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# Seasonal Populations and Vertical Distribution of Birds in a South Central Louisiana Bottomland Hardwood Forest.

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# SEASONAL POPULATIONS AND VERTICAL DISTRIBUTION OF BIRDS IN A SOUTH CENTRAL LOUISIANA BOTTOMLAND HARDWOOD FOREST

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by
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## ABSTRACT

Estimated monthly bird populations and vertical distributions were determined from transect counts on the Thistlethwaite Wildlife Management Area in south central Louisiana from January 1972 to February 1974. Year round bird populations were estimated from variable width strip censuses. Census strip widths were based on effective detection distances of the various species. Censusing of conspicuous birds was consistent. Non-vocal birds (e.g., migrating warblers) present during the growing season of the hardwood forest, flocking birds, and flying birds were not effectively censused by transects.

Results of various breeding bird census techniques were compared. The census techniques in decreasing order of magnitude of total estimated bird populations were: 20-acre area spot map census (8 counts), transect spot map census (11 counts), transect spot map census (8 counts), summation technique (11 counts), transect spot map census (6 counts), and transect mean number of birds per count (11 counts).

Vegetation on the study area was measured on variable radii plots. The mature bottomland hardwood forest was fully stocked (122.7 sq. ft. B. A.). Oaks (Quercus spp.)

were dominant overstory vegetation. Cane, (Arundinaria gigantea), Palmetto (Sabal minor), and Ironwood (Carpinus caroliniana) were primary understory species.

Birds were mist-netted in order to compare bird captures to estimated populations. There were 1,863 individual birds, representing 62 species and 14 families, captured in 9,701 mist net hours (1 mist-net hour = one 7 feet x 30 feet net set for one hour). Highly conspicuous birds (e.g., Cardinals) tended to have high estimated population to capture ratios. Other birds (e.g., lower strata breeding season warblers) tended to be captured often in relation to their estimated populations.

Vertical height data from 4,103 sightings of 26 species of birds were analyzed in order to better understand height segregations and resource utilization. Height categories used were: ground to 2 feet, 2 feet to 25 feet, and 25 feet to canopy top (approximately 85 feet). Bird height distributions were compared by means of the chi square test for two independent samples. Height diversities were computed by the information theory (height diversity = $-\Sigma P_i \log_e P_i$, where $P_i$ = proportion of observations in the ith category) and compared by the student's t test where sufficient samples permitted. The most ubiquitous species in height dispersal were: American Robin, Common

Flicker, Rusty Blackbird, American Goldfinch, and Brown Thrasher. The species most narrow in forest profile utilization and the zones they inhabited were: Red-headed Woodpecker and Blue Jay - canopy; White-eyed Vireo, Hooded Warbler, and Carolina Wren - mid-story. There was a gradual upward shift in distribution of all birds from winter through spring to the summer breeding season. The winter to summer distribution changed significantly ($P < .01$) from a nearly equal distribution in all levels in winter to a predominantly mid-story and canopy distribution in summer. Corresponding with this was a highly significant ($P < .01$) reduction in height diversity of the aggregate of all birds. This shift was presumably a response of the birds to the seasonal change in foliage profile of a deciduous forest.

# INTRODUCTION

## Background

### Forest Ecosystem Management

Historically, forest management in the United States has been based primarily on wood fiber production. The public is now demanding that forest land be managed for all its inhabitants, not just trees. U. S. Forest Service lands are managed on a wide spectrum basis as outlined in the Multiple Use Act (PL 86-517, 1960). Other public and private forest land holding agencies are, or should be considering multiple use forest management. Many of our wildlife populations, especially the long neglected non-game species, are integral components of our forest ecosystem and should be included in resource management.

If we are to recognize our various wildlife populations as forest resources, then we should be able to more closely identify the variables which influence these resources. When we have defined our total resource picture; and all inputs have been considered, more comprehensive long-term resource management decisions can be made.

The need for this information is especially critical

in the mature Louisiana bottomland hardwood forests. These areas, which are prime breeding and overwintering habitat for many of our nation's birds, are disappearing at an alarming rate (Yancey 1970).

## Ornithological Background

Ornithological investigations of a qualitative nature have a long history in North America. These works have been invaluable in understanding our native birds, their population dynamics, and ecology. Recent strides in systems analysis, bio-energetics, statistical analysis of data, and population ecology have pointed out the need to bolster our stockpile of information with quantitative avian population data. Recent works (Beals 1960, Bond 1957, Hagan 1960, Johnson and Odum 1956, Karr 1968, Parnell 1969, and Stewart and Aldrich 1952) have utilized a quantitative and ecological approach, tying bird populations to vegetation types and successional seres. Several recent investigations (Cody 1968, Hespenheide 1971, MacArthur and MacArthur 1961, and MacArthur *et al*. 1962) have correlated avian populations with vegetative form or profile. This investigation was an attempt to quantify bird populations by season on selected sites on the Thistlethwaite Wildlife Management Area in south central Louisiana, and to acquire

supplemental information on bird movements, behavior, and vertical stratification to better understand the ecological requirements of the various avian species.

## Bird Vertical Distributions

Resources utilized by avian species are in limited supply in forest ecosystems. This results in interspecific competition and the segregation of species into niches. One means of such segregation is a spatial segregation of birds into vertical strata. By looking at the vertical distributions of species a clearer picture of niche segregation and resource utilization can be gained. MacArthur (1958) demonstrated vertical selectivity from observations of five species of warblers in coniferous forests. One objective of this investigation was to ascertain vertical distributions of the various avian species and to analyze the seasonal changes of these distributions.

## Population Estimates

Complete enumeration of terrestrial bird populations is difficult. Differences in observer ability result in high variation in censuses, thereby masking real bird population differences. Variations in bird mobility and conspicuousness have been difficult to compensate for when evaluating census results. A few investigators have

attempted to correct for the above variables in bird censuses. Colquhoun (1940) working with an assumed known population, calculated relative conspicuousness for various species as $c=\frac{P}{y}$ where c = relative conspicuousness, P = population, and y = abundance per hour of census. Seierstand et al. (1965) used a similar formula for computing census efficiency when individuals in the population are recognizable. The theoretical population was estimated by the formula $\hat{N} = \frac{Y}{1-(1-\hat{p})^n}$ where $\hat{N}$ = unbiased estimate of population, Y = total number of discovered individuals, $\hat{p}$ = discovery chance, and n = number of times a population is counted.

There are limitations in each of these computations of conspicuousness. In the Colquhoun (1940) method the number of individuals in the population is assumed to be known. The Seierstand et al. (1965) formula to quantify inconspicuousness is based on the recognition of individuals in the population. The difficulty of obtaining these requisites limits the utility of each of these population estimation techniques.

In other European bird studies, Enemar (1960) and Williamson (1964) were concerned with the "effectivity" of each census. Williamson (1964) determined the total number of males and calculated the "effectivity" as the ratio of

singing males tallied each census to the total number of singing males on the area. In the United States, Emlen (1971) applied a correction factor for distance of detections for each particular species. Applying his "coefficient of detectability", he corrected the total detections to the level of optimum detections. Further, he suggested that an overall basal correction factor should be applied for each species.

Due to difficulties inherent in censusing birds in seasons other than the breeding period, most censusing has been limited to the counting of singing males during the breeding season. This appears to be the period of most uniform conspicuousness. The problem here, as with other seasons, has been the imprecision or incompleteness of each single census. The males are calling intermittently. The censuser moves slowly through the censused area. The probability is less than one that each territorial male will emit a detectable song while the censuser is within the bird's detection radius. Therefore, on each particular census all of the territorial males are not included. Coupled with this is the problem of surplus males [i.e., birds categorized as: (1) migrant, (2) visiting males outside their territory, (3) wandering unmated males, (4) males temporarily holding territories, and (5) wandering

males who stayed on the study area (Williamson 1964)].

The census technique seemingly most often used for territorial males has been the "spot" census (Williams 1936). The position of each territorial male detected during each census is plotted. After a series of censuses these detection positions are summed for each species and clusters are interpreted as territories. Williamson (1964) thought a minimum of three individual detections for the series of censuses was sufficient for interpretation as a valid territorial male. A minimum of three detections of territorial males in a cluster is also considered sufficient for a territorial male in the nationwide Breeding Bird Census (Hall 1964).

The other common method that has been used in censusing singing males is called the "Summation" method (Palmgren 1930). The highest number of males calling on any one census is taken as the total male population. The assumption is made with this technique that the probability will approach one, that all the territorial males will be detected on a minimum of one of the series of censuses. Both of these breeding bird techniques, the spot census and the summation technique, were devised to compensate for incomplete or imprecise censusing of territorial males on any one census. Usually, in the case of censusing territorial

birds, a 1:1 male to female ratio of the breeding segment of the population is assumed, and the breeding population is estimated at twice the number of territorial males.

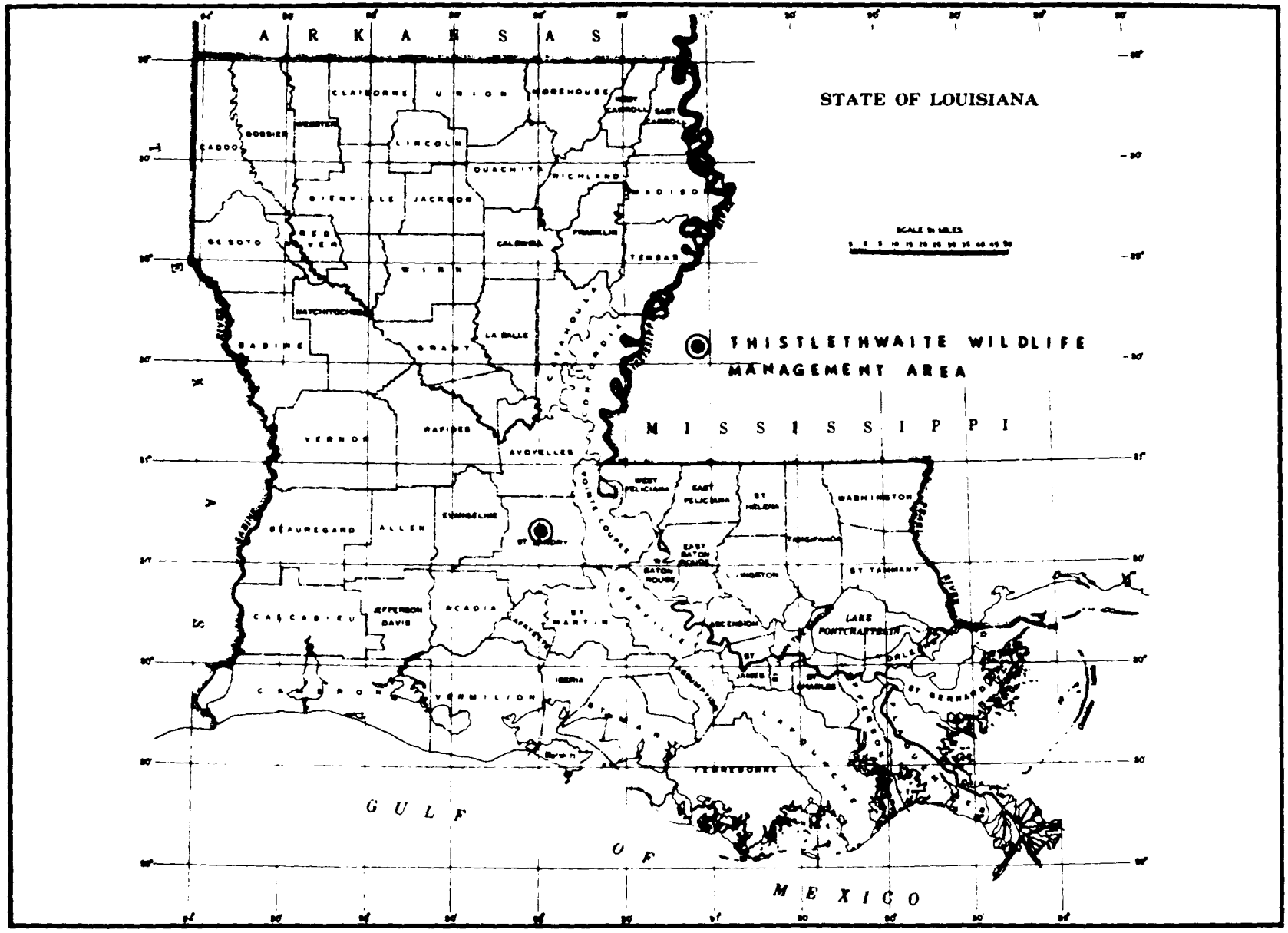
While some difficulties have been encountered in censusing territorial males, greater problems are usually inherent in censusing schemes at other seasons. Greater species and sex variation in conspicuousness appears to be present. Also, the mobility of migrating or wintering birds has to be considered. Kolb (1965) discussed these variables (mobility and seasonal fluctuations) in his treatment of the Audubon Winter Bird Population Study. He considered the winter study a sampling procedure, similar in some respects to studies of bird populations by the unit-of-effort method. He described census results as a statistic, not an enumeration.

## Description of Study Area

### Geography

This investigation was conducted on the Thistlethwaite Wildlife Management Area, which is situated at 30°-40'N, 092°-00'W, (Township 4, 5 South, Range 4, 5 East), between Washington and Labeau, Louisiana, in St. Landry Parish (Figure 1). The Management Area is leased to the Louisiana Wildlife and Fisheries Commission on a long term basis from

Figure 1. Location of Thistlethwaite Wildlife Management Area.


STATE OF LOUISIANA
THISTLETHWAITE WILDLIFE MANAGEMENT AREA
ARKANSAS
MISSISSIPPI
GULF OF MEXICO

members of the Thistlethwaite family. There are 11,000 acres, of which approximately 10,000 acres are forested. The remaining acreage is composed of roads, a pipe line right-of-way, and gas well sites. The Sohio Oil Company has numerous gas wells dispersed throughout the area. Cattle graze the northwest portion of the tract.

The area is an old floodplain of the Mississippi and Red Rivers. It is described as a south central Louisiana mature bottomland hardwood forest, and classified as a hardwood bottom (Braun 1950:293). It is subject to periodic flooding, mostly in the winter months. Elevation ranged from 25 to 35 feet above sea level over the entire area, and from 30 to 35 feet on the study area. Soils are predominantly clay. Most of the area is classified as the Sharkey Association with a small portion classified as the Moreland-Portland Association (Soil Conservation Service 1970).

The study area portion of the Thistlethwaite area was last logged around 1938 to 1940 (pers. comm., Jewell Willis, area forester). Presently, the forest is being selectively cut at the rate of about 1,000 acres per year.

## Specific Study Areas

A one-mile transect and a 20-acre area (660 feet x 1320 feet) were established as study areas on the northwest

portion of the Thistlethwaite Wildlife Management Area, hereafter referred to as TWMA. The transect began approximately 1/4 mile east of the Louisiana Wildlife and Fisheries cabin, ran 1/2 mile south, and 1/2 mile east. The transect traversed mostly closed-canopy, mature, bottomland hardwood forests with Cane (Arundinaria gigantea) and Palmetto (Sabal minor) being the predominant understory species [plant nomenclature from Radford et al. (1958) unless otherwise specified]. The most southerly 1/8 mile section of the north/south portion of the transect presented a semi-open canopy. It was heavily grazed, and it had a very limited shrub cover. The west boundary of the 20-acre area coincided with the south 1/4 mile section of the north-south portion of the transect. The south boundary of the 20-acre area coincided with the west 1/8 mile section of the east-west portion of the transect. Vegetation on the 20-acre area was similar to that on the closed canopy portion of the transect.

## Mammals

Several mammalian species are common in the Thistlethwaite Area. The annual White-tailed Deer (Odocoileus virginianus) harvest by hunters has recently leveled off at approximately 90 animals (pers. comm., Cecil LeCaze, District Supervisor, Louisiana Wildlife and Fisheries

Commission). The annual Gray Squirrel (Sciurus carolinesis) and Fox Squirrel (S. niger) kill fluctuates considerably, but in good years it approaches one squirrel per acre. Feral hogs (Sus scrofa) are commonly taken by hunters during the deer hunting season.

Previous studies on the Thistlethwaite Area have furnished data on several mammalian wildlife species. Mills (1964) examined squirrel habitat; Neal (1967) investigated the ecology of the Eastern Woodrat (Neotoma floridana); and Hall (1973) radio monitored six Bobcat (Lynx rufus) over the area.

Other mammals encountered during the study and believed to be fairly common on the area are: Coyote (Canis latrans), Cottontail (Sylvilagus floridanus), Swamp Rabbit (S. aquaticus), Northern Raccoon (Procyon lotor), Virginia Opossum (Didelphis virginiana), Nine-banded Armadillo (Dasypus novemcinctus), and American Beaver (Castor canadensis).

In 82 trap nights using museum specials on the northwest transect only three Peromyscus sp. were captured. One hundred ninety-one trap nights along the railroad track to the west of the TWMA yielded four Least Shrews (Cryptotis parva), ten Hispid Cotton Rats (Sigmodon hispidus), two Marsh Rice Rats (Oryzomys palustris), four Fulvous Harvest Mice (Reithrodontomys fulvescens), and four House Mice

(Mus musculus). These species, while probably not found in the wooded Thistlethwaite Area, were probably present in the brushy roadsides and on the gas well sites.

## METHODS AND PROCEDURES

### Vegetation

Vegetation on the study areas was measured by means of variable radii plots. Twenty-four plots were situated on the transect. Three plots were randomly located on each 1/8 mile section. Each plot was offset 14 feet from the transect to negate the effects of human traffic on the sampled vegetation. On the 20-acre area, 20 plots were located systematically with a random start.

Variable radii plots were used in tree and ground cover measurements. Trees over 9 inches Diameter Breast Height (dbh) were measured on 0.1 acre circular plots. Also, in each of the 0.1 acre plots, canopy closure was estimated and height of the tallest tree was measured with a Sunto Clinometer. Woody vegetation 1 to 9 inches dbh was measured in the 0.01-acre plots. Ground cover was determined from circular mil-acre plots. The percentage of cover of each plant taxon up to 6 feet high was visually estimated. The median of each 10 percent interval of cover was used (e.g., 5 percent for one to 10 percent, etc.). Average cover for a plant taxon was calculated by dividing

the total number of plots in which the total cover estimate for that taxon by the taxon occurred.

## Vertical Distribution

Vertical height data from 4,103 sightings of 26 species of birds were analyzed in order to better understand height segregations and resource utilization. Sightings were made from sunrise to 4 hours after sunrise; therefore, no data on daily patterns in heights were gathered. Vertical strata categories (MacArthur and MacArthur 1961) were: ground-2 feet, 2 feet - 25 feet, 25 feet - canopy top, and above - canopy. These zones probably corresponded, as well as any, to the vegetation profile, although certainly no distinct layers of vegetation were observable. No corrections were applied to compensate for differences in sighting distances in foliage profile throughout the year, although there were decided seasonal changes. In summer the vegetation appeared to be almost equally distributed at different heights. In winter after the deciduous leaves had fallen, the ground and mid-story vegetation, which consisted mainly of Palmetto and Cane (both evergreen), was denser than the mostly leafless canopy area.

Some investigators have observed differences in bird heights due to different behavioral patterns. Dunlavy

(1935) considered feeding behavior extremely variable, and used height to which birds flew when startled, as his basis for vertical height preferences. He found a similarity between escape height and nesting height for most species. Colquhoun and Morely (1943) and Pearson (1971) based their height measurements on feeding birds. Sightings in this study were not restricted to any particular behavioral category, although most birds were foraging when detected. There may have been some height differences corresponding to different bird behavior but I didn't attempt to distinquish behavior when recording heights. Also, a behavioral division of height classes would have reduced sightings to a point of low utility for many species.

Birds were categorized into one of four strata at the time of initial sighting with a few minor exceptions. Ground occupants were often first seen in mid-air after flushing from the ground. These cases of flushing were regarded as ground sightings.

Height diversities were calculated from the information theory of Shannon (1948). More recently, MacArthur and MacArthur (1961) popularized this formula in ornithological work by calculating bird and foliage height diversity. Using this formula, dispersal among classes, or diversity, was calculated, based on the number of classes and equality

of distribution of observations between the classes. Height diversity = $-\Sigma P_i \log_e P_i$, where $P_i$ = proportion of observations in the ith category. For the three height categories used, 1.099 would represent maximum diversity or equal dispersal among categories, and conversely, a complete distribution in only one category would have zero diversity.

Birds in the "above-canopy" stratum were divided into two groups: those carrying on their "normal" activities at that height and those merely relocating themselves. I included the above-canopy stratum for Black Vultures and Common Crows because they appeared to regularly utilize that height while carrying on their "normal" activities. Those relocating themselves in the "above-canopy" stratum and the percent of total sightings for each species were: Pileated Woodpecker (9), Red-headed Woodpecker (1), Blue Jay (9), Brown-headed Cowbird (23), Common Grackle (59), White-throated Sparrow (< 1), Brown Thrasher (1), and American Robin (3). These sightings were not included in the following consideration of bird vertical distribution.

Bird vertical stratifications were compared on a seasonal, species, and family basis. The three strata comparisons within the forest were used for all species except the Black Vulture and Common Crow. Comparisons were tested by means of the chi square test for independent

samples at the .01 level of significance unless otherwise specified. Individual species were mostly compared to the overall vertical height distributions for the aggregate of all species. The basic assumption of this test is that all observations were independent of all other observations. I felt that data on Common Grackles and Cedar Waxwings did not meet the basic assumption, due to their occurrence in flocks and to my influence on their vertical distribution. As a result, they were excluded from further consideration. The criterion for sufficient samples for reliability was taken from Siegel (1956). In comparing the three vertical strata no expected values less than one were tolerable, and no more than 20 percent of the expected values could be less than five. In a few cases of a low value in one stratum, strata were combined for purposes of comparison.

For comparative purposes, the three strate (four for Black Vultures and Common Crows) were assigned the following values: ground- 1, mid-story- 2, canopy- 3, and above-canopy- 4. Relative mean height was calculated by multiplying these values in each stratum by the frequency in each stratum. The sum of these products divided by total frequency defined relative mean height, based on frequency of observations in each of the three (or four) strata.

## Population Estimates

### Transects

Population estimates were determined from transect counts and 20-acre area censuses, and compared with mist netting results. Variable width strip transects were the primary means of population estimates. Variable width strip censuses have been utilized previously in censusing Ruffed Grouse (Bonasa umbellus) (Leopold 1933: 151), Marsh Wrens (Breckenridge 1935), and a variety of other birds (Emlen 1971). With the present census technique different width strips were used for different species of varying effective detection distances. These effective detection distances were determined for each species from the distribution of detection points perpendicular to the transect line. The effective detection distance for each species was the distance perpendicular to the transect line beyond which detections fell below 75 percent of detections at distances nearer the transect line. Distance categories (21, 41, 62, 82, 103, 206, 412, and 825 feet) were selected for easy conversion to area per mile transect (Emlen 1971). There were small rounding errors in conversion from lateral distances to acreage due to the use of whole distance units (feet), but the level of

accuracy was commensurate with the visually estimated distances. For example: 21 feet from both sides of transect = 42 feet x 5280 feet (1 mile) ≅ 5 Acres. Accordingly, 41 feet ≅ 10 Acres, 62 feet ≅ 15 Acres, 82 feet ≅ 20 Acres, 103 feet ≅ 25 Acres, 206 feet ≅ 50 Acres, and 412 feet ≅ 100 Acres (Table 1).

Based on general field observations and the overall distribution of detection distances, it was assumed that each species was detected effectively to a minimum of 62 feet. Beyond this point the effective distance for each species was determined to be that point beyond which the number of birds per unit area dropped below 75 percent of the mean number of birds per unit area of the more proximal distance units. This point of the limit of effective detection would correspond very closely to the inflection point used by Emlen (1971) in determining the level of maximum detection for the various species.

The transect was censused 127 times in alternate directions from January 1972 to February 1974 to gather data on bird populations and vertical stratification. The mile line was divided into 80 one-chain (one chain = 66 feet) segments and each 10 chain segment was tallied on one sheet of graph paper. Each bird detected was plotted according to its appropriate position. Birds visually

Table 1. Lateral detection distances of birds and area censused per mile transect.

| Detection distance (ft.) | X 2 = strip width (ft.) | X 5280 (ft. per mile) / 43,560 (sq. ft. per acre) ≅ acres per mile transect |
|---|---|---|
| 21 | 42 | 5 |
| 41 | 82 | 10 |
| 62 | 124 | 15 |
| 82 | 164 | 20 |
| 103 | 206 | 25 |
| 206 | 412 | 50 |
| 412 | 825 | 100 |
| 825 | 1650 | 200 |

detected while censusing were categorized into vertical strata of: 0-2 feet, 2-25 feet, 25 feet - canopy top, and above canopy.

Various weather factors were recorded before and after every transect. Temperature ($^{o}$F) in 10 degree increments and the percent of cloud cover were estimated. Wind direction and speed (Beaufort scale) in the woods were also estimated. Other special conditions (e.g., sleet, snow, rain, and fog) were recorded. During the transect, notations were made for substantial weather changes. Time from sunrise was noted at the start and finish of every transect.

Comparison of Census Techniques

Breeding bird census results from the 20-acre and the north transect are presented in Table 2. Totals from each are converted to birds per 50 acres for comparison. The rectangular area was censused eight mornings between 14 May and 20 June 1973. The transect was censused 11 mornings between 18 April and 20 June 1973. Area census and transect populations were computed by the spot census technique (Williams 1936). These data are compared with the highest number of calling male birds on any one census (summation technique of Palmgren 1930) and the mean number of birds detected per transect. The area and transect were

Table 2. Comparison of breeding bird census techniques on the Thistlethwaite Wildlife Management Area, May, June 1973.[ab]

| | Area spot mapping census[c] | Transects | | | |
|---|---|---|---|---|---|
| | | Maximum transect detections[d] | Spot mapping census | | Mean detections per census |
| Number of censuses | 8 | 1 | 11 | 8 | 6 | 11 |
| Species | | | | | | |
| Yellow-billed Cuckoo | 17.5 | 11 | 9.5 | 9.5 | 9.5 | 6.50 |
| Red-bellied Woodpecker | 2.5 | 6 | 8.0 | 5.0 | 3.0 | 3.36 |
| Acadian Flycatcher | 12.5 | 12 | 8.0 | 8.0 | 8.0 | 5.60 |
| Tufted Titmouse | 16.2 | 13 | 21.0 | 18.0 | 10.7 | 9.27 |
| Carolina Wren | 30.0 | 19 | 28.0 | 24.5 | 19.0 | 14.09 |
| White-eyed Vireo | 27.5 | 20 | 27.0 | 20.0 | 16.0 | 12.91 |
| Yellow-throated Vireo | 6.2 | 4 | 3.0 | 2.0 | 1.0 | 2.00 |
| Red-eyed Vireo | 5.0 | 4 | 8.0 | 6.0 | 2.5 | 3.09 |
| Swainson's Warbler | 5.0 | 4 | 4.0 | 2.0 | 0.0 | 2.00 |
| Kentucky Warbler | 2.5 | 4 | 4.0 | 4.0 | 2.0 | 2.50 |
| Hooded Warbler | 2.5 | 4 | 2.0 | 2.0 | 2.0 | 1.46 |
| Cardinal | 18.8 | 11 | 17.0 | 15.0 | 10.0 | 8.18 |
| Total | 146.2 | 112 | 139.5 | 116.0 | 83.7 | 70.96 |

[a]Only species with a minimum of 1 male per 50 acres included.
[b]All figures are converted to singing males per 50 acres.
[c]20 acre rectangular area, 1/8 mile x 1/4 mile.
[d]Summation method of Palmgren (1930).

not exactly comparable because of the geographical difference, but there was considerable overlap in area and the portions of each not overlapping were, nevertheless, similar in vegetative composition.

Mist-Netting

Birds were captured by mist net on the TWMA from February 1972 to May 1974. Nets were set along the one-mile transect from 3 February 1972 to 13 January 1973. On 26 January I commenced netting on the 20-acre area and continued periodic netting there until 14 May 1974. I usually netted from one to three consecutive days. Most of the nets were 7 feet x 30 feet, 1.5 inch mesh, constructed of terylene. A few nets were 7.9 feet x 39.4 feet, 1.4 inch mesh. Catch was computed on a mist net hour basis. One mist net hour equals one 7 feet x 30 feet net set for one hour. The area of the larger nets was approximately 1.5 times the area of the 7 feet x 30 feet net; therefore, mist net hours with the 7.9 feet x 39.4 feet nets were computed with 1.5 nets.

Mist nets were usually set near sunrise and taken up near sunset. They were situated with the bottom edge of the net touching the ground, usually in pairs (two nets, end to end).

## RESULTS AND DISCUSSIONS

### Vegetation

The study area portion of the Thistlethwaite Wildlife Management Area is described as a mature bottomland hardwood forest (Figures 2 and 3). Results of the forest tree sampling are presented in Table 3. There was an average of 76 trees per acre. Basal Area of trees equal to or greater than 9 inches dbh was 101.8 sq. ft. per acre. Average height of dominant trees was 85 feet. There were 18 species of trees encountered on the 43 0.1-acre plots. Of these, six were bottomland oaks (Quercus). Eight species constituted 90 percent of the total trees. These were, in decreasing order of abundance, Water Oak (Quercus nigra), Sweetgum (Liquidambar styraciflua), Sugarberry (Celtis laevigata), Cherrybark Oak (Quercus falcata var. pagodaefolia), Cow Oak (Quercus michauxii), Green Ash (Fraxinus pennsylvanica), and American Elm (Ulmus americana). Water Oak was, by far, the most abundant species. It was found in 91 percent of the plots, comprising 36.9 percent of all trees, and 41.5 percent of tree basal area.

Woody vegetation from 1 to 9 inches dbh was sampled

Figure 2. Summer vegetative cover on the Thistlethwaite Wildlife Management Area, May 1974.

Figure 3. Winter vegetative cover on the Thistlethwaite Wildlife Management Area, February 1974.

Table 3. Overstory vegetation composition of a selected portion of the Thistlethwaite Wildlife Management Area, 1974.

| Common name | Scientific name | Number per acre | Basal area (B. A.) per acre (sq. ft.) | Relative density | Relative dominance (B. A.) | Frequency of occurrence |
|---|---|---|---|---|---|---|
| | | | | Percent | | |
| Water Oak | *Quercus nigra* | 27.9 | 42.3 | 36.9 | 41.5 | 91 |
| Sweetgum | *Liquidambar styraciflua* | 11.4 | 10.6 | 15.1 | 10.4 | 70 |
| Sugarberry | *Celtis laevigata* | 8.6 | 10.3 | 11.4 | 10.1 | 49 |
| Cherrybark Oak | *Quercus falcata* var. *pagodaefolia* | 7.4 | 12.9 | 9.8 | 12.7 | 40 |
| Cow Oak | *Quercus michauxii* | 4.9 | 8.9 | 6.5 | 8.7 | 35 |
| Green Ash | *Fraxinus pennsylvanica* | 4.4 | 4.7 | 5.8 | 4.6 | 33 |
| American Elm | *Ulmus americana* | 2.3 | 2.6 | 3.0 | 2.6 | 23 |
| Pignut Hickory | *Carya glabra* | 2.3 | 1.7 | 3.0 | 1.7 | 23 |
| American Sycamore | *Platanus occidentalis* | 1.6 | 2.2 | 2.1 | 2.2 | 14 |
| Nuttall Oak[b] | *Quercus nuttallii* | 1.4 | 2.8 | 1.8 | 2.8 | 12 |
| Ironwood | *Carpinus caroliniana* | 1.2 | 0.6 | 1.5 | 0.6 | 9 |
| Honeylocust | *Gleditsia triacanthos* | 0.7 | 0.7 | 0.9 | 0.7 | 7 |
| Shumard Oak | *Quercus shumardii* | 0.5 | 0.6 | 0.7 | 0.6 | 5 |

Table 3. (Continued)

| Common name | Scientific name | Number per acre | Basal area (B. A.) per acre (sq. ft.) | Relative density | Relative dominance (B. A.) | Frequency of occurrence |
|---|---|---|---|---|---|---|
| | | | | - - - - - - - - Percent - - - - - - | | |
| Post Oak | Quercus stellata | 0.2 | 0.2 | 0.3 | 0.2 | 2 |
| Hercules'-club | Zanthoxylum clava-herculis | 0.2 | 0.1 | 0.3 | 0.1 | 2 |
| Boxelder | Acer negundo | 0.2 | 0.2 | 0.3 | 0.2 | 2 |
| Red Maple | Acer rubrum var. drummondii | 0.2 | 0.2 | 0.3 | 0.2 | 2 |
| American Basswood | Tilia caroliniana | 0.2 | 0.2 | 0.3 | 0.2 | 2 |
| | | 76 | 101.8 | | | |

[a]Determined from 43 0.1 acre circular sample plots of trees nine inches and above diameter breast height.

[b]From Fernald (1950).

on 44 0.01-acre circular plots (Table 4). In this size category there were 154 stems per acre totaling 20.9 sq. ft. basal area per acre. Of the 16 species recorded, 13 were mid-story reproduction of common tree species on the area. Plant species likely to remain in the one to nine inch size category were the common Muscadine (Vitis rotundifolia) and uncommon Hawthorn (Crataegus sp.). Ironwood (Carpinus caroliniana) was the main plant in the woody mid-story. Although a few Ironwoods (1.2 per acre) surpassed the 9 inch criterion, most (25 per acre) were small. Over 50 percent of this 1 to 9 inch group was made up of Ironwood, Sugarberry, American Elm, and Pignut Hickory (Carya glabra var. megacarpa).

Winter ground vegetation less than 6 feet high is presented in Table 5, and summer ground vegetation is presented in Table 15 (appendix). There were many more species tallied in the summer sampling than in the winter sampling. During summer 60 species were recorded, whereas, only 35 species were recorded in winter. I believe only a few of these summer plants were of any importance in regard to bird habitat. During summer six species comprised over 61 percent of average cover. These were, in decreasing order of cover: Cane, Sedges (Cyperaceae), Poison Ivy (Rhus radicans), Ironwood, Palmetto, and Jumpseed (Tovara

Table 4. Mid-story vegetation composition of a selected portion of the Thistlethwiate Wildlife Management Area, February 1974.

| Common name | Scientific name | Number per acre | Basal area (B. A.) per acre (sq. ft.) | Relative density | Relative dominance (B. A.) | Frequency of occurrence |
|---|---|---|---|---|---|---|
| | | | | Percent | | |
| Ironwood | Carpinus caroliniana | 25.0 | 4.2 | 16.2 | 20.1 | 25 |
| Sugarberry | Celtis laevigata | 20.4 | 4.3 | 13.2 | 20.6 | 7 |
| American Elm | Ulmus americana | 15.9 | 1.7 | 10.3 | 8.1 | 16 |
| Pignut Hickory | Carya glabra | 15.9 | 2.0 | 10.3 | 9.6 | 14 |
| Sweetgum | Liquidambar styraciflua | 13.6 | 2.0 | 8.8 | 9.6 | 11 |
| Muscadine | Vitis rotundifolia | 13.6 | 0.4 | 8.8 | 1.9 | 9 |
| Cow Oak | Quercus michauxii | 11.4 | 1.8 | 7.4 | 8.6 | 9 |
| Water Oak | Quercus nigra | 9.1 | 2.1 | 5.9 | 10.0 | 9 |
| Hawthorn | Crataegus sp. | 9.1 | 0.2 | 5.9 | 0.9 | 5 |
| Winged Elm | Ulmus alata | 6.8 | 0.1 | 4.4 | 0.5 | 1 |
| Green Ash | Fraxinus pennsylvanica | 4.5 | 0.3 | 2.9 | 1.5 | 5 |
| Post Oak | Quercus stellata | 2.3 | 0.1 | 1.5 | 0.5 | 2 |
| Cherrybark Oak | Quercus falcata var. pagodaefolia | 2.3 | 0.3 | 1.5 | 1.4 | 2 |

Table 4. (Continued)

| Common name | Scientific name | Number per acre | Basal area (B. A.) per acre (sq. ft.) | Relative density | Relative dominance (B. A.) | Frequency of occurrence |
|---|---|---|---|---|---|---|
| | | | | Percent | | |
| American Sycamore | Platanus occidentalis | 2.3 | 0.8 | 1.5 | 3.8 | 2 |
| Honeylocust | Gleditsia triacanthos | 2.3 | 0.6 | 1.5 | 2.9 | 1 |
| | | 154.5 | 20.9 | 100.1 | 100.0 | |

[a]Determined from 43 0.01-acre circular sample plots of vegetation 1 to 9 inches diameter breast height.

Table 5. Winter understory vegetative composition of a portion of the Thistlethwaite Wildlife Management Area, February 1974.

| Common name | Scientific name | Average cover | Frequency of occurrence |
|---|---|---|---|
| | | -----Percent----- | |
| Cane | Arundinaria gigantea | 23.3 | 70.4 |
| Sedges | Cyperaceae (family) | 11.8 | 86.4 |
| Oak | Quercus spp. | 4.8 | 81.8 |
| Palmetto | Sabal minor | 4.8 | 40.9 |
| Violet | Viola sp. | 3.8 | 61.4 |
| Cross Vine | Anisostichus capreolata | 3.1 | 61.4 |
| Dewberry | Rubus sp. | 3.0 | 45.4 |
| Aster | Aster sp. | 2.4 | 47.7 |
| Greenbriar | Smilax spp. | 2.0 | 40.9 |
| Nemophila | Nemophila microcalyx | 1.6 | 13.6 |
| Sugarberry | Celtis laevigata | 1.3 | 11.4 |
| Rattan Vine | Berchemia scandens | 1.2 | 20.4 |
| Ironwood | Carpinus caroliniana | 1.1 | 22.7 |
| Oplismenus | Oplismenus setarius | 0.9 | 18.2 |
| Geum | Geum canadense | 0.9 | 18.2 |
| Erigeron | Erigeron sp. | 0.7 | 13.6 |
| Green Ash | Fraxinus pennsylvanica | 0.4 | 9.1 |
| Butterweed | Senecio glabellus | 0.4 | 9.1 |

Table 5. (continued)

| | | | |
|---|---|---|---|
| Buttercup | Ranunculus sp. | 0.4 | 4.6 |
| Muscadine | Vitis rotundifolia | 0.4 | 9.1 |
| Elderberry | Sambucus candensis | 0.3 | 2.3 |
| Virginia Creeper | Parthenociosus quinquefolia | 0.3 | 6.8 |
| Poison Ivy | Rhus radicans | 0.3 | 6.8 |
| Swamp Dogwood | Cornus drummondii[a] | 0.2 | 4.6 |
| Honey-locust | Gleditsia triacanthos | 0.2 | 4.6 |
| Chickweed | Stelaria media | 0.2 | 4.6 |
| Spilantes | Spilanthes americana | 0.2 | 4.6 |
| Grass | Poaceae (family) | 0.1 | 2.3 |
| Boxelder | Acer negundo | 0.1 | 2.3 |
| Trifoliate Orange | Poncirus trifoliata | 0.1 | 2.3 |
| Vetch | Vicia sp. | 0.1 | 2.3 |
| Hydrocotyl | Hydrocotyl sp. | 0.1 | 2.3 |
| Coralbeads | Cocculus carolinus | 0.1 | 2.3 |
| Pignut Hickory | Carya glabra | 0.1 | 2.3 |
| Dayflower | Commelina virginica | 0.1 | 2.3 |

a. from Fernald (1950).

virginiana). Sedges and Jumpseed grew near the ground. Poison Ivy grew near the ground and also climbed on other vegetation. Palmetto had a taller profile, growing commonly to 4 or 5 feet, and occasionally higher. Ironwood, which was the main woody plant of the mid-story, represented 5 percent of the ground cover during summer. Cane was also a main ground and mid-story constituent. Mean coverage of cane over the area within 6 feet of the ground was 27.7 percent.

During the winter vegetation sampling in February, fewer species (35) and less cover were noted. Four species covered more than 44 percent of the area. Sedges were located near the ground and oak seedlings were mostly less than 2 feet above ground. Cane and Palmetto were primary winter vegetation components from ground to 6 feet, and above. I believe these two species were the most important ones in providing understory bird habitat in winter. Cane, Palmetto, and Ironwood were, in my opinion, the primary plant species serving as bird habitat in summer.

## Vertical Distribution

### Species and Families

Individual species and family groupings are considered first. Black Vultures had the highest mean vertical

distributions (Table 6). Over 2/3 of the sightings were of soaring birds above the canopy.

The woodpeckers were predominately canopy dwellers. Snags and living tree limbs provided abundant food sources for the seven species of Picidae found at Thistlethwaite. Of all sightings, 68 percent were above 25 feet and less than 3 percent were found near the ground (Figure 4). Most relied heavily on the forest canopy. Pileated Woodpeckers and Red-bellied Woodpeckers showed no difference from the aggregate of woodpecker distributions. Of the five individual species of Picidae, three differed in vertical distribution ($P < .01$) from the aggregate of the Picidae. Although commonly seen in the canopy and mid-story, Common Flickers were more ground oriented than the other woodpeckers. Of 43 sightings, nine (21 percent) were within two feet of the ground. As expected, their diversity index (DI) was completely different from the other members of the family. This bird had the second most diverse vertical distribution in the woods (DI-1.056, Table 7). Yellow-bellied Sapsuckers were a fairly diverse (DI= 0.762), mainly mid-story occupant. Secondarily, they were canopy occupants (41 percent of sightings) during their winter presence. They differed by only 3 percent from the mean of all birds in vertical diversity index. Red-headed

Table 6. Relative mean vertical height of common Thistlethwaite birds based on frequency of occurrence in three strata (determined from monthly sightings, January 1972 to February 1974)[a]

| Species | Mean height[b] | Species | Mean height |
|---|---|---|---|
| Black Vulture | 3.50 | Common Flicker | 2.23 |
| Common Crow | 3.04 | Ruby-crowned Kinglet | 2.14 |
| Red-headed Woodpecker | 2.80 | White-eyed Vireo | 2.13 |
| Blue Jay | 2.75 | American Goldfinch | 2.10 |
| Pileated Woodpecker | 2.74 | Brown Thrasher | 2.08 |
| Carolina Chickadee | 2.67 | Carolina Wren | 2.01 |
| Red-bellied Woodpecker | 2.66 | Cardinal | 2.00 |
| Tufted Titmouse | 2.51 | American Robin | 1.94 |
| Yellow-bellied Sapsucker | 2.39 | Kentucky Warbler | 1.88 |
| Yellow-rumped Warbler | 2.34 | Hermit Thrush | 1.77 |
| Brown-headed Cowbird | 2.30 | Rusty Blackbird | 1.74 |
| Hooded Warbler | 2.24 | Rufous-sided Towhee | 1.41 |
| Mockingbird | 2.24 | White-throated Sparrow | 1.27 |
| | | | 58.88 |
| | | | $\bar{x}$ 2.26 |

[a] Fourth stratum (above canopy) used only for Black Vulture and Common Crow.

[b] Means were computed by multiplying number of sightings in each stratum by: 1 for stratum 1 (ground -2 feet), 2 for stratum 2 (2 feet - 25 feet), and 3 for stratum 3 (25 feet - canopy top). The sum of these products for each species was then divided by total sightings, giving relative mean height.

Figure 4. Vertical height distribution of common birds on the Thistlethwaite Wildlife Management Area as determined from monthly sightings, January 1972 to February 1974.

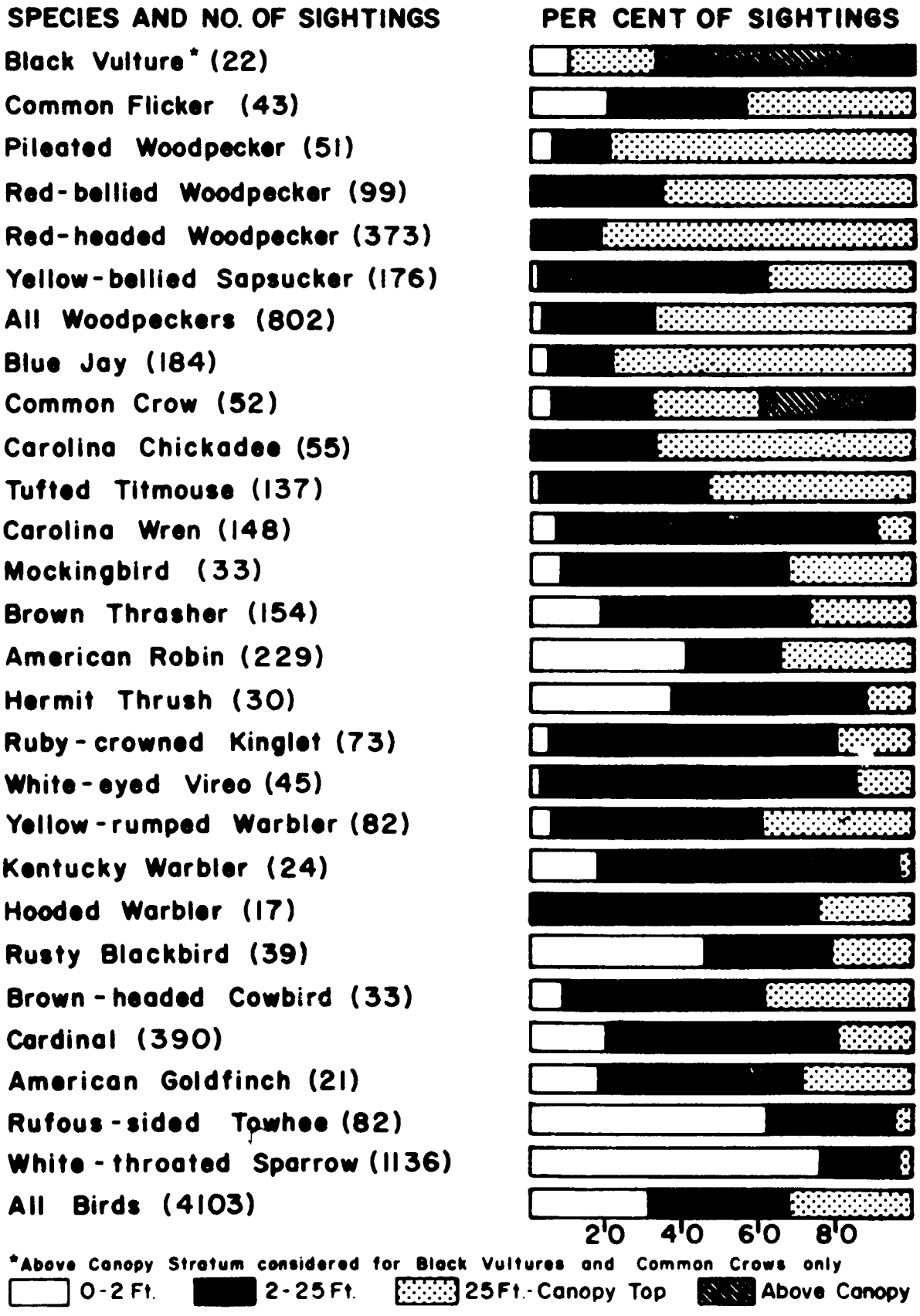

SPECIES AND NO. OF SIGHTINGS
PER CENT OF SIGHTINGS
Black Vulture* (22)
Common Flicker (43)
Pileated Woodpecker (51)
Red-bellied Woodpecker (99)
Red-headed Woodpecker (373)
Yellow-bellied Sapsucker (176)
All Woodpeckers (802)
Blue Jay (184)
Common Crow (52)
Carolina Chickadee (55)
Tufted Titmouse (137)
Carolina Wren (148)
Mockingbird (33)
Brown Thrasher (154)
American Robin (229)
Hermit Thrush (30)
Ruby-crowned Kinglet (73)
White-eyed Vireo (45)
Yellow-rumped Warbler (82)
Kentucky Warbler (24)
Hooded Warbler (17)
Rusty Blackbird (39)
Brown-headed Cowbird (33)
Cardinal (390)
American Goldfinch (21)
Rufous-sided Towhee (82)
White-throated Sparrow (1136)
All Birds (4103)
2'0
4'0
6'0
8'0
*Above Canopy Stratum considered for Black Vultures and Common Crows only
0-2 Ft.
2-25 Ft.
25 Ft.-Canopy Top
Above Canopy

Table 7. Vertical height diversity of common birds in three height categories on the Thistlethwaite Wildlife Management Area (determined from monthly sightings, January 1972 to February 1974).

| Species | Diveristy[a] | Species | Diversity |
|---|---|---|---|
| Maximum Diversity[b] | 1.099 | Yellow-bellied Sapsucker | .762 |
| American Robin | 1.075 | Red-bellied Woodpecker | .682 |
| Common Flicker | 1.056 | Ruby-crowned Kinglet | .678 |
| Rusty Blackbird | 1.051 | White-throated Sparrow | .650 |
| American Goldfinch | 1.014 | Carolina Chickadee | .634 |
| Brown Thrasher | 1.006 | Pileated Woodpecker | .622 |
| Hermit Thrush | .980 | Kentucky Warbler | .616 |
| Cardinal | .950 | Blue Jay | .604 |
| Brown-headed Cowbird | .924 | Carolina Wren | .571 |
| Mockingbird | .898 | Hooded Warbler | .551 |
| Yellow-rumped Warbler | .868 | White-eyed Vireo | .534 |
| Tufted Titmouse | .801 | Red-headed Woodpecker | .513 |
| Rufous-sided Towhee | .792 | | 18.832 |
| | | $\bar{X}$ | .785 |

a. Computed by information theory (Height diversity = $-\Sigma P_i \log_e P_i$, where $P_i$ = proportion of observations in the ith height category).

b. Equal distribution in all height categories, height diversity= 1.099; distribution in only one height category, height diversity=0.

Woodpeckers also differed from the Picidae group in being the most heavily canopy dependent (82 percent, as opposed to 68 percent for all Picidae). The Red-headed Woodpecker was the most limited in vertical distribution of all birds (DI=0.513, Table 7).

The corvids were located high in the Thistlethwaite woods (Table 6). Blue Jays were closely associated with the canopy level (mean height 2.75, DI=0.604). They were even more strongly canopy oriented than the Picidae ($x^2$=12.6, $P < .01$). Common Crows were located even higher, with 40 percent of their sightings above the tree tops.

The similarly distributed ($P > .01$) Tufted Titmouse and Carolina Chickadee were common canopy occupants. Fifty-four percent of the Tufted Titmice and 67 percent of the Carolina Chickadees were observed in the canopy. They were both less frequently observed in the mid-story (43 percent titmice, 33 percent chickadees). The Paridae, along with the Picidae, were the least frequent ground level occupants. Titmice were observed there in three percent of their detections, and of 55 sightings not one chickadee was observed near the ground. The diversity of each was within 19 percent of the mean of all species.

The Carolina Wren was very closely associated with the mid-story area. Eighty-three percent of the Carolina Wrens

sighted were in the mid-story. The chi square value for the comparison of wrens to the aggregate of all birds (which was also most numerous in mid-story sightings) was 128.6. Supporting this idea of mid-story association is the low height diversity of .571.

The Mimidae (Northern Mockingbirds and Brown Thrashers) was a vertically diverse group (DI=0.898 Northern Mockingbirds, DI=1.006 Brown Thrashers), tending toward the mid-story level. Over 50 percent of the sightings of each were in this level.

The Turdidae exhibited an unusual pattern of height distributions. Although I assumed my intrusion into the woods had no influence on bird heights, I may have had some effect on the heights at which Hermit Thrushes and American Robins were observed. Half of the Hermit Thrust sightings were in the mid-story and over one third on the ground (Figure 4). Perhaps a small portion of the mid-story sightings were of birds that flew there from the ground due to my disturbance. The robin was the most uniformly distributed bird in the three strata (DI=1.075). Most were detected in the forest canopy (41 percent), slightly fewer on the ground (35 percent), and a few less in the mid-story (24 percent).

Ruby-crowned Kinglets were common mid-story winter

residents in the Thistlethwaite woods. Of 73 sight tallies 75 percent were within the 2-25 feet level. The ground stratum was of little importance (5 percent) and the canopy stratum was of medium importance (19 percent). Their dispersal between the three strata was 0.678, which was near the mean of all species (0.785).

White-eyed Vireos were the only breeding vireo commonly seen. These birds were closely associated with the mid-story. This is shown by the proportion of mid-story sightings (82 percent) and the low height diversity (0.534, second lowest of all birds). Although there were insufficient sightings of Red-eyed and Yellow-throated Vireos for valid conclusions, the few that were sighted, and those aurally detected, showed a canopy preference.

Yellow-rumped Warblers, one of two common winter warblers, were located mainly from mid-story (54 percent) to canopy (40 percent). The two commonly seen breeding season warblers (Kentucky Warbler and Hooded Warbler) were narrow in their forest profile utilization. Over 75 percent of sightings of Kentucky Warblers and Hooded Warblers were in the 2-25 feet stratum, and the height diversity of each was less than the mean of all birds by more than 25 percent. They appeared to differ in utilization of the ground stratum (4 of 24 sightings-Kentucky Warblers, 0 of

17 sightings-Hooded Warbler), although there were insufficient data for a valid statistical test.

Brown-headed Cowbirds were mainly a mid-story, and secondarily a canopy occupant (DI=0.924). Rusty blackbirds were diversely distributed (DI=1.051, 34 percent higher than the mean for all birds), found on the ground, mid-story, and canopy in decreasing order of occurrence.

The seed eating fringillids, as expected, tended to be close to the ground. The two species (White-throated Sparrow and Rufous-sided Towhee) found most frequently near the ground were in this family (Table 6). Seventy-six percent of the White-throated Sparrows and 62 percent of the Rufous-sided Towhees were detected within two feet of the ground. Conversely, only 3 percent of the sparrows and 4 percent of the towhees were detected in the tree canopies. The Northern Cardinal and the less common American Goldfinch differed ($P < .01$) from other fringillids. Both were mainly located in mid-story (60 percent of cardinals and 52 percent of goldfinches), and both showed high dispersal within the three strata (DI > 20 percent higher than the mean of all species).

The aggregate heights of all birds revealed a farily uniform utilization of the different strata by the sum of the avian community. However, most individual species were

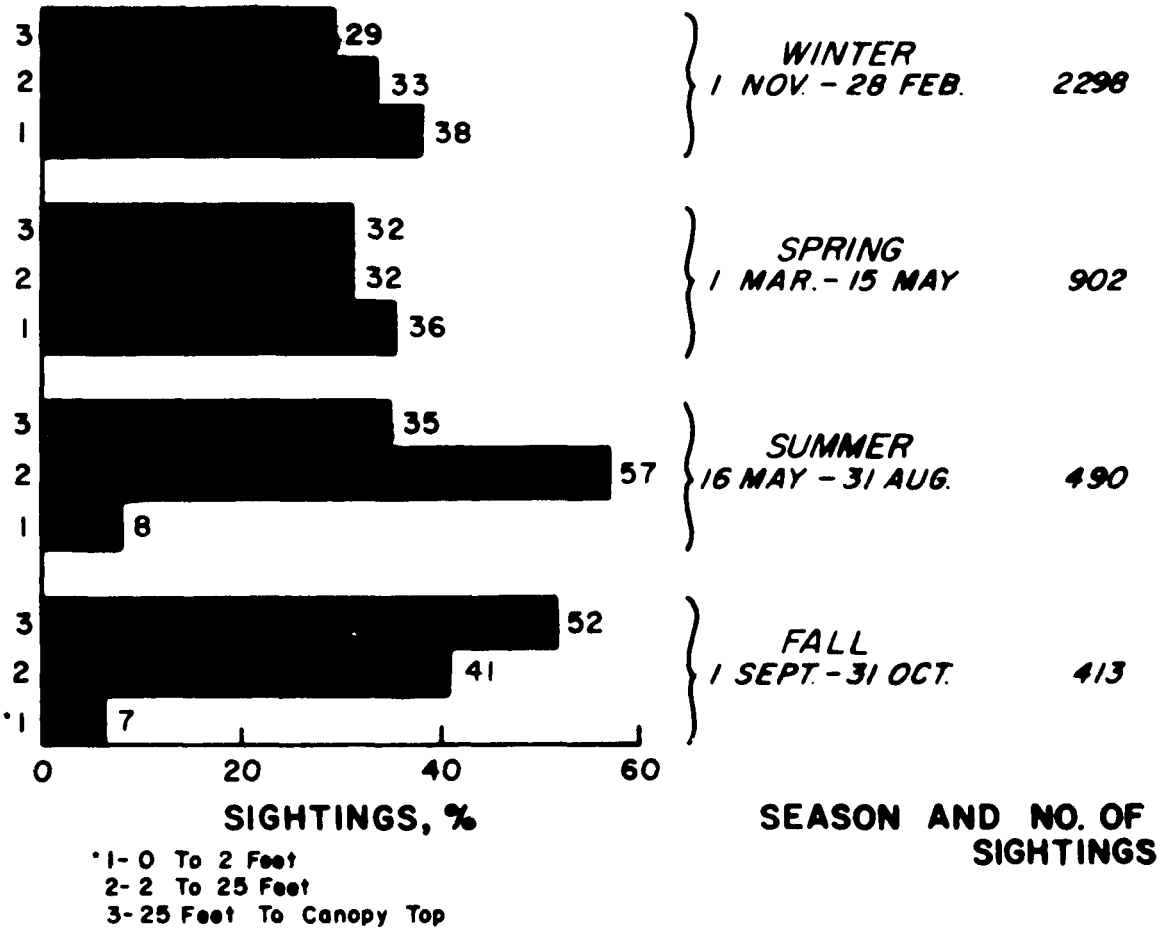
more specialized than the overall sum. Of the different species investigated, only Brown-headed Cowbirds, American Goldfinch, Hermit Thrush, and Northern Mockingbirds did not differ significantly ($P > .05$) in height distribution from the aggregate of sightings of all species. These species were commonly found in all strata and as a result, exhibited a greater than average height diversity.

Seasonal Vertical Distribution

Seasonal shifts in vertical distribution were evident in Thistlethwaite birds. Due to the seasonal occurrence of some species, and the small number of samples of many others when broken down into seasons, individual species were usually grouped into higher taxons or on a residency status basis.

There was a gradual shift in distribution of birds upward in height through the three strata from the winter season through spring to the summer breeding season. Generally, there was a slight shift upwards from winter to spring, and another more pronounced shift from spring to summer. The comparison of winter to summer showed decided differences. There was a slight, but nonsignificant ($P > .05$), shift upward in height for the aggregate of all birds and permanent residents considered separately (Figures 5 and 6). For all birds ground detections fell from 38 percent to 36

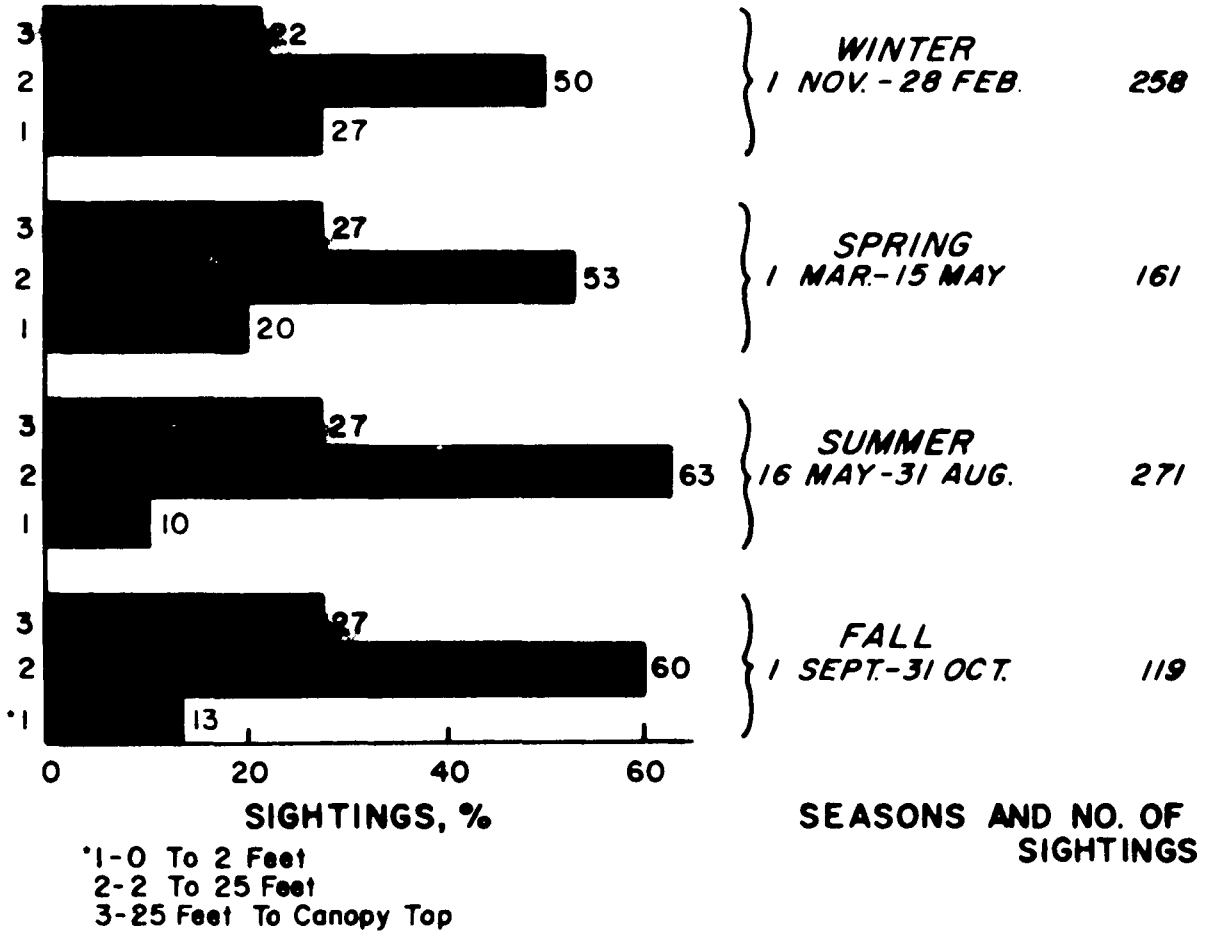
Figure 5. Seasonal vertical distribution of Thistelthwaite birds, January 1972 to February 1974.




## SEASONAL VERTICAL DISTRIBUTION OF THISTLETHWAITE BIRDS

(COMMON GRACKLES AND CEDAR WAXWINGS NOT INCLUDED)

Figure 6. Seasonal vertical distribution of permanent resident Thistlethwaite birds, January 1972 to February 1974.




## SEASONAL VERTICAL DISTRIBUTION OF PERMANENT RESIDENT THISTLETHWAITE BIRDS

(CAROLINA CHICKADEE, TUFTED TITMOUSE, CAROLINA WREN, CARDINAL, RUFOUS-SIDED TOWHEE)

percent and canopy detections rose from 29 to 32 percent from winter to spring. In the permanent resident group, ground detections fell from 27 to 20 percent and canopy sightings increased from 22 to 27 percent from winter to spring. Common fringillids (White-throated Sparrows, Rufous-sided Towhees, and Northern Cardinals), which were, in part, included in the two previous groupsings, showed a significant ($P < .05$) shift upward in distribution from winter to spring. Ground detection fell from 70 to 65 percent, and canopy detections increased from 4 to 7 percent, as the birds responded to the seasonal spring flourish of primary production of trees and the corresponding shift of available food. White-throated Sparrows and Northern Cardinals were commonly observed feeding on new buds and samaras of American Elm in March. This winter to spring height distribution shift of the common fringillids was partially responsible for the change in height distribution of other bird groupings in which the fringillids may have been included (permanent residents and all birds).

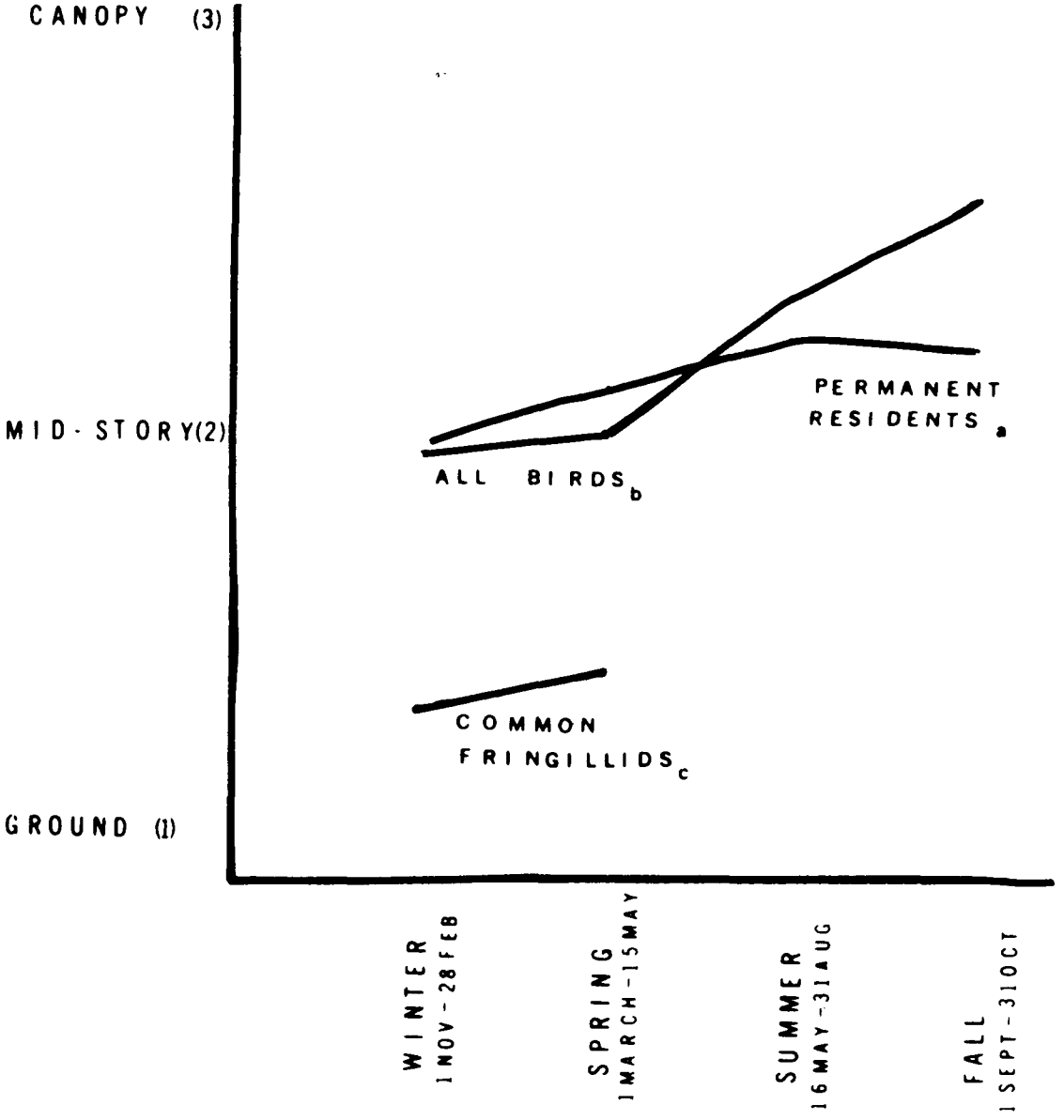
The movement from ground to mid-story, and from mid-story to canopy, was more pronounced from spring to summer. In comparing the spring to summer distributions of all birds combined, a chi square value of 144 was noted. Ground sightings declined to 8 percent, mid-story sightings

increased to 57 percent, and canopy sightings increased to 35 percent. The increase in mean height of birds (Figure 7) sbustantiated this upward movement. This was partially due to a species change between seasons. The departure of White-throated Sparrows from February to April lessened the lower strata detections. But this was not the complete picture. The permanent residents also exhibited a significant ($X^2$=8.98, $P < .05$) shift upward in the forest in response to the vegetation profile change.

A highly significant difference ($P < .01$) was noted between vertical height distributions of winter and summer for common permanent residents and the aggregate of all birds. There was a slight change in height distribution from winter to spring, and a more pronounced change from spring to summer. The winter to summer comparison embodied these two lesser seasonal height distribution changes.

The summer to fall comparison showed no discernible shift in vertical distribution of Thistlethwaite birds. Ground detection percentages remained virtually unchanged for all birds and permanent residents. Figure 5 reveals a shift of about 16 percent of sightings of all birds from mid-story to canopy. I believe this was misleading due to the autum arrival of numerous Red-headed Woodpeckers. This conspicuous canopy dweller inflated the number of

Figure 7. Seasonal mean vertical heights of Thistlethwaite birds, January 1972 to February 1974.




(a) CAROLINA CHICKADEE TUFTED TITMOUSE, CAROLINA WREN, CARDINAL, RUFOUS-SIDED TOWHEE

(b) EXCEPT COMMON GRACKLE AND CEDAR WAXWING

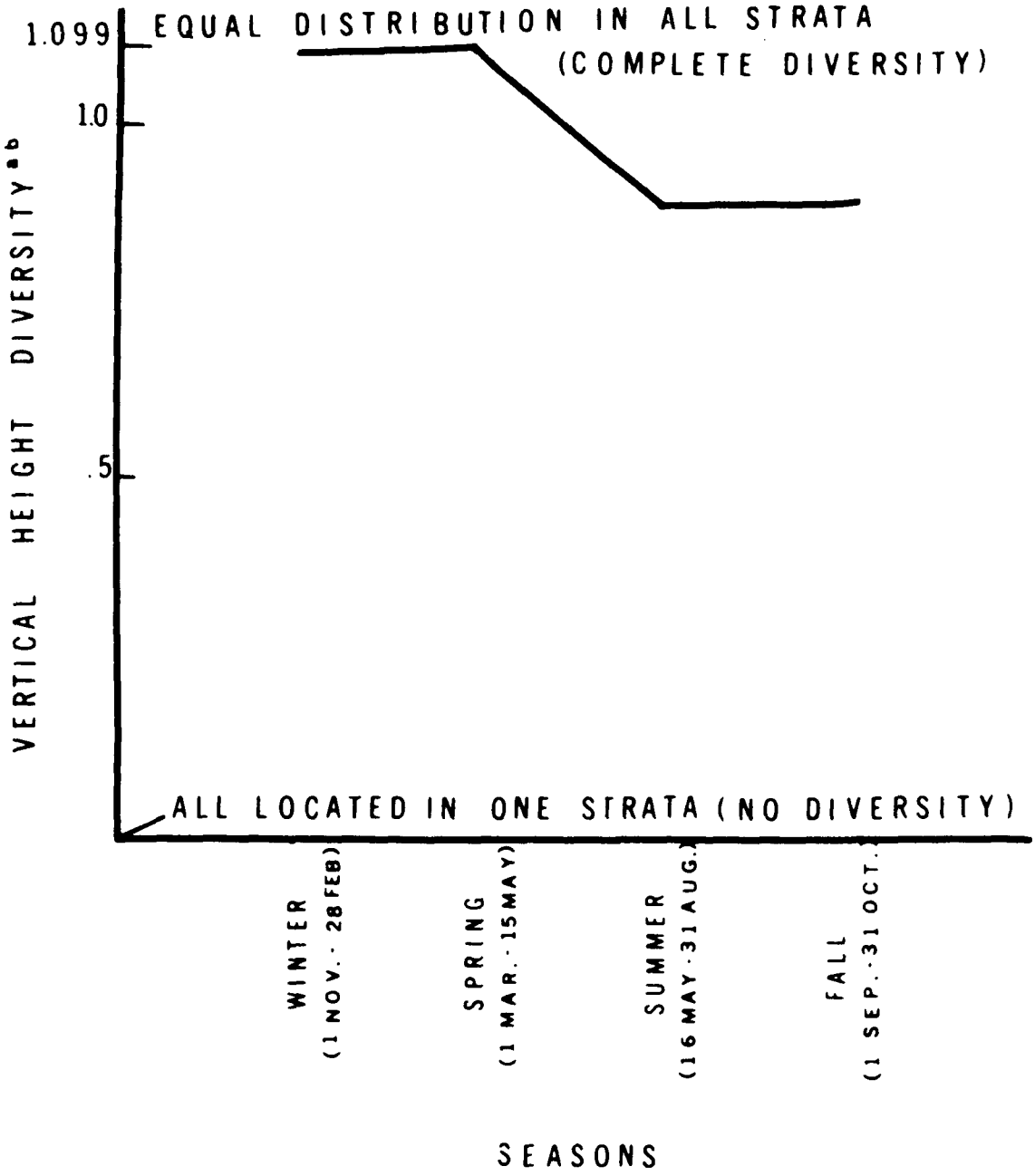
(c) CARDINAL, WHITE-THROATED SPARROW, RUFOUS SIDED TOWHEE

canopy detections. A check of the common permanent residents revealed no change in vertical distribution from summer to fall (Figure 6, $P > .01$).

The fall to winter change in vertical distribution was a reverse of the winter to spring and spring to summer elevation shift in bird heights. In the fall, and expecially early winter, gravity lowered the previous spring's primary production toward the ground. As the vegetation profile shifted so did the avifauna. The birds redistributed themselves at lower levels in the profile. There was a highly significant difference ($P < .01$) between fall and winter for the aggregate of all birds, and for permanent residents.

This seasonal height distribution change resulted in a corresponding change in vertical height diversity (Figure 8). Although there were too few monthly sightings of permanent residents for treatment, data for all birds were summed by months and compared between seasons with the students test. For comparison, a complete uniform dispersal in three categories would yield a figure of 1,099, and conversely no dispersal (or all birds in one stratum) would have a diversity value of zero. Diversities for the four seasons were: winter (1.092), spring (1.097), summer (0.890), and fall (0.894). Although there was a slight shift upward

Figure 8. Seasonal vertical height diversity of Thistlethwaite birds, January 1972 to February 1974.




a. THREE HEIGHT CATEGORIES: 0 - 2 FT., 2 - 25 FT., 25 FT. - CANOPY TOP

b. HEIGHT DIVERSITY CALCULATED BY INFORMATION THEORY - $\Sigma P_i \log_e P_i$, WHERE $P_i$ = PROPORTION OF OBSERVATIONS IN $i$TH HEIGHT CATEGORY

in height from winter to spring, the diversity of vertical distribution of all birds remained the same ($P > .05$). The spring to summer change in heights resulted in less dispersal ($t=2.71$, $P < .05$) as the birds moved away from the ground. The diversity differences between winter and summer were highly significant ($t=5.46$, $P < .01$). There was no change from summer to fall ($P > .05$), and a highly significant difference ($P < .01$) between fall and winter as the birds redistributed themselves toward the ground during the winter.

## Population Estimates

### Species Detectability

Effective detection distances of common birds (i.e., those detected more than 10 times) are shown in Table 8. These effective detection distances ranged from 62 feet for the more inconspicuous avian forest inhabitants to 206 feet for those more easily seen or heard.

The group detected to 62 feet was essentially non-vocal during the season of their presence (Table 9). Black Vultures, Hairy Woodpeckers, Downy Woodpeckers, White-throated Sparrows, Cedar Waxwings, Yellow-rumped Warblers, and Ruby-crowned Kinglets were included in the group detected the shortest distance. The Black Vulture is the

Table 8. Effective detection distances of birds censused from transect line on the Thistlethwaite Wildlife Management Area, January 1972 to February 1974.[ab]

| 62 Feet | 82 Feet |
|---|---|
| Black Vulture | Gray Catbird |
| Hairy Woodpecker | Carolina Chickadee |
| Downy Woodpecker | Prothonotary Warbler |
| Ruby-cronwed Kinglet | Northern Parula Warbler |
| Cedar Waxwing | Kentucky Warbler |
| Yellow-rumped Warbler | Hooded Warbler |
| White-throated Sparrow | Rusty Blackbird |
| | Common Grackle |
| **103 Feet** | |
| Red-headed Woopecker | Hermit Thrush |
| Yellow-bellied Sapsucker | Swainson's Warbler |
| Acadian Flycatcher | Brown-headed Cowbird |
| Brown Thrasher | Cardinal |
| American Robin | American Goldfinch |
| | Rufous-sided Towhee |
| **206 Feet** | |
| Yellow-billed Cuckoo | Tufted Titmouse |
| Common Flicker | Carolina Wren |
| Pileated Woodpecker | Mockingbird |
| Red-bellied Woodpecker | Wood Thrush |
| Great Crested Flycatcher | Starling |
| Blue Jay | White-eyed Vireo |

Table 8. (Continued)

| | |
|---|---|
| Common Crow | Yellow-throated Vireo |
| | Red-eyed Vireo |
| 412 Feet | |
| Red-shouldered Hawk | Barred Owl |

a. limited to species detected a minimum of 10 times.

b. effective detection distance is distance perpendicular from transect line beyond which detections fall below 75 percent of detections at distances nearer the transect line.

Table 9. Comparision of aural and visual detections of birds censused on the Thistlethwaite Wildlife Management Area, January 1972 to February 1974.[ab]

| Species | Percent of Observations Detected | | Total Detections |
|---|---|---|---|
| | Visually | Aurally | |
| Black Vulture | 100 | | 16 |
| Red-shouldered Hawk | 10 | 90 | 48 |
| Yellow-billed Cuckoo | 6 | 94 | 235 |
| Barred Owl | 23 | 77 | 35 |
| Common Flicker | 38 | 62 | 103 |
| Pileated Woodpecker | 30 | 70 | 178 |
| Red-bellied Woodpecker | 16 | 84 | 563 |
| Red-headed Woodpecker | 51 | 49 | 653 |
| Yellow-bellied Sapsucker | 67 | 33 | 246 |
| Downy Woodpecker | 84 | 16 | 19 |
| Great Crested Flycatcher | 15 | 85 | 41 |
| Acadian Flycatcher | 4 | 96 | 103 |
| Blue Jay | 38 | 62 | 593 |
| Common Crow | 58 | 42 | 52 |
| Carolina Chickadee | 81 | 19 | 67 |
| Tufted Titmouse | 10 | 90 | 988 |
| Carolina Wren | 6 | 94 | 1688 |
| Mockingbird | 55 | 45 | 60 |
| Gray Catbird | 54 | 46 | 13 |
| Brown Thrasher | 43 | 57 | 307 |
| American Robin | 70 | 30 | 260 |
| Wood Thrush | 14 | 86 | 64 |
| Hermit Thrush | 21 | 79 | 78 |
| Ruby-crowned Kinglet | 94 | 6 | 63 |
| Cedar Waxwing | 100 | | 21 |
| Starling | 21 | 79 | 14 |
| White-eyed Vireo | 3 | 97 | 907 |
| Yellow-throated Vireo | 13 | 87 | 87 |

Table 9. (Continued)

| Species | Percent of Observation Detected | | Total Detections |
|---|---|---|---|
| | Visually | Aurally | |
| Red-eyed Vireo | 4 | 96 | 176 |
| Prothonotary Warbler | 32 | 68 | 28 |
| Swainson's Warbler | 9 | 91 | 22 |
| Northern Parula Warbler | 11 | 89 | 18 |
| Yellow-rumped Warbler | 100 | | 68 |
| Kentucky Warbler | 67 | 33 | 33 |
| Hooded Warbler | 37 | 63 | 43 |
| Rusty Blackbird | 92 | 8 | 39 |
| Brown-headed Cowbird | 92 | 8 | 37 |
| Summer Tanager | 31 | 69 | 32 |
| Cardinal | 34 | 66 | 949 |
| American Goldfinch | 78 | 22 | 28 |
| Rufous-sided Towhee | 70 | 30 | 121 |
| White-throated Sparrow | 99 | 1 | 1116 |

a. Limited to species detected a minimum of 10 times.

b. Individuals seen and heard simultaneously were omitted; all Common Grackles were omitted due to the preponderance of individuals seen and heard simultaneously.

oddest member here, and should probably be in a longer distance category. Fifteen of the 22 Black Vultures seen were within 62 feet of the transect. This distorted picture is due to their location and movement in the stratum above the canopy. I did not detect the flying birds until they were nearly directly overhead. Hairy and Downy Woodpeckers were the least conspicuous Picidae. They neither called loudly nor showed much movement. White-throated Sparrows demonstrated a detection pattern contrary to most other species. They showed a steady decline in detection as distance from the transect line increased. They were rarely detected aurally, were mostly in the ground stratum where the winter cover was thickest, and seemed to be less affected by the observer's intrusion than other species. Yellow-rumped Warblers showed a similar steady decline in detectability in distance from the transect. They were found in all strata, especially in the canopy level (Figure 4) where the observer had little effect on the birds' behavior. The last of the least conspicuous group, Ruby-crowned Kinglets, were small birds often found in the 2-25 feet stratum where the Cane and Palmetto winter cover was dense (Table 5).

Those slightly more conspicuous than the previous group were detected effectively to 82 feet. In this group were

two of the winter blackbirds, all but one of the common breeding warblers, one mimid, and one Paridae. The Carolina Chickadee and Gray Catbird were censused effectively to 82 feet. Many of the Common Grackles were first encountered in the above-canopy stratum when they were close to a vertical point above the observer. Rusty Blackbirds were usually found within 82 feet of the transect line. This distance was also the effective distance for Prothonotary Warblers, Northern Parula Warblers, Kentucky Warblers, and Hooded Warblers. No Prothonotary or parula warblers were detected beyond 103 feet. Two Hooded Warblers (4 percent) were detected beyond 103 feet, but the level of detection fell below 75 percent beyond 82 feet.

The 103 feet distance category contained 11 species in 6 families. Yellow-bellied Sapsuckers were common in winter and Red-headed Woodpeckers common in fall and winter. At these times of their peak population, neither were very loud voiced, but both were conspicuous visually and aurally to 103 feet. Acadian Flycatchers, common during the breeding season, were also not very loud voiced but were aurally detected easily to 103 feet. Brown-headed Cowbirds were detected effectively to this distance. American Goldfinch and Rufous-sided Towhees were detected effeciently within this distance category by sight and sound. Northern

Cardinals were the only species in which a seasonal pattern was discernible. They were detected efficiently to 103 feet in winter, spring, and fall. During the summer months in which they were singing profusely, detections were effective to 206 feet. Swainson's Warblers were the only Parulidae effectively detected to 103 feet. Their summer singing was of sufficient volume to permit census to this distance. American Robin, Brown Thrasher, and Hermit Thrush winter calls and sightings were effectively detected up to 103 feet.

More species were detected effectively to 206 feet than to any other distance. All, but for one exception were mainly detected by voice, which accounts for the relatively long detection distance. Yellow-billed Cuckoos were common breeding birds in this grouping. Common Flickers, Pileated Woodpeckers, and Red-bellied Woodpeckers, although frequently heard beyond 412 feet were effectively heard to 206 feet. Great-crested Flycatchers were commonly heard beyond 103 feet. Blue Jays and Common Crows were two common loud voiced birds. The vocal Tufted Titmouse and Carolina Wren were commonly heard up to 206 feet. The uncommon European Starling was detected effectively to 206 feet (based on a small sample of 15 sightings). Detections of the three common spring and summer Vireos (Red-eyed, Yellow-throated,

and White-eyed Vireo) were mostly of singing males. All were detected consistently to 206 feet. Northern Mockingbirds were forest edge dwellers which were detected by sight and sound between 103 and 206 feet. Wood Thrush, with their melodious far ranging song, were detected at distances beyond 412 feet, but beyond 206 feet the level of detection fell to approximately 50 percent of the 0 to 206 feet distance category.

Two loud voiced non-passerines were detected the farthest from the transect line. Barred Owls and Red-shouldered Hawks were heard at a consistent level from 0 to 412 feet. Both were heard beyond 412 feet but detections dropped sharply beyond this point.

## Comparison of Census Techniques

A few trends were noticeable from comparisons of census results (Table 2). Singing male census (Williams 1936) results from the 20-acre area were generally higher than the results from the same number of census trips (8) on the transect. Of the twelve common species of birds ($>1$ singing male per 20 acres), eight were more numerous on the area census. The transect counts were lower than the area counts by a range of 20 to 68 percent for the eight species. The total number of birds by the transect census was 21 percent less than the area census total. I believe

design of the censuses was the main reason underlying the difference. On the transect a one-mile path was followed. In censusing the rectangular area a series of essentially parallel strips were censused. The chances of the observer coming within the birds detection radius more than once was greater with the series of parallel strips, than with the one continuous strip. Strip widths were established as approximately twice the effective detection distance of the species with the shortest effective detection distance. Therefore, a small portion of these species with the shortest detection range (i.e., those outside the effective detection distance) and a substantial proportion of the species with longer detection distances, had a higher probability of being detected by a series of parallel transects. The censuser usually came within the detection radius of most of the birds more than once; therefore, there was a greater probability of detecting any one bird by the area census than by the transect census.

Results from the spot census technique (Table 2) indicated that estimated populations of singing males per unit area increased with number of individual censuses. Of the twelve common species censused, nine showed a steady increase in number from six to eleven individual censuses (counts). Only Yellow-billed Cuckoos, Acadian Flycatchers,

and Hooded Warblers showed no increase in estimated population with an increase in counts. Estimated total populations of territorial males increased by 39 percent from six to eight counts, and by 20 percent from eight to eleven counts. There was a 67 percent increase in total estimated birds as the number of counts was increased from six to eleven.

The less frequent census (6 counts) appeared to "miss" many singing males because of insufficient detections ($< 3$). Conversely, the most frequent census (12 counts) appeared to have more double counting as singing males relocated themselves into different territories during the census period. In a census consisting of six separate counts the probability of an individual bird emitting a detectable signal would have to be $> .50$ to be included as a territorial male in the census results (i.e., be counted $>$ three times). Preliminary results indicate many individuals do not meet this criterion. On the other hand, with many counts covering a long time span there is a greater chance of double counting singing males if they change their territories. This could possibly cause over-counting of singing males. Results from eight censuses probably come closest to the actual number of territorial males present. However, most of the basic assumptions of this census technique remain untested (Hall 1964).

Results from the summation census technique (Palmgren 1930) were compared with the spot census mapping technique. The summation population estimates were generally lower than spot mapping with 11 counts. Estimates in four of ten species were less in the summation technique. Identical results were found in two species.

When number of counts in spot mapping was reduced to eight, results from the summation technique became more closely aligned with those from spot mapping. In two species, estimates from the two techniques were identical. In six species, the summation estimate was higher; and in four species, the eight census spot mapping estimates were higher. In all species, estimates from the two methods differed by less than 50 percent. Population estimates from the summation technique were consistently higher than spot census estimates with six counts. Eleven of the twelve species were more numerous by the summation technique, and in one species (Carolina Wren) estimates were the same.

Mean numbers of birds per individual census were mostly lower than population estimates from the other techniques. Estimates in seven of twelve species were lower than all other estimates. In five of the relatively uncommon species the individual census means were higher than the spot mapping results from six counts, but not greater than results

from eight counts. The mean of total birds for all species was lower than each of the other census methods. Only a portion of the singing males were detected on any one census. The "summation" and "spot" census techniques were adjustments for incompleteness in the detection of singing males on each individual census. Therefore, results from these techniques resulted in higher population estimates than the mean number of birds per individual census.

Seasonal Populations and Netting

Monthly catches by mist nets are presented in Table 10. There were 1,863 individual birds, representing 62 species and 14 families, captured in 9,701 mist-net hours. Captures were computed on a 100 net hour basis for comparisons.

Seasonal populations determined from transect counts are presented in Tables 11, and 16 and 17, in appendix. Due to the larger number of samples in 1973 and the resulting more meaningful confidence limits, discussion is concentrated on 1973 populations (Table 11) and supplemented by the 1972 and 1973 censuses (Tables 16 and 17, appendix).

Birds only flying over the forest and not classified as forest dwellers were not included in the population figures. For example, White Ibis, Cattle Egret, and Snow Geese were occasionally detected flying high over the area

Table 10. Monthly bird captures per 100 mist-net hours on the Thistlethwaite Wildlife Management Area, February 1972 to May 1974.[a]

| Species | Months and Hundred Mist Net Hours | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J (7.48) | F (8.59) | M (5.82) | A (7.16) | M (8.58) | J (9.26) | J (10.03) | A (13.74) | S (6.75) | O (5.49) | N (6.84) | D (7.27) |
| Yellow-billed Cuckoo | [b] | .11 | | | .12 | | | .07 | | | | |
| Ruby-throated Hummingbird | | | .17 | .14 | | | | | | | | |
| Common Flicker | .27 | .11 | .17 | | | | | | | | | .27 |
| Pileated Woodpecker | | | | | | | | | .15 | | | |
| Red-bellied Woodpecker | .40 | .11 | | .28 | | | | | | | .15 | |
| Red-headed Woodpecker | .27 | .93 | .17 | .14 | | | | | | | .15 | .41 |
| Yellow-bellied Sapsucker | 1.87 | 2.21 | .86 | .14 | | | | | | | .44 | .82 |
| Hairy Woodpecker | .27 | .11 | | | .12 | .22 | | | | | | |
| Downy Woodpecker | | | | | .23 | | | | | | | |
| Great Crested Flycatcher | | | | | .12 | .11 | | | | | | |
| Eastern Phoebe | .13 | | | | | | | | | | .29 | .69 |
| Yellow-bellied Flycatcher | | | | | | | | .15 | | | | |
| Acadian Flycatcher | | | | | .58 | .43 | .40 | .07 | | | | |
| Empidonax Flycatcher | | | | .14 | | | | | | | | |

Table 10. (Continued)

| Species | Months and Hundred Mist Net Hours | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J (7.48) | F (8.59) | M (5.82) | A (7.16) | M (8.58) | J (9.26) | J (10.03) | A (13.74) | S (6.75) | O (5.49) | N (6.84) | D (7.27) |
| Blue Jay | 1.60 | 1.40 | .69 | .70 | | | | | | .18 | .29 | .41 |
| Carolina Chickadee | .67 | .46 | .17 | .14 | .12 | | | | .15 | .18 | | .14 |
| Tufted Titmouse | .80 | 1.98 | .69 | .70 | .47 | .11 | .10 | .15 | .89 | 1.28 | .59 | 1.10 |
| House Wren | | | | | | | | | | .18 | | |
| Winter Wren | .13 | | | | | | | | | | | |
| Carolina Wren | 2.81 | 2.33 | 2.58 | 2.79 | 2.33 | 2.48 | 2.89 | 1.75 | .74 | 3.10 | 2.34 | 2.06 |
| Mockingbird | .13 | .11 | | | | | | | | | | |
| Gray Catbird | | .11 | | .28 | .12 | | | | | | .15 | |
| Brown Thrasher | 1.47 | .70 | .69 | .42 | | | | | | 1.09 | .29 | |
| American Robin | 1.60 | 1.40 | .17 | | | | | | | | .59 | 1.92 |
| Wood Thrush | | | | .56 | .70 | .43 | .70 | .15 | | .73 | | |
| Hermit Thrush | 2.94 | 2.21 | .69 | .56 | | | | | | .18 | 1.76 | 1.92 |
| Ruby-crowned Kinglet | 3.34 | 1.28 | .17 | | | | | | | | 1.32 | 2.75 |
| Loggerhead Shrike | .13 | | | | | | | | | | | .14 |
| White-eyed Vireo | .27 | | .86 | 2.37 | 1.52 | 2.27 | .90 | .58 | .44 | | .29 | .27 |
| Yellow-throated Vireo | | | | | .12 | .22 | .10 | | | | | |

Table 10. (Continued)

| Species | Months and Hundred Mist Net Hours | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J (7.48) | F (8.59) | M (5.82) | A (7.16) | M (8.58) | J (9.26) | J (10.03) | A (13.74) | S (6.75) | O (5.49) | N (6.84) | D (7.27) |
| Solitary Vireo | .13 | | | | | | | | | | | .14 |
| Red-eyed Vireo | | | | | .12 | .32 | .20 | | | | | |
| Black-and-white Warbler | | | | | | | | | .15 | | | |
| Prothonotary Warbler | | | | | .23 | .11 | .20 | .07 | | | | |
| Swainson's Warbler | | | | .98 | 1.87 | 1.29 | .30 | .22 | | | | |
| Worm-eating Warbler | | | | .42 | | | | .07 | .15 | | | |
| Tennessee Warbler | | | | .14 | | | | | | | | |
| Orange-crowned Warbler | .94 | 1.40 | | | | | | | | | .44 | .27 |
| Nashville Warbler | | | | | | | | | .15 | | | |
| Northern Parula Warbler | | | | .14 | | | | | | | | |
| Yellow-rumped Warbler | | 1.05 | .69 | .28 | | | | | | | | .14 |
| Ovenbird | | | | .42 | .12 | | | | | .18 | | |
| Northern Waterthrush | | | | | .23 | | | | | | | |
| Louisiana Waterthrush | | | | .14 | | | | | | | | |
| Kentucky Warbler | | | .34 | 2.65 | 1.28 | 1.62 | .60 | .73 | 1.19 | | | |
| Common Yellowthroat | .13 | | | | | | | | | | | |

Table 10. (Continued)

| Species | Months and Hundred Mist Net Hours | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J (7.48) | F (8.59) | M (5.82) | A (7.16) | M (8.58) | J (9.26) | J (10.03) | A (13.74) | S (6.75) | O (5.49) | N (6.84) | D (7.27) |
| Yellow-breasted Chat | | | | .14 | .23 | | | | | | | |
| Hooded Warbler | | | | .84 | .23 | .32 | .40 | .36 | .15 | | | |
| Canada Warbler | | | | | .12 | | | | | | | |
| Rusty Blackbird | .80 | .46 | .17 | | | | | | | | | |
| Common Grackle | 1.87 | 1.98 | | | | | | | | | .15 | .14 |
| Brown-headed Cowbird | | | | .14 | .35 | .32 | | | | | | |
| Summer Tanager | | | | .14 | .23 | | | | | | | |
| Cardinal | 2.01 | .34 | 2.06 | 1.26 | .58 | .97 | .80 | 1.46 | .59 | 2.00 | 2.78 | 1.92 |
| Indigo Bunting | | | | .42 | | | | | | | | |
| Painted Bunting | | | | .42 | .12 | | | .07 | | | | |
| American Goldfinch | .27 | .23 | | | | | | | | | | .55 |
| Rufous-sided Towhee | .40 | .58 | .51 | .70 | .12 | | | | | | .29 | .27 |
| White-throated Sparrow | 20.32 | 11.64 | 8.42 | 5.03 | | | | | | 1.28 | 11.56 | 27.63 |
| Fox Sparrow | | .11 | | | | | | | | | | .14 |
| Swamp Sparrow | .40 | | | .14 | | | | | | | .15 | .14 |

Table 10. (Continued)

| Species | Months and Hundred Mist Net Hours | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J (7.48) | F (8.59) | M (5.82) | A (7.16) | M (8.58) | J (9.26) | J (10.03) | A (13.74) | S (6.75) | O (5.49) | N (6.84) | D (7.27) |
| Total Birds Caught per 100 Mist Net Hours | 46.37 | 33.35 | 20.27 | 23.76 | 12.38 | 11.22 | 7.59 | 5.88 | 4.75 | 10.38 | 24.02 | 44.24 |
| Total Birds Caught | 347 | 286 | 118 | 170 | 106 | 104 | 76 | 81 | 32 | 57 | 164 | 322 |

[a]Mist net size: 7 feet x 30 feet.

[b]Blank monthly value equals zero.

Table 11. Mean monthly bird population estimates per 50 acres determined from transect counts on the Thistlethwaite Wildlife Management Area, 1973.

| Species[ab] | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | F | M | A | M | J | J | A | S | O | N | D-J |
| Red-shouldered Hawk | .25 | .50 | .25 | .21 | .04 | .25 | [d] | .06 | .14 | .12 | .29 | .25 |
| Yellow-billed Cuckoo | | | | | 3.43 | 7.00 | 4.00 | 2.37 | 1.14 | *[c] | .14 | |
| Barred Owl | | .17 | .25 | .29 | .21 | .12 | .12 | .25 | .14 | | .14 | .06 |
| Ruby-throated Hummingbird | | | | .47 | .47 | | | | | | | |
| Common Flicker | .67 | 2.00 | .38 | | | | | | | 4.00 | 2.29 | 1.62 |
| Pileated Woodpecker | 1.83 | 1.67 | 1.88 | .43 | .86 | .50 | .29 | 1.12 | 1.00 | .25 | 1.14 | .88 |
| Red-bellied Woodpecker | 3.83 | 1.67 | 3.50 | 3.00 | 3.43 | 2.75 | 2.43 | 2.00 | 2.43 | 6.00 | 5.86 | 3.88 |
| Red-headed Woodpecker | 23.33 | 22.67 | 17.00 | 5.43* | * | | | | 4.86* | 22.50* | 15.71 | 13.25 |
| Yellow-bellied Sapsucker | 16.67 | 17.33 | 5.50* | .29* | | | | | | 6.50 | 7.71 | 11.50 |
| Hairy Woodpecker | | 1.10 | | | | | | .41 | | | 1.41 | .41 |
| Downy Woodpecker | .56 | | | | .47 | | .47 | | .47 | .83 | .47 | |
| Great Crested Flycatcher | | | | .14 | 1.57 | .50 | 1.14 | .25 | | | | |
| Eastern Phoebe | .55 | | | | | | | | | | | .82 |
| Acadian Flycatcher | | | | .29 | 4.29 | 5.00 | 4.86 | 2.25 | .86 | | | |

Table 11. (Continued)

| Species[ab] | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | F | M | A | M | J | J | A | S | O | N | D-J |
| Eastern Wood Pewee | | | | | .47 | .82 | | | | | | |
| Blue Jay | 11.50 | 9.67 | 9.50 | 10.86 | .50* | | | .12 | 1.29 | 1.75 | 1.00 | 2.12 |
| Common Crow | 1.00 | .33 | .50 | .14 | .14 | | .43 | .87 | .43 | .50 | .71 | .75 |
| Carolina Chickadee | 1.67 | 2.50 | 2.19 | .71 | | | .71 | .31 | .71 | .63 | .36 | 1.56 |
| Tufted Titmouse | 5.16 | 6.33 | 14.50* | 7.29* | 9.29 | 7.25 | 5.00 | 7.87 | 6.43 | 11.00 | 4.43 | 10.88* |
| Carolina Wren | 8.67 | 6.00 | 15.62* | 15.43 | 14.00 | 10.50 | 8.25 | 12.50 | 13.14 | 11.75 | 11.57 | 13.54 |
| Mockingbird | 1.33 | 1.33 | .71 | * | | | | | | 1.60 | 1.00 | .88 |
| Gray Catbird | | | | .86 | | | | | .29 | 2.00 | | |
| Brown Thrasher | 15.33 | 14.00 | 10.00 | 5.14 | * | | | | 2.29 | 7.00 | 3.14 | 2.50 |
| American Robin | 13.33 | 9.33 | 4.50 | | | | | | | | 20.71 | 15.00 |
| Wood Thrush | | | | .57 | 1.43 | .75 | .43 | .88 | .29 | | | |
| Hermit Thrush | 5.33 | 1.33 | .75 | .29 | | | | | | 1.00 | 8.57* | 2.25 |
| Gray-cheeked Thrush | | | | | .36 | | | | .36 | | | |
| Golden-crowned Kinglet | 1.10 | 1.10 | | | | | | | | | | .41 |
| Ruby-crowned Kinglet | 8.80 | 2.20 | 2.06 | .47 | | | | | | | .94 | 4.54 |
| Cedar Waxwing | | 1.10 | 4.95 | | | | | | | | | 3.30 |

Table 11. (Continued)

| Species[ab] | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | F | M | A | M | J | J | A | S | O | N | D-J |
| Starling | | .33 | .50 | .12 | .29 | .25 | .29 | .25 | | | | |
| White-eyed Vireo | | | 1.88 | 15.28* | 12.14 | 14.25 | 10.00* | 9.25 | 11.43 | .50* | .57 | .38 |
| Yellow-throated Vireo | | | .75* | 2.14 | 1.71 | 1.75 | .86 | 1.00 | .86 | * | | |
| Red-eyed Vireo | | | | 1.86* | 2.86 | 3.75 | 2.57 | 1.50 | * | | | |
| Prothonotary Warbler | | | | 2.14* | .71 | 2.50 | | .31 | | | | |
| Swainson's Warbler | | | | .86 | 2.00 | 2.00 | .86 | .50 | | | | |
| Orange-crowned Warbler | 1.10 | 2.20 | | | | | | | | | | .82 |
| Northern Parula Warbler | | | 2.19 | 1.07 | .36 | | .71 | | | | | |
| Yellow-rumped Warbler | .55 | 1.10 | 3.30 | 3.30 | | | | | | | 2.36 | 4.95 |
| Kentucky Warbler | | | | 1.79 | 1.07 | .62 | | 1.96 | 1.07 | | | |
| Hooded Warbler | | | .31 | 2.86 | 1.79 | .62 | .71 | .94 | .71 | | | |
| Rusty Blackbird | 2.50 | 18.33 | .94 | | | | | | | | | 1.25 |
| Common Grackle | 41.25 | 43.33 | 24.04 | | .36 | | | | | 1.87 | 20.71 | 209.71* |
| Brown-headed Cowbird | 4.67 | | .50 | .29 | 1.14 | | | | | | | |
| Summer Tanager | | | | .86 | 1.71 | 1.00 | 2.86 | .50 | .86 | | | |
| Cardinal | 7.00 | 17.33 | 17.50 | 12.00 | 9.67 | 5.50 | 6.86 | 10.75 | 6.86 | 6.50 | 5.71 | 9.12 |

Table 11. (Continued)

| Species[ab] | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | F | M | A | M | J | J | A | S | O | N | D-J |
| Painted Bunting | | | | | .71 | .62 | | | | | | |
| American Goldfinch | 1.00 | .67 | 1.50 | | | | | | | | | 2.25 |
| Rufous-sided Towhee | 7.33 | 5.33 | 5.50 | 2.29 | .57 | .50 | | .50 | | 1.00 | .57 | 2.75* |
| White-throated Sparrow | 98.45 | 59.40 | 40.84 | 50.53 | * | | | | | .83 | 20.27 | 89.10* |

[a]The preponderance of detections of birds during the breeding season [(March (for birds remaining throughout the season) April, May, June, July)] were of singing males (Table 9), therefore the population figure more accurately represents bird pairs.

[b]Limited to species detected a minimum of two months.

[c]* Denotes significant difference ($P < .05$) from previous month.

[d]Blank monthly value equals zero.

but were not included in the tabulations.

The following is a discussion of the monthly populations of Thistlethwaite birds. These figures were determined from transect counts and converted to birds per 50 acres. Accompanying the population figures are results from mist-netting based on birds caught per 100 mist-net hours. Yellow-crowned Night Herons were heard in the Thistlethwaite woods during one census (August 1972). Wood Ducks were another rare visitor (detected in March 1972 and in December 1973 at levels not over 0.5/50 acres). Flocks of wide ranging Black Vultures were occasionally seen above the woods or on one occasion feeding on a dead bull on the ground. Black Vulture population estimates were 1.41 and 4.85/50 acres for March 1972 and 1973, and .25/50 acres in December 1973.

Two species of buteos were observed on the transect. Red-tailed Hawks were not normally a bird of the woods and were detected infrequently in only three of the twenty-five months. Red-shouldered Hawks were a regular forest dweller. Although number per unit area were relatively low compared to other smaller avian species, these forest inhabitants were commonly heard throughout the year. Monthly population estimates ranged from zero to 0.50 birds per 50 acres (Table 11).

Turkeys were commonly seen along the roads. Two were flushed from a night roost during a September 1973 census. One American Woodcock was flushed while censusing in January 1973, and one Mourning Dove was seen flying over the transect line in December 1973.

Yellow-billed Cuckoos were commonly heard but seldom seen from May through September. Peak numbers, based mainly on callings (Table 9), were in June (7 per 50 acres), with somewhat less in May and July (3 to 4 per 50 acres), and diminishing numbers in August and September. One straggler was heard in November. Most Yellow-billed Cuckoos had departed TWMA by September. Yellow-billed Cuckoos were somewhat large and located too high in the forest canopy to be easily caught. Only three individuals were netted in over 9,000 net hours.

Barred Owl populations were estimated at less than 0.50 per 50 acres through the year. Although low in numbers in comparison with the other smaller species, they would probably be considered abundant when compared to similar sized avian predators. Night censuses would probably have been more productive than the early morning censuses.

Chimney Swifts were seen foraging above the trees during two censuses in August 1972. Ruby-throated Hummingbirds were irregularly seen from the transect line from

March through August. Population estimates ranged from approximately 0.5 to 1.65 per 50 acres. Two were caught in mist-nets. On two occasions, individuals were observed changing their flight direction or speed to avoid the nets. This was the only species observed displaying that ability.

The mature bottomland hardwoods provided suitable habitat for seven species of woodpeckers. Common Flickers were present from October through March, and one rare summer inhabitant was observed in July 1972. Population estimates for the winter months ranged from less than one to four birds per 50 acres. Although they were too large for efficient capture by the small mest mist-nets, six birds were caught during four different months.

Pileated Woodpeckers, the largest Picidae, were present year round. Monthly population means for Pileated Woodpeckers varied from 0.25 to 1.88 per 50 acres throughout the year. Although much too large for the mest size of mist-nets used, one did become ensnarled in a net.

Red-bellied Woodpeckers were another permanent resident Picidae. Monthly population estimates varied from 1.67 to 6.00 per 50 acres for the 12 months. These birds were generally too high in the canopy (Figure 4) and somewhat large to be captured. Red-bellied Woodpeckers were captured during four months, but captures were always below the rate

of 0.5 per 100 mist-net hours.

There were seasonal differences in numbers of Red-headed Woodpeckers. During the summer months (June, July, and August) they were rarely encountered. No population estimate for the summer months exceeded one bird per 50 acres. The population for September swelled to 4.86, and increased even more in October to 22.50 birds per 50 acres. Both of these population changes were significant at the .05 level. November and December levels were 15.71 and 13.25 per 50 acres. The birds were abundant (20 to 25/50 acres) in January and February, dropped slightly in numbers in March (17/50 acres), significantly ($P < .05$) in April (5.43/50 acres), and again in May when no birds were detected. Captures in fall and winter never exceeded one per 100 hours due to the high position of the species in the forest profile (Figure 4).

The Yellow-bellied Sapsucker was an abundant winter resident. First arrivals were in October (6.50/50 acres). Populations from November to February ranged from 7.71 to 17.33 per 50 acres. Spring exoduses of the birds from Thistlethwaite significantly reduced ($P < .05$) populations to 5.50 in March and 0.29 in April. Of the woodpeckers, sapsuckers were low in height and were commonly caught in mist-nets (Table 10). Forty-eight individuals (3 percent

of the total catch) were captured. Catch per 100 net hours ranged from a high of over two birds during the period of peak numbers of mid-winter, to a low of 0.14 in April when the last birds were departing the area.

Hairy and Downy Woodpeckers were uncommon permanent residents. They were irregularly detected and captured throughout the year. Estimated populations ranged from zero to approximately two birds per 50 acres. Two Downy and six Hairy Woodpeckers were captured during the study.

There were five members of the Tyrannidae detected by transect census or caught in mist-nets. Great Crested Flycatchers were regularly heard on the transects. They arrived in April (0.14/50 acres), reached peaks from May to July (1.07/50 acres), and were heard less frequently (0.25/50 acres) in August. Due to their elevation in the forest profile, only two were captured in mist-nets.

Eastern Phoebes were uncommon winter residents (November to February). Maximum populations were near one per 50 acres (January-Febraury 1972, January 1973, December 1973). Catches were below one per 100 net hours (November 0.29/100 net hours, December-0.69/100 net hours, and January-0.13/100 net hours).

The Acadian Flycatcher was a common breeding season resident. The first birds arrived in April (0.29/50 acres),

and the highest numbers occurred from May through July (4 to 5/50 acres). August levels fell to 2.25 per 50 acres, and the last birds of the season were detected in September (0.86/50 acres). Catches per 100 net hours approximated 0.5 in May, June, and July, and dropped to 0.07 in August. Although no Yellow-bellied Flycatchers were detected by transect census, one was caught during the August migration. Also, Eastern Wood Pewees were occasionally seen on the area in May and June (less than 1/50 acres), but none were captured.

Two corvids (Blue Jay and Common Crow) were commonly observed on the study area. Blue Jays were abundant from January to April (9.5 to 11.5/50 acres), decreased significantly ($P < .05$) in May (0.5/50 acres), remained uncommon in summer (less than 1/50 acres), and increased in fall (high of approximately 2/50 acres). Captures per 100 net hours showed a similar pattern. High catches occurred in January and February (1.6, 1.4). Fewer numbers were caught in March and April (0.69 and 0.70/50 acres). There were no captures May through August, and few fall captures (0.18 to 0.41). Common Crows were detected throughout the year. Populations were consistently low, never exceeding one per 50 acres. The mist-nets used were too small to capture crows.

Two Paridae were regularly observed and netted on the study area throughout the year. The Carolina Chickadee was a fairly common permenent resident. These tiny birds were hard to detect because of their high vertical position and lack of a substantial call. Monthly population estimates varied substantially (from 0 to 7.5) due to their flocking habits. Captures for all months were below one per 100 net hours. Tufted Titmice were a common parid. There were an estimated 4.43 to 14.50 birds per 50 acres for the different months. Low numbers occurred mainly during the quiescent late summer period. Significantly high numbers ($P < .05$) were recorded in March (14.50/50 acres) during the calling peak. Few birds were caught in summer (mean of 0.12/100 net hours for June, July, and August). Higher numbers were netted in fall and winter (from 0.47 to 1.98 per 100 net hours).

Carolina Wrens were the most common permanent resident species in the Thistlethwaite woods. Monthly population estimates fluctuated between 6.00 and 15.62 per 50 acres throughout the year. Significantly high ($P < .05$) numbers were noted during March and April (15.62 and 15.43/50 acres), probably due to increased calling with the establishing of territories. These birds were also frequently caught, being located mainly in the mid-story (Figure 4). Catches

per month exceeded two per 100 net hours with the exception of August (1.75) and September (0.74). Winter Wrens were observed infrequently during the fall of 1972 (October-0.55, November 0.82/50 acres). One Winter Wren was captured in January and a lone House Wren in October, although none were observed on the transect census.

The three Mimidae of the eastern United States were encountered in the bottomland hardwoods. Northern Mockingbirds are not really a bird of the mature forest. Most of these occurred along the woods' edge, although they were seen in the woods' interior in winter. Mockingbirds were observed while censusing from October to March. Numbers dropped significantly ($P < .05$) to zero in April, and no mockingbirds was encountered throughout the summer. Two Northern Mockingbirds were daught during winter. Gray Catbirds were observed and captured infrequently, mainly during the fall (September-November) and spring (April, May). Birds were detected in April 1973 (0.86/50 acres) and September and October of 1972 and 1973 (0.29 to 2.00/50 acres). Total captures were as follows: February - 1, April - 2, May - 1, November - 1. Brown Thrashers were common but somewhat erratic fall, winter, and spring visitors. Winter populations fluctuated greatly with immigration and emigration on the area. The extremes were

1.00 in March 1972 and 40.67 per 50 acres in October 1972. All the birds departed by May (significant drop in population, $P < .05$).

The thrush family was well represented in the hardwood forest. American Robins were sometimes abundant but erratic over-winterers. Peak numbers were present from November through January (usually greater than 10/50 acres). Fewer birds were present in spring, and two individuals were all that were detected during the summer months (in August 1972). Capture results were similar. One to two birds per 100 net hours were caught from December to February, and lesser numbers in March and November (less than 1/100 net hours). The Wood Thrush occurred consistently on the transect from April through September and rarely in October. Numbers were never high, ranging from 0.29 to 1.43 per 50 acres during the breeding season. Here again, captures substantiated transect results. Few birds were regularly caught from April to August and a few, presumable migrants, were caught in October. The catch never exceeded 0.75/100 net hours.

Hermit Thrushes were common winter birds at Thistlethwaite. First arrivals were in October (1.00/50 acres), and the main influx in November [significant ($P < .05$) population increase to 8.57/50 acres]. November to January population

estimates fluctuated between 2.25 and 8.57. Numbers dropped in February (1.33/50 acres), again in March (0.75/50 acres), and again in April (0.29/50 acres). Captures for the winter months were from 1.76 to 2.94 per 100 net hours. Captures in October, and in March and April were less than one per 100 net hours.

Swainson's Thrush and Gray-cheeked Thursh were irregularly seen during Spring and Fall Migration. Swainson's Thrushes were observed in May 1973. Gray-cheeked Thrushes were seen in October 1972, May 1973, and September 1973. None of these two rare visitors were caught. The Eastern Bluebird was another rarely seen thrush. They were observed at the woods' edge in December 1973 (0.41/50 acres). None were captured.

There were two very uncommon and one seasonably common old world warblers (Sylviidae). An occasional Blue-gray Gnatcatcher was detected in March 1972, July 1972, and September 1973. Monthly population estimates never exceeded two per 50 acres. These birds were high in the canopy and were not noticeably vocal; therefore, detection was difficult. None were captured in mist-nets. Golden-crowned Kinglets were present during the winter 1972-1973, and one was detected in December 1973. Monthly populations from November to February (1972-1973) were very close to one

per 50 acres (0.82 to 1.10). There were no catches of these small foragers.

Ruby-crowned Kinglets were one of the more common winter residents. The birds arrived on the study area in November (0.94/50 acres), were at their peak in December and January (4.54 and 8.80/50 acres), declined in February and March (2.20 and 2.06/50 acres), and had left the area by the last of April (0.47/50 acres). The species was located mainly in the mid-story (2 to 25 feet). Consequently, this small bird was frequently netted. Catches per 100 mist net hours were as follows: November, 1.32; December, 2.75; January, 3.34; February, 1.28; and March, 0.17. The captures followed a pattern similar to the population estimates from transects.

The Loggerhead Shrike was neither seen nor heard during the transect censuses. This predaceous passeriform was captured twice in nets, which I believe was due to the attraction of this bird to the distress calls of netted birds.

Flocks of Cedar Waxwings occurred irregularly during winter. They were recorded during censuses in three winter months over the two year period. Estimated populations ranged from 1.10 to 4.95 per 50 acres. These birds were not observed close to the ground (all were detected in the

canopy stratum) and none were caught.

European Starlings were detected two months in 1972 and seven months in 1973. They were never more common than 0.5 per 50 acres during their presence from February to August. They were usually above the canopy top and were never captured.

There were three common and one rare vireo in the mature bottomland hardwood forest of TWMA. The White-eyed Vireo was one of the most plentiful birds during the breeding season, remaining abundant until fall. First spring arrivals occurred in March (1.88/50 acres). Maximum populations were attained in April (15.28/50 acres), significantly higher than March ($P < .05$). The population remained above nine per 50 acres until October when the fall departures significantly ($P < .05$) reduced numbers to below one per 50 acres. The birds were detected uncommonly (less than one per 50 acres) throughout the winter. The birds were mainly located in the mid-story and were captured often. Catches were of a pattern similar to that of estimated populations. Catches for November to February never exceeded 0.3 per 100 net hours. Captures increased to 0.86 per 100 net hours in March, reached maximum levels April to June (1.52 to 2.37), and declined steadily July through September (0.90, 0.58, 0.44).

Yellow-throated Vireos and Red-eyed Vireos were less common than the White-eyed Vireo. Yellow-throated Vireos arrived in March (0.75/50 acres), reached peak numbers in April (2.14/50 acres), were detected slightly less in May and June (1.71 and 1.75/50 acres), dwindled even more from July to September ($\leq$ 1/50 acres), and were gone from Thistlethwaite by 1 October. Red-eyed Vireos showed a different seasonal trend. These birds arrived a month later (April) and departed a month earlier (August) than Yellow-throated Vireos, although the calling Yellow-throated Vireos in May and September may have been migrants. Estimated Red-eyed Vireo populations were always above 1.50 per 50 acres. Peak detections, mainly from calling, were in June (3.75/50 acres). Both Red-eyed and Yellow-throated Vireos were mainly canopy birds. This was substantiated by the low number of sightings (13 percent Yellow-throated Vireos, 4 percent Red-eyed Vireos; Table 9) due to their presence in the seasonally thick canopy. I believe this is the reason for the few captures (4 Yellow-throated Vireos, 6 Red-eyed Vireos) of these two species. The Solitary Vireo was the rarest Vireonidae. None were detected on the transect but two birds were caught in winter.

Nineteen species of wood warblers were observed during censuses or caught in mist nets on the study area during

the 25 month study. Two of these were common, and somewhat erratic, overwintering birds. Orange-crowned Warblers were present on the area from November to March. December to February populations were estimated at close to one per 50 acres (0.82 to 2.20). The March 1972 population was within this range (1.65), but in 1973 the birds had apparently departed by March 1. Captures for November through February ranged from 0.27 to 1.40 for these mid-story birds.

The other common winter resident warbler was the erratically occurring Yellow-rumped Warbler. Highest numbers were recorded in February 1972 (33.00/50 acres) and April 1972 (8.25/50 acres), when the area was inundated with migrants. In 1973 estimated populations were lower. Peaks (above 2/50 acres) occurred in November-December, and again in March-April as the apparent migrants moved through the study area. Not many of these birds were captured. They were found in abundance in the canopy and in lesser numbers in the mid-story and at ground level (Figure 4). Catches from December through April varied from 0 to 1.05 per 100 net hours.

Five species of warblers were fairly common during the breeding season. The Prothonotary was observed on the area from April to August (Table 11). Greater than two birds per 50 acres were estimated in April and June.

Estimated population was 0.71 in May, none in July and 0.31 in August. Corresponding to these low populations were low catches of 0.23, 0.11, 0.20, 0.07 for May, June, July, and August respectively (1972 and 1973 combined). Detections and catches were lower in June than in May or July. The bottomland hardwoods of the TWMA appeared to be marginal habitat for the swamp loving Prothonotary Warbler. The study area was rarely flooded in spring and summer. The birds seemed to wander through the area, possibly searching for suitable habitat. I believe this tendency to move about the Thistlethwaite woods during the breeding season was the most plausible explanation for the fluctuations in census and netting results.

Swainson's Warblers were common in the Cane thickets. The birds started arriving in April (0.86/50 acres), were at optimum numbers in May and June (2.00/50 acres), tapered off in July and August (0.86, 0.50/50 acres), and had departed the area by the end of August. Mist-net catches followed a similar pattern for the secretive Swainson's Warbler. Birds were first captured in April (0.98/100 net hours), highest numbers were caught in May and June (1.87, 1.29/100 mist-net hours), and lesser numbers were captured in July and August (0.30, 0.22/100 net hours).

Northern Parula Warblers were observed on the study

area from March to July. They were more numerous in March (2.19/50 acres), slightly less numerous in April (1.07/50 acres), and lower in number May to July (0 to 0.71/50 acres). The high number of singing Northern Parula Warblers heard during March and April had probably departed the area by May. Only one bird was caught during the two seasons of 1972 and 1973. I attribute this to their position in the forest canopy. Few birds were sighted due to their position in the canopy. Eighty-nine percent of detections were aural, due to the difficulty of seeing the birds in the leaf occluded canopy.

Kentucky Warblers were another bird well suited to the habitat provided by the bottomland hardwoods, and the Cane and Palmetto understory. The greatest number occurred in April and May, and later in August and September during which time the population was above one per 50 acres. Lower numbers were estimated in the interim (June and July). This lower strata bird was captured more frequently than any other warbler (69 total, 4 percent of all catches). Kentucky Warbler captures fluctuated between 0.34 to 2.65 per 100 net hours from March through September. The birds arrived in March (0.34/100 net hours). Highest numbers were caught in April (2.65/100 net hours) and somewhat fewer caught in May and June (1.28 and 1.62/100 mist net

hours). Less than one per 100 net hours was captured in July and August and a slight increase to 1.19 birds per 100 net hours occurred in September. Kentucky Warblers were on the area until late summer; later than most other breeding season warblers. April and September peaks occurred in population estimates and mist-net captures. I believe the high numbers in April were due to the active movements and intense singing of the new arrivals. Fall migrants and the movements of young birds were two likely explanations for the high numbers noted in September.

Hooded Warblers were another of the common breeding warblers. First seasonal arrivals were in March (0.31/ 50 acres). The highest monthly estimate was April (2.86/ 50 acres), and somewhat fewer were estimated in May (1.79/ 50 acres). Between 0.62 and 0.94 birds per 50 acres were estimated for the months July through September. A few Hooded Warblers were caught in each month from April to September. The highest was 0.84 per 100 net hours in April, and the lowest was 0.15 per 100 net hours in September, the month the birds left the area. The pattern of estimated bird populations and netting captures for Hooded Warblers was similar to the pattern of most other breeding season warblers. Peak numbers were usually noted the month after the first spring arrivals. Subsequently, estimated popula-

tions dropped during the summer months. I believe these spring peaks are best explained by the high numbers and intense activity of the new arrivals. Later in the season, there was a decrease in activity (particularly singing), and an emigration of spring migrants and/or birds not able to secure satisfactory territories.

Twelve warbler species were only rarely observed or captured on the TWMA. Most of these appeared to be migrants passing through the area. Most were rarely heard, and were on the area only a short time during their normal migration period. One Black-and-white Warbler was detected from a transect line in August 1972 and another caught by net in September 1973. Migrating Worm-eating Warblers passed through the area in Spring and Fall. Two detections in August 1973, produced a population estimate of 0.82 per 50 acres. Less than 0.5 bird per 100 net hours was captured in the months of April, August, and September. One Tennessee Warbler was captured in April 1973. One Nashville Warbler was captured in September 1973. Small numbers (less than 1/50 acres) of Bay-breasted Warblers were observed in October and November 1972. Although not detected from the transect, a few Ovenbirds (total of 5) were caught in April, May, and October (less than 0.5/100 mist-net hours for each month). One Northern Waterthrush (converted to 0.47/50 acres

for the month) was seen while censusing in April and two were captured in May. One Louisiana Waterthrush was seen in March 1972 and one was captured in April 1973. A single Common Yellow-throat was captured in winter (January 1973). Four Yellow-breasted Chats (1.11/50 acres for the month) occurred near the woods' edge in August 1972. Four others (less than 0.25/100 net hours for each month) were caught in April 1972 and May 1973. One American Redstart was seen during the censuses in April 1973. A single Canada Warbler was entangled in a mist-net on 14 May 1973.

Four members of the blackbird family in varying numbers inhabited the Thistlethwaite woods. Red-winged Blackbirds were uncommon. One flock of birds was detected while censusing (2.06/50 acres/month) during the March migration period. None were caught in the nets. The more common Rusty Blackbirds varied in numbers during the winter. Populations were fairly low in mid-winter (December-1.25/50 acres, January-2.50/50 acres), increased in February (18.33/50 acres), and dropped noticeably in March (0.94/50 acres). Rusty Blackbird captures were low (0.80, 0.46, and 0.17) for January, February, and March.

Census results showed Common Grackles to be abundant and variable in numbers due to their gregarious meanderings. Grackles were not detected on the area in June, July, August, or September. First arrivals were in October

(15.50/50 acres - 1972, 1.86/50 acres - 1973). Greater numbers were estimated from December through March. Population estimates during that period fluctuated between 20.71 per 50 acres to 209.71 per 50 acres. None were recorded in April and only 0.36 per 50 acres in May. These birds were probably overestimated due to their easy detectability, rapid movement across the transect line, and distribution in all four strata, from ground to above the canopy. There were a few birds caught, but captures were probably low in relation to their populations because of their elevated height distribution and large size. One bird was caught in November, (0.15/100 net hours), one in December (0.14/100 net hours), and slightly more in January (1.87/100 net hours) and February (1.98/100 net hours).

Brown-headed Cowbirds were a sometimes common, but irregularly occurring icterid. In 1972 they were seen in June (3.20/50 acres), August (0.22/50 acres), and December (5.00/50 acres). In 1973 they occurred on the study area only in late Winter and Spring. Estimated populations were: January-4.67 per 50 acres, February-0, March-0.50 per 50 acres, April-0.29 per 50 acres, and May-1.14 per 50 acres. Captures were low ($\leq$ 0.50/100 net hours) and occurred only in April, May and June of 1972 and May 1973. I believe there were no winter catches because the birds were

higher in the vegetative profile than in summer, when they appeared secretive and were probably parasitizing the nests of breeding warblers, vieos, etc.

Summer Tanagers were estimated at between 0.50 and 2.86 per 50 acres from April through September. First arrivals were in April (0.86/50 acres), highest estimates occurred from May to July (1.00 to 2.86/50 acres), and a reduction in numbers was noted in August (0.50/50 acres) and September (0.86/50 acres). Catches were minimal (3 total in April and May), which I attribute to the scarcity of the bird at net level. Only 31 percent of these brightly colored tanagers were visually detected (Table 9) because of their choice of location high in the leaf occluded canopy. Three-fourths of those seen were in the canopy.

The ubiquitious Northern Cardinal was one of the most abundant permanent residents at Thistlethwaite. It was observed regularly in every month. Population estimates showed some changes seasonally. The birds were abundant in winter (November-5.71/50 acres, December-9.12/50 acres, and January-7.00/50 acres). Seasonal highs were detected with the early onset of calling and territory establishment (February-17.33/50 acres, and March-17.50/50 acres). This is evidenced by the almost complete reversal of percentages of aural and visual detections from January to February

(Table 12). In January 69 percent of detections were visual; whereas, in February and March visuals comprised only 26 and 24 percent of total detections respectively. Activity and corresponding numbers detected dropped slightly in April (12.00/50 acres), and again in June (5.50/50 acres). There was little change in July (6.86/50 acres), but a noticeable rise in Ausust (10.75/50 acres) as the juvenile birds of the season became active. Fall (September and October) estimated numbers were stable at 6.86 and 6.50 per 50 acres. Cardinals were mainly a mid-story (60 percent of sightings), and secondarily, a ground dwelling (20 percent) bird. Therefore, they were caught in substantial numbers (121 total, 6 percent of all captures). More were captured in winter than in summer. During the period of October through March, the catch approximated two birds per 100 net hours, except for the unusually low 0.34 February figure. Catches in April dropped to 1.26, and captures for May through September were below one per 100 net hours with the exception of a rise in August to 1.46/ 100 net hours. This rise in captures corresponded to the population increase for August.

Indigo Buntings were rare visitors to the woods' edge. All observations of this species were in April. A group of three (4.95/50 acres), was observed during a census in

Table 12. Monthly comparisons of aural and visual detections of selected species of permanent resident birds censused on the Thistlethwaite Wildlife Management Area, February 1972 to February 1974.

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Red-bellied Woodpecker | | | | | | | | | | | | | |
| Total detections | 50 | 15 | 35 | 27 | 35 | 17 | 49 | 92 | 75 | 72 | 62 | 34 | 563 |
| Aural detections (%) | 70 | 53 | 60 | 85 | 85 | 100 | 96 | 89 | 87 | 92 | 90 | 74 | 84 |
| Visual detections (%) | 30 | 47 | 40 | 15 | 15 | | 4 | 11 | 13 | 8 | 10 | 26 | 16 |
| Tufted Titmouse | | | | | | | | | | | | | |
| Total detections | 92 | 47 | 134 | 83 | 111 | 66 | 92 | 121 | 78 | 77 | 46 | 41 | 988 |
| Aural detections (%) | 77 | 81 | 84 | 95 | 98 | 91 | 97 | 93 | 92 | 88 | 91 | 80 | 90 |
| Visual detections (%) | 23 | 19 | 16 | 5 | 2 | 9 | 3 | 7 | 8 | 12 | 9 | 20 | 10 |
| Carolina Wren | | | | | | | | | | | | | |
| Total detections | 134 | 52 | 130 | 147 | 147 | 123 | 155 | 230 | 186 | 148 | 130 | 106 | 1688 |
| Aural detections (%) | 92 | 88 | 96 | 97 | 99 | 98 | 93 | 88 | 94 | 96 | 97 | 97 | 94 |
| Visual detections (%) | 8 | 12 | 4 | 3 | 1 | 2 | 7 | 12 | 6 | 4 | 3 | 3 | 6 |
| Cardinal | | | | | | | | | | | | | |
| Total detections | 71 | 55 | 128 | 112 | 98 | 95 | 148 | 117 | 44 | 30 | 26 | 25 | 949 |
| Aural detections (%) | 31 | 74 | 76 | 78 | 82 | 84 | 83 | 62 | 20 | 17 | 12 | 8 | 66 |
| Visual detections (%) | 69 | 26 | 24 | 22 | 18 | 16 | 17 | 38 | 80 | 83 | 88 | 92 | 34 |
| Rufous-sided Towhee | | | | | | | | | | | | | |
| Total detections | 30 | 10 | 22 | 10 | 3 | 4 | 6 | 4 | 2 | 3 | 5 | 22 | 121 |
| Aural detections (%) | 23 | 20 | 9 | 10 | 100 | 75 | 50 | 100 | 50 | | 80 | 27 | 30 |
| Visual detections (%) | 77 | 80 | 91 | 90 | | 25 | 50 | | 50 | 100 | 20 | 73 | 70 |

April 1972, and three were caught in nets during April 1972 (0.42/100 net hours). Painted Buntings were found on the area infrequently from April to July. Populations were estimated at levels below one per 50 acres in July 1972 and May and June 1973. They were captured in May and June at 0.71 and 0.62 birds per 100 net hours. These two colorful finches appeared to inhabit low vegetation. They were commonly seen in brushy areas along roads but rarely ventured into the interior of the mature hardwoods.

American Goldfinch was a fairly common winter resident. They were present on the area from December to March at estimated levels of 0.67 to 2.25 per 50 acres (Table 11). They were captured from December to February at levels of 0.23 to 0.55 per 100 net hours (Table 10). These birds were usually around the woods' edge.

The Rufous-sided Towhee population fluctuated seasonally. The population increased significantly ($P < .05$) from 0.57 in November to 2.75 in December. Numbers were even higher in January through March (5.33-7.33/50 acres). The level dropped in April (2.29/50 acres), and again from May through November (0-1.00/50 acres). These birds were mainly ground oriented (62 percent of sightings, Figure 4) and were commonly caught. Captures per 100 net hours varied between 0.12 and 0.70 from November to May. No

birds were captured in August through October.

White-throated Sparrows were the most common over-wintering bird in the Thistlethwaite woods. Fall arrivals were first seen on the area in October (0.83/50 acres). Numbers swelled to 20.27 per 50 acres in November. Another increase was noted in December (89.10/50 acres, significant at the .05 level). January numbers approached two per acre (98.45/50 acres). Departures for their northern breeding grounds began in February (59.40/50 acres) and continued in March (40.84/50 acres). Numbers increased in April both years (to 50.53/50 acres in 1973). Numbers on the area were inflated by spring migrants. These birds were also the most commonly captured bird in the 25 months of netting (624 individuals, 33 percent of total catches). First fall captures were in October (1.28/100 net hours). Netting activity picked up considerably in November (11.56/100 net hours), and again in mid-winter (December- 27.63/100 net hours, January-20.32/100 net hours). Successive drops in unit catches occurred in February (11.64/100 net hours), March (8.42/100 net hours), and April (5.03/100 net hours). The annual pattern of catches per 100 mist-net hours followed very closely that of population estimates with the exception of captures in April. From March to April there was an increase in population estimates, but a decline in

captures. This was due to the rise in height of the birds in the forest corresponding to the spring change in the deciduous vegetation (Figure 7).

A few sparrow species were rarely encountered on the study area. Fox Sparrows were observed on a census in January 1973 (0.55/50 acres), and two were caught, one in December 1972 and one in February 1974. Swamp Sparrows were slightly more common than the elusive Fox Sparrow. They were seen during censuses in April 1972 (1.65/50 acres). A few captures were scattered throughout the year. Total catches were as follows: January- 3 (0.40/ 100 net hours), April- 1, November- 1, December-1. One Song Sparrow was seen on the transect in December 1972.

## Relationship of Population Estimates to Mist-Net Captures

The relationship of estimated populations per 50 acres to captures per 100 mist-net hours is presented in Table 13. Only common species are considered. Also, those birds too high in vertical distribution and those too large or too small to be captured in mist-nets are excluded. There are many variables possibly influencing this population to capture ratio. Number of birds, bird conspicuousness, bird mobility, bird location, size of birds, bird behavior, censuser's ability to detect and correctly identify birds,

Table 13. Relationship of estimated populations per 50 acres to captures per 100 mist-net hours for birds on the Thistlethwaite Wildlife Management Area, 1972-1973.

| | Estimated birds per 50 acres | Birds per 50 acres within net height[a] | Captures per 100 mist net hours | Birds per 50 acres/ captures per 100 net hours |
|---|---|---|---|---|
| | | Winter (November - February)[b] | | |
| Yellow-bellied Sapsucker | 13.30 | 2.00 | 1.34 | 1.49 |
| Tufted Titmouse | 6.70 | .80 | 1.12 | .71 |
| Carolina Wren | 9.95 | 2.49 | 2.39 | 1.04 |
| Brown Thrasher | 13.11 | 4.06 | .95 | 4.27 |
| American Robin | 14.59 | 6.71 | 1.38 | 4.86 |
| Hermit Thrush | 5.38 | 2.58 | 2.21 | 1.17 |
| Ruby-crowned Kinglet | 6.67 | 1.47 | 3.04 | .48 |
| Yellow-rumped Warbler | 2.59 | .47 | .36 | 1.30 |
| Cardinal | 7.28 | 2.40 | 2.24 | 1.07 |
| Rufous-sided Towhee | 6.05 | 4.17 | .50 | 8.34 |
| White-throated Sparrow | 67.66 | 54.80 | 14.61 | 3.75 |
| | | | | 28.48 |
| | | | | X 2.59 |
| | | Breeding season (March - June)[c] | | |
| Acadian Flycatcher | 4.72 | .52 | .47 | 1.11 |
| Tufted Titmouse | 9.58 | 1.15 | .49 | 2.35 |
| Carolina Wren | 13.87 | 3.47 | 2.54 | 1.37 |
| White-eyed Vireo | 12.06 | 2.41 | 1.35 | 1.78 |
| Swainson's Warbler | 1.43 | .31 | 1.11 | .28 |
| Kentucky Warbler | 1.09 | .37 | 1.34 | .28 |
| Hooded Warbler | 2.33 | .40 | .54 | .74 |
| Cardinal | 11.17 | 3.69 | 1.22 | 3.02 |
| | | | | 10.93 |
| | | | | X 1.37 |

a. Portion of population within seven feet of ground [i.e., 100 percent of birds in stratum 1, and 22 percent (5 net feet/23 feet height in stratum 2 (Figure 4)].

b. Varied somewhat with peak population period of individual species.

c. Due to the preponderance of aural detections of singing male birds (Table 9) and the pairing of sexes during the breeding season, population figures more realistically represent bird pairs.

and censuser's speed while censusing are some of the factors involved in estimating numbers. Number of birds, bird behavior, bird mobility, size of birds, and bird location would all effect mist-net captures. A combination of these factors is usually operating and effect the estimated population per 50 acres to captures per 100 mist net hour ratio.

This ratio ranged from 0.48 to 8.34 for 11 different bird species during the winter period (November to February). A low ratio means a low population estimate or high number of captures in relation to the other birds. A mean ratio of 2.59 was noted for the 11 common species of winter birds. The species with the lowest ratios (less than 50 percent lower than the mean for all birds) were Tufted Titmouse and Ruby-crowned Kinglet. I believe different factors of the aforementioned causes are responsible in these two cases. Tufted Titmice seemed to be netted when other birds were in the nets. I believe the alarm cries of netted birds aroused the curiosity of the inquisitive Tufted Titmouse, attracting them to the net.

The Ruby-crowned Kinglet was netted in relatively high numbers (0.48-population/capture ratio, 81 percent below the mean of all birds). Mobility influences the capture of birds. The further a bird travels per unit time the greater the probability it w' l intersect a net.

I believe this is the case with kinglets. They were constantly in motion, seeming to always be actively foraging, which probably increased their chance of capture. Both titmice and kinglets were of the optimum size for the 1½ inch mist nets.

Three species of winter birds exhibited population to capture ratios greater than 50 percent above the mean of all birds. Brown Thrashers and American Robins had population to capture ratios of 4.27 and 4.86 respectively. Vociferousness and size were the best explanations for the high population to capture ratios of thrashers and robins. Both were vocal during the winter at the TWMA, resulting in high conspicuousness. Both species were observed to hit the nets and yet escape. Both were too large for efficient mist-net capturing. The Rufous-sided Towhee had the highest population to capture ratio (8.34). Plausible explanations were the tendency to flush, the easily seen white retrices spots, and the familiar winter call, all of which combined probably resulted in a relatively high conspicuousness.

Six species were within 50 percent of the mean of all birds in the population to capture ratio. These species were: Yellow-bellied Sapsucker, Carolina Wren, Hermit Thrush, Yellow-rumped Warbler, Northern Cardinal, and

White-throated Sparrow.

There were eight birds of approximate size, vertical height distribution, and numbers to be considered in the comparison of estimated population per 50 acres/catch per 100 mist-net hours during the breeding season (March-June). Five of these differed by more than 50 percent from the mean of all birds. All three common warblers (Swainson's, Kentucky, and Hooded) had ratios a minimum of 50 percent below the mean of the eight birds for the breeding season (1.37). These birds were either low in detectability and/or high in mist-net susceptability. There were few singing males detected in relation to net catches. Low conspicuousness is, in my opinion, the most plausible explanation. A sizable portion of these birds were not detected by the census. All the singing males were not detected each census, and all the males on the area probably were not singing during the breeding season (March-June). A sizable portion of the population must have been "surplus." Also, these birds were of the optimum capture size for the mist-nets used and catchability probably was somewhat higher than that of the larger birds.

Two species of birds, Tufted Titmouse and Northern Cardinal, had a population to capture ratio above two (above mean of all birds by more than 72 percent). Tufted Titmice

were high in conspicuousness and lower in captures in the spring. Calling increased during this March to June period (aural detections increased to over 90 percent for each of these months) thereby inflating census results. Furthermore, there were far less catches during the breeding season (Table 10) and less captured birds to attract the Tufted Titmouse to the nets. Additionally, daily movements were probably less in spring than during winter because of the need for more food forging in winter. The Northern Cardinal's estimated population to capture ratio (3.02) was 120 percent above the mean for all birds. I attribute this mainly to the increased spring calling and resulting conspicuousness. The fairly large size may also have played a small part.

# CONCLUSIONS

Louisiana bottomland hardwood forests are prime habitat for birds, particularly during the critical winter period. A standard Audubon winter bird census was conducted during the winter of 1972-1973 on a 20-acre area (Dickson 1973). Of the 34 forest habitat censuses conducted during the same period throughout the United States and Canada, none showed a greater number of total birds, and only five contained more species than the present study (1606 birds per sq. km., 32 species).

There were an estimated 2,521,511 acres of bottomland hardwoods in 21 parishes in north Louisiana in 1968 (Yancey 1970). From 1962 to 1968, 111,235 acres of hardwoods were clear-cut per year and converted to crop and pastureland. Although this rate of cutting probably decreased as the more suitable land was cleared, there was a projected 1,854,101 acres of bottomland hardwoods in 1974, based on past cutting. In the present study (in a bottomland hardwood forest of south central Louisiana) there were an estimated 285 birds per 50 acres (5.7 per acre) during January. Extrapolation of the TWMA winter population figure to the north Louisiana hardwood area yields a winter

population estimate of 10,567,800 birds. Realistically, an extrapolation of that magnitude would not be very accurate; but it does provide some insight into the value of Louisiana bottomland hardwoods to wintering birds.

The Louisiana bottomland hardwoods are also important as breeding bird habitat. There was a total estimated TWMA May population of 3.1 birds per acre. Employing the same extrapolation as with the winter birds, I estimate the north Louisiana bottomland hardwoods would harbor approximately 5,794,480 breeding birds in May.

One means of resource division in the bottomland hardwoods was a vertical height stratification between species. Species of Picidae, Paridae, and Corvidae tended to be canopy oriented (Figure 4). On the other hand, the seed-eating fringillids were located near the ground. The most ubiquitous species in height dispersal were: American Robin, Common Flicker, Rusty Blackbird, American Goldfinch, and Brown Thrasher (Table 7). The species most narrow in forest profile height utilization, and the zones they inhabited were: Red-headed Woodpecker and Blue Jay - canopy; White-eyed Vireo, Hooded Warbler, and Carolina Wren - mid-story.

I observed seasonal changes in bird height distribution. There was a gradual shift in distribution of all birds upward in height from winter through spring, to the

summer breeding season. The winter to summer distributions changed significantly ($P < .01$) from a nearly equal distribution at all levels in winter to a predominantly mid-story and canopy distribution in summer (Figure 5). Corresponding with this was a highly significant ($P < .01$) reduction in height diversity of the aggregate of all birds (Figure 8). Presumably, these height changes were responses to the seasonal shift of foliage profile and primary production of the forest.

A wide range in estimated populations resulted from a comparison of different "singing male" breeding season censuses. Due to incomplete counting of all singing males on any one census, mean detections per individual census (count) resulted in lowest estimated populations. In the "spot mapping" techniques (from transect) estimated populations increased steadily as number of counts increased from six to eight to eleven. Maximum population estimates per day for each individual species (summation technique) produced estimates similar to spot mapping with eight censuses. The highest number of birds was estimated from the area spot map census. This was due mainly to the intersection of the censurer with the bird's detection radius more than once in the area census, and also to the greater chance of counting one individual more than once.

The transect census technique produced the most consistent results in winter and during the spring and summer breeding season. Incompleteness of each single census is a factor that has to be recognized and dealt with, particularly during the breeding season. Censusing was effective with birds of high conspicuousness. Non-vocal birds present during the hardwood forest growing season were ineffectively censused (e.g., migrating warblers). Transect censusing overestimated numbers of flying birds. Yapp (1956) pointed out the affect of animal speed on the total detection area of each particular animal. The faster an animal moves the more area it covers and the higher the probability that animal will be censused. I believe Common Grackles were not censused effectively due to their flocking habits and flights.

Year yound censusing was more sensitive to some behavior patterns than to actual numbers. With most species of birds, higher numbers were noted during the spring period of peak calling, rather than the quiescent late summer period of optimum numbers (Table 11).

Many variables could have possibly influenced the ratio of estimated population to mist-net captures. Highly conspicuous birds tended to have higher population estimates; therefore, high population to catch ratios (e.g.,

Northern Cardinals). Relatively low captures resulted in high estimated population to capture ratios. Vertical height distribution of birds in the forest profile influenced captures (populations were adjusted to net height in Table 13). Size of birds also played a role. Brown Thrashers and Blue Jays were of marginal catch size for the 1 1/2 inch mesh mist-nets and birds larger than these were rarely caught.

Other bird species were frequently caught in relation to their estimated population. Breeding season warblers tended to exhibit high catchability and/or low conspicuousness. Occasionally, it appeared that inquisitive birds (e.g., Tufted Titmice) were lured into the nets by other captured birds. Also, highly mobile birds with short effective detection distances were captured often in relation to estimated populations (e.g., Ruby-crowned Kinglet).

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# APPENDIX

Table 14. Scientific nomenclature of birds on the Thistlethwaite Wildlife Management Area

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| Yellow-crowned Night Heron | Nyctanassa violacea (Linnaeus) |
| Wood Duck | Aix sponsa (Linnaeus) |
| Black Vulture | Coragyps atratus (Bechstein) |
| Red-tailed Hawk | Buteo jamaicensis (Gmelin) |
| Red-shouldered Hawk | Buteo lineatus (Gmelin) |
| Turkey | Meleagris gallopavo Linnaeus |
| American Woodcock | Philohela minor (Gmelin) |
| Mourning Dove | Zenaida macroura (Linnaeus) |
| Yellow-billed Cuckoo | Coccyzus americanus (Linnaeus) |
| Barred Owl | Strix varia Barton |
| Chimney Swift | Chaetura pelagica (Linnaeus) |
| Ruby-throated Hummingbird | Archilochus colubris (Linnaeus) |
| Common Flicker | Colaptes auratus (Linnaeus) |
| Pileated Woodpecker | Dryocopus pileatus (Linnaeus) |
| Red-bellied Woodpecker | Centurus carolinus (Linnaeus) |
| Red-headed Woodpecker | Melanerpes erythrocephalus (Linnaeus) |
| Yellow-bellied Sapsucker | Sphyrapicus varius (Linnaeus) |
| Hairy Woodpecker | Dendrocopos villosus (Linnaeus) |

Table 14. (Continued)

| | |
|---|---|
| Downy Woodpecker | Dendrocopos pubescens (Linnaeus) |
| Great Crested Flycatcher | Myiarchus crinitus (Linnaeus) |
| Eastern Phoebe | Sayornis phoebe (Latham) |
| Empidonax Flycatcher | Empidonax sp. |
| Yellow-bellied Flycatcher | Empidonax flaviventris (Baird and Baird) |
| Acadian Flycatcher | Empidonax virescens (Vieillot) |
| Eastern Wood Pewee | Contopus virens (Linnaeus) |
| Rough-winged Swallow | Stelgidopteryx ruficollis (Vieillot) |
| Blue Jay | Cyanocitta cristata (Linnaeus) |
| Common Crow | Corvus brachyrhynchos Brehm |
| Carolina Chickadee | Parus carolinensis (Audubon) |
| Tufted Titmouse | Parus bicolor Linnaeus |
| House Wren | Troglodytes aedon Vieillot |
| Winter Wren | Troglodytes troglodytes Linnaeus |
| Carolina Wren | Thryothorus ludovicianus (Latham) |
| Mockingbird | Mimus polyglottos (Linnaeus) |
| Gray Catbird | Dumetella carolinensis (Linnaeus) |
| Brown Thrasher | Toxostoma rufum (Linnaeus) |
| American Robin | Turdus migratorius (Linnaeus) |
| Wood Thrush | Hylocichla mustelina (Gmelin) |
| Hermit Thrush | Catharus guttatus (Pallas) |
| Swainson's Thrush | Catharus ustulatus (Nuttall) |
| Gray-cheeked Thrush | Catharus minimus (Lafresnaye) |
| Eastern Bluebird | Sialia sialis (Linnaeus) |

Table 14. (Continued)

| | |
|---|---|
| Blue-gray Gnatcatcher | Polioptila caerulea (Linnaeus) |
| Golden-crowned Kinglet | Regulus satrapa Lichtenstein |
| Ruby-crowned Kinglet | Regulus calendula (Linnaeus) |
| Cedar Waxwing | Bombycilla cedrorum Vieillot |
| Loggerhead Shrike | Lanius ludovicianus Linnaeus |
| Starling | Sturnus vulgaris Linnaeus |
| White-eyed Vireo | Vireo griseus (Boddaert) |
| Yellow-throated Vireo | Vireo flavifrons Vieillot |
| Solitary Vireo | Vireo solitarius (Wilson) |
| Red-eyed Vireo | Vireo olivaceus (Linnaeus) |
| Black-and-white Warbler | Mniotilta varia (Linnaeus) |
| Prothonotary Warbler | Protonotaria citrea (Boddaert) |
| Swainson's Warbler | Limnothlypis swainsonii (Audubon) |
| Worm-eating Warbler | Helmitheros vermivorus (Gmelin) |
| Tennessee Warbler | Vermivora peregrina (Wilson) |
| Orange-crowned Warbler | Vermivora celata (Say) |
| Nashville Warbler | Vermivora ruficapilla (Wilson) |
| Northern Parula Warbler | Parula americana (Linnaeus) |
| Yellow-rumped Warbler | Dendroica coronata (Linnaeus) |
| Bay-breasted Warbler | Dendroica castanea (Wilson) |
| Ovenbird | Seiurus aurocapillus (Linnaeus) |
| Northern Waterthrush | Seiurus noveboracensis (Gmelin) |
| Louisiana Waterthrush | Seiurus motacilla (Vieillot) |
| Kentucky Warbler | Oporornis formosus (Wilson) |
| Common Yellowthroat | Geothlypis trichas (Linnaeus) |

Table 14. (Continued)

| | |
|---|---|
| Yellow-breasted Chat | Icteria virens (Linnaeus) |
| Hooded Warbler | Wilsonia citrina (Boddaert) |
| Canada Warbler | Wilsonia canadensis (Linnaeus) |
| American Redstart | Septophaga ruticilla (Linnaeus) |
| Red-winged Blackbird | Agelaius phoeniceus (Linnaeus) |
| Rusty Blackbird | Euphagus carolinus (Muller) |
| Common Grackle | Quiscalus quiscula (Linnaeus) |
| Brown-headed Cowbird | Molothrus ater (Boddaert) |
| Summer Tanager | Piranga rubra (Linnaeus) |
| Cardinal | Cardinalis cardinalis (Linnaeus) |
| Indigo Bunting | Passerina cyanea (Linnaeus) |
| Painted Bunting | Passerina ciris (Linnaeus) |
| Purple Finch | Carpodacus purpureus (Gmelin) |
| American Goldfinch | Spinus tristis (Linnaeus) |
| Rufous-sided Towhee | Pipilo erythrophthalmus (Linnaeus) |
| White-throated Sparrow | Zonotrichia albicollis (Gmelin) |
| Fox Sparrow | Passerella iliaca (Merrem) |
| Swamp Sparrow | Melospiza georgiana (Latham) |
| Song Sparrow | Melospiza melodia (Wilson) |

[a] From American Ornithologists' Union. 1957. Check-list of North American birds, fifth ed. Baltimore, Amer. Ornith. Union 650 p. and Thirty-Second Supplement to the American Ornithologists' Union Check-list of North American Birds. 1973. Auk 90(2): 411-419.

Table 15. Summer understory vegetative composition of a selected portion of the Thistlethwaite Wildlife Management Area, May 1974.

| Common name | Scientific name | Average cover | Frequency of occurrence |
|---|---|---|---|
| | | - - Percent - - - - | |
| Cane | Arundinaria gigantea | 27.7 | 68.2 |
| Sedges | Cyperaceae (family) | 10.1 | 7.4 |
| Poison Ivy | Rhus radicans | 9.9 | 79.6 |
| Ironwood | Carpinus caroliniana | 5.0 | 36.4 |
| Palmetto | Sabal minor | 4.3 | 40.9 |
| Jumpseed | Tovara virginiana | 4.2 | 47.7 |
| Oak | Quercus spp. | 4.0 | 79.6 |
| Elm | Ulmus americana and Ulmus alata | 3.2 | 43.1 |
| Greenbriar | Smilax spp. | 3.3 | 52.3 |
| Cross Vine | Anisostichus capreolata | 3.0 | 54.6 |
| Dewberry | Rubus sp. | 2.7 | 40.9 |
| Sugarberry | Celtis laevigata | 2.7 | 36.4 |
| Rattan Vine | Berchemia scandens | 2.5 | 40.9 |
| Oplismenus | Oplismenus setarius | 2.2 | 34.1 |
| Virginia Creeper | Parthenocissus quinquefolia | 2.2 | 38.6 |
| Elephant's-foot | Elephantopus carolinianus | 2.0 | 31.8 |
| Beggar Lice | Desmodium sp. | 1.8 | 27.3 |

Table 15. (continued)

| Common name | Scientific name | Average cover - - - Percent | Frequency of occurrence - - - - |
|---|---|---|---|
| Green Ash | Fraxinus pennsylvanica | 1.7 | 29.6 |
| Trumpet Vine | Campsis radicans | 1.6 | 27.3 |
| Geum | Geum canadense | 1.5 | 29.6 |
| Violet | Viola sp. | 1.5 | 29.6 |
| Aster | Aster spp. | 1.4 | 22.7 |
| Pignut Hickory | Carya glabra | 1.2 | 15.9 |
| Boxelder | Acer negundo | 1.0 | 11.4 |
| Muscadine | Vitis rotundifolia | 1.0 | 15.9 |
| Pepper-vine | Ampelopsis arborea | 0.9 | 13.6 |
| Mistflower | Eupatorium coelestinum | 0.9 | 18.2 |
| False Nettle | Boehmeria cylindrica | 0.7 | 7.1 |
| Coralbeads | Cocculus carolinus | 0.7 | 13.6 |
| Waterwillow | Justicia ovata | 0.6 | 11.4 |
| Hawthorn | Crataegus sp. | 0.6 | 11.4 |
| Dayflower | Commelina virginica | 0.4 | 4.6 |
| Sweetgum | Liquidambar styraciflua | 0.4 | 4.6 |
| Persimmon | Diospyros virginiana | 0.4 | 9.1 |
| Matelea | Matelea gonocarpa | 0.4 | 9.1 |
| Erigeron | Erigeron sp. | 0.4 | 9.1 |

Table 15. (continued)

| Common name | Scientific name | Average cover - - - Percent- | Frequency of occurrence - - - - - |
|---|---|---|---|
| Mulberry | Morus rubra | 0.3 | 6.8 |
| Verbena | Verbena brasiliensis | 0.3 | 6.8 |
| Elderberry | Sambucus canadensis | 0.3 | 2.3 |
| Ironweed | Vernonia altissima | 0.3 | 6.8 |
| Spiderwort | Tradescantia ohiensis | 0.2 | 4.6 |
| Ladies'-eardrops | Brunnichia cirrhosa | 0.2 | 4.6 |
| Clover | Trifolium sp. | 0.2 | 4.6 |
| Water Pimpernel | Samolous canadensis | 0.2 | 4.6 |
| Green Dragon | Arisaema dracontium | 0.1 | 2.3 |
| Knotweed | Polygonum spp. | 0.1 | 2.3 |
| Alligator-weed | Alternanthera philoxeroides | 0.1 | 2.3 |
| Iresine | Iresine sp. | 0.1 | 2.3 |
| Redbud | Cercis canadensis | 0.1 | 2.3 |
| Partridge Pea | Cassia fasciculata | 0.1 | 2.3 |
| Honeylocust | Gleditsia triacanthos | 0.1 | 2.3 |
| Sida | Sida rhombifolia | 0.1 | 2.3 |
| Pennywort | Hydrocotyle sp. | 0.1 | 2.3 |
| Swamp Dogwood | Cornus drummondii | 0.1 | 2.3 |

Table 15. (continued)

| Common name | Scientific name | Average cover | Frequency of occurrence |
|---|---|---|---|
| | | Percent | |
| Penstemon | *Penstemon* sp. | 0.1 | 2.3 |
| Ruellia | *Ruellia carolinensis* | 0.1 | 2.3 |
| Plantain | *Plantago* sp. | 0.1 | 2.3 |
| Japanese Honeysuckle | *Lonicera japonica* | 0.1 | 2.3 |
| Wild Lettuce | *Lactuca* sp. | 0.1 | 2.3 |
| Butterweed | *Senecio glabellus* | 0.1 | 2.3 |

a. Determined from 44 milacre circular plots. Includes all vegetation from ground level to six feet high.

Table 16. Mean monthly bird population estimates per 50 acres and confidence limits (.05 level) determined from transect censuses on the Thistlethwaite Wildlife Management Area[a]

1972
Months and Number of Censuses

| | Jan. | | Feb. (3)[b] | | Mar. (2) | | Apr. (2) | | May (2) | | Jun. (5) | | Jul. (8) | | Aug. (9) | | Sep. (5) | | Oct. (6) | | Nov. (4) | | Dec. (4) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL |
| Yellow-crowned Night Heron | | | | | | | | | | | | | | | .22 | .52 | | | | | | | | |
| Wood Duck | | | | | .50 | | | | | | | | | | | | | | | | | | | |
| Black Vulture | | | | | 14.85 | | | | | | | | | | | | | | | | | | .82 | 2.62 |
| Red-tailed Hawk | | | .67 | | | | | | | | | | | | | | | | | | | | .25 | .80 |
| Red-shouldered Hawk | | | | | | | | | | | | | .062 | .15 | .11 | .16 | .80 | 1.04 | .33 | .43 | .88 | .76 | .50 | .63 |
| Yellow-billed Cuckoo | | | | | | | | | 5.00 | | 5.80 | 4.42 | 4.25 | 1.71 | 6.33 | 2.46 | .40 | .68 | | | | | | |
| Barred Owl | | | | | | | .25 | | .50 | | | | | | .06 | .11 | .10 | .28 | | | | | | |
| Chimney Swift | | | | | | | | | | | | | | | 1.10 | 1.79 | | | | | | | | |
| Ruby-throated Hummingbird | | | | | 1.65 | | 1.65 | | | | .67 | 1.83 | | | .73 | 1.69 | | | | | | | | |
| Common Flicker | | | 3.00 | | | | | | | | | | .12 | .29 | | | | | 2.67 | 1.08 | 1.75 | 1.52 | 1.75 | 2.72 |
| Pileated Woodpecker | | | 1.00 | | 1.00 | | .50 | | 1.00 | | 2.60 | 1.41 | 3.38 | 1.54 | 2.89 | 1.51 | 1.20 | 3.33 | .83 | 1.23 | .50 | .92 | 1.00 | 1.30 |
| Red-bellied Woodpecker | | | 7.00 | | 4.00 | | 3.50 | | 4.00 | | 1.40 | .68 | 4.00 | 2.09 | 8.44 | 1.09 | 12.40 | 5.01 | 8.33 | 2.87 | 5.00 | 4.50 | 4.25 | 3.97 |
| Red-headed Woodpecker | | | 8.00 | | 4.00 | | 4.00 | | 1.00 | | 1.00 | 1.39 | | | .22 | .52 | 19.60 | 12.09 | 33.67 | 4.07 | 31.00 | 12.30 | 29.00 | 9.88 |
| Yellow-bellied Sapsucker | | | 8.67 | | 8.00 | | | | | | | | | | | | .40 | 1.11 | 2.00 | 1.88 | 7.00 | 5.50 | 11.50 | 7.05 |
| Hairy Woodpecker | | | | | | | | | | | | | | | .73 | 1.69 | | | | | | | | |
| Downy Woodpecker | | | 2.20 | | | | | | | | .67 | 1.83 | 1.24 | 2.05 | 1.47 | 1.84 | | | 1.10 | 1.79 | | | | |
| Great Crested Flycatcher | | | | | | | | | .50 | | 1.40 | 1.11 | .50 | .63 | .44 | .56 | | | | | | | | |
| Eastern Phoebe | | | 1.10 | | | | | | | | | | | | | | | | | | | | | |
| Empidonax Flycatcher | | | | | | | 1.65 | | 3.3 | | 1.32 | 3.66 | | | | | 1.20 | 1.36 | | | | | | |
| Acadian Flycatcher | | | | | | | | | 3.0 | | 3.20 | 2.83 | 5.00 | 1.78 | 2.89 | 1.90 | 2.80 | 2.83 | | | | | | |
| Rough-winged Swallow | | | | | | | | | | | | | 1.24 | 2.92 | | | | | | | | | | |
| Blue Jay | | | 2.00 | | 1.00 | | 1.00 | | 1.00 | | .20 | .55 | .25 | .39 | .67 | 1.02 | 2.20 | 3.55 | 16.33 | 7.50 | 16.75 | 10.81 | 18.75 | 9.39 |
| Common Crow | | | .67 | | 1.00 | | | | 2.00 | | | | .25 | .39 | .56 | .56 | .20 | .55 | .166 | .43 | 1.00 | 3.13 | | |
| Carolina Chickadee | | | .83 | | 1.25 | | | | 7.50 | | 1.00 | 2.78 | 3.75 | 3.16 | .83 | 1.36 | 3.00 | 2.60 | 2.92 | 4.20 | .62 | 1.98 | | |
| Tufted Titmouse | | | 10.33 | | 12.00 | | 18.50 | | 17.50 | | 7.80 | 1.36 | 6.62 | 2.09 | 7.11 | 1.41 | 7.80 | 2.22 | 5.50 | 4.02 | 4.00 | 5.80 | 2.75 | 2.00 |
| Winter Wren | | | | | | | | | | | | | | | | | | | .55 | 1.42 | .82 | 2.62 | | |
| Carolina Wren | | | 10.33 | | 10.00 | | 17.50 | | 19.00 | | 16.40 | 3.35 | 12.88 | 3.01 | 16.56 | 2.96 | 19.00 | 2.78 | 16.67 | 6.59 | 12.25 | 1.52 | 14.75 | 7.38 |
| Mockingbird | | | .67 | | | | | | | | .20 | .55 | | | | | .60 | 1.11 | 2.00 | 1.49 | | | .50 | 1.59 |
| Gray Catbird | | | | | | | | | | | | | | | | | .80 | 1.36 | 1.00 | 1.75 | | | | |
| Brown Thrasher | | | 1.33 | | 1.00 | | | | | | | | | | | | | | 40.67 | 24.36 | 6.50 | 1.59 | 11.00 | 7.56 |
| American Robin | | | 10.00 | | 2.00 | | | | | | | | | | .44 | 1.02 | | | | | 1.00 | 3.18 | 34.50 | 57.11 |
| Wood Thrush | | | | | | | 2.50 | | .50 | | 2.00 | 1.76 | 1.75 | 1.07 | .44 | .56 | | | .166 | .43 | | | | |
| Hermit Thrush | | | | | 1.00 | | | | | | | | | | | | | | 1.67 | 3.36 | 7.00 | 1.83 | 5.00 | 5.50 |

Table 16. (Continued)

| | Jan. | | Feb. (3)[b] | | Mar. (2) | | Apr. (2) | | May (2) | | Jun. (5) | | Jul. (8) | | Aug. (9) | | Sep. (5) | | Oct. (6) | | Nov. (4) | | Dec. (4) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI |
| Gray-cheeked Thrush | | | | | | | | | | | | | | | | | | | .417 | 1.07 | | | | |
| Blue-gray Gnatcatcher | | | | | 1.65 | | | | | | | | .82 | 1.28 | | | .66 | 1.83 | | | | | | |
| Golden-crowned Kinglet | | | | | | | | | | | | | | | | | | | | | .82 | 2.62 | .82 | 2.62 |
| Ruby-crowned Kinglet | | | 6.60 | | 8.25 | | 3.30 | | | | | | | | | | | | | | 7.42 | 15.06 | 9.08 | 9.93 |
| Starling | | | .33 | | .50 | | | | | | | | | | | | | | | | | | | |
| White-eyed Vireo | | | | | 3.00 | | 12.50 | | 11.00 | | 11.20 | 5.78 | 12.75 | 4.16 | 10.56 | 1.44 | 17.00 | 4.56 | .83 | 1.39 | .25 | .80 | | |
| Yellow-throated Vireo | | | | | 1.50 | | 1.50 | | 1.00 | | .40 | .68 | .50 | .24 | 1.00 | .62 | 2.00 | 1.96 | | | | | | |
| Red-eyed Vireo | | | | | | | 1.50 | | 2.00 | | 2.20 | 1.49 | 3.63 | 1.76 | 4.22 | 1.37 | .20 | .55 | | | | | | |
| Black-and-white Warbler | | | | | | | | | | | | | | | .37 | .85 | | | | | | | | |
| Prothonotary Warbler | | | | | | | 3.75 | | | | 4.00 | 3.54 | .94 | 1.08 | | | | | | | | | | |
| Swainson's Warbler | | | | | | | 1.00 | | | | 1.20 | 1.36 | | | | | | | | | | | | |
| Orange-crowned Warbler | | | | | 1.65 | | | | | | | | | | | | | | | | | | .82 | 2.62 |
| Northern Parula Warbler | | | | | | | | | | | 1.00 | 1.70 | .62 | .96 | | | .63 | 1.50 | | | | | | |
| Yellow-rumped Warbler | | | 33.00 | | 8.25 | | | | | | | | | | | | | | | | 1.65 | 5.24 | 1.65 | 3.02 |
| Bay-breasted Warbler | | | | | | | | | | | | | | | | | | | .55 | 1.41 | .82 | 2.62 | | |
| Louisiana Waterthrush | | | | | 1.65 | | | | | | | | | | | | | | | | | | | |
| Kentucky Warbler | | | | | | | 5.00 | | | | 1.70 | 2.78 | .94 | 1.08 | 1.11 | 1.95 | .50 | 1.39 | | | | | | |
| Common Yellowthroat | | | | | | | | | | | | | | | | | | | | | | | 0.82 | 2.62 |
| Yellow-breasted Chat | | | | | | | | | | | | | | | 1.11 | 1.69 | | | | | | | | |
| Hooded Warbler | | | | | | | 2.50 | | 1.25 | | 2.00 | 4.05 | 1.56 | 1.08 | 1.39 | 1.55 | 1.00 | 1.70 | | | | | | |
| Rusty Blackbird | | | | | | | | | | | | | | | | | | | | | | | 1.25 | 3.97 |
| Common Grackle | | | 40.83 | | 52.50 | | | | | | | | | | | | | | 15.50 | 24.82 | 55.00 | 81.86 | 49.38 | 46.71 |
| Brown-headed Cowbird | | | | | | | | | | | 3.20 | 4.84 | | | .22 | .52 | | | | | | | 5.00 | 15.69 |
| Summer Tanager | | | | | | | 1.00 | | 3.00 | | 3.60 | 4.08 | 1.75 | 1.88 | 1.11 | 1.12 | 1.20 | 1.36 | | | | | | |
| Cardinal | | | 15.33 | | 21.00 | | 25.00 | | 21.00 | | 13.60 | 5.38 | 16.50 | 2.32 | 7.33 | 3.84 | 6.00 | 5.27 | 5.00 | 3.45 | 2.50 | 4.77 | 5.50 | 4.77 |
| Indigo Bunting | | | | | | | 4.95 | | | | | | | | | | | | | | | | | |
| Painted Bunting | | | | | | | | | | | | | .31 | .74 | | | | | | | | | | |
| American Goldfinch | | | 1.33 | | | | | | | | | | | | | | | | | | | | 1.50 | 3.04 |
| Rufous-sided Towhee | | | 2.00 | | 1.00 | | 2.00 | | 1.00 | | 1.20 | 1.36 | 1.50 | 1.48 | .44 | .68 | .80 | 2.22 | .33 | .86 | 1.50 | | 7.00 | 11.75 |
| White-throated Sparrow | | | 60.50 | | 74.25 | | 77.55 | | | | | | | | | | | | 5.50 | 9.96 | 20.62 | 30.88 | 113.85 | 131.93 |
| Swamp Sparrow | | | | | | | 1.65 | | | | | | | | | | | | | | | | | |
| Song Sparrow | | | | | | | | | | | | | | | | | | | | | | | .82 | 2.27 |

[a] The preponderance of detections of birds during the breeding season [March (for birds remaining throughout the season), April, May, June, and July] were of singing males (Table 9 ) therefore the population figure more accurately represents bird pairs.

[b] Less than four samples per month were insufficient for determination of meaningful confidence limits.

Table 17. Mean monthly bird population estimates per 50 acres and confidence limits (.05 level) determined from transect censuses on the Thistlethwaite Wildlife Management Area[a]

1973
Months and Number of Censuses

| | Jan. (6) | | Feb. (3) | | Mar. (8) | | Apr. (7) | | May (7) | | Jun. (4) | | Jul. (7) | | Aug. (8) | | Sep. (7) | | Oct. (4) | | Nov. (7) | | Dec.-Jan.(8) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL | $\bar{x}$ | CL |
| Wood Duck | | | | | | | | | | | | | | | | | | | | | | | .25 | .59 |
| Black Vulture | | | | | 1.41 | 2.15 | | | | | | | | | | | | | | | | | | |
| Red-tailed Hawk | | | | | | | | | | | | | | | | | | | | | | | .12 | .29 |
| Red-shouldered Hawk | .25 | .43 | .50 | | .25 | .22 | .21 | .24 | .04 | .09 | .25 | .80 | | | .06 | .15 | .14 | .35 | .125 | .40 | .29 | .52 | .25 | .22 |
| Turkey | | | | | | | | | | | | | | | | | .57 | 1.40 | | | | | | |
| American Woodcock | .55 | 1.41 | | | | | | | | | | | | | | | | | | | | | | |
| Mourning Dove | | | | | | | | | | | | | | | | | | | | | | | .41 | .97 |
| Yellow-billed Cuckoo | | | | | | | | | 3.43 | 3.77 | 7.00 | 5.35 | 4.00 | 1.41 | 2.37 | 1.54 | 1.14 | .99 | | | .14 | .35 | | |
| Barred Owl | | | .17 | | .25 | .31 | .29 | .36 | .21 | .24 | .12 | .41 | .12 | .33 | .25 | .33 | .14 | .22 | | | .14 | .22 | .06 | .15 |
| Ruby-throated Hummingbird | | | | | | | .47 | 1.15 | .47 | 1.15 | | | | | | | | | | | | | | |
| Common Flicker | .67 | .85 | 2.00 | | .38 | .62 | | | | | | | | | | | | | 4.00 | 4.49 | 2.29 | 1.39 | 1.62 | .88 |
| Pileated Woodpecker | 1.83 | 1.39 | 1.67 | | 1.88 | 1.13 | .43 | .49 | .86 | 1.12 | .50 | 1.59 | .29 | .45 | 1.12 | .83 | 1.00 | 1.07 | .25 | .80 | 1.14 | .83 | .83 | .70 |
| Red-bellied Woodpecker | 3.83 | 1.23 | 1.67 | | 3.50 | 1.48 | 3.00 | .93 | 3.43 | 1.92 | 2.75 | 3.28 | 2.43 | 1.68 | 2.00 | 1.26 | 2.43 | .49 | 6.00 | 4.49 | 5.86 | 2.29 | 3.83 | 1.51 |
| Red-headed Woodpecker | 23.33 | 8.87 | 22.67 | | 17.00 | 5.85 | 5.43 | 4.50 | | | | | | | | | 4.86 | 4.12 | 22.50 | 36.27 | 15.71 | 4.59 | 13.25 | 6.18 |
| Yellow-bellied Sapsucker | 16.67 | 6.46 | 17.33 | | 5.50 | 4.16 | .29 | .70 | | | | | | | | | | | 6.50 | 12.54 | 7.71 | 4.83 | 11.50 | 5.03 |
| Hairy Woodpecker | | | 1.10 | | | | | | | | | | | | .41 | 1.40 | | | | | 1.41 | 3.46 | .41 | .97 |
| Downy Woodpecker | .56 | 1.41 | | | | | | | .47 | 1.15 | | | .47 | 1.15 | | | .47 | 1.15 | .83 | 2.62 | .47 | 1.15 | | |
| Great Crested Flycatcher | | | | | | | .14 | .35 | 1.57 | 1.92 | .50 | .92 | 1.14 | .99 | .25 | .39 | | | | | | | | |
| Eastern Phoebe | .55 | 1.41 | | | | | | | | | | | | | | | | | | | | | .82 | 1.19 |
| Acadian Flycatcher | | | | | | | .29 | .70 | 4.29 | 2.49 | 5.00 | 5.50 | 4.86 | 3.18 | 2.25 | 1.65 | .86 | .99 | | | | | | |
| Eastern Wood Pewee | | | | | | | | | .47 | 1.15 | .82 | 2.62 | | | | | | | | | | | | |
| Rough-winged Swallow | | | | | | | | | | | .82 | 2.62 | | | | | | | | | | | | |
| Blue Jay | 11.50 | 5.68 | 9.67 | | 9.50 | 3.89 | 10.86 | 4.32 | .50 | .87 | | | | | .12 | .30 | 1.29 | 1.03 | 1.75 | 2.38 | 1.00 | 1.07 | 2.12 | 2.07 |
| Common Crow | 1.00 | 1.63 | .33 | | .50 | .63 | .14 | .35 | .14 | .35 | | | .43 | .73 | .87 | 1.37 | .43 | .33 | .50 | 1.59 | .71 | 1.03 | .75 | .74 |
| Carolina Chickadee | 1.67 | 2.14 | 2.50 | | 2.19 | 1.74 | .71 | 1.75 | | | | | .71 | 1.13 | .31 | .74 | .71 | 1.13 | .63 | 1.98 | .36 | .87 | 1.56 | 1.91 |
| Tufted Titmouse | 5.16 | 4.71 | 6.33 | | 14.50 | 3.54 | 7.29 | 3.24 | 9.29 | 3.53 | 7.25 | 3.52 | 5.00 | 2.74 | 7.87 | 2.46 | 6.43 | 1.99 | 11.00 | 5.94 | 4.43 | 1.99 | 10.88 | 4.77 |
| Carolina Wren | 8.67 | 3.55 | 6.00 | | 15.62 | 3.76 | 15.43 | 1.76 | 14.00 | 2.39 | 10.50 | 3.78 | 8.25 | 2.49 | 12.50 | 3.43 | 13.14 | 3.56 | 11.75 | 6.91 | 11.57 | 5.63 | 13.54 | 3.79 |
| Mockingbird | 1.33 | .85 | 1.33 | | .71 | .62 | | | | | | | | | | | | | 1.60 | 1.87 | 1.00 | .93 | .88 | .70 |
| Gray Catbird | | | | | | | .86 | .99 | | | | | | | | | .29 | .70 | 2.00 | 3.67 | | | | |
| Brown Thrasher | 15.33 | 7.70 | 14.00 | | 10.00 | 5.28 | 5.14 | 4.64 | | | | | | | | | 2.29 | 3.77 | 7.00 | 9.53 | 3.14 | 3.36 | 2.50 | 1.48 |
| American Robin | 13.33 | 7.47 | 9.33 | | 4.50 | 5.19 | | | | | | | | | | | | | | | 20.71 | 30.93 | 15.00 | 13.45 |
| Wood Thrush | | | | | | | .57 | .73 | 1.43 | .73 | .75 | 1.52 | .43 | .73 | .87 | 1.13 | .29 | .45 | | | | | | |
| Hermit Thrush | 5.33 | 5.26 | 1.33 | | .75 | .87 | .29 | .70 | | | | | | | | | | | 1.00 | 1.83 | 8.57 | 4.75 | 2.25 | 2.26 |

Table 17. (Continued)

| | Jan. (6) | | Feb. (3)[b] | | Mar. (8) | | Apr. (7) | | May (7) | | Jun. (4) | | Jul. (7) | | Aug. (8) | | Sep. (7) | | Oct. (4) | | Nov. (7) | | Dec.-Jan.(8) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI | $\bar{x}$ | CI |
| Swainson's Thrush | | | | | | | | | 1.41 | 3.46 | | | | | | | | | | | | | | |
| Grey-cheeked Thrush | | | | | | | | | .36 | .87 | | | | | | | .36 | .87 | | | | | | |
| Eastern Bluebird | | | | | | | | | | | | | | | | | | | | | | | .41 | .97 |
| Blue-grey Gnatcatcher | | | | | | | | | | | | | | | | | .47 | 1.15 | | | | | | |
| Golden-crowned Kinglet | 1.10 | 2.83 | 1.10 | | | | | | | | | | | | | | | | | | | | .41 | .97 |
| Ruby-crowned Kinglet | 8.80 | 6.81 | 2.20 | | 2.06 | 3.88 | .47 | 1.15 | | | | | | | | | | | | | .94 | 1.49 | 4.54 | 2.53 |
| Cede. Waxwing | | | 1.10 | | 4.95 | 11.69 | | | | | | | | | | | | | | | | | 3.30 | 5.10 |
| Starling | | | .33 | | .50 | .63 | .12 | .33 | .29 | .70 | .25 | .80 | .29 | .45 | .25 | .39 | | | | | | | | |
| White-eyed Vireo | | | | | 1.88 | 2.21 | 15.28 | 3.45 | 12.14 | 3.94 | 14.25 | 2.00 | 10.00 | 1.41 | 9.25 | 2.39 | 11.43 | 2.72 | .50 | .92 | .57 | .49 | .38 | .43 |
| Yellow-throated Vireo | | | | | .75 | .74 | 2.14 | 1.24 | 1.71 | 1.38 | 1.75 | 2.00 | .86 | .83 | 1.00 | 1.34 | .86 | .64 | | | | | | |
| Red-eyed Vireo | | | | | | | 1.86 | 1.12 | 2.86 | .99 | 3.75 | 3.01 | 2.57 | 1.59 | 1.50 | 1.26 | | | | | | | | |
| Prothonotary Warbler | | | | | | | 2.14 | 2.08 | .71 | 1.13 | 2.50 | 3.24 | | | .31 | .74 | | | | | | | | |
| Swainson's Warbler | | | | | | | .86 | 1.46 | 2.00 | 1.51 | 2.00 | 2.59 | .86 | .99 | .50 | 1.18 | | | | | | | | |
| Worm-eating Warbler | | | | | | | | | | | | | | | .82 | 1.27 | | | | | | | | |
| Orange-crowned Warbler | 1.10 | 1.79 | 2.20 | | | | | | | | | | | | | | | | | | | | .82 | 1.27 |
| Northern Parula Warbler | | | | | 2.19 | 2.35 | 1.07 | 1.24 | .36 | .87 | | | .71 | 1.75 | | | | | | | | | | |
| Yellow-rumped Warbler | .55 | 1.41 | 1.10 | | 3.30 | 5.70 | 3.30 | 4.67 | | | | | | | | | | | | | 2.36 | 4.57 | 4.95 | 5.89 |
| Northern Waterthrush | | | | | | | .47 | 1.15 | | | | | | | | | | | | | | | | |
| Kentucky Warbler | | | | | | | 1.79 | 2.90 | 1.07 | 1.82 | .62 | 1.98 | | | 1.96 | 3.86 | 1.07 | 1.82 | | | | | | |
| Hooded Warbler | | | | | .31 | .74 | 2.86 | 3.39 | 1.79 | 1.13 | .62 | 1.98 | .71 | 1.13 | .94 | 1.08 | .71 | 1.13 | | | | | | |
| American Redstart | | | | | | | .47 | 1.15 | | | | | | | | | | | | | | | | |
| Red-winged Blackbird | | | | | 2.06 | 4.87 | | | | | | | | | | | | | | | | | | |
| Rusty Blackbird | 2.50 | 2.87 | 18.33 | | .94 | 1.55 | | | | | | | | | | | | | | | | | 1.25 | 2.95 |
| Common Grackle | 41.25 | 36.69 | 43.33 | | 24.04 | 39.08 | | | .36 | .87 | | | | | | | | | 1.875 | 5.96 | 20.71 | 26.93 | 209.71 | 157.20 |
| Brown-headed Cowbird | 4.67 | 6.18 | | | .50 | .77 | .29 | .70 | 1.14 | 1.46 | | | | | | | | | | | | | | |
| Summer Tanager | | | | | | | .86 | 1.46 | 1.71 | 1.67 | 1.00 | 1.83 | 2.86 | 1.46 | .50 | .77 | .86 | 1.46 | | | | | | |
| Cardinal | 7.00 | 6.05 | 17.33 | | 17.50 | 6.94 | 12.00 | 4.00 | 9.67 | 3.90 | 5.50 | 5.43 | 6.86 | 2.36 | 10.75 | 6.37 | 6.86 | 4.76 | 6.50 | 14.99 | 5.71 | 3.61 | 9.12 | 4.63 |
| Painted Bunting | | | | | | | | | .71 | 1.75 | .62 | .76 | | | | | | | | | | | | |
| Purple Finch | | | | | | | | | | | | | | | | | | | | | | | .41 | .97 |
| American Goldfinch | 1.00 | 1.15 | .67 | | 1.50 | 2.93 | | | | | | | | | | | | | | | | | 2.25 | 2.26 |
| Rufous-sided Towhee | 7.33 | 6.73 | 5.33 | | 5.50 | 3.65 | 2.29 | 2.49 | .57 | 1.40 | .50 | 1.59 | | | .50 | .77 | | | 1.00 | 3.18 | .57 | .91 | 2.75 | 1.24 |
| White-throated Sparrow | 98.45 | 26.60 | 59.40 | | 40.84 | 22.14 | 50.53 | 31.31 | | | | | | | | | | | .83 | 2.62 | 20.27 | 23.64 | 89.10 | 29.75 |
| Fox Sparrow | .55 | 1.41 | | | | | | | | | | | | | | | | | | | | | | |

[a]The preponderance of detections of birds during the breeding season [March (for birds remaining throughout the season), April, May, June, and July] were of singing males (Table 9 ) therefore the population figure more accurately represents bird pairs.

[b]Less than four samples per month were insufficient for determination of meaningful confidence limits.

# VITA

James G. Dickson was born to Mr. and Mrs. James R. Dickson on April 26, 1943 in Chattanooga, Tennessee. He attended public schools there, and graduated from Chattanooga High School in June 1961.

He matriculated at the University of the South in 1961 and received his Bachelor of Science in forestry there in 1965. From 1965 to 1967 he undertook graduate work at the University of Georgia, earning the Master of Science Degree (forestry, wildlife management major) in August, 1967.

He attended U. S. Navy Officer Candidate School in Newport, Rhode Island from October 1967 to April 1968, receiving his commission as Ensign in April 1968. He was stationed aboard the U.S.S. Grand Canyon (AD-28), first as Communications Officer and later as Operations Officer, from April 1968 until release from active duty in January 1971.

The former Elizabeth Donnelly became his wife in June 1971 and a son, John D. Dickson, was born to them in April 1974.

James started his Ph.D. work at Louisiana State University, Baton Rouge, Louisiana in February 1971 and is presently a candidate for that degree.

**EXAMINATION AND THESIS REPORT**

Candidate: James Gary Dickson

Major Field: Forestry

Title of Thesis: Seasonal Populations and Vertical Distribution of Birds in a South Central Louisiana Bottomland Hardwood Forest

Approved:

Robert E. Noble
Major Professor and Chairman

James L. Traynham
Dean of the Graduate School

EXAMINING COMMITTEE:

Leslie L. Glasgow

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Date of Examination:

November 15, 1974

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