To the Graduate Council

I am submitting herewith a thesis written by Mark S. Burch entitled "Nesting Ecology of Mourning Doves in Knox and Loudon Counties, Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

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NESTING ECOLOGY OF MOURNING DOVES IN KNOX AND LOUDON COUNTIES, TENNESSEE

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Mark S. Burch

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ABSTRACT

The nesting ecology of mourning doves (Zenaida macroura) was investigated on a rural area in Loudon County and an urban area in Knox County, Tennessee, from 1 February to 31 October 1979 and 1980. Data were collected on nesting chronology, proportion of annual recruitment occurring after 1 September, nesting success, annual production, and nest site selection. On the rural area, the earliest nests were initiated on 6 April 1979 and 1 April 1980, while on the urban area, the earliest nests were initiated on 26 February 1979 and 20 February 1980. On the rural area, a major peak in nest initiations occurred in April and a minor peak in June during 1979, while during 1980, a small peak occurred in April, followed by a larger peak in August. On the urban area, peak periods of nest initiation occurred in March, May, and August during 1979, while during 1980, peak periods of nest initiation occurred in March and June. The latest nests on the rural area were begun on 3 August 1979 and 2 September 1980. The latest nests on the urban area were started on 8 September 1979 and 31 August 1980. On the rural area, the last young fledged on 27 August 1979 and 30 September 1980. On the urban area, the last young fledged on 6 October 1979 and 26 September 1980. The proportion of annual recruitment occurring after 1 September varied widely between years on the same area. On the rural area, no young were produced after 1 September 1979, while 7 (35.0%) young were produced after 1 September 1980. On the urban area, 2 (6.0%) and 10 (10.2%) young were produced after 1 September 1979 and 1 September 1980, respectively. On the rural area, 38.9% of the nests in 1979 and 61.1% of

the nests in 1980 were successful in fledging at least 1 young. On the urban area, nest success was 85.7% in 1979 and 70.1% in 1980. Production on the rural area was 0.7 young per nest attempt in 1979 and 1.1 young per nest attempt in 1980. On the urban area, production was 1.6 young per nest attempt in 1979 and 1.3 young per nest attempt in 1980. On the rural area, doves made 3.0 nest attempts per pair in 1979 and 3.6 nest attempts per pair in 1980, while on the urban area, doves initiated 3.5 nests per pair in 1979 and 4.8 nests per pair in 1980. On the rural area, 2.2 young per pair were produced in 1979 and 4.0 young per pair in 1980, while on the urban area, there was a production of 5.5 young per pair in 1979 and 6.1 young per pair in 1980. On the rural area, most (72.2%) nests were located in wooded fencerows, while on the urban area, most (94.9%) nests were in ornamental landscape plantings.

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CHAPTER I

INTRODUCTION

The mourning dove is the most heavily harvested game bird in North America. Its annual harvest has been estimated at approximately 49.9 million birds (Keeler 1977). Within Tennessee, almost 95,000 people killed an estimated 2.2 million doves in nearly 500,000 hunting trips during 1978 (TWRA 1980). As a result of this avid interest in dove hunting, considerable emphasis is placed on proper management of the species.

Doves were legally hunted in 32 states in 1978 (USFWS 1977). Hunting seasons opened in September in 31 of these states. The hunting season in Tennessee has opened on 1 or 2 September every year since 1953 (USFWS 1977). Since mourning doves commonly nest during September, there has been much criticism of the regulations permitting hunting in September (USFWS 1977, Weber 1963).

In an effort to assess accurately the impact of September hunting on the maintenance of the mourning dove population, the Migratory Bird and Habitat Research Laboratory (MBHRL) of the United States Fish and Wildlife Service (USFWS) initiated a cooperative research program in 1978 to determine the importance of late nesting and the effect of September hunting on recruitment. The present study was initiated in conjunction with this cooperative effort and was designed to provide data for the first objective of the project. This objective was to

determine the proportion of annual mourning dove recruitment that occurs in September and October.

Although numerous studies have been published on mourning dove nesting ecology in various regions of the country, only 2 such studies have been conducted in Tennessee. Monk (1949) studied the nesting ecology of the mourning dove for 34 years, but most intensively during 1934-1939, 1942, and 1946-1948, in a portion of Centennial Park and the surrounding residential area in Nashville. Hammond (1954) reported on 5 years of nesting studies from 1949 to 1953 which were conducted on the same area as Monk's studies, but he discussed these data only briefly in his extensive report on the mourning dove in Tennessee. Thus, there is a considerable lack of recent information concerning dove nesting in Tennessee. Also, literature on their nesting ecology in other physiographic regions of Tennessee is completely absent. In addition to providing data for the cooperative research project, this study should furnish necessary information on the nesting ecology of mourning doves in the Ridge and Valley physiographic region of east Tennessee.

The present investigation was designed to study the nesting ecology of mourning doves on an urban and a rural area of east Tennessee. The objectives of this study were to determine: (1) nesting chronology, (2) proportion of annual recruitment occurring in September and October, (3) nesting success, (4) annual production, and (5) nest site preferences.

CHAPTER II

STUDY AREA DESCRIPTION

I. SELECTION OF THE STUDY AREAS

The study areas were selected using guidelines established by the USFWS for the cooperative mourning dove research program. These guidelines required that the areas be located in representative mourning dove nesting habitat within the state. An effort was made to avoid locating study areas in unusually good or unusually poor nesting habitat. The size of each area was determined by the amount of habitat that could be reasonably searched in a single day.

Two study areas were established in Loudon County, Tennessee, under these guidelines. In order to search the greatest amount of habitat, the areas were located on farmland with many contiguous wooded fencerows. These areas were probably fairly representative of dove nesting habitat on east Tennessee farmland but were obviously not typical of the entire state.

During the course of this study, a large number of doves were observed on the agricultural campus of The University of Tennessee, Knoxville. A third study area was established on the agricultural campus; however, this area did not meet the conditions necessary for inclusion in the cooperative research project. The area appeared to be unusually good nesting habitat and could be thoroughly searched within 3 hours. Consequently, this area was not utilized in the cooperative project and was included only for the purposes of the present study.

II. RURAL AREA

Location and Size

The rural area consisted of 2 study areas (Figs. 1 and 2). These areas were located approximately 9.7 km east of Lenoir City in Loudon County and were contiguous. The entire rural area was in the Ridge and Valley physiographic province of east Tennessee.

Only areas within the perimeter of fencerows and woodland edges that were searched were considered when determining the size of the area. Area 1 contained 129.1 ha and Area 2 contained 91.6 ha, for a total rural area of 220.7 ha.

Agricultural Practices

Alternate parallel ridges underlain by sandstone or sandy shale and valleys underlain by limestone and shale are characteristic of the Ridge and Valley province (Elder 1961). The rural area was located on farmland typical of this region. Cultivated fields and pastures were in the valleys and on the lower slopes, while woodlands occurred on the upper slopes and ridges.

Most of Area 1 was devoted to dairy and beef cattle operations, and, consequently, a major portion of this area was in pasture. All pastures were cut for hay in the early summer. The only agricultural practices on Area 2 were corn and soybean cultivation. Hay, soybeans, and corn were the major crops on the rural area during this study (Table 1).

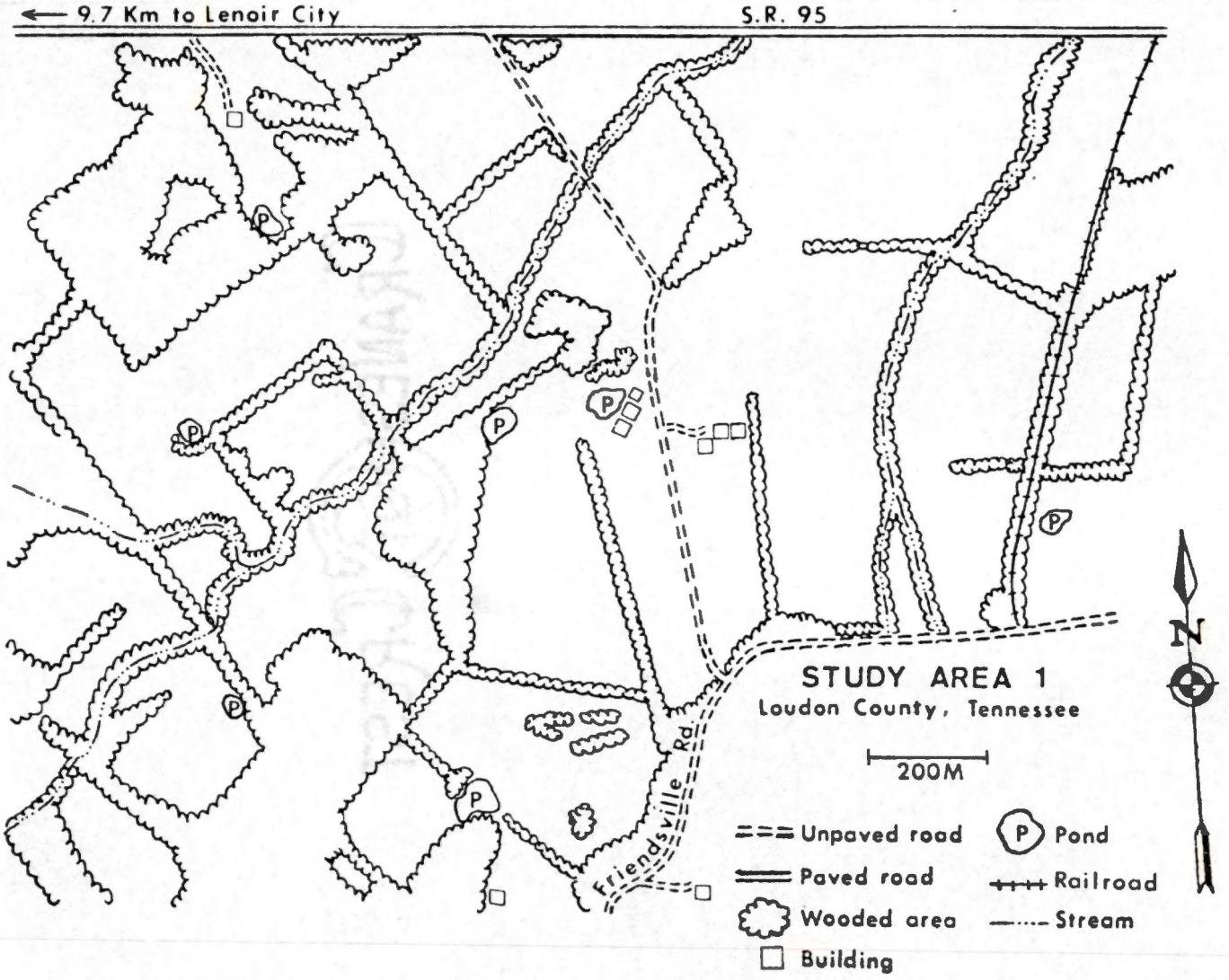


Figure 1. Map of Area 1 of the rural area in Loudon County, Tennessee.

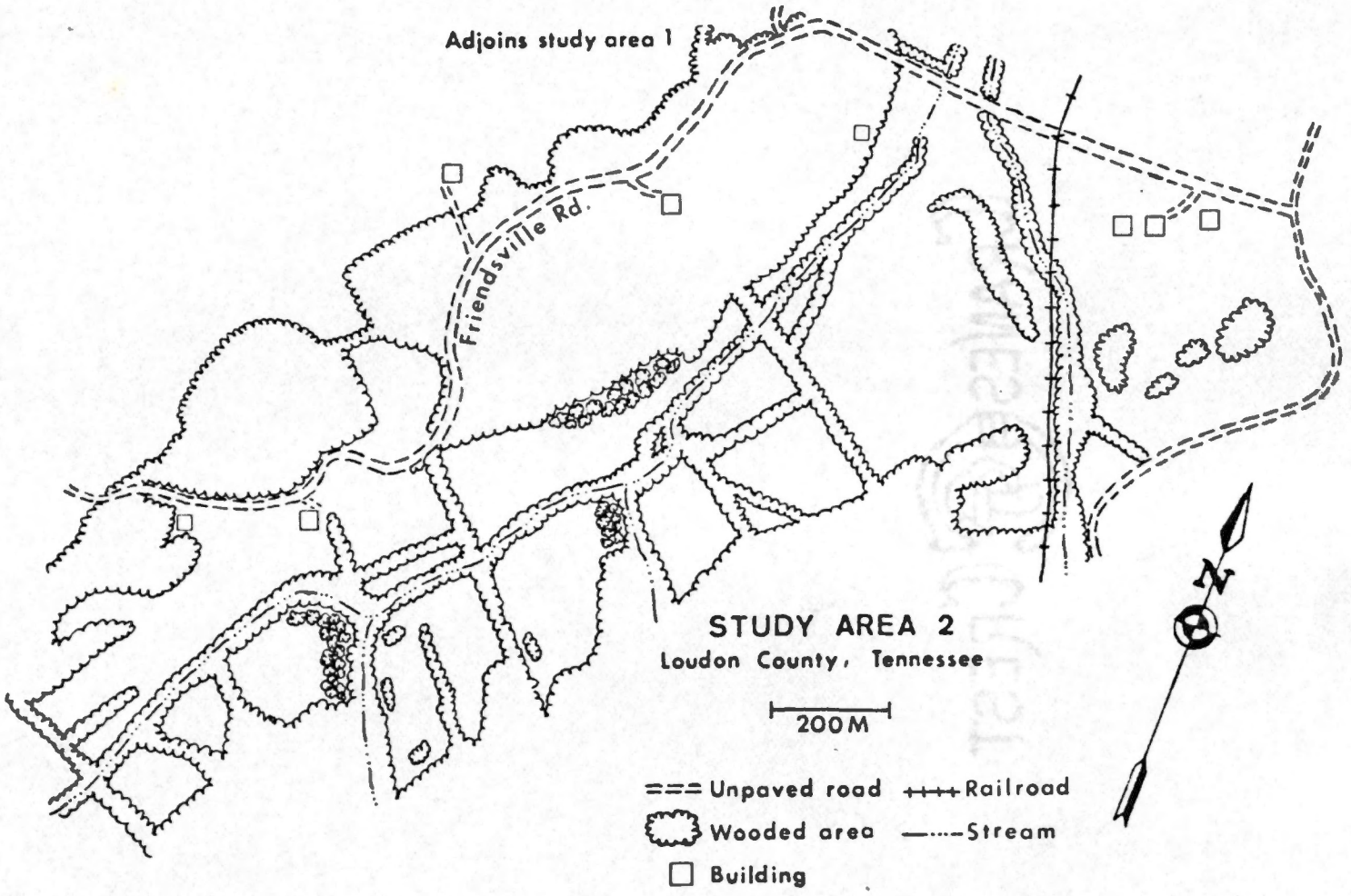


Figure 2. Map of Area 2 of the rural area in Loudon County, Tennessee.

Table 1. Crops grown on the rural study areas in Loudon County, Tennessee, during 1979 and 1980.

	Hectares					
	1979			1980		
Crop	Area 1	Area 2	Total	Area 1	Area 2	Total
Hay	81.5		81.5	81.5		81.5
Soybean		16.1	16.1		34.1	34.1
Corn	4.9	13.2	18.1	4.9	18.8	23.7
Wheat	9.1		9.1	9.1		9.1
Tobacco	1.8		1.8	1.8		1.8
Idle Fields		23.6	23.6			
Total	97.3	52.9	150.2	97.3	52.9	150.2

Habitat Types

Pastures and cultivated fields were the dominant habitat types on the rural area (Table 2). Together they comprised 68.0% of the area. These large open field habitats were not searched for dove nests. The 3 habitat types that were searched included wooded fencerows, woodland edges, and old fields. There were 30.4 ha of these habitat types on Area 1 and 38.7 ha on Area 2. Therefore, the total mourning dove nesting habitat searched on the rural area was 69.1 ha. This was 31.4% of the study area.

Included in the wooded fencerow habitat type were wooded fencerows, wooded streams and gullies, and overgrown abandoned home sites. Although the abundance of the different plant species varied, the major species in most of these areas were similar. Eastern redcedar (Juniperus virginiana), hackberry (Celtis occidentalis), and Japanese honeysuckle (Lonicera japonica) were the most common species. Other common vegetation included sassafras (Sassafras albidum), sourwood (Oxydendrum arboreum), black locust (Robinia pseudoacacia), and American elm (Ulmus americana)

The major plant species of woodland edges were oaks (Quercus spp.), maples (Acer spp.), hickories (Carya spp.), Virginia pine (Pinus virginiana), yellow poplar (Liriodendron tulipifera), eastern redcedar, and honeysuckle. Woodland edges varied in growth form from very abrupt edges (when adjoining a pasture of cultivated field) to very gradual edges (when slowly encroaching on an old field).

While old fields were not a major habitat type on the study area, they appeared to offer potential dove nesting habitat. The

Table 2. Habitat types on the rural study areas in Loudon County, Tennessee, during 1979 and 1980.

Habitat Type	Hectares			Percentage of total area		
	Area 1	Area 2	Total	Area 1	Area 2	Total
Pasture	81.5		81.5	63.1		36.9
Cultivated fields	15.8	52.9	68.7	12.2	57.8	31.1
Wooded fencerows	19.1	15.7	34.8	14.8	17.1	15.8
Woodland edges	11.3	20.2	31.5	8.8	22.1	14.3
Old fields		2.8	2.8		3.0	1.3
Ponds	1.4		1.4	1.1		0.6
Total	129.1	91.6	220.7	100.0	100.0	100.0

woody vegetation on these areas consisted predominantly of eastern redcedars ranging from 1 to 4 m in height. Scatterings of hardwood saplings, mainly yellow poplar and sweet gum (Liquidambar styraciflua) occasionally occurred in these habitats. Multiflora rose (Rosa multiflora) and Carolina rose (Rosa carolina) were also encountered.

Water was available on the rural area throughout the year. Five permanent ponds of about 0.2 to 0.3 ha were present on Area 1. There were also approximately 0.9 km of perennial streams and 1.8 km of intermittent streams on Area 1. Area 2 had approximately 2.6 km of perennial streams.

III. URBAN AREA

Location and Size

The urban area was located on The University of Tennessee Agricultural Campus in Knox County approximately 3.2 km southwest of downtown Knoxville (Fig. 3). This area was also in the Ridge and Valley physiographic region.

During 1979, mourning dove nest searches were conducted on a 36.2 ha area between Neyland Drive, Alcoa Highway, and Third Creek. In 1980, a 9.0 ha area between Cumberland Avenue, Neyland Drive, and Alcoa Highway (subsequently referred to as the triangle) was included in the study. Thus, the urban area was 36.2 ha in 1979 and 45.2 ha in 1980.

Structures and Human Activities

In 1869, the 45.2 ha bottomland area along the Tennessee River was purchased for the establishment of the Agricultural Experiment

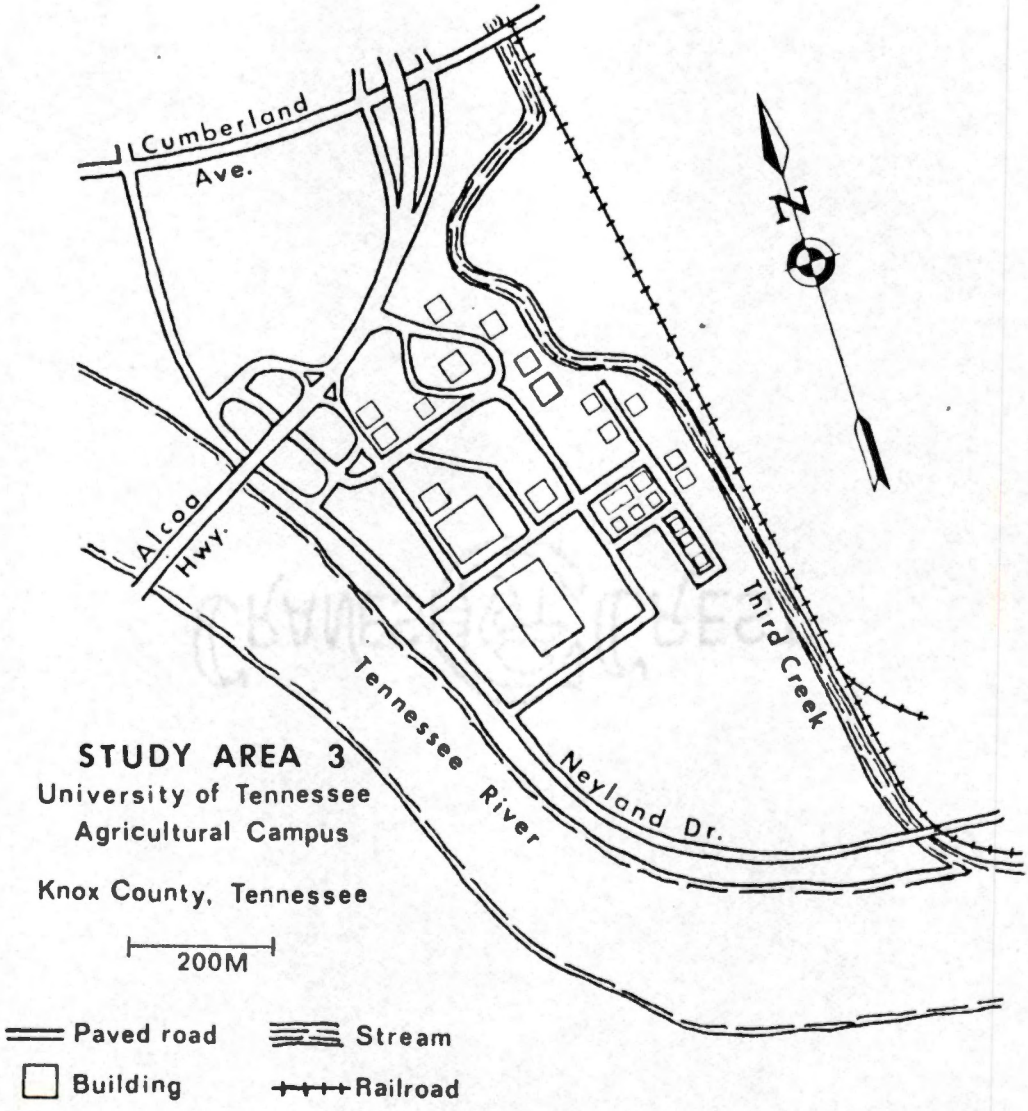


Figure 3. Map of the urban area on The University of Tennessee Agricultural Campus in Knox County, Tennessee.

Station (Sims 1947). By 1919, the campus included 1 teaching building (Morgan Hall), the H. A. Morgan residence, the O. P. Temple Pavilion, miscellaneous barns, and a few other residences (Montgomery 1971). With the completion of the College of Veterinary Medicine in 1978, the agricultural campus had grown to over 20 buildings. No structures were present on the triangle area during this study. Approximately one-fourth of the 45.2 ha area was occupied by buildings, streets, and parking areas.

Only one residence was located on the campus during this study. However, there was a considerable amount of human activity on this area. This activity was mostly limited to the areas immediately surrounding the buildings and parking areas during the morning and early afternoon when most students were present. After about 1700 hrs on weekdays and all day on Saturdays and Sundays, there was usually very little activity. There was only a very small amount of human activity on the triangle area at any time.

Habitat Types

Since buildings, streets, and parking areas occupied approximately 25.0% of the urban area, the total mourning dove nesting habitat searched was 27.2 ha in 1979 and 33.9 ha in 1980. This total nesting habitat was composed of only 2 habitat types. The first was the park-like ornamental landscape plantings which occurred over 88.5% of the nesting habitat. The second was the natural area along Third Creek which occupied the remaining 11.5% of the total mourning dove nesting habitat.

A majority of the campus and the entire triangle consisted of ornamental landscape plantings. These included various varieties of

flowering trees and shrubs, exotic and native conifers, numerous species of holly (*Ilex* spp.), and many native and exotic hardwood trees. There were also a few areas planted with annual flowers, dwarf trees and shrubs, and various ground covers. The lawn was usually mowed weekly during the growing season and the trees and shrubs pruned when necessary.

The natural area along Third Creek supported vegetation more typical of the region. Sycamore (*Plantanus occidentalis*), black willow (*Salix nigra*), hackberry, and American elm were the most common trees. Dense growths of honeysuckle and kudzubean (*Pueraria thunbergiana*) occurred frequently. Virtually no grounds maintenance was attempted on this area.

The urban area was bordered on 1 side by Third Creek and on another side by the Tennessee River. Consequently, ample water was available throughout both nesting seasons.

IV. CLIMATE

Knox and Loudon Counties have a humid-temperate climate (Elder 1961, Roberts 1955). Winter is moderate, but short cold periods do occur. The normal mean monthly temperature for January, the coldest month, as determined over the period from 1941 to 1970, is 4.7 C (NOAA 1979-80). Temperatures below -15.0 C in winter are rare. Summer is warm, with temperatures in the daytime usually between 24.0 C and 32.0 C. The normal mean monthly temperature for July, the warmest month, as determined over the period from 1941 to 1970, is 25.7 C (NOAA 1979-80). Normal annual precipitation averages 117.3 cm, as determined over the

period from 1941 to 1970 (NOAA 1979-80). The average frost-free season extends from 14 April to 23 April.

During the period of this study, local climatological data were compiled by the National Weather Service at McGhee Tyson Airport (NOAA 1979-80), located approximately mid-way between the rural and urban areas. Generally, the spring of 1979 was warmer and the summer cooler than normal, while the spring of 1980 was colder and the summer hotter than normal. Precipitation during 1979 was near normal in the spring and above normal during the summer, while during 1980, precipitation was above normal in the spring and below normal during the summer (Fig. 4).

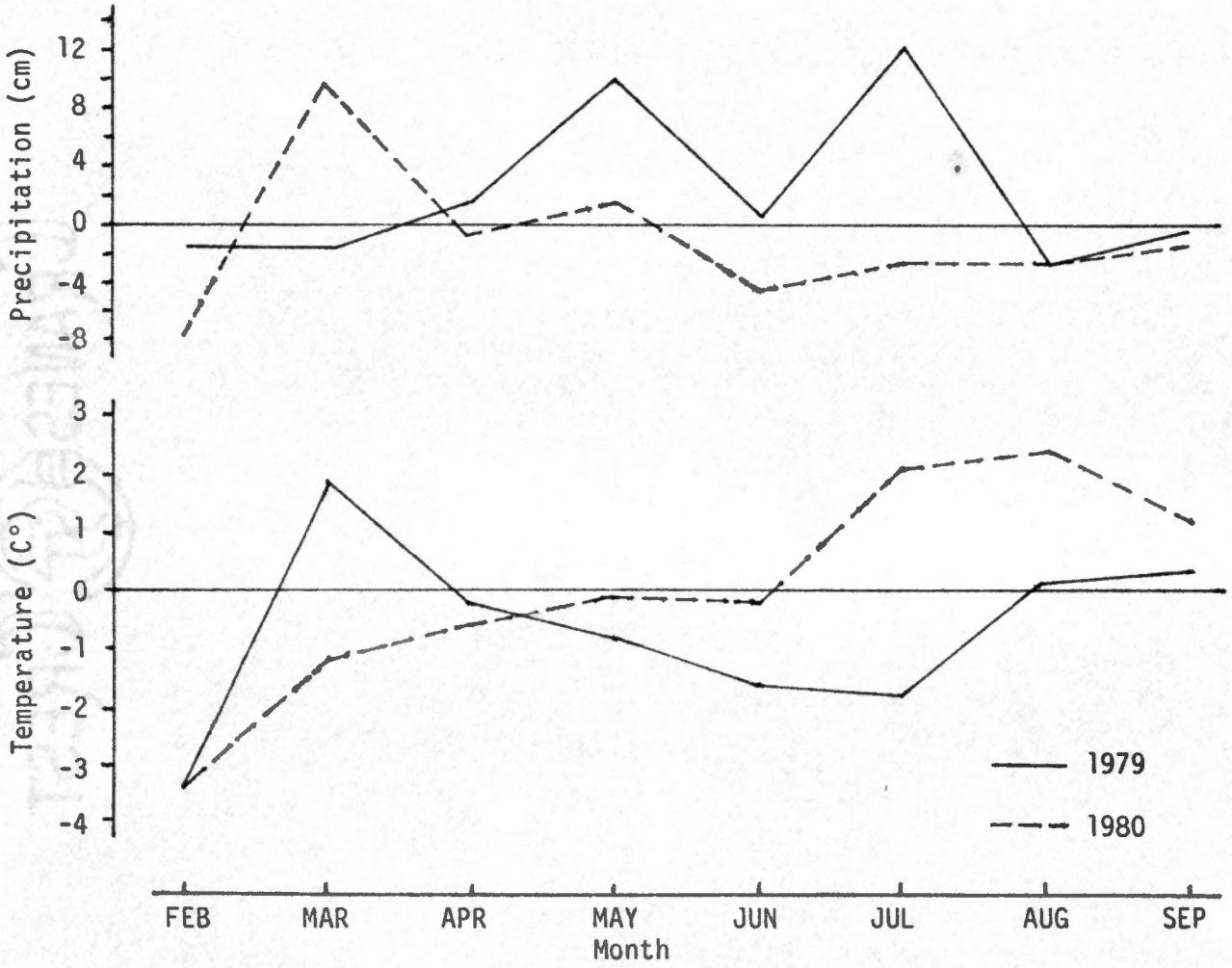


Figure 4. Departure from normal monthly precipitation and mean monthly temperature during 1979 and 1980 at McGhee Tyson Airport, Knoxville, Tennessee.

CHAPTER III

METHODS

Each study area was searched thoroughly 1 day each week between 1 February and 31 October, 1979 and 1980. All active nests (nests containing eggs or nestlings) located on each search day were recorded. At the same time, previously found active nests were rechecked and their status determined. Nest data were recorded on standardized data forms provided by the USFWS (Appendix).

The number of eggs or nestlings present was determined the day the nest was found. An extensible fiberglass fishing pole with an attached mirror was used to observe the nest contents. Each active nest was rechecked weekly during incubation and through the ninth day of brooding. Additional checks were made daily from the time the nestlings were 10 days old until they fledged. Nestlings were aged using the method described by Hanson and Kossack (1963). The age of the older nestling was used when there was an apparent difference in the age of the 2 nestlings. The date of nest initiation was calculated by back-dating to the date on which the first egg of the clutch was laid, assuming that incubation began on the day following the laying of the first egg and lasted for 14 days (Hanson and Kossack 1963). If the nestlings were present when 10 days old, the nesting attempt was considered successful.

The small sample sizes obtained during this study precluded detailed statistical treatment of the data.

CHAPTER IV

RESULTS

I. NESTING CHRONOLOGY

Courtship

On the first visits to the rural area (14 February 1979 and 4 February 1980) mourning doves were associating in paris as well as in small flocks of 6 to 8 birds. The earliest dates that doves were heard cooing on this area were 28 February 1979 and 6 March 1980.

The urban area was visited during the winters preceding both nesting seasons. Small groups and pairs of doves were observed throughout both winters. The earliest dates that doves were heard cooing on this area were 11 February 1979 and 4 February 1980.

Nest Initiation

A nest was considered to be initiated on the date the first egg was laid. On the rural area the earliest nests were initiated on 6 April 1979 and 1 April 1980. In 1979 a major peak in nest initiations occurred in April and a minor peak in June (Fig. 5). In 1980 a small peak occurred in April, followed by a larger peak in August. During 1979, 14 of 18 nests were initiated by 1 July, whereas only 7 of 18 nests were initiated by that date in 1980 (Fig. 6). By 1 August, 16 and 11 of the nests had been started in 1979 and 1980, respectively. No nests were begun after 1 September 1979, while 1 nest was initiated

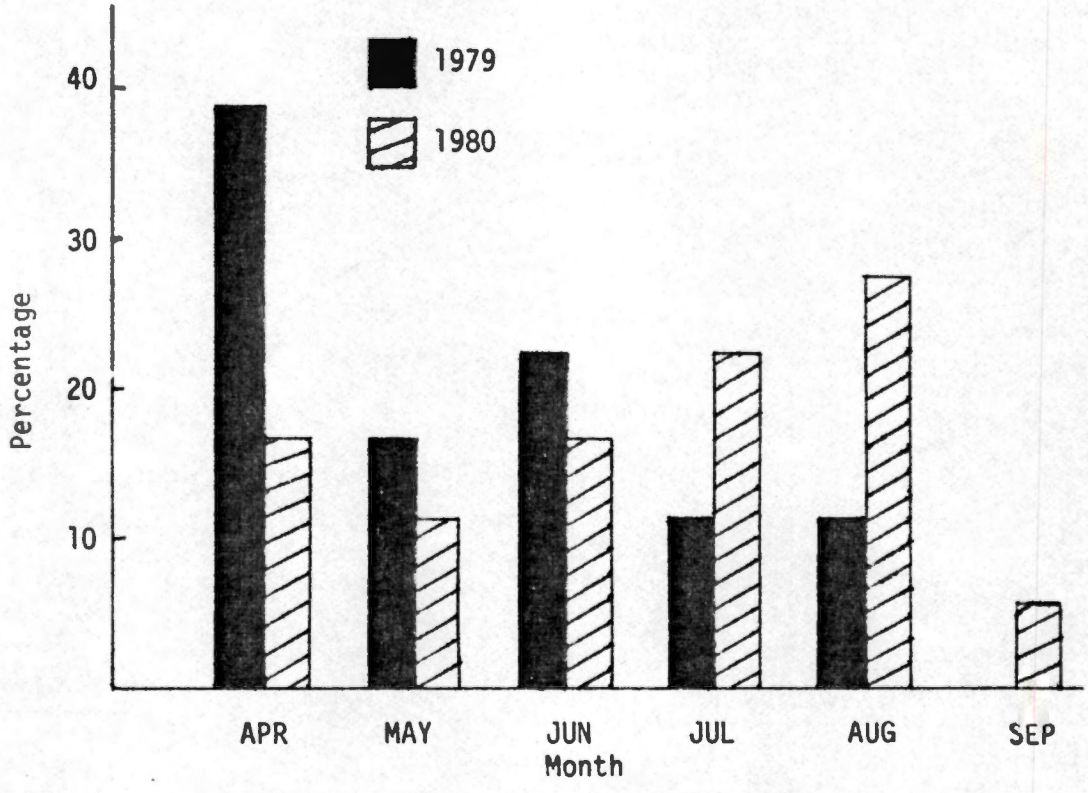


Figure 5. Percentage of nests initiated each month on the rural area in Loudon County, Tennessee. 1979-18 nests, 1980-18 nests.

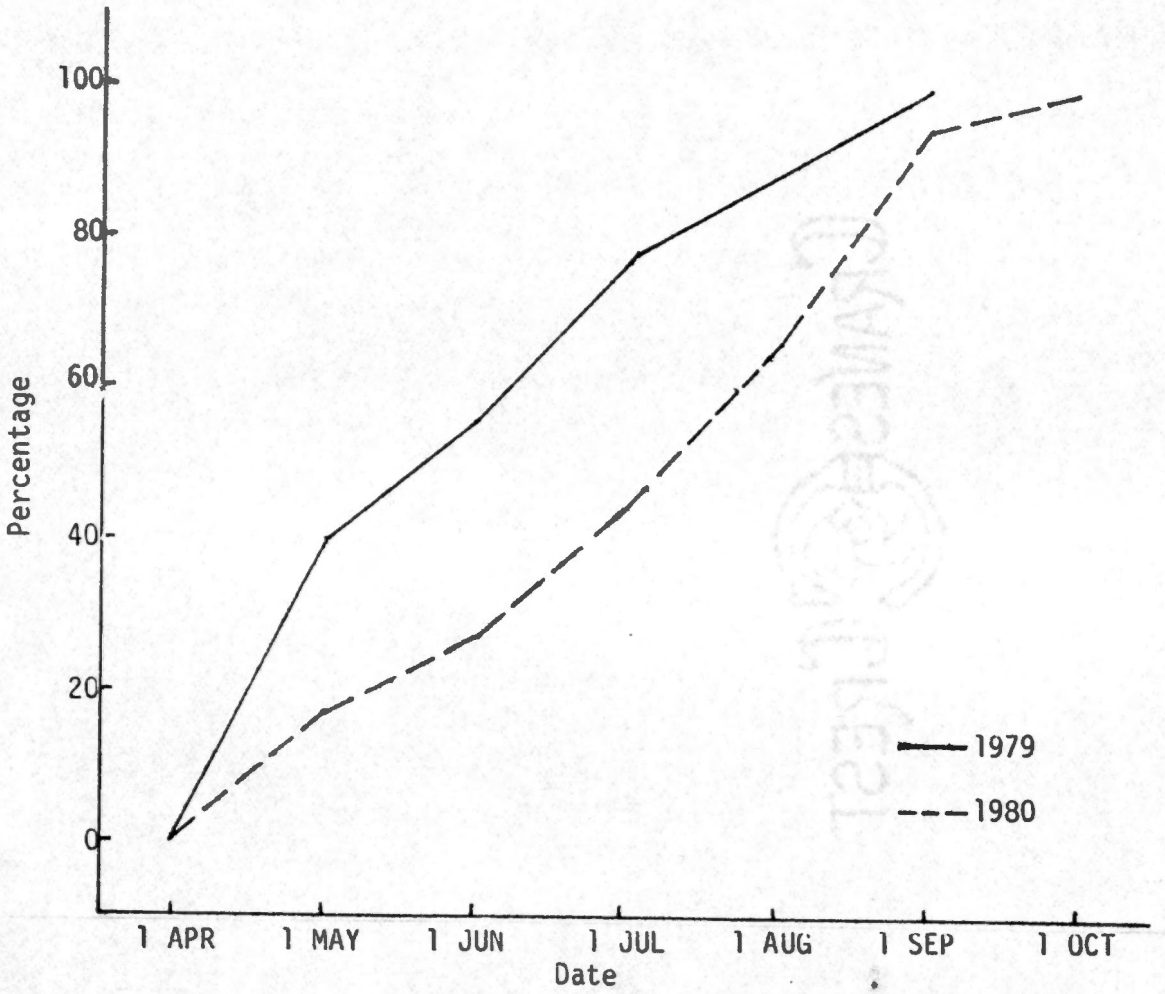


Figure 6. Cumulative percentage of nests initiated on the rural area in Loudon County, Tennessee. 1979-18 nests, 1980-18 nests.

after 1 September 1980. The latest nests were initiated on 3 August 1979 and 2 September 1980.

On the urban area the first nests were initiated on 26 February 1979 and 20 February 1980. Peak periods of nest initiation occurred in March, May, and August during 1979, with the greatest peak occurring in May (Fig. 7). Peak periods of nest initiation during 1980 occurred in March and June. In 1979, 15 of 21 nests were initiated by 1 June, while only 39 of 77 nests were initiated by that date in 1980 (Fig. 8). By 1 August, 17 and 68 of the nests had been initiated in 1979 and 1980, respectively. Only 1 nest was started after 1 September 1979 and no nests were begun after 1 September 1980. The latest nests were initiated on 8 September 1979 and 31 August 1980.

Egg Laying

Six nests were observed on the day the first egg was laid. The second egg of each of these clutches was laid on the successive day. Clutch size varied from 1 to 4 eggs (Table 3). Clutches of 2 eggs predominated, with 91.0% of all clutches containing 2 eggs. However, nests containing 1 egg occasionally occurred on both the rural and urban areas and nests with 3 and 4 eggs occurred on the urban area. The mean clutch sizes for the rural and urban areas were 1.9 eggs and 2.0 eggs, respectively.

Incubation

Of the 6 nests observed on the day the first egg was laid, 5 were incubated for 14 days (considering the day following the laying of the

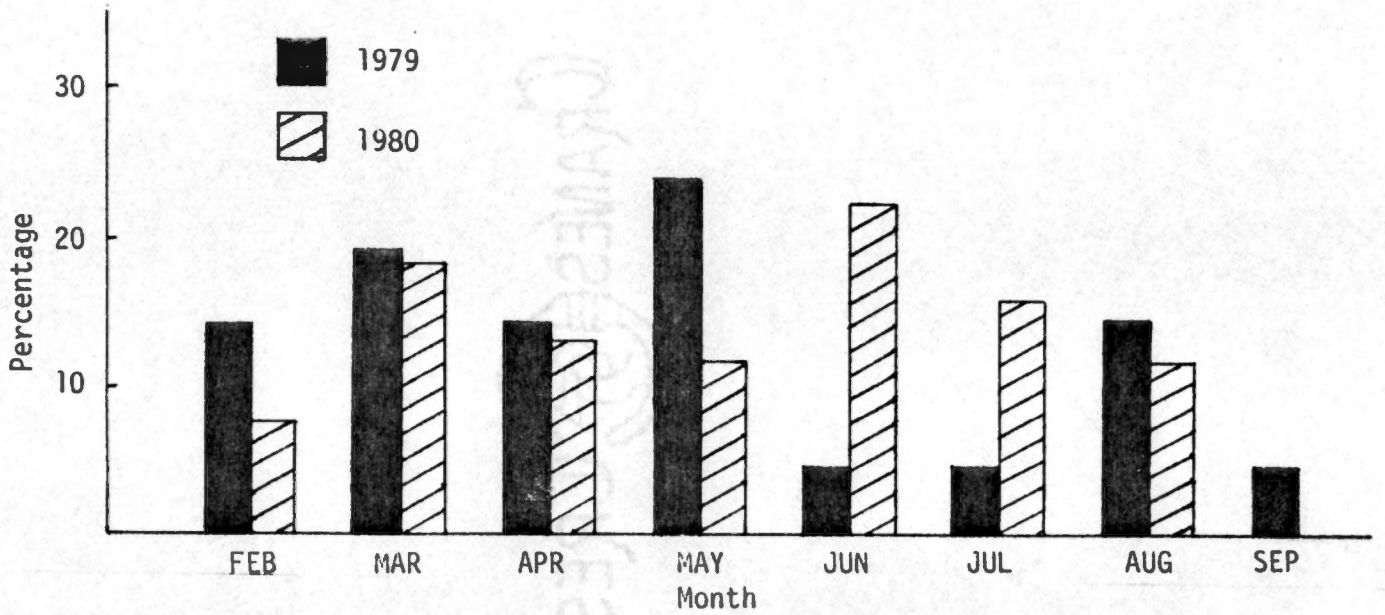


Figure 7. Percentage of nests initiated each month on the urban area in Knox County, Tennessee. 1979-21 nests, 1980-77 nests.

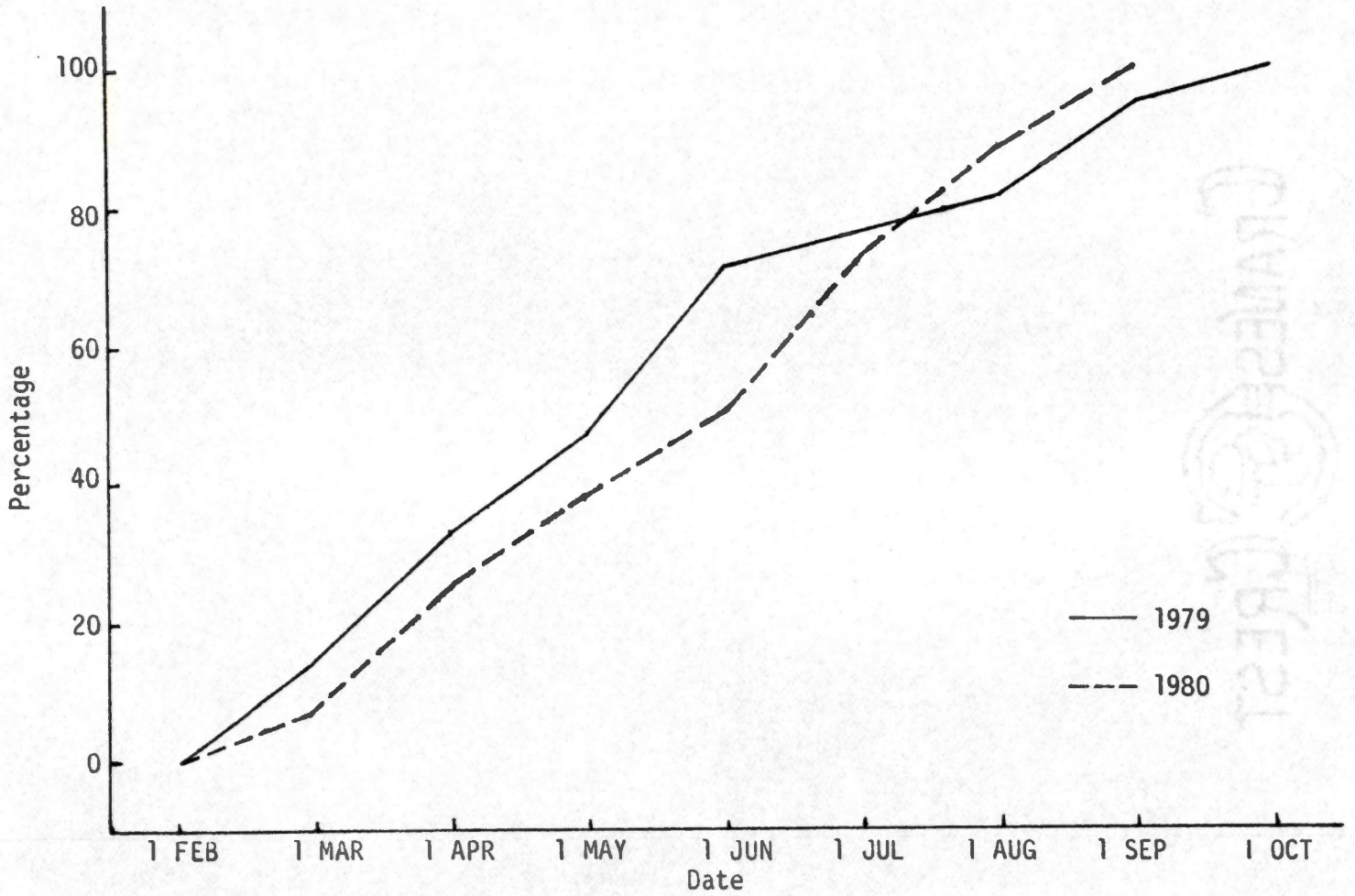


Figure 8. Cumulative percentage of nests initiated on the urban area in Knox County, Tennessee. 1979-21 nests, 1980-77 nests.

Table 3. Clutch size of mourning dove nests on the rural area in Loudon County and the urban area in Knox County, Tennessee, during 1979 and 1980.

Clutch size	Number of clutches							
	Rural area			Urban area			Grand total	Percentage of all clutches
	1979	1980	Total	1979	1980	Total		
1	2	1	3	1	4	5	8	6.0
2	16	17	33	19	70	89	122	91.0
3				1	2	3	3	2.2
4					1	1	1	0.8
Total	18	18	36	21	77	98	134	100.0

first egg the first full day of incubation) and 1 clutch was set for 15 days before the first nestlings hatched. The second egg of all 6 clutches was incubated for 14 days before hatching. Thus, nestlings hatched on successive days in 5 nests and on the same day in 1 nest.

Hatching

On the rural area the first eggs hatched on 21 April 1979 and 12 May 1980. In 1979 peak periods of hatching occurred in April and June, while in 1980 peak hatching occurred in August (Fig. 9). During 1979, 15 of the 19 eggs that hatched had hatched by 1 July, whereas only 3 of 22 eggs had hatched by that date during 1980 (Fig. 10). By 1 August, 17 and 8 of the eggs had hatched in 1979 and 1980, respectively. No eggs hatched after 1 September 1979, but 6 eggs hatched after 1 September 1980. The last eggs hatched on 15 August 1979 and 16 September 1980.

On the urban area the first eggs hatched on 12 March 1979 and 6 March 1980. In 1979 the greatest peak in hatching occurred in March, followed by a small peak in July (Fig. 11). In 1980 peak periods of hatching occurred in April, May, and July. In 1979, 24 of the 33 eggs that hatched had hatched by 1 June, while only 51 of 103 eggs had hatched by that date in 1980 (Fig. 12). By 1 August, 30 and 84 of the eggs had hatched in 1979 and 1980, respectively. One egg hatched after 1 September 1979, while 8 eggs hatched after 1 September 1980. The last eggs hatched on 22 September 1979 and 13 September 1980.

Brooding

When a nest was visited, an adult was nearly always found brooding the young up until about the tenth day after hatching. However,

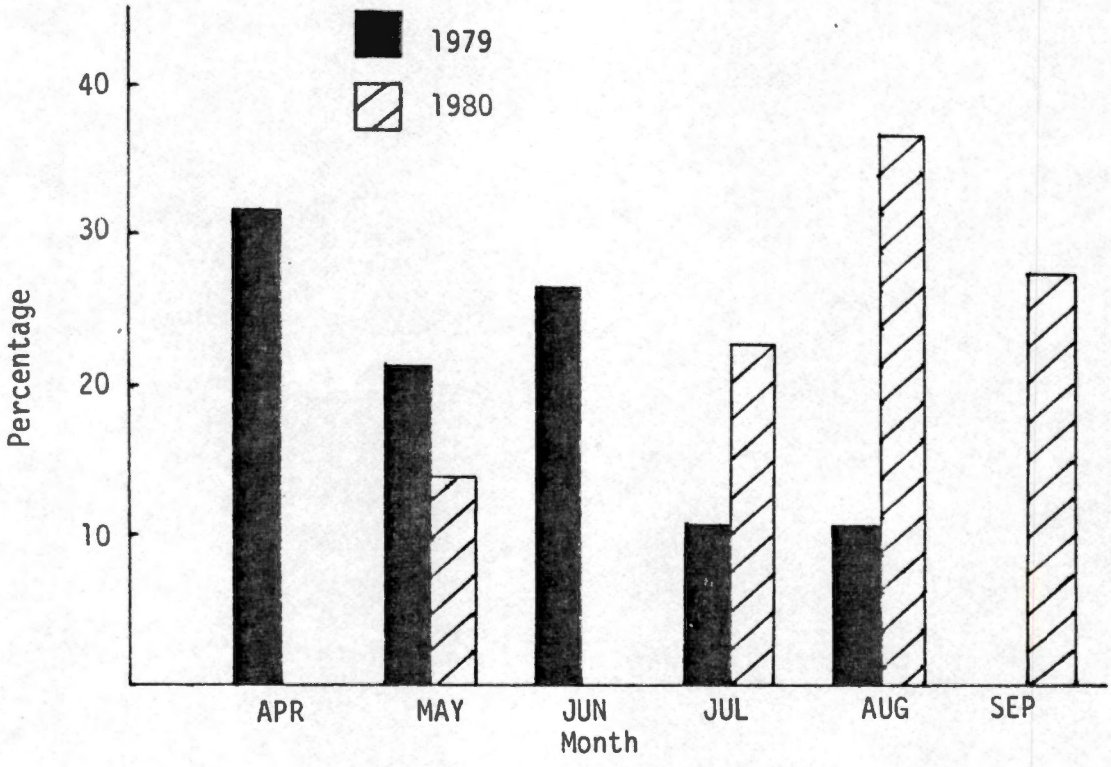


Figure 9. Percentage of eggs hatched each month on the rural area in Loudon County, Tennessee. 1979-19 eggs, 1980-22 eggs.

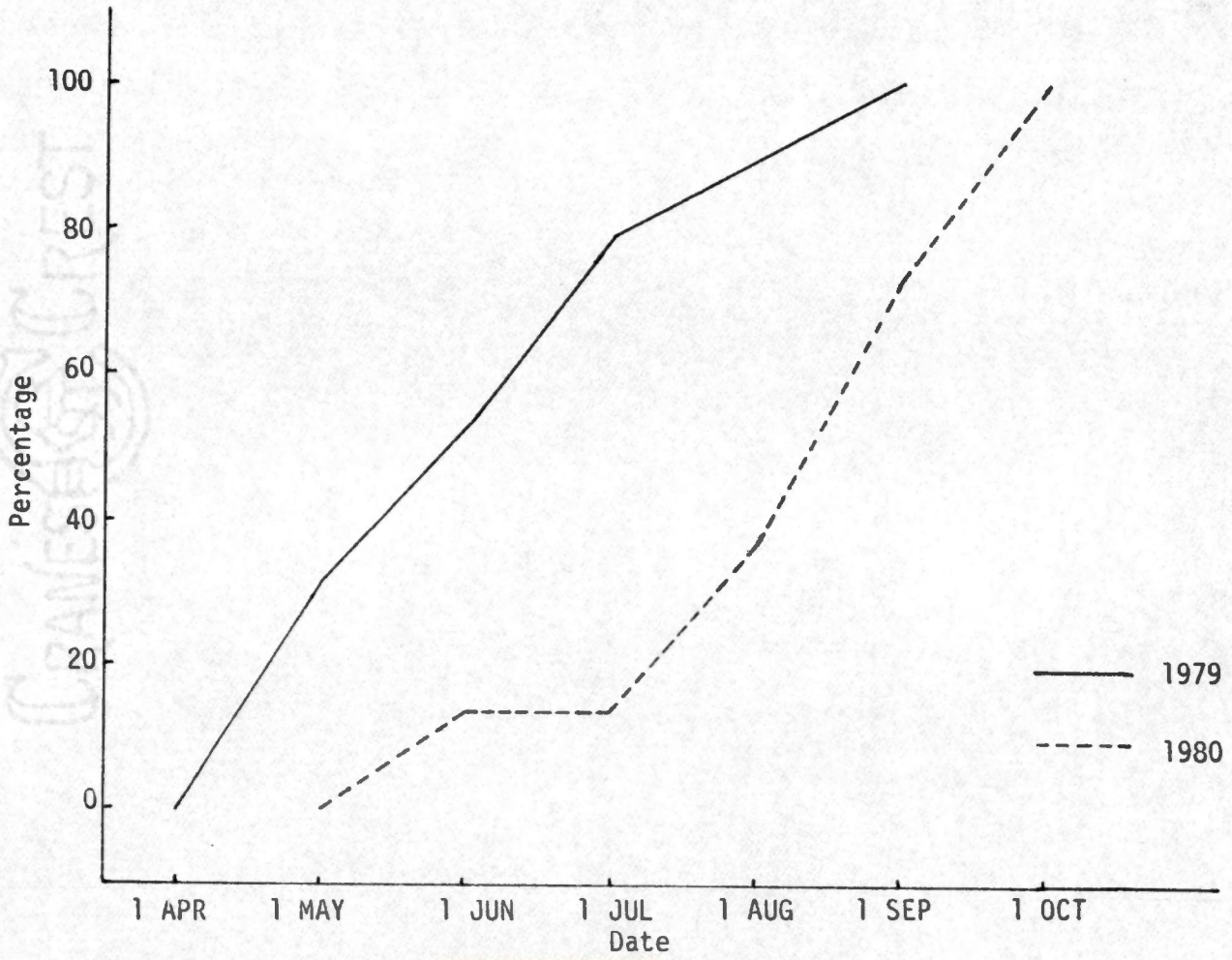


Figure 10. Cumulative percentage of eggs hatched on the rural area in Loudon County, Tennessee. 1979 - 19 eggs, 1980 - 22 eggs.

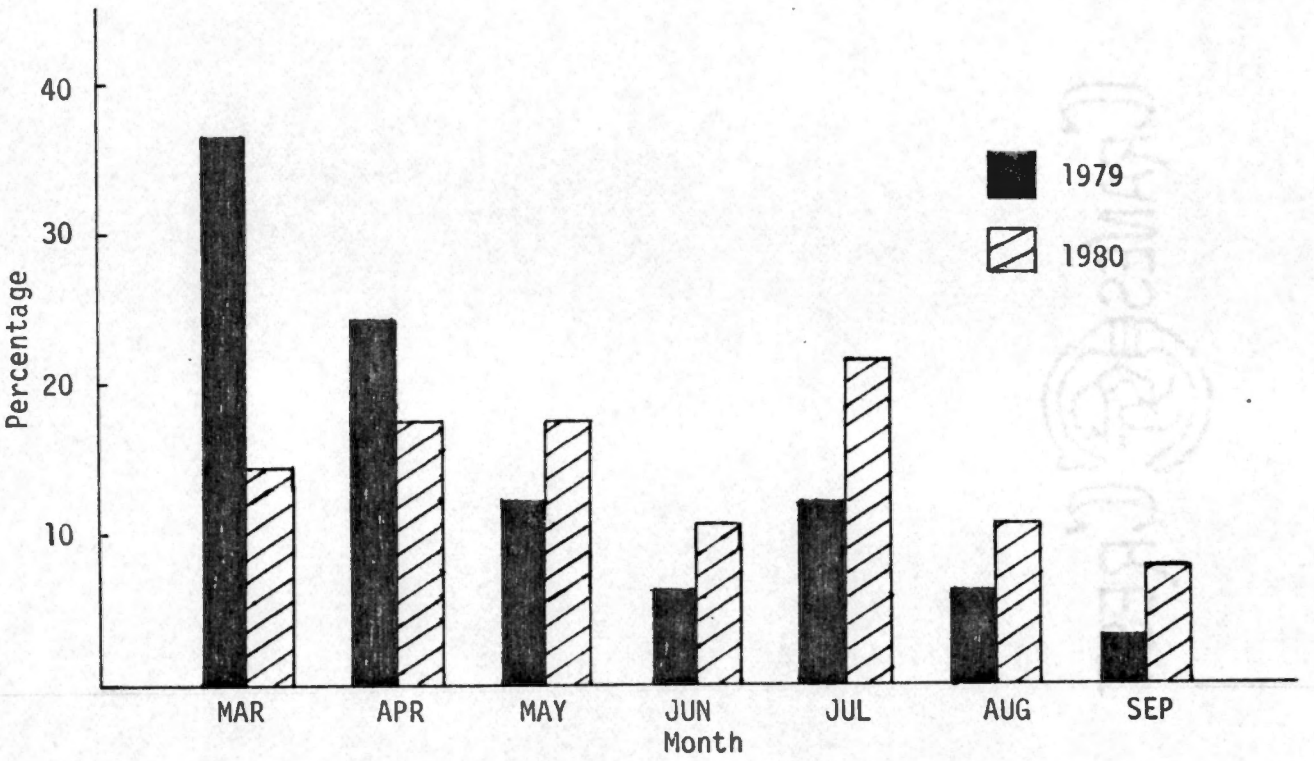


Figure 11. Percentage of eggs hatched each month on the urban area in Knox County, Tennessee. 1979 - 33 eggs, 1980 - 103 eggs.

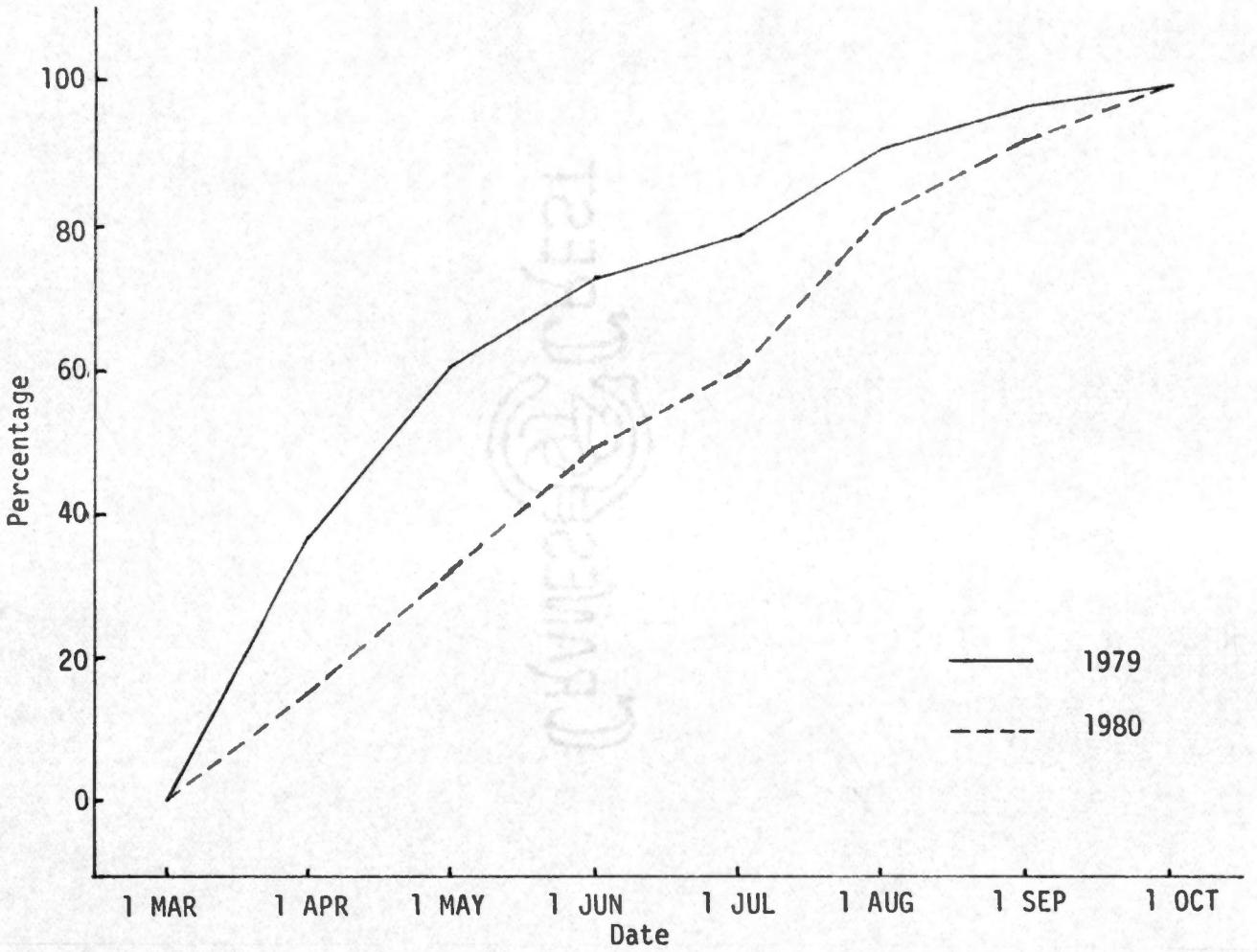


Figure 12. Cumulative percentage of eggs hatched on the urban area in Knox County, Tennessee. 1979 - 33 eggs, 1980 - 103 eggs.

there was no adult present once when the nestlings were 6 days old, twice when they were 8 days old, and once when they were 9 days old. Adults were often absent from the nest after the nestlings were about 10 days old.

Nestlings remained in the nest from 12 to 15 days on the rural area and from 12 to 17 days on the urban area (Table 4). The mean lengths of the nestling periods on the rural area were 13.0 days in 1979 and 13.5 days in 1980. On the urban area the mean lengths of the nestling periods were 14.6 days in 1979 and 14.1 days in 1980.

Fledging

The first young fledged on the rural area on 2 May 1979 and 26 May 1980. During 1979 a major peak in fledging occurred in May with a minor peak occurring in July (Fig. 13). During 1980 peak fledging occurred in September. In 1979, 8 of 13 young had fledged by 1 July, while only 3 of 20 young had fledged by that date in 1980 (Fig. 14). By 1 August, 11 and 7 of the young had fledged in 1979 and 1980, respectively. In 1979 no young fledged after 1 September, but in 1980, 7 fledged after that date. Of the 7 young to fledge in September 1980, 5 left the nest after 15 September. The latest fledgings occurred on 27 August 1979 and 30 September 1980.

On the urban area the first young fledged on 27 March 1979 and 18 March 1980. The months in which the greatest number of fledgings occurred were March, April, and June in 1979, with the greatest peak occurring in April (Fig. 15). During 1980 the months in which most fledgings occurred were April, July, and August, with the greatest peak

Table 4. Number of days that nestlings remained in the nest on the rural area in Loudon County and on the urban area in Knox County, Tennessee, during 1979 and 1980.

Number of days	Number of nests							
	Rural area				Urban area			
	1979	1980	Total	Percentage	1979	1980	Total	Percentage
12	2		2	11.1		2	2	2.8
13	4	5	9	50.0	2	9	11	15.2
14		6	6	33.3	8	29	37	51.4
15	1		1	5.6	5	12	17	23.6
16					2	2	4	5.6
17					1		1	1.4
Total	7	11	18	100.0	18	54	72	100.0

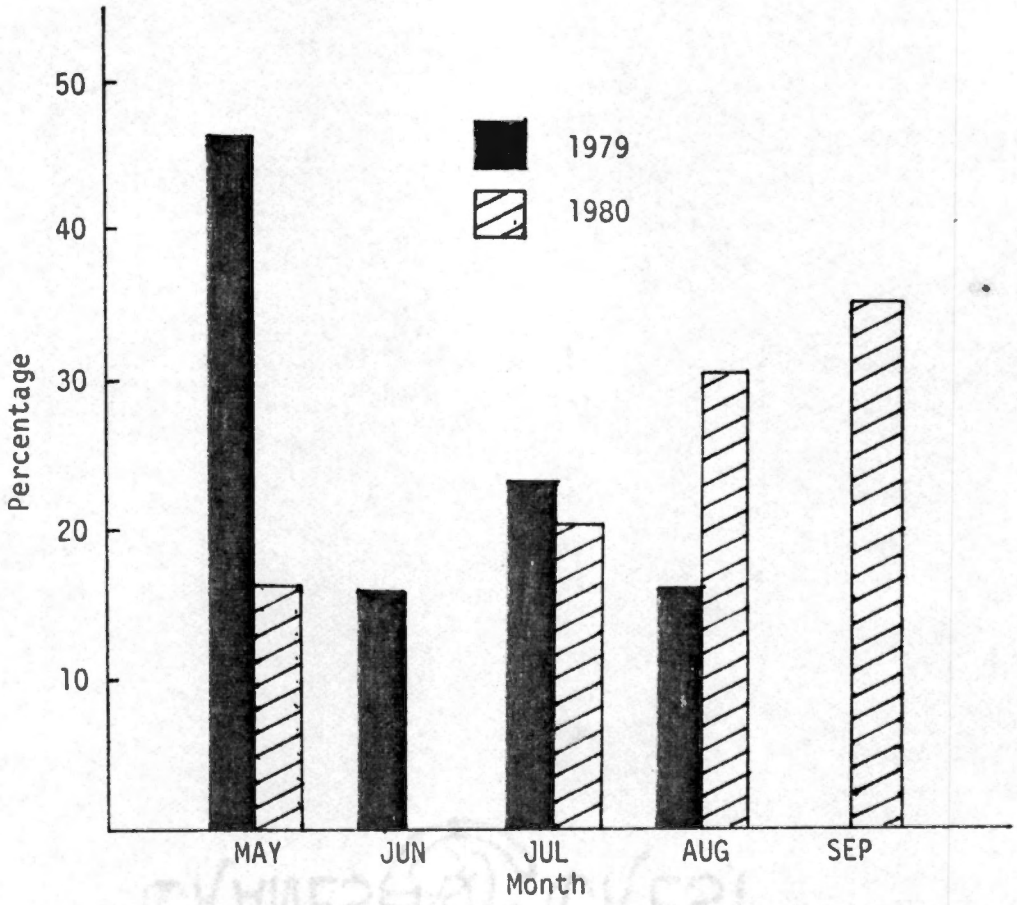


Figure 13. Percentage of young fledged each month on the rural area in Loudon County, Tennessee. 1979 - 13 young, 1980 - 20 young.

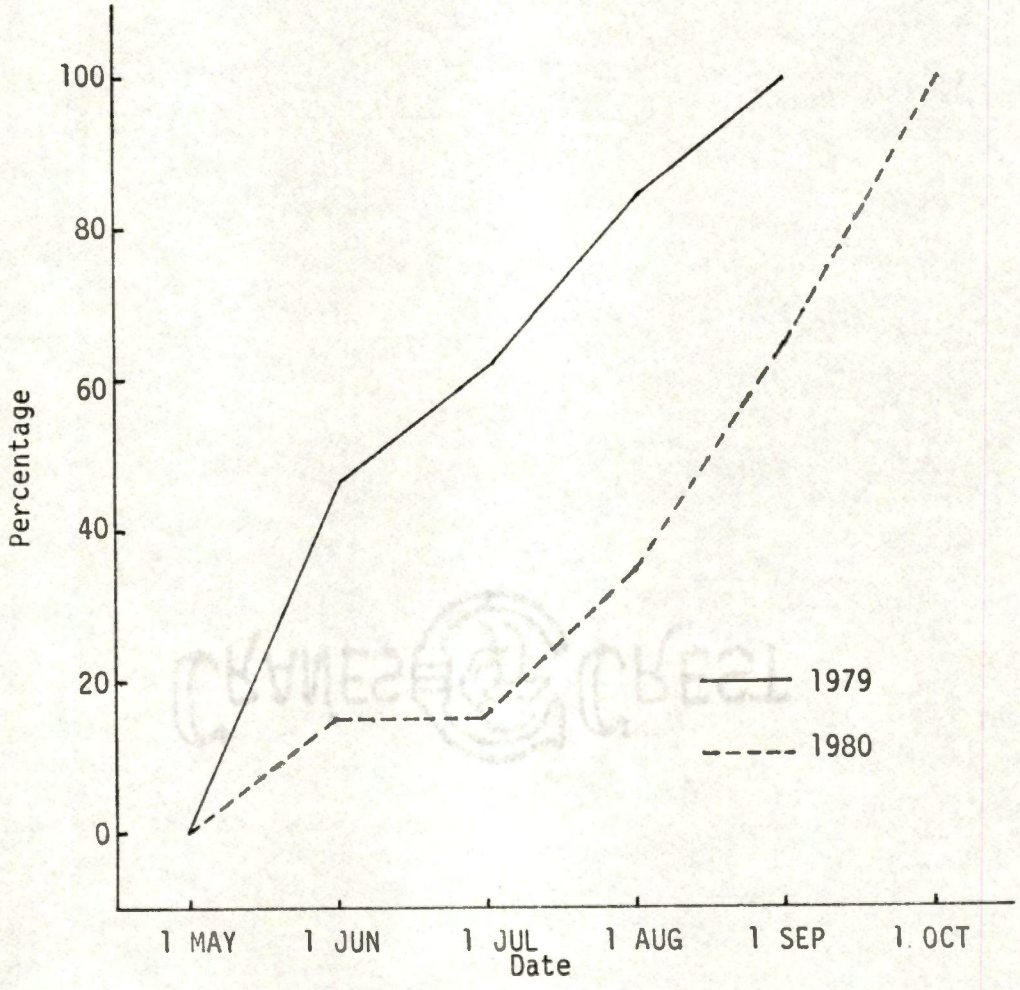


Figure 14. Cumulative percentage of young fledged on the rural area in Loudon County, Tennessee. 1979 - 13 young, 1980 - 20 young.

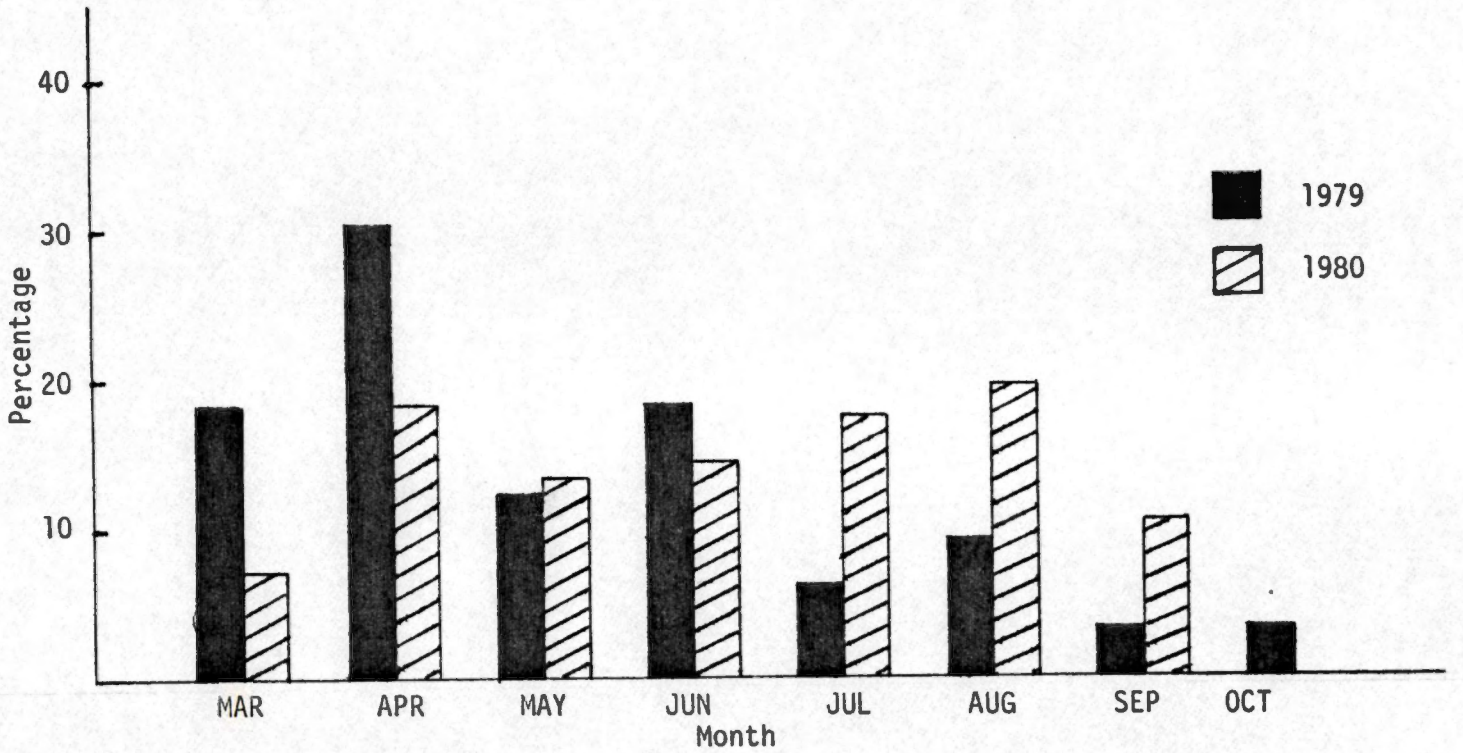


Figure 15. Percentage of young fledged each month on the urban area in Knox County, Tennessee. 1979 - 33 young, 1980 - 98 young.

occurring in August. In 1979, 20 of 33 young had fledged by 1 June, while only 38 of 98 young had fledged by that date in 1980 (Fig. 16). By 1 August, 28 and 69 of the young had fledged in 1979 and 1980, respectively. In 1979, 2 young fledged after 1 September, while in 1980, 10 fledged after 1 September. Of all the young to leave the nest after 1 September, 1 fledged after 15 September 1979 and 8 fledged after 15 September 1980. The latest fledgings occurred on 6 October 1979 and 26 September 1980.

Duration of the Nesting Season

The duration of the nesting season (the time from the first nest initiation until the last fledging) on the rural area was 143 days in 1979 and 183 days in 1980. On the urban area the nesting season extended for 222 days in 1979 and 219 days in 1980. The mourning dove nesting season was 55.2% longer on the urban area than on the rural area during 1979 and 19.7% longer during 1980.

II. NESTING SUCCESS

Success of Eggs and Nestlings

On the rural area 59.4% of the eggs that were laid hatched. Only 1 (2.4%) of the eggs that were not destroyed on this area failed to hatch. On the urban area 69.4% of the eggs that were laid hatched. Fourteen (9.3%) of the eggs that were not destroyed on this area failed to hatch.

On the rural area 80.5% of the eggs that hatched resulted in young that fledged. On the urban area 96.3% of the eggs that hatched

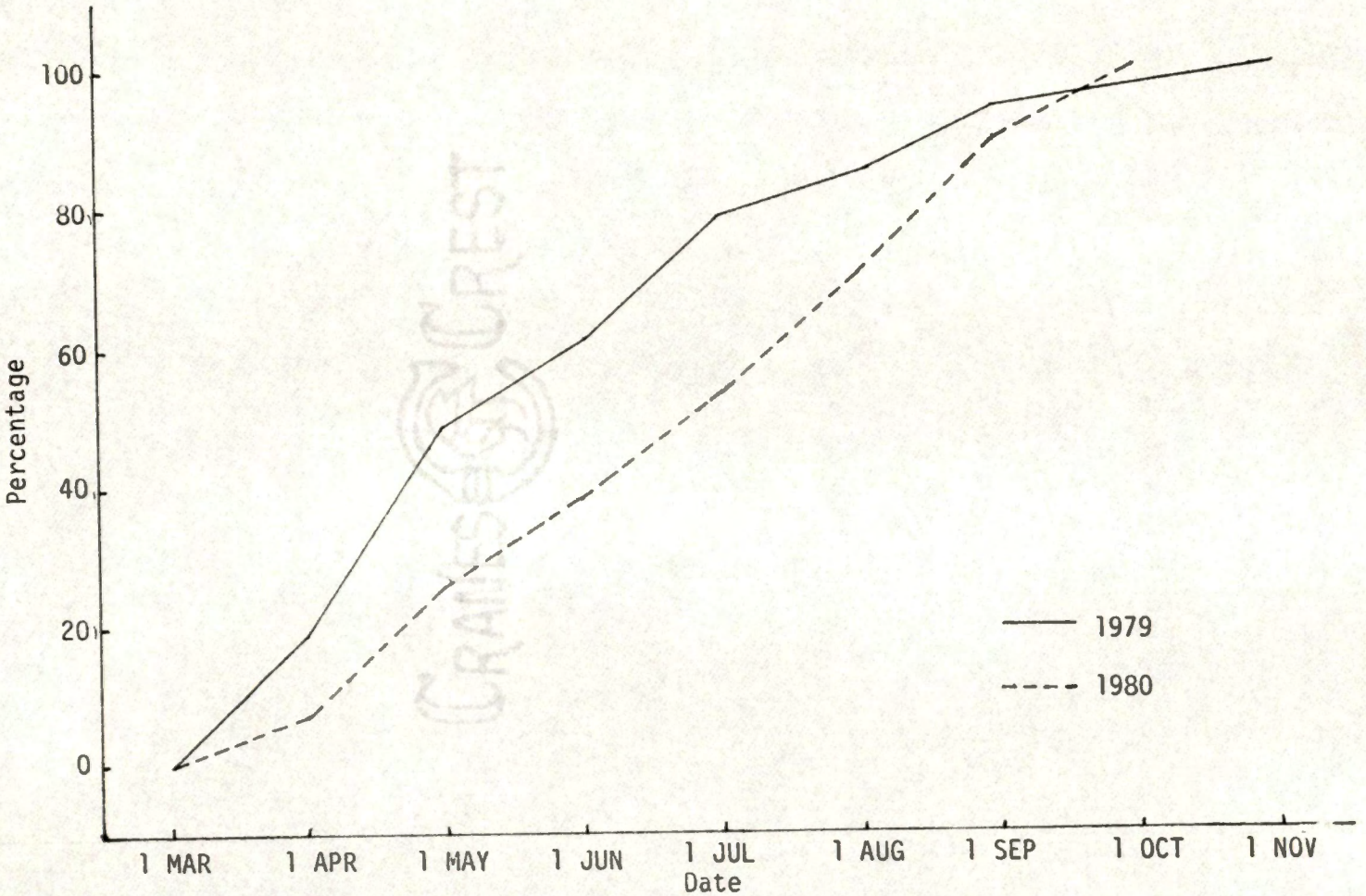


Figure 16. Cumulative percentage of young fledged on the urban area in Knox County, Tennessee. 1979 - 33 young, 1980 - 98 young.

resulted in young that fledged. The proportion of eggs lost was considerably greater than the proportion of nestlings lost on both the rural and urban area during both nesting seasons (Table 5).

Nest Success

During this study a nest was considered successful if at least 1 young fledged. On the rural area 38.9% of the nests in 1979 and 61.1% in 1980 were successful. Nest success on the urban area was 85.7% in 1979 and 70.1% in 1980. Nest success was 120.3% greater on the urban area than on the rural area during 1979 but only 14.7% greater during 1980 (Table 6).

Seasonal Nest Success

Nest success during the first half of the nesting season on the rural area was 28.6% in 1979 and 25.0% in 1980, while during the second half of the nesting season nest success was 75.0% in 1979 and 90.0% in 1980. On the urban area nest success during the first half of the season was 86.7% in 1979 and 69.2% in 1980, while during the last half of the season nest success was 83.3% in 1979 and 71.1% in 1980. Nest success was substantially greater during the second half of the nesting season on the rural area during both years, but early and late season nest success on the urban area was essentially the same (Table 7).

Causes of Nest Failures

Known factors causing nest failures included weather, predation, and desertion (Table 8), but causes for most nest failures were undetermined due to lack of evidence at the nest site. Most (86.4%) nests

Table 5. Success of mourning dove eggs and nestlings on the rural area in Loudon County and the urban area in Knox County, Tennessee, during 1979 and 1980.

Area and year	Eggs laid	Eggs hatched		Young fledged	
		Number	Percentage	Number	Percentage of eggs hatched
Rural					
1979	34	19	55.9	13	68.4
1980	35	22	62.9	20	90.9
Total	69	41	59.4	33	80.5
Urban					
1979	42	33	78.6	33	100.0
1980	154	103	66.9	98	95.1
Total	196	136	69.4	131	96.3
Total	265	177	66.8	164	92.7

Table 6. Mourning dove nest success on the rural area in Loudon County and the urban area in Knox County, Tennessee, during 1979 and 1980.

Area	Number of nests		Number of successful nests		Percentage nest success	
	1979	1980	1979	1980	1979	1980
Rural						
Area 1	11	6	3	3	27.3	50.0
Area 2	7	12	4	8	57.1	66.7
Total	18	18	7	11	38.9	61.1
Urban						
Campus	21	34	18	23	85.7	67.7
Triangle		43		31		72.1
Total	21	77	18	54	85.7	70.1
Total	39	95	25	65	64.1	68.4

Table 7. Seasonal mourning dove nest success on the rural area in Loudon County and the urban area in Knox County, Tennessee, during 1979 and 1980.

Area and season	Number of nests		Number of successful nests		Percentage nest success	
	1979	1980	1979	1980	1979	1980
Rural						
Apr-Jun	14	8	4	2	28.6	25.0
Jul-Sep	4	10	3	9	75.0	90.0
Total	18	18	7	11	38.9	61.1
Urban						
Feb-May	15	39	13	27	86.7	69.2
Jun-Sep	6	38	5	27	83.3	71.1
Total	21	77	18	54	85.7	70.1

Table 8. Causes of mourning dove nest failures on the rural area in Loudon County and the urban area in Knox County, Tennessee, during 1979 and 1980.

	Number of nest failures							
	Rural area				Urban area			
Cause	1979	1980	Total	Percentage	1979	1980	Total	Percentage
Unknown	5	6	11	61.1		7	7	26.9
Predation	4	1	5	27.8	2	9	11	42.3
Weather	2		2	11.1		2	2	7.7
Desertion					1	5	6	23.1
Total	11	7	18	100.0	3	23	26	100.0

were lost during incubation. Most commonly failures represented loss of both eggs with no disturbance of the nest structure.

While 5 of the 18 nest losses on the rural area were known to be caused by predators, it is highly probable that many of the other failures were also due to predation. Avian predation was most easily recognized on the rural area, while snakes were probably responsible for many of the failures attributed to "unknown" causes. Snakes typically consume eggs in their entirety, leaving neither shall fragments nor disturbed nest structures. Black racers (Coluber constrictor) and black rat snakes (Elaphe obsoleta) were frequently encountered in the fencerows at heights at which dove nests commonly occurred. Predators were responsible for 11 of the 26 nest failures on the urban area. Avian predators were responsible for 8 of these losses, while house cats (Felis catus) were believed to have destroyed the remainder.

Heavy rain was also responsible for nest failures. Some nests were completely washed out and the remains found on the ground. High winds were not thought to be a major cause of nest losses.

Nest desertion was observed only on the urban area; causes for abandonments were not known. Frequent interactions with other nesting pairs may have been at least partly responsible.

III. PRODUCTION

Nesting Density

Mourning doves initiated 18 nests on the rural area and 21 nests on the urban area during 1979. During 1980, 18 nests were initiated on

the rural area and 77 on the urban area. The nesting density on the rural area was 1.6 nests per 20 ha during both nesting seasons. On the urban area the nesting was 11.6 nests per 20 ha in 1979 and 34.1 nests per 20 ha in 1980. The nesting density was 7.3 times greater on the urban area than on the rural area in 1979 and 21.3 times greater in 1980 (Table 9).

Estimates of the minimum number of breeding pairs of mourning doves on the rural and urban areas were determined from the greatest number of different nests that were active during any 1 weekly period of the nesting season (Harris et al. 1963). The density of breeding pairs on the rural area was 0.5 pairs per 20 ha during both nesting seasons. On the urban area the density of breeding pairs was 3.3 pairs per 20 ha in 1979 and 7.1 pairs per 20 ha in 1980 (Table 9).

Production per Nest Attempt

On the rural area 38.2% and 57.1% of the eggs laid in 1979 and 1980, respectively, resulted in young that fledged. Young were produced from 78.6% and 63.6% of the eggs laid in 1979 and 1980, respectively, on the urban area (Table 10).

Production on the rural area was 0.7 young per nest attempt in 1979 and 1.1 young per nest attempt in 1980. On the urban area production was 1.6 young per nest attempt in 1979 and 1.3 young per nest attempt in 1980 (Table 10).

While most nests fledged broods of 2 young, broods of 1 young fledged from 14 nests and 1 nest fledged a brood of 3. There was a production of 1.8 young per successful nest on both the rural and urban areas during both nesting seasons.

Table 9. Mourning dove nesting density on the rural area in Loudon County and the urban area in Knox County, Tennessee, during 1979 and 1980.

	Number of nests		Breeding pairs		Nests per 20 ha		Breeding pairs per 20 ha	
Area	1979	1980	1979	1980	1979	1980	1979	1980
Rural								
Area 1	11	6			1.7	0.9		
Area 2	7	12			1.5	2.6		
Total	18	18	6	5	1.6	1.6	0.5	0.5
Urban								
Campus	21	34			11.6	18.8		
Triangle		43				95.6		
Total	21	77	6	16	11.6	34.1	3.3	7.1

Table 10. Mourning dove production of young per 100 eggs laid and per nest attempt on the rural area in Loudon County and the urban area in Knox County, Tennessee, during 1979 and 1980.

	Number of young fledged		Young fledged per 100 eggs laid		Young fledged per nest attempt	
Area	1979	1980	1979	1980	1979	1980
Rural						
Area 1	5	5	25.0	41.7	0.5	0.8
Area 2	8	15	57.1	65.2	1.1	1.3
Total	13	20	38.2	57.1	0.7	1.1
Urban						
Campus	33	42	78.6	62.7	1.6	1.2
Triangle		56		64.4		1.3
Total	33	98	78.6	63.6	1.6	1.3
Total	46	118	60.5	62.4	1.2	1.2

Production per Breeding Pair

On the rural area mourning doves made 3.0 nest attempts per pair during 1979 and 3.6 nest attempts per pair during 1980. The average number of successful nests per pair was 1.2 in 1979 and 2.2 in 1980, which resulted in the production of 2.2 young per pair in 1979 and 4.0 young per pair in 1980 (Table 11).

Mourning doves on the urban area initiated 3.5 nests per pair in 1979 and 4.8 nests per pair in 1980. There were 3.0 successful nests per pair in 1979 and 3.4 successful nests per pair in 1980, which resulted in the production of 5.5 young per pair in 1979 and 6.1 young per pair in 1980 (Table 11). During 1979, 3.3 more young per pair were produced on the urban area than on the rural area and during 1980, 2.1 more young per pair were produced on the urban area than on the rural area.

Production Density

The production densities on the rural area were 1.2 young per 20 ha in 1979 and 1.8 young per 20 ha in 1980. On the urban area the production densities were 18.2 young per 20 ha in 1979 and 43.4 young per 20 ha in 1980 (Table 12). In 1979 the number of young fledged per 20 ha on the urban area was more than 15 times greater than the number fledged on the rural area. In 1980 the number of young fledged per 20 ha was over 24 times greater on the urban area than on the rural area.

Table 11. Mourning dove production of young per breeding pair on the rural area in Loudon County and the urban area in Knox County, Tennessee, during 1979 and 1980.

Area and year	Number of pairs	Nest attempts per pair	Successful nests per pair	Young produced per pair
Rural				
1979	6	3.0	1.2	2.2
1980	5	3.6	2.2	4.0
Urban				
1979	6	3.5	3.0	5.5
1980	16	4.8	3.4	6.1

Table 12. Density of mourning dove production of young on the rural area in Loudon County and the urban area in Knox County, Tennessee, during 1979 and 1980.

Area	Number of young fledged		Young fledged per 20 ha	
	1979	1980	1979	1980
Rural				
Area 1	5	5	0.8	0.8
Area 2	8	15	1.7	3.3
Total	13	20	1.2	1.8
Urban				
Campus	33	42	18.2	23.2
Triangle		56		124.4
Total	33	98	18.2	43.4

IV. NESTING HABITAT

Habitat Utilization

Mourning doves nested in all 3 habitat types searched on the rural area during both nesting seasons. Most (72.2%) nests were located in wooded fencerows, with 22.2% and 5.6% occurring in woodland edges and old fields, respectively (Table 13).

Nearly all (94.9%) of the nests on the urban area were in ornamental landscape plantings (Table 13). Only 5.1% of the nests occurred in the natural area along Third Creek.

Vegetation Utilized

Eight different species of vegetation were used for nest sites by mourning doves on the rural area during 1979, while 6 species were used during 1980 (Table 14). The greatest number of nests occurred in hackberry trees (38.9%) in 1979 and in eastern redcedars (61.1%) in 1980. Eastern redcedar was the only evergreen species utilized for nesting on the rural area. Nearly all (90.9%) of the nests in deciduous trees were located in dense growths of honeysuckle.

Mourning doves nested in 12 different species of plants on the urban area during 1979 and in 20 different species in 1980 (Table 15). During 1979 there seemed to be no preference for any particular species of vegetation, with no more than 3 nests occurring in any species. However, during 1980 white pine (*Pinus strobus*) and Chinese juniper (*Juniperus chinensis*) were the most used species, with 27.3% of the nests occurring in white pines and 23.4% in Chinese junipers. Seventeen of

Table 13. Habitat types utilized for nesting by mourning doves on the rural area in Loudon County and the urban area in Knox County, Tennessee, during 1979 and 1980.

Area and habitat type	Number of nests			
	1979	1980	Total	Percentage
Rural area				
Wooded fencerow	15	11	26	72.2
Woodland edge	2	6	8	22.2
Old field	1	1	2	5.6
Total	18	18	36	100.0
Urban area				
Landscape plantings	18	75	93	94.9
Natural area	3	2	5	5.1
Total	21	77	98	100.0

Table 14. Species of vegetation used for nest sites by mourning doves on the rural area in Loudon County, Tennessee, during 1979 and 1980.

Species of vegetation	Number of nests		
	1979	1980	Total
Eastern redcedar	3	11	14
Hackberry	7	3	10
Sassafras	2	1	3
Ash (*Fraxinus* sp.)	1	1	2
Honey locust (*Gleditsia triacanthos*)	1	1	2
Sourwood	1	1	2
American elm	2		2
Black locust	1		1
Total	18	18	36

Table 15. Species of vegetation used for nest sites by mourning doves on the urban area in Knox County, Tennessee, during 1979 and 1980.

Species of vegetation	Number of nests		
	1979	1980	Total
White pine		21	21
Chinese juniper		18	18
Hackberry		7	7
Autumn elaeagnus (Elaeagnus umbellata)	1	6	7
Canadian hemlock (Tsuga canadensis)	3	3	6
Viburnum (Viburnum siboldi)	3	1	4
Eastern redcedar		3	3
Chinese holly (Ilex cornuta)	1	2	3
Yaupon holly (Ilex vometoria)	2	1	3
Norway spruce (Picea abies)		3	3
Scotch pine (Pinus sylvestris)		3	3
Privet (Ligustrum vulgare)	2		2
Boxwood (Buxux sempervirens)	2		2
Black walnut (Juglans nigra)	2		2
China fir (Cunninghamia lanceolata)	1	1	2
American holly (Ilex opaca)	2		2
Callery pear (Pyrus calleryana)	1		1
Japanese honeysuckle	1		1
Southern magnolia (Magnolia grandiflora)		1	1
Arizona cypress (Cupressus arizonica)		1	1
Colorado blue spruce (Picea pungens)		1	1
Multiflora rose		1	1
River birch (Betula nigra)		1	1
Japanese ligustrum (Ligustrum japonicum)		1	1
Smoke tree (Cotinus coggyria)		1	1
California incense cedar (Libcedrus decurrens)		1	1
Total	21	77	98

the 26 species of vegetation utilized were evergreen species and 78 (79.6%) of the nests were located in these plants. Most of the nests were located in trees (55.1%); however, a substantial proportion was located in shrubs (43.9%). One nest was found in honeysuckle vines growing on a chain-link fence.

Nest Height

Mourning dove nests on the rural area ranged in height from 1.8 m to 6.1 m above the ground. Most nests were located between 1.0 m and 4.0 m above the ground (Table 16). The mean height of dove nests on this area was 2.8 m.

On the urban area mourning dove nests ranged in height from 0.9 m to 7.6 m above the ground. A majority of these nests were also between 1.0 m and 4.0 m above the ground (Table 17). The mean height of mourning dove nests on this area was 2.7 m.

Secondary Use of Nest Structures

Annual use of nest sites. Nest sites were occasionally used during both nesting seasons, although the actual nest structures did not always remain intact until the second year. On the rural area 3 (16.7%) of 18 nests in 1980 were located in sites also used in 1979. On the urban area 4 (11.8%) of 34 nests in 1980 occurred in 1979 sites.

Use of nest structures of other species. Mourning doves used only nest structures they constructed on the rural area. However, they occasionally utilized nest structures of other species on the urban areas.

Table 16. Height of mourning dove nests on the rural area in Loudon County, Tennessee, during 1979 and 1980.

Nest height (meters)	Number of nests			Percentage of nests		
	1979	1980	Total	1979	1980	Total
0.0 - 1.0						
1.1 - 2.0	2	3	5	11.1	16.7	13.8
2.1 - 3.0	12	9	21	66.6	50.0	58.3
3.1 - 4.0	2	4	6	11.1	22.2	16.7
4.1 - 5.0		2	2		11.1	5.6
5.1 - 6.0	1		1	5.6		2.8
6.1 - 7.0	1			5.6		2.8
Total	18	18	36	100.0	100.0	100.0

Table 17. Height of mourning dove nests on the urban area in Knox County, Tennessee, during 1979 and 1980.

Nest height (meters)	Number of nests			Percentage of nests		
	1979	1980	Total	1979	1980	Total
0.0 - 1.0		1	1		1.3	1.0
1.1 - 2.0	2	30	32	9.5	38.9	32.7
2.1 - 3.0	9	16	25	42.9	20.8	25.5
3.1 - 4.0	7	21	28	33.3	37.3	28.6
4.1 - 5.0	2	6	8	9.5	7.8	8.2
5.1 - 6.0		2	2		2.6	2.0
6.1 - 7.0		1	1		1.3	1.0
7.1 - 8.0	1		1	4.8		1.0
Total	21	77	98	100.0	100.0	100.0

Nest structures built by robins (Turdus migratorius) were used twice and a nest structure built by mockingbirds (Mimus polyglottos) was used once. New nest material was added to 1 of the robin nest structures and to the mockingbird nest structure by the mourning doves before any eggs were laid.

Reuse of nest structures. Mourning doves occasionally nested in nest structures previously used during the same nesting season on both the rural and urban areas (Table 18). On the rural area only 1 (2.9%) nest structure was used twice and none were used any more than this. On the urban area 12 (16.2%) nest structures were used twice, 3 (4.1%) were used 3 times, and 2 (2.7%) were used 4 times.

Intervals between the completion of 1 nest attempt and the initiation of the next clutch for 20 nests in nest structures previously containing successful nests ranged from 5 to 95 days. Thirteen (65.0%) of these intervals were between 5 and 15 days, with a mean of 8.8 days. Nests in nest structures previously containing successful nests were 80.0% successful.

Five (20.0%) nests occurred in nest structures which previously held unsuccessful nests. The intervals between these nests ranged from 15 to 135 days. Three (60.0%) were successful.

Table 18. Number of mourning dove nests per nest structure on the rural area in Loudon County and the urban area in Knox County, Tennessee, during 1979 and 1980.

Number of nests per nest structure	Number of nest structures							
	Rural area			Urban area			Grand Total	Percentage of all nest structures
	1979	1980	Total	1979	1980	Total		
1	18	16	34	9	48	57	91	83.5
2		1	1	6	6	12	13	11.9
3					3	3	3	2.8
4					2	2	2	1.8
Total	18	17	35	15	59	74	109	100.0

CHAPTER V

DISCUSSION

I. NESTING CHRONOLOGY

Initiation of Nesting

Mourning dove nesting was initiated on the urban area on 26 February 1979 and 20 February 1980. Doves on the rural area began nesting approximately 6 weeks later than the urban doves, with the first nests being initiated on 6 April 1979 and 1 April 1980. Although Cole (1933) demonstrated fairly conclusively that mourning doves respond to increasing day-lengths with a concomittant increase in gonadal development and sexual activity, the marked later dates of initial nesting on the rural area suggest that other factors, such as temperature, winter residency, and social stimuli, may influence the onset of breeding in mourning doves.

The early initiation of nesting on the urban area may have been partially stimulated by ameliorating temperatures at that time during both years. Between 21 and 25 February 1979, minimum nighttime temperatures ranged from 2.8 C to 12.8 C, while during the previous 3 weeks, a minimum temperature above freezing occurred on only 1 night. The first nests in 1979 were initiated immediately following this warm spell. Similarly, between 20 and 24 February 1980, minimum nighttime temperatures ranged from 3.9 C to 12.2 C, while during the previous 3 weeks, a minimum temperature above freezing occurred on only 1 night. However, the first nests in 1980 were initiated during this warm period. Minimum

temperatures did drop below freezing during the latter part of February during both years, and 8.9 cm of snow fell on 1 March 1980. Despite the drop in minimum temperatures during this time, 3 nests were initiated before the end of February 1979, and 6 were started before the end of February 1980. Although a similar relationship between temperature and the initiation of nesting was not as evident on the rural area, one may still have existed. Hanson and Kossack (1963) also suggested that temperature played an important role in controlling the time of dove nesting. Local differences in temperatures may have been partially responsible for the differences in the time of initiation of nesting on the urban and rural areas.

Perhaps the urban dove population consisted of local winter residents while the rural population consisted of migrants, which could explain the earlier initiation of nesting on the urban area. Hanson and Kossack (1963) suggested that the early initiation of nesting in southern Illinois represented the activity of pairs that had wintered in the area. While the breeding population was present on the urban area during February of both years, the breeding population on the rural area may not have been present until March.

Social stimuli provided by the concentrated breeding population on the urban area may have also contributed to the earlier nesting on this area. An experiment with ring doves (Streptopelia roseogrissa) by Lott et al. (1967) showed that stimulation from surrounding pairs was "capable of producing acceleration of reproductive development over and above that induced by day-length and by interaction with the mate." A similar response to surrounding pairs may also occur in mourning doves.

Monthly Nesting Activity

Monthly nesting activity varied considerably between years, especially during the middle of the nesting season. A comparison of the percentage of nests initiated each month (Figs. 5 and 7, pp. 18 and 21) and the departure from normal monthly precipitation and mean monthly temperatures (Fig. 4, p. 15) suggests a relationship between nesting activity and weather conditions. In 1979, above-average temperatures and near-normal precipitation during spring were accompanied by a rapid progression of nesting. But, above-normal rainfall persisted during summer; this was accompanied by a rapid decline in nest initiations. Weather conditions and monthly nesting activity in 1980 were nearly opposite those of 1979. During spring of 1980, below-normal temperatures and above-normal precipitation depressed early nesting activity. Extreme drought and heat during the ensuing summer seemed to have little suppressing effect on nesting activity during this time. Although temperatures were considerably above normal and precipitation below normal during July and August of 1980, a major portion of the nesting activity on both the rural and urban areas occurred during this time (50.0% and 27.3% of all nests during 1980 were initiated during these 2 months on the rural and urban areas, respectively). Doves on both the rural and urban areas seemed to respond similarly to weather conditions, though the urban doves seemed to less affected by the cool, wet spring weather of 1980.

Calling activity of mated birds is known to vary with weather (LaPerriere and Haugen 1972), and results of this study indicated that

the persistence of rainy, overcast weather may have a dramatic effect on nesting activity and subsequently on the number of nest attempts. The generally long nesting season, lasting from early March until October, in the southeast presumably allows doves to make 5 or 6 nest attempts (Southeastern Association of Game and Fish Commissioners 1957). However, results of the present study suggest that doves in Tennessee would rarely make this many nest attempts unless ideal weather prevailed throughout the nesting season. Such weather conditions normally do not often occur and consequently fewer nest attempts are made than are possible. For example, during 1979, there were 3.0 and 3.5 nest attempts per pair on the rural and urban areas, respectively. During 1980, there were 3.6 nest attempts per pair on the rural area and 4.8 nest attempts per pair on the urban area.

Monthly Production of Young

Monthly production of young varied considerably between years and between areas. Peak levels of fledging on the rural area were reached during the months of May and June in 1979 and during September in 1980 (Fig. 13, p. 31). On the urban area, peak fledging periods occurred in April and June in 1979 and April and August 1980 (Fig. 15, p. 33). The difference between the urban and rural areas in the months of greatest production was related to the earlier initiation of the nesting season by the urban doves; highest levels of production were attained roughly 1 month earlier than on the rural area. Prevailing weather may have been responsible for the differences in monthly production between years. As stated earlier, overcast, rainy weather during summer of 1979 may have

curtailed nesting activity of doves on both areas, and, consequently, fewer young were produced late in 1979. Also as previously discussed, the heat wave and drought during summer of 1980 seemed to have no suppressive effects on nesting and, in fact, a major portion of the nesting activity on both areas occurred during July and August of that year; this resulted in a majority of the young being produced late in 1980.

The proportion of annual recruitment which occurs after 1 September is of particular interest due to the opening of mourning dove hunting seasons on 1 September in most states permitting dove hunting. Results of the present study show that this proportion varies widely between years on the same area. For example, while in 1979, no young were produced after 1 September on the rural area, in 1980, 7 (35.0%) young were produced after 1 September on this area. The difference in this proportion was not as pronounced on the urban area, with 2 (6.0%) and 10 (10.2%) young being produced after 1 September 1979 and 1 September 1980, respectively. Monk (1949) reported that 17.2% of the total number of successful broods were produced after 1 September on his study area in Nashville, Tennessee. Harris et al. (1963) stated "where complete data are available it seems clear that nearly 20% of all young fledged from nesting areas leave the nest after 1 September." A more recent review of the literature by the USFWS (1977) has indicated the proportion of young fledged after 1 September to average about 10.0%.

While eggs or nestlings may be in a precarious situation with the opening of the hunting season at this time, it is noteworthy that only 1 (7.1%) of the September nests during this study was unsuccessful, and

this was on the urban area where hunting was not believed to be a factor. Although there was dove hunting on the rural area on 1 September of both years, no dove nests active at this time were affected by this hunting.

Although only a small portion of the annual dove recruitment in east Tennessee is produced after 1 September, and, apparently, this is not highly susceptible to loss due to hunting, the nesting season is still in progress when hunting begins. If the hunting season is postponed until all nesting is completed, the results of this study indicate that the earliest opening date would be 1 October.

Nesting Season Duration

During this study the nesting seasons differed in length between years by as much as 40 days on the rural area, but by only 3 days on the urban area. Various other authors have also found the length of the nesting season to vary among years within the same state (Nice 1923, McClure 1942, Pearson and Moore 1939). The large difference on the rural area was due to the abrupt cessation of nesting by the end of August 1979. This was probably related to the persistence of inclement weather during that summer. Taking this into consideration, one could expect the normal nesting season in Loudon County to extend from early April until the end of September, or for about 180 days. This was similar to the nesting season found by Monk (1949) for doves nesting in Centennial Park in Nashville, Tennessee. Dove nesting in Loudon County is probably fairly typical of dove nesting throughout the Ridge and

Valley region of Tennessee, so this probably could be considered the normal breeding season for this region.

The nesting season on the urban area in Knox County continued much longer than on the rural area. Nesting began in late February and lasted until late September or early October, for an average length of approximately 220 days. The substantially longer duration of the breeding season on the urban area was probably a major factor contributing to the greater productivity of doves on this area.

II. NESTING SUCCESS

Success of Eggs and Nestlings

On the rural area, 59.4% of the eggs that were laid hatched, and 80.5% of the eggs that hatched resulted in young that fledged. On the urban area, 69.4% of the eggs laid hatched, and 96.3% of these resulted in young that fledged. On both the rural and urban areas, the rate of nestling success was over 20.0% greater than the rate of egg success. Thus, mourning dove nestlings appeared to be less vulnerable to decimating factors than were dove eggs. Several authors have reported on this differential vulnerability of eggs and nestlings including Fichter (1959), Harris et al. (1963), and McClure (1942). McClure (1942) attributed the greater success of nestlings to increased parental care during the nestling stage, the tendency for nestlings to cling to the nest, and the added stability of the nest from weight of the young. Also, predators were a major cause of nest failures during this study, and the conspicuous nature of mourning dove eggs may have contributed to their greater vulnerability to predators.

Nest Success

The rate of nest success on the rural area was 38.9% in 1979 and 61.1% in 1980, with a mean of 50.0%. Rates of nest success reported for other areas in the southeast have been 50.0% in North Carolina (Quay 1951), 49.0% in Kentucky (Russell 1954), 52.0% in Tennessee (Monk 1949), 48.5% in Georgia (Hopkins and Odum 1953), and 52.0% in Alabama (Pearson and Moore 1939). An average nest success of about 50.0% has been reported for the southeast (Southeastern Association of Game and Fish Commissioners 1957, USFWS 1977). On the urban area, the rate of nest success was 85.7% in 1979 and 70.1% in 1980, with a mean of 77.9%. Nest success on this area was substantially greater than that on the rural area and the average reported for the southeast. A major factor which may have been responsible for this greater nest success was the presence of fewer nest predators on the campus area.

Seasonal Nest Success

The urban dove population did not show any appreciable difference in early and late season nest success. Soileau (1960) reported similar results for mourning doves nesting in a cemetery in Louisiana. In contrast to the urban area, nest success was substantially greater during the second half of the nesting season on the rural area. A number of other investigators have also reported nest success to be greater late in the nesting season (Hanson and Kossack 1963, Harris et al. 1963, Lund 1952, Monk 1949, Nice 1923, Quay 1951, Sheldon 1957). This higher success of late nests has been attributed to improved weather, a decrease in predation, and increased parental care (Hanson and Kossack 1963, Harris et al. 1963).

III. PRODUCTION

Breeding Density

The difference in breeding densities on the rural and urban areas during this study was striking. Nesting on the Loudon County farmland was dispersed, with a breeding density of 0.5 pairs per 20 ha during both nesting seasons. Nesting on the agricultural campus was concentrated, with a breeding density of 3.3 pairs per 20 ha in 1979 and 7.1 pairs per 20 ha in 1980.

Low breeding densities seem to be characteristic of mourning dove populations in the southeastern United States (Hopkins and Odum 1953, Lowe 1956). Hopkins and Odum (1953) reported an average breeding density of 1.6 pairs per 20 ha and suggested that this low density was characteristic of the Coastal Plain and Piedmont regions of Georgia. Lowe (1956) found an average density of 1.2 pairs per 20 ha in Oconee County, Georgia. Quay (1951) found an average of 1.5 nests per 20 ha in North Carolina.

The degree of concentration or dispersion of nesting has been attributed to the quality of the nesting habitat and, consequently, to the availability of suitable nest sites (Hopkins and Odum 1953). In other words, in areas of abundant nesting habitat, dove nesting tends to be dispersed, while in areas where nesting habitat is sparse, doves tend to concentrate in the limited available habitat. Hopkins and Odum (1953) suggested that ample nest sites in Georgia allowed doves to nest over more area, thus no large concentrations of nesting pairs occurred. Although they found no large concentrations, they did find a clumping

tendency on some of their study areas where 2 or more pairs often nested close together and some "traditional" areas were used more often than other apparently similar areas. There was no evidence of a clumping tendency on the farmland in Loudon County. The nearest distance between 2 active nests on the rural area was over 200 m. Stogsdill (personal communication) also found no evidence of a clumping tendency on farmlands in Knox County, Tennessee, although she, too, noted that some areas were used more frequently than other similar areas. The characteristically dispersed nesting of mourning doves on east Tennessee farmland may be due to the abundant nesting habitat in this area.

Mourning doves on the urban area were definitely gregarious in their nesting habits. No only was there a high breeding density on this area, but doves often nested in very close proximity to each other even when alternate nest sites were available. For example, at one time, there were 3 active nests in about 4 m of a Chinese juniper hedge that was over 30 m long. While the concentrated nesting on the campus may have been mostly attributable to the quality of this nesting habitat as compared with the immediate surrounding habitat, the tendency for pairs to nest very close to each other on this area suggests that factors other than the availability of nest sites may influence breeding density.

Expressing Productivity

At least 6 different methods of expressing mourning dove productivity have been reported in the literature. This lack of standardization in reporting dove production has been discussed by Fichter (1959) who concluded that the number of young fledged per 100 eggs laid

and the number fledged per nest attempt were the most accurate expressions of breeding success and provided a "standard for comparison of the basic reproductive performance throughout the country." Fichter (1959) summarized various nesting studies and found the number of young fledged per 100 eggs laid varied between 44.5 and 70.3 and the number fledged per nest attempt varied between 0.85 and 1.38. In the present study, the number of young produced per 100 eggs laid ranged from 38.2 (rural area 1979) to 78.6 (urban area 1979) and the number produced per nest attempt ranged from 0.7 (rural area 1979) to 1.6 (urban area 1979).

Several authors have reported production in terms of the number of young produced per acre and have extrapolated these data to estimate production on a county-wide (Lowe 1956, McClure 1942) or state-wide (Taylor 1941) basis. Production densities determined during this study ranged from 1.2 young per 20 ha to 1.8 young per 20 ha on the rural area and from 18.2 young per 20 ha to 43.4 young per 20 ha on the urban area. While these figures may be indicative of the relative effectiveness of these individual habitats in terms of mourning dove production, county-wide production could not be determined accurately from the production density on either of these areas. The density of production on the rural area was probably close to that of Loudon County farmland as a whole, but the degree of dove nesting in other habitat types (such as orchards and conifer plantings) found on farmlands other than those sampled during this study was not known. Also, while there was a large amount of contiguous wooded fencerows on the farmland under study, other farmlands had far fewer wooded fencerows, which would suggest an even lower production density.

The density of production found on the agricultural campus was probably not representative of Knox County, though it may have been indicative of nesting in established urban and suburban residential areas. Lowe (1956) pointed our that the high densities in nesting concentrations may be misleading unless the feeding areas were considered (which would tend to lower the density) and that this area was usually completely unknown. This was certainly the case on the campus. Also, much of Knox County consists of farmland similar to that of Loudon County where dove nesting would probably resemble that of the rural area. Thus, while the number of young produced per unit area on the rural area may have closely approximated that of farmland throughout Loudon County, the urban area was probably not very typical of Knox County. The variability of habitat types and the absence of data on dove nesting in some habitat types in both counties precluded the use of the available data for estimating production on a county-wide basis.

Productivity data "which indicate population structure and trend in terms of numbers annually available for harvest" (Fichter 1959) are those of greatest value to mourning dove management. Fichter (1959) indicated that mourning dove production per breeding pair was the expression of productivity most useful in assisting in the formulation of hunting regulations. This study estimated the number of young produced per pair to range from 2.2 to 4.0 on the rural area and from 5.5 to 6.1 on the urban area. Estimates of the number of young fledged per breeding pair have been determined by many other investigators and have been summarized by several authors (Fichter 1959, Hanson and

Kossack 1963, USFWS 1977). Generally, these production values vary between 1.4 and 7.0 fledglings per pair.

The greatest number of active nests found on a single day has been an often-used method of approximating the size of the breeding population (Fichter 1959, McClure 1942, Randall 1955). Lowe (1956) pointed out that this method undoubtedly underestimated the population and thereby overestimated production since not all pairs would be nesting on a single day. To estimate the breeding population more accurately, the number of different nests active in any 1 weekly period was used by Harris et al. (1963) and in the present study. Though this method resulted in higher figures, these probably still underestimated the true breeding population.

Productivity Requirements for a Stable Population

Natality must equal mortality in order for a stable mourning dove population to be maintained. Annual mortality rates for dove populations, as determined from banding data, are high. The Southeastern Association of Game and Fish Commissioners (1957) reported a first-year mortality rate of approximately 70.0% and an adult rate of 50.0% to 55.0%. The USFWS (1977) determined average annual mortality rates in the Eastern Management Unit to be 76.0% for immatures and 62.0% for adults. Orr (1973) calculated average annual mortality rates in Tennessee to be 82.2% for immatures and 66.7% for adults.

The productivity requirement for meeting their estimated mortality rates was determined by the Southeastern Association of Game and Fish Commissioners (1957) to be 4.6 fledglings per pair. The USFWS

(1977) reported that the productivity necessary for a stable population in the Eastern Management Unit must be 5.0 fledglings per pair. Orr (1973) reported that a production of 3.8 immatures per adult (7.6 per pair was needed to maintain a stable mourning dove population in Tennessee.

The Southeastern Association of Game and Fish Commissioners (1957) concluded that "doves average three successful broods annually, from five or six nesting attempts and produce 5.1 young per pair." An annual recruitment of 2.5 immatures per adult (5.0 per pair) was determined for the Eastern Management Unit by the USFWS (1977) from wing analysis, which essentially matched the estimated rate needed for maintaining the population. Orr (1973) estimated average dove production from wing analysis in Tennessee to be 3.23 immatures per adult (6.5 per pair). My data indicated average production rates on the rural area (2.2 young per pair and 4.0 young per pair) were much lower than those reported by the Southeastern Association of Game and Fish Commissioners (1957), the USFWS (1977), and Orr (1973). Production rates on the urban area (5.5 young per pair and 6.1 young per pair) exceeded those reported by the Southeastern Association of Game and Fish Commissioners (1957) and the USFWS (1977), but were still lower than that reported by Orr (1973). Productivity requirements as determined by the Southeastern Association of Game and Fish Commissioners (1957) and the USFWS (1977) were met during both nesting seasons by the urban dove population but during neither nesting season by the rural population. Productivity requirements as determined by Orr (1973) were not met during either nesting season by either dove population.

II. NESTING HABITAT

Habitat Utilization

On the rural area, mourning doves were found nesting most often in wooded fencerows, with 72.2% of all nests occurring in this habitat type. On the urban area, nearly all (94.9%) of the nests were in ornamental landscape plantings. Although most nests occurred in these habitat types, one cannot state that they were actually preferred for nesting, since these were also the dominant habitat types searched on the respective areas. Nevertheless, the importance of these habitat types as mourning dove nesting habitat remains obvious. Wooded fencerows are probably 1 of the most important nesting habitat types on east Tennessee farmlands, while park-like landscape plantings are important dove nesting habitats in urban areas.

Nest Site Selection

Although a quantitative analysis of the relative numbers of each plant species was not attempted, a subjective analysis did seem to indicate that some species were preferred for nest sites. However, these preferred species differed between the rural and urban areas and between the 1979 and 1980 nesting seasons on the same area. On the rural area, hackberry trees seemed to be favored during 1979, with 39.9% of the nests occurring in this species; but during 1980, eastern redcedars were preferred, with 61.1% of the nests occurring in these trees. Most (83.3%) of the nests on this area during 1972 were located in deciduous trees, while in 1980, most (61.1%) were in evergreen trees. Nearly all (90.9%) of the nests in deciduous trees were located in dense growths of

honeysuckle. Most probably, the presence of honeysuckle was an important contributing factor influencing the selection of a nest site, and, if it were absent, there may have been much less use of deciduous trees. However, various other authors have reported that deciduous trees and shrubs were preferred nest sites, and they made no mention of any accompaning vegetation such as honeysuckle (Boldt and Hendrickson 1952, Carpenter 1970, Cowan 1952, LaPointe 1958, Nice 1922).

On the urban area, there was no indication of a preference to nest in any particular species of vegetation during 1979. However, during 1980, white pines and Chinese junipers seemed to be favored nest sites, with 27.3% and 23.4% of the nests occurring in these species, respectively. Neither of these species was utilized during 1979, yet they were the most used species in 1980. Evergreen species were preferred over deciduous species on this area during both nesting seasons. During 1979, 57.1% of the nests were in evergreen species, and during 1980, 85.7% were in evergreens. Numerous other investigators have also found evergreen plants to be preferred dove nest sites (Caldwell 1964, Carter 1957, Hanson and Kossack 1963, Harris et al. 1963, Hoffman 1974, McClure 1946, Moore 1940, Pearson and Moore 1939, Quay 1951, Sprunt 1957, Taylor 1941). Contrary to the rural area, the agricultural campus has been landscaped with a variety of ornamental plants. A knowledge of the use of these species by doves may prove to be important and helpful if a need for creating nesting habitat is recognized.

Mourning dove nests ranged in height from 1.8 m to 6.1 m above the ground on the rural area and from 0.9 m to 7.6 m above the ground on

the urban area. Since the placement of the nest is mostly determined by the growth form of the plant in which the nest occurs and a large number of different plant species are used for nesting by doves, one would expect a wide range in mourning dove nest placement. Thus, the variability in nest heights that was found during this study and reported in others (Boldt and Hendrickson 1952, Harris et al. 1963, Hoffman 1974, Monk 1949, Moore 1940, Nice 1922, Pearson and Moore 1939, Quay 1951, Taylor 1941) is not particularly surprising.

During this study, 24 (24.5%) of the nests on the urban area occurred in previously constructed nest structures, while only 1 (2.9%) nest on the rural area was located in a previously constructed nest structure. This secondary use of nest structures has been reported by other investigators (Hanson and Kossack 1963, Monk 1949, Nice 1922, Nickell 1943) and may be an important element of mourning dove nesting behavior that influences the selection of a nest site. The secondary use of nest structures is necessarily controlled by the availability of alternate nest sites and the availability of preconstructed nest structures. The apparently ample supply of alternate nest sites on both the rural and urban areas and yet the substantial difference in the secondary use of nest structures found between these areas suggests that the latter of these factors may be the more important.

CHAPTER VI

CONCLUSIONS

Initiation of mourning dove nesting differed markedly between the rural and urban areas during both nesting seasons. Nesting began in late February on the urban area, while nesting began in early April, approximately 6 weeks later, on the rural area. Factors which may have been partially responsible for this difference in the onset of breeding between these areas included local differences in temperatures, winter residency, and social stimuli.

Monthly nesting activity varied considerably between years on both the rural and urban areas. During 1979, most nesting occurred during the first half of the nesting season, while during 1980, most nesting occurred during the second half of the season. Differences in monthly nesting activity may be related to prevailing weather conditions. Overcase, rainy weather during summer seemed to have a suppressive effect on nesting activity, while extreme heat and drought during summer did not seem to depress nesting activity.

Indications are that the nesting season extends from early April until late September on Loudon County farmlands. This may be characteristic of most farmland areas in the Ridge and Valley region of Tennessee. The nesting season on The University of Tennessee Agricultural Campus extended from late February until late September or early October. This may be representative of park-like urban areas and established urban-suburban residential areas in this region.

The proportion of annual recruitment occurring after 1 September varies widely between years on the same area. On the rural area, no young were produced after 1 September 1979, while 7 (35.0%) young were produced after 1 September 1980. On the urban area, 2 (6.0%) and 10 (10.2%) young were produced after 1 September 1979 and 1 September 1980, respectively. Results of this study suggest that this September production is not highly susceptible to loss due to hunting of the parents.

Mourning dove nestlings were considerably more successful than were dove eggs. Predators were a major cause of nest failures during this study, and the conspicuous nature of dove eggs may have contributed to their greater vulnerability to predators.

The mean rate of nest success on the rural area (50.0%) was comparable to the rates of nest success reported for other areas in the southeast. However, the mean rate of nest success on the urban area (77.9%) was considerably greater than that on the rural area. The presence of fewer nest predators on the urban area may have allowed for this greater nest success.

Breeding densities on the rural and urban areas were substantially different during this study. Nesting on the Loudon County farmland was dispersed, while nesting on the agricultural campus was concentrated. The degree of concentration or dispersion of nesting may be mostly influenced by the availability of suitable nest sites, but the gregarious nesting behavior of the urban doves suggests that other factors may also influence breeding density.

Annual mourning dove production in terms of fledglings per 100 eggs laid, fledglings per nest attempt, fledglings per pair, and

fledglings per 20 ha was substantially greater on the urban area than on the rural area. This was probably due to the longer duration of the nesting season on the campus and to the greater nesting success of the urban doves.

Productivity requirements for a stable mourning dove population as determined by the Southeastern Association of Game and Fish Commissioners (1957) and the USFWS (1977) were met during both nesting seasons by the urban dove population but during neither nesting season by the rural population. Productivity requirements as determined by Orr (1977) were not met during either nesting season by either dove population.

While wooded fencerows are probably 1 of the most important mourning dove nesting habitat types on east Tennessee farmlands, park-like landscape plantings are probably 1 of the more important dove nesting habitat types in urban areas.

Evergreen trees and deciduous trees supporting dense growths of honeysuckle are preferred sites for nesting on Loudon County farmlands. Evergreen trees and shrubs are preferred nest sites on The University of Tennessee Agricultural Campus.

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Observer's Name(s) _____ Phone Number _____

DATA FORM FOR OBJECTIVES 1 AND 2 - COOPERATIVE MOURNING DOVE PROJECT
(Use separate form for each active nest)

STATE __ __ (1 2) YEAR __ __ (3 4) SEARCH AREA __ __ __ (9 10 11) PRIMARY (P)[2] / ALTERNATE (A) __ (12) NEST __ __ __ (13 14 15)

HABITAT:	Old Field	Shelterbelt	Coniferous Forest	Suburban
	Roadside	Cropland	Deciduous Forest	Riparian
	Cemetery	Grassland	Mixed Forest	Orchard
	Fencerow	Shrubland	Hedgerow	Swamp
	Rural Residence			Other

0 (18)

__ (19) __ (20) (USFWS USE)

GENERAL HABITAT DESCRIPTION (Immediate vicinity):
_____
_____
_____
_____
_____
_____

HEIGHT OF DOMINANT VEGETATION (ft.) __ __ (21 22 23)

HEIGHT OF NEST (ft.) __ __ (24 25)

VEGETATION IN WHICH NEST OCCURS _____ (Genus) _____ (Species)

__ __ __ (30 31 32) (USFWS USE)

DATE (M/D) (17 18 19 20)	CHECK[1] (22)	NO. (24)	STAGE (26)	STATUS (28)	LOSS (30-31)	AGE OF NESTLING(S) (DAYS) (33)	REMARKS (Describe evidence of status, loss, and fledging)
__/__							
__/__							
__/__							
__/__							
__/__							
__/__							
__/__							
__/__							
__/__							
__/__							
__/__							
__/__							

(Use additional sheet if needed)

NOTE: If stage or status is different for each bird on one day, use two lines, each with same date (e.g., one nestling fledges, and one remains in nest).

CHECK	NO.	STAGE	STATUS
S=Search day	No. eggs,	E=egg	A=active
A=Additional day	nestlings,	N=nestling	D=deserted
(to be used for objective 1 only)	fledglings, or No. fledged	B=both egg & nestling	E=empty
		F=fledgling	F=fledged
		U=unknown	X=destroyed

CAUSE OF LOSS
Predator: PA=avian; PM=mammalian; PR=reptilian; PU=unknown
Weather: WW=wind; WR=rain; WH=hail; WI=ice; WS=snow; WU=unknown
Human Disturbance: HH=hunting; HO=other; HU=unknown
UU=unknown
OO=other

SUMMARY OF NEST FATE

NO. EGGS LAID __ __ (34)

NO. EGGS HATCHED __ __ (36)

DATE HATCHED (M/D) __/__ (38 39 40 41)

NO. FLEDGED __ __ (43)

DATE FLEDGED (M/D) __/__ (45 46 47 48)

FORMER NEST NO. IF THIS IS A RENEST __ __ __ (50 51 52)

[1] *Use for objective 1 only;* [2] *Use for objective 2 only*

Figure 17. Data form used for field data collection, 1979 and 1980.

VITA

Mark S. Burch was born in Los Angeles, California, on 13 December 1954. He is the son of Daniel W. Burch and Regina A. Burch.

Mr. Burch attended elementary and high schools in Louisville, Kentucky, and graduated from Trinity High School in 1972. He entered Oxford College of Emory University, Oxford, Georgia, in September 1972 and received the degree of Associate of Arts in Biology in June 1974. He entered the University of Georgia in June 1974 and received the degree of Bachelor of Science in Forest Resources in August 1977. In September 1977 he accepted a temporary fisheries laboratory technician position with the University of Georgia, School of Forest Resources which terminated in January 1978. Between February 1978 and July 1978 he was employed by the United States Fish and Wildlife Service on a 700 hour appointment as a wildlife biologist with Merritt Island National Wildlife Refuge, Titusville, Florida. He entered The University of Tennessee, Knoxville, in September 1978 and accepted a research assistantship with the Department of Forestry, Wildlife and Fisheries. He received the degree of Master of Science in Wildlife and Fisheries Science in March 1982.