PURPLE MARTIN POPULATION CHANGES OVER FIFTEEN YEARS

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THE ability of animal species to sustain losses and to recover from them is of great interest to biologists. Yet long-term studies of fluctuations in natural populations are available for only a few species—among mammals principally those sought by hunters and trappers and among birds principally game species, rare forms, or those that nest conspicuously, as in seaside colonies. This kind of information is particularly scarce on small abundant migratory land birds.

Therefore I offer this account of the changes from year to year in a population of Purple Martins (*Progne subis*) at Toledo, Ohio, over 15 years, 1953–67. This is the final installment of a study previously reported at the end of 10 years (Mayfield, 1964).

THE SAMPLE

For a sample of the local population, I have taken a set of martin houses, ranging in number from 18 to 28 in different years. The mean number of houses per year was 24.5. They were scattered about Lucas County within 20 km (12½ miles) of the county courthouse in downtown Toledo. All the houses were identical, containing 16 cavities each and standing on poles 4 m high.

To measure fluctuations in numbers of birds from year to year, I made annual counts of nests in this set of houses each fall, usually in November after the martins had left. At this time workmen took down the houses for cleaning and repair to put them in fresh condition before the birds returned the next spring.

I believe the number of nests constitutes a reasonably good measure of the number of adult birds in the vicinity, because martins have not been known to build more than one nest a year in this region and no evidence suggests the presence of any considerable number of nonbreeding birds nor any variable proportion of nonbreeding birds from year to year. I find only one recorded instance of two nests in one year for this species, and it occurred in an abnormally early spring at a more southerly location in southern Illinois (Johnston and Hardy, 1962).

In 12 instances (out of 347 opportunities for such judgments) I have judged that the total absence of martins from a box was due to unfavorable circumstances at the location rather than a variance in general population. These houses, along with those destroyed, I classified as not habitable and took them out of the sample. The apparently disqualifying circumstances

included disturbance from human construction work nearby, the overshadowing of a house by tree growth, and a strong odor from a chemical factory close at hand. The suggestion that martins might be intolerant of strong odors came from an observation that martins abandoned a roost when tar barrels were burned in the vicinity (Johnston, 1923). Another example of uninhabitability in a box of normal outward appearance was provided by a martin house of my own, not in this sample, that a family of Red Squirrels (*Tamiasciurus hudsonicus*) occupied for 2 years. The mean number of habitable houses per year was 22.7 (363.7 cavities).

If nest houses are to measure upswings adequately, more than enough cavities must be available at all times, even in the years when the population is at its highest. Here, in the year of highest occupancy, only 7 of 22 houses were filled, and in only 2 years were more than 3 houses full. The highest ratio of occupancy in any year was 73 per cent of the cavities.

Nests of House Sparrows, *Passer domesticus*, and Starlings, *Sturnus vulgaris*, were counted also but are not reported here. Nearly every house had other nests unless all its cavities were occupied by martins.

Population Index

Although this sample was chosen specially to provide comparable conditions from year to year and to minimize variables not a part of the natural environment, human interference was still an important factor. Almost every year a few houses were moved to new sites or were destroyed by vandals after being put in place. For example, a total of 44 locations were used over the 15 years, although the number of sites in any year was never more than 28 and the number of habitable boxes was never more than 26. Consequently, a simple count of nests each year reflects in part these artificial influences and includes some nests in situations not identical to those of the year before or the year after.

To make continuous comparisons over a long period with the scene shifting slightly from year to year, I have constructed an index like those used by economists who are faced with similar measurement problems. Starting with the first year, 1953, and representing it as 100 on the scale, I have charted all the later years in relation to it. Thus, using the first year as the base, I have taken the decrease in the second year and expressed the size of the second year's population as an index number proportionately smaller than 100. Then I compare the third year with the second in the same way, getting a third index number on the same scale of 100, and so on for every year. Thus, I construct a train of rising and falling index numbers expressing every year's population in relation to the first.

In comparing each year with the next, I have considered only those

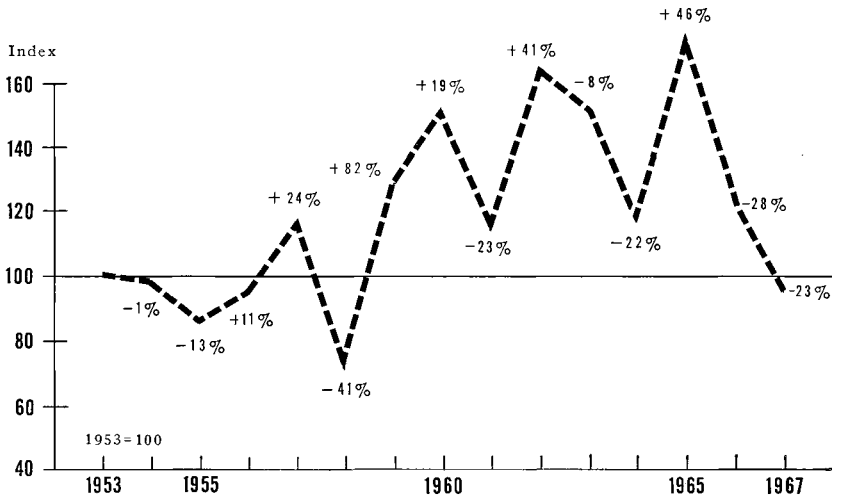

Figure 1. Changes in Purple Martin population. The broken line plots the population for each year in relation to the first year's population. Each number along the broken line shows the yearly change as a percentage of the year immediately preceding. These numbers, along with the data from which they were derived, appear in Table 1.

houses identically situated in both years, not counting nests if in a house destroyed in either year or placed in a different location in the second year. Thus new and relocated houses were used in the comparisons only when in one place for two successive nesting seasons.

POPULATION FLUCTUATIONS

The fluctuations in population are charted in Figure 1, summarized in Table 1, and reported in detail in Table 2.

The chart shows rapid ripples on a long swell, but the span of time was not sufficient to be sure of any cyclic quality in the larger wave. The minimum points in the ripples are spaced exactly 3 years apart, with the decline or recovery each time taking 1 or 2 years. The greatest decline in 1 year, 41 per cent, was followed immediately by the greatest gain, 82 per cent. The high point on the index, 172, was about 2½ times the low point, 70.

The Purple Martin, a swallow dependent on flying insects for food, sometimes dies of starvation in numbers when caught by cold weather in spring during migration or after arrival in the nesting region. Yet the regularity of the population changes shown on the chart seems to preclude any neat correlation with weather.

In scanning Audubon Field Notes for the period, I find that field ob-

TABLE 1

SUMMARY OF PURPLE MARTIN NESTS, 1953–1967

Variable	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Number of boxes erected	18	21	21	27	27	28	26	27	26	26	25	24	24	24	23
Number of boxes habitable[1]	15	17	20	25	23	26	25	25	24	22	24	24	24	24	23
Per cent of habitable cavities occupied[2]	47	44	34	40	51	31	58	62	49	70	62	49	73	52	41
Nests in situations like next year	108	119	93	151	182	119	203	247	177	244	238	189	280	195	
Nests in situations like year before		107	104	103	188	107	216	242	189	249	225	185	275	201	151
Percentage—point difference from preceding year		−1	−13	+11	+24	−41	+82	+19	−23	+41	−8	−22	+46	−28	−23
Yearly index (1953 = 100) relating each year to first year	100	99	86	95	118	70	127	151	116	164	151	118	172	124	95

[1] See text for explanation.
[2] Based on 16 cavities per habitable box. For 15 years, 51 per cent.

TABLE 2
PURPLE MARTIN NESTS OVER A FIFTEEN-YEAR PERIOD

Loc. No.	Number of nests per year, 1953–1967 (numbered 1–15)[1]															To-tal	Mean number of nests per year
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
1	9	12	7	5	8	8	11	14	8	11	15	13	8	0	2	131	8.7
2	13	11	8	9	1											42	8.4
3	8	10	8	5	11	10	12	15	10	15	12	8	14	0	6	144	9.6
4	D	D	3	6	12	12	9	1	2	0						45	5.0
5	12	12	9	7	5	7	5	12	8	10	15	11	15	14	12	154	10.3
6	D															0	
7	13	12	9	13	13	2	7	16	8	16	8	5	10	6	9	147	9.8
8	2	5	9	8	6	3	8	8	9	12	10	6	14	10	5	115	7.7
9	5	D	0	3	D	4	13	12	7	D	11	16	15	6		92	8.4
10	14	10	11													35	11.7
11	3	5	1	4	8	3	7	12	0	0	0					43	3.9
12	7	3	4	8	8	1	7	3	3	8	4	0	12	3	3	74	4.9
13	X	X														0	
14	3	7	5	12	5	D										32	6.4
15	9	3	5	6	8	3	8	D								42	6.0
16	8	6	3	2	6	5	5									35	5.0
17	7	10	3													20	6.7
18	0	1	0	3	5	10		0	X	X	0					19	2.4
19		1	6	4	10	4	13	12	9	14	11	11	16	12	10	133	9.5
20		X	X													0	
21		0	4	8	13	4	9	14	12	15	15	12	16	15	11	148	10.6
22		11	12	0	5	4	3	2	9	2	10	6	12	15	9	100	7.1
23			3													3	3.0
24				X	D											0	
25				12	9	6	10	9	14	16	15	11	16	12	5	135	11.2
26				7	13	8	11	14	10	9	13	8	2	2	1	98	8.2
27				X	D											0	
28				12	6	3	3	14	4	5						47	6.7
29				7	D	5	6	5	5	D						28	5.6
30				3	5	4	7	11	9	11	10	16	10	12	5	103	8.6
31				8	11	1	6	8	7	14	16	12	15	16	2	116	9.7
32				4	7	0	10	9	4	16	6	6	14	7	4	87	7.2
33				5	13	9	14	16	15	16	16	13	16	16	16	165	13.7
34						5	13	14	15	16	16	13	16	15	14	137	13.7
35						X	X	X	X							0	
36						4	9	10	4	16	11	9	16	13	12	104	10.4
37						4	10	11	11	11	13	3	5	6	2	76	7.6
38								5	6	16	9	6	6	4	5	57	7.1
39										D						0	
40											2	0	8	1	3	14	2.8
41												4	10	0	4	18	4.5
42												0	9	10	9	28	7.0
43												0				0	
44													5	6	2	13	4.3
Totals	113	119	110	161	188	129	216	247	189	249	238	189	280	201	151	2,780	8.15[1]

[1] Mean number of nests per habitable box per year. D = Destroyed by vandalism; X = Box judged not habitable; blank space = house not in place for nesting season.

servers believed cold weather was detrimental to martins in five springs: 1953 (Nolan, 1953), 1958 (James, 1958), 1960 (Lupient, 1960), 1965 (Petersen, 1965), and 1966 (Petersen, 1966). Two of these years, 1958 and 1966, found the population in my sample down from the previous year;

and two, 1960 and 1965, found it up. The remaining year, 1953, cannot be recognized as up or down, because it was the first year of the study. We are totally in the dark about any catastrophes that may have overtaken martins in the fall migration or on the South American wintering grounds. Impressions gained from observations at any one martin house may lead one to think that martins are scarce or abundant in a year when the regional population actually has the opposite trend, as the tables in this paper show. And yet impressions from such small samples often get into print.

Rapid fluctuations similar to these have been found in another group of small passerine birds. Lack (1954: 8–11; 1966: 11–18) reports on four species of tits in England and Holland. These also are cavity-nesting birds but, unlike the Purple Martin, are nonmigratory and noncolonial. Yet they, and especially the Great Tit (*Parus major*) show rapid fluctuations, with a ratio not greater than one to four from lowest to highest. In his study at Marley Wood, the Great Tit population showed six low points in 18 years; and, ignoring two extremes that may have been anomalous because of human factors, the number of pairs varied from 21 to 54, a range of variation similar to that of the Purple Martins in this study.

Even more surprising is that American game birds, which are unlike swallows in many aspects of life history, also show similar loss and recovery rates from one nesting season to the other, "with annual increases of less than 100 percent and with annual decreases of less than 50 percent," (Hickey, 1955).

Estimate of Total Population of County

The principal aim of this study was to provide a view of fluctuations in a population. Incidentally it gave an inkling of the number of Purple Martins to be found in a midwestern region of city, suburb, and rich level farm land. In one rural area believed typical, consisting of intensively cultivated land interlaced with roads at 1-mile intervals on a rectangular grid, I counted 19 martin boxes in 25 miles of road, all located near farm homes.

The usual number of adult martins summering in Lucas County appears to be about 20,000 birds, and the sample of martin houses in this study is of the order of 1 per cent of all those in the county. This estimate was derived from a count of 140 martin houses in the 30 sq km (19 sq mi) of Waterville Township, which is reasonably representative of the habitat in the 550 sq km (343 sq mi) of Lucas County. From this, I concluded that the county contains about 2,500 martin houses of assorted shapes and sizes, but I judged that these other houses, less systematically placed and

maintained than the houses of my sample, may be only half as successful in attracting martins.

ACKNOWLEDGMENTS

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SUMMARY

Fluctuations in a local population of Purple Martins over a period of 15 years, 1953–1967, are charted from annual counts of nests in a sample consisting of 18 to 28 identical martin houses, each with 16 nesting cavities. To minimize distortions in the data resulting from human interference with some of the boxes, I have compared each year with the next, using only the nesting boxes in situations undisturbed in that pair of years. In this way, I have shown population changes in terms of an index, with 1953 = 100. The high point on the population index, 172, was about 2½ times the low point, 70. The greatest decline in 1 year was 41 per cent of the previous year's population, and this was followed immediately by the greatest gain, 82 per cent of the previous year's population. The population minima occurred at exactly 3-year intervals, with decline or recovery taking 1 or 2 years each time.

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