall may be real or induced by the data, which are fewer for advanced years.

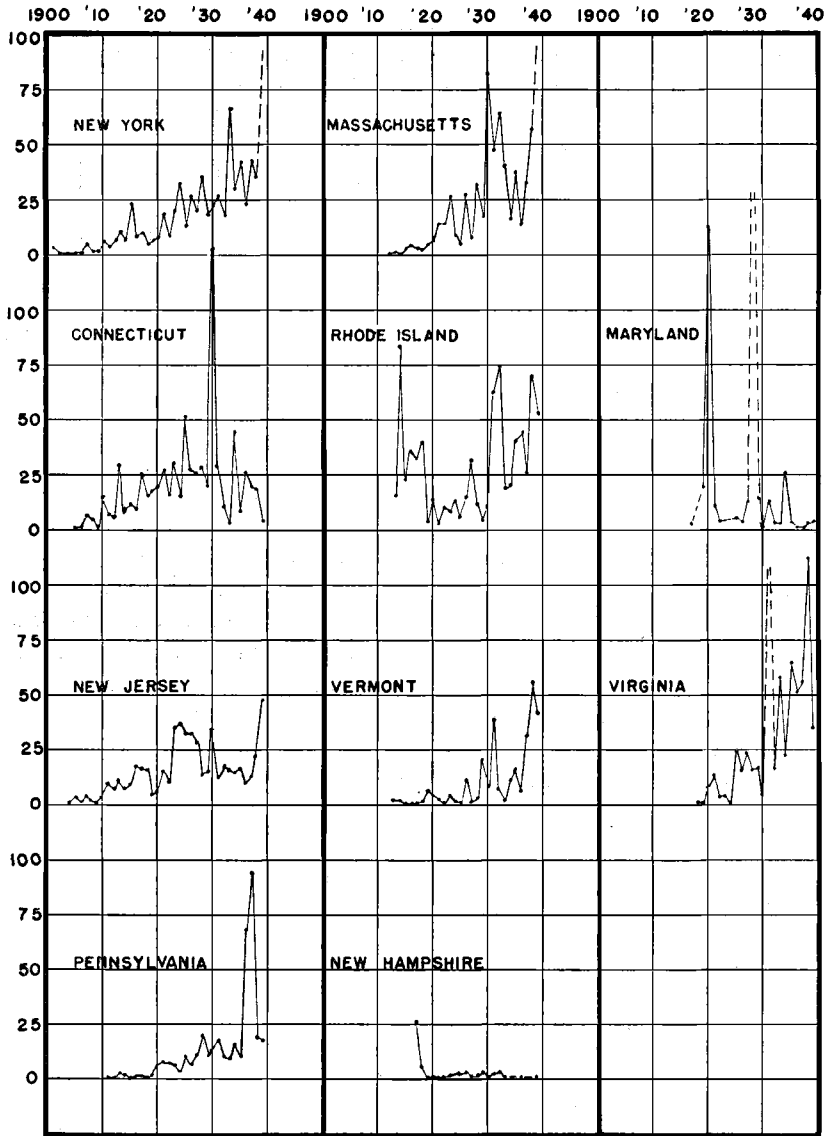
The decline which follows this rise, however, agrees in part with the data from the states which have long been occupied by the Starling (see Text-figure 4). Inasmuch as the North, especially the Northeast, is best represented beyond the third pentad, the decline may reflect the preponderance of data from this locality. The sudden rise of the fourth pentad may represent many birds that have migrated to the southern states. Actually, these would be birds missing from the sixth and seventh pentads because the sixth and seventh are chiefly northern and northeastern birds of the same calendar years as the fourth and fifth pentads of the south.

Because the Christmas-census data lag behind the first appearance (as given by published reports), we shall probably obtain a better picture of the steady increase if we add a pentad to the beginning. This has been done in Text-figure 3.

If we are to make any generalizations from the first-appearance figures, it would be that the first appearance is by small flocks,—flocks of less than fifty birds. In fact, more than half the reports of first appearances are for groups of less than five birds each, which probably indicates that the first appearance is by stragglers.

In order to see if any similarities of the population curve occurred in all areas, I graphed the figures for the birds per hour in those states where the Starling has been established longer than twenty years (Text-figure 4). Because we are dealing with observational data—and rough data at that—there are many minor differences in the curves as well as occasional ‘surges,’ the latter probably caused by chance.

The ten curves of Text-figure 4, however, follow the same general



TEXT-FIG. 4.—Starling increase (birds per hour) in ten states where the species has been established for twenty or more years and for which the census records are complete for each year or nearly so. The broken lines indicate surges too large for the scale of the graph.

trend: the rise of the first ten to fifteen years is gradual; then follows a rather sharp rise for a few years more; the rate of rise begins to slow up somewhere in the neighborhood of the twentieth year; and it is thereupon followed in the 25–30 year period by indications of approaching stabilization. The first appearance of Starlings in the census reports, it must be remembered, lag behind the advancing front by about five years. If we add five years to the approximations just given, we shall probably have a true picture of the increase in population from the time of first appearance.

Despite the plausible appearance of the data, we must not overlook the very real possibility that the Starling may not yet have reached its maximum abundance even where it has occupied an area for half a century. Kalmbach expressed the belief in 1928 that the maximum was reached in fifteen to twenty years in established areas.¹ This may be true of the breeding season, but the data for Christmas birds—that is, wintering birds—(hence, the whole year), indicate that, instead of leveling off, the increase rate is several years from the level point and has only begun to slow up, if it is slowing up at all; it cannot be said to be stable. The difference in opinions is probably due to the fact that this study deals with mass data from filled and unfilled ranges, whereas the data used by Kalmbach dealt, for the most part, with birds in filled range. In a regional study, the filling of unoccupied range would be shown as a population increase whereas a local study would deal only with a small part of the range, and the earlier stabilization could be clearly indicated.

In order to study the data for indications of present distribution, I averaged the data for the years 1937, 1938, and 1939. These data are mapped in Text-figure 1C. They show a clear concentration in the strip between the western Gulf states and New England. Whether this is a true picture of winter concentration remains to be seen when more data are available, but it agrees with the concept of a north-east-southwest migration. The concentration areas within this strip appear to be areas of cities and towns, and farm lands.

A map of the data for the average birds per hour in the year of first appearance (Text-figure 1D) reveals the same strip of territory wherein the Starling shows a concentration. Indeed, the map shows a more pronounced concentration in the lower Mississippi Valley and western Gulf region for the first year than for the present time.

It hardly seems possible to estimate very adequately the Starling population of the country on the basis of present data. Nevertheless,

¹ Kalmbach, E. R. 'The European Starling in the United States.' U. S. Dept. Agr., Farmers' Bulletin No. 1571, 1928.

the data of *individual stations* for 1939, when adjusted by removal of fifteen extraordinarily large flock groups totaling 147,713 birds, averaged 5.93 birds seen for each mile of travel. By assuming that the observers spotted birds for forty rods each side of the census path, we arrive at the figure of one-fourth square mile of area covered by each mile of travel, or 23.72 birds to the square mile. This would indicate a Starling population of 64,451,059. On the basis of the *combined totals* for all stations, the 1939 averages of birds per mile and square mile are 7.24 and 28.96 respectively, or 78,688,983 birds. If we again split the difference between the two methods, we arrive at a figure of 71,570,021 Starlings in this country. Were we to study the data closely enough to allow for uninhabited areas, the total would probably not exceed 50,000,000. Similar treatment of the data for the English Sparrow gives an estimate of 205,769,619 birds, and were we to allow likewise for uninhabited range, the figure would probably not exceed 150,000,000. These figures are in sharp contrast to statements in literature that these species are present "by the billions."

My figures for the total bird population of the United States is 5,660,000,000 for the breeding birds and 3,776,000,000 for the wintering population. Although the Starling and English Sparrow figures are not for a comparable area, it would appear that they constitute not more than 1.00% and 3.00% respectively of the breeding population, and 1.50% and 4.50% of the wintering population of the United States. It seems likely, however, that further study will reduce this figure.

SUMMARY

The Starling data of the forty years of Bird-Lore Christmas-censuses have been tabulated and used in this study. In addition, reports of first arrivals have been sought in the literature.

Only the broader and more general aspects of spread and abundance have been considered.

The appearance of the Starling in the census reports averages five years later than the reports in the literature.

The Starling is not limited by low altitudes but has reached areas more than 6,000 feet above sea level.

The spread has been more rapid through the southern and south-central states than in the north.

The rate of spread, as measured by percentage of area covered, was fastest in the 26-30 years (1916-1920) after its introduction.

The area covered by 1940 is calculated as 2,717,161 square miles for

the Starling which is still spreading. For the English Sparrow, the area is calculated as 3,676,427 square miles.

The English Sparrow spread much faster than the Starling, and its occupation was substantially completed forty years after its introduction. The Starling spread is still far from finished fifty years after its introduction. Presumably it will occupy the same territory as the sparrow.

The first appearance of the Starling in a new area is usually by small flocks of winter stragglers. The flocks generally are less than five birds in size. The establishment of the species as a breeding bird tends to lag behind the first appearance by about five years.

The increase of the population is gradual for the first ten to fifteen years after the appearance of the bird in a locality. Then comes a sharp rise for a few years which is followed by a slowing up of the increase rate and signs of approaching stabilization by the twenty-fifth to thirtieth year.

The census data for the 1937-1939 years, as well as the first year of appearance, show a concentration in a strip from New England to the western Gulf region.

The number of Starlings and English Sparrows is estimated to be not more than 50,000,000 and 150,000,000, respectively. They constitute about 1.00% and 3.00% of the breeding bird population, and about 1.50% and 4.50%, respectively, of the wintering bird population.

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