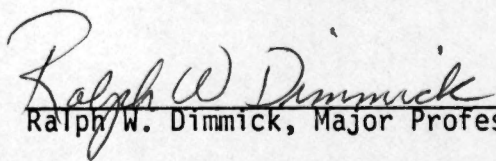
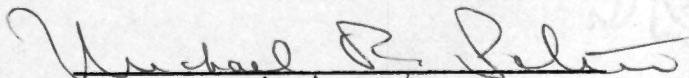
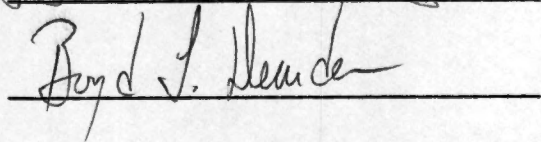


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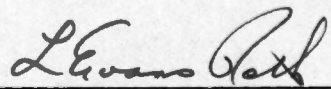
I am submitting herewith a thesis written by Thomas H. Coppinger entitled "An Evaluation of Food Plantings for Wildlife on Pine Plantations in Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

  
Ralph W. Dimmick, Major Professor

We have read this thesis  
and recommend its acceptance:

Accepted for the Council:

  
Vice Chancellor  
Graduate Studies and Research

AN EVALUATION OF FOOD PLANTINGS FOR WILDLIFE  
ON PINE PLANTATIONS IN TENNESSEE

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Thomas H. Coppinger

August 1981

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## ABSTRACT

This thesis represents the latter two years of a six year study of food plantings for wildlife in young pine plantations in Eastern Tennessee. Wildlife food plantings were established on the Stinging Fork study areas in the spring of 1972, and on the Cumberland County study areas in the spring of 1975. Initial establishment of food plantings included soybeans (Glycine max), Korean lespedeza (Lespedeza stipulacea), Kobe lespedeza (Lespedeza striata), bicolor lespedeza (Lespedeza bicolor), red clover (Trifolium pratense), white Dutch clover (Trifolium repens) and autumn olive (Elaeagnus umbellata).

Bobwhite quail (Colinus virginianus) densities on the Stinging Fork study areas were consistently higher on the experimental area than the control. Experimental areas in Cumberland County also had higher quail densities than did the control area. These differences in densities were assumed to be the result of the presence of food plantings on the experimental area since this was the only habitat manipulation not common to all areas. However, habitat quality of the Cumberland County control and surrounding area may have been inferior to that of the three experimental areas.

The average cost per hectare per year for the food plantings on the Stinging Fork study area over the 5 year period of this study was \$2.11. The average cost per hectare per year on the Cumberland County study areas when projected over the 6 year period in which they are thought to be of benefit to quail is \$0.66. The reduced cost for the Cumberland County areas reflects the fact that only perennial food



plantings were used and no maintenance or replanting was provided after initial establishment.

The average cost per bird attributed to food plantings was \$5.82 on the Stinging Fork study area; on the Cumberland County areas it was \$3.68 for Dugger Branch, \$8.21 for Laurel Creek, and \$3.68 for Taylor Chapel.

Utilization of food plantings was determined by examination of crop content. Pokeweed (Phytolacca americana), (48% relative volume) was the most important food item consumed on the Cumberland County areas in 1976-1977. Bicolor lespedeza (49% relative volume) was the most important food item in 1977-1978.

Populations of cottontail rabbit (Sylvilagus floridanus) and non-game birds appeared to be more related to vegetative structure than to the presence or absence of food plantings.

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## CHAPTER I

### INTRODUCTION

The pressures of an ever increasing human population call for increased production from forest lands. To meet increased demands for certain wood products, many natural pine-hardwood stands are being converted to even-aged pine stands and rotations are being shortened, often at the expense of wildlife and their habitat. The conversion to even-aged pine stands may involve intensive site preparations such as shearing, windrowing, burning and disking which further alter the sites. Although little food or cover is provided directly by the young pine stand, the early stages of succession promoted by land clearing provide plant communities that are favorable to such species as bobwhite quail, cottontail rabbit (Sylvilagus floridanus), and white-tailed deer (Odocoileus virginianus).

Wheeler (1970) reported that forest industries in the South own approximately 16.2 million ha of forest land. Arner (1972) reported that forest land in the Southeast was being cleared and planted to pines at a rate of over 400,000 ha per year. For this reason, habitat improvements for wildlife that can be incorporated into modern forest management without reducing timber production are in need of development.

The usefulness of food and cover planted specifically for bobwhite quail has varied among areas. Murray (1958) noted that land use practices on farm lands had more influence on quail populations than did food plantings. Gehrken (1956) and Wunz (1959) reported that perennial plantings had no practical benefit in increasing quail over the regional

indices. Ellis et al. (1969) found that an intensive system of annual food and cover plantings was not successful in elevating quail numbers on a managed area above those of regional indices of bobwhite abundance. On the other hand, Brown (1974) and Burt (1976) reported that both farm and forest lands containing food and cover plantings sustained higher quail densities than similar areas without habitat enhancements. Schumacher (1969) reported that bobwhite populations can be increased with the aid of food and cover plantings, and Burger and Linduska (1967) stated that cover plantings were of major importance for winter cover and nesting cover. Therefore, additional evaluation of food and cover plantings is justifiable to determine the long term effects of the habitat enhancements.

The effects of clear-cutting and forest monoculture on non-game birds is variable. An increase in avian density through a progression of successional communities has been documented by Sanders (1936) in New York, Kendeigh (1948) in Michigan, Odum (1950) in North Carolina, Johnston and Odum (1956) in Georgia, Karr (1968) in Illinois, and Shugart and James (1973) in Arkansas. These findings, drawn from diverse regions, are in general agreement although there are notable exceptions to this pattern. For example, Kendeigh (1947) found highest bird densities in shrubby seral stages of communities in the Helderberg Plateau region in New York. There is, however, an expected pattern of higher densities of birds in mature forests. In principle, habitat niche variety is directly related to habitat complexity. Simple plant communities, such as even-aged monoculture, will not support as large a number of bird species as a more diverse community. Data supporting these principles with respect to non-game bird populations has been published

by Saunders (1936), Kendeigh (1948), Odum (1950), Johnston and Odum (1956), Bond (1957) and Shugart and James (1973).

Dickson and Segelquist (1978) reported that winter bird populations were probably more closely associated with available food than with foliage layers. However, the importance of niches provided by shrub layer development has been noted by many authors (Hagar 1960, Kilgore 1971, McClure and Othman 1965, and Warbach 1958).

Rosene (1956) considered bicolor lespedeza to be of little benefit to song birds. The failure of food patches to provide critical winter food for song birds was reported by Wallace (1942), while Davison (1945) observed songbirds frequenting patches of lespedeza but did not discuss the implications of this to songbird management. Dambach (1940) and Hooper (1967), however, reported that the introduction of food patches was beneficial to some species. It appears that more research is needed to determine the value of food and cover plantings to non-game birds throughout the year.

Increasing interest is developing in quantifying the costs and benefits of management practices for wildlife. Burger and Linduska (1967), Ellis et al. (1969), Brown (1974), and Burt (1976) have evaluated costs of food and cover plantings for bobwhite quail.

Objectives of this study were (1) to determine the extent and duration of time that food and cover plantings enhance bobwhite quail populations and quail hunting in young pine plantations, (2) to determine if quail populations can be increased using only perennial food and cover plantings, (3) to determine the impact of perennial and reseeding annual food and cover plantings on populations of bobwhite quail, cottontail rabbit, and community complexes of non-game birds in young



pine plantations, and (4) to evaluate the economic feasibility and management practicality of food and cover plantings in young pine plantations.

## CHAPTER II

### DESCRIPTION OF STUDY AREA

#### Stinging Fork

The Stinging Fork study area in Rhea County, Tennessee has been described in detail by Brown (1974) and Burt (1976). Location and physiography, soils and geology, and climate of the Stinging Fork study area (Figure 1) do not require additional information in this report. Only changes in vegetation having occurred since the 1976 description will be discussed.

As plant succession has progressed, the density and abundance of the herbaceous ground cover species have increased. Bare areas of exposed mineral soil were uncommon by the summer of 1977. Broomsedge (Andropogon virginianus) became well established over the entire area. Dense blackberry (Rubus spp.)-hardwood roughs are common along the incompletely burned windrows.

Abandoned (since 1976) soybean strips have been naturally seeded by adjacent kobe lespedeza, Korean lespedeza, and clovers. Other strips of the reseeding annual lespedeza-clover mixtures increased in density and in area of occupancy. Seed production was rated fair in both 1976 and 1977.

Bicolor lespedeza plantings averaged over 2.2 m in height in 1977. The bicolor plantings were evaluated for seed production and absence of weed growth within the strip using criteria outlined by Rosene (1956). In 1976 and 1977 50 to 90% of the ground within the

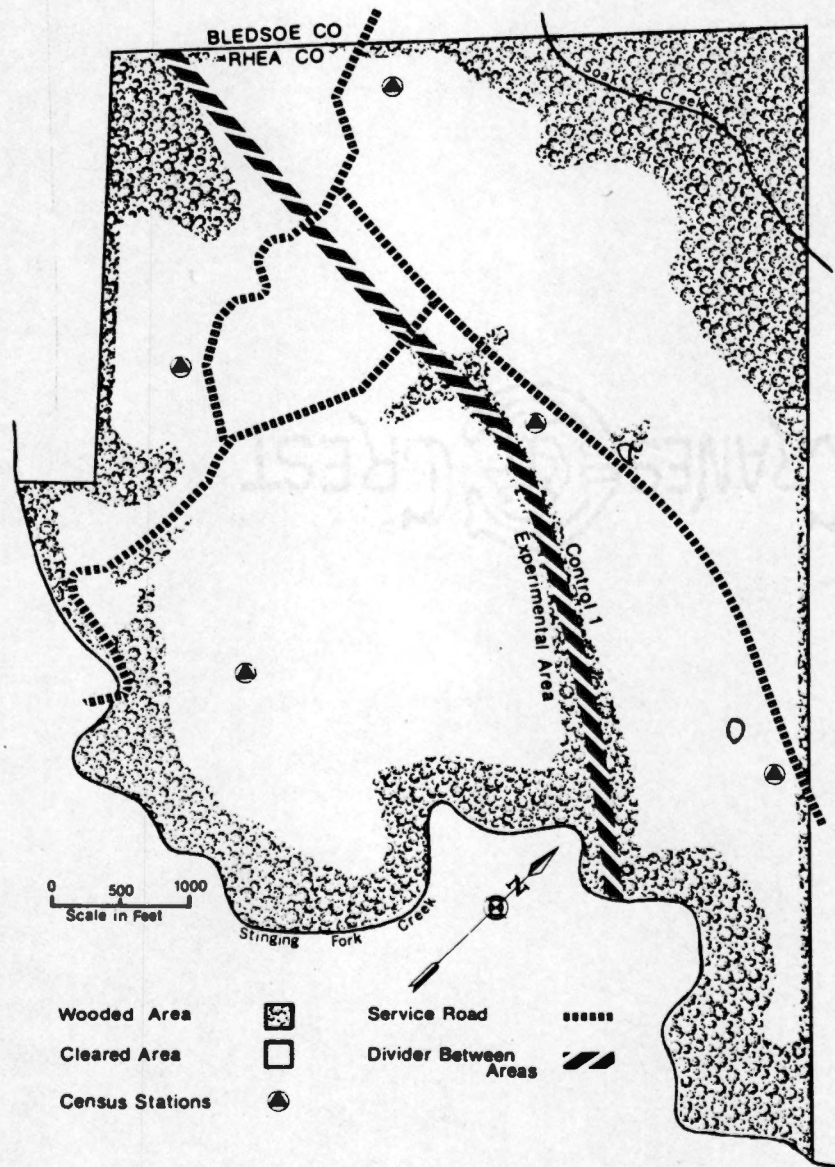


Figure 1. Stinging Fork Study Area, Rhea County, Tn., 212.9 ha comprised of 89 ha experimental unit and 123.9 ha control unit.



strips was clear of weeds and seed production was average, yielding a rating of "fair" by Rosene's standards.

Loblolly pine (Pinus taeda) on the Stinging Fork study area averaged over 3.7 m in height in 1977. Dominance by the pine trees greatly reduced the incidence of naturally occurring shade-intolerant quail food such as ragweed (Ambrosia artemisiifolia) and beggar weed (Desmodium glabellum).

### Cumberland County

#### Location and Physiography

In 1976 four additional study areas were established in Cumberland County, Tennessee. The study areas are owned and managed by Hiwassee Land Company (Division of Bowaters Southern Paper Corporation) as pine plantations for the production of pulpwood.

The study areas are located on the Appalachian Plateau Province (Cumberland Plateau). In general, the plateau has a smooth surface, dissected by young valleys whose steepness and depth increase toward the edges (Hubbard 1938). The elevation ranges from less than 304 m to slightly more than 914 m. Drainage of Cumberland County is via the Tennessee and Cumberland River systems. Some physical characteristics of the Cumberland County areas are presented in Table I.

Dugger Branch study area. The 81 ha Dugger Branch study area (Figure 2) is located approximately 24 km southwest of Crossville, Tennessee. Elevation is between 584 m and 591 m. The topography is gently undulating to rolling. Dugger Branch is surrounded by loblolly pine plantations of approximately the same age on the north, east and

TABLE I. Physical Characteristics of the Cumberland County Study Areas

| Area          | Elevation | Topography             | Soils                      | Cleared | Planted                                  |
|---------------|-----------|------------------------|----------------------------|---------|------------------------------------------|
| Dugger Branch | 584-591 m | Undulating/<br>Rolling | Hartsells<br>and<br>Ramsey | 1974    | 1974                                     |
| Hatfield Ford | 518-555 m | Rolling/<br>Steep      | Hartsells<br>and<br>Ramsey | 1975    | Not<br>planted<br>in wild-<br>life foods |
| Laurel Creek  | 567-585 m | Undulating/<br>Rolling | Hartsells                  | 1974    | 1974                                     |
| Taylor Chapel | 561-585 m | Undulating/<br>Hilly   | Hartsells<br>and<br>Ramsey | 1974    | 1974                                     |

## DUGGER BRANCH AREA

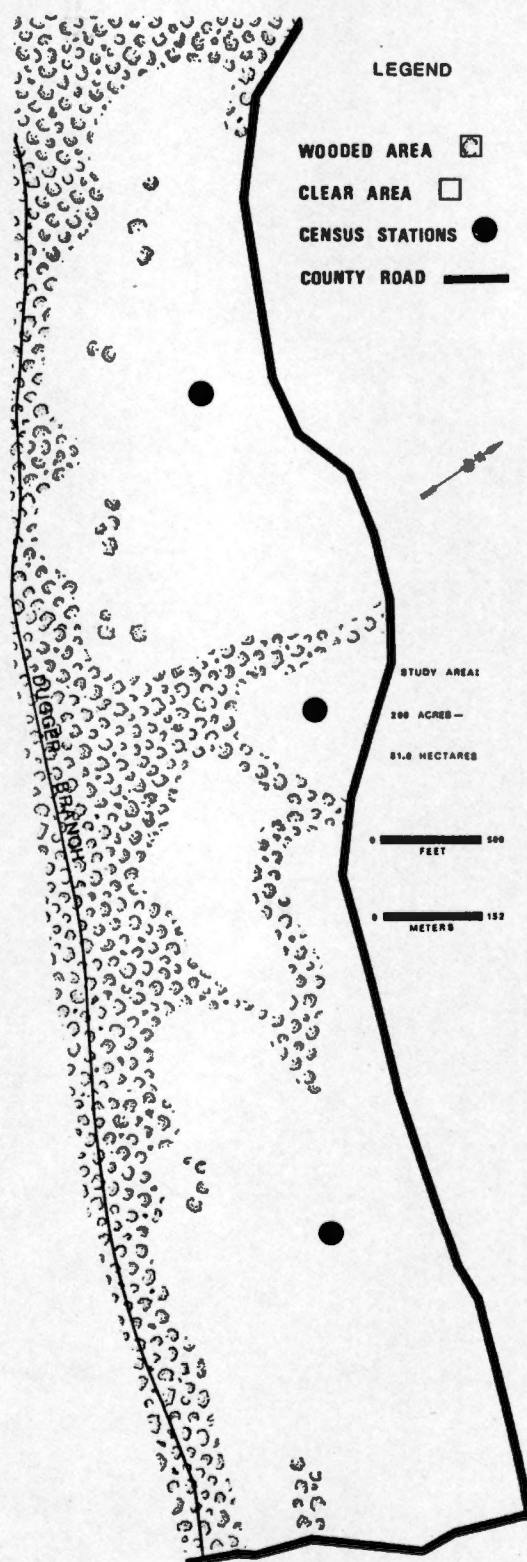


Figure 2. Dugger Branch Study Area, Cumberland County, Tn., 81 ha experimental unit.



west and by second-growth hardwoods on the south.

Hatfield Ford study area. The 66.8 ha Hatfield Ford study area (Figure 3) is located approximately 7.9 km north of Crab Orchard, Tennessee on County Road No. 4383. This area has been designated a control for the Cumberland County study. Elevation of the area ranges from 518 m to 555 m. Topography is gently undulating and rolling to steep. The Hatfield Ford area is completely surrounded by second-growth hardwoods in the 40-50 year age class with the exception of a 100 m strip of pasture along the eastern border.

Laurel Creek study area. Laurel Creek study area (Figure 4) is located approximately 20 km southwest of Crossville on County Road No. 4253 (Lantana Road). The area covers 65 ha. Elevation ranges from 567 to 585 m. Topography is gently undulating and rolling. Laurel Creek area is bordered on the southeast by open pasture and by second growth hardwoods on all other margins.

Taylor Chapel study area. Taylor Chapel study area (Figure 5) is a 71.7 ha pine plantation located 12.5 km southwest of Crossville on Taylor Chapel Road. The elevation ranges from 561 m to 585 m. The topography is undulating to hilly. Taylor Chapel study area is surrounded by a hardwood margin ranging from 15 m to over 400 m wide. Outside this margin to the north is a pine plantation and to the east, west and south lay open pasture.

### Geology and Soils

The rocks of the Cumberland Plateau are level bedded and mostly sandstone of the Pennsylvania series of the Carboniferous system (Hasty 1948).

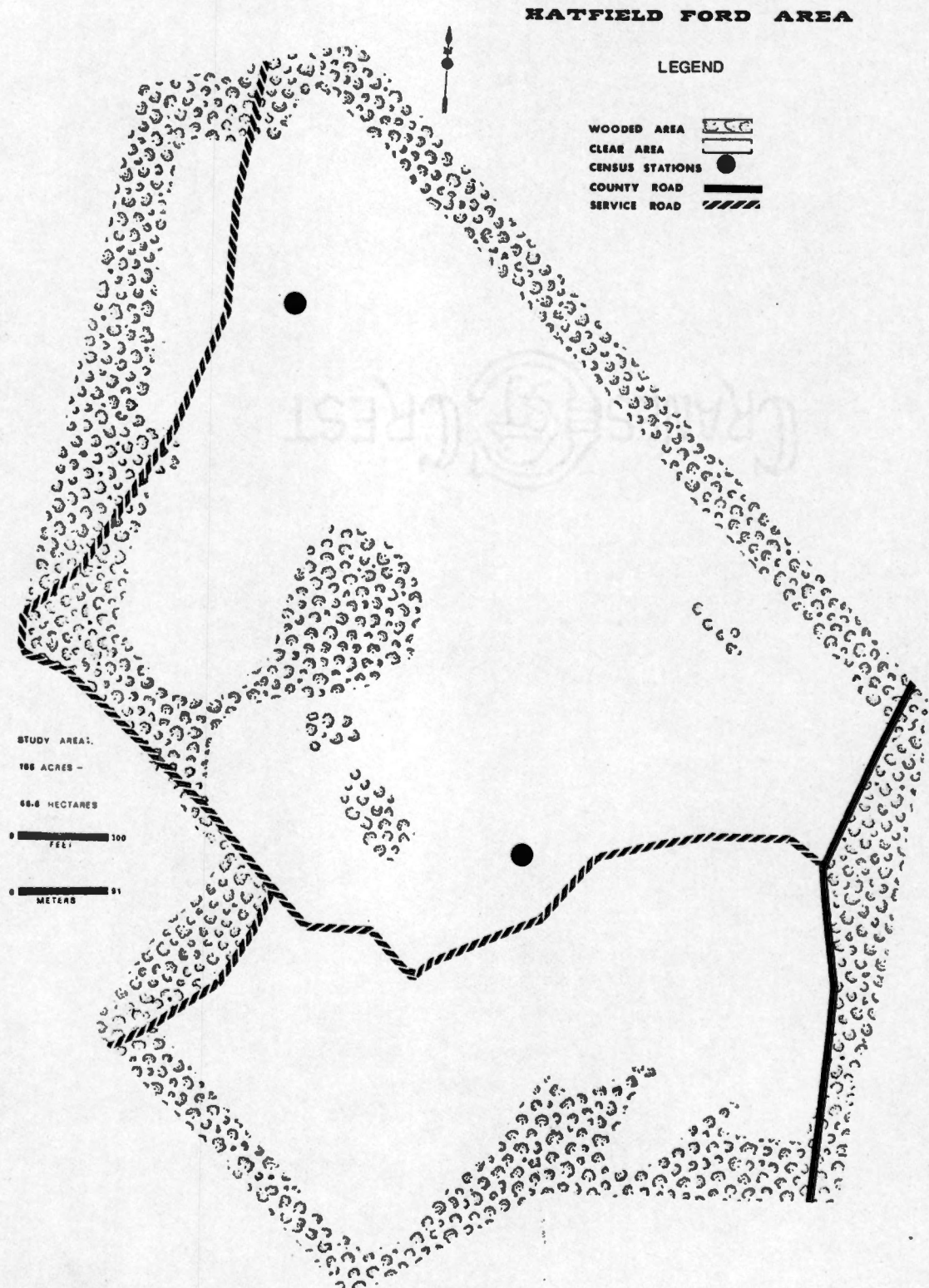


Figure 3. Hatfield Ford Control Area, Cumberland County, Tn., 66.8 ha control unit.

## LAUREL CREEK AREA

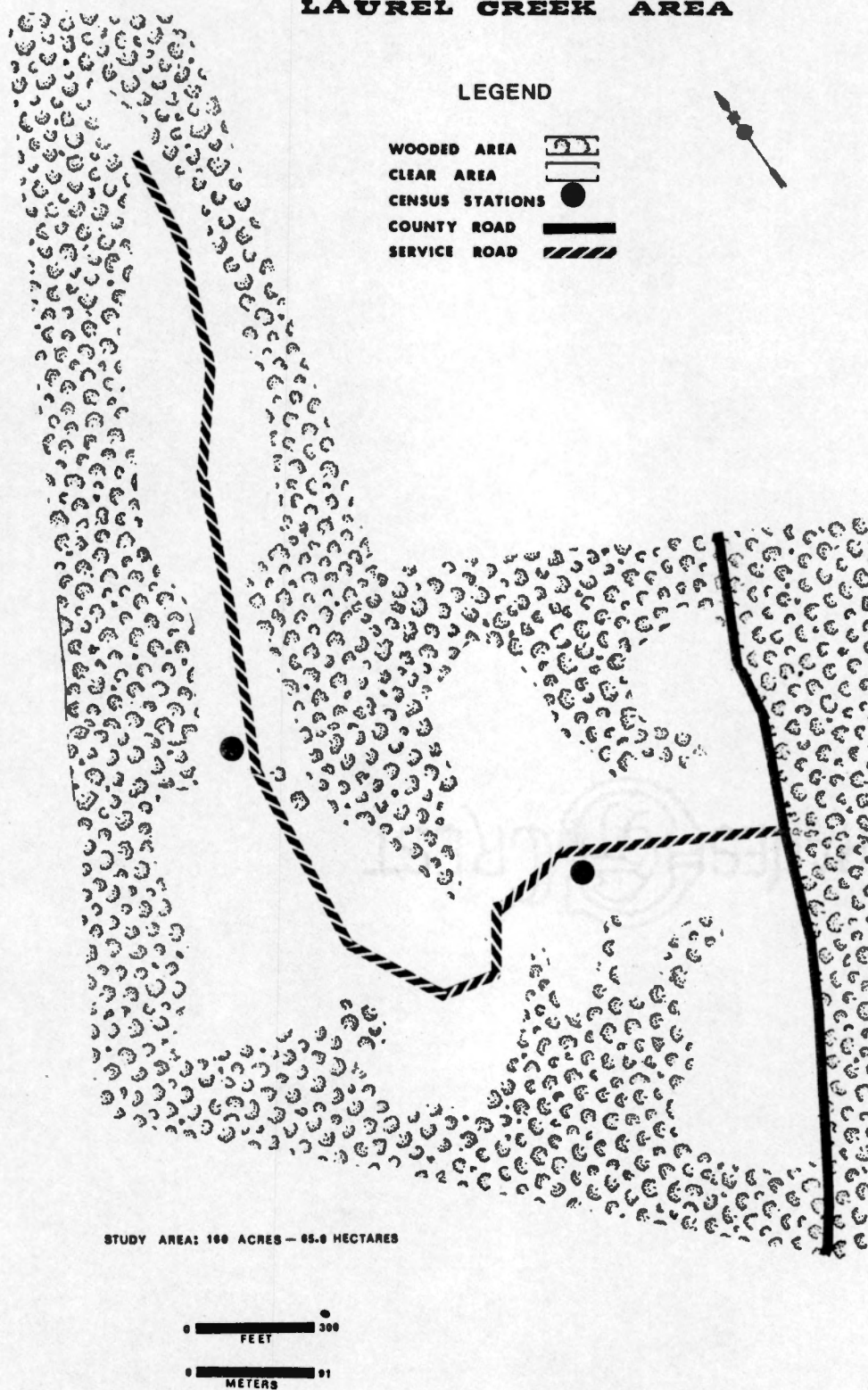


Figure 4. Laurel Creek Study Area, Cumberland County, TN., 65 ha. experimental unit.



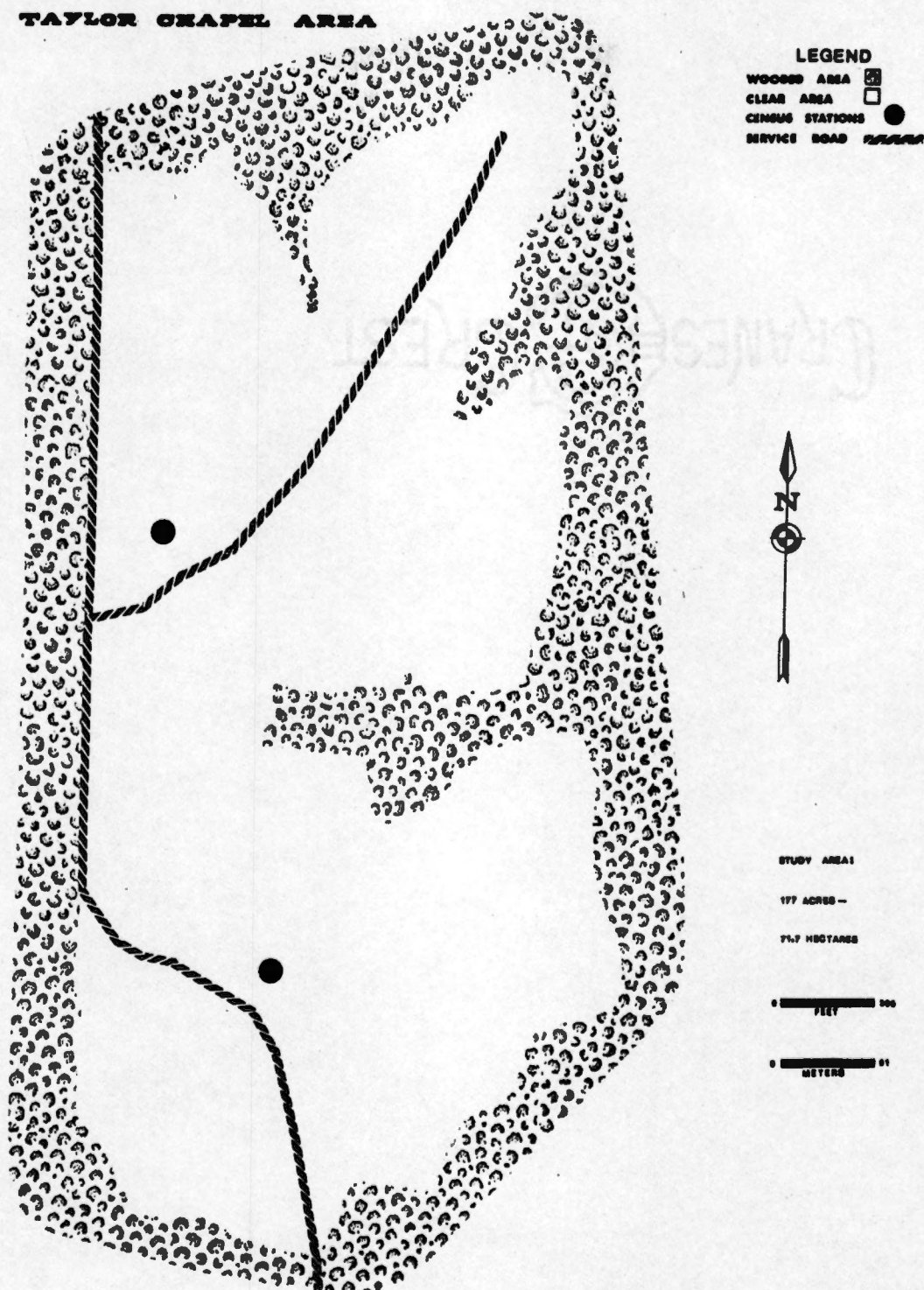


Figure 5. Taylor Chapel Study Area, Cumberland County, Tn., 71.7 ha experimental unit.

Dugger Branch study area. The soil of the Dugger Branch study area is composed of 75% Ramsey stony, fine sandy loam, hilly phase. This soil type occurs on slopes ranging from 9 to 30%. The remaining area is composed of Hartsells fine sandy loam, rolling phase. The slope ranges from 5 to 9%. External drainage of both soil types is medium to rapid and unprotected areas are subject to erosion (Hubbard 1938).

Hatfield Ford study area. The soil of the Hatfield Ford study area is composed of 80% Ramsey stony, fine sandy loam, hilly phase. The slope is less than 14%. Ten percent of the area soil is Harsells fine sandy loam, rolling phase. External drainage of both soil types is medium to rapid. The remaining area is composed of Hartsells fine sandy loam, gently undulating. Slope is 5% or less. External drainage is very slow to medium.

Laurel Creek study area. The Laurel Creek study area is composed primarily of two soil types. Hartsells fine sandy loam, gently undulating, is found on 50% of the area. Hartsells fine sandy loam, rolling phase, on 40 to 50% of the area, is the next most prevalent soil type.

Taylor Chapel study area. Hartsells fine sandy loam, rolling phase, comprises 50% of the Taylor Chapel study area. Hartsells fine sandy loam, gently undulating, occurs on 25 to 30% of the area. Ramsey stony, fine sandy loam, comprises the remaining soil type of this study area.

### Climate

The climate of Cumberland County is temperate and continental, having moderate winters with short cold periods and warm summers

(Hubbard 1938). The average annual temperature is approximately 12.9 C with a difference of 0.8 C between mean summer and winter temperatures. The average precipitation is 137.6 cm annually, with snowfall averaging 30.7 cm. Generally, precipitation is highest in winter and spring and lowest in fall. There is an average of 179 frost free days, providing an adequate growing season for most field crops. Climatological data gathered at the Crossville Office of the U. S. Weather Bureau are presented in Tables II and III.

### Vegetation

Cumberland County lies within the mixed mesophytic forest region of the Appalachian Forest (Smith 1962). Second-growth hickory (Carya spp.), oak (Quercus spp.), dogwood (Cornus florida) and shortleaf pine (Pinus echinata) predominate in the forest cover (TVA 1941).

The Cumberland County study areas prior to 1974 were covered by second-growth hardwood. Following a process of shearing, windrowing, burning and disking, the areas were planted with loblolly pine during the spring of 1975. At this time wildlife food and cover plantings were established.

Only sparse ground cover occurred on the study areas in the spring of 1976. Exposed mineral soil was common on all study areas. Early vegetative cover included panic grass (Panicum spp.), common ragweed, blackberry and various hardwood sprouts. Vegetative cover of the Hatfield Ford area was obviously less advanced than that of the other study areas.

Hardwood species commonly occurring on all Cumberland County study areas include oak, hickory, dogwood, sourwood (Oxydendron arboreum), maple (Acer spp.), sassafras (Sassafras albidum), black cherry (Prunus



TABLE II. Precipitation Data from Crossville, Tennessee

| Month     | Total Monthly Precipitation in Centimeters <sup>a</sup> |        |                                     |  |        |                        |        |
|-----------|---------------------------------------------------------|--------|-------------------------------------|--|--------|------------------------|--------|
|           | 1931<br>to<br>1960                                      | 1975   | Deviation <sup>b</sup><br>from mean |  | 1976   | Deviation<br>from mean |        |
|           |                                                         |        |                                     |  |        |                        |        |
| January   | 14.81                                                   | 17.07  | + 2.26                              |  | 10.64  | -4.17                  | 6.15   |
| February  | 14.27                                                   | 17.50  | + 3.23                              |  | 6.48   | -7.79                  | 6.55   |
| March     | 13.84                                                   | 38.96  | +25.12                              |  | 19.56  | +5.72                  | 14.61  |
| April     | 11.10                                                   | 5.79   | - 5.31                              |  | 4.32   | -6.78                  | 28.12  |
| May       | 9.91                                                    | 10.77  | - .86                               |  | 15.29  | +5.38                  | 9.02   |
| June      | 10.24                                                   | 9.58   | - .66                               |  | 16.31  | +6.07                  | 11.76  |
| July      | 11.84                                                   | 10.82  | - 1.02                              |  | 10.67  | -1.17                  | 6.57   |
| August    | 11.18                                                   | 4.52   | - 6.66                              |  | 4.52   | -6.66                  | 14.09  |
| September | 8.64                                                    | 21.79  | +13.15                              |  | 11.66  | +3.02                  | 18.26  |
| October   | 7.19                                                    | 13.89  | + 6.70                              |  | 15.11  | +7.92                  | 15.84  |
| November  | 10.24                                                   | 14.02  | + 3.78                              |  | 4.42   | -5.82                  | 21.08  |
| December  | 13.92                                                   | 11.53  | - 2.39                              |  | 8.23   | -5.69                  | 10.23  |
| Annual    | 137.16                                                  | 176.25 | +39.09                              |  | 127.20 | -9.96                  | 162.28 |

<sup>a</sup>Source: U. S. Weather Bureau, Climatological Data, Tennessee, U. S. Dept. Commerce. Annual Summary, 1975-1977. Vols. 80, 81 and 82.

<sup>b</sup>Deviation from mean--determined by subtracting monthly data for years 1975, 1976 and 1977 from the average data collected during the years 1931 to 1960.

TABLE III. Temperature Data from Crossville, Tennessee

| Month     | Average Monthly Temperature in °C <sup>a</sup> |       |                                     |       |                        |       |                        |
|-----------|------------------------------------------------|-------|-------------------------------------|-------|------------------------|-------|------------------------|
|           | 1931<br>to<br>1960                             |       | 1975                                |       | 1976                   |       | 1977                   |
|           |                                                |       | Deviation <sup>b</sup><br>from mean |       | Deviation<br>from mean |       | Deviation<br>from mean |
| January   | 2.74                                           | 4.65  | +1.91                               | -.39  | -3.13                  | -5.54 | -8.28                  |
| February  | 3.47                                           | 5.60  | +2.13                               | 8.34  | +4.87                  | 3.19  | -.28                   |
| March     | 7.17                                           | 6.38  | -.79                                | 9.91  | +2.74                  | 11.09 | +3.92                  |
| April     | 12.94                                          | 12.71 | -.23                                | 12.15 | -.79                   | 15.62 | +2.68                  |
| May       | 17.70                                          | 18.98 | +1.28                               | 14.50 | -3.20                  | 20.05 | +2.35                  |
| June      | 21.67                                          | 21.22 | -.45                                | 20.38 | -1.29                  | 22.66 | +.99                   |
| July      | 23.41                                          | 22.74 | -.67                                | 21.78 | -1.63                  | 25.61 | +2.20                  |
| August    | 22.96                                          | 23.80 | +.84                                | 22.18 | -.78                   | 24.94 | +1.98                  |
| September | 20.22                                          | 17.58 | -2.64                               | 18.03 | -2.19                  | 21.94 | +1.72                  |
| October   | 14.00                                          | 14.28 | +.28                                | 10.53 | -3.47                  | 11.88 | =2.12                  |
| November  | 4.39                                           | 8.79  | +1.40                               | 4.09  | -3.30                  | 9.99  | +2.60                  |
| December  | 6.16                                           | 3.47  | -2.69                               | 1.68  | -4.48                  | 2.66  | -3.50                  |
| Annual    | 13.05                                          | 13.33 | +.28                                | 11.93 | -1.12                  | 13.67 | +.62                   |

<sup>a</sup>Source: U. S. Weather Bureau, Climatological Data, Tennessee, U. S. Dept. Commerce. Annual Summary, 1976-1977. Vols. 80, 81 and 82.

<sup>b</sup>Deviation from mean--determined by subtracting monthly data for years 1975, 1976 and 1977 from the average data collected during the years 1931 to 1960.

serotina), yellow poplar (Liriodendron tulipifera), black tupelo (Nyssa sylvatica), winged sumac (Rhus copallina), smooth sumac (R. glabra) and staghorn sumac (R. typhina).

Major vegetative changes on the Cumberland County study areas from 1976 to 1977 occurred in density and abundance of species present. Areas of exposed mineral soil were greatly reduced. Some erosion has occurred on all study areas with gullies 45 cm deep or less being common. By the summer of 1977 broomsedge was well established on the study areas. Blackberry roughs were abundant, especially near the partially burned windrows. In or near these windrows pokeweed, ragweed and various hardwood sprouts were abundant.

During the summer of 1977 loblolly pine trees on the four areas averaged 1.9 m in height with trees on the Laurel Creek study area having the greatest height and those on the Hatfield Ford study area the least.

Bicolor lespedeza plantings during this same time period averaged 2.2 m in height with greatest plant height occurring on the Taylor Chapel study area and the least on the Laurel Creek study area. An appraisal of food production by the bicolor plantings was made in 1976 and 1977. Vigor and productivity of the plantings and degree of weed growth in the planted strips were noted. In 1976 bicolor plantings were rated poor on all Cumberland County study areas. Less than 50% of the ground was clear of weeds and seed production was low. Following periodic inspection in 1977, all Cumberland County study areas were rated fair, indicating that 50 to 90% of the ground was clear of weeds and seed production was average. The improved rating from 1976 to 1977 reflected increased seed production and density of the bicolor stand which shaded out much of the herbaceous growth within the strip. Absence of weed



growth in the food strip enables bobwhites to find fallen seeds more readily.

### Management Practices

#### Stinging Fork

Detailed descriptions of the procedures followed in establishing food and cover plantings for wildlife on the Stinging Fork study area (Figure 6) were given by Brown (1974) and Burt (1976).

#### Cumberland County

Site preparation for the study areas included a procedure of shearing, windrowing, burning and disking. Following the 1974 logging operation the slash was pushed into windrows and burned as completely as possible. Cleared areas were then disked, thus preparing the soil for planting of pine seedlings. Extensive site preparation such as this provides suitable conditions for the establishment of food and cover strips for wildlife. Three Cumberland County study areas (Dugger Branch, Laurel Creek, and Taylor Chapel) received food and cover plantings. The fourth, Hatfield Ford, did not receive plantings and was designated the control area for the Cumberland County study.

The management program established by Hiwassee Land Company for food and cover plantings (Table IV) included: (1) a mixture of perennial clovers, white Dutch and red, and kobe lespedeza on 5% of the area, (2) a perennial shrub lespedeza (bicolor lespedeza) on 1% of the area and (3) hand planting small plots and strips of autumn olive in moist areas and near strips of permanent type cover. The management program had originally called for soybeans (Var. Lee and Dare) to be included in the

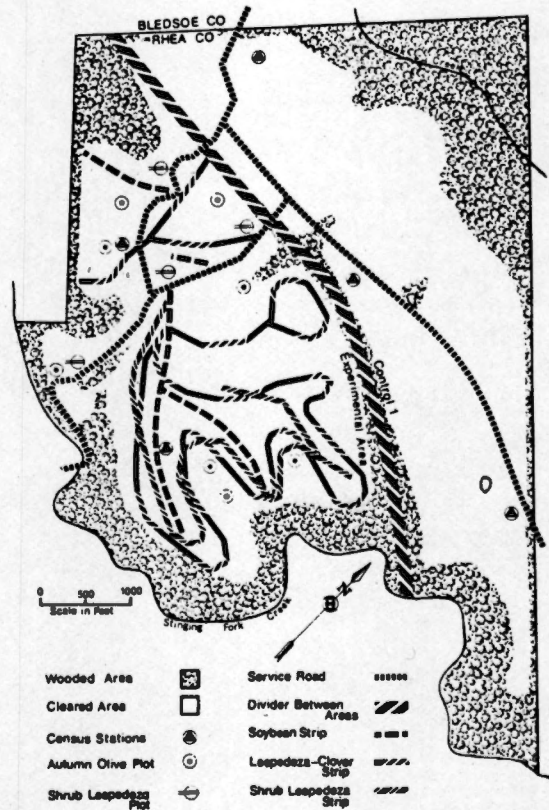


Figure 6. Location of food and cover plantings on the Stinging Fork experimental unit, Rhea County, Tn.

TABLE IV. The Average Seeding and Fertilization Rates per Hectare and the Total Hectares of Plant Food Species Planted on the Cumberland County Study Areas

| Species           | Seeding Rate<br>(kg/ha) | Fertilization<br>Rate (kg/ha) | Total Hectares Planted |                  |                 |                  |
|-------------------|-------------------------|-------------------------------|------------------------|------------------|-----------------|------------------|
|                   |                         |                               | Dugger<br>Branch       | Hatfield<br>Ford | Laurel<br>Creek | Taylor<br>Chapel |
| Bicolor Lespedeza | 6.82                    | 68.18                         | 0.81                   | -                | 0.65            | 0.72             |
| Mixed legumes     | 6.82                    | 45.45                         | 4.05                   | -                | 3.24            | 3.58             |
| Autumn Olive      | -                       | -                             | .40                    | -                | .33             | .36              |
| Total             | n/a                     | n/a                           | 5.26                   | -                | 4.21            | 4.66             |



plantings. Following the 1975 season Hiwassee Land Company eliminated soybeans from their management program, thus concentrating on perennial and reseeding annual species. Destruction of the soybean strips by white-tailed deer prompted this decision.

In establishing food and cover plantings Hiwassee Land Company wanted to minimize the amount of land taken out of wood production. The perennial clovers and reseeding annual lespedeza do not noticeably compete with young pine seedlings and will not require any further maintenance. The perennial shrub lespedeza does grow high enough to compete with pine seedlings, therefore it was planted in very narrow strips to remove the least amount of land from tree production as possible.

Food strips were established by broadcasting seed with an Ezee Flow No. 109 seeder-spreader and a Seymour No. 75 hand seeder. Kobe lespedeza, white Dutch clover and red clover were applied as a mixture while the shrub lespedeza was sown alone in strips.

Site preparation prior to actual planting of the food and cover plants was held to a minimum. The lespedeza-clover mixture was broadcast directly onto the site with no disking or covering of the seed. The shrub lespedeza was sown on the prepared site with no covering of the seed. A "no-nitrogen" fertilizer (0-20-20) was used with all the leguminous plantings to help minimize weed growth within the strips and plots. Fertilizer was applied to the mixed legumes at a rate of 45 kg per ha. The shrub lespedeza received 68 kg per ha. Autumn olive plots were not fertilized. Food plantings are shown in Figures 7, 8 and 9.

## DUGGER BRANCH AREA

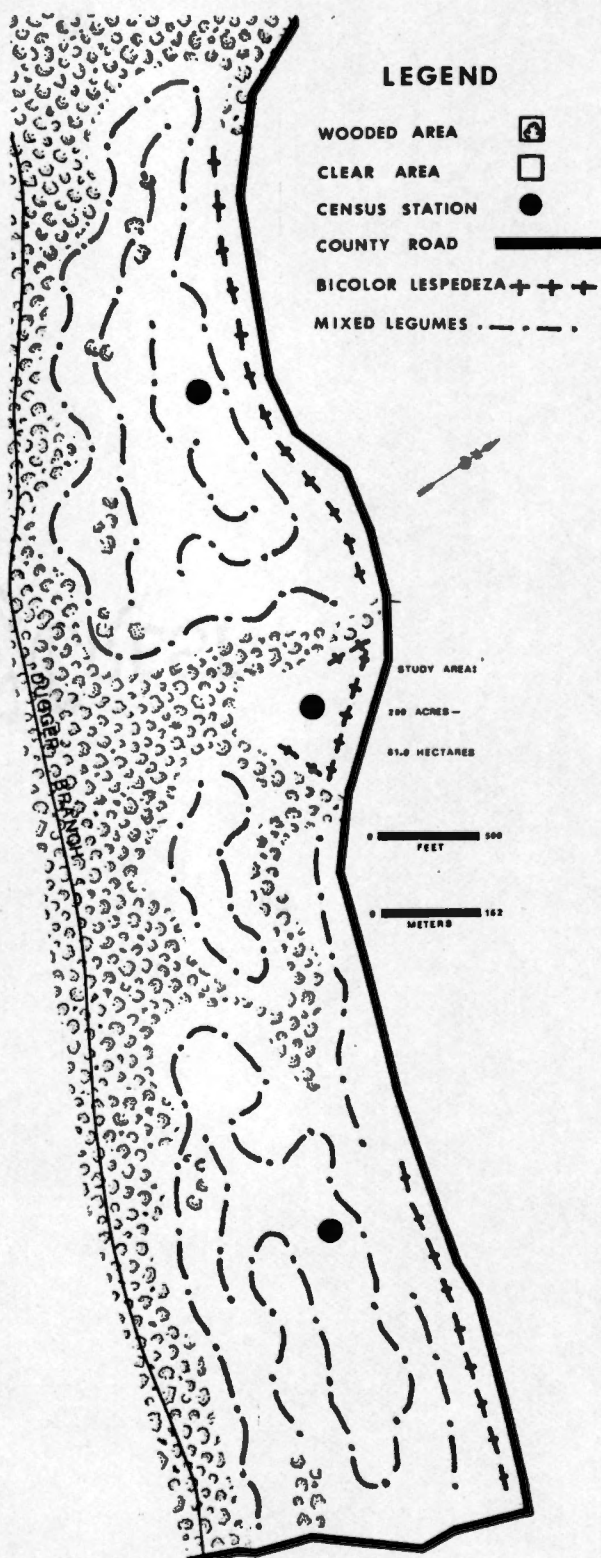


Figure 7. Location of food plantings on the Dugger Branch Study Area, Cumberland County, Tn.

## LAUREL CREEK AREA

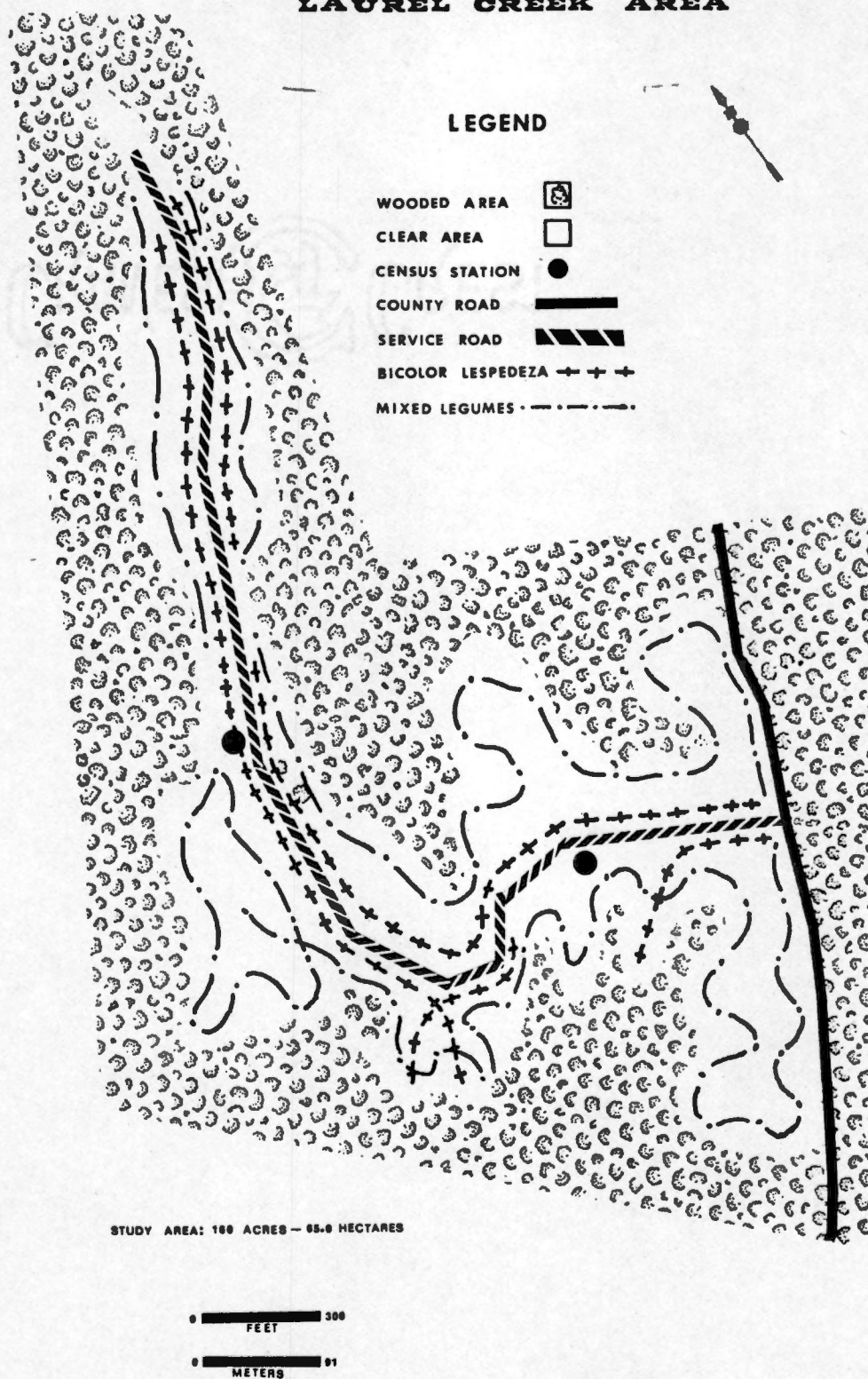


Figure 8. Location of food plantings on the Laurel Creek Study Area, Cumberland County, Tn.



## TAYLOR CHAPEL AREA

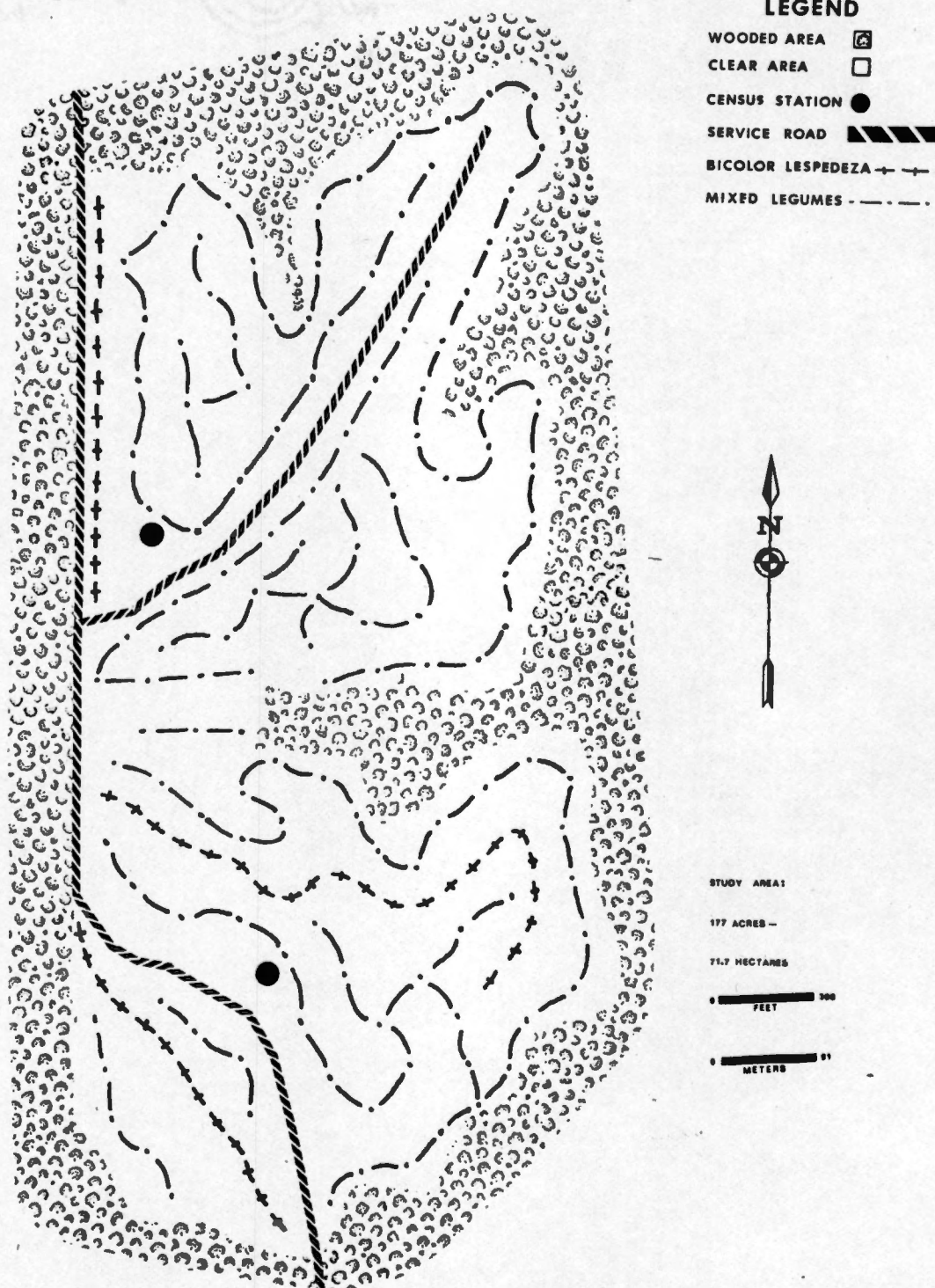


Figure 9. Location of food plantings on the Taylor Chapel Study Area, Cumberland County, Tn.

## CHAPTER. III

### METHODS

#### Population Surveys

Call indices were used in the spring as an index to bobwhite quail breeding populations. Songbird numbers were surveyed during winter and spring. Direct flush counts, in early fall and late winter, were employed in surveying bobwhite quail and cottontail rabbit populations.

#### Call Indices

Bobwhite Quail. Several permanent listening stations were established on all study areas (Figures 1, 2, 3, 4 and 5, pp. 6, 9, 11, 12, and 13). Stations were located to allow the investigator to hear all quail calling on the area. Five minutes were allowed at each station during which time the number of quail calling and the total number of calls heard were recorded (Brown 1974, Burt 1976).

The Stinging Fork study area was visited 4 times in June 1976 and 4 times in June 1977. Study areas in Cumberland County were visited a minimum of 4 times during June 1976 and 1977. The visits were concentrated in June, the peak month for calling activity (Saunders 1973). Surveys began as soon as possible after sunrise and continued until each station had been visited twice. To reduce some of the bias due to decreased bird activity during late morning, the station visited first was rotated each census day.

Non-game birds. Songbirds were censused each winter and spring throughout this study. Birds identified by sight and sound at the listening stations and those seen enroute to and from stations were recorded. Data from this study were not used to determine actual population density, but were used as an index to relative abundance.

#### Direct Flush Counts

Fall and spring bobwhite quail and cottontail rabbit populations were surveyed each year on the Stinging Fork and Cumberland County study areas. The Stinging Fork study area was censused during spring of 1976 and 1977, and in the fall of 1975 and 1976. Cumberland County study areas were censused in the spring and fall of 1976 and 1977. Direct flush counts used 4 to 8 persons walking abreast at 20-25 m intervals. Field notes were kept of the number of bobwhite coveys flushed, number of birds per covey, cover type of the area where flushed, direction of flush, time of day flushed and number of cottontail rabbits flushed. Notes were recorded on a map of the appropriate area. In addition to the bobwhite quail and cottontail rabbit information, observations of ruffed grouse (Bonasa umbellus) and white-tailed deer were also noted.

Statistical analyses. Statistical methods used were the paired t-test and one way analysis of variance. Duncan's New Multiple Range Test was used to detect any significant differences in data. The 0.05 level of significance was used for all statistical interpretations (Steel and Torrie 1960).



### Crop Analysis

Bobwhite quail were collected by shooting during the 1975-1976, 1976-1977 and 1977-1978 Tennessee hunting seasons. Crops were immediately removed from the bird and placed in a plastic bag or small coin envelope. Sex, age, location and data of harvest were recorded. Only the crop was examined because it is the only portion of the alimentary canal from which foods may be retrieved in the same proportions as eaten (Davison 1940). The volume of each food item was measured to the nearest 0.1 cc by water displacement as described by Korschgen (1948). Plant food items were identified to the lowest taxon possible, with most seeds being identified to species. Leafy material was identified as such. Animal food items were identified to Order when possible. Food items were tabulated by their scientific names with common names presented in the discussion. The following significant characteristics of each food were determined (Eubanks and Dimmick 1974):

- |                    |                                                                                                      |
|--------------------|------------------------------------------------------------------------------------------------------|
| Relative volume    | - total volume of one item as a percentage of the total volume of all items.                         |
| Relative frequency | - number of occurrences of one item as a percentage of the total occurrences of all items.           |
| Relative number    | - number of individuals of one item as a percentage of the total number of individuals of all items. |

Frequency of occurrence - percentage of crops in which an individual food occurred.

Relative volume was considered the most significant statistic, with most conclusions and inferences regarding the diet of quail based upon this characteristics. Haugen (1955) and Stoddard (1931) were used as guides to aging bobwhite quail.

### References

References used to identify plants, animals, and food items and for common and scientific names included: Harlow (1941), Jacques (1947), Peterson (1947), Core and Ammons (1958), Martin and Barkley (1961), Gleason and Cronquist (1963), Burt and Grossenheider (1964), Robbins, Bruun, and Zim (1966), Brockman (1968), and Landers and Johnson (1976). The personal seed collection of the author and the seed collection of The University of Tennessee, Knoxville, Department of Forestry, Wildlife and Fisheries was invaluable in the seed identification.

### Hunter Utilization

Study area use was monitored during the 1975-1976, 1976-1977 and 1977-1978 Tennessee hunting season. Views and opinions of visitors to the study areas concerning the wildlife management program, their awareness of food and cover plantings, effectiveness of food and cover plantings, species of game hunted, quality of hunting on the study areas and suggestions regarding changes and improvements to the management program were discussed.

## CHAPTER IV

### RESULTS AND DISCUSSION

#### Response of Wildlife to Food Plantings on Stinging Fork Study Areas

##### Bobwhite Quail

Flush counts. Quail numbers on the Stinging Fork experimental area during 1976 and 1977 continued a slight downward trend established in 1974 (Burt 1974) following the peak density occurring in 1973 (Brown 1974) (Table V). For all years reported, the fall censuses usually resulted in greater numbers of birds being counted than did the spring censuses. This is probably due to normal population fluctuations of breeding success and overwinter mortality. The experimental area had greater numbers of birds than the control (with one exception). I interpret this to indicate that food plantings were responsible since they were the only management practice different between the two study areas.

It should be emphasized that the experimental and control areas are subunits of the same clearcut, and are adjacent to each other. It seems obvious that major events influencing quail on one subunit will have some impact on quail of the other. During the first 4 years of the study Brown (1974) and Burt (1976) utilized a second control area, Bumbee Creek, which was geographically disjunct from the Stinging Fork area. During that period, quail numbers generally were lowest on the Bumbee Creek area and highest on the Stinging Fork experimental area; numbers on the Stinging Fork control area were intermediate between the



TABLE V. Bobwhite Quail Spring and Fall Flush Census Results on the Stinging Fork Study Area from 1972 to 1977

|              |                     | 1972 | 1973   |      | 1974   |      | 1975   |      | 1976   |      | 1977   |
|--------------|---------------------|------|--------|------|--------|------|--------|------|--------|------|--------|
|              |                     | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring |
| Experimental | Number of coveys    | 1    | 2      | 8    | 2      | 3    | 1      | 4    | 3      | 1    | 2      |
|              | Number of birds     | 20   | 23     | 130  | 7      | 41   | 7      | 52   | 30     | 4    | 27     |
|              | Hectares per bird   | 4.5  | 3.9    | 0.7  | 12.7   | 2.2  | 12.7   | 1.7  | 2.9    | 22.4 | 3.3    |
|              | Change <sup>a</sup> | (NA) | (NA)   | +110 | -13    | -89  | 0      | +11  | +23    | -48  | -3     |
| Control      | Number of coveys    | 2    | 1      | 5    | 0      | 2    | 1      | 0    | 1      | 3    | 1      |
|              | Number of birds     | 17   | 8      | 73   | 0      | 10   | 1      | 0    | 5      | 19   | 12     |
|              | Hectares per bird   | 7.3  | 15.5   | 1.7  | -      | 12.4 | 123.8  | -    | 24.7   | 6.5  | 10.3   |
|              | Change <sup>a</sup> | (NA) | (NA)   | +56  | -8     | -63  | +1     | -10  | +4     | +19  | +7     |

<sup>a</sup>Denotes the change in the number of quail from the same season previous year.

two. This indicates that habitat improvement on the experimental area resulted in some increase in the quail numbers on the adjacent control area, likely through higher survival and carryover of the winter population. Redistribution of the population during the nesting season resulted in increased production on the control as well as experimental area.

The data indicated that the experimental area with its food and cover plantings was somewhat more attractive to quail than the control area. Although the seasonal data were not consistent from year to year a trend was apparent and this judgment is based on that trend. Rosene (1956) and Burger and Linduska (1967) appeared to confirm this in reporting that food plantings increased quail numbers on certain areas where natural foods were lacking, and that quality habitat management practices including food and cover plantings, can produce a significant increase in bobwhite quail numbers. It is important to note that Rosene (1956) stated that plantings were successful in increasing quail numbers where natural foods were lacking.

Call counts. Neither the number of individuals nor the number of calls per station were significantly different between the control and experimental areas in either 1976 or 1977 (Table VI). Calls on the control area decreased from 1976 to 1977 although not significantly while the decrease on the experimental area was significant between these same years. These data fit the apparent trend in numbers of quail, that is, a peak in quail numbers in 1973 and a decline in each successive year.

Saunders (1973) and Stoddard (1931) reported that numbers of

TABLE VI. Bobwhite Quail Spring Whistle Counts on the Stinging Fork Study Area During 1976 and 1977

| Parameter                                | Control |      | Experimental |      |
|------------------------------------------|---------|------|--------------|------|
|                                          | 1976    | 1977 | 1976         | 1977 |
| Total Calls                              | 480     | 264  | 353          | 155  |
| Average Calls/5 minutes/<br>station      | 20.0    | 11.0 | 22.0         | 9.9  |
| Total Individuals                        | 53      | 34   | 44           | 20   |
| Average Individuals/5<br>minutes/station | 2.2     | 1.4  | 2.8          | 1.3  |



persistently whistling cock quail in early summer furnish a key to the breeding population over a large area when the sex ratio is known. Also Bennet (1951), Reeves (1951) and Rosene (1957) reported that summer whistling cock counts are reliable indicators of wintering populations when they are considered over a large area. However, this study did not encompass an area large enough to rely on the whistling cock counts as an accurate index to the breeding or wintering populations of bobwhite on the Stinging Fork study area. The data may, however, indicate yearly trends in the breeding populations of bobwhite quail on this area.

#### Cottontail Rabbit

Trends in cottontail rabbit populations were determined by counting all rabbits flushed during the fall and spring direct flush censuses (Table VII). The population increased slowly during the first four years of the study, peaking in the fall of 1975 on both areas. Numbers declined during 1976 on the experimental area, but did not change on the control portion of the Stinging Fork clearcut. Spring trends were roughly similar, but lagged behind one calendar year.

Except for autumns of 1973 and 1976, rabbit numbers on the experimental area were higher than those of the control area (Table VII). Although rabbit numbers appear to have decreased on both control and experimental areas since 1975, this decrease may not be real, due to the decreased visibility and therefore reduced accuracy of the census technique. Throughout the study, rabbit distribution on both the experimental and control areas did not appear to be related to food plantings.

The higher numbers observed on the experimental area may reflect the influence of lespedeza and clover food plantings as spring and

TABLE VII. Spring and Fall Flush Census Results for Cottontail Rabbit on the Stinging Fork Study Area from 1972 to 1977

| Area                          | Population<br>Characteristic | 1972 | 1973   |      | 1974   |      | 1975   |      | 1976   |      | 1977   |
|-------------------------------|------------------------------|------|--------|------|--------|------|--------|------|--------|------|--------|
|                               |                              | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring |
| Stinging Fork<br>Experimental | No. Rabbits                  | 1    | 1      | 3    | 1      | 10   | 10     | 20   | 15     | 6    | 10     |
| Control                       | No. Rabbits                  | 1    | 1      | 4    | 1      | 7    | 10     | 9    | 13     | 9    | 6      |

summer food sources since their value as food sources for cottontail rabbits has been well documented (Dalke and Sime 1941, Davison 1943, and Rosene 1955). Clover and lespedeza are valuable in the spring and summer months, while bicolor lespedeza was reported by Rosene (1955) to be a desirable late winter food source for rabbits. Rosene observed that rabbits sever bicolor stems and eat the fallen seed heads. Evidence of this was observed on the experimental area during the winters of 1975 and 1976.

#### Non-Game Birds

Non-game birds were surveyed for abundance and for species diversity during the winters of 1975 and 1976 and during the summers of 1976 and 1977. The average number of species observed during both winters was 12.5 on the control and 9.5 on the experimental area. The average number of individuals was 63.5 on the control and 70.5 on the experimental area for the same time period. During the summer censuses of 1976 and 1977 the average number of species observed on the control area was 21.5 as compared with 13.5 on the experimental area. Mean number of individuals totaled 106 on the control and 77.5 on the experimental areas during this same time period (Table VIII).

It was hypothesized that food plantings would increase the number of species and individuals observed on the experimental area as opposed to those of the control area. However, some important habitat components on the control area were not present on the experimental area. These components included a pond and snag trees left in the vicinity of the pond during site preparation.

It was apparent that the presence of the snag trees and/or the



TABLE VIII. Mean Numbers of Non-Game Bird Species and Individuals from the Stinging Fork Study Area During the 1976-1977 Censuses

|               | Mean Species        |                     | Mean Individuals    |                     |
|---------------|---------------------|---------------------|---------------------|---------------------|
|               | Winter<br>(1975-76) | Summer<br>(1976-77) | Winter<br>(1975-76) | Summer<br>(1976-77) |
| Stinging Fork |                     |                     |                     |                     |
| Control       | 12.5                | 21.5                | 63.5                | 106.0               |
| Experimental  | 9.5                 | 13.5                | 70.5                | 77.5                |

water increased the number of species and individuals on the control area as compared to the experimental area. Snag trees have proven an excellent management tool for non-game birds (U.S.D.A. 1974). Food plantings themselves may not increase numbers on one area over that of another. Conner and Adkisson (1974) and Conner (1978) have noted that snags left in harvested areas are important as perches to many species, and as potential nest sites to such species as bluebirds (Sialia sialis), woodpeckers and other cavity nesting and excavating birds. Balda (1975) noted that increases in availability of snags on forest lands have been shown to increase the abundance, diversity and species richness of non-game birds. Food plantings did not appear to have as much effect on species composition and number of individuals as did the pond and the uncut snags.

With the exception of birds unique to the control area, species occupying both areas were typical of those found in early successional habitat types (Dickson et al., 1980). A list of bird species observed during this study is included in the Appendix (Table XVIII).

#### Cost of Manipulation

A total of 6.4 ha of food plantings was established on the Stinging Fork experimental area in 1972 at a cost of \$303.25. The average cost for the area planted was \$47.38 per ha, and the average cost for the entire 89 ha study area was \$3.38 per ha (Brown 1974).

The re-establishment of the soybeans through 1976 was the only maintenance necessary for this study area. The cost of re-establishing the 1.46 ha strip of soybeans in 1973 was \$76.85 (Brown 1974). Costs for the years 1974, 1975 and 1976 were \$157.93, \$217.65 (Burt 1976),

and \$187.10 (Table IX), respectively. The lower cost for 1976 reflected the reduced amount of soybeans and fertilizer that was used for the same area planted.

Total cost for the five years of treatments was \$942.78. Total cost per ha for the 89 ha unit was \$10.59. The cost over the 5 year period for the 89 ha management unit was \$2.11 per ha per year.

#### Cost Return for Bobwhite Quail

Since food and cover plantings were the only management differences between the areas, increased numbers of birds on the experimental area were attributed to the presence of these food plantings. Quail density of the control area was assumed to be representative of the density on the experimental area had the food plots not been established. A total of 247 quail was flushed during fall on the experimental area since 1972 while 119 birds were flushed on the control during this same time (Table V, p. 31). This difference of 128 birds, equal to 1.82 birds per ha, is attributed to the presence of food plantings. Based on this density of 1.82 birds per ha and a cost of \$10.59 per ha for habitat enhancements, a cost per bird of \$5.82 was derived. The cost, however, does not consider any influence the food plots may have had on the control area, as Burt (1976) reported that color marked birds were found to be using both areas. Considering that only about 50% of the quail population is flushed by the census method utilized (pers comm R. W. Dimmick), the estimated cost per bird can be further reduced to around \$2.91 per bird. This figure is double that reported by Burt (1976), probably due to the increased planting costs of the years 1974, 1975 and 1976. Since food plots do not significantly replace or retard tree growth,



TABLE IX. Cost of Establishing Soybean Food Strips on the Stinging Fork Experimental Area in 1976

| Type of Expense                                        | Costs        |
|--------------------------------------------------------|--------------|
| I. 1.46 hectares of Soybeans                           |              |
| A. Strip width--9.1 meters                             |              |
| B. Strip length--1,539.8 meters                        |              |
| C. Cost:                                               |              |
| <u>Materials</u>                                       |              |
| 3.3 bushels Soybeans at \$10.00/bu.                    | \$ 33.30     |
| 450 lbs. Fertilizer at \$150.00/ton                    | 34.50        |
| 1-1.46 hectare bag of Inoculant and Molybdenum         | <u>3.60</u>  |
| sub-total                                              | \$ 71.40     |
| <u>Equipment Usage</u>                                 |              |
| (Single disk) Diesel Farm Tractor at \$15.00/hr.       | \$ 27.00     |
| (Sow seed) Diesel Farm Tractor at \$15.00/hr.          | 13.50        |
| (Spread fertilizer) Diesel Farm Tractor at \$15.00/hr. | 13.50        |
| (Cover seed) Diesel Farm Tractor at \$15.00/hr.        | <u>27.00</u> |
| sub-total                                              | \$ 81.00     |
| <u>Labor</u>                                           |              |
| 8 hrs. for Tractor Operator at \$3.47/hr.              | \$ 27.76     |
| Fringe benefits for Operator at 25%                    | <u>6.94</u>  |
| sub-total                                              | \$ 34.70     |
| Total Planting Costs                                   | \$ 187.10    |
| Cost per Hectare Treated                               | \$ 128.15    |

alternative land uses were not considered in the cost return evaluation.

### Response of Wildlife to Food Plantings on Cumberland County Study Areas

The use of food plantings by bobwhite quail, cottontail rabbits and non-game birds was evaluated through whistle counts, walk-flush census and food habits identification.

#### Bobwhite Quail

Flush counts. Direct flush counts indicated that initial bobwhite quail numbers on the Cumberland County study areas were very low in spring 1976; no birds were flushed on the Taylor Chapel study areas, only three birds were flushed on the Laurel Creek study area, and four birds on the Dugger Branch study area (Table X).

In 1977 no birds were flushed on the Cumberland County study areas during the late winter-spring censuses (Table X). Very heavy hunting pressure during the 1976-1977 season may have contributed to the decline (or absence) of birds on the three experimental areas during spring 1977. Field observations and personal communications with local hunters indicated the areas received heavy hunting pressure prior to the spring census. Convenience, relative ease of hunting, and hunter success helped make the study areas attractive to a number of hunting parties and may have led to an over-harvest of birds or to their harassment, forcing birds into less disturbed habitat.

In addition, the hardwood margins of the study areas were not censused and birds using these areas could have been missed, as hardwood cover strips within the clearcut area were surveyed and many birds were flushed in or near these areas. Brunswig and Johnson (1972) noted that

TABLE X. Bobwhite Quail Spring and Fall Flush Census Results on the Cumberland County Study Areas from 1976 to 1977

| Area          | Type Parameter              | 1976   |      | 1977   |      |
|---------------|-----------------------------|--------|------|--------|------|
|               |                             | Spring | Fall | Spring | Fall |
| Dugger Branch | Number of coveys            | 1      | 3    | 0      | 5    |
|               | Number of birds             | 4      | 44   | 0      | 63   |
|               | Hectares per bird           | 20.2   | 1.8  | -      | 1.3  |
|               | Percent change <sup>a</sup> | -      | -    | -      | +43  |
| Hatfield Ford | Number of coveys            | 0      | 0    | 0      | 1    |
|               | Number of birds             | 0      | 0    | 0      | 16   |
|               | Hectares per bird           | -      | -    | -      | 4.2  |
|               | Percent change <sup>a</sup> | -      | -    | -      | -    |
| Laurel Creek  | Number of coveys            | 1      | 3    | 0      | 1    |
|               | Number of birds             | 3      | 36   | 0      | 10   |
|               | Hectares per bird           | 21.7   | 1.8  | -      | 6.5  |
|               | Percent change <sup>a</sup> | -      | -    | -      | -72  |
| Taylor Chapel | Number of coveys            | 0      | 5    | 0      | 2    |
|               | Number of birds             | 0      | 66   | 0      | 28   |
|               | Hectares per bird           | -      | 1.1  | -      | 2.6  |
|               | Percent change <sup>a</sup> | -      | -    | -      | -58  |

<sup>a</sup>Percent change denotes the relative change in the number of birds from the same season previous year.



coveys often prefer woods edges, windrows, brushpiles, and densely vegetated areas on recently cleared land.

During the fall of 1976 (Table X), 44 birds were flushed on Dugger Branch, 36 on Laurel Creek and 66 on Taylor Chapel. These numbers reflect densities of 1.8 ha per bird for Dugger Branch and Laurel Creek and 1.1 ha per bird for the Taylor Chapel area. The appearance of increased numbers of birds in the fall probably reflects the increased food availability due to the presence of the food plantings and also the availability of pokeweed and other naturally occurring bobwhite quail foods. During fall 1977, the number of birds on Dugger Branch increased to 63, while numbers on Laurel Creek and Taylor Chapel declined to 10 and 28 birds, respectively (Table X).

Pine plantations in the second year following conversion are frequently in the peak habitat stage for quail populations (Brunswig and Johnson 1972), and one may expect quail numbers to peak during this year. However, it is believed that heavy hunting pressure during the 1976-1977 hunting season caused many birds to move from the two areas into adjacent, less disturbed habitat. This hypothesis is strengthened by the work of Dimmick and Yoho (1972), who reported that with sufficient disturbance quail may shift the location of their activity centers and home ranges.

No birds were flushed on the Hatfield Ford control area until the fall of 1977 when 1 covey of 16 birds was located. Failure of the Hatfield Ford area to have quail densities comparable to the other areas is attributed to an absence of food plantings and an initially lower breeding stock. This population may have been insufficient due to the predominance of hardwood habitat adjacent to the control area. The

Hatfield Ford area was consistently devoid of birds in the summer and fall. Numbers of calls heard and males calling in breeding season and number of birds flushed in the fall indicate the area did not support a viable bobwhite quail population. It is likely that the overall habitat of the general area (study area and surrounding area) was not suitable bobwhite quail habitat and therefore supported very few birds.

Call counts. The average number of individual males heard calling per station per day in 1976 and 1977 increased from 0.9 to 1.2 on the Laurel Creek area, from 3.7 to 3.9 on the Taylor Chapel area, and from 1.3 to 1.5 on the Dugger Branch study area. The Hatfield Ford Control area experienced a decrease from 0.3 in 1976 to 0.2 in 1977 (Table XI). The average number of bobwhite calls heard per station per day increased from 6.9 in 1976 to 10.1 in 1977 on the Laurel Creek area and from 37.1 in 1976 to 41.9 in 1977 on the Taylor Chapel area. The number of calls heard on the Hatfield Ford Control area and those heard on the Dugger Branch area both decreased from 1.4 in 1976 to 1.1 in 1977 and from 12.8 in 1976 to 10.8 in 1977 on the two areas, respectively.

An analysis of variance and Duncans New Multiple Range Test were used to determine differences between areas for the number of individuals calling and the number of calls heard. The Taylor Chapel area in 1976 was significantly higher than all other areas for both parameters, while no significant differences existed between any of the other areas. In 1977 the test again revealed the Taylor Chapel area to be significantly higher than all other areas, for both the number of individuals calling and the number of calls heard. Also, in 1977 the Dugger Branch and Laurel Creek areas were significantly different from each other for the number of

TABLE XI. Bobwhite Quail Spring Whistle Count Results on the Cumberland County Study Areas During 1976 and 1977

| Parameter           | Laurel Creek |      | Taylor Chapel |      | Dugger Branch |      | Hatfield Ford |      |
|---------------------|--------------|------|---------------|------|---------------|------|---------------|------|
|                     | 1976         | 1977 | 1976          | 1977 | 1976          | 1977 | 1976          | 1977 |
| Total Calls         | 100          | 161  | 594           | 670  | 308           | 260  | 22            | 17   |
| Average Calls       | 6.9          | 10.1 | 37.1          | 41.9 | 12.8          | 10.8 | 1.4           | 1.1  |
| Total Individuals   | 14           | 19   | 57            | 62   | 31            | 35   | 4             | 3    |
| Average Individuals | 0.9          | 1.2  | 3.7           | 3.9  | 1.3           | 1.5  | 0.3           | 0.2  |



individuals calling only. These data suggest that habitat conditions were more suitable on the Taylor Chapel area than on the other study areas. These conditions included an early growth of grasses, the preferred nesting cover for quail, and an early growth of annual foods. Perhaps this was due to degree of site preparation or to the time at which the site was prepared.

Another possibility for the significantly higher numbers of calls and males calling on the Taylor Chapel study area is the existence of more suitable habitat in the adjacent areas prior to the timber harvest, site preparation and planting of food and cover species. The Taylor Chapel area was surrounded by narrow hardwood stringers that lay between this and an older pine plantation to the north. Also, farmland and pastures were abundant on the east, west and south margins of the study area, and there were many overgrown fence rows associated with the farmland. This could have provided a source of recruitment for birds to move into the new area. All experimental areas had similar habitat to that surrounding the Taylor Chapel area, though perhaps not as well-developed for quail.

The population trends determined from call counts were not supported by the walk flush censuses of early spring, but were consistent with results of the fall walk-flush censuses. These differences may be due to movement of birds into the areas for breeding purposes following the spring flush counts. These birds were also detected during the fall flush counts, and then either moved back out of the area during the winter, died from natural causes, or were harvested by hunters.

### Utilization of Food Plantings

A total of 61 birds was collected from the Cumberland County research areas, 19 during 1976-1977 and 42 during 1977-1978. During 1976-1977, pokeweed was the most important food source on the Cumberland County research areas (Table XII), accounting for 48% of the total food volume. Kobe lespedeza was the next most important species, accounting for 20.8% of the total food volume. Kobe was followed by leafy plant material (17.3%), beggar weed (8.3%), partridge pea (Cassia nictitans) (2.4%), and sericea lespedeza (1.6%). Although bicolor lespedeza was available on the experimental areas, it was scarce and found in only trace amounts in 15.8% of the crops examined (Table XVI, Appendix). This lack of bicolor utilization may be the result of poor seed production and dense ground cover within the bicolor strip, as Murray (1958) and Rosene (1956) found that bicolor lespedeza was a leading quail food in years when the plantings were of good quality. The poor quality of the bicolor stand and subsequent lack of seed production probably explains the poor showing of bicolor in the quail's diet in 1976-1977.

Bicolor was the most important food source during the 1977-1978 period, accounting for 49.4% of the total food, occurring in 38% of the crops examined (Table XVII, Appendix). Following bicolor in importance were common ragweed (11.8%), acorns (11.2%), pokeweed (8.3%), kobe lespedeza (8.1%), grasshoppers (Orthoptera) (6.4%), and beggar weed (3.0%). The improved quality of the food strip in 1977-1978 was reflected in the increased utilization of bicolor by bobwhite quail.

Wild foods provided 76% of the total food volume in 1976-1977 and only 39% in 1977-1978. The use of wild foods during 1976-1977 reflected the poor production by the planted foods, especially bicolor

TABLE XII. Twelve Important Food Items of Bobwhite Collected During the 1976-1977 and 1977-1978 Hunting Seasons on the Cumberland County Study Areas

| Food Items                     | Percent of Volume                 |                      |                      |                      |                      |                      |                       |                       |                       |                       |
|--------------------------------|-----------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
|                                | DB                                |                      | HF                   |                      | LC                   |                      | TC                    |                       | Total                 | Total                 |
|                                | 1976-<br>1977<br>(0) <sup>a</sup> | 1977-<br>1978<br>(6) | 1976-<br>1977<br>(2) | 1977-<br>1978<br>(0) | 1976-<br>1977<br>(7) | 1977-<br>1978<br>(0) | 1976-<br>1977<br>(10) | 1977-<br>1978<br>(36) | 1976-<br>1978<br>(19) | 1977-<br>1978<br>(42) |
| <u>PLANT FOODS</u>             |                                   |                      |                      |                      |                      |                      |                       |                       |                       |                       |
| <u>Lespedeza bicolor</u>       | -                                 | 87.2                 | -                    | -                    | -                    | -                    | -                     | 34.0                  | -                     | 49.4                  |
| <u>Phytolacca americana</u>    | -                                 | -                    | -                    | -                    | -                    | -                    | 78.4                  | 11.7                  | 48.0                  | 8.3                   |
| <u>Lespedeza striata</u>       | -                                 | 11.7                 | 3.2                  | -                    | 44.6                 | -                    | 12.9                  | 6.7                   | 20.8                  | 8.1                   |
| Leafy plant material           | -                                 | -                    | 92.9                 | -                    | 11.9                 | -                    | -                     | -                     | 17.3                  | -                     |
| <u>Ambrosia artemisiifolia</u> | -                                 | -                    | -                    | -                    | -                    | -                    | -                     | 16.6                  | -                     | 11.8                  |
| <u>Desmodium spp.</u>          | -                                 | 1.1                  | -                    | -                    | 19.0                 | -                    | 1.3                   | 3.8                   | 8.3                   | 3.0                   |
| <u>Quercus spp.</u>            | -                                 | -                    | -                    | -                    | -                    | -                    | -                     | 15.8                  | -                     | 11.2                  |
| <u>Cassia nictitans</u>        | -                                 | -                    | 3.2                  | -                    | 2.3                  | -                    | 0.2                   | -                     | 2.4                   | -                     |
| <u>Lespedeza stipulacea</u>    | -                                 | -                    | 0.4                  | -                    | 3.1                  | -                    | -                     | 0.5                   | 1.6                   | 0.3                   |
| <u>Panicum spp.</u>            | -                                 | -                    | 0.3                  | -                    | 2.5                  | -                    | 0.6                   | -                     | -                     | -                     |
| ORTHOPTERA                     | -                                 | -                    | -                    | -                    | 15.9                 | -                    | 6.4                   | 9.0                   | -                     | 6.4                   |
| COLEOPTERA                     | -                                 | -                    | -                    | -                    | 0.8                  | -                    | -                     | 1.0                   | -                     | 0.7                   |

DB: Dugger Branch, HF: Hatfield Ford, LC: Laurel Creek; TC: Taylor Chapel.



lespedeza. In 1977-1978 wild food usage dropped as the bicolor strip began producing. Apparently, when present in quality and quantity, planted lespedezas become favored foods and make up the greater part of the diet. Natural foods were very important, but no data were collected on their abundance or availability on the study areas.

Pearson and Howell (1943), Davison (1945), Haugen and Fitch (1955), Rosene (1956), Gehrken (1956), Webb (1960) and McConnel (1965) reported bicolor lespedeza to be an important quail food in the south-east. However, the bicolor was not planted exclusively for the food it produced. It also provided cover in areas where none had existed, although this may not become obvious until the bicolor strip increases in area of occupancy and density. The importance of kobe lespedeza was noted by Brown (1974). He stated that during the 1972-1973 season on the Stinging Fork area, kobe was the most important food item on the experimental area, comprising 74% of the total food volume. The importance of kobe was also reported by Hurst (1972) in Mississippi. He indicated that during the summer months kobe was utilized by broods of quail as "bugging areas." Kobe lespedeza is apparently an important species to quail but the length of time it can compete with the natural succession of a pine plantation without some type of maintenance is unknown.

Autumn olive and clover seeds were not found in any of the crops examined. Davison (1958) considered clover an inferior food for quail. Autumn olive does not produce fruit until the third to fifth year after planting (Allen and Steiner 1959) and was not available during this study on the Cumberland County study areas.

### Cottontail Rabbits

Cottontail rabbit numbers on the Cumberland County study areas appeared consistent between years throughout this study, although slight changes have occurred on all areas (Table XIII). From 1976 to 1977 spring rabbit numbers changed from 1 to 3 on the Dugger Branch, from 2 to 3 on the Hatfield Ford Control and from 1 to 4 on the Taylor Chapel study area. Laurel Creek was the only area on which fewer rabbits were flushed in 1977 (1) than 1976 (2).

Numbers of rabbits flushed during fall 1977 on the Dugger Branch area changed from 3 to 7 over the fall 1976 results. Small changes also occurred on the Hatfield Ford Control area, from 2 to 3, and on the Taylor Chapel area, from 4 to 6. The Laurel Creek area went from 1 in 1976 to 5 in 1977.

In the fall of 1977 all experimental areas recorded more rabbits than the control area. None of the differences between years or between areas appears to be significant. Rabbit population figures from the Cumberland County study areas are consistent with those from the Stinging Fork study area recorded by Brown (1974) and Burt (1976), in that very low numbers were recorded for the first 3 years. On the Stinging Fork area, as vegetative cover became more advanced the cottontail rabbit population increased. Grange (1949) reported that after 4 years cottontail rabbits become increasingly abundant on clear-cut areas.

The value of clover as a spring and summer food source for rabbits has been reported by many authors (Dalke and Sime 1941, Davison 1943, Dusi 1952, and Rosene 1955). Davison (1945) reported that bark and leaves of bicolor are also utilized by rabbits, and Rosene (1955) found bicolor to be a highly desirable food source during the winter

TABLE XIII. Spring and Fall Flush Census Results for Cottontail Rabbits on the Cumberland County Study Areas from 1976 to 1977

| Area          | Type Parameter              | 1976   |      | 1977   |      |
|---------------|-----------------------------|--------|------|--------|------|
|               |                             | Spring | Fall | Spring | Fall |
| Dugger Branch | Number of rabbits           | 1      | 3    | 3      | 7    |
|               | Hectares per rabbit         | 81     | 27   | 27     | 12   |
|               | Percent change <sup>a</sup> | -      | -    | +200   | +133 |
| Hatfield Ford | Number of rabbits           | 2      | 2    | 3      | 3    |
|               | Hectares per rabbit         | 36     | 36   | 24     | 24   |
|               | Percent change <sup>a</sup> | -      | -    | +50    | +50  |
| Laurel Creek  | Number of rabbits           | 2      | 1    | 1      | 5    |
|               | Hectares per rabbit         | 33     | 65   | 65     | 13   |
|               | Percent change <sup>a</sup> | -      | -    | -50    | +400 |
| Taylor Chapel | Number of rabbits           | 1      | 4    | 4      | 6    |
|               | Hectares per rabbit         | 71     | 18   | 18     | 12   |
|               | Percent change <sup>a</sup> | -      | -    | +300   | +50  |



months. However, there was no evidence on the Cumberland County areas of rabbits severing the stems of bicolor plants as was found on the Stinging Fork study area.

No readily identifiable concentration of rabbits in or around food strips was apparent. This may indicate little, if any, dependence upon the food plantings by cottontail rabbits, though no food habit studies were conducted to confirm this.

#### Non-Game Birds

Non-game birds were surveyed for abundance and for variety of species present during 1976 and 1977 (Table XIV). The average number of species observed per census day for both years on the Taylor Chapel, Dugger Branch, and Laurel Creek areas was 7.5, 6.0, and 4.8 respectively. The Hatfield Ford control area averaged 6.2 species per census day. A single class analysis of variance ( $P > 0.05$ ) indicated that no significant difference in number of species between areas existed. Neither were there significant differences between areas for average numbers of individuals per census day. Averages for each area were 21.3, 14.1, and 11.9 for Dugger Branch, Taylor Chapel, and Laurel Creek respectively, while the control area averaged 19.3 individuals per census day.

Bird species observed on these areas are those species that are typically found in early successional habitat, such as prairie warbler (Dendroica discolor), yellow breasted chat (Icteria virens), cardinal (Richmondia cardinalis), indigo bunting (Passeina cyanea) and rufous sided towhee (Pipilo erythrophthalmus). These species are similar to those reported by Dickson et al. (1980) in their study of breeding birds in the southeast. Noon and Able (1978) noted that habitat selection in

TABLE XIV. Mean Number of Non-Game Bird Species and Individuals on the Cumberland County Study Areas During the 1976-1977 Censuses

| Study Area            | Species | Individuals |
|-----------------------|---------|-------------|
| Taylor Chapel         | 7.5     | 14.1        |
| Dugger Branch         | 6.0     | 21.3        |
| Laurel Creek          | 4.8     | 11.9        |
| Hatfield Ford Control | 6.2     | 19.3        |

passerine birds appears to be influenced by the physical structure of the vegetation without particular regard to the plant species present, and Gill et al. (1974) believed the life form of vegetation is more important than individual plant species to bird-habitat management. This internal plant variation in vegetation profile is the key to bird species abundance. Since the vegetative structure of the experimental areas was essentially the same as the control, one would not expect there to be a significant difference in number of species or individuals present. The data support this hypothesis. Areas with food plantings did not support populations of song birds greater than the control area. Additional research in this area is needed considering the increased importance being placed on non-game wildlife and its management. A list of bird species observed during this study is included in the Appendix (Table XVIII).

#### Cost of Manipulation

Food and cover planting costs for 1975 on the Cumberland County study areas were \$324.77 for the Dugger Branch area, \$255.82 for the Laurel Creek area, and \$284.85 for the Taylor Chapel study area (Table XV). An average cost of \$3.97 per ha was recorded for the 3 areas that received food and cover plantings. When compared with the initial cost of \$3.38 per ha reported by Brown (1974), this figure appears reasonable, but Brown's figures included the cost of establishing 1.46 ha of soybeans which were not planted on the Cumberland County areas. Thus, inflation has increased the cost of planting in the 3 years since the foods were originally planted in 1972, or the Stinging Ford area.

Cost per ha per year over the 2 year period of this study



TABLE XV. Cost of the Initial Establishment of Wildlife Food Plots on the Cumberland County Study Areas

| Species                              | Ha Planted |      |      | Cost per Ha |         |         | Total Cost |          |          |
|--------------------------------------|------------|------|------|-------------|---------|---------|------------|----------|----------|
|                                      | DB         | LC   | TC   | DB          | LC      | TC      | DB         | LC       | TC       |
| Bicolor Lespedeza                    | 0.81       | 0.65 | 0.72 | \$99.07     | \$97.68 | \$97.57 | \$80.25    | \$63.50  | \$70.25  |
| Lespedeza-Clover                     | 4.1        | 3.2  | 3.6  | \$57.81     | \$56.79 | \$57.40 | \$234.12   | \$184.00 | \$205.50 |
| Autumn Olive                         | 0.4        | 0.3  | 0.4  | \$26.00     | \$25.21 | \$25.28 | \$10.40    | \$8.32   | \$9.10   |
| Total ha Planted                     | 5.3        | 4.2  | 4.7  | -           | -       | -       | -          | -        | -        |
| Total Cost                           | -          | -    | -    | -           | -       | -       | \$324.77   | \$255.82 | \$284.85 |
| Average Cost Per ha                  | -          | -    | -    | -           | -       | -       | \$61.74    | \$60.76  | \$61.13  |
| Average Cost Per ha for Area Treated | -          | -    | -    | -           | -       | -       | \$4.01     | \$3.94   | \$3.97   |

DB: Dugger Branch  
 LC: Laurel Creek  
 TC: Taylor Chapel

following initial establishment was \$2.00, \$1.97, and \$1.99 for the Dugger Branch, Laurel Creek, and Taylor Chapel areas, respectively. The cost per ha over a 6 year period in which the plantings are thought to be of benefit to quail averages \$0.66.

#### Cost Return for Bobwhite Quail

A total of 107 birds was flushed on the Dugger Branch area, 46 on the Laurel Creek area, and 94 on the Taylor Chapel area during censuses in 1976 and 1977. On the Hatfield Ford control, 16 birds were flushed during this same period (0.23/ha). The differences between the experimental areas and the control area were 91 (1.32/ha), 30 (0.71/ha) and 78 (1.31/ha), respectively. Cost per bird was determined by dividing the average cost per ha for food plantings by the differences in birds per ha on each of the experimental areas when compared with the control. This amounted to \$3.68, \$8.21 and \$3.68 per bird on the Dugger Branch, Laurel Creek and Taylor Chapel areas respectively. Applying a 50% flush success rate for the census technique used reduced costs to \$1.84, \$4.11 and \$1.84 per area. The costs are considerably lower than costs per bird obtained on the Stinging Fork area.

#### Comparative Cost-Effectiveness of Perennial vs. Annual Plantings

A major objective of this study was to compare the relative merits of perennial plantings vs. annual plantings for producing bobwhites. The criterion selected for objective comparison was the cost of management per quail produced over the life of the project. The estimate of quail production attributable to habitat manipulation on the experimental areas was based on the differential in quail numbers on equivalent units of experimental and control areas. As the experimental area

planted with annuals was evaluated for 5 production seasons, and the perennial areas were evaluated for only 2, it would be necessary to project quail numbers on the latter using trends observed on the former. Such projections obviously are less valid than numbers based on census results, and a reduction in cost per bird could only be implied although it is felt that such a reduction would occur. Such shortcomings, however, are not attendant to the figures for management costs. For the annual plantings on the Stinging Fork area, the costs are a matter of record. For the perennial plantings, management costs were accrued only during establishment, while the effect should continue at least for the estimated 5-year life of the project. These costs are documented in this report.

In summation, perennial plantings were approximately as effective in enhancing quail numbers as was a combination of annuals and perennials. Costs of production were markedly lower when projected over the life of the project.

#### Hunter Utilization

Many visitors to the Rhea and Cumberland County study areas were interviewed during the two years of this research project. Most of the visitors to the areas were local residents, although some people had driven as far as 140 km to hunt on the areas.

Almost all of those interviewed were aware that the recently clearcut areas offered good quail and rabbit hunting, but many were unaware of the food and cover plantings. Many people were not able to identify the bicolor and kobe lespedeza plants.

Some of the hunters thought the plantings in the interior of the



areas would receive little use. Their reasoning was that food strips were of greater benefit to wildlife if they were nearer to protective cover (the purpose of plantings in the interior of the areas was discussed in the Utilization of Food Plantings section).

Hunters of quail, rabbit, grouse and white-tailed deer were the primary users of the areas. Quail and rabbit hunters were predominant on the Dugger Branch, Laurel Creek, and Taylor Chapel areas while grouse and deer hunters occurred in greatest numbers on the Stinging Fork and Hatfield Ford study areas. Quail hunting was considered by this group to be good for the initial 3 years after planting. After this time the areas became increasingly difficult to hunt. Rabbit hunting was considered by the hunters to be good on areas 2 years old and older.

Field observations and personal communications with local residents indicated the clear-cut areas were hunted very heavily during the 1976-1977 and 1977-1978 seasons. The easy access and quality hunting of the areas made them vulnerable to over-harvest.

Most suggestions involving improvements to the food plantings were concerned with the placement and quality of the food strips. Better quality strips nearer to protective cover would do much to enhance the hunting on the areas.

The degree of cooperation given the author by hunters on the study areas was outstanding. Many crops for the food habits research were collected from hunters who were willing to do what they could to help with the project.

## CHAPTER V

### SUMMARY

This thesis concludes the final 2 years of a 6 year evaluation of food plantings for wildlife on pine plantations in eastern Tennessee. Research for this project was conducted on pine plantations in Rhea County and Cumberland County, Tennessee.

Wildlife food and cover plantings were established on pine plantations in Rhea County in the spring of 1972 and in Cumberland County in the spring of 1975. Initial establishment of food plantings in Rhea County included soybeans, Korean lespedeza, kobe lespedeza, white Dutch clover, red clover, bicolor lespedeza and autumn olive, on the 89 ha Stinging Fork experimental area. Total cost for the initial establishment of 6.4 ha of food plantings on the Stinging Fork experimental area in 1972 was \$305.25. Since the initial establishment in 1972 only soybeans have required annual replanting through 1976 when their use was discontinued. Costs for soybean plantings were \$76.85 in 1973, \$157.93 in 1974, \$217.65 in 1975, and \$187.10 in 1976. The decrease in costs for 1976 were the result of using less soybeans and fertilizer per acre.

Initial food plot establishment on the Cumberland County study areas included kobe lespedeza, red clover, white Dutch clover, bicolor lespedeza and autumn olive. Total cost for the 5.3 ha of food plantings on the Dugger Branch area was \$324.77, 4.2 ha on the Laurel Creek area was \$255.82, and 4.7 ha on the Taylor Chapel area was \$284.85. The average cost per ha per year since foods were established, for the 81 ha Dugger Branch area was \$4.01, for the 65 ha Laurel Creek area

\$3.94, and for the 71.7 ha Taylor Chapel area \$3.97.

Density calculated from the direct flush census on the Stinging Fork control area increased from one bird per 24 ha in the spring of 1976 to one bird per 6.5 ha in the fall of 1976, but then decreased to one bird per 10.3 ha in the spring of 1977. Densities from the experimental area showed a decrease from one bird per 1.7 ha in the fall of 1975 to one bird per 2.9 ha in the spring of 1976. Density decreased to one bird per 22.4 ha in the fall of 1976. The spring 1977 density increased to one bird per 3.3 ha. The overwinter increase in the spring 1977 survey possibly reflected movement into the dense protective cover of the pine plantation from the surrounding hardwoods, which provide little protective cover, or food during the winter months.

Direct flush counts on Cumberland County areas indicated that Laurel Creek and Taylor Chapel areas both experienced decreases in numbers of birds in 1977 from that recorded in 1976. The Dugger Branch area recorded an increase in birds flushed in 1977 over 1976. The Hatfield Ford control area also experienced a slight increase in 1977 over 1976. Hunting pressure during the 1976-1977 season could have caused a movement of the birds that was noted as a population decrease by the 1977 census. The habitat of the experimental and control areas should have been at the stage of development that supported the greatest number of birds.

The average number of bobwhite males calling on the Stinging Fork control area decreased from 2.2 birds per day in 1976 to 1.4 per day in 1977. Average numbers of calling males on the experimental area decreased from 2.8 birds per day in 1976 to 1.3 per day in 1977. The Stinging Fork pine plantation was 5 years old in 1977 and could no longer



be considered good bobwhite quail habitat.

Average numbers of bobwhite males heard in 1977 on Cumberland County areas increased or remained unchanged from 1976. The Laurel Creek area recorded an increase from 0.9 in 1976 to 1.2 in 1977. Average number of males per station per day on the Taylor Chapel area increased from 3.7 in 1976 to 3.9 in 1977. Average numbers of males increased on the Dugger Branch area from 1.3 to 1.5 but decreased on the Hatfield Ford Control area, from 0.3 to 0.2 birds per station per day.

A total of 61 bobwhite quail was collected from the Cumberland County study areas during the 1976-1977 and 1977-1978 Tennessee hunting season. Pokeweed was the most important food item on the Cumberland County research areas during the 1976-1977 hunting season, accounting for 48% of the food volume. Pokeweed was abundant in windrows and was associated with the preferred cover of quail on the study areas. Kobe lespedeza was next with 20.8% of the relative food volume. Kobe was followed in importance by leafy plant material, beggar weed, partridge pea, and sericea lespedeza. Bicolor lespedeza was utilized only in trace amounts in 15.8% of the crops examined in 1976-1977. Its availability was limited due to the poor quality of the food strip.

During the 1977-1978 hunting season, bicolor became the most important food source, accounting for over 49% of the volume, and occurring in 38% of the crops examined. The increased utilization of bicolor during this period reflected the improved quality of the food strip. Following bicolor in importance were common ragweed, acorns, pokeweed, kobe lespedeza, grasshoppers, and beggarweed.

Fall cottontail rabbit numbers on the Stinging Fork experimental study area decreased from 20 in 1975 to 6 in 1976, while numbers on the

control area were unchanged (9). Spring numbers on the experimental area decreased from 15 to 10, and from 13 to 6 on the control area. Actual numbers were likely greater but the possibility of observing or flushing rabbits had decreased with the increase in density of the ground cover.

Rabbit numbers on the Cumberland County areas increased slightly during each year of this study on both the control and experimental study areas. This seems to parallel the trend observed on the Stinging Fork area with greater numbers of rabbits being observed after the third year following planting.

Non-game bird species were surveyed for abundance and species diversity on the Stinging Fork and Cumberland County areas. Food plantings did not appear to have as great an effect on species composition of the Stinging Fork areas as did the presence of a small pond surrounded by uncut snags on the control area. With the exception of those species found only on the control area the birds observed were those typical of early successional habitat.

On the Cumberland County areas common species observed included American goldfinch (Spinus tristis), eastern bluebird, white-crowned sparrow (Zonotricha leucophrys), dark-eyed junco (Junco hyemalis), blue jay (Cyanocitta cristata), indigo bunting (Passeina cyanea), prairie warbler (Dendroica discolor), yellow-breasted chat (Icteria virens) and eastern meadowlark (Sturnella magna). These data are inconclusive but suggest little if any dependence by non-game bird populations on food plantings.

Physical structure of the vegetation is thought to be more important in determining habitat selection on the study areas than the

presence or absence of food plantings.

The average cost per ha for the initial establishment of food plantings on the 89 ha Stinging Fork experimental area was \$3.38. Total cost per ha for the 89 ha unit was \$10.59. The average cost per bird attributed to management on the Stinging Fork study area was \$5.82.

Average cost per ha for food planted on Cumberland County areas was \$3.97. Average cost per ha per year for the 2 year period since the initial planting amounted to \$1.99. The average cost per bird attributed to management was \$3.68 on Dugger Branch, \$8.21 on Laurel Creek and \$3.68 on the Taylor Chapel area. Average cost per bird was less on 2 of the 3 Cumberland County areas with only perennial foods, as opposed to the Stinging Fork areas where annuals and perennials were used. Average cost per ha per year over a 6 year period in which the plantings are thought to be of benefit to quail was \$0.66.



## LITERATURE CITED

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## APPENDIX



TABLE XVI. Important Food Items of Nineteen Bobwhite Collected During the 1976-1977 Hunting Season on the Cumberland County Study Areas

| Food Item                      | Volume      |                | Frequency      |                   |                 | Number           |                  |
|--------------------------------|-------------|----------------|----------------|-------------------|-----------------|------------------|------------------|
|                                | Total<br>cc | % Rel.<br>vol. | Times<br>Occur | % Freq.<br>Occur. | % Rel.<br>Freq. | Total #<br>Items | % Rel.<br>Number |
| <u>Phytolacca americana</u>    | 12.2        | 48.0           | 10             | 52.6              | 17.5            | 3330             | 41.2             |
| <u>Lespedeza striata</u>       | 5.3         | 20.8           | 8              | 42.1              | 14.0            | 4218             | 52.2             |
| Leafy plant material           | 4.4         | 17.3           | 6              | 31.6              | 10.5            | tr               | tr               |
| Animal material                | 2.1         | 8.3            | 3              | 15.8              | 5.3             | tr               | tr               |
| <u>Desmodium</u> spp.          | 0.6         | 2.4            | 5              | 26.3              | 8.8             | 138              | 1.7              |
| <u>Cassia nictitans</u>        | 0.4         | 1.6            | 7              | 36.8              | 12.3            | 66               | 0.8              |
| <u>Lespedeza cuneata</u>       | 0.3         | 1.0            | 4              | 21.0              | 7.0             | 164              | 2.0              |
| <u>Panicum</u> spp.            | 0.9         | tr             | 5              | 26.3              | 8.8             | 139              | 1.7              |
| <u>Ambrosia artemisiifolia</u> | tr          | tr             | 1              | 5.3               | 1.8             | 2                | tr               |
| <u>Lespedeza bicolor</u>       | tr          | tr             | 3              | 15.8              | 5.3             | 15               | 0.2              |
| UNKNOWN                        | tr          | tr             | 5              | 26.4              | 8.9             | 8                | 0.1              |



TABLE XVII. Important Food Items of Forty-Two Bobwhite Collected During the 1977-1978 Hunting Season on the Cumberland County Study Areas

| Food Item                      | Volume   |             | Frequency   |               |              | Number        |               |
|--------------------------------|----------|-------------|-------------|---------------|--------------|---------------|---------------|
|                                | Total cc | % Rel. Vol. | Times Occur | % Freq. Occur | % Rel. Freq. | Total # Items | % Rel. Number |
| <u>Lespedeza bicolor</u>       | 30.8     | 49.4        | 16          | 38.1          | 12.0         | 7875          | 61.7          |
| <u>Lespedez striata</u>        | 5.1      | 8.1         | 21          | 50.0          | 15.8         | 1882          | 14.6          |
| <u>Desmodium spp.</u>          | 1.9      | 3.0         | 11          | 26.2          | 8.3          | 490           | 3.8           |
| <u>Cassia fasciculata</u>      | tr       | tr          | 7           | 16.7          | 5.3          | 38            | 0.3           |
| Arachnida                      | tr       | tr          | 1           | 2.4           | 0.8          | 1             | tr            |
| <u>Bidens fondosa</u>          | tr       | tr          | 1           | 2.4           | 0.8          | 1             | tr            |
| <u>Pinus spp.</u>              | tr       | tr          | 1           | 2.4           | 0.8          | 8             | 0.1           |
| <u>Phytolacca americana</u>    | 5.2      | 8.3         | 19          | 45.2          | 14.3         | 832           | 6.7           |
| <u>Quercus spp.</u>            | 7.0      | 11.2        | 9           | 21.4          | 6.7          | 6             | 0.1           |
| <u>Ambrosia artemisiifolia</u> | 7.4      | 11.8        | 9           | 21.4          | 6.8          | 1522          | 11.8          |
| <u>Galactia mollis</u>         | tr       | tr          | 4           | 9.5           | 3.0          | 24            | 0.2           |
| Orthoptera                     | 4.0      | 6.4         | 7           | 16.7          | 5.3          | 12            | 0.1           |
| <u>Impatiens spp.</u>          | 0.5      | 0.7         | 6           | 14.3          | 4.5          | 36            | 0.3           |
| <u>L. cuneata</u>              | 0.2      | 0.3         | 11          | 26.2          | 8.3          | 90            | 0.7           |
| <u>Paspalum spp.</u>           | tr       | tr          | 1           | 2.4           | 0.8          | 2             | tr            |
| Coleoptera                     | 0.5      | 0.7         | 4           | 9.5           | 3.0          | 4             | tr            |
| Hymenoptera                    | tr       | tr          | 1           | 2.4           | 0.8          | 1             | tr            |
| Gastropoda                     | tr       | tr          | 2           | 4.8           | 1.5          | 2             | tr            |
| <u>Panicum dichotomiflorum</u> | tr       | tr          | 2           | 4.8           | 1.5          | 14            | 0.1           |

TABLE XVIII. A Complete List of Scientific and Common Names of Birds  
Observed on the Stinging Fork and Cumberland County  
Study Areas

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Cathartidae

Cathartes aura

Turkey vulture

Accipitridae

Buteo jamaicensis

Red-tailed hawk

Buteo lagopus

American rough-legged hawk

Buteo platypterus

Broad-winged hawk

Falconinae

Falco sparverius

American kestrel

Tetranodae

Bonasa umbellus

Ruffed grouse

Phasianidae

Colinus virginianus

Bobwhite quail

Columbidae

Zenaida macroura

Mourning dove

Cuculidae

Coccyzus americanus

Yellow-billed cuckoo

Mimidae

Toxostoma rufum

Brown thrasher

Turdidae

Turdus migratorius

American robin

Hylocichla mustelina

Wood thrush

Hylocichla guttata

Hermit thrush

Sialia sialis

Eastern bluebird

Sylviidae

Regulus satrapa

Golden-crowned kinglet

Regulus calendula

Ruby-crowned kinglet

TABLE XVIII (Continued)

## Sturnidae

Sturnus vulgaris

Starling

## Parulidae

Dendroica discolor  
Vermivora ruficapilla  
Vermivora pinus  
Dendroica pinus  
Dendroica dominica  
Geothlypis trichas  
Icteria virens  
Vermivora chrysoptera

Prairie warbler  
 Nashville warbler  
 Blue-winged warbler  
 Pine warbler  
 Yellow-throated warbler  
 Yellow throat  
 Yellow-breasted chat  
 Golden-winged warbler

## Icteridae

Sturnella magma  
Agelaius phoeniceus  
Quiscalus quiscula  
Molothrus ater

Eastern meadowlark  
 Redwinged blackbird  
 Grackle  
 Brown-headed cowbird

## Caprimulgidae

Caprimulgus vociferus

Whip-poor-will

## Apodidae

Chaetura pelagica

Chimney swift

## Trochilidae

Archilochus colubris

Ruby-throated hummingbird

## Alcedinidae

Megaceryle alcyon

Belted kingfisher

## Picidae

Colaptes auratus  
Dryocopus pileatus  
Dendrocopos pubescens  
Melanerpes erythrocephalus  
Dendrocopos villus

Yellow-shafted flicker  
 Pileated woodpecker  
 Downy woodpecker  
 Red-headed woodpecker  
 Hairy woodpecker



TABLE XVIII (Continued)

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Tyrannidae

|                          |                    |
|--------------------------|--------------------|
| <u>Tyrannus tyrannus</u> | Eastern kingbird   |
| <u>Sayornis phoebe</u>   | Eastern phoebe     |
| <u>Contopus virens</u>   | Eastern wood pewee |

## Airundinidae

|                        |              |
|------------------------|--------------|
| <u>Hirundo rustica</u> | Barn swallow |
|------------------------|--------------|

## Corvidae

|                              |          |
|------------------------------|----------|
| <u>Cyanocitta cristata</u>   | Blue jay |
| <u>Corvus brachyrhynchos</u> | Crow     |

## Paridae

|                           |                    |
|---------------------------|--------------------|
| <u>Parus carolinensis</u> | Carolina chickadee |
| <u>Parus bicolor</u>      | Tufted titmouse    |

## Troglodytidae

|                                 |               |
|---------------------------------|---------------|
| <u>Thryothorus ludovicianus</u> | Carolina wren |
| <u>Troglodytes troglodytes</u>  | Winter wren   |
| <u>Troglodytes aedon</u>        | House wren    |

## Thraupidae

|                         |                 |
|-------------------------|-----------------|
| <u>Piranga olivacea</u> | Scarlet tanager |
|-------------------------|-----------------|

## Fringillidae

|                                |                        |
|--------------------------------|------------------------|
| <u>Richmondia cardinalis</u>   | Cardinal               |
| <u>Guiraca coerulea</u>        | Blue grosbeak          |
| <u>Passeina cyanea</u>         | Indigo bunting         |
| <u>Spinus tristis</u>          | American goldfinch     |
| <u>Pipilo erythrophthalmus</u> | Rufous-sided towhee    |
| <u>Spizella busilla</u>        | Field sparrow          |
| <u>Zonotrichia albicollis</u>  | White-throated sparrow |
| <u>Melospiza melodia</u>       | Song sparrow           |
| <u>Zonotrichia leucophrys</u>  | White-crowned sparrow  |
| <u>Passerella iliaca</u>       | Fox sparrow            |
| <u>Junco hyemalis</u>          | Dark-eyed junco        |
| <u>Spizella passerina</u>      | Chipping sparrow       |

## Sittidae

|                         |                         |
|-------------------------|-------------------------|
| <u>Sitta canadensis</u> | White-breasted nuthatch |
|-------------------------|-------------------------|

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## VITA

Thomas H. Coppinger was born in Sweetwater, Tennessee, on July 16, 1949. He attended elementary and high school in Tellico Plains, Tennessee, and graduated from Tellico Plains High School in 1967. In March 1969 he entered the U. S. Army and was honorably discharged in October 1970.

In July 1971 he entered East Tennessee State University in Johnson City, Tennessee with a major in biology. He received a B. S. degree in August 1974.

In November 1974 he began employment with the U.S.D.A. Agricultural Research Service in Stoneville, Mississippi. In September 1975 he entered The University of Tennessee, Knoxville, on a research assistantship to begin study toward a Master of Science degree in Wildlife and Fisheries Science. He received this degree in August 1981.

He is employed by the U. S. Forest Service in Rolling Fork, Mississippi. He is married to the former Lynn Peterson, of Hillsdale, Michigan, and they have one daughter, Elizabeth Lynn Coppinger.