

It is estimated that the Hillsborough finches are a sample from a mean annual population of 63,400 birds. The general increase with time of the total of living birds in the banded population is discussed.

The real rate of first returns is estimated as 62.6 per cent of the available birds and for second returns 44.5 per cent.

Further evidence is given for the tendency of returning birds to be those which stay at Hillsborough a relatively long time. Three graphical displays of this are given.

The coloration of the known females is discussed. The relative scarcity of pink females is noted.

The proportion of red males is consistent with the view that the local population contains less than 50 per cent of females.

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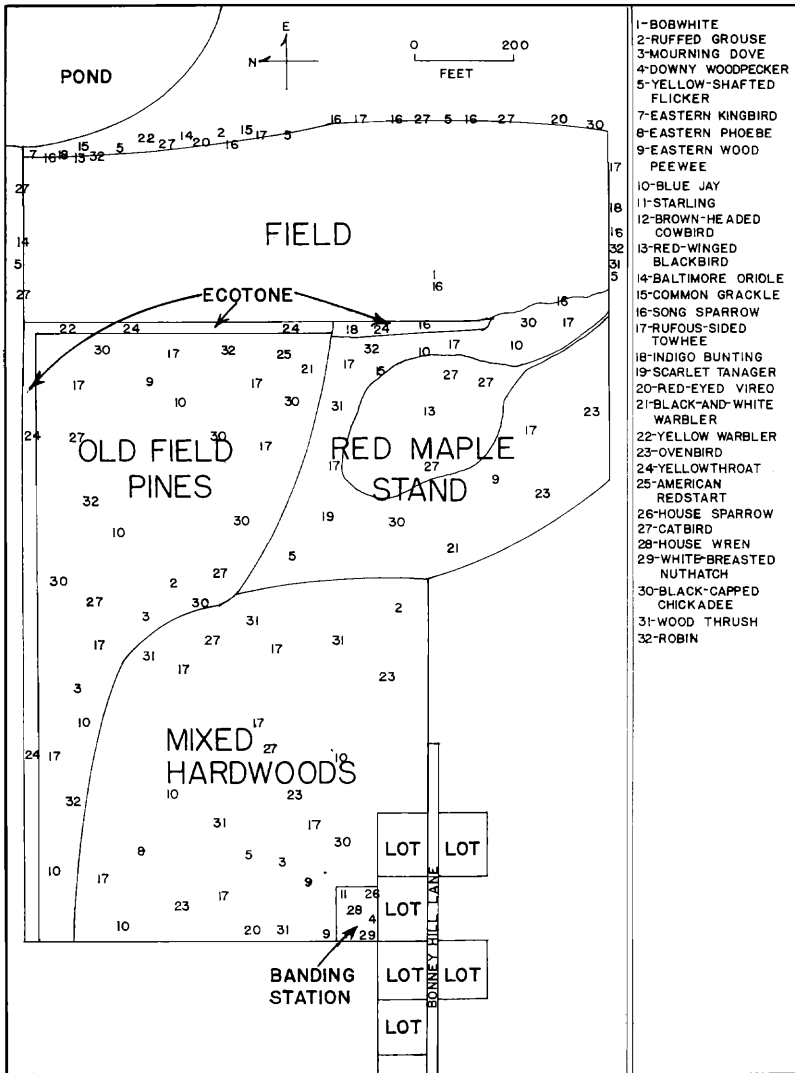
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AVIAN POPULATIONS IN A RECENTLY DISTURBED OLD FIELD SUCCESSION

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Because of the rapid pace of house and road construction in southeastern Massachusetts and other areas, it seems desirable to determine effects of these activities on native bird and other animal populations. Only with this fund of information can effective measures be taken to ensure preservation and continuation of native animal species. Academically, it is of interest to determine succession of bird and other animal populations as formerly cultivated areas revert to woodland. Studies of succession of avian species populations have been made in other sections of the country, but have been generally lacking in southeastern New England. The study reported herein was conducted to determine effects of plant succession, and subsequent suburbanization, on avian populations.

Fig. 1. Study area in Hanson, Massachusetts, and locations of pairs (breeding and others) in June, 1964.



HISTORY AND DESCRIPTION OF THE STUDY AREA

The study area (Fig. 1) is located in Hanson, Plymouth County, Massachusetts, on the east side of Bonney Hill, north and east of Bonney Hill Lane. The east side of the hill has a downward slope of about two degrees, and terminates at the west shore of

Wampatuck Pond. Bonney Hill Lane, about 900 feet long, was constructed in 1955 eastward from High Street which runs north to south along the crest of Bonney Hill. Prior to 1955, that portion of the east side of Bonney Hill was covered with uncut second-growth woodland. From 1955 to 1957 lots were cleared and houses were constructed along both sides of the western half of Bonney Hill Lane. In September 1958 the lot abutting the south side of the banding station, 700 feet east of High Street, was cleared, and the house was permanently occupied in February 1959. The south lot at the eastern end of Bonney Hill Lane was cleared in August 1960, and the house was occupied in February 1961. The lot abutting the west side of the banding station was cleared in July 1961, and the house was occupied the following November. The lot abutting the east side of the banding station was cleared in May 1962, and the house was occupied the following October.

As may also be seen in Figure 1, the study area is divided into four sections. The entire field was planted to corn the summer of 1958, to winter rye the spring of 1959, and to grass and clover the spring of 1960. Each summer subsequently the grass, and most of the forb zone of the field succession, has been cut for hay. Hence, the succession is truncated. The west shore of Wampatuck Pond, and the swamp continuing from the pond southward, are less than thirty yards east and southeast of the field. Red maples (*Acer rubrum*) and a few white oaks (*Quercus alba*) are separated from the eastern border of the field by a narrow ecotone. The north side of the field is bordered directly by mature white pines (*Pinus strobus*) and a few black cherry trees (*Prunus serotina*). The ecotone between the west side of the field and the old field pine stand is twenty to thirty feet wide. It consists primarily of winged sumac *Rhus copallina*, sweetfern (*Comptonia peregrina*), low blueberry (*Vaccinium angustifolium*), scattered thickets of greenbrier (*Smiilax rotundifolia*), rose (*Rosa* sp.) and sheep laurel (*Kalmia angustifolia*) grading back into white cedar (*Chamaecyparis thyoides*), black cherry, gray birch (*Betula populifolia*), young white oak, and young black oak (*Quercus velutina*), which in turn grade back abruptly into the white pine stand. The ecotone along the north side of the old field pine stand consists of a dense tangle of greenbrier and white cedar, with scattered black cherry, winged sumac, and grape (*Vitis novaeangliae*). The northern half of the border (not a good ecotone) between the field and the red maple stand consists of a dense tangle of greenbrier and mature white oaks, and along the rest of the border red maple saplings and alder (*Alnus rugosa*) intrude directly onto the field.

Linear furrows indicate that the area of the old field white pine stand was formerly cultivated. The largest trees from which cores were taken are 30-35 feet high and 18-20 years old. Thus, cultivation of this area was probably terminated in the late 1930's. In addition to the white pines of all age (and size) groups, there are a few scattered white cedars, gray birches, red maples, white oaks, black oaks, and red oaks (*Quercus rubra*). There is no clearly

definable middle story, and there is almost no ground cover in the deep pine needle litter. In the few small openings there is some grass, sheep laurel, low blueberry, and bristly dewberry (*Rubus hispidus*).

The red maple stand is separated with almost no intergradation from the old field pine stand by a path. There is no evidence of former cultivation, but more elevated (dry) portions may have once been open pasture. The central portion is lower than the field, contains permanent standing water, and has a brook flowing from the southeast corner. The upper story in the area of standing water is almost entirely red maple, and trees from which cores were taken are 60-65 feet tall and 40-45 years old. The middle story is made up primarily of red maple saplings and alder, with some highbush blueberry (*Vaccinium corymbosum*), ironwood (*Carpinus caroliniana*), and scattered holly (*Ilex opaca*). The ground cover is primarily sphagnum moss (*Sphagnum* sp.), with considerable horsetail (*Equisetum arvense*) and cinnamon fern (*Osmunda cinnamomea*). There is also scattered greenbrier, and some leaf litter. In the more elevated drier portions (north, west, and south sides) there are also a few mature white pines and white oaks, and numerous club mosses (*Lycopodium* sp.) in the ground cover.

TABLE 1. PHYSICAL MEASUREMENTS RECORDED IN WOODED PORTIONS OF THE STUDY AREA ON JUNE 1964 BETWEEN 11:30 A.M. AND 12:00 P.M.

Seral Stage	Light Penetration At Five Foot Level In Foot Candles	Air Temperature At Five Foot Level In Degrees Centigrade	Relative Humidity At Five Foot Level In Per Cent
Old Field Pines	5	23	57
Red Maples	3	21	73
Mixed Hardwoods	2	22	61

The red maple stand grades rather abruptly, perhaps because of the slope, into the mixed hardwoods stand. Dominant trees in the latter are pignut hickory (*Carya glabra*), white ash (*Fraxinus americana*), and white pine. The largest trees are sixty to seventy feet tall, and cores indicate that they are 35-45 years old. There are also a few scattered red maples, white oaks, and gray birches. The middle story consists largely of saplings of the upper story hardwoods, with a few scattered holly trees, white cedars, highbush blueberry, and southern arrowwood (*Viburnum dentatum*). The ground cover consists of interrupted fern (*Osmunda claytonia*), sheep laurel, greenbrier, club mosses, seedlings of upper story trees, and some grasses. There is a thick layer of leaf litter.

It may be said that elements of two seres leading to the same climax are represented—from hydric and xeric to mesic. This contention is supported not only by heretofore described vegetational and structural differences, but also by the other physical differences (Table 3). Thus, birds living and breeding in the old

field pine stand are subject to warmer, drier conditions and more light than birds in the other areas, and those in the red maple stand are subject to the coolest, most moist conditions. However, differences in light intensity, temperature, and relative humidity between the three wooded areas are not extreme.

METHODS

The banding station was established in June 1960 in the southwest corner of the mixed hardwoods section (Fig. 1). Two nine-meter Japanese mist nets were set running north-south, and two three-meter nets were set perpendicular to the south end of these. Mist nets were set a total of 47 days—27 June to 24 September 1960, and 16 June to 20 September 1961. Two three-cell and two single-cell traps were set on individual platforms, five feet high, east of the nets. Trapping was continuous except for the following periods: 1 January to 9 March 1962, 17 September to 20 December 1962, 1 January to 5 June 1963. From 27 June 1960 to 15 June 1964 the four traps were set a total of 241 days. Banding was discontinued after 6 October 1963. Because of the gaps in 1962 and 1963, heavy emphasis is placed on results obtained from 27 June 1960 through 31 December 1961. Statistical analysis is not warranted because of the gaps, and thus the study fell far short of its original objectives.

Color banding was initiated 6 June 1963 and terminated 25 August 1963. Bands were applied 6-7 June to seven house sparrows, 13 June to two white-breasted nuthatches, 14 June to one starling, and 17 June to 25 August to fifteen black-capped chickadees. The starling and house sparrows were not recaptured or seen subsequent to banding.

The distribution of breeding pairs observed in the study area 3-19 June 1964 is summarized in Figure 1. Each section of the study area was cruised twice a week, 8-10 A.M.—a total of six times.

RESULTS - ACCOUNTS BY SPECIES

Total capture results are summarized in Table 2. About 19 per cent were recaptured subsequent to being banded, but less than seven per cent were recaptured more than three months after being banded or after the last capture date. Only four individuals were captured or otherwise recovered more than five miles from the banding station.

Mourning Dove.—Thirteen were banded from 28 May to 3 August 1961, one a day on most capture days. One was also banded 25 December 1963. None of these were recaptured. One adult banded 15 June 1961 was shot by a hunter near Fayetteville, North Carolina on 30 December 1961.

Several remained through the winter of 1958-59, and were most frequently seen in the east side of the old field pine stand and in the corn field. A few persisted in the same location through the winter of 1959-60, but none were seen anywhere in the study area during the winter of 1960-61. A few fed through the winters of

TABLE 2.
SPECIES TRAPPED AND MIST-NETTED AT HANSON, MASSACHUSETTS, 1960-64.

Species	Total Captured	Total Recaptured	Total Returns	Foreign Recoveries
Mourning Dove (<i>Zenaidura macroura</i>)	14	0	0	1
Yellow-shafted Flicker (<i>Colaptes auratus</i>)	1	0	0	0
Hairy Woodpecker (<i>Dendrocopos villosus</i>)	1	0	0	0
Downy Woodpecker (<i>Dendrocopos pubescens</i>)	3	1	1	0
Eastern Wood Peewee (<i>Contopus virens</i>)	2	0	0	0
Blue Jay (<i>Cyanocitta cristata</i>)	81	2	0	0
Black-capped Chickadee (<i>Parus atricapillus</i>)	116	78	32	0
White-breasted Nuthatch (<i>Sitta carolinensis</i>)	19	9	3	0
Brown Creeper (<i>Certhia familiaris</i>)	1	0	0	0
House Wren (<i>Troglodytes aedon</i>)	2	0	0	0
Robin (<i>Turdus migratorius</i>)	4	0	0	0
Wood Thrush (<i>Hylocichla mustelina</i>)	4	1	0	0
Starling (<i>Sturnus vulgaris</i>)	16	0	0	0
Red-eyed Vireo (<i>Vireo olivaceus</i>)	2	0	0	0
Black-and-white Warbler (<i>Mniotilta varia</i>)	3	0	0	0
House Sparrow (<i>Passer domesticus</i>)	67	1	2	0
Red-winged Blackbird (<i>Agelaius phoeniceus</i>)	26	4	1	0
Common Grackle (<i>Quiscalus quiscula</i>)	115	2	4	0
Brown-headed Cowbird (<i>Molothrus ater</i>)	163	11	1	3
Scarlet Tanager (<i>Piranga olivacea</i>)	1	0	0	0

TABLE 2.—Continued

Species	Total Captured	Total Recaptured	Total Returns	Foreign Recoveries
Evening Grosbeak (<i>Hesperiphona vespertina</i>)	2	0	0	0
Purple Finch (<i>Carpodacus purpureus</i>)	36	8	1	0
American Goldfinch (<i>Spinus tristis</i>)	7	0	0	0
Rufous-sided Towhee (<i>Pipilo erythrophthalmus</i>)	13	2	0	0
Slate-colored Junco (<i>Junco hyemalis</i>)	265	21	7	0
Tree Sparrow (<i>Spizella arborea</i>)	144	70	19	0
Fox Sparrow (<i>Passerella iliaca</i>)	7	1	0	0
Swamp Sparrow (<i>Melospiza georgiana</i>)	1	0	0	0
Song Sparrow (<i>Melospiza melodia</i>)	3	0	0	0
White-throated Sparrow (<i>Zonotrichia albicollis</i>)	10	3	0	0
TOTALS:	1123	214	71	4

1961-62 and 1962-63 at the banding station. The amount of feed placed out for birds was increased during the winters of 1962-63 and 1963-64, and during the latter winter often more than twenty at a time were seen feeding at the banding station—frequently with bobwhites. Apparently availability of food is an important factor determining where mourning doves will over-winter.

In June 1964 there was one breeding pair in the mixed hardwoods north of the banding station, and there were two others in the western part of the old field pine stand (Fig. 1). It is not known if these were migrants, residents, or both.

Yellow-shafted Flicker.—One was banded 29 June 1960. In June 1964 there was one breeding pair in the mixed hardwoods 150 feet north of the banding station, and another in the northwestern corner of the red maple stand (Fig. 1). There were five breeding pairs in the woods bordering all except the north side of the field. None are known to have over-wintered in the study area.

Hairy Woodpecker.—An adult male was banded 31 December 1960. Individuals occurred sporadically each winter in the banding area, no more than a few days at a time. These probably originated from forest breeding areas elsewhere. There were no summer residents during the entire study period.

Downy Woodpecker.—A female was banded 5 November 1960, and a male and female were banded 11 December 1960. The female banded 5 November repeated to 27 November 1960, and returned (was recaptured) 14 July 1961. The other two may not have been resident in the study area. In June 1964 there was one breeding pair in the banding station area, and a fledgling young was first noticed there 19 June 1964.

Eastern Wood Pewee.—Two adults were banded 22 August 1960; they may have nested in the vicinity of the banding station. In June 1964 there were breeding pairs off each northern corner of the banding station, in the red maple stand just west of the standing water, and in the eastern part of the old field pine stand (Fig. 1).

Blue Jay.—One was banded 28 June 1960, and three were banded 12-24 November 1960. Forty were banded from 13 May to 15 July 1961. Most were taken in May, with a high of seven on 20 May. No more than two were taken on any given day in June or July. Seventeen were banded from 26 September to 9 November 1961, the peak being four on 29 September. In 1962 the first were captured on 20 May, and in 1964 on 3 May. One banded 13 May 1961 was retrapped 17 June 1961, and another banded 20 May 1961 was retrapped 18 June 1961. It is not known if this was a breeding pair. Those trapped from September through November, and in May, were probably largely transients (see: Griscom and Snyder, 1955). Some of those arriving in May became summer residents in the study area. There is no evidence that any were permanent residents. In June 1964 there were breeding pairs about 100 feet northeast of the banding station and in the northern part of the mixed hardwoods (Fig. 1). There were also two breeding pairs in the eastern part of the red maple stand, and four pairs in various sections of the old field pine stand. The old field pine stand was the preferred breeding area.

Black-capped Chickadee.—Forty-eight were banded from 23 August 1960 to 23 April 1961, and all except 15 were recaptured at least once. Of 13 that were trapped and netted the last week of August 1960, four remained at the banding station until the second and third weeks of April 1961. One was killed by a house cat 23 October 1960. Two remained at the banding station less than two weeks, and six remained there until November and December 1960. One of the latter returned 19 March 1962. One that left 30 December 1960 returned 17 October 1961, remained until 4 November 1961, returned again 17 March 1962 and remained until 29 March 1962. Those banded after 1 September 1960 arrived at the rate of one, two, or three a day until 23 April 1961. Fifteen of the 33 recaptured left the banding station the second and third weeks of April 1961. It was at this time that the last of the tree sparrows and juncos departed, and the influx of large numbers of cowbirds began. These phenomena may be related to passage of a warm front from the south. It is suspected that the arrival of

cowbirds caused the chickadees to depart. Six chickadees returned in September 1961, and one returned in November. To these were added one banded on 29 August 1961, nine banded in September, ten in October, five in November, and seven in December. Twelve more were banded in March 1962. Thus, there was no obvious decrease in the population over that of the previous year. Five of the original 48 were still at the banding station in March 1962, and one was retrapped 5 April 1964. After 5 August 1963 only four of 97 banded prior to that date returned, and from that date through 3 May 1964 only 28 new individuals were banded. Thus, there seems to have been some decrease in the overall population. Reasons for this are not known.

Speirs (1963) suggests that first year mortality in chickadees is about 89 per cent. Data produced in the present study seem in close agreement with that figure. McCamey (1962) states that most mortality in adults occurs in July and August, and this also seemed to be true of the population sampled in the present study. The fate of those not recaptured after being banded is not known. Many may have dispersed in various directions, and some may have gone much farther south (see: Cutler, 1933; Brewer, 1963). Some of the new individuals were undoubtedly produced in the study area (see: McCamey, *op. cit.*), whereas others may have originated from areas peripheral to the study area (see: Kluyver, 1961). Some may have originated from areas much farther north (see: Lawrence, 1958).

Attempts to trace local movements by color banding were unsuccessful. From 21 July 1963 until 29 March 1964 individuals and groups were seen most frequently in various parts of the old field pine stand. A few were also seen and heard occasionally in other wooded areas bordering the field.

In June 1964 there was one breeding pair in the mixed hardwoods east of the banding station, and another pair (with young) in the woods at the southeast edge of the field (Fig. 1). There were also two breeding pairs in the red maple stand, and five pairs in the old field pine stand. Thus, the old field pine stand was preferred for breeding as well as winter habitat.

White-breasted Nuthatch.—As can be seen in Table 3, six of the 19 banded were never recaptured. Three banded in September and October 1960 left the banding station the first and second weeks of November 1960. Two of these returned in March and April 1961, and remained in the banding station area until the middle and end of June 1961 respectively. Two banded 29 August and 16 October 1961 left the last week of December 1961. The former returned in June 1962 and may have bred in the study area. Thus, none banded in the fall wintered at the banding station, but several returned the following spring. None spent the summer at the banding station, but some may have not been very far away. One banded 13 June 1963 returned 9 September 1963. Some may have wandered farther away. One banded 13 June 1963 did not return until 29 March 1964. In June 1964 there was one pair at the banding station.

TABLE 3. WHITE-BREASTED NUTHATCHES TRAPPED AND MIST-NETTED
IN HANSON, MASSACHUSETTS, 1960-64.

Date Initially Captured	Last Repeat Date	Return Date	Last Repeat Date After Return
8 September 1960	9 November 1960	17 April 1961	16 June 1961
23 October 1960	12 November 1960	18 March 1961	29 June 1961
30 October 1960	6 November 1960		
10 December 1960	11 December 1960		
20 May 1961	16 June 1961		
7 July 1961			
29 August 1961	22 December 1961	3 June 1962	10 June 1962
26 September 1961	29 September 1961		
2 October 1961	10 October 1961		
16 October 1961	29 December 1961		
11 March 1962	15 March 1962		
25 July 1962	13 September 1962		
16 September 1962			
27 December 1962			
13 June 1963		29 March 1964	
13 June 1963		9 September 1963	6 October 1963
2 December 1963			
29 March 1964			
6 April 1964			

There is no doubt that nuthatches breed regularly in the study area, and it seems probable that several are resident in the vicinity of the study area. It would be interesting to learn more about the movements of apparent transients. Groskin (1944) reported one known to have moved about 200 miles, from Pennsylvania to New York. It would be equally interesting to learn more about local movements of resident birds. One banded 16 September 1962 was accidentally killed one-half mile northwest of the banding station on 5 December 1962. Efforts to trace local movements using colored bands were unsuccessful.

Brown Creeper.—One was banded 22 August 1961. Individuals were seen at irregular intervals at the banding station during the summers of 1961, 1962, and 1963, but breeding activity within the study area was not noted.

House Wren.—One was banded on 21 August 1962, and another was trapped on 6 June 1964. The latter may have been a member of a breeding pair seen in the banding station area. About 12 were seen at the banding station nearly every day the last two weeks of June 1963 and again the last two weeks of July 1963.

Robin.—Immature individuals were netted and banded 26 August 1960, 2 September 1960, 26 July 1961, and 30 July 1961. In June 1964 there were three breeding pairs in the old field pine stand, one on the east side of the red maple stand, and one in the red maples between the northeast corner of the field and the pond (Fig. 1). The immature specimens banded may have originated in part from these breeding areas. None are known to have wintered in or near the study area. It is believed that a flock of two dozen males seen in the field on 8 March 1964 were migrants.

Wood Thrush.—In 1960 immature individuals were netted and banded on 27 June, 28 June, and 30 June. One was also netted and banded on 19 June 1961. The latter was netted again on 6 July 1961. In June 1964 there were five breeding pairs in the mixed hardwoods, and there was also one pair on the north side of the red maple stand (Fig. 1). These observations do not agree entirely with Forbush (1929), who concluded that wood thrushes prefer moist lowland woods or thickets, often near water. In the present study, wood thrushes were associated with the more mesic portions of the study area.

Starling.—Individuals were banded 28 January 1961, 5 February 1961, 13 May 1961, and 15 June 1961. Two were banded 26 September 1961, and individuals were banded 29 September 1961, 4 April 1962, 23 December 1962, 22 December 1963, 25 December 1963, and 1 March 1964. Immature individuals were banded 19 July 1961, 30 and 31 July 1962, and 14 June 1963. None were recaptured, or recovered elsewhere. Each spring, 1961 through 1964, a pair nested and produced young in a cavity in a dead oak tree on the north side of the banding station.

The status of starlings in the study area is not clear. Large flocks were seen frequently in the field in fall, winter, and spring each year of the study period, but breeding activity was noted only in the banding station area. Griscom and Snyder (1955) state that the starling is an abundant transient with blackbirds in early spring and late fall, but this was not confirmed by data from the present study. Instead, the data suggest that starlings may arrive in the study area any month of the year, and none become permanent residents. Bergstrom (1961) believes that starlings banded by him at West Hartford, Connecticut were strongly resident winter and summer, whereas Heimerdinger (1961) believes that starlings banded by her at Somers, Connecticut were summer, not permanent, residents. Davis (1960) believes that many New England starlings are permanent residents, and others may migrate as far as Canada and Pennsylvania. More data are needed.

Red-eyed Vireo.—One was netted and banded 19 July 1961, and another 5 August 1961. In June 1964 there was one breeding pair about 200 feet northwest of the banding station, and there were two pairs in the red maples along the east side of the field (Fig. 1).

Black-and-White Warbler.—Males were netted and banded 27 June 1960 and 31 July 1961, and a female on 22 August 1960. In June 1964 there was one pair in the southeastern section of the old field pine stand, and another pair in the western section of the red maple stand (Fig. 1). These warblers have never been seen breeding in the banding station area, and those banded may have originated from woods east of the banding station.

House Sparrow.—In 1961 a female was banded on 1 June, and a male on 3 June. In 1962 two males and a female were banded on 27 May, and two other males on 10 June and 30 July. Also in 1962 five immature individuals were banded on 25 July, five on 30 July, two on 31 July, eight on 21 August, ten on 22 August, eight on 13 September, five on 16 September, and one recognizable as a male on 23 December. One of the immatures banded on 30 July returned 20 June 1963 and was recognizable as a female. Another banded 21 August was killed 18 September 1962 one-fourth mile northwest of the banding station. In 1963 five males and two females were banded 6-7 June, and another male was banded on 2 December. In 1964 two males and a female were trapped on 12 April, another on 6 June, and a fourth on 14 June. Two immature individuals were also trapped on the latter two dates. Beginning in May 1962, house sparrows were seen almost continuously, year-round, at the banding station through the remainder of the study period. They were not seen in other sections of the study area. Apparently the food placed out was the main attraction at the banding station.

It is suspected that the first invaders originated from a horse barn about one-eighth mile west of the banding station. The placing out of food for winter birds has resulted in a permanent colony in the banding station area. It was hoped to determine, by using colored bands, if there is movement of individuals between the banding station area and the horse barn, but this effort was unsuccessful.

Red-winged Blackbird.—Only males were seen and captured at the banding station. Even though large flocks, along with grackles and cowbirds, fed regularly at the banding station each spring, usually only one, and never more than three individuals, were captured per day. In 1961 the first was trapped on 13 May, and the last on 6 July. In 1964 the first was trapped on 9 April, but several were seen feeding with grackles at the banding station on 22 March. Several fed with grackles at the banding station 19-20 October 1963, but none were trapped. Two banded in 1961 (29 May, 6 July) were retrapped the following day, and one banded 3 June 1961 was retrapped three days later. One banded 10 June 1962 returned (was captured) 7 June 1963, and another banded 21 May 1961 was found dead 16 May 1962 in the field about 100 feet east of the red maple stand. Thus, 11.5 per cent of those banded are known to have returned.

In June 1964 there was one breeding pair in the standing water section of the red maple stand, and another in the red maples

between the field and the southwest shore of Wampatuck Pond. Most nesting activity was seen in the cattail succession at the south end of the pond, and in a cat-tail swamp in a cranberry bog about one-eighth mile south of the pond. It is not known what proportion of the population sampled at the banding station were transients. None are known to have wintered in or adjacent to the study area. It is believed that returns cited are expressions of homing instinct.

Common Grackle.—In 1961 migrants were trapped and banded from 13 May to 8 July. In 1962 migrants were trapped from 20 May to 10 June, and three were also captured on 21 August. In 1962 immature individuals were trapped and banded on 30 July (one), 31 July (four), 21 August (one), and 22 August (three). In 1964 several were seen feeding at the banding station on 22 March, and the first capture was on 29 March. The last capture that year was on 15 June, but several fed each day the remainder of the month at the banding station. One banded 20 May 1961 returned (was captured) 14 June 1964. Another banded 27 May 1962 was killed one-half mile south of the banding station 13 June 1963, and a third banded 10 June 1962 returned 6 June 1963. Thus, the homing instinct is strong in this species. None are known to have wintered in or adjacent to the study area.

In June 1964 there was one breeding pair in the northeast corner of the red maple stand, and there were also two breeding pairs in the red maples between the field and the southwest side of Wampatuck Pond.

Brown-headed Cowbird.—In 1961 the first were banded on 8 April and the last on 19 June. Eighty males and 59 females were trapped, the peak being the second week of May. The pattern was similar in 1962 (30 March to 3 June; one male on 30 July), and in 1964. Less than 7 per cent of the total trapped were recaptured at the banding station (see: Table 2). None were recaptured after the third week of June, 1961-63, but in 1964 a few males fed almost daily at the banding station until 30 June. One male banded 6 May 1961 returned (was recaptured) 10 June 1962. A female banded 31 April 1961 was found dead about 20 miles northwest of the banding station (near Dedham, Massachusetts) 31 May 1962. A male banded 30 April 1961 was trapped and released by a bander near Sandy Hook, New Jersey on 29 November 1961. Another male banded 14 May 1961 was trapped and released by a Fish and Wildlife Service employee near Wilmington, Delaware on 10 February 1962. In the spring cowbirds arrive in the study area in large flocks with grackles and red-winged blackbirds. Meanley and Webb (1961) have determined that a large proportion of the latter species winters in the Delaware-Chesapeake Bay area. It would be of interest to determine if the cowbird population sampled winters there, or if they move up in late winter from points farther south and join the red-winged blackbirds in their northward migration.

Probably the majority of cowbirds arriving at the banding station in spring are transients and continue to move on to other points, particularly northward. However, some have been resident at least through the breeding period. It is not known exactly where breeding occurs. Except for occasional individuals seen along the north side of the field, cowbirds have been seen only at the banding station.

The homing instinct is discussed by Manwell (1962), and need not be further discussed herein.

Scarlet Tanager.—A male was netted and banded 10 July 1961. In June 1964 there was a breeding pair in the northwest corner of the red maple stand. For three successive summers, before the house adjacent to the south side of the banding station was constructed, at least one breeding pair was seen in the banding station area—usually associated with large white pines. None were seen thereafter. It is suspected that either house construction in adjacent lots, or the invasion of house sparrows and starlings, has inhibited scarlet tanagers from nesting in the banding station area.

Evening Grosbeak.—One male was banded 20 January 1961, and a female was trapped 25 December 1963. On both occasions there was a driving snowstorm, and the birds were members of large flocks that suddenly entered the banding station, remained a few minutes, and left. Otherwise, only one or a few at a time were seen at the banding station, and none ever stayed more than a few minutes.

Purple Finch.—In 1961 16 males and 20 females were banded from 23 January to 19 July. Three females banded 14 May repeated (remained in the study area) until mid-July. A male banded 30 April also stayed in the study area until mid-July. One of the three females returned 30 July 1962. Four other females (banded 30 April, 6 May, 15 June, 19 July) were recaptured two days to two weeks after being banded, but not subsequently. It is not known where nesting occurred. Males were occasionally seen at the banding station in early spring in 1963 and 1964, but not elsewhere in the study area.

Failure of purple finches to remain (and breed?) in the study area subsequent to 1961 may be related to two important events—land clearing and house building, and entry of large numbers of house sparrows into the banding station area in the spring and summer of 1962. Perhaps the latter event (and invasion of starlings?) was the more important (see: Forbush, 1929). There has been no decrease of white pines in the study area.

American Goldfinch.—In 1961 two were banded on 26 January, two on 5 February, one on 11 March, one on 18 March, and one on 23 April. Breeding pairs were never seen in the study area. Goldfinches breed each summer in brush borders in the cranberry bog one-eighth mile southeast of the study area. Perhaps those banded in winter originated from there. It is doubtful that any except perhaps the April bird were transients.

Rufous-sided Towhee.—In 1961 males were banded 13 May, 17 June, and 29 September, and a female was banded 29 June. Also in 1961 two immature individuals were banded on 3 August, two on 29 September, and two on 6 October. The male banded on 13 May was recaptured 21 July 1961, and the female was recaptured 1 July 1961. In 1962 males were banded on 20 May and 31 July, and a female was banded on 25 July. The pattern was similar in 1963. In June 1964 there were six breeding pairs in the mixed hardwoods, six pairs in the old field pine stand, five pairs in the red maple stand, and three pairs in the woods along the south and east sides of the field (Fig. 1). Thus, the towhees were about equally numerous and dense in xeric, hydric, and mesic habitats, and were near wood edges as well as back from the edge. Individuals were also active in the standing water section of the red maple stand, even though none nested there.

Slate-colored Junco.—None spent the summer in the study area. The first winter, inclusive banding dates were 19 November 1960 to 21 April 1961. A total of 61 males and 42 females were banded, with a peak of 11 on 18 December 1960. Inclusive dates for the second winter were 16 October 1961 to 15 April 1962, and inclusive dates for the last winter were 2 December 1963 to 19 April 1964. During the last winter 41 males and 40 females were trapped. On the basis of birds per trap day, there was no apparent significant population decrease from the first winter to the last.

Only 7.9 per cent of those banded were recaptured, and only 2.6 per cent returned to the banding station (were recaptured) after an absence of more than three months. This causes one to wonder if the homing instinct is weaker in juncos than in tree sparrows. One male banded 24 November 1960 returned 25 December 1963, and another banded 11 December 1960 returned 11 March 1962. A few others returned the winter subsequent to that in which banded, but not thereafter. Of those known to have remained in the banding station area after being banded in the winter of 1960-61, the average stay was about three weeks. Some remained as little as one day, and one remained two months. The pattern, in general, was one of arrival and departure of small groups (both sexes). For example, one group of two females and a male were banded the first week of December 1961 and left the third week of that month. Others arrived at the banding station in early winter, departed shortly thereafter, and then returned again in late winter and early spring.

Findings in this study are in general agreement with those of Helms and Drury (1960). Juncos arrived almost daily in small groups and foraged in the banding station area with similar groups of tree sparrows. It would be of interest to determine if those that arrived in early winter and returned again in late winter and early spring had remained in the general vicinity of the study area or had gone much farther south.

Tree Sparrow.—None spent the summer in the study area. Inclusive dates for the first winter were 4 December 1960 to 20 April 1961—a total of 118 birds banded. There were small waves of arrivals (two to four per day) in December 1960, but the great majority were captured in the last ten days of January 1961. Most of those subsequently recaptured were of the latter group. There was a small wave of arrivals the second week of March 1961 (transients moving northward), and just a few after that until 20 April 1961. Only 20 were captured and banded the second winter. The station was not operated from 1 January to 19 March 1962, and the main wave of migrants was probably missed. In the winter of 1963-1964, none were captured until 8 March 1964. Reasons for this are not known. Perhaps some meteorological event altered the migration pattern that winter. Perhaps, also, the large number of house sparrows inhibited tree sparrows from remaining at the banding station.

Of the total captured, 48.5 per cent were recaptured, and 13.2 per cent returned (were recaptured) after an absence of more than three months. Some remained as little as one day at the banding station, and others remained as long as three months. In the winter of 1960-61 the average stay was about one month. One banded 30 December 1960 repeated until 11 February 1961, and then returned 10 April 1964. Five banded early in the winter of 1960 returned in early spring of 1961. One banded 17 December 1960 was found dead near Hanson by a hunter on 16 February 1962. Five banded the last week of December 1960 returned the last week of December 1961, and four banded the last week of January 1961 also returned the last week of December 1961. Four banded the second week of March 1961 returned the last week of December 1961, and another banded that week returned 23 December 1962. These data suggest that small groups of tree sparrows remain and travel together from one year to the next, and often return to the same wintering area. These findings are in agreement with those of Mason (1952) and Helms and Drury (1960). Many transients spent little time at the banding station during their spring and fall migrations, but the data suggest that a few spent up to several weeks there before moving on. Several were winter residents.

Fox Sparrow.—Individuals were banded 12 November 1960, 17 December 1960, 21 January 1961, 31 March 1961 (two), 26 March 1961, and 9 April 1961. The individual banded 17 December 1960 was retrapped 18 December 1960. Those banded in November, March, and April were probably transients and may have spent the winter as near as Cape Cod (see: Broun, 1934). Those banded in December and January may have been winter residents in the vicinity of the banding station. It is not known why none were trapped or seen in subsequent winters. Perhaps their absence was related to land clearance and house construction, or the invasion of starlings and house sparrows.

Swamp Sparrow.—One was banded 4 August 1961. It may have wandered up from the cat-tail swamp in the cranberry bog, where many breed each year. None were resident and breeding in the study area during the study period.

Song Sparrow.—Individuals were banded 19 December 1960, 21 January 1961, and 25 March 1961. The latter may have been a spring migrant, but the other two were probably winter residents. None of these were recaptured or recovered elsewhere. In June 1964 there were eight breeding pairs along the western, southern, and eastern edges of the field (Fig. 1). All were in areas of thick brush with water nearby. Perhaps those banded originated from one or more of these breeding areas.

White-throated Sparrow.—In 1960 six were banded from 20 November to 24 December. Two were banded 21 January 1961, one on 23 March 1962, and one on 6 April 1964. One banded 20 November 1960 was retrapped 12 February 1961. Another banded 26 November 1960 was retrapped 23 December 1960, and a third banded 17 December 1960 was retrapped 25 December 1960. Thus, some were apparently transients, and others were winter residents in the banding station area. There were no summer residents in the study area. Some of the transients may have traveled a considerable distance southward. Wharton (1933) banded an adult at Milton, Massachusetts 7 October 1932 that was taken 13 March 1933 at Summerville, South Carolina.

Species Seen But Not Captured.—A woodcock (*Philohela minor*), in spring 1962, was observed in mating behavior in the northeast corner of the red maple stand, and another was seen 21 July 1963 in the northeast corner of the old field pine stand. A covey of bobwhites (*Colinus virginianus*) is known to have been in the study area since the fall of 1961, and up to 12 fed regularly through the winters of 1961-64 at the banding station, often along with mourning doves. On 12 June 1964 a male was observed calling from a limb of a large white pine tree about 100 feet east of the red maple stand, and on 29-30 June one was heard calling in the mixed hardwoods north and east of the banding station. Ruffed grouse (*Bonasa umbellus*) were seen throughout the study period in the mixed hardwoods and old field pine stand, occasionally in the red maple stand, and in the woods north and east of the field. In June 1964 a female with young was observed in the southeast corner of the mixed hardwoods, and another with young was seen in the southwest corner of the old field pine stand (Fig. 1). On 10 June 1964 a male ruby-throated hummingbird (*Archilochus colubris*) was seen at the south side of the banding station. In June 1964 a breeding pair of eastern kingbirds (*Tyrannus tyrannus*) was seen in the red maples between the northeast corner of the field and Wampatuck Pond, and during the same period there was a breeding pair of eastern phoebes (*Sayornis phoebe*) in the northwestern corner of the mixed hardwoods. Common crows (*Corvus brachyrhynchos*) were often seen in the study area, but none were resident

and breeding there. In June 1964 there was a breeding pair of Baltimore orioles (*Icterus galbula*) in the woods beside the north side of the field. At the same time there was a breeding pair of indigo buntings (*Passerina cyanea*) in the red maples between the northeast corner of the field and the pond, and there was another pair in the ecotone along the east side of the red maple stand (Fig. 1). Barn swallows (*Hirundo rustica*) were seen every summer hawking insects over the field, but did not breed within the study area. Yellow warblers (*Dendroica petechia*) were seen each summer of the study period in the ecotone along the east side of the old field pine stand. In June 1964 there was one breeding pair in this ecotone, and another in the red maples between the field and the pond. Ovenbirds (*Seiurus aurocapillus*) were observed in the study area each summer, and in June 1964 there were three breeding pairs in the mixed hardwoods and two pairs in the southwestern section of the red maple stand (Fig. 1). Also in June 1964 there were four breeding pairs of yellowthroats (*Geothlypis trichas*) in the ecotones along the east and north sides of the old field pine stand, and one pair in the ecotone on the east side of the red maple stand. American redstarts (*Setophaga ruticilla*) were seen in the study area only in June 1964, when there was one breeding pair in the southeast corner of the old field pine stand. Catbirds (*Dumetella carolinensis*) were observed each summer throughout the study period. In June 1964 there were two breeding pairs in the mixed hardwoods, three pairs in the old field pine stand, three pairs in the red maple stand, and five pairs in the woods along the eastern and northern sides of the field.

DISCUSSION

It is regrettable that circumstances made it impossible to conduct a continuous trapping and netting program. Trends suggested by data obtained might have been more distinct, and statistical analysis might have been warranted. Nevertheless, data of some interest were produced.

Land clearing and house construction along Bonney Hill Lane has eliminated more than six acres of woodland habitat. No birds were seen to breed in the open cleared areas. Thus, in this single residential development, extrapolating from density values for the mixed hardwoods stand studied, the woodland breeding bird population has probably been reduced by about sixteen pairs over what it was ten years ago. There has been no ecotone development along the edges of the house lots (and probably will not be), and thus no addition of ecotonal avian species. Several house cats have been added to the area, and have been seen hunting *throughout* the study area. They undoubtedly kill many birds each year, particularly nestlings and fledglings. The tree bat population has apparently been wiped out. If one considers the total area of housing developments in Plymouth County (Massachusetts) alone, probably between 50,000 and 100,000 breeding pairs of woodland birds have been permanently eliminated. It is estimated that 500-

1,000 pairs have been permanently eliminated from Hanson since the end of World War II. Additional numbers of birds have been and are being destroyed by insecticides. Mr. Raymond Seamans of Halifax, Massachusetts has noted that the breeding bird population of Great Cedar Swamp in Hanson has decreased considerably over what it was 25 years ago. Mr. Seamans, a skilled amateur field ornithologist, has studied the avian population of Great Cedar Swamp more continuously and intensively than any other living person—over a period of nearly thirty years. It would be helpful to conduct field studies of the total effects of insecticides on bird and other animal populations. Unfortunately, most large-scale applications of insecticides in this area are made by cranberry growers and other agriculturalists, and by politically appointed and dominated mosquito control agencies. There are no personnel associated with either group who have the vaguest idea of how to conduct such studies, and neither group would willingly permit any action that would delete in any way their monetary or political gains and advantages.

This study indicates that removal of habitats is not the only damage done by suburbanization. Trash species—starlings and house sparrows—invade newly cleared areas. Large numbers of both species were observed in more than a score of housing developments cursorily surveyed in Plymouth County. These species consume large quantities of food, occupy tree holes and other nesting sites, and in other ways cause the removal of native species (e.g., purple finches). Unfortunately, placing out food for native species attracts trash species, to the detriment of the former.

This study also revealed something of the distribution of avian species in a southeastern New England old field succession. Most species known to breed in the study area do so in two or more different types of habitat, but others are more restricted. Five species were observed only in the mesic (mixed hardwoods) area, and six species only in ecotones or edges. Several species that occurred in two or more habitats displayed (in numbers) a preference for one over the other. The mixed hardwoods area and the ecotones had the most species, and the xeric (old field pine) habitat the fewest. A discussion of reasons for differences in numbers and kinds of species in the different habitats is beyond the scope of this paper. Suffice it to state that the two seres represented start with some different species, some of which are replaced by other species in the course of plant succession. There is a greater number and diversity of species in the terminal ("climax") floral association than in the intermediate seral stages. Deleterious effects of suburbanization on the latter—the product of a half-century of transition—have been discussed.

Anderson and Maxfield (1962) sampled, by mist-netting, birds in the middle of a white cedar-red maple swamp in southeastern Massachusetts. Only in certain sections of this swamp may one see a typical sedge-cat-tail to white cedar to red maple succession from center (open water) to edge. More than one-half century ago road beds were built across this swamp, and there are now

fairly mature red maple stands along them. Anderson and Maxfield set their nets along these road beds, and thus sampled red maple but not white cedar stands. They captured or noted eight species observed in the red maple stand in the present study. They did not net red-winged blackbirds or scarlet tanagers, and they decided that immature rufous-sided towhees that they netted were wanderers into the swamp. That is, the latter dispersed one-half mile into the swamp from surrounding upland woods rather than into adjacent upland woods. Anderson and Maxfield also recorded ruffed grouse, hairy woodpeckers, and yellowthroats. The latter two species indicate that they were, in fact, sampling an edge, but otherwise their results agree rather well with those of the present study.

Methodology used in the present study has several limitations. Color bands were found to be useless in tracing local movements. Because of the small area sampled by traps and nets, totals obtained cannot be construed as representative for the entire study area. Several species, including some within the banding station area, were not sampled at all. Banded birds that didn't remain in or return to the banding station area may have been only a short distance away. Distributing traps and nets throughout and around the entire study area would have provided more representative samples. Even then, however, certain species (e.g., crows, ruffed grouse, barn swallows), and those confining their activities to the upper story in wooded areas could not be adequately sampled. A spot or strip census indicates the number of individuals or breeding pairs at a given time, but unless the birds are marked so that they can be distinguished individually, it is difficult to determine local movements and turnover in the population. A combination of techniques must be used, and new techniques are needed.

Nevertheless, in spite of all the limitations of this study, certain trends and events discussed herein are unmistakable, and would seem to indicate the need for additional studies.

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POSTJUVENAL MOLT AND DETERMINATION OF AGE OF THE CARDINAL

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In the winter of 1957 I began banding Cardinals, *Richmondia cardinalis*, on the campus of the University of Western Ontario, London, Ontario, Canada. At that time I sought some method which would enable me to discriminate between adults (more than one-year-old) and birds in their first winter (hereafter referred to as immature). I attempted to use the method proposed by Miller (1946) for determining the age of live passerines, but it was unsatisfactory. The crest of the Cardinal made difficult a quick, clear view of the skull. By winter the unfossified portions of the skull were very small in some birds and consequently were difficult to find. Finally, in the extreme cold prevailing at the time of banding, it seemed unwise to subject birds to any additional stress which might be caused by minor surgery and by the time required for the examination. So, I sought other means of age determination.

In December and, to a lesser degree, in January some birds retain obvious marks of immaturity, such as a dark culmen and dark spots on the mandible dorsal to the angle of the gonyes. In