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BREEDING BIRDS IN A FLORIDA SUBURB

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BREEDING BIRDS IN A FLORIDA SUBURB

GLEN E. WOOLFENDEN AND SIEVERT A. ROHWER¹

SYNOPSIS: A study of bird populations in the residential suburbs of St. Petersburg and Gulfport, Pinellas County, Florida based on observations made in three study plots totaling 100.5 acres during portions of two years, 1963 and 1964. The dominant vegetation is described in detail. Part I includes our estimates of the total number of breeding pairs for each plot, which varied from 200 pairs per 100 acres in new residential suburbs to 500 and 600 pairs per 100 acres in mature suburbs. Of the 11 species that breed in the three plots, four, the House Sparrow, Mourning Dove, Blue Jay, and Mockingbird, were the most abundant and accounted for more than 90 per cent of the total. House Sparrows alone comprised about 50 per cent of all breeding birds. Only four species not found in the quadrats, two of which are introduced, breed in similar habitats in the county. When natural areas are replaced by suburbs a marked change in avian species composition occurs, and, with the eventual maturing of the suburbs, breeding populations increase in pairs per hundred acres from an estimated maximum of 200 pairs to 500 or 600 pairs. Part I also discusses the birds breeding in peripheral habitats, total breeding populations for the two cities, non-breeding birds, and predators.

Part II deals with the breeding biology of several of the more common breeders, excluding the House Sparrow, based on almost 900 nest records. A discussion of currently existing methods for measuring nesting success is followed by an explanation of a new method which may prove useful in certain other studies. By this method a calculated number of hypothetical unfound failures are added to the sample of known nests to compensate for nests found after incubation or egg laying has begun. Using our method we found that nest success was approximately 40 per cent for Mourning Doves breeding in pine-dominated suburbs and 20 per cent for those breeding in oak-dominated suburbs. Based on the same method nest success for Mockingbirds was about 52 per cent in the two habitats combined. A method of expressing nest-site preference based on the relative abundance of plants and the distribution of nests is proposed also. Additional information on phenology of nesting, clutch size, and nest location is given in the species accounts. Information is especially extensive for the Mourning Dove where 625 nestings were analyzed.

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INTRODUCTION

With the rapid growth of human populations man-modified environments are of increasing importance to wildlife. In North America a type of man-modified habitat undergoing a particularly rapid expansion is the residential suburb. In 1963 and 1964 we studied the birds inhabiting the suburbs of Pinellas County, Florida, which support a markedly large and rapidly growing human population.

The immediate practical value of the study is related to investigations of the ecology of arboviruses. The Tampa Bay area of Florida, including Pinellas County, had three outbreaks of human St. Louis encephalitis between 1959 and 1963. The last and major epidemic in 1962 was the second largest outbreak of urban St. Louis encephalitis in the United States. As a number of bird species are known to carry St. Louis and other types of arbovirus (Hammon et al., 1951; Chamberlain et al., 1957; Ranzenhofer et al., 1957; Stamm, 1966), a knowledge of those species found in close proximity to man is mandatory to understanding arbovirus ecology. This may be especially true for breeding species, as young birds that have not built up an immunity to viruses are more important as hosts than old birds.

Little information on bird populations in residential areas is available, particularly for the western hemisphere. The work of Graber and Graber (1963) is a notable exception. Grosvenor (1916), Whitaker (1916), and Pitelka (1942) have published brief reports of high bird densities existing in the vicinity of man's establishments, but these were studies of nest densities and not breeding-bird densities.

Our objectives were to determine species composition, density, habitat preference, and duration of the nesting season for the birds of suburban Pinellas County. Data on clutch size, productivity, and nest location based on almost 900 nests are included; such information seems rather scarce for Florida birds. Changes in the land-bird populations of Pinellas peninsula, as evidenced comparing our data with those of the early chroniclers of Pinellas County birds (Pangburn, 1919; Fargo, 1926; Bent and Copeland, 1927; and DuMont, 1931), are discussed, as are differences between the Florida populations and those of suburban Illinois (Graber and Graber, 1963) and New York (Simmers, 1965), and between the populations in residential and natural areas (Udvardy, 1957).

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DESCRIPTIONS OF THE PLOTS

Three study plots totalling 100.5 acres and representing the three major types of residential vegetation associations were chosen and given the names "oak," "pine," and "new" in reference to their dominant vegetative features (fig. 1 and 2). Two plots (oak and new) were in the city of St. Petersburg, the third was in adjacent Gulfport; all were within 4 miles of each other. The boundaries of all three plots were the midlines of public streets or alleys. Standing vegetation (overstory and understory but not ground cover) was measured by counting the number of individuals of each plant species and estimating the amount of ground each covered. In the field the diameter of the vertical projection of above ground parts was measured for each plant large enough to be a potential nest site; the total space each plant species covered was later calculated from these measurements. Little overlap between over and understory plants occurred, but where it did the areas of both plants were included. In the vegetation summaries the ground covered by each plant species is presented as a percentage of the total standing vegetation of the plot. Ground cover in all three plots consisted mainly of a few varieties of lawn grasses; differences in ground cover are mentioned below. Plant names are from Kurz and Godfrey (1962) and Bailey et al. (1949).

OAK PLOT. — Located in St. Petersburg, bounded by 46th Street and the alleys east of 49th Street, south of 9th Avenue North, and

north of 5th Avenue North, a rectangle 385.7 yards by 221.3 yards containing 17.6 acres (7.9 h). Two streets and one unpaved alley extended the length of the quadrat and were intersected perpendicularly by one street. Another street extended one-quarter of the way through the width of the plot. Streets occupied 8.0 per cent of the quadrat and unpaved alleys 3.0 per cent. The 53 dwellings in the plot and a few additional structures occupied 12.8 per cent of the area. Two lots were vacant and both were wooded.

Standing vegetation covered 28.3 per cent of the quadrat. Oak trees, genus *Quercus*, were dominant. The number of individuals and percentages each contributed to the standing vegetation were:

| Species | Number of individuals | Percentage of standing vegetation |
|---|-----------------------|-----------------------------------|
| Turkey oak (<i>Quercus laevis</i>) | 181 | 44.73 |
| Laurel oak (<i>Quercus hemisphaerica</i>) | 45 | 18.49 |
| Citrus (<i>Citrus</i> spp.) | 92 | 6.17 |
| Jacaranda (<i>Jacaranda</i> sp.) | 22 | 6.12 |
| Longleaf pine (<i>Pinus palustris</i>) | 21 | 4.84 |
| Live oak (<i>Quercus virginiana</i>) | 7 | 3.77 |
| Bluejack oak (<i>Quercus incana</i>) | 11 | 3.63 |
| Sand-live oak (<i>Quercus geminata</i>) | 14 | 3.50 |
| Cherry laurel (<i>Prunus caroliniana</i>) | 29 | 1.66 |
| Silk oak (<i>Grevillea robusta</i>) | 15 | 1.12 |

An additional 25 or more plant species formed the remaining 5.97 per cent of the standing vegetation, no one accounting for more than one per cent. These plants are listed below in order of decreasing percentage. The palms were common small to medium-sized trees for which areas were not calculated because of their small and sparse canopies.

| | |
|---|---|
| Bamboo (at least two genera) | Azalea (several genera) |
| Ligustrum and privet (<i>Ligustrum</i> and <i>Forestiera</i>) | Saw palmetto (<i>Serenoa repens</i>) |
| Australian brush-cherry (<i>Eugenia paniculata</i>) | Water oak (<i>Quercus nigra</i>) |
| Southern magnolia (<i>Magnolia grandiflora</i>) | Red maple (<i>Acer rubrum</i>) |
| Sand pine (<i>Pinus clausa</i>) | Brazilian pepper (<i>Schinus terebinthifolius</i>) |
| White mulberry (<i>Morus alba</i>) | Strawberry guava (<i>Psidium cattleianum</i>) |
| Podocarpus (<i>Podocarpus</i> sp.) | American holly (<i>Ilex opaca</i>) |
| Punk tree (<i>Melaleuca leucadendra</i>) | Firethorn (<i>Pyracantha</i> sp.) |
| Vitex (<i>Vitex trifolia</i>) | Kumquat (<i>Fortunella</i> sp.) |
| Loquat (<i>Eriobotrya japonica</i>) | Crape-myrtle (<i>Lagerstroemia indica</i>) |
| False-cypress (<i>Chamaecyparis</i> sp.) | Feather palms (probably mostly <i>Phoenix canariensis</i>) |
| Avocado (<i>Persa</i> sp.) | Cabbage-palm (<i>Sabal palmetto</i>) |



Figure 1. Habitats in the pine plot in suburban Pinellas County, Florida. *Upper.*—A view looking into an empty lot near the middle of the plot, the center of density of breeding Mourning Doves. *Lower.*—A view down an alley in the plot.



Figure 2. Habitats in the oak and new plots. *Upper.*—A dense stand of turkey oaks on the house lots in the oak plot. *Lower.*—A view in the new plot showing its less dense standing vegetation and rather uniform new houses. The few remaining old longleaf pines indicate the original vegetation was pine flatwoods.

PINE PLOT.— Located in Gulfport, bounded by 61st and Gray Streets and 7th and 13th Avenues South, a rectangle 333.7 yards by 658.0 yards containing 9 city blocks and 45.4 acres (18.4 h). Two streets and three alleys running north-south, intersected perpendicularly by two more streets lay within the quadrat. Streets occupied 9.3 per cent of the plot, alleys 2.6 per cent. The plot was almost entirely residential with 163 dwellings and 8 empty lots; buildings occupied 9.4 per cent of the 45.4 acres.

The standing vegetation, predominantly longleaf pine, covered 10.1 per cent of the plot. Plant species that accounted for more than one per cent of the standing vegetation are tabulated below. Certain of these abundant plants were grown as hedges. We did not count the number of individuals in these instances. None of the 25 additional species that made up the remaining 5.97 per cent of the pine plot vegetation accounted for more than 0.8 per cent of the total; the plants listed for the oak plot include virtually all of these.

| Species | Number of individuals | Percentage of standing vegetation |
|---|-----------------------|-----------------------------------|
| Longleaf pine | 231 | 50.49 |
| Australian-pine (<i>Casuarina equisetifolia</i>) | 75 + hedges | 13.06 |
| Water and laurel oak | 26 | 6.91 |
| Citrus | 142 | 5.68 |
| Silk oak | 59 | 4.12 |
| Punk tree | 169 + hedges | 3.90 |
| Sand-live oak | 11 | 3.56 |
| Brazilian pepper | primarily hedges | 2.23 |
| Slash pine (<i>Pinus elliottii</i>) | 4 | 1.44 |
| Ligustrum and privet | 70 + hedges | 1.36 |
| Vitex | 26 + hedges | 1.28 |

NEW PLOT.— Located in a recently developed suburb (houses built since 1956); afforded a more uniform environment with much less standing vegetation than the other two plots. Bounded by Benson and 26th Streets and 38th and 41st Avenues North in St. Petersburg, the quadrat included 6 city blocks, measured 660 by 275 yards, and contained 37.5 acres (15.2 h). Paved streets occupied 10.9 per cent of the plot. No alleys were present; concrete driveways covered 1.8 per cent of the surface. Each block contained 16 house lots; only one lot was vacant. The 95 houses occupied 8.5 per cent of the quadrat.

The standing vegetation, although dominated by longleaf pines, covered only 1.4 per cent of the plot. The plant species accounting

for more than one per cent of the standing vegetation are tabulated below. Eighteen additional species made up the remaining 5.24 per cent of the standing vegetation all but two of which are in the list of vegetation on the oak plot.

Lawn grasses, primarily St. Augustine (*Stenotaphrum secundatum*), were the dominant ground cover in all three plots. The pine plot, and particularly the oak plot because of its dense overstory, had many patches of bare ground or leaf litter. Such areas were essentially nonexistent in the new plot where lawns were more lush and unpaved alleys were absent.

From 11 to 16 December 1962 much of Florida, including Pinellas County, was subjected to a severe freeze. St. Petersburg registered a low of 20° F on 13 December, and the temperature remained below

| Species | Number of individuals | Percentage of standing vegetation |
|---|-----------------------|-----------------------------------|
| Longleaf pine | 45 | 46.49 |
| Citrus | 83 | 12.05 |
| Ligustrum and privet | 63 + hedges | 9.89 |
| Silk oak | 28 | 3.37 |
| Jacaranda | 2 | 3.13 |
| Podocarpus | 96 | 3.03 |
| Live oak | 10 | 2.82 |
| Juniper | 58 | 2.29 |
| Punk tree | 47 | 2.10 |
| Miscellaneous shrubs | 42 | 1.85 |
| Southern magnolia | 9 | 1.74 |
| Chinese tallow-tree (<i>Sapium sebiferum</i>) | 4 | 1.68 |
| Turkey oak | 1 | 1.12 |
| Cherry laurel | 4 | 1.12 |
| Camphor-tree (<i>Cinamomum camphora</i>) | 2 | 1.06 |
| Loquat | 6 | 1.00 |

26° F for more than 7 hours (*Climatological Data, Florida*, vol. 66, no. 12). The native trees that dominated our study plots showed no signs of damage, but other important species, particularly Australian-pine, punk, silk oak, Brazilian pepper, hibiscus (*Hibiscus* spp.), and ixora (*Ixora coccinea*), were severely injured. By spring many of the apparently dead shrubs and smaller trees had been cut to within a few feet of the ground. In most cases only the trunks and bases of the major limbs of the larger Australian-pines, punks, and silk oaks were living, and they also underwent severe trimming. For these

species, new growth from their trunks and the stubs of their major limbs produced bushy clumps of branchlets which did not resemble their normal arborescence.

VISITS

In 1963 we spent 582 man-hours in 105 visits to the plots. The totals for each were: oak plot, 44 visits, 180 man-hours; pine plot, 50 visits, 373 man-hours; and new plot, 11 visits, 29 man-hours. Censusing was begun during the fourth week in April and continued through December in the oak and pine plots, but ended on 11 July for the new plot. In the period between 21 April and 7 September we censused both the oak and pine plots an average of twice a week. Weekly visits continued through mid October and we also made one December census. Less time was spent censusing the new plot because this habitat had relatively little vegetation and its bird densities were less than half those in the mature oak and pine plots.

In 1964 we continued observations in portions of the oak and pine plots to establish the beginning of nesting, which we missed in 1963, and also to obtain additional nest records. In the oak plot 5.7 acres were chosen where the trees were densest. In the pine plot 10.2 acres (two city blocks) in the south-central section were chosen for similar reasons. After an initial visit on 11 January, we censused the "restricted" oak and pine plots at least every week from 25 January through 27 September. In this season we made 39 visits totaling 95 man-hours to the oak plot and 40 visits totaling 195 man-hours to the pine plot.

We tried to find all nests by searching all possible nest sites each week. Field maps were used to record new nests, fledglings, adults caring for young, visiting species, migrants, and other pertinent information. Data on the new nests were transferred to nest-record cards (Woolfenden, 1965); cards for the active nests were taken in the field on succeeding trips to record the current status of each nest. In 1964 the use of a three-piece 15-foot pole with attachable mirror substantially increased the information gained on nest contents.

PART I DENSITIES AND COMPOSITIONS

PROCEDURES

Biologists have been and continue to be plagued by the numerous sources of error inherent in the various practical methods of censusing animals. These sources of error have been well documented and, as

we have been unable to invent any better method, they need not be presented here. We do not believe the estimates biologists are obtaining differ so much from the actual densities that censusing should be discontinued. On the contrary, we feel that employing a variety of the existing methods and using these as checks upon each other can produce a useful estimate of population sizes.

Residential habitats are open and the birds living in them are accustomed to people. These two features made our census work somewhat easier. Of the several methods we used to establish the breeding-bird densities, four were particularly important: (1) plotting singing males, (2) plotting all nests built in one breeding season, (3) comparing total counts of adults taken on different days, and (4) calculating maximum number of active nests for one day.

Plotting singing males, known nests, and other related information as developed by Williams (1936) is recommended by Kendeigh (1944) as the best means of establishing breeding-bird densities. Plotting singing males and territorial disputes on composite maps was useful in determining the densities of the highly territorial Mockingbirds, Cardinals, and Red-winged Blackbirds, but was of little value for House Sparrows, Blue Jays, and Mourning Doves.

Composite mapping of all nests built during one breeding season is useful in determining the densities of strongly territorial species. Concurrently active nests usually belong to separate pairs, and chronological sequences of active nests in close proximity to each other were considered to represent the nestings of a single pair. Lines drawn around clusters of sequentially active nests fell within territorial boundaries as established by plotting the activities of the birds themselves and thus corroborated the results we obtained by the plotting of singing males.

Total counts of adult birds made at intervals throughout the season gave useful density estimates for all species, and were of primary importance in establishing the numbers of the semicolonial Common Grackle and House Sparrow, and the Purple Martin and Blue Jay. House Sparrows tended to nest in colonies of 6 to 25 pairs. Estimates of the sizes of these groups soon became fairly consistent, and the total numbers of pairs was obtained by combining the numbers found in these groups with the numbers of isolated pairs.

Blue Jay territories are poorly defined and defended only against intruders showing particular behavior patterns (Hardy, 1961); thus total counts give the best estimates of their densities. Following the dispersal of winter flocks, paired Blue Jays stay together almost

constantly, and densities can be established by counting pairs. Most lone adults were also scored as pairs; often they were known to have a mate on a nearby nest.

The maximum number of nests active on one day of a breeding season establishes the minimum breeding density. To establish this daily maximum, each nest for which the age of the contents is known is extrapolated back to its date of beginning, and then the number of active nests is totaled for each day. Birds with territories partially out of a plot but nests within are balanced by those having nests out of a plot but territories partially within, provided (1) the plots are large and lie within a uniform habitat, (2) the species have small territories relative to plot size, and (3) the species confines its activities to the habitat type.

We agree with Hopkins and Odum (1953) who state that for Mourning Doves "the number of active nests can be used as a basis for estimating population density." We should add that extrapolating to the beginning of individual nest cycles and then using the maximum count for any one day makes the estimate even more accurate. Using the number of active nests for estimating breeding densities is particularly good for Mourning Doves where little time elapses between successive nestings (Swank, 1955). In other species, Blue Jays for example, weeks may be spent caring for fledglings (Hardy, 1961), thus counts of active nests made while some pairs were caring for fledglings would result in underestimates.

In most instances in the discussions that follow, including those cases using data from other authors, birds per unit area is presented as pairs per 100 acres for monogamous species and abbreviated such that 607 pairs per hundred acres will appear as 607p/100.

SPECIES ACCOUNTS

BREEDING BIRDS

Table I lists the densities of breeding birds in the three study areas in suburban Pinellas County in 1963: 11 species bred in the pine plot, 8 of the 11 bred in the oak plot, and 6 of the 11 bred in the new plot. Active nests were found in each plot for all species reported as breeding therein, and no other species was suspected to have bred in the plots. Our 1964 field work in restricted portions of the oak and pine plots added a nesting record for one species, the Great Crested Flycatcher whose status is discussed in the following section, "Species Nesting in Similar Habitats."

TABLE 1. BREEDING-BIRD DENSITIES IN THREE SUBURBAN HABITATS OF PINELLAS COUNTY, FLORIDA, IN 1963 IN NUMBERS OF PAIRS PER 100 ACRES.

| Species | Pairs per 100 acres followed by actual number of pairs (in parentheses). | | |
|------------------------|--|------------------------|------------------------|
| | pine plot 45.4 acres | oak plot 17.6 acres | new plot 37.5 acres |
| House Sparrow | 330 (150) | 217 (38) | 127 (47) |
| Mourning Dove | 150 (68) | 103 (18) | 23 (8) |
| Blue Jay | 33 (15) | 114 (20) | 16 (6) |
| Mockingbird | 35 (16) | 40 (7) | 24 (9) |
| Cardinal | 13 (6) | 29 (5) | 8 (3) |
| Red-winged Blackbird | 11 (5) | | 5 (2) |
| Red-bellied Woodpecker | 5 (2) | 11 (2) | |
| Common Grackle | 13 (6) | | |
| Purple Martin | 13 (6) | | |
| Starling | 2 (1) | 6 (1) | |
| Yellow-shafted Flicker | 2 (1) | 6 (1) | |
| Totals | 607 (276) | 526 (92) | 203 (75) |

HOUSE SPARROW. — House Sparrows account for approximately half (55, 41, and 63 per cent in the pine, oak, and new plots, respectively) of all birds breeding in residential Pinellas County. Suburban areas provide an ideal habitat for the species as it requires grassy cover and open ground for feeding, dust-bathing, and gathering nest material, and human edifices or dense trees for nesting. Graber and Graber (1963) consider that in Illinois "residential areas are probably the most important habitat for the House Sparrow." In cities such as parts of Chicago and London where livestock numbers have declined, few House Sparrows now exist where formerly their populations were high (Rand, 1956; Fisher, 1954); as nesting sites are still available, reduced food sources are the limiting factor. Suburban areas contain few livestock (our plots had none), but humans, both intentionally and unintentionally, and the vegetation, particularly lawn grasses, provide the necessary fare. The rapid spread of the suburbs augments House Sparrow populations, for in no other present-day habitat are they so abundant.

We recorded House Sparrow densities of 330p/100 in the pine plot, 217p/100 in the oak plot, and 127p/100 in the new plot. The species nested in crevices in buildings in all three plots. In the new plot houses were rather uniform in construction with few crevices and, except for a few nest boxes, almost the entire population nested within covered roof vents.

The thick carpet of regularly mowed grass with few patches of bare ground may also have contributed to the relatively low density of sparrows in the new plot. Sparrows nested in trees only in the pine plot, where they built in the dense clumps of needles in the lower limbs of tall longleaf pines or in the dead tops of punk trees. The extensive areas of shade in the oak plot may have contributed to the lower densities there. That certain oaks provide suitable nest sites is substantiated by Rohwer's observation of five House Sparrow nests in a copse of sand-live oaks in Winter Haven, Florida, in 1965. The sand-live oak has denser branches than the turkey oak, and its limbs end in numerous stout twigs capable of supporting nests. The factors common to the three different nest sites in trees appeared to be a relatively exposed location that also provided adequate support for the nest; in no case was the nest well shielded by leaves. Nesting in the dead tops of the punk trees killed by the freeze is of interest, as we have not observed nests in the foliated portions of punks.

Few published studies of breeding densities of the House Sparrow are available for comparison. Hickey (1943) lists a census of 25 acres in a village in Alabama by M. T. Cooke, from which we calculate a density of 437p/100. Our average of 337p/100 is lower, but higher than the Grabers' (1963) 181p/100 (range for three regions 136-218p/100) on strip censuses in Illinois.

MOURNING DOVE. — To support high nesting densities of Mourning Doves a habitat apparently must have trees suitable for nesting near a good source of nest material. Swank (1955) and Harris et al. (1963) point out the importance to Mourning Doves of open areas for gathering nest material, also for feeding and obtaining grit, which our own observations confirm. All nest material Cowan (1952) saw gathered came from within 20 yards of the nests; our own observations extend this distance to 40 or 50 yards, which is still comparatively short. In our residential plots doves gathered almost no nest material from mowed lawns, but took most of it from such bare spots as flower beds and the edges of driveways, streets, and alleys, as Swank (1955) also noted on a Texas college campus. Perhaps doves seldom search mowed lawns for nest material because the dense grass retards the rapid gait normally used when gathering it.

The pine plot, or at least sections of it, appeared to be optimum dove nesting habitat, with its groves of spaced pines and ample open ground. The Mourning Dove generally prefers conifers for nesting (Pearson and Moore, 1939; McClure, 1943; Quay, 1951; Harris et al., 1963), though in some regions it may not (Boldt and Hendrickson,

1952). The lower density of doves in the oak plot may have resulted from the generally greater density of trees and the dominance of deciduous trees. In Georgia, Hopkins and Odum (1953) found doves preferred edges to closed stands of forests. The scarcity of both trees and bare ground accounts for the much lower density in the new plot.

Table 2 lists breeding densities of Mourning Doves recorded in natural communities in southeastern United States and in man-modified habitats elsewhere. Dove densities in suburban Pinellas County are far greater than those in natural habitats in the south-

TABLE 2. MOURNING DOVE BREEDING DENSITIES (IN PAIRS PER 100 ACRES) IN VARIOUS HABITATS, NATURAL AND MAN-MODIFIED.

| State | Habitat | Plot size (acres) | p/100 | Source |
|-----------|---|----------------------|---------|--|
| Georgia | various | 1000 | 3.3 | Hopkins and Odum (1953) (total of ten 100 acre plots) |
| Georgia | beech-magnolia hammock | 12.8 | 0 | Norris (1951) |
| Georgia | mature longleaf pine | 43 | 0 | Norris (1951) |
| Georgia | old field and fence row | 70 | 11.5 | Norris (1951) |
| Florida | longleaf pine- turkey oak assoc. | 25 | 8 | AFN 12(6): census no. 15 |
| | | 25 | 12 | AFN 13(6): census no. 14 |
| Florida | pine flatwoods | 25 | 0 | Robertson (1955) |
| | pine flatwoods | 25 | 0 | Robertson (1955) |
| Minnesota | city park 1957 | 160 | 40 | Harris et al. (1963) |
| | city park 1958 | 160 | 58 | Harris et al. (1963) |
| | city park 1959 | 160 | 61 | Harris et al. (1963) |
| Wisconsin | park | 5 | 100 | Young (1949) |
| Iowa | town and farm 1938 | 220 | 113.6 | McClure (1942) |
| | town and farm 1939 | 220 | 150.0 | McClure (1942) |
| Texas | college campus, 25% bldgs, & parking lots | 81 | 173° | Swank (1955) (°153 without added 14%, see Cowan, 1952: 519) |
| Illinois | residential areas | 333 | 13 av. | Graber and Graber (1963) (strip census) |
| Florida | residential areas | 100.5 | 113 av. | this paper; range 23 to 150 |

east, but are equalled by those in certain other man-modified environments.

The abundance of the Mourning Dove as a breeding bird in suburban Pinellas County seems to be a recent development. Pangburn (1919) and Bent and Copeland (1927) listed the species only as "a common bird in the central part of the county" and "a common resident in the open country on the mainland [east of Pinellas County]." Their comments show they did not ignore the birds of residential areas, where Pangburn (1919) considers the Mockingbird, Blue Jay, and Loggerhead Shrike, in that order, the most abundant birds; he calls the Mockingbird "the most conspicuous, most abundant and best known land bird in the county. Every yard has one or more nests." Blue Jays he records as "everywhere and in the city nest in trees along the streets and in the yards." Bent and Copeland (1927) call the Mockingbird "abundant everywhere about human habitations" and the jay "a common resident in towns."

The present-day dense breeding populations of the Mourning Doves are not restricted to the 100.5 acres we happened to choose for study. On more than 100 miles of strip censuses taken in Bradenton, Tampa, Clearwater, and St. Petersburg in 1962 and 1963 (Woolfenden and Rohwer, in press) the Mourning Dove was the fourth most abundant species, exceeded only by the House Sparrow, Blue Jay, and Mockingbird. In Clearwater and St. Petersburg, the two cities in Pinellas County, the Mourning Dove was surpassed only by the House Sparrow. Had this species been as conspicuous a part of the suburban avifauna four decades ago, it surely would not have gone without comment by Pangburn or Bent and Copeland.

The Grabers (1963) suggest the Mourning Dove may be adapting to the expanding residential habitat in Illinois. In 1907-1909 Forbes and Gross recorded 0.9p/100 in urban and rural residential Illinois; in 1957-1958 the Grabers obtained densities of 14.3p/100.

If indeed Mourning Doves became an integral part of the suburban avifauna in Illinois and parts of Florida only during the past 40 years or so, the phenomenon warrants further comment. As residential areas have always provided the proper nesting habitat, the change may have been toward an increased tolerance of man. In 1921 Nice (1923) noted on an Oklahoma college campus, that approximately one-third of 76 doves left their nests when observers merely walked beneath the tree. At no time did a dove in our plots leave a nest containing eggs or young before the tree was being climbed, and frequently the bird had to be prodded to make it move.

The rapid turnover rate of dove populations (Harris et al., 1963) could encourage the rapid acquisition of such a behavioral adaptation. Doubtless another important factor is the current prohibition of hunting in suburban areas.

Also noteworthy in connection with the increase in Mourning Doves is the apparent decrease in the numbers of Ground Doves in suburban Pinellas County in the last 40 years. Of the Ground Dove Pangburn (1919) writes "In St. Petersburg they are often seen about the door yards," and Bent and Copeland (1927) consider the species "A very common resident seen almost everywhere, but especially near houses."

Today Ground Doves are decidedly uncommon in most Pinellas residential areas. On 37.2 miles of suburban habitat strip censusing in the county (25.5 miles in St. Petersburg, 11.7 miles in Clearwater) from July through October 1963 and 1964, we saw three Ground Doves, and on 184 trips to the three study plots, we saw only three Ground Doves, all in the pine plot. As an exception, in a suburb south of Largo that has numerous citrus trees and thick lawns but no tall trees, we heard six Ground Doves and saw three others on 23 May 1965. Thus the species was and still is common in certain residential habitats.

BLUE JAY. — Jay populations in Florida have probably increased with the development of residential suburbs. Breeding densities of the Blue Jay in forested regions are not high; the average for 50 censuses (vols. 14-17) in Audubon Field Notes (AFN in subsequent citations and literature cited) that record the species is 8.5p/100. In Georgia Norris (1951) found comparable densities of 11.7p/100 in a beech-magnolia hammock, 11.6p/100 in mature longleaf pineland, and 4.3p/100 in old field and fence-row habitat. For southern Florida Robertson (1955) found 4p/100 in each of two pine flatwoods tracts and 6p/100 in forest edge. The Blue Jay was recorded as breeding only once (4p/100) in 5 years in a longleaf pine-turkey oak association in north central Florida (AFN, 12-16). The highest density recorded from 1960 through 1963 in AFN is 38p/100 (Shugart, AFN, 15) in a small plot of 16 acres with considerable edge and near a subdivision. Kendeigh (1944) considers the Blue Jay a forest-edge species, in support of which he notes its steady increase over a 7-year period as an elm tree disease opened up the interior of a forest (Kendeigh, AFN, 13).

Suburban areas with trees resemble forest edge and provide good jay nesting habitat. The oak plot, with 28.3 per cent standing

vegetation, had a Blue Jay breeding density of 114p/100, far greater than any we have found in the literature. As the surrounding suburbs had similar vegetation, this high density was not caused by edge habitat. Furthermore the jays nesting in the pine and oak plots seemed to restrict their movements during breeding to the plots. The pine plot, with one-third the standing vegetation (10.1 per cent) had one quarter the jay density, 33p/100. Standing vegetation covered only 1.4 per cent of the new plot, and here the Blue Jay density was only 16p/100. The great density of jays in the oak plot must in part have been the result of more trees, but an additional unanalyzed factor was the difference in the type of trees that dominated the pine and oak plots and the food these might supply.

The Grabers (1963) suggest the ecology of the Blue Jay is changing. The species declined in all habitats censused both in 1907-1909 and 1957-1958 in Illinois except residential areas. Forests that supported the bulk of the population in 1907-1909, and which have increased in total area since then, show a decrease in jay densities from 16.6p/100 in 1907 to 3.3p/100 in 1958. Residential areas, to the contrary, show an increase from 6.0p/100 in 1907 to 8.9p/100 in 1958, and now support most of the state's Blue Jays.

MOCKINGBIRD. — Little information on densities of breeding Mockingbirds is available. It is a species of disturbed regions, and most breeding-bird censuses are taken in uniform natural habitats. For Maryland Stewart and Robbins (1958) list various edge habitats in the vicinity of residential and agricultural lands as preferred and give densities of 15p/100 for a residential suburb and 2p/100 for a census in mixed agricultural land. Our densities (40p/100 in the oak plot, 31p/100 in the pine plot, and 24p/100 in the new plot), and those of Stewart and Robbins indicate that suburbs with many shrubs, extensive lawns, and spaced trees provide ideal Mockingbird habitat. An adaptability to man himself, suggested by Beddall (1963), may also be involved.

Plotting Mockingbird nests and territories on vegetation maps of the oak and pine plots shows clearly that the species prefers the less densely wooded portions. Territorial boundaries usually coincide with wooded sections, and no territories included the most heavily wooded places.

In Illinois the Mockingbird is rare in suburbs; only one bird was recorded on 333 acres of strip censuses scattered throughout the state. Densities higher than 3p/100 were recorded only in orchards in southern Illinois. Herein 5.5p/100 were obtained in 1907, 11.5p/100

in 1909 and 6p/100 in 1957. An overall decline in Illinois Mockingbird populations is suggested for the 50-year period.

Udvardy's (1957) suggestion that walls, houses, fences, and other man-made structures diminish territory size and thereby increase density is an untested idea that, if valid, could help account for the high densities we obtained in residential suburbs.

CARDINAL. — In 4 years of AFN censuses (vols. 14-17) in eastern North America, the Cardinal occurs on 72 with an average density of 27p/100 (range 3p/100 to 88p/100). Of our three quadrats only the oak plot had a comparable density (29p/100); densities in the pine (13p/100) and new (8p/100) plots were considerably lower. These differences are probably directly related to differences in vegetational densities, especially in the number of low trees and shrubs suitable for nest sites. Such potential nest sites were twice as plentiful (3.7 per cent) in the oak plot as in the pine plot (1.9 per cent); they covered only 0.5 per cent of the new plot.

Roberts (AFN, 17) lists 50p/100 for a planted pine tract with a low hardwood understory in Georgia. This supports our contention that the predominant overstory plant species is not a factor directly affecting Cardinal abundance. A pine-dominated suburb containing an equal amount of low dense vegetation suitable for nesting probably would support a breeding population as high as that found in the oak plot.

RED-WINGED BLACKBIRD AND COMMON CRACKLE. — The low densities in our plots and the semi-colonial breeding habits of the two icterids make density comparisons with other habitats and areas unprofitable. The polygynous Red-winged Blackbird nested in the pine (3 males and 5 females) and new (2 males, 3 or 4 females) plots with densities of 6.6 and 5.4 males/100. We cannot explain their absence from the oak plot, where one less densely wooded section appeared suitable for nesting. The species was recorded on only 5 of 83 trips to the plot, and several of these records were of a single subadult male.

As with other icterids, Red-winged Blackbird populations have increased tremendously in recent years, apparently in response to man's modifications of the environment. The Grabers give higher population estimates for this species than any other in Illinois for the summer of 1958. They recorded the species in most agricultural habitats but not in residential areas. On 103 miles of strip censuses made in four Tampa Bay cities including two in Pinellas County in 1962 and 1963, we found Red-wings the seventh most abundant

bird. Thus the species is a significant part of the breeding avifauna in suburbs in central Florida but not in Illinois.

The Common Grackle nested only in the pine plot, which contained a small colony (13p/100) in 1963 and 1964. The species regularly visited the new plot, but was recorded only 4 times in 83 visits to the oak plot. It is generally suspected that grackles prefer conifers for nesting, although the species regularly nests in broad-leaved trees elsewhere (Peterson and Young, 1950; Sprunt, 1954; Stewart and Robbins, 1958). The Common Grackle breeds commonly in suburban areas in Illinois (Graber and Graber, 1963).

YELLOW-SHAFTED FLICKER AND RED-BELLIED WOODPECKER. — The extensive territories and the relatively small size of our plots made it difficult to determine densities of the two resident woodpeckers. Our estimates for the Yellow-shafted Flicker of 2 and 6p/100, and for the Red-bellied Woodpecker of 5 and 11p/100, in the pine and oak plots respectively, appear similar to published densities. The density of flickers on 30 breeding-bird censuses on which they were recorded (AFN 16 and 17) ranged from 1.2 to 21p/100 with an average of 7p/100. Stewart and Robbins (1958) cite a density of 3p/100 for both an edge and a forest habitat in Maryland, and the Grabers (1963) estimate 2.3p/100 in residential Illinois. Red-bellied Woodpeckers recorded on 22 censuses (AFN 16 and 17) had densities ranging from 2 to 22.2p/100. Stewart and Robbins (1958) list densities for four forest habitats ranging from 5 to 19p/100. In southern Illinois 2.5p/100 occur in forest habitat (Graber and Graber, 1963). An interesting difference between the Illinois and Florida populations is that in Illinois the Red-bellied Woodpecker is not associated with man. The Grabers saw none in their censusing of 333 acres of residential suburbs. In Florida the species nests commonly in many suburbs and is a regular visitor to feeding stations. That Illinois is on the periphery of the species' range and has a much denser Starling population may account in part for this difference. No recent change in habitat preference in Pinellas County is suspected, as Bent and Copeland (1927) found it to be the commonest woodpecker and note that it often nests near homes.

STARLING. — Although we have not been able to find a record of the first occurrence of the Starling in Pinellas County, the species probably arrived in the late 1930's. Up to 1931 (DuMont, 1931; Howell, 1932) the species appears to have been absent. The St. Petersburg Christmas Bird Count (AFN, 9:140-141) first reported Starlings in 1954 when 5 birds were seen, and have recorded the

species annually in generally increasing numbers ever since. Starlings first bred in Tampa in 1942 (Nicholson, 1964).

Because the Starling is primarily a bird of urban and suburban habitats, few estimates of breeding densities are available for comparison. Simmers (1965) estimated 26p/100 in residential Ithaca, New York, and Graber and Graber (1963) record 60-90p/100 in suburban Illinois. The lower densities in Pinellas County (2 and 6p/100 in the pine and oak plots respectively), perhaps reflect the species' recent arrival. The greater number of Starlings in the oak plot undoubtedly reflects the larger number of nest cavities. Starlings foraged in the new plot, but did not breed there.

Two Starlings were seen competing with a Red-bellied Woodpecker for a nest hole 30 feet up a silk oak in the pine plot 25 January 1964. The Starlings succeeded in driving away the woodpecker, and on 1 February were seen taking nesting material to the hole; the nesting was successful. On 24 March 1966 in adjacent Pasco County S. E. Swimmer watched a Starling toss to the ground singly with its bill four Yellow-shafted Flicker eggs from a nest cavity whose entrance was 18 inches above the ground in a citrus tree. Swimmer chased the Starling away and did not see it near the nest again. The Grabers (1963) suggest that Starlings have been important in reducing the Illinois flicker population. As Starlings increase in numbers in Florida, they may reduce the suburban populations of all woodpeckers.

PURPLE MARTIN.—Purple Martin nest boxes were present only in the pine plot, with two boxes in one yard. One of the two houses was occupied by six pairs of martins; the other was used at various times by House Sparrows and Starlings. Martins frequently flew through the oak and new plots.

SPECIES NESTING IN SIMILAR HABITATS

Five species for which we obtained no nest records during our 1963 plot censusing undoubtedly breed in small numbers in the suburbs on the Pinellas peninsula; the Great Crested Flycatcher, Downy Woodpecker, Screech Owl, and the introduced Budgerigar and Ringed Turtle Dove.

In 1964 Great Crested Flycatchers fledged young from a nest box in the restricted pine plot. The species was recorded regularly in the pine plot in 1963 and in the oak plot both seasons, but only the one pair bred.

Downy Woodpeckers, including birds of the year, were seen on

37 out of 83 trips (1963 and 1964) to the oak plot; their breeding territories probably included portions of the oak plot in both seasons, but no nest was located in the plot. We never recorded the Screech Owl in residential Pinellas County, but we have received reports from other observers, and we have a fledgling specimen (G.E.W. 2821) from nearby Bellairé.

The feral nesting of the Budgerigar in Pinellas County is a recent event that probably became pronounced in the late 1950's. We have seen adults entering excavations in cabbage palms and dead stubs of longleaf pines, and they breed in the numerous nest boxes regularly. At present the colonies, though large, are local and scattered, and are usually found near dwellings where flocks are kept in captivity.

A small population of Ringed Turtle Doves has existed in the Mirror Lake region of St. Petersburg since at least 1953 when first reported by S. A. Grimes (Sprunt, 1954). These doves nest in an area vegetated by many huge live oaks, which is poor habitat for Mourning Doves. Woolfenden observed an adult on a nest in one of these oaks in September 1962. The largest total count of the species was made in the fall of 1965 by Herbert W. Kale (pers. comm.) who estimated 150 individuals near Mirror Lake where people feed them regularly.

Two Catbirds, presumably a pair, remained in the same small part of the oak plot until 25 April 1963 but disappeared thereafter; we have no evidence that the species currently breeds anywhere on the peninsula, although apparently it bred in Clearwater in earlier years (Howell, 1932).

SPECIES NESTING IN PERIPHERAL HABITATS

Our definition of residential habitat, or suburbs, is more restricted than that of other authors, and we intentionally selected plots that lacked parks, large estates, numerous vacant lots, farmland, roadside habitat, or business districts. On frequent visits to other parts of the county we noted 21 additional species in these peripheral habitats that we did not find breeding in the suburbs. As might be expected the list includes the most frequent visitors to our true residential plots. In the following list the figure in parenthesis after each species is the number of times each was recorded in 184 trips to the plots, and an asterisk preceding the name denotes a Pinellas County breeding record established by us in the 1960's (by observation of either an adult on a nest or nonflying young). These peripheral species are:

| | | |
|------------------------|-----------------------------|----------------------------|
| *Bobwhite (4) | *Red-headed Woodpecker (26) | *White-eyed Vireo (10) |
| *Killdeer (0) | *Eastern Kingbird (2) | *Black-whiskered Vireo (1) |
| Rock Dove (34) | *Gray Kingbird (13) | *Prairie Warbler (18) |
| *Ground Dove (2) | *Fish Crow (86) | *Yellowthroat (1) |
| *Barn Owl (0) | *Carolina Wren (0) | Eastern Meadowlark (0) |
| *Common Nighthawk (17) | *Brown Thrasher (4) | *Boat-tailed Grackle (20) |
| Chimney Swift (31) | *Loggerhead Shrike (2) | *Rufous-sided Towhee (30) |

Of the 21 species found in peripheral habitats, the following four visited our study plots with dependent fledglings: Boat-tailed Grackle (pine and new plots), Red-headed Woodpecker and Gray Kingbird (pine plot), and Rufous-sided Towhee (oak plot). The towhees probably nested in the dense shrubbery on an estate across a wide street from the oak plot.

The Prairie Warblers and White-eyed Vireos recorded frequently in the oak plot were migrants or post-nesting wanderers, as of course were some of the individuals of the species listed above. The scarcity in the plots of three widespread and abundant peripheral species, Carolina Wren, Brown Thrasher, and Loggerhead Shrike, seems worthy of emphasis.

EFFECTS ON NATURAL HABITATS

The replacement of natural habitats by residential suburbs has altered considerably the species composition and total bird density of Pinellas peninsula. The topography of the peninsula indicates that pine flatwoods, oak ridges, and mangrove (*Avicennia*, *Laguncularia*, and *Rhizophora*) and wax myrtle (*Myrica cerifera*) shores were the dominant plant associations the suburbs replaced. Observations in remnants of these natural habitats, and reference to earlier publications (Pangburn, 1919; Fargo, 1926; Bent and Copeland, 1927; Dumont, 1931; and Howell, 1932) show that in addition to 19 of the 21 species in the peripheral habitats (the Rock Dove and Chimney Swift are deleted as they breed peripherally in urban areas) at least 10 other species found in the natural habitats are eliminated by the spread of suburbs: Red-tailed Hawk, Red-shouldered Hawk, Bald Eagle, Yellow-billed Cuckoo, Chuck-will's-widow, Red-cockaded Woodpecker, Scrub Jay, Brown-headed Nuthatch, Pine Warbler, and Bachman's Sparrow. Some colonies of nesting water birds have no doubt also been eliminated from certain areas. Densities of the Yellow-shafted Flicker, Red-bellied Woodpecker, Downy Woodpecker, Great Crested Flycatcher, Common Grackle, and Cardinal probably have changed little with the replacement of native habitats by suburbs. None of these six appears to be more plentiful in the vestiges

of natural habitats in the county than in mature residential areas.

Evaluation of the changes in total breeding birds with the spread of suburbs into natural areas is hampered by lack of local censuses of the natural habitats. Nevertheless the changes appear to be marked.

We have derived an average density of 200p/100 for the natural habitats of Pinellas peninsula from the following information: Norris (1951) lists 197p/100 in a 43 acre plot of mature longleaf pineland in southern Georgia. From this figure, 21p/100 of Eastern Wood Peewees and 6p/100 of Yellow-throated Vireos that do not breed in central Florida are deleted, leaving 171p/100. Robertson (1955) censused two south Florida pine flatwoods that averaged 45p/100. Adding 70p/100 of Bachman's Sparrows that breed in Pinellas County from Norris' count gives a hypothetical figure of 115p/100. The existing flatwoods in Pinellas County contain numerous vegetation-choked shallow ponds where Red-winged Blackbirds commonly breed. Using the adjusted figures from Norris (171p/100) and Robertson (115p/100), and adding some for Red-wings and other pond edge species, such as the Yellowthroat, we estimate a *maximum* of 200p/100 for the original pine flatwoods on the peninsula.

Breeding densities for xeric oak ridges, the original habitat of the oak plot, are generally low. The densities recorded for a 25-acre plot in Alachua County (AFN, 12-16) yield a 5-year average of only 84p/100, which is reduced to 77p/100 by deleting the Yellow-throated Vireo. The turkey oak ridges in the interior of Pinellas peninsula probably supported a comparable low density of less than 100p/100. The more humid oak ecotones on the shores of Tampa Bay and the Gulf were dominated by live oaks and probably supported a density closer to that of the pine flatwoods. In 1964 a remnant of live oak ecotone on Pine Key (now called Tierra Verde) contained numerous pairs of Black-whiskered Vireos, Prairie Warblers, Cardinals, Rufous-sided Towhees, White-eyed Vireos, and Carolina Wrens (listed in order of decreasing abundance). Of these, only the Cardinal occurred in the Alachua County turkey oak plot.

Originally the shoreline habitat was mangrove-wax myrtle, most of which has been replaced by residential developments. We cannot assess total population changes in this ecotone because we have found no censuses of the original habitat. It probably takes shore developments longer to become mature suburbs with high breeding-bird densities because waterfront properties are frequently built on sand fill and initially lack large trees.

As the density for mature residential sections of Pinellas County, exemplified by the pine and oak plots, is approximately 550p/100, the replacement of natural habitats by mature suburbs increases the breeding-bird population by approximately 175 per cent (200p/100 to 550p/100). The succession begins with an almost complete destruction of the original habitat and elimination of the avifauna as the land is cleared. As new suburbs are established, the bird population increases to the estimated original density (as indicated by 203p/100 in the new plot), but with a marked change in species composition. As the suburb matures, density increases to well over twice the original, and a few more species are added. Although quantitative data are few, Homes, et al. (1957) describes a similar successional sequence for suburban London.

TOTAL BREEDING BIRDS

The cities of St. Petersburg and Gulfport covered approximately 54.00 square miles of Pinellas peninsula in 1963. Study of 1965 aerial photographs of the county showed 18.00 square miles of the suburbs to be mature, typified by the pine and oak plots, and 12.25 square miles to be new residential habitat. The remainder was either peripheral (see page 22) or urban. Line transects through the mature suburbs showed approximately 50 per cent of them to be dominated by oaks. The new suburbs are built almost entirely in former pine flatwoods, and are typified by the new plot.

With these figures it was possible to estimate the total number of breeding adults of the 11 species inhabiting the 30.25 square miles of residential suburbs in St. Petersburg and Gulfport. Doubling the number of pairs per acre (from Table I), and multiplying by the number of acres occupied by each type of residential habitat yields the following numbers of breeding birds rounded to the nearest 100: House Sparrow, 83,000; Mourning Dove, 32,800; Blue Jay, 19,400; Mockingbird, 12,400; Cardinal, 6,100; Red-winged Blackbird, 2,100; Red-bellied Woodpecker, 1,800; Common Grackle, 1,500; Purple Martin, 1,500 (an unreliable figure as their density is greatly affected by the number of martin houses); Starling, 900; and Yellow-shafted Flicker, 900. The total for the 11 species is 162,400 adult individuals. Including the birds breeding in the 20 square miles of peripheral habitat within the city limits would augment this number significantly. Furthermore the production of young by the adults and the influx of wintering species and transients would more than double the number of birds present at certain seasons.

The 30.25 square miles now occupied by residential suburbs originally contained approximately 77,400 breeding adults (calculated by doubling our estimate of 2 pairs per acre and multiplying by the total acreage). Thus the total number of breeding birds has already increased by 84,900 individuals and as the suburbs mature, should increase by another 31,400 birds to reach a total of 193,800. This figure will continue to enlarge as the suburbs spread.

COMPARISON WITH OTHER RESIDENTIAL HABITATS

A number of censuses of man-modified environments are on record (Cooke, 1923; Goodman, 1940; Steinbacher, 1942; and Young, 1949) giving densities from 545 to 1850p/100, but we know of only two extensive surveys of birds breeding in residential suburbs: Simmers (1965) censused a 38-acre plot in Ithaca, New York for one season and Graber and Graber (1963) strip-censused 333 acres of residential habitat in Illinois.

The available censuses indicate that mature north temperate suburbs typically support 15 to 30 species. Simmers lists 19 breeders for his plot and the Grabers list 28 potential breeders for suburban Illinois. Fitter (in Homes, et al., 1957) lists 22 species known to have bred in the suburbs of London in 1936, of which 6 bred only in a 6-acre garden, leaving 16 species that bred in the residential suburbs. We recorded 16 species breeding in the residential suburbs of Pinellas County.

The species inhabiting Florida suburbs differ considerably from those in New York and Illinois suburbs. The differences reflect the breeding ranges of the species involved rather than changes in the ecology between the northern and southern habitats. The breeding ranges of 9 of the species listed for New York and 10 of those listed for Illinois do not include central Florida; 9 of the 16 species breeding in suburban Pinellas County occur on Simmer's list and 11 occur on the Grabers' list; 8 species are common to all three areas and these account for 50.4 per cent of the Ithaca birds, 70.2 per cent of the Illinois birds and 89.1 per cent of the Pinellas birds. Two species amounting to 5.0 per cent of the Ithaca population and six species amounting to 8.5 per cent of the Illinois population we included in our category of peripheral species.

Five of our 16 species do not appear on either Simmer's or Grabers' lists. Two of these, the Ringed Turtle Dove and the Budgerigar, are recent introductions and one, the Screech Owl, was probably overlooked in New York and Illinois. The absence of the remaining two,

the Red-winged Blackbird and the Red-bellied Woodpecker, seems to indicate different ecological preferences between the Pinellas and the northern populations. The Red-wing breeds commonly in all three states, and the Red-bellied Woodpecker is common in Illinois and Florida, but apparently neither species breeds in the northern suburbs.

Mature residential areas of North America appear to have breeding-bird densities of 350-600p/100. Simmers obtained a density of approximately 363p/100 in a maple-dominated suburb, which included 66p/100 of two semi-colonial forms. For Illinois the Grabers give an average of 434p/100. We found 526p/100 in the oak plot and 607p/100 in the pine plot.

The House Sparrow is by far the most abundant suburban bird in all three states. The species made up 26 per cent of the birds breeding in the New York plot, 34 to 47 per cent of all summer birds in suburban Illinois, and 42 to 63 per cent of the birds breeding in our Florida plots. Additionally, 45 per cent of the birds we counted on 28.8 miles (17.1 in St. Petersburg, 11.7 in Clearwater) of strip censusing in Pinellas County suburbs were House Sparrows. In New York and Illinois the Robin and Starling were the next important species. Starlings, which have only recently invaded Pinellas County, are increasing in density. Robins do not breed in peninsular Florida, and their suburban niche seems occupied by Mockingbirds; both species feed on terrestrial invertebrates, and we observed a number of interspecific conflicts between territorial Mockingbirds and wintering or migrant Robins.

COMPARISON WITH NATURAL HABITATS

When assessing bird densities in a variety of habitats it is best to compare study areas that are geographically near each other. Unfortunately few breeding-bird censuses are available for Florida. Robertson (1955) gives data for six natural areas in extreme southern Florida where he found forest edge habitat to have the greatest density (102p/100). Data from three other central Florida woodland habitats we have analyzed (Rohwer and Woolfenden, 1969) show an oak-palm hammock 35 miles northeast of St. Petersburg to have the greatest density (183p/100), surpassing a mixed oak ridge (154p/100) and a maple-dominated wet woods (111p/100) both some 10 miles north of our suburban plots. These low densities in the natural habitats of peninsular Florida make the high densities of birds breeding in the suburbs of the peninsula even more remarkable.

The average breeding-bird density in mature suburbs appears to be unsurpassed by any of the major natural habitats of North America. Suburban densities are comparable to those found in flood-plain deciduous forest, northern coniferous forest, mixed deciduous forest, and edge habitat, which are the natural habitats with the greatest breeding-bird densities (Udvardy, 1957). The densities Udvardy lists for tundra, grassland, marsh, brush and scrub, oak-hickory forest, beech-maple forest, and mixed coniferous-deciduous forest contain only about half the density found in mature suburbs.

The number of species in residential habitats is slightly lower or about equal to the number in the forested habitats of North America, and at least twice the number typically found in open habitats.

LATE SUMMER AND WINTER POPULATIONS

Winter populations of birds are difficult to estimate because individuals typically wander widely, often in sizable flocks; nonetheless, some of our observations on the birds wintering in suburban Pinellas County seem worth recording. Of the 16 breeding species 14 are permanent residents; only the Great Crested Flycatcher and Purple Martin leave after nesting; the martins return in February, the flycatcher in April. Only small seasonal fluctuations occur in the numbers of the four most abundant species (House Sparrow, Blue Jay, Mockingbird, and Mourning Dove). A late-summer increment caused by fledglings is evident for House Sparrows and to a lesser extent for Blue Jays, but not for Mockingbirds and Mourning Doves which drive their young away from the breeding grounds. Concentrations of juvenile Mockingbirds and also jays produced in suburbs later moved to habitats unsuitable for nesting (Kale and Jennings, 1966; Rohwer and Woolfenden, in press). Starlings and grackles tended to move out of the plots, while numbers of Red-wings and flickers increased slightly. Of the species that bred in our plots, Mourning Doves fluctuated most in numbers, but these fluctuations seemed no greater in winter than they were in summer when many doves apparently left the suburbs between nesting attempts.

Three species of nonbreeding birds, Myrtle Warblers, Palm Warblers, and Robins, form a significant part of winter bird populations in suburban Pinellas County. Three other species, the Yellow-bellied Sapsucker, Black-and-White Warbler, and American Goldfinch, are regular winter residents in small numbers. Cedar Waxwings occa-

sionally are present in large flocks, but their erratic wanderings make their presence unpredictable.

In summary the winter bird populations in suburban Pinellas County are as large or somewhat larger than the breeding populations. Peak bird densities in the suburbs probably occur in early fall when the breeding species and their young, the early transients, and some wintering species are present concurrently.

TRANSIENTS

We include the following data on transient species because they show significant differences between the plots as "stopping-off" places for migrants. On each trip we recorded all species seen in the plots (not including birds seen high overhead) and frequently we estimated the number of individuals.

Of the 75 species we identified, we recorded 51 in the pine plot, only 4 of which were not seen in the oak plot. Two of these four, Eastern Kingbird and Pine Warbler, nest nearby in open or pine-dominated communities, and of the remaining two, the Bank Swallow is an open-country bird, and the Solitary Vireo was recorded only once.

The oak plot, with its numerous large turkey oaks, is one of the most attractive habitats for migrant land birds in the county. Here we saw 71 of the 75 species, including 24 not recorded in the other quadrats. Eighteen of these 24 were species that breed in deciduous or northern coniferous forests and winter in large numbers in the tropics: 11 warblers, 3 vireos, 2 thrushes, 1 oriole, and 1 grosbeak. The variety of migrants and number of individuals present in the oak plot was sometimes high: on 29 March 1964 between 0645 and 0900 hours, while concentrating on finding nests, we recorded 16 species of migrants in the 5.7 acre restricted oak plot, including 20 White-eyed Vireos and 15 Red-eyed Vireos; on 22 March 1964 we estimated 60 Palm Warblers and 15 Parula Warblers. Unlike the pine plot migrants which were "flighty" and frequently left the plot entirely when approached, the migrants in the oak plot appeared to be systematically foraging through the vegetation.

Virtually no transients visited the new plot (censused 19 times, 23 April to 11 July, 1963), but as the vegetation grows this situation will change.

PREDATORS

Fish Crows, Blue Jays, gray squirrels (*Sciurus carolinensis*), house

cats, dogs, humans, and perhaps owls were the only important potential predators of birds in the plots. Snakes, raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), and hawks were not present, although they occur locally in natural habitats.

Fish Crows frequently visited our plots, and although we did not observe them robbing nests they probably did so. Their visits were most frequent in early morning when they passed through at tree-top level as they dispersed from their roosts; frequently they landed in the tall trees and almost always were mobbed by resident jays, Mockingbirds, Red-wings, grackles, or House Sparrows. Mr. E. A. Scott, a reliable observer who lives in the pine plot, claims he has observed crows and jays take eggs or small young from dove nests in his yard on several occasions.

Possibly the late breeding of Fish Crows is scheduled to coincide with nesting peaks of other species. Howell (1932) states that Fish Crows nest later than Common Crows in Florida and gives nesting dates ranging from 30 April to 20 May (4 nests with eggs). Fresh eggs of Common Crows are usually found in February and March, the dates ranging from 21 January to 3 April. We observed a Fish Crow sitting on a nest, apparently incubating, near St. Petersburg Beach, Pinellas County, 15 May 1963.

Two incidents confirm Blue Jay predation. A housewife who lives in the pine plot watched a jay rob an exposed Red-wing nest in her yard of two of its three young; she told us "the jay pecked at their heads the way they open a nut," while she watched from a window a few feet away. We saw a jay harassing a dove on an exposed nest in the oak plot. The dove showed the wing-up aggressive posture and struck vigorously when the jay approached closely. The nest contents were not seen, but it probably contained eggs, as it was a complete but new nest; by our next visit it was empty and deserted.

Gray squirrels, frequently cited as nest predators, were common in the pine and oak plots, but we saw no predation. We never noted active squirrel and bird nests in the same tree, and jays vigorously chased squirrels from their own nest trees.

Domestic cats and dogs present in all three plots undoubtedly accounted for some bird mortality, though we observed no predation and we do not feel they had much effect on the bird populations.

Excluding climatological factors humans, in most instances inadvertently, probably account for the largest number of nest failures, particularly for species such as Mockingbirds and Cardinals that build low nests. Mockingbirds seem to desert their nests readily

while the clutch is being laid and early in incubation; our own activities appeared to have caused several failures. The attacks Red-wings make on human intruders probably occasionally results in the intentional destruction of their nests, and one Mockingbird nest was intentionally destroyed by a property owner who did not want us entering his yard. Care of standing vegetation, such as shrubbery pruning and tree removal, destroyed a few nests.

An unknown predator, perhaps an owl, took three adult doves from nests in the oak plot within one month. Each nest when next seen was flattened and contained only a few rump feathers from an adult dove. Adjacent to the pine plot in the tower of Stetson Law College was a nest of Barn Owls. Several hundred pellets were removed and are currently being analyzed. A precursory examination shows that the owls fed on several species of birds common in residential areas, including Mourning Dove, Blue Jay, Mockingbird, Purple Martin, and Red-bellied Woodpecker. Other remains, however, suggest that these Barn Owls foraged over the golf course, salt marsh, and overgrown fills on the opposite side of the campus; we found no evidence of their presence in the pine plot.

PART II BREEDING BIOLOGY

The primary objective of our study was to determine bird densities in suburbs. This required the use of several census techniques and extensive field work. The frequent visits to the study plots (an average of 2 per week for 6 months in 1963, and 1 per week for 9 months in 1964) allowed us to accumulate records on 867 nests. For four species we obtained sufficient records to analyze the duration of breeding season, number of broods per year, clutch size, nesting success, productivity, and nest location. Nest records were kept for all species found breeding in the suburban study areas except House Sparrows. This ubiquitous species nests in the outer limbs of tall pines and in crevices of houses. Checking nests so placed would have left insufficient time for work on the other species. The nest records used herein and others accumulated for Florida are at the University of South Florida where any biologist may consult them.

PROCEDURES

We developed two apparently new methods for the analysis of certain nesting data. One deals with the vexing problem of

measuring nesting success and the other with the problem of quantifying data on nest-site preference. Before introducing these we define some terms and discuss the shortcomings of the existing procedures for measuring nesting success.

Throughout Part II the term "nesting success" refers to any or all of the various specific measures of survival of nest contents, such as nest success and fledging success. Nest success is defined as the percentage of those nests receiving a full clutch of eggs that fledge at least one young. It is given by the expression

$$S_n = \left(\frac{N_f}{N_c} \right) 100 \quad (1)$$

where N_f is the number of nests fledging at least one young, and N_c is the number of nests receiving a complete clutch of eggs. In some cases it is instructive to include in this calculation nests in which at least one egg appeared. Here the equation is modified to

$$S'_n = \left(\frac{N_f}{N_e} \right) 100 \quad (2)$$

where N_e is all nests in which at least one egg appeared.

Fledging success is the percentage of eggs in complete clutches that produce fledglings. It may be expressed as

$$S_f = \left(\frac{Y_f}{E_c} \right) 100 \quad (3)$$

where Y_f is the number of young fledged, and E_c is the number of eggs in all complete clutches. In this calculation when one wishes to count all eggs laid, including those appearing in nests that fail before the clutch is completed, the expression is written

$$S'_f = \left(\frac{Y_f}{E_l} \right) 100 \quad (4)$$

where E_l is all eggs laid.

For many of our nest histories we established by extrapolation the date the clutch was completed or the date the first egg was laid. The date the clutch was completed we obtained by subtracting the age of the embryos in days from the date this age was established or, if young were seen, by subtracting their age plus the time required for incubation from the date the young were aged. The location of many nests prevented our checking their

contents the day they were discovered, but we were able to establish the ages of many of these on later visits.

Establishing whether or not young fledge from a nest is often difficult. With many species it is virtually impossible to observe fledging or to find fledglings for a large sample of nests. For such species fledging must be established by arbitrary means such as defining a time (age) after which nestlings are assumed to have left the nest successfully. The time limit used in a particular study is best defined by the investigator on the basis of his estimate of the frequency of nest failures just before fledging and the frequency of visits to the nests. When using this method it is important to exclude all nests not observed within the established time limit. The inclusion of nests whose success is determined by observation of fledged young may bias the results toward success. This is true because all nests whose fledglings were not seen, including those that failed late in their cycle, may be listed as of unknown fate, and thus excluded from the calculations.

For Mockingbirds we counted as successful all nests, and only those nests, in which nestlings were seen within 3 days of their normal fledging time. For Mourning Doves success and failure could safely be determined by the presence or absence of fledglings because, in our plots at least, newly fledged doves virtually always stayed close to their nest.

SOURCES OF ERROR IN EXISTING PROCEDURES

CUSTOMARY METHODS. — Ornithologists are becoming increasingly aware of the deficiencies in the customary methods of measuring nesting success (Mayfield, 1961; Skutch, 1966). The major difficulty is with the kinds of nest histories that can be used for such calculations. Ideally only nests found before egg laying begins should be used in equations 2 and 4 above, and only nests found before the clutch is completed should be used in equations 1 and 3. The use of nests found later in their cycle results in a bias toward success because these nests have existed for a period during which other unfound nests may have existed and failed; we refer to these hypothetical nests as unfound failures. Snow (1955) was concerned with this problem in his estimates of nest success for the Blackbird and Song Thrush. His results, as computed by equation 2, were 41 and 36 per cent respectively, but he carefully notes that these figures are slightly biased toward success because nests found after the first egg was laid but before the clutch was com-

plete were included in his calculations. Nolan (1963) calculated fledging success by equation 4 for a sample of 170 nests of 11 open-nesting altricial species; his result was 17.6 per cent. Both of these figures are below those obtained by Nice (1957), who based her calculations on 7,788 nest histories of open-nesting, altricial species appearing in 35 studies. Nest success computed from these data by equation 2 was 49 per cent, and fledging success by equation 4 was 46 per cent.

We have studied 17 of the 35 papers Nice used, and were surprised, and disappointed, to find that not one of the investigators described his procedures for selecting usable nest records. Because of these omissions, and because visits varied from daily to weekly in these studies, we must assume that some of the investigators included in their calculations histories of nests found after they contained more than one egg or even after the clutch was complete. Incorporation of such nest histories may result in a large bias toward success; thus the average success figures given by Nice may be considerably less accurate than implied by the impressive columns of data from which they were calculated.

As Mayfield (1961) pointed out, in many studies it is impossible to find a large number of nests at the beginning of their cycles and follow them to completion. A practical, though arbitrary, way to avoid discarding all less-than-ideal nest histories is to set a time limit beyond which nests are not included. Setting a time limit does not allow one to obtain real percentages of nesting success, but it does make possible comparisons with other data treated in a similar fashion. Generally the degree of comparability and the accuracy of the estimations of success increase as the time interval beyond which nests are not included in calculations is shortened. We strongly urge all students to consider these important sources of error and to give details of their procedures when reporting on nesting success.

To emphasize further the importance of these points we include here the analysis of 222 dove nests (see table 3) found in the restricted pine plot of 1964. Three methods of limiting the nest histories included in the calculation of nest success are considered and their biases toward either success or failure (or both) are noted. Any or all of these methods may have been used in the 35 studies summarized by Nice (1957). In our calculations we use equation 2 because Mourning Doves begin incubation when the first egg is laid. It should be emphasized that disturbance

caused by the observer, which almost invariably alters the chances of success, is present in all of the following calculations.

First we use only those nests found before the hatching of the last egg, as established by direct observation of contents, and whose fates were known. Under these limitations substituting from table 3 in equation 2 gives:

$$\left(\frac{13}{44} \right) 100 = 29.5 \text{ per cent "nest success"}$$

TABLE 3. DOVE NESTS EXISTING IN THE 10.2 ACRE PLOT OF 1964.

| Class | Category | Number of nests |
|---|---|--------------------|
| Division I: Successful nests | | |
| 1 | Found before hatching (eggs seen) | 13 |
| 2 | Found before hatching as determined by extrapolation from subsequent aging of nestlings (eggs not seen) | 57 |
| 3 | Found after hatching (young seen when found) | 6 |
| 4 | Found immediately after fledging | 3 |
| sub-total | | 79 |
| Division II: Unsuccessful nests | | |
| 5 | Found before hatching (eggs seen) | 31 |
| 6 | Found before hatching as determined by extrapolation from subsequent aging of nestlings (eggs not seen) | 15 |
| 7 | Found after hatching (young seen when found) | 1 |
| 8 | Found and failed while being built (before laying of eggs) | 28 |
| 9 | Found while containing eggs as assumed by extrapolation (see text for explanation) | 35 |
| 10 | Found and failed before eggs were laid as assumed by extrapolation (see text for explanation) | 26 |
| sub-total | | 136 |
| 11 | Division III: Nests of unknown fate | 7 |
| total nests found | | 222 |
| Division IV: Hypothetical unfound nests (see "New Method" section) | | |
| 12 | Calculated from preceding classes 5, 6, and 7 | 9.3 |
| 13 | Calculated from preceding class 9 | 12.4 |
| 14 | Calculated from preceding classes 8 and 10 | 78.2 |
| Total nests (found and unfound) | | 321.9 |

where N_f is class 1 and N_e is classes 1 and 5 of table 3. Use of these nests results in a bias toward success because nests discovered at any stage of incubation are included, including some that have survived a time during which other undiscovered nests failed. Furthermore, increased failure caused by the observer is an important factor because with doves it is necessary to flush the adult from the nest to see the eggs.

A way to enlarge the previous sample of nest histories to be used in the estimations of nest success is to include those nests found before hatching as determined by extrapolation. Substituting in equation 2 from table 3 gives:

$$\left(\frac{70}{116} \right) 100 = 60.3 \text{ per cent "nest success,"}$$

where N_f is classes 1 and 2, and N_e is classes 1, 2, 5, and 6 of table 3. As in the preceding example the existence of unfound failures biases the result toward success. The inclusion of nests found before hatching as determined by extrapolation is also a bias toward success because nests whose contents were not seen, some of which may have failed while they contained eggs, could not be included by extrapolation as our extrapolations were based mostly on subsequent aging of young. In this particular example the bias toward apparent success is especially large because few of our dove nests failed after the eggs hatched. In comparison with the preceding example the bias toward failure is reduced by the inclusion of nests from which the adult was never flushed. If all of these nests had been checked early in their cycle, more of them probably would have failed because the effect of human disturbance is most acute at that time.

A still larger sample is obtained by including all nests, no matter when found, if they were determined either by observation or extrapolation to have had contents while under observation. Substituting in equation 2 from table 3 gives:

$$\left(\frac{79}{161} \right) 100 = 49.1 \text{ per cent "nest success,"}$$

where N_f is classes 1, 2, 3, and 4, and N_e is classes 1, 2, 3, 4, 5, 6, 7, and 9 in Table 3. All of the possible biases incorporated in this estimate of nest success have been mentioned above. The major one is the inclusion of nests found long after hatching, which

disregards other concurrent undiscovered nests that must have failed.

In these three examples calculated nest success ranges from 30 to 60 per cent, yet each example represents a method of selecting nest histories that earlier workers may have used. It is unfortunate that our sample contains too few nests found before the clutch was completed to permit estimating nest success solely on ideal nest histories. An estimate made by combining nearly ideal nest histories for the pine plots of 1963 and 1964 by equation 2 gives a nest success of 40.5 per cent. As the per cent success (see Mourning Dove account further on) obtained by the new method proposed below is closely similar for each of the two years, we feel that nest success for the two years was essentially the same. Thus 40.5 should closely approximate the actual percentage of nest success in 1963, and is a good standard to which the results in the preceding examples may be compared.

EXPOSURE METHOD. — In calculating fledging success by the exposure method of Mayfield (1960) a daily probability of survival for nest contents is computed for each stage of the nest cycle, incubation, hatching, and nestling. The probability of survival through any stage of the nest cycle is established by exponential expansion of the daily probability of survival for that stage, the exponent being the normal duration of the stage. Hatching is considered instantaneous and has an exponent of one. These expansions assume that the probability of survival is independent for each day within a stage. Again assuming independence, the probabilities for the survival of eggs through incubation, the survival of the embryo through hatching, and the survival of young through the nestling stage are multiplied together to obtain the probability of an egg producing a fledgling. The result when multiplied by 100 is comparable to the per cent fledging success obtained by equation 4.

In calculating nest success by the exposure method, each day that a nest survives represents a nest-day of exposure for the stage of the nest cycle being considered. The number of exposure days and the number of nests lost are totaled for each stage of the nest cycle. Dividing the number of nests lost in a stage by the number of nest-days of exposure for that stage gives the daily probability of nest loss for that stage of the cycle. Subtracting this figure from one gives the daily probability of nest survival for the stage being considered.

A shortcoming of the exposure method, and one which Mayfield

clearly notes, is that the daily loss rates during the incubation and nestling periods must be assumed to be constant. Unfortunately the validity of this assumption can be tested only with a large sample of nesting data, including the histories of many nests found before incubation began. Thus the exposure method will probably prove valid for some studies but not for others, and we urge investigators to consider this fault carefully before adopting the procedure. The magnitude of error possible can be shown in the sample of 222 dove nests already considered (table 3).

For the 222 dove nests found in the reduced pine plot of 1964 the exposure method gives a probability of 0.0612 for the fledging of individual eggs; supposedly this figure is equivalent to 6.12 per cent fledging success using only ideal nest histories in equation 4. Observation showed that approximately 150 young doves were fledged. To obtain 150 fledglings using the success rate calculated by the exposure method the number of eggs laid would have to have been 2,451, a number far beyond the seasonal capacity of the approximately 40 pairs of doves breeding in this 10-acre plot. This error results mainly from a high incidence of nest loss just after egg laying. Also doves that fail early in the incubation period renest almost immediately (Hanson and Kossack, 1963), and as we found most nests soon after they were built, our sample contains more nest histories of this type than any other. By the exposure method of expanding daily probabilities, this high loss rate early in incubation is applied to the entire incubation period, yielding much too low a figure for the probability of survival of eggs.

In using Mayfield's exposure method care must be taken to avoid rounding error in the exponential expansion of daily probabilities of survival. When the exponent is large, a considerable error can result if the original daily probability of survival is rounded to only a few figures before expansion. Our calculations were done to 10 place accuracy.

An advantage of Mayfield's method is that small lots of data insufficient for individual analysis may be tabulated for future combination with other data. The value of small lots of data is limited by the difficulty of determining whether or not loss rates have been constant. Loss rates definitely were not constant for our Mourning Doves. Our data did not show conclusively the loss patterns for Blue Jays, Mockingbirds, and Cardinals, thus we give exposure summaries for these species in tables 11, 14, and 16. In these tables data on nest success are given for the periods of the nest cycle in

rows 2, 4, and 6, and data on fledging success are given in rows 3, 5, and 7; data on nest success without division of nest histories into the three periods are given in row 1.

A NEW METHOD FOR ESTIMATING NESTING SUCCESS

The formulas for calculating nesting success (of which equations 1-4 are examples) may be used with less than ideal samples of nest histories if an estimated number of nests that failed before they were discovered (the unfound failures) is added to the denominator. A simple computation allows one to determine this number of unfound failures; but it may be used only if the observer searches in a manner that insures an equal probability of finding nests destined to succeed or fail. For example, if exposed nests, which are easier to find than better concealed nests, fail more frequently than the better concealed nests, a larger per cent of nests destined to fail would be found per day than of nests destined to succeed, then discovery rates for the two classes are unequal and not comparable. An attempt to inspect all potential nest sites in a study area periodically is usually necessary to insure that nests destined to succeed or to fail are found at similar rates.

As the standard error of a statistic (such as an estimate of nesting success) decreases as sample size increases, confidence limits for an estimate of success narrow as the sample of nests increases. For any one sample size the standard error will vary some as the rates of nest loss and nest discovery vary; thus the standard error of an estimate of nesting success cannot be calculated readily. Without subjecting our data to computer analysis, it seems reasonable to assume that a fairly valid estimate of success is obtained if plotting the time in their cycle when successful nests are found (to be explained) results in a fairly smooth curve. As more failures than successes are recorded in most studies, if the sample of successes is large enough, the sample of failures should be also.

Our method for calculating the number of unfound failures is demonstrated in the following example: suppose that for a certain species 10 of 20 successful nests were found by day X of an average nest cycle. Suppose also that 5 other nests, found earlier in their cycle, failed on day X. One may predict that additional nests failed on day X that were not found because of their brief existence. Assuming the rates of finding successes and failures are comparable, the number of these unfound failures would approximate 5. Thus, on day X of the average nest cycle 10 nests failed,

5 found and 5 unfound. A similar estimate is made for each day (or whatever time interval is being used) of the normal nest cycle. The sum of these daily estimates gives the total number of unfound failures; adding these hypothetical nests to the denominator (total number of nests) gives the best estimate of nesting success.

The general statement for this method of calculating the number of unfound failures is given by the equation

$$F_u = F_f \left(\frac{S_n}{S_f} \right) \quad (5)$$

where F_u is the number of unfound failures (hypothetical) failing on a given day of the nest cycle, F_f is the number of found nests failing on that day, S_n is the number of successful nests that had not been found by and including that day, and S_f is the number of successful nests found by and including that day. It is essential to realize that the word *on* in the previous sentence cannot be replaced by the word *by*, because the terms F_u and F_f refer only to the nests failing on any one day. The use of the word *by* would imply that these terms are cumulative which they are not. Usually the most convenient time units are days although some other unit could be used. Separate calculations of unfound failures must be made for each day in the nest cycle for which known nests fail. The data from the hypothetical example substitute into the general equation as follows:

$$F_u = 5 \left(\frac{10}{10} \right) \text{ or } F_u = 5.$$

In practice the numerical values for the terms S_n and S_f in equation 5 are usually per cents, S_n becoming the per cent of successes not yet found by a given day, and S_f the per cent of successes found by that day. The reason for this is that per cents may be read from a graph showing when successful nests are found. This graph is obtained by plotting the cumulating per cent of successful nests found (Y axis) against the duration of the average nest cycle (X axis). Drawing a curve through these plottings will tend to correct for the presumably artificial plateaus formed by periods when no additional successful nests were found. An additional function of this graph is the picture it gives of the observers' ability to find successful nests; the steeper the initial slope of the curve, the more

successful the observer has been in finding nests early in their cycle.

If all the successful nests are found in a study area (as seems to have been the case for doves in the 1964 pine plot, see fig. 4) adding the calculated number of unfound failures to the number of found nests gives the total number of nesting attempts in that area. This figure divided by the number of pairs in the study area gives the average number of nesting attempts per pair. Although such information is rare in the literature, it is essential to a basic understanding of population dynamics.

We have followed this method in calculating nest success for Mourning Doves and Mockingbirds. The species account for the Mourning Dove should be consulted to compare the results using this method with those obtained in the preceding examples used to demonstrate possible sources of error in other calculations of nesting success.

A METHOD FOR EXPRESSING NEST-SITE PREFERENCE

Differential use of habitat components is seldom expressed quantitatively. Hanson and Labesky (1964) have demonstrated highly significant differences in seasonal association of Ring-necked Pheasants and vegetative types, but in general such observations seem so self-evident that observers tend to ignore them. In nesting studies on habitats that include a number of plant species, selection or avoidance of certain plant species as nest sites may be considerably less than obvious. Many workers (e.g., Putnam, 1949) list the number of nests found in the various plants used for nesting, but such expressions have little significance if one also does not know the relative abundance of the various plant species that appear to be potential nest sites.

The *G*-test for goodness of fit may be used to demonstrate whether or not nests are randomly distributed in the vegetation. This test is similar in function to the Chi-square test, but *G* values appear to follow the X^2 distribution a bit more closely than do X^2 values (Sokal and Rohlf, 1968). Thus, the *G*-test is preferred when expected frequencies are low. If nesting be random (our null hypothesis), the number of nests expected to occur in each plant species should be roughly proportionate to the amount of the total standing vegetation that plant occupies. Thus, if 50 per cent of the total vegetation is pine trees, one would expect to find 50 per cent of the nests in pines if nest placement were random.

Any plant composing one or more per cent of the standing vege-

tation is listed separately in our tables summarizing nest-site preference. Those followed by (+) had expected values of less than one nest and were lumped with the "other plants" category in calculating the G values.

In most of our cases the G -test indicated a departure ($p < .05$) from a random use of the vegetation for nesting, but this test applies only to the entire distribution of nests, and does not indicate use or disuse of individual plant species. Some plants usually are preferred strongly and others strongly avoided, still others seem to be selected randomly. A statistical demonstration of departure from random use of individual plant species is rather complex and will not be presented here.

For this study we have developed a nest-site preference index that quantifies selection for or against a given plant species. For this index, if the percentage of the nests found in a plant species is greater than the percentage of the vegetation the plant species constitutes, then the per cent of nests found in it is divided by the per cent of the vegetation it constitutes. The result is a numerical value indicating the intensity of preference for that plant species. If the percentage of nests in a plant species is less than the percentage of vegetation the plant constitutes, the percentage of vegetation the plant constitutes is divided by the percentage of nests found therein. This result is given a negative sign signifying that it indicates the degree of negative preference for that plant species. Thus if a plant occupies 25 per cent of the vegetation but contains 50 per cent of the nests, its preference index would be $+2$; if another plant occupies 60 per cent of the vegetation but contains only 20 per cent of the nests, its preference index would be -3 . A random association of nests with plants is shown by an index value of ± 1 .

This method of analysis excludes other environmental factors of possible importance, such as height and spacing of trees and the position of various plants in relation to other environmental features, but it does give a fair indication of which plants are relatively more important as nest sites.

SPECIES ACCOUNTS

MOORING DOVE

In all we found 625 Mourning Dove nests in our residential study areas: 323 in the pine plot in 1963, 222 in the reduced pine plot in 1964, 40 in the oak plot in 1963, 26 in the reduced oak plot in 1964, and 14 in the new plot in 1963. The following generalizations about

the breeding biology of doves in Pinellas County, Florida, are based on this sample.

Figure 3 graphs for each quarter of each month the average number of active nests per day; this average is calculated by dividing the sum of the nest-days in a quarter ($1 \text{ nest-day} = 1 \text{ nest} \times 1 \text{ day of exposure}$) by the number of days in that quarter. Based on one complete (1964) and one partial (1963) season of observation in central Florida it appears that nesting begins in late January and ends by mid-October, with the bulk of breeding confined to the 6 months March through August. Actually we recorded a few fledglings in the pine plot in early December 1964 and in early January 1965, which shows a small amount of breeding also takes place in November and December. Doves may breed during late fall and winter less frequently in natural habitats of Florida. Hanson and Kossack (1963) found evidence of earlier breeding by doves inhabiting residential areas in Illinois. In neighboring Alabama nesting begins in late February; it ends in mid-October as is typical of most Florida populations (Pearson and Moore, 1939).

In our May to October records of the 1963 breeding season three distinct peaks of nesting activity occurred both in the 45.4 acre pine plot and the 17.6 acre oak plot. In the pine plot the time between the early June and mid-July peak was approximately 36 days. About 31 days elapsed between the mid-July and mid-August peaks. Our graph of the complete 1964 breeding season shows only one peak of nesting activity, in mid-April, a peak that we suspect was also present in 1963. Inclement weather in 1964 probably prevented the development of at least two additional peaks, one in late June and another in mid-August. Hanson and Kossack (1963) show a close correlation between weather and Mourning Dove nest initiation in Illinois and the same appears to be true in Pinellas County, Florida. We recorded several instances when adult doves began pre-nesting behavior and then left, apparently discouraged by windy, rainy, cloudy weather. The extensive periods of inclement weather for the two seasons are marked by dark bars on the graphs of nesting activity (fig. 3). The storms of the 1963 season were either of short duration or occurred when doves were not beginning to re-nest in large numbers. In 1964 the opposite was true; the stormy weather of 19 to 24 June, 23 to 29 July, and 2 and 10 August coincided with observed peaks in pre-nesting behavior. The earlier finish of nesting in 1964 also may be attributed to weather, as hurricanes caused prolonged bad weather in the Tampa Bay region.

Although inclement weather may suppress the formation of nesting peaks, the factors that initiate these peaks remain unknown. The graph of the 1963 breeding season (fig. 3) shows that prior to the final decline in nesting the minimum number of active nests was always between 50 and 70 per cent of the maximum. Thus a synchronization of only about 40 per cent of the pairs would account for the nesting peaks. In both wild and captive doves Hanson and Kossack (1963) found an interval of approximately 30 days between the initiation of clutches in successful breeders. Thus the time intervals of 31 and 36 days between our 1963 nesting peaks suggest that renesting by successful breeders may have produced these peaks of activity. Two factors seem to help synchronize renesting by successful pairs: First the short time interval between fledging of young and initiation of renesting (approximately 5 days, see Hanson and Kossack, 1963); second the species' colonial nesting habits (see Hopkins and Odum, 1953).

The 1963 nest records for the 10.2 acres of the 45.4 acre pine plot that were censused again in 1964 are graphed separately to allow direct comparison of a single plot over most of two breeding seasons. Similarities in the maximum number of active nests for a single day (33 in 1963 and 35 in 1964) and computed as a weekly average (29 in 1963 and 31 in 1964) suggest breeding densities were about the same for the two years. Although Mourning Doves tend to nest colonially, we were justified in using our plot density figures to calculate densities in the remainder of suburban Pinellas peninsula because on 55 miles of strip censuses taken in 1962, 1963, and 1965 we found no habitat that appeared to be suitable for doves that was not heavily populated (Woolfenden and Rohwer, 1969).

Figure 4, based on 79 successful nests, including 3 found shortly after the young had left (class 4 in table 3) represents virtually all of the successful breeding by doves in the reduced pine plot in 1964. We checked all possible nest sites weekly and we found no fledglings whose nests were not known. It is easy to follow dove fledglings during their short period of dependency as they tend to remain near the nest. After about a week their parents drive them away. We often noted adults attacking juveniles, and we almost never saw independent young in our study plots. The young doves tended to flock together nearby in open areas unsuited for nesting.

Table 4 shows our calculations for the number of unfound failures for each of two classes, those for which the contents were seen sometime in the cycle, and those for which the contents were never seen

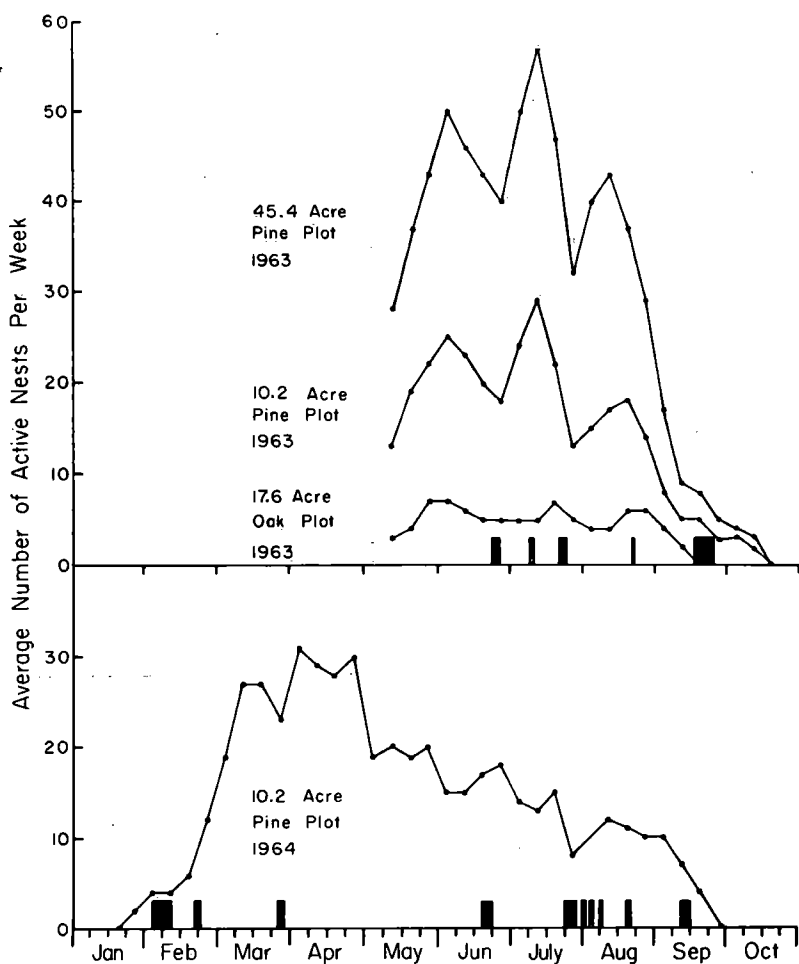


Figure 3. Graph of the average number of active dove nests by monthly quarters for the pine and oak plots in 1963 and 1964. The bars on the base line for each year represent periods of inclement weather. The line for the 10.2 acre pine plot of 1963 is a subsample of the 45.4 acre pine plot of 1963; this subsample for 1963 is taken from the same 10.2 acres that served as the 1964 pine plot, and may be compared with the lower graph for 1964.

but were established by an extrapolation procedure described below. The extrapolation procedure previously described, which is used to approximate the number of days of activity was relatively easy to use on those nests whose contents were eventually observed for it was necessary only to establish the approximate day of egg laying

and/or incubation or the approximate day of failure. Extrapolation for nests whose contents were never seen was more difficult as estimating the age of most of them was virtually impossible. The minimum number of days nests whose contents were not observed could have existed we determined on the basis of the number of days we noted an adult on the nest, adjusting the duration according to the condition of the nest.

Once the minimum time these nests have existed is established, the approximate time in their cycle at which they failed can be assigned by comparing the total sample with nests of known age. Failures of known age also are extrapolated as described above, and histograms of the number of nests failing at 2-day intervals after they are first thought to have existed are then constructed for the two classes of failures. The histogram for the nests of unknown contents is then compared to that for nests of known age to establish the approximate time in their cycle the nests of unknown contents failed. The histograms of the two categories of failures matched closely when 43 per cent of the unknown contents failures were considered building failures. Thus after preliminary extrapolations to establish a minimum time of existence for each nest, the approximate time in the cycle that nests of unknown contents failed is set by considering the two classes of failures comparable. By this method 43 per cent of the nests that failed whose contents were unknown were considered building failures, whereas only 37 per cent of the known age failures failed during building. This may mean that we considered a few too many of the unknown contents failures as building failures. As the calculation of nesting success is based only on nests with contents, the per cent success we obtained still may be slightly higher than the actual, even with our correction for unfound nests.

This problem of extrapolation for nests that failed and whose contents were never seen was a major one, as we had a fairly large number of such cases. It does not exist in studies where the contents of all the nests discovered can be checked. Examining nest contents was especially difficult in our quadrats because many nests were so high they could be reached only with special climbing equipment and special permission of the property owners, which in many cases would not have been granted.

Table 3 lists the 222 nests found in the 10.2 acre pine plot in 1964 (classes 1 through 11). Below these are listed our calculations of the number of unsuccessful nests we did not find (total 99.9) divided

into two categories, nests that failed with contents (21.7) and nests that failed before laying (78.2).

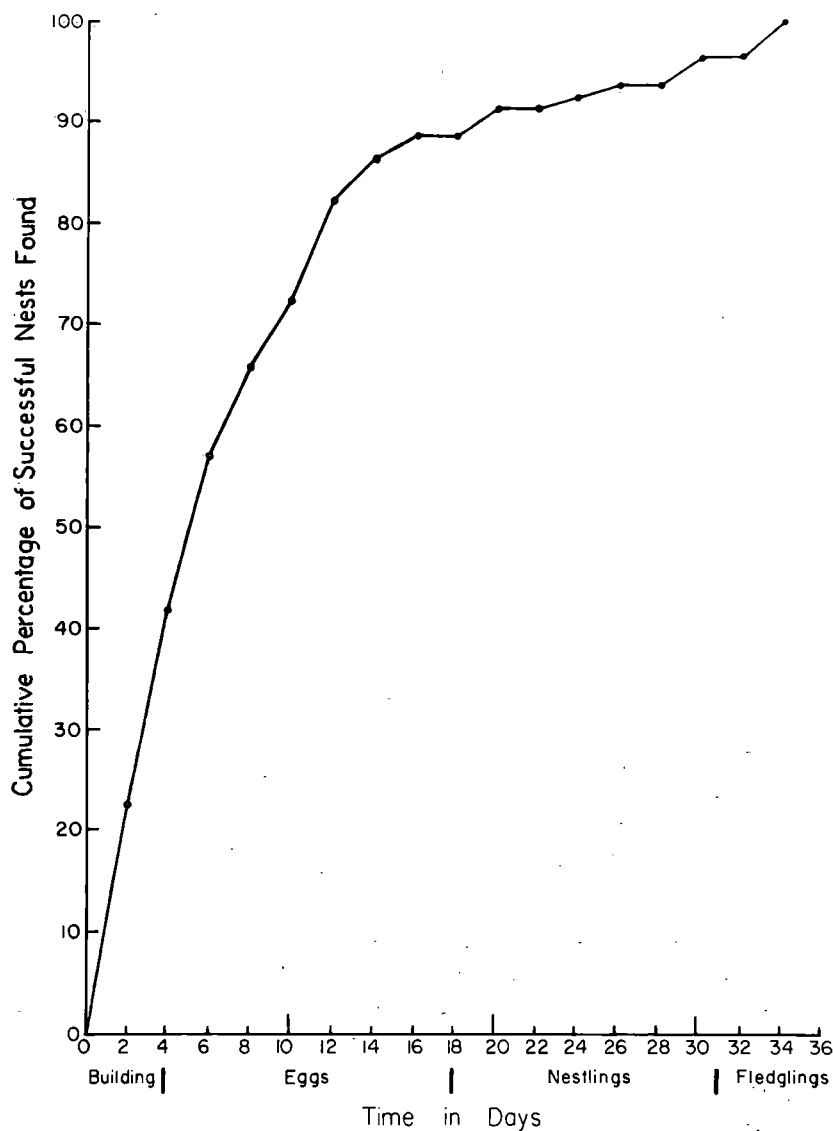


Figure 4. Graph of the time in the nesting cycle when successful dove nests were found in the 10.2 acre pine plot of 1964. The graph is based on 79 successful nests. Note that connecting the plotted points by straight lines is nearly curvilinear.

TABLE 4. CALCULATIONS OF HYPOTHETICAL UNFOUNDED FAILURES FOR MOURNING DOVES OF THE 10.2 ACRE PINE PLOT OF 1964.

| Time in the cycle (days) | Total unknown contents failures (sum of known and cal- culated) | Calcu- lated unfounded failures | Number of unknown contents failures observed to fail | Cumu- lative per cent of 79 found success- ful nests (from graph) | Number of known contents failures observed to fail | Calcu- lated unfounded failures | Total known contents failures (sum of known and cal- culated) |
|-----------------------------------|--|--|--|---|--|--|--|
| bldg. | 62.2 | 36.2 | 26 | 41.8 | 28 | 42.0 | 70.0 |
| Incubation | | | | | | | |
| 1-2 | 15.8 | 6.8 | 9 | 57.0 | 0 | 0.0 | 0.0 |
| 3-4 | 3.0 | 1.0 | 2 | 65.8 | 3 | 1.6 | 4.6 |
| 5-6 | 4.2 | 1.2 | 3 | 72.2 | 10 | 3.9 | 13.9 |
| 7-8 | 10.9 | 1.9 | 9 | 82.3 | 3 | 0.6 | 3.6 |
| 9-10 | 3.5 | 0.5 | 3 | 86.1 | 5 | 0.8 | 5.8 |
| 11-12 | 0.0 | 0.0 | 0 | 88.6 | 6 | 0.8 | 6.8 |
| 13-14 | 2.3 | 0.3 | 2 | 88.6 | 3 | 0.4 | 3.4 |
| Nestlings | | | | | | | |
| 15-16 | 2.2 | 0.2 | 2 | 91.1 | 4 | 0.4 | 4.4 |
| 17-18 | 3.3 | 0.3 | 3 | 91.1 | 2 | 0.2 | 2.2 |
| 19-20 | 1.1 | 0.1 | 1 | 92.4 | 4 | 0.3 | 4.3 |
| 21-22 | 1.1 | 0.1 | 1 | 93.7 | 2 | 0.1 | 2.1 |
| 23-24 | 0.0 | 0.0 | 0 | 93.7 | 2 | 0.1 | 2.1 |
| 25-26 | 0.0 | 0.0 | 0 | 96.2 | 3 | 0.1 | 3.1 |
| 27 | 0.0 | 0.0 | 0 | 96.2 | 0 | 0.0 | 0.0 |
| fldg. | — | — | — | 100.0 | — | — | — |

Read from center outward; figures to the left of the percentage column are for nests whose contents were assumed by extrapolation, those to the right are for nests whose contents were seen. See text for an explanation of the method used in assigning a time of failure to nests whose contents were not observed.

Nesting success for doves in the reduced pine plot of 1964 was 43.3 per cent when calculated by our method of dividing the total successes by the total nesting attempts (successes and both found and unfounded failures). Substituting in equation 2 from table 3 gives

$$\left(\frac{79}{182.7} \right) 100 = 43.3 \text{ per cent nest success,}$$

where N_1 is classes 1-4 and N is classes 1-7, 9, 12, and 13. The seven nests of unknown fate (class 11 of table 3) are eliminated

from our calculations. We consider this calculation of nesting success the most accurate approximation obtainable from the available data, but it should be realized that incorporation of unfound failures does not eliminate all variables. The effect of the observer cannot be eliminated; this bias, no doubt toward failure in our study may be of considerable importance, for the dove population we studied was coexisting with a dense population of Blue Jays, which are known egg predators.

Some investigators (e.g. Kendeigh, 1942) have attempted to include all nests built in their calculations of nest success. This is not without merit as nest construction is an integral part of the nesting cycle. Including them in dove calculations introduces difficulties because doves often reuse old nests. No formula for this calculation is included in our "Procedures," but it is easily obtained by adding 132.2 nests (classes 8, 10, and 14 of table 3) to the preceding denominator of 182.7. The result for the 10.2 acre pine plot in 1964 is 25.1 per cent success.

The graph showing when successful nests were found for the 45.4 acre pine plot, 1963 (fig. 5), was constructed from 111 successful nests. As many nests had completed their cycle before we began field work in 1963, the addition of calculated unfound failures will correct only the ratio of successes to failures (as discussed in the section "A New Method for Estimating Nesting Success") and will not compute the actual number of nests built in the plot. We deleted seven successful nests from the calculations because they were begun before we began field work and it was not possible to have found them earlier in their cycles (* in table 6). It would be incorrect to incorporate these seven into the graph not only because they would distort the picture of when successful nests were found, but also because no corresponding failures could have been added. With the deletion of these seven nests and the addition of the hypothetical unfound failures with contents (see table 5), substituting in equation 2 gives

$$\left(\frac{111}{292.0} \right) 100 = 38.0 \text{ per cent nest success,}$$

where N_f is classes 1 through 4, and N is classes 1-7, 9, 12, and 13.

We obtained too few nest records from the 17.6 acre oak plot of 1963 and 5.7 acre oak plot of 1964 to treat them separately. Thus both seasons are included in the graph showing when successful nests were found (fig. 6), in the tables of calculations of

unfound failures (table 7), and in the summary of all existing nests (table 8). The sample used to construct the graph contained

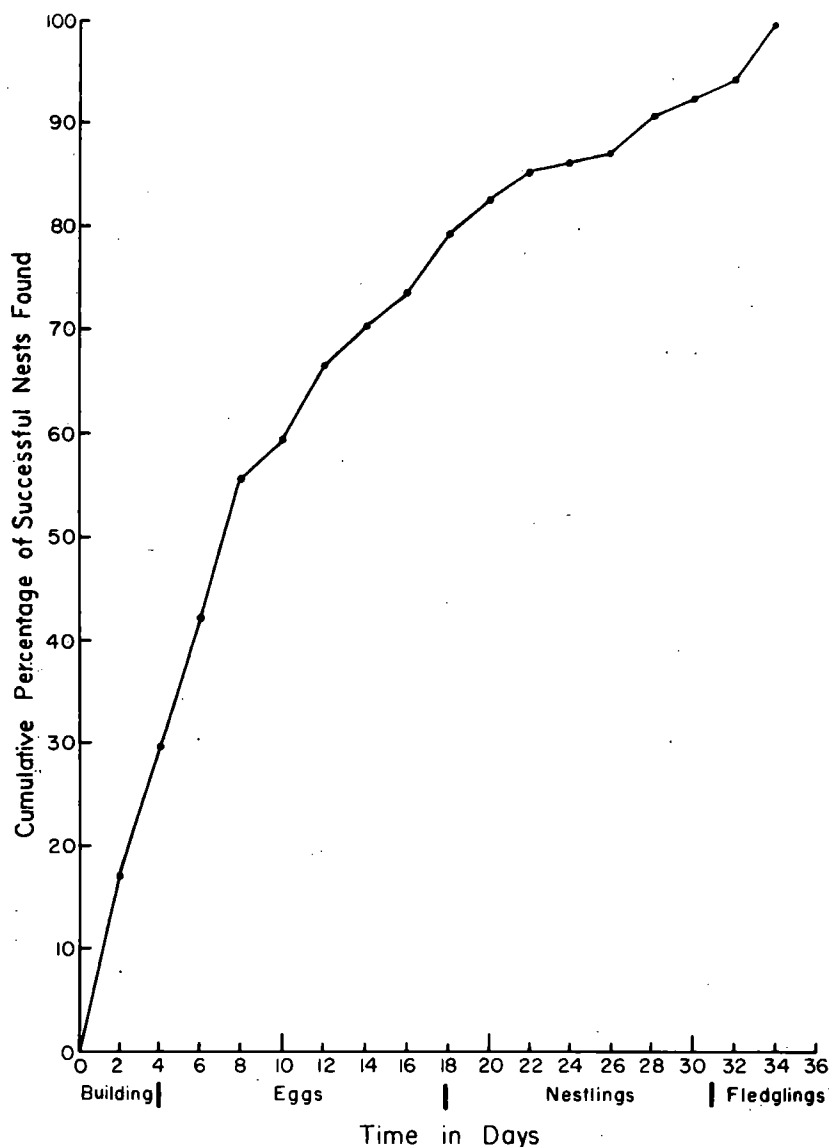


Figure 5. Graph of the time in the nesting cycle when successful dove nests were found in the 45.4 acre pine plot of 1963. The graph is based on 111 successful nests. Connecting the plotted points by straight lines is nearly curvilinear.

TABLE 5. CALCULATIONS OF HYPOTHETICAL UNFOUND FAILURES FOR MOURNING DOVES OF THE 45.4 ACRE PINE PLOT OF 1963.

| Time in the cycle (days) | Total unknown contents failures (sum of known and cal- culated) | Calcu- lated unfound failures | Number of unknown contents failures observed to fail | Cum- lative per cent of 111 found success- ful nests (from graph) | Number of known contents failures observed to fail | Calcu- lated unfound failures | Total known contents failures (sum of known and cal- culated) |
|-----------------------------------|--|--|--|---|--|--|--|
| early bldg. | 0.0 | 0.0 | 0 | 17.1 | 1 | 4.8 | 5.8 |
| bldg. | 77.4 | 54.4 | 23 | 29.7 | 12 | 28.4 | 40.4 |
| Incubation | | | | | | | |
| 1-2 | 35.4 | 20.4 | 15 | 42.3 | 12 | 16.3 | 28.3 |
| 3-4 | 19.7 | 8.7 | 11 | 55.9 | 4 | 3.2 | 7.2 |
| 5-6 | 13.4 | 5.4 | 8 | 59.5 | 4 | 2.7 | 6.7 |
| 7-8 | 4.5 | 1.5 | 3 | 66.7 | 3 | 1.5 | 4.5 |
| 9-10 | 8.5 | 2.5 | 6 | 70.3 | 2 | 0.8 | 2.8 |
| 11-12 | 2.7 | 0.7 | 2 | 73.9 | 2 | 0.7 | 2.7 |
| 13-14 | 2.5 | 0.5 | 2 | 79.3 | 5 | 1.3 | 6.3 |
| Nestlings | | | | | | | |
| 15-16 | 7.2 | 1.2 | 6 | 82.9 | 0 | 0.0 | 0.0 |
| 17-18 | 5.8 | 0.8 | 5 | 85.6 | 6 | 1.0 | 7.0 |
| 19-20 | 1.2 | 0.2 | 1 | 86.5 | 3 | 0.5 | 3.5 |
| 21-22 | 2.3 | 0.3 | 2 | 87.4 | 1 | 0.1 | 1.1 |
| 23-24 | 0.0 | 0.0 | 0 | 91.0 | 4 | 0.4 | 4.4 |
| 25-26 | 0.0 | 0.0 | 0 | 92.8 | 2 | 0.2 | 2.2 |
| 27 | 1.1 | 0.1 | 1 | 94.6 | 0 | 0.0 | 0.0 |
| fldg. | — | — | — | 100.0 | — | — | — |

Read from center outward: figures to the left of the percentage column are for nests whose contents were assumed by extrapolation, those to the right are for nests whose contents were seen. See text for an explanation of the method used in assigning a time of failure to nests whose contents were not observed.

only 15 nests; its smallness was caused not only by the lower number of pairs, but also by a significantly lower percentage of nesting success.

Substituting in equation 1 from table 8 gives

$$\left(\frac{15}{73.3} \right) 100 = 20.5 \text{ per cent nest success,}$$

TABLE 6. DOVE NESTS EXISTING IN THE 45.4 ACRE PINE PLOT OF 1963.

| Class | Category | Number of nests |
|--|---|-----------------|
| Division I: Successful nests | | |
| 1 | Found before hatching (eggs seen) | 23 |
| 2 | Found before hatching as determined by extrapolation from subsequent aging of nestlings (eggs not seen) | 65 |
| 3 | Found after hatching (young seen when found) | 17* |
| 4 | Found immediately after fledging | 6 |
| sub-total | | 111 |
| Division II: Unsuccessful nests | | |
| 5 | Found before hatching (eggs seen) | 41 |
| 6 | Found before hatching as determined by extrapolation from subsequent aging of nestlings (eggs not seen) | 3 |
| 7 | Found after hatching (young seen when found) | 4 |
| 8 | Found and failed while being built (before laying of eggs) | 13 |
| 9 | Found while containing eggs as assumed by extrapolation (see text for explanation) | 62 |
| 10 | Found and failed before eggs were laid as assumed by extrapolation (see text for explanation) | 23 |
| sub-total | | 146 |
| 11 | Division III: Nests of unknown fate | 59 |
| Total nests found | | 316 |
| Division IV: Hypothetical unfound nests (see "New Method" section) | | |
| 12 | Calculated from preceding classes 5, 6, and 7 | 28.7 |
| 13 | Calculated from preceding class 9 | 42.3 |
| 14 | Calculated from preceding classes 8 and 10 | 87.6 |
| Total nests (found and unfound) | | 474.6 |
| *Seven nests deleted from this class (see text) | | |

where N_f is classes 1-4 and N_e is classes 1-7, 9, 12, and 13 from table 8.

Nest success for the two mature suburban habitat types (pine and oak) can be compared after combining the data for the two pine plots:

$$\left(\frac{79 + 111}{182.7 + 292.0} \right) 100 = 40.0 \text{ per cent.}$$

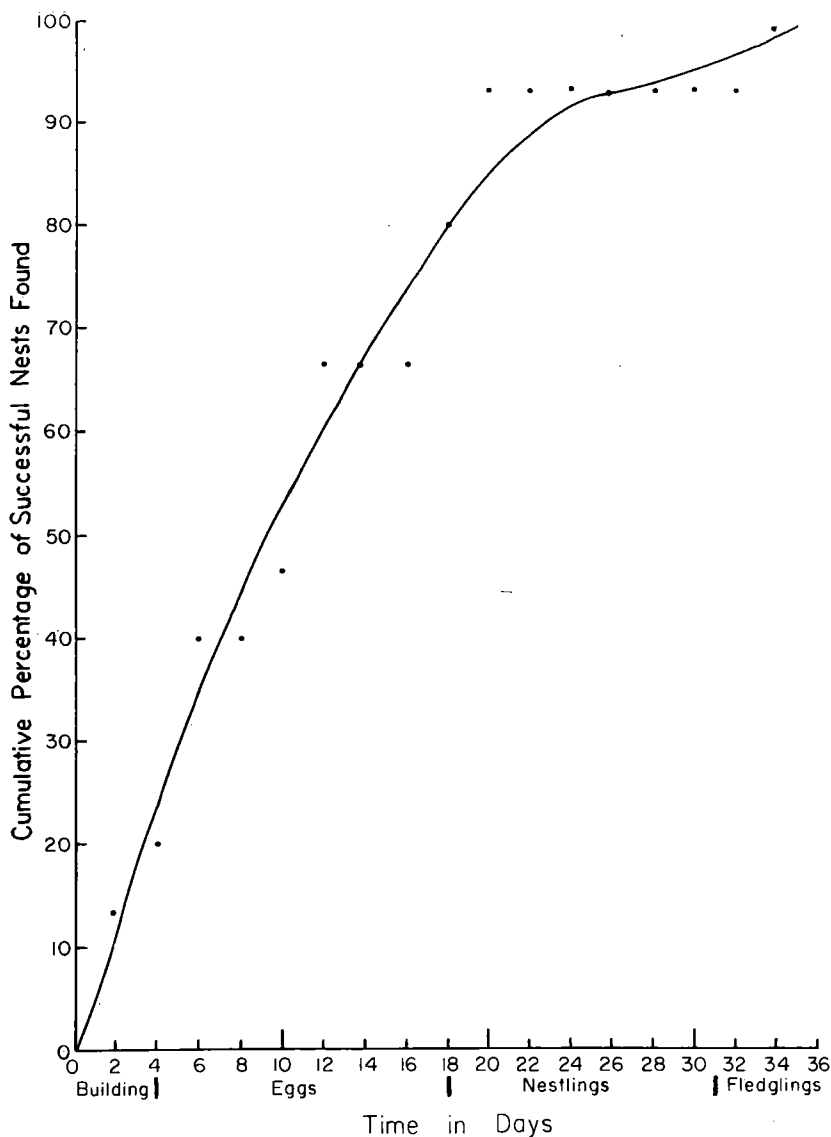


Figure 6. Graph of the time in the nesting cycle when successful dove nests were found in the oak plot. The graph is based on 15 successful nests and combines the successful nest records of both 1963 and 1964. The curve was fitted by eye.

TABLE 7. CALCULATIONS OF HYPOTHETICAL UNFOUND FAILURES FOR MOURNING DOVES IN THE OAK PLOTS OF 1963 AND 1964 COMBINED.

| Time in the cycle (days) | Total unknown contents failures (sum of known and cal- culated) | Calcu- lated unfound failures | Number of unknown contents failures observed to fail | Cumu- lative per cent of 15 found success- ful nests (from graph) | Number of known contents failures observed to fail | Calcu- lated unfound failures | Total known contents failures (sum of known and cal- culated) |
|-----------------------------------|--|--|--|---|--|--|--|
| early bldg. | 0.0 | 0.0 | 0 | 10.0 | 0 | 0.0 | 0.0 |
| bldg. | 9.0 | 7.0 | 2 | 22.2 | 9 | 31.5 | 40.5 |
| Incubation | | | | | | | |
| 1-2 | 0.0 | 0.0 | 0 | 32.7 | 1 | 2.1 | 3.1 |
| 3-4 | 7.0 | 4.0 | 3 | 43.0 | 2 | 2.7 | 4.7 |
| 5-6 | 3.9 | 1.9 | 2 | 51.9 | 4 | 3.7 | 7.7 |
| 7-8 | 5.0 | 2.0 | 3 | 59.8 | 3 | 2.0 | 5.0 |
| 9-10 | 3.0 | 1.0 | 2 | 66.7 | 0 | 0.0 | 0.0 |
| 11-12 | 0.0 | 0.0 | 0 | 73.1 | 0 | 0.0 | 0.0 |
| 13-14 | 2.5 | 0.5 | 2 | 80.0 | 0 | 0.0 | 0.0 |
| Nestlings | | | | | | | |
| 15-16 | 0.0 | 0.0 | 0 | 85.5 | 1 | 0.2 | 1.2 |
| 17-18 | 2.2 | 0.2 | 2 | 89.3 | 1 | 0.1 | 1.1 |
| 19-20 | 2.2 | 0.2 | 2 | 92.0 | 3 | 0.3 | 3.3 |
| 21-22 | 0.0 | 0.0 | 0 | 93.3 | 2 | 0.1 | 2.1 |
| 23-24 | 0.0 | 0.0 | 0 | 94.2 | 1 | 0.1 | 1.1 |
| 25-26 | 1.1 | 0.1 | 1 | 95.2 | 1 | 0.1 | 1.1 |
| 27 | 0.0 | 0.0 | 0 | 96.6 | 1 | 0.0 | 1.0 |
| fldg. | — | — | — | 100.0 | — | — | — |

Read from center outward; figures to the left of the percentage column are for nests whose contents were assumed by extrapolation, those to the right are for nests whose contents were seen. See text for an explanation of the method used in assigning a time of failure to nests whose contents were not observed.

Even though the results for the pine and oak plots are strikingly different, we feel they validly may be compared as they were censused in the same seasons by the same method. A large difference was suspected throughout much of the field work, and the primary cause seems to have been predation. As mentioned in Part I, the chief predators on bird nests in suburban Pinellas County appear to be Blue Jays, Fish Crows, and gray squirrels. Blue Jays, which Pearson and Moore (1939) found to be important predators of dove eggs

and nestlings in Alabama, were more than three times as abundant in oak-dominated suburbs of Pinellas County than in those dominated by pines. In Iowa, McClure (1943) lists Blue Jays as important predators of dove eggs in towns, but relatively unimportant in other habitats. We did not estimate densities for gray squirrels, but they also were more abundant in the oak plot. A greater loss of nesting adults also may occur in oak-dominated suburbs; three previously

TABLE 8. DOVE NESTS EXISTING IN THE OAK PLOTS OF 1963 AND 1964.

| Class | Category | Number of nests |
|---|---|--------------------|
| Division I: Successful nests | | |
| 1 | Found before hatching (eggs seen) | 7 |
| 2 | Found before hatching as determined by extrapolation from subsequent aging of nestlings (eggs not seen) | 3 |
| 3 | Found after hatching (young seen when found) | 4 |
| 4 | Found immediately after fledging | 1 |
| sub-total | | 15 |
| Division II: Unsuccessful nests | | |
| 5 | Found before hatching (eggs seen) | 15 |
| 6 | Found before hatching as determined by extrapolation from subsequent aging of nestlings (eggs not seen) | 4 |
| 7 | Found after hatching (young seen when found) | 1 |
| 8 | Found and failed while being built (before laying of eggs) | 9 |
| 9 | Found while containing eggs as assumed by extrapolation (see text for explanation) | 17 |
| 10 | Found and failed before eggs were laid as assumed by extrapolation (see text for explanation) | 2 |
| sub-total | | 68 |
| 11 | Division III: Nests of unknown fate | 3 |
| total nests found | | 86 |
| Division IV: Hypothetical unfound nests (see "New Method" section) | | |
| 12 | Calculated from preceding classes 5, 6, and 7 | 11.4 |
| 13 | Calculated from preceding class 9 | 9.9 |
| 14 | Calculated from preceding classes 8 and 10 | 38.5 |
| Total nests (found and unfound) | | 145.8 |

active nests in the oak plot were found containing only a few rump feathers from an adult bird; no such event was recorded for the pine plot. The absence of hawks and of reptilian and most native mammalian predators leads one to suspect owls in these cases.

The more successful 1964 breeding season for pairs nesting in the pine plot (43.3 per cent versus 38.0 per cent) coincided with a lower incidence of trichomoniasis. While neither year could be considered epidemic, it was our impression, confirmed by others working locally with doves during both seasons (W. L. Jennings, pers. comm.) that the incidence of the disease was higher in 1963.

As discussed under "Procedures," an unbiased estimate of nest success by equation 2 can be calculated only from a sample of nests found on or before the day the first egg is laid. An estimation using such ideal nests provides a test of our method of estimating success. Using nests found in the pine plot both seasons, we had 84 that were nearly ideal, of which 34 were successful. These 84 nests either had one egg or were being built when first checked and, if under construction, were known to exist at least 2 more days. Our assumptions are that nests with one egg had incomplete clutches, and that nests normally had contents if active 2 days after building. Nest success for these 84 nests was 40.5 per cent, which is almost identical to the 40.0 per cent obtained for the same plots using our method of incorporating unfound failures. We caution that this figure may be biased slightly toward success as some nests observed during construction may have received contents and failed before a second observation.

With the data we accumulated it is possible to estimate the average annual productivity for Mourning Doves breeding in the mature residential areas of Pinellas County. In the 10.2 acre pine plot of 1964 an estimated 40 pairs of doves accounted for approximately 215 active nests. Thus, each pair produced an average of 5.4 clutches. Doves nesting in the oak plot made fewer nesting attempts. Calculations from the estimated densities, and the total number of nests found in 1963 and 1964, indicate each pair produced approximately 3.5 active nests per season. Early in the first year of field work we both suspected that breeding was less intense by doves inhabiting the oak plot, and the approximately 2-weeks greater time gap between the first and second peaks of nesting (fig. 1) in the oak plot supports this impression. Perhaps the lower percentage of nesting success in the oak plot causes the greater interval between nesting peaks.

The number of young present in the nest within the last 4 days of the nestling period was noted for 23 nests, which contained a total of 39 nestlings. These and other records suggest that an average of 1.7 young left successful dove nests in our plots. Our observations further indicated the average number of young leaving successful nests was somewhat higher in the pine plot than in the oak plot, thus we use 1.8 and 1.6 for the two plots. McClure (1950) and Hanson and Kossack (1963) estimated that an average of 1.8 young left successful nests in their study areas.

Considering only nests that contained eggs, the combined success for two seasons was 40.0 per cent for pine-dominated suburbs, and approximately 20.5 per cent for oak-dominated suburbs. Thus one pair of Mourning Doves breeding in the pine habitat would average 3.9 fledglings per season ($5.4 \text{ attempts} \times .40 \text{ per cent success} \times 1.8 \text{ young per successful nest}$). Their potential is much higher; if all nestings were successful ($5 \text{ or } 6 \times 1.00$) and all the eggs produced fledglings ($\times 2$) 10 or 12 fledglings could be produced. Pairs of doves breeding in the oak habitat averaged 1.1 fledglings per season ($3.5 \times .205 \times 1.6$).

Because our method of calculating nesting success and, therefore, productivity, differs considerably from that of other workers, we do not feel that detailed comparisons of our productivity figures with those published for other regions would be valid. Much greater production rates are listed for other regions in the United States (up to 7 young per pair in one season) with Illinois and Georgia being exceptions (see Hanson and Kossack, 1963). In Illinois the same authors estimated that production varied between 1.50 and 2.86 fledglings per pair per season over a 9-year period, and in Georgia according to Hopkins and Odum (1953), doves produced an estimated 2.1 fledglings per pair per season.

It is possible to test our methods of calculating productivity by using the data accumulated for the 10.2 acre pine plot of 1964. Here we recorded 79 successful nests and we think we found essentially all nests that succeeded (see fig. 4). An estimated 8 of the 79 nests fledged only one bird; therefore productivity for the plot must have been close to 150 fledglings. Multiplying the average number of clutches per season (5.4), the per cent nesting success (.43), and the average number of young leaving successful nests (1.8) times the number of pairs gives a similar figure of 164 fledglings.

Multiplying the number of fledglings produced per pair per season by the density of breeding pairs per acre and the total acreage provides

an estimate of the number of young doves produced per season in the mature residential areas of St. Petersburg and Gulfport in Pinellas County. As arboviruses require a supply of infectable vertebrates to maintain and amplify themselves, such figures are of significance to arbovirus ecology. Approximately 5,760 acres of suburbs of these two municipalities are pine dominated; for this habitat we have estimated an average density of 1.5 pairs per acre and an average productivity per pair of 3.9 fledglings per nesting season. Thus the doves breeding in the pine-dominated suburbs of St. Petersburg and Gulfport produce about 33,700 fledglings annually. Oak-dominated suburbs occupy an equal area, but have a density of only 1.0 pairs per acre, and produce an average of only 1.1 fledglings per pair in a season; thus the oak-dominated suburbs of St. Petersburg and Gulfport produce approximately 6,300 fledglings annually.

The small sample of nestings observed in new residential suburbs does not permit calculation of nesting success for this habitat. Total productivity per unit area of new residential suburbs must be considerably lower than in mature ones because of the low density of breeding adults.

Doves nesting in mature residential areas produce an average of approximately 2.8 young per pair per season. The mean annual mortality rate for such a population must be less than 60 per cent if it is maintaining itself. Studies elsewhere show the annual mortality rate is typically higher. Estimates for Cape Cod, Massachusetts (Austin, 1951) are 80 per cent loss of first-year birds and 55 per cent loss of older doves; for North Carolina (Quay, 1954) about 85 per cent for first-year individuals, 57 per cent for older birds. The overall figures for southeastern United States are 70 per cent loss of first-year birds and 55 per cent thereafter (Webb, 1967). The estimates for Illinois (Hanson and Kossack, 1963) are lower with 60 per cent loss for first-year birds, and 51 per cent for older individuals.

Possibly post-nestling mortality in doves is lower for a population breeding in suburbs. As previously mentioned the primary predators we observed were Blue Jays and Fish Crows, neither of which normally kill full-grown doves. Hopkins and Odum (1953) suggest that doves in southeastern United States may tend to live longer because they are not subjected to the hazards of migration. Another possible factor is that northern migratory populations are legal game for a greater portion of the year.

The use of nests of other species by doves appears to be less frequent in Florida (at least in suburban Pinellas County) than in

other regions. We observed 625 dove nestings in the three plots during the two seasons, of which only 11 (1.8 per cent) were in nests of other species: Blue Jay 6, Common Grackle 3, and Mockingbird and gray squirrel 1 each. In Iowa and Illinois the use of nests of other species has been shown to range from 4 to 15 per cent (McClure, 1943; Hanson and Kossack, 1963). In these more northern states, nests of the Robin and Common Grackle constitute over 85 per cent of other species' nests reused. Robins do not breed in Pinellas County, and grackles occur only in low densities. The only open nests commonly built in trees in the Pinellas County suburbs are those of Blue Jays, and with these the immediate site is often too dense and perhaps frequently too high to be acceptable to doves.

Doves often reuse nests made by their own species. As we marked no adults we were unable to establish how often the same pair reused a given nest, but Cowan (1952) and others have shown this to be common. Of the 222 nestings we observed in the 10.2 acre pine plot of 1964, 52 were in old dove nests; thus, each nest was used an average of 1.3 times; similar figures for other regions are: California 1.1, Nebraska 1.2, Iowa 1.4 (McClure, 1950), and Illinois 1.1 (Hanson and Kossack, 1963). In the 1964 pine plot the frequency of reuse of nests of both doves and other species increased until the last month of the breeding season: all 6 nests receiving eggs in January were newly built; in February 3.6 per cent of 28 nests were reuses; in March 21.9 per cent of 32 nests; in April 28.9 per cent of 45 nests; in May 31.6 per cent of 38 nests; in June 35.5 per cent of 31 nests; in July 39.1 per cent of 23 nests; and in August 25.0 per cent of 20 nests.

We have calculated nest success for reused nests, but without making corrections for unfound failures. In the 10.2 acre pine plot of 1964, the per cent success for all reused nests, including some found late in the egg cycle and even one found after hatching was 47.2 per cent (26 successes out of the 55 reuses of known fate), and if it were possible to incorporate unfound failures in the calculation, the figure would be lower and even closer to our estimate of 43.3 per cent for all nestings in this plot in 1964. Thus the reuse of nests does not appear to increase the probability that nests will succeed.

Although calculations of nesting success for Mourning Doves are typically higher than those for other birds, many authors consider the species' flimsy nest detrimental to this success. We suggest two possible advantages of this small nest; first, small nests should harbor fewer parasites, an important factor for a species that frequently

reuses old nests; secondly the short time needed to build this simple nest leaves more time for producing additional clutches.

We analyzed 287 different dove nests (reuses were not counted) found in the pine plot in 1963 for nest-site placement. These were built in 14 species of plants (table 9); an additional nest found in a feather palm is not included in table 9 because the areas covered by palms were not measured. For the oak plot, 1963, a total of 35 nests were analyzed; an additional nest built atop a post beneath a porch was excluded. In both plots nest placement departed strongly from random ($p < .01$).

Our index values (tables 9 and 10) indicate that punk trees and silk oaks were favored in the oak plot, and perhaps also in the pine plot. A severe freeze the previous winter killed the outer limbs of both these tree species, and nests were often built in the bushy clumps of new limbs growing from the living lower portions of their trunks. These sites, which would not have been present but for the freeze, may account for their higher values. In the oak plot laurel oaks, and in the pine plot both laurel and water oaks appeared to be low priority nesting trees. The high value of + 9.1 for Australian brush-cherry in the oak plot is of little significance as this plant occupied only a small area, and the two nests found therein were built in the same tree probably by the same pair of doves. The high figure for cherry laurel in the pine plot is also unimportant as it contained but one nest and comprised only .04 per cent of the vegetation.

No plant species were added to the list of those used as nest sites by Mourning Doves with the additional full season of field work in 1964 in portions of the pine and oak plots, but one each of 14 dove nests found in the new plot in 1963 was built in podocarpus and American holly, two plant species not used in the other plots.

During the 1963 season the heights of all Mourning Dove nests above 10 feet were estimated; in 1964 the heights of those nests less than 22 feet from the ground were judged more accurately by using the mirror pole previously described. Combining the nest records for both plots in the two seasons the 531 different nests averaged 18.2 feet from the ground (S.D. = 9.9 feet). The two most commonly recorded heights were 15 and 20 feet, however, these two modes result from the nest heights being estimated and not from any feature of the environment. The average heights for the pine and oak plots, both seasons combined, were a similar 18.4 and 18.2 feet. The nests found in the restricted portions of the pine and oak plots in 1964 averaged 4.6 and 3.1 feet higher than those found in the more

TABLE 9. MOURNING DOVE NEST-SITE PREFERENCE, PINE PLOT, 1963.

| Plant category | Per cent of vegetation | Per cent of nests | Index value |
|----------------------|------------------------|-------------------|-------------|
| Longleaf pine | 50.49 | 63.07 | +1.2 |
| Australian-pine | 13.06 | 14.29 | +1.1 |
| Silk oak | 4.12 | 8.36 | +2.0 |
| Punk | 3.90 | 5.57 | +1.4 |
| Pepperbush | 2.23 | 2.09 | -1.1 |
| Jacaranda | 0.75 | 1.74 | +2.3 |
| Citrus | 5.68 | 1.39 | -4.1 |
| Laurel & water oaks | 6.91 | 1.05 | -6.6 |
| Sand-live oak | 3.56 | 0.70 | -5.1 |
| Slash pine | 1.44 | 0.70 | -2.1 |
| Vitex | 1.28 | 0.35 | -3.7 |
| Bluejack oak | 0.42 | 0.35 | -1.2 |
| Cherry laurel | 0.04 | 0.35 | +8.8 |
| Ligustrum and privet | 1.36 | 0.0 | — |
| Other plants* | 4.41 | 0.0 | — |

The 15 plant categories (all vegetation) covered 22,190 square yards; the sample size for nests was 287. Cherry laurel was lumped with "Other plants" for the G-test; nest distribution departed significantly from random ($p < .01$).

*Includes all plants comprising less than one per cent of the vegetation and containing no nests.

TABLE 10. MOURNING DOVE NEST-SITE PREFERENCE, OAK PLOT, 1963.

| Plant category | Per cent of vegetation | Per cent of nests | Index value |
|-----------------------------|------------------------|-------------------|-------------|
| Turkey oak | 44.73 | 34.29 | -1.3 |
| Sand-live oak | 3.50 | 11.43 | +3.3 |
| Punk (+) | 0.33 | 11.43 | +34.6 |
| Silk oak (+) | 1.12 | 8.57 | +7.7 |
| Jacaranda | 6.12 | 8.57 | +1.4 |
| Citrus | 6.17 | 5.71 | -1.1 |
| Bluejack oak | 3.63 | 5.71 | +1.6 |
| Australian brush-cherry (+) | 0.63 | 5.71 | +9.1 |
| Longleaf pine | 4.84 | 2.86 | -1.7 |
| Laurel oak | 18.49 | 2.86 | -6.5 |
| Cherry laurel (+) | 1.66 | 2.86 | +1.7 |
| Live oak | 3.77 | 0.0 | — |
| Other plants* | 5.01 | 0.0 | — |

The 13 plant categories (all vegetation) covered 24,142 square yards; the sample size for nests was 35. Plants followed by (+) were lumped with "Other plants" for the G-test; nest distribution departed significantly from random ($p < .01$).

*Includes all plants comprising less than one per cent of the vegetation and containing no nests.

inclusive pine and oak plots studied in 1963. The greater height of nests in 1964 reflects the greater concentration of large trees in the restricted portions of both plots. The new plot, with few tall trees, had the lowest average nest height, 15.5 feet, but here the sample included only 14 nests.

The mean height for 30 dove nests Taylor (1965) found in campus and farm habitat in Louisiana was 12.7 feet. The greater average height of our nests may be attributable to the fact that more than 60 per cent of our records were of nests built in longleaf pines, the larger individuals of which have no low limbs.

In our frequent visits to the plots we observed an aspect of columbid behavior that apparently has been reported only once for the Mourning Dove. Among other aspects of columbid behavior Goodwin (1963) describes "driving," an aggressive display that males of several species show toward their mates when the pair is in the presence of other males. When a female approaches other males, or they approach her, her mate drives her away from the potential rivals. We often noted such behavior when an adult Mourning Dove, apparently a male, alighted near what appeared to be a mated pair. Normally the presumed mated male immediately moved between the potential rival and his mate and attempted to drive her away. Sometimes this driving, or some extrinsic factor, caused the female to fly, and she was invariably followed closely by her mate and sometimes the intruder. This initiated the rapid, erratic "three bird chase" Jackson and Baskett (1964) describe. Fighting between the rival males sometimes occurred before or after the flight. Jackson and Baskett observed the initiation of these "three bird chases" only twice. Our many observations of the flights and their initiation indicate that both are phases of "driving" as described by Goodwin (1956) for other columbids. As the two behaviors are surely homologous we see no further need for Jackson and Baskett's term the "three bird chase." Stone (1937) observed "high direct" three bird flights, especially in late summer, which he interpreted as a pair and its young; as the flights were "high" and "direct" and tended to occur late in the summer, his interpretation is probably correct.

BLUE JAY

We found 120 Blue Jay nests in the three plots during the two seasons. A combination of the considerable height of many nests, which made examining their contents impractical, and the complexities of jay breeding behavior (Hardy, 1961) made the nesting data

for this species difficult to analyze.

Based on records for the 2 years the breeding season for the Blue Jays of suburban Pinellas County extends almost 6 months from mid-March (earliest completed clutch 10 March 1964) to August (last completed clutch 6 August 1963). Only in 1964 did field work begin before jay nesting, therefore it is possible to describe and depict (fig. 7) but one complete annual cycle. In this year breeding activity intensified rapidly and nesting was at its peak in late March and early April. A second period of egg laying occurred in late April. The first decline in nesting began after the April peak and reached its low in mid-June. A final surge of nesting, which was only half the magnitude of the first, reached its peak in late June – early July.

The 6-month breeding season in central Florida allows ample time for the rearing of two successful broods. One complete breeding cycle requires approximately 70 days: 7 days for building and egg-laying, 17 days for incubating, 18 days for care of nestlings, and 28 days for care of fledglings (Hardy, 1961). The 90-day breeding season for Blue Jays in Kansas (Johnston, 1964) is too short for two successful broods to be raised and his histogram of the breeding schedule for the species shows no second peak. One brood per year also is produced in Maine according to Palmer (1949), but two occur in Georgia (Burleigh, 1958).

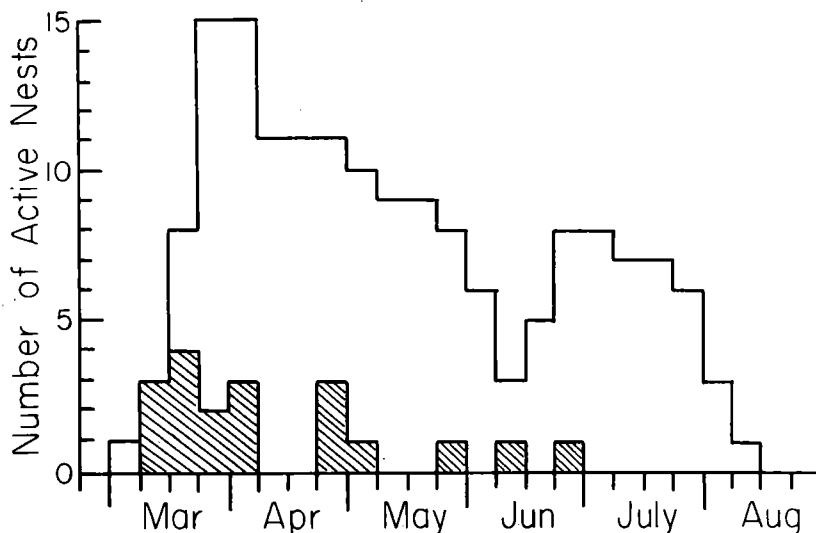


Figure 7. Histogram of the numbers of active jay nests per week (open area) and the time of completion of the clutch for certain of these nests (hatched area) for the pine and oak plots combined (15.9 acres) of 1964.

Based on the discovery of egg clutches Nicholson wrote of a third nesting period for Blue Jays at Orlando in central Florida (Howell, 1932):

"In the season of 1910 a few pairs bred in the latter part of March, but the majority commenced to nest about April 5; the second sets were found about June 1-8; the height of the third nesting period was July 23, when 2 sets of 3 eggs each were collected, and other occupied nests observed. The first sets nearly always comprised 4 eggs, the second sets 3 or 4, the third sets nearly always 3."

From these data one might conclude, as did Bent (1946: 54), that Blue Jays produce three broods per season in central Florida. If, for the 69 Florida egg dates listed in Bent, one takes the extremes (17 March and 29 August) and assumes these to be the day the eggs hatched for the former and the day the clutch was completed for the latter (two unlikely occurrences) one can obtain a breeding season of 239 days for Florida, time enough for three broods with almost a month to spare. This, however, combines several improbable events, and in our opinion three broods per season are rarely produced in Florida. The only real evidence for three broods per season is Nicholson's observation of two sets of eggs and additional occupied nests in late summer (23 July). Our data suggest only two broods per season. The duration of the 1964 breeding season was too short for three successful nestings, and, furthermore, only two peaks of nesting are apparent for this season.

Of the 120 jay nests we found 91 were true nests and 29 appeared to be false nests. The contents of only 40 of the 91 true nests were seen. Of the 91 true nests, 30 were successful, 40 failed, and the fates of 21 were unknown.

Using egg sets observed any time during incubation, clutch size was established for 10 nests: 7 contained 4 eggs, and 3 contained 3. The estimated time of completion of the clutches for the 7 nests containing 4 eggs ranged from 25 March to 21 May, the 3 nests containing 3 eggs had completed clutches between 10 and 26 June. These data support Nicholson's (*vide supra*) observation of clutch-size reduction in Florida Blue Jays from 4 eggs to 3 as the breeding season progresses. We find no evidence for, or reference to, a Blue Jay nest in Florida containing more than 4 eggs, although 5 (Kansas, Johnston, 1964), 6 (New Jersey, Stone, 1937; Georgia, Burleigh, 1958), and rarely 7 eggs (Bent, 1946) occur in nests farther north.

The number of young leaving a successful nest was established for only 6 Blue Jay nests; 2 nests fledged 3 young, 3 fledged 2, and

1 fledged 1. These 6 are the only active nests for which the number of young was noted within the last 5 days of the nestling stage; nests for which we observed the number of young sitting on the edge of the nest were excluded as some of the young already might have left.

In 1964 between 17 and 20 pairs of jays nested in the 15.9 acres of the densely wooded portions of the oak (5.7) and pine (10.2) plots combined. We based this estimate on 7 concurrently active nests in the oak plot and 8 in the pine plot. At other times during the season we had a total of 17 pairs either nesting (12) or caring for fledglings (5) in the two plots. However, the plots censused in 1964 are too small to use for estimating densities.

We found 57 nests built by these 17 to 20 pairs, 40 true and 17 false. The inaccessibility of most of the jay nests prevented our obtaining extensive histories of their contents, though we found 31 of the 40 true nests before hatching. As 12 of the 31 were successful,

TABLE 11. BLUE JAY NESTING SUCCESS DATA FOLLOWING MAYFIELD'S EXPOSURE METHOD.¹

| Row | Category | Exposure | Loss |
|-----|--|----------------------|-------------|
| 1 | Entire nest period (incubation to fledging) | 208 nest days | 8 nests |
| | Incubation | | |
| 2 | Complete nest (entire clutch) | 64.5 nest days | 3 nests |
| 3 | Individual eggs (including above) | 120 egg days | 14 eggs |
| | Hatching | | |
| 4 | Complete nest (all contents) | 3 nests (no time) | 0 nests |
| 5 | Individual eggs or young ² (including above) | 18 eggs (no time) | 9 items |
| | Nestlings | | |
| 6 | Complete nest (all nestlings) | 97.5 nest days | 3 nests |
| 7 | Individual nestlings (including above) | 190.5 nestling days | 8 nestlings |

¹Nest histories from both years and all three plots are included.

²The number of eggs seen after clutch completion was used as the number entering the hatching period; nests are included only if nestlings were seen within 4 days after hatching.

using hatching as the time before which nests had to be found to be included in the calculations, nest success using equation 1 was 38.7 per cent. With a maximum of 2 successful broods per season, and an average of 2 fledglings per successful nest, 4 young per season would be the average annual yield for pairs that succeeded in raising 2 broods. Average seasonal productivity for all pairs would be considerably lower. We felt that we were proficient at finding jay nests in 1964 (most were found while building), yet of the 35 true nests of known fate (5 of unknown fate are not considered) built by the 17 to 20 pairs, only 12 were successful. We do not feel that our nesting data for jays are sufficient for further analysis, but we have summarized them by the exposure method in table 11. When combined with additional data they may prove useful.

We observed one instance of the reuse of an old nest, or nest site, by Blue Jays. A pair successfully fledged young from a nest concealed by Spanish moss (*Tillandsia usneoides*) 12 feet up in a longleaf pine in 1964; the nest had also been successful in 1963.

In the 2 years of censusing, Blue Jays used 12 species of trees as nest sites, all of which are listed in table 12 except Australian-pine and punk tree. In the 1963 pine plot 21 jay nests were found in longleaf pines and 2 in punk trees; this distribution departed strongly from random ($p < .001$). In the oak plot of 1963 jays nested in 7 species of plants; here distribution of nests also departed significantly

TABLE 12. BLUE JAY NEST-SITE PREFERENCE, OAK PLOT, 1963.

| Plant category | Per cent of vegetation | Per cent of nests | Index value |
|-------------------|---------------------------|----------------------|----------------|
| Turkey oak | 44.73 | 34.38 | -1.3 |
| Jacaranda | 6.12 | 21.88 | +3.6 |
| Longleaf pine | 4.84 | 18.75 | +3.9 |
| Laurel oak | 18.49 | 12.50 | -1.5 |
| Live oak | 3.77 | 6.25 | +1.7 |
| Silk oak (+) | 1.12 | 3.13 | +2.8 |
| Bluejack oak | 3.63 | 3.13 | -1.2 |
| Citrus | 6.17 | 0.0 | --- |
| Sand-live oak | 3.50 | 0.0 | --- |
| Cherry laurel (+) | 1.66 | 0.0 | --- |
| Other plants* | 5.97 | 0.0 | --- |

The 11 plant categories (all vegetation) covered 24,142 square yards; the sample size for nests was 32. Plants followed by (+) were lumped with "Other plants" for the G-test; nest distribution departed significantly from random ($p < .01$).

*Includes all plants comprising less than one per cent of the vegetation.

from random ($p < .01$). Nest-site preference indices for the oak plot suggest Blue Jays sought longleaf pine (+3.9), jacaranda (+3.6), and silk oak (+2.8) as nest sites. An index value of +1.8 for longleaf pines in the pine plot adds support to the suggestion that this tree may be a favored site for nest building.

Nests varied in height above the ground from 7 to an estimated 45 feet (pine plot 10 to 45, oak plot 7 to 40, new plot 12 to 25). The average height for all nests was 24.4 feet (S.D. = 9.5). Taylor (1963) obtained a lower average of 13.1 feet (range 4.5 to 25.0) for 19 jay nests found in campus and farm habitat in Louisiana. Perhaps trees with low limbs were more prevalent there than in our plots. Longleaf pines, which housed 55 per cent of our nests, have no low limbs when of moderate or large size. Low limbs were more prevalent in the oak plot than in the pine plot, and the average nest height was 5.4 feet lower. Combining records for both years 59 jay nests in the oak plot averaged 22.2 feet (S.D. = 8.6), and 52 nests in the pine plot averaged 27.6 feet (S.D. = 9.8).

MOCKINGBIRD

In the 2 years of our study we recorded 73 Mockingbird nests in the 3 Pinellas County plots. This sample is variously limited according to the particular aspect of the breeding biology being considered. In extrapolations of nest histories we have used 3 days as the time required for the laying of the clutch, 13 days for incubation, and 12 days for the fledging of young. These figures are similar to those presented by Laskey (1962) who gave 12 to 12.5 days as the incubation period and 10 to 12.5 days as the time required for the nestlings to fledge; our data indicated that 13 days was a more accurate measure of the incubation period.

Nesting was well underway when field work began in 1963, thus the beginning of the breeding season was established from the early nestings of the estimated 8 pairs of Mockingbirds inhabiting our two reduced plots of 1964. The bulk of the Mockingbird population begins nesting in the last quarter of March and continues through the third quarter of July (fig. 8). Although most nesting takes place in this 4-month period, the season as defined by extreme nest dates is somewhat longer; the earliest nest we found contained 1 egg on 7 March 1964 (but failed 3 days later) and the latest we recorded fledged young on 7 August 1963.

Bent (1948) reports 56 records of Mockingbird nests containing eggs for Florida between 25 March and 12 August, half between 24

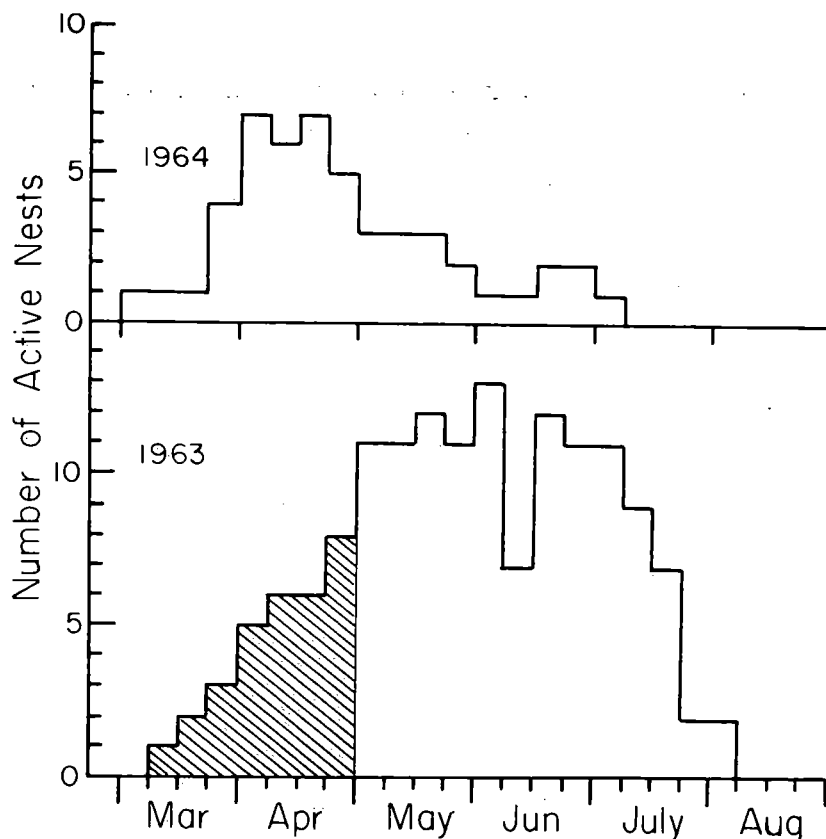


Figure 8. Histogram of the numbers of active Mockingbird nests per week for the pine and oak plots of 1963 and 1964 combined. The hatched area represents nests known by extrapolation to have been active before field work began.

April and 12 May. Our earliest egg record is 18 days earlier than any he gives, and his record of eggs seen on 12 August is 18 days later than our latest record of eggs that hatched on 25 July.

In calculating nesting success for Mockingbirds our data for the different plots and different years have been combined as the sample sizes are too small for valid comparisons either between the pine and oak plots or between the 2 years of observation. We have calculated nesting success both by our method of incorporating unfound failures and also by the exposure method of Mayfield as our data indicated that the rates of loss during the incubation and nestling periods were about constant. The results obtained by these two methods are only roughly comparable.

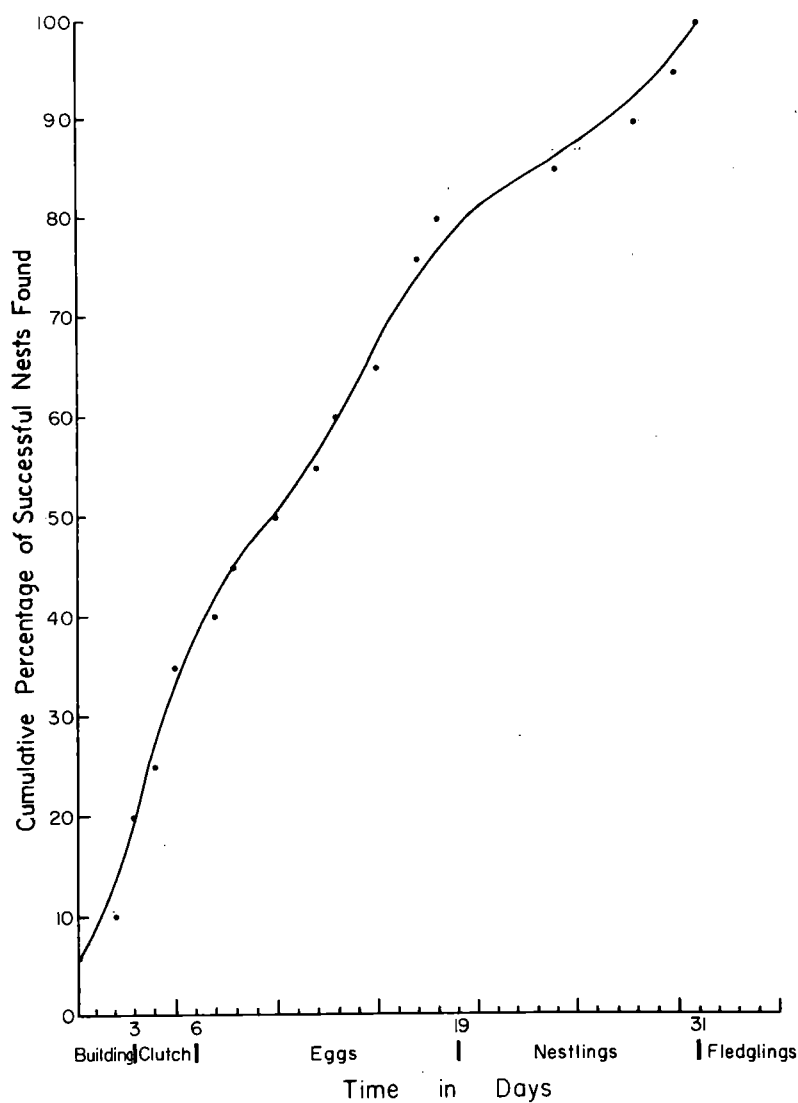


Figure 9. Graph of the time in the nesting cycle when successful Mockingbird nests were found. The graph is based on 20 successful nests recorded in the pine and oak plots in 1963 and 1964. The curve was fitted by eye.

We used 47 nests in calculating nesting success by incorporating unfound failures: 20 were successes, used to construct the graph.

showing when successful nests were found (fig. 9), and 27 were failures, used in calculating the number of unfound failures. Only 47 records could be used because many of those in the original sample were of nests begun before field work started (using such nests would produce a bias), and because it was necessary to drop all new plot records as irregular and infrequent visits to this plot resulted in unequal discovery rates for successful and unsuccessful nests.

Table 13 shows calculations of unfound failures for each day in the typical nest cycle. Including the hypothetical unfound failures, nest success as given by equation 1 was 52.4 per cent. This figure is considerably lower than a 67.2 per cent nest success (perhaps

TABLE 13. CALCULATIONS OF HYPOTHETICAL UNFOUND FAILURES FOR MOCKING-BIRD COMBINING THE PINE AND OAK PLOTS FOR 1963 AND 1964.

| Day in the nest cycle on which known nests failed | Cumulative per cent of 20 found successful nests (from graph) | Number of known nests observed to fail | Calculated unfound failures | Total number of failures (sum of known and calculated) |
|---|---|---|-----------------------------------|--|
| Building | | | | |
| 1 | 10 | 1 | 9.0 | 10.0 |
| 2 | 15 | 1 | 5.7 | 6.7 |
| 3 | 20 | 2 | 8.0 | 10.0 |
| Laying | | | | |
| 4 | 27 | 4 | 10.8 | 14.8 |
| 5 | 33 | 3 | 6.1 | 9.1 |
| 6 | 38 | 3 | 4.9 | 7.9 |
| Incubation | | | | |
| 7 | 42 | 1 | 1.4 | 2.4 |
| 11 | 53 | 1 | 0.9 | 1.9 |
| 12 | 56 | 1 | 0.8 | 1.8 |
| 13 | 60 | 1 | 0.7 | 1.7 |
| 19 | 79 | 2 | 0.5 | 2.5 |
| Nestlings | | | | |
| 21 | 82 | 1 | 0.2 | 1.2 |
| 23 | 85 | 1 | 0.2 | 1.2 |
| 24 | 86 | 1 | 0.2 | 1.2 |
| 26 | 89 | 1 | 0.1 | 1.1 |
| 28 | 93 | 1 | 0.1 | 1.1 |
| 29 | 96 | 2 | 0.1 | 2.1 |
| Totals | | 27 | 49.6 | 76.6 |

TABLE 14. MOCKINGBIRD NESTING SUCCESS DATA FOLLOWING MAYFIELD'S EXPOSURE METHOD.¹

| Row | Category | Exposure | Loss | Daily Probability of survival ² | Probability of surviving period |
|------------|--|-----------------------|--------------|--|---------------------------------|
| 1 | Entire nest period (incubation to fledging) | 396.5 nest days | 13 nests | $(1-13/396.5)^{25}$ | .43456 |
| Incubation | | | | | |
| 2 | Complete nest (entire clutch) | 146 nest days | 3 nests | $(1-3/146)^{13}$ | .76345 |
| 3 | Individual eggs (including above) | 407 egg days | 13 eggs | $(1-13/407)^{13}$ | .65573 |
| Hatching | | | | | |
| 4 | Complete nest (all contents) | 16 nests (no time) | 3 nests | $(1-3/16)^1$ | .81250 |
| 5 | Individual eggs or young (including above) | 57 eggs (no time) | 21 items | $(1-21/57)^1$ | .63158 |
| Nestlings | | | | | |
| 6 | Complete nest (all nestlings) | 136.5 nest days | 5 nests | $(1-5/136.5)^{12}$ | .63902 |
| 7 | Individual nestlings (including above) | 391 nestling days | 16 nestlings | $(1-16/391)^{12}$ | .60570 |

¹Nest histories from both years and all three plots are included.

²The value in parentheses is the daily probability of survival for the segment of the nest cycle being considered; the exponent is the number of days in that segment of the nest cycle. Raising the daily probability to the designated exponent yields the probability of survival for the period.

equation 2) we calculated from Laskey's (1962) data on 180 Mockingbird nests in Tennessee. Her sample may be biased toward success as her statement that "success is based on the number of eggs" laid may not mean that nests found after incubation had begun were excluded from her calculations and from the table in which she summarizes her data. Pinellas County Mockingbirds showed an exceedingly high loss rate during the periods of nest building and egg laying. By including nests in which at least one egg appeared (equation 2), nest success estimated by the unfound failure method drops to 28.6 per cent; and, by also including building failures (in extrapolations we arbitrarily assigned 3 days to building) nest success is only 20.7 per cent.

Our Mockingbird data on nesting success are analyzed by the exposure method in table 14. All nest histories that could be used were incorporated, including those from the new plot and those found shortly after field work began; the sample size is thus considerably larger than that used in our unfound failures estimate of success. By definition nests were included in the calculation of hatching success if the clutch size had been established at any time during incubation (individual egg loss from completed clutches rarely occurred), and if the number of young surviving the hatching period was established sometime up to 4 days after the time of hatching. (The hatching date was established by extrapolation from aged nestlings.)

As shown in table 14, row 1, if the loss of nests is constant throughout the nest cycle, nest success, as calculated by Mayfield's exposure method, is 43.5 per cent; the remainder of table 14 summarizes the loss rates for each of the three stages of the nest cycle. Combining nest success values for the three periods of the nest cycle (multiplication of the probabilities in rows 2, 4, and 6 in table 14) gives a nest success value of 39.6 per cent.

The difference of almost 13 per cent between the nest success value as calculated by Mayfield's exposure method and our method is difficult to explain. High loss rates do not seem to be present either early in the incubation period or early in the nestling period; as shown by our dove data such high loss rates would lower considerably nesting success calculations by Mayfield's exposure method. Part of the discrepancy between the results probably lies in the differences between the samples, as a larger number of nest records could be used with the exposure method than with ours. The results produced by our method would be inaccurate if the figures for nests found early in their cycle are non-representative. The discovery early in its cycle of another nest (successful or unsuccessful) would considerably influence our estimates as we are dealing with small numbers of nests.

Of 26 nests whose eggs were observed at some time during incubation, 19 (73 per cent) contained 4 eggs, and 7 (27 per cent) contained 3 eggs; no larger clutches were recorded. In 182 nests observed by Laskey (1962) in Tennessee 63 per cent contained 4 eggs, 23 per cent 3 eggs, and 14 per cent 5 eggs. Bent (1948) cites a record by Fargo of a 5-egg clutch in Pinellas County laid in the first quarter of April; thus clutches larger than 4 do occur as far south as central Florida, but they appear to be more common farther north.

As has been demonstrated now for other species (see Lack, 1954), Mockingbirds tend to have a reduced clutch in later nestings. Before 25 May, the mid point of the 4-month period of intensive breeding, we recorded only 2 clutches of 3 eggs; the remaining 5 clutches of 3 eggs were recorded after this date.

An average of 2.67 young were fledged from the 18 nests for which the number of young was established within the last 3 days of their stay in the nest (4 nests fledged 4 young, 7 fledged 3 young, 4 fledged 2, and 3 fledged 1). In no case was a sighting of fledglings used in this estimate as fledglings are difficult to find.

Our data allows little more than speculation about yearly productivity for Mockingbirds. In 1964 we had too few pairs under observation to generalize, and in 1963 almost no censusing was done in April, the most important month of the breeding season according to the histogram for 1964 (fig. 8). In 1963 in the pine and oak plots, 23 pairs produced 25 successful nests, some of which were known only by fledglings. If an average of 2.7 young leave a successful nest, these 25 nests produced 67.5 fledglings, a figure which surely would be increased by 25 per cent had data from March and April been available.

Michener (1951) and Laskey (1962) report frequent observation or recapture of breeding Mockingbirds more than 2 years old. No mortality data are known to us, but if nesting adults frequently live more than 2 years and if the population size is stable, fledgling mortality must be high as our 46 adults apparently produced well over 70 fledglings in a single season.

Nest-site preference for Mockingbirds (table 15) was calculated only for the 1963 pine plot. As Mockingbirds nest low, longleaf and slash pines and Australian-pine were not included in the analysis (only one nest, on a lower limb in a longleaf pine, was found in these trees). Inclusion of these plants that constituted 65 per cent of the vegetation would result in high, positive index values for the plants used as nest sites; their exclusion does not affect the order of preference, but facilitates comparison by distributing the index values around ± 1 . The distribution of nests in the low vegetation departed significantly from random ($p < .050 > .025$). The index values for punk trees and silk oaks were undoubtedly higher in 1963 than they would be in normal years, as these trees were recovering from an unusually severe freeze of the previous winter and were much bushier than normal. Where vitex and podocarpus were both present our impression was that vitex was the preferred species, but podocarpus

showed a higher preference rating. This may be in part a function of the high density of the breeding population of Mockingbirds. If territorial boundaries were established by factors other than the presence and position of favored nest sites, there would be less choice of nest sites; rather, any suitable plant within the territory would have to be used. Podocarpus grew on more of the house lots than any other plant that Mockingbirds used for nesting and because of territorial location it sometimes offered the only nesting site available to a pair.

TABLE 15. MOCKINGBIRD NEST-SITE PREFERENCE, PINE PLOT, 1963.

| Plant category | Per cent of vegetation | Per cent of nests | Index value |
|----------------|------------------------|-------------------|-------------|
| Punk | 11.06 | 25.93 | +2.3 |
| Vitex (+) | 3.65 | 18.52 | +5.1 |
| Podocarpus (+) | 1.52 | 14.81 | +9.7 |
| Citrus | 16.11 | 11.11 | -1.5 |
| Silk oak | 11.68 | 7.41 | -1.6 |
| Juniper (+) | 1.06 | 7.41 | +7.0 |
| Laurel oak | 19.62 | 3.70 | -5.3 |
| Sand-live oak | 10.11 | 3.70 | -2.7 |
| Ligustrum spp. | 3.86 | 3.70 | -1.0 |
| Fig (+) | 0.00 | 3.70 | — |
| Other plants* | 21.32 | 0.00 | — |

The 11 plant categories covered 7,820 square yards; the sample size for nests was 27. Plants followed by (+) were lumped with "Other plants" for the G-test; nest distribution in these low plants departed significantly from random ($p < .050 > .025$).

*All other standing vegetation in the plot except longleaf and slash pines and Australian-pine.

In the oak plot 11 nests were distributed in 8 species of plants. This sample was too small for analysis, but it is worth noting that vitex appears to have been strongly favored as it contained three nests but represented only 0.3 per cent of the total vegetation. No Mockingbird nests were built in the predominant turkey oaks which tended to be tall trees lacking bushy limbs.

Nest heights recorded for 61 Mockingbird nests ranged from 3 to 22 feet with a mean of 7.9 feet (S.D. = 3.2 feet). Taylor (1965) also found a mean nest height of 7.9 feet for 151 nests in northern Louisiana.

CARDINAL

We found 30 active Cardinal nests in the 2 seasons of censusing. The earliest nest, discovered 29 March 1964, presumably contained an egg on 21 March. The latest active nest failed 7 August 1963. Extrapolation from observed contents is based on a 13-day incubation period and a 10-day nestling period (Laskey, 1944). As other active nests were discovered near the times of these extreme dates, apparently nesting normally begins during the third quarter of March and ends in the first quarter of August. This provides ample time for the production of four broods, although more time would be needed for five. In Tennessee Laskey (1944) recorded a marked female that had 4 nestings, 3 of them successful, in each of 2 consecutive years, and Shaver and Roberts (1930) report a marked pair that raised 4 broods from 5 attempts in one season. These must be extreme cases. In our plots the average number of broods, based on records for the entire population, was much lower. Although the histogram of the 1963 breeding season (fig. 10) shows some indication of 3 peaks of nesting activity, we have no evidence of any pair fledging three broods. For the estimated 11 pairs of Cardinals that occupied the pine and oak plots in 1963, we recorded only 10 nests (including one record based on observed fledglings) that contained young more than 8 days old, and 2 of these were unsuccessful. It is improbable

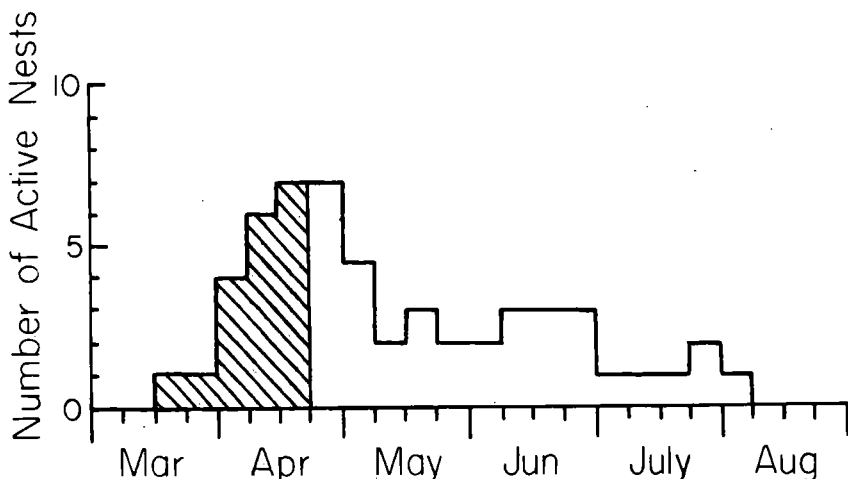


Figure 10. Histogram of the numbers of active Cardinal nests per week for the pine and oak plots (63.0 acres) of 1963 combined. The hatched area represents nests known by extrapolation to have been active before field work began.

that any successful breeding occurred before field work began, for we found 6 nests late in their cycle shortly after we began censusing, and no recently fledged young. Thus in 1963 at least, the average number of successful broods per pair was considerably less than 2.

The average clutch size for 18 nests checked during incubation was 2.56 eggs (8 clutches of 2 eggs and 10 of 3). This average may be low as we knew of three nests that lost one egg each and continued to be active. The mode for 93 nests from Tennessee (Laskey, 1944), Oklahoma (Nice, 1931), and Kansas (Johnston, 1960) was 3 eggs, with 20 to 25 per cent of the nests containing 4 or rarely 5 eggs. The only mention of 2-egg clutches is by Ganier (1941), who states that near Nashville, Tennessee, "late summer nests often have but two eggs." Because of these data we caution those who might automatically exclude Cardinal nests with 2 eggs from their tabulations on clutch size.

Nest success as estimated from nests found before the eggs hatched (after equation 2) was 31.6 per cent (6 of 19 nests successfully fledged at least 1 young). Because of our small sample of nests, we included in this calculation active nests for which success was based on an observation of fledglings; in cases where no fledglings were found the nest was assumed to have failed. In this case this procedure seems reasonable as recently fledged Cardinals remain near their nest and call frequently, and therefore are easy to find.

We recorded the number of young in eight nests seen within the last 4 days of the nestling period. Assuming this number is the number of young that fledged, an average of 2.0 young left successful nests (2 nests fledged 3 young, 4 fledged 2, and 2 fledged 1). Further analysis of nesting success from our small sample of data for the Cardinal seems unwarranted. However, in order that these data might be added to those obtained by other workers, we have summarized them by the exposure method in table 16.

The 33 Cardinal nests found in the pine and oak plots were located in 17 species of plants; as many of these plants constituted but small parts of the vegetation and contained only one nest, we have not analyzed nest-site preference for Cardinals. The only plant form that contained more than two Cardinal nests was citrus, which housed four nests in the pine plot and six in the oak plot. No nests were found in longleaf pines or turkey oaks.

The mean nest height for 38 nests was 7.9 feet (S.D. = 3.3), with a range of 3 to 25 feet. The distribution was bimodal, with 6 nests 5 feet high and 6 nests 8 feet high; 14 nests were between 3 and

5 feet and 14 between 8 and 10 feet up. Shrub nesting accounted for the lower mode and tree nesting for the higher. The nests built in trees were in the lower limbs, but these were higher than the sites chosen in the shrubs. The mean is closer to the higher mode because of a few nests built high in trees. Taylor (1965) gives an average of 6.3 feet and a range of 3 to 24 feet for 39 nests in Louisiana.

TABLE 16. CARDINAL NESTING SUCCESS DATA FOLLOWING MAYFIELD'S EXPOSURE METHOD.¹

| Row | Category | Exposure | Loss |
|-----|--|----------------------|-------------|
| 1 | Entire nest period (incubation to fledging) | 188 nest days | 13 nests |
| | Incubation | | |
| 2 | Complete nest (entire clutch) | 111 nest days | 10 nests |
| 3 | Individual eggs (including above) | 243.5 egg days | 25 eggs |
| | Hatching | | |
| 4 | Complete nest (all contents) | 7 nests (no time) | 0 nests |
| 5 | Individual eggs or young ² (including above) | 18 eggs (no time) | 2 items |
| | Nestlings | | |
| 6 | Complete nest (all nestlings) | 34.5 nest days | 3 nests |
| 7 | Individual nestlings (including above) | 62 nestling days | 6 nestlings |

¹Nest histories from both years and all three plots are included.

²The number of eggs seen after clutch completion was used as the number entering the hatching period; nests are included only if nestlings were seen within 4 days after hatching.

Fledgling Cardinals soon moved to the upper regions of trees in our residential plots and were not seen in the low vegetation or on the ground until they were becoming independent. This may have been in response to the frequent ground-level disturbances that occur in residential suburbs, as in a nearby natural habitat small Cardinal fledglings tended to remain in the understory.

RED-WINGED BLACKBIRD

We found 11 Red-wing nests in the pine plot and one in the new plot. Seven were built in citrus, from 6 to 12 feet from the ground, three were built 4 to 5 feet high in vitex, and one was 8 feet up in a small stand of bamboo. The plant species that appear to be preferred as nest sites locally in natural habitats, salt bush *Baccharis halimifolia* and wax myrtle, are rare in the suburbs.

Clutch size was established for 6 nests: 3 had 2 eggs, 2 had 3 eggs, and one had 4 eggs. One egg each disappeared from a 2-egg, 3-egg, and the 4-egg nest; however, each successfully fledged young.

COMMON GRACKLE

The small colony of 6 pairs of Common Grackles nested high in the densest stand of longleaf pines in the pine plot. We were unable to climb to any of the 8 nests we found but one nest that blew down 22 March 1964 contained 5 nestlings of varying sizes. Nest building began during the second quarter in February 1964, and fledglings were seen from 22 March to 23 April. All breeding activity ceased by the second quarter of May.

We obtained too few nesting data for the remaining five species that nested in our residential area study plots (Yellow-shafted Flicker, Red-bellied Woodpecker, Purple Martin, Starling, House Sparrow) to warrant analysis.

SCIENTIFIC NAMES OF BIRDS MENTIONED IN THE TEXT

Red-tailed Hawk, *Buteo jamaicensis*
Red-shouldered Hawk, *Buteo lineatus*
Bald Eagle, *Haliaeetus leucocephalus*
Bobwhite, *Colinus virginianus*
Ring-necked Pheasant, *Phasianus colchicus*
Killdeer, *Charadrius vociferus*
Rock Dove, *Columba livia*
Ringed Turtle Dove, *Streptopelia risoria*
Mourning Dove, *Zenaidura macroura*
Ground Dove, *Columbigallina passerina*
Budgerigar, *Melopsittacus undulatus*
Yellow-billed Cuckoo, *Coccyzus americanus*
Barn Owl, *Tyto alba*
Screech Owl, *Otus asio*
Chuck-will's-widow, *Caprimulgus carolinensis*
Common Nighthawk, *Chordeiles minor*
Chimney Swift, *Chaetura pelagica*
Yellow-shafted Flicker, *Colaptes auratus*
Red-bellied Woodpecker, *Centurus carolinus*

Red-headed Woodpecker, *Melanerpes erythrocephalus*
Yellow-bellied Sapsucker, *Sphyrapicus varius*
Downy Woodpecker, *Dendrocopos pubescens*
Red-cockaded Woodpecker, *Dendrocopos borealis*
Eastern Kingbird, *Tyrannus tyrannus*
Gray Kingbird, *Tyrannus dominicensis*
Great Crested Flycatcher, *Myiarchus crinitus*
Eastern Wood Pewee, *Contopus virens*
Bank Swallow, *Riparia riparia*
Purple Martin, *Progne subis*
Blue Jay, *Cyanocitta cristata*
Scrub Jay, *Aphelocoma coerulescens*
Common Crow, *Corvus brachyrhynchos*
Fish Crow, *Corvus ossifragus*
Brown-headed Nuthatch, *Sitta pusilla*
Carolina Wren, *Thryothorus ludovicianus*
Mockingbird, *Mimus polyglottos*
Catbird, *Dumetella carolinensis*
Brown Thrasher, *Toxostoma rufum*
Blackbird, *Turdus merula*
Song Thrush, *Turdus philomelos*
Robin, *Turdus migratorius*
Cedar Waxwing, *Bombycilla cedrorum*
Loggerhead Shrike, *Lanius ludovicianus*
Starling, *Sturnus vulgaris*
White-eyed Vireo, *Vireo griseus*
Yellow-throated Vireo, *Vireo flavifrons*
Solitary Vireo, *Vireo solitarius*
Black-whiskered Vireo, *Vireo altiloquus*
Red-eyed Vireo, *Vireo olivaceus*
Black-and-white Warbler, *Mniotilta varia*
Parula Warbler, *Parula americana*
Myrtle Warbler, *Dendroica coronata*
Pine Warbler, *Dendroica pinus*
Kirtland's Warbler, *Dendroica kirtlandii*
Prairie Warbler, *Dendroica discolor*
Palm Warbler, *Dendroica palmarum*
Yellowthroat, *Geothlypis trichas*
House Sparrow, *Passer domesticus*
Eastern Meadowlark, *Sturnella magna*
Red-winged Blackbird, *Agelaius phoeniceus*
Boat-tailed Grackle, *Cassidix mexicanus*
Common Grackle, *Quiscalus quiscula*
Cardinal, *Richmondia cardinalis*
American Goldfinch, *Spinus tristis*
Rufous-sided Towhee, *Pipilo erythrophthalmus*
Bachmans' Sparrow, *Aimophila aestivalis*
Song Sparrow, *Melospiza melodia*

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