To the Graduate Council:

I am submitting herewith a thesis written by Peter George Poulos entitled "Houseplace Influence on the Avian Utilization of Pine Monocultures, Savannah River Plant, South Carolina." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

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HOUSEPLACE INFLUENCE ON THE AVIAN UTILIZATION OF PINE MONOCULTURES, SAVANNAH RIVER PLANT, SOUTH CAROLINA

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Peter George Poulos

December 1977

DEDICATION

Γιά τούς γονεῖς μου:

Στόν Πατέρα μου πού πίστευε ὅτι τίποτε
δέν εἶναι σπουδαιότερο στόν ἄνθρωπο ἀπό τή
μόρφωση καί στήν Μητέρα πού μέ βοήθησε
τόσο πολύ μ' ὅλη της τήν ἀγάπη νά
πραγματοποιήσω τόν σκοπό μου.

ABSTRACT

The purpose of this study was to measure the avifaunal utilization of abandoned farm houseplaces and selected pine stand monocultures. A further consideration was the influence of houseplaces on the avian composition of adjacent pine stands.

The study was conducted on the Energy Research and Development Administration's Savannah River Plant, South Carolina, during the period April-July, 1976. The study area consisted of five study plots of nine hectares each. Forty-four species were recorded in the area during the study period. Fifteen species were breeding, and 29 were visitants.

Importance value was utilized to determine that the pine warbler (IV = 125.6) and brown-headed nuthatch (120.1) were the two most important species in the managed pine habitat. The Carolina chickadee (114.3) and cardinal (106.5) were the two most important species in the houseplace habitat. These four species comprised 48.3 percent of all individuals recorded.

Avian populations of houseplace-pine stand plots were compared to pine stands without houseplaces using the coefficient of community. The similarity of these two

communities was .237 indicating dissimilar avian composition. Breeding bird diversity between the houseplace-pine stand plots and the pine stand without houseplace was significantly different ($p < .01$). Total bird diversity (breeding and visitant) for the two habitats was also significantly different ($p < .05$).

Results indicate that houseplaces provided a habitat diversity which attracted bird species not occurring in the pine stands without houseplaces. This was true of breeding birds and visitants. Evaluation of the results suggests that management practices aimed at maintaining or increasing avian diversity in pine regions of the Savannah River Plant incorporate the houseplace concept.

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CHAPTER 1

INTRODUCTION

The trend of forest management in the Southeastern United States is devoting increased land area to single species pine (Pinus spp.) cultures. The demand for pine products in our present society indicates that this trend will likely continue. The Southern Resources Analysis Committee, formed to study Southern forest demand, recommended the additional planting of 4,048,000 hectares of genetically improved pine seedlings by 1985 and the replacement of 8,096,000 hectares of low quality upland hardwood with pine (Wheeler 1970). Concurrently, increasing demands for declining recreational and aesthetic outlets are expected. The dramatic altering of the landscape which accompanies the conversion of old fields and hardwoods to pines, and the related changes in faunal composition, may significantly affect the recreational potential of these forest lands.

Non-game birds comprise an element of the forest community which has high recreational and aesthetic value. However, the influence which the present land use trends will have upon non-game avian community complexes is poorly

understood. Information on the relationship between age of pine stands and the associated avifauna is necessary for initiating and evaluating management approaches which will enhance these plantations for recreational enjoyment.

Avifaunal studies in predominantly pine habitat are by necessity becoming of interest to wildlife managers and avian biologists. Field studies of avian populations in deciduous forests are common (Bond 1957, Williamson 1964, Brewer 1970, Trap 1970, Anderson and Shugart 1974 and others). Brewer (1967) studied the avian composition of bogs while Tomoff (1974) observed desert scrub avifauna. Weins (1973) and Snow (1965) observed grassland and field avian communities, while the avian composition of forest recreational areas was determined by Hooper et al. (1973). Odum (1950), Johnson and Odum (1956), Howell (1960), Shugart and James (1973), Holt (1974) and others studied avian populations in relation to plant succession.

Studies in pine monocultures are not well represented in the literature. Noble and Hamilton (1975) observed avifauna in even-aged loblolly (Pinus taeda) stands of Louisiana to determine breeding populations. Macdonald (1965) conducted censuses in red pine (Pinus resinosa) plantations of Ontario. In Eastern Texas, Michael and Thornburgh (1971) censused the bird populations of a pine stand after the removal of all hardwoods to determine the

effect of removal on the avian composition of the stand.

In 1950 the United States Atomic Energy Commission (AEC) established a site, the Savannah River Plant (SRP), for the production of nuclear materials. In 1952 the United States Forest Service (USFS) instituted a reforestation program on this site (Beavers et al. 1973). The initial effort was to reforest farmland left idle by purchase of the land; however, the abandoned farmhouse places were left undisturbed, allowing natural succession to occur. In many instances these houseplaces with the man-made structures removed during relocation, were literally isolated by planted pine stands.

The USFS at SRP is currently interested in determining the avian composition of these planted pine stands and the adjacent abandoned farmhouse places which they surround. There have been few non-game avian studies conducted on the SRP (Norris 1957, 1963) or in the Aiken-Augusta area (Murphy 1937). The main focus of this study has been on the breeding populations of the selected areas and the diversity and abundance of species by habitat type.

An increase in the structural complexity of a habitat has been linked to an increase in numbers (Emlen 1973). Avian composition and the diversity of avian communities are directly associated with the vegetational structural features of the habitat (MacArthur 1964, Cody 1970, Willson 1974). The monocultures produced by pine plantations,

therefore, provide an opportunity to observe an avian community in the least complex of vegetational habitats. These results in conjunction with observations made on the more structurally complex abandoned houseplaces offer the occasion to observe the influence of vegetational complexity on the diversity of avian communities.

This study, funded by the USFS through a graduate research grant, was conducted with the full cooperation of USFS personnel to insure that the resulting data would be of significant management value to the Forest Service.

CHAPTER II

DESCRIPTION OF STUDY AREA

Savannah River Plant

Location and Description

The SRP occupies a roughly circular site of 77,891 hectares in South Carolina. It is bounded on the southwest by 43 kilometers of the Savannah River and is located 19 kilometers south of Aiken, South Carolina, on state highway 19. Occupying parts of Aiken, Barnwell, and Allendale counties, it is located in the upper Atlantic Coastal Plain of South Carolina (Figure 1). Elevation on the plant site ranges from 27 to 122 meters above mean sea level. The SRP is composed of two physiographic subregions (Figure 2), the Pleistocene Coastal Terraces, below 82 meters, and the Aiken Plateau, 82-122 meters (Langley and Marter 1973). The Sandhill region of the plant site is located on the Aiken Plateau and was intensively cultivated prior to acquisition of the land by the United States government. The soil, however, is poor in quality and is classified as agriculturally submarginal (Aydelott 1971).

The major forest types of this region consist of the

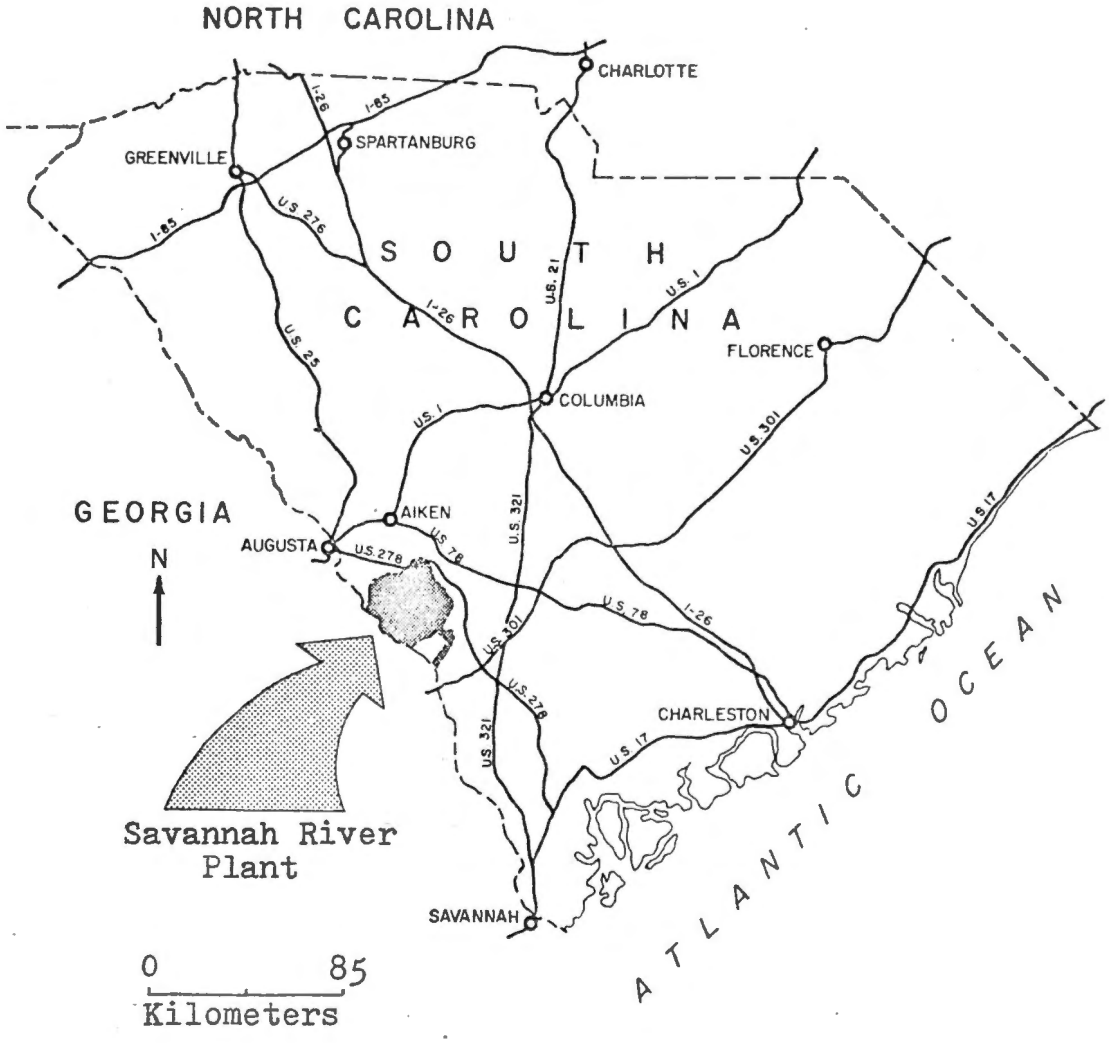

Figure 1. Location of the Savannah River Plant

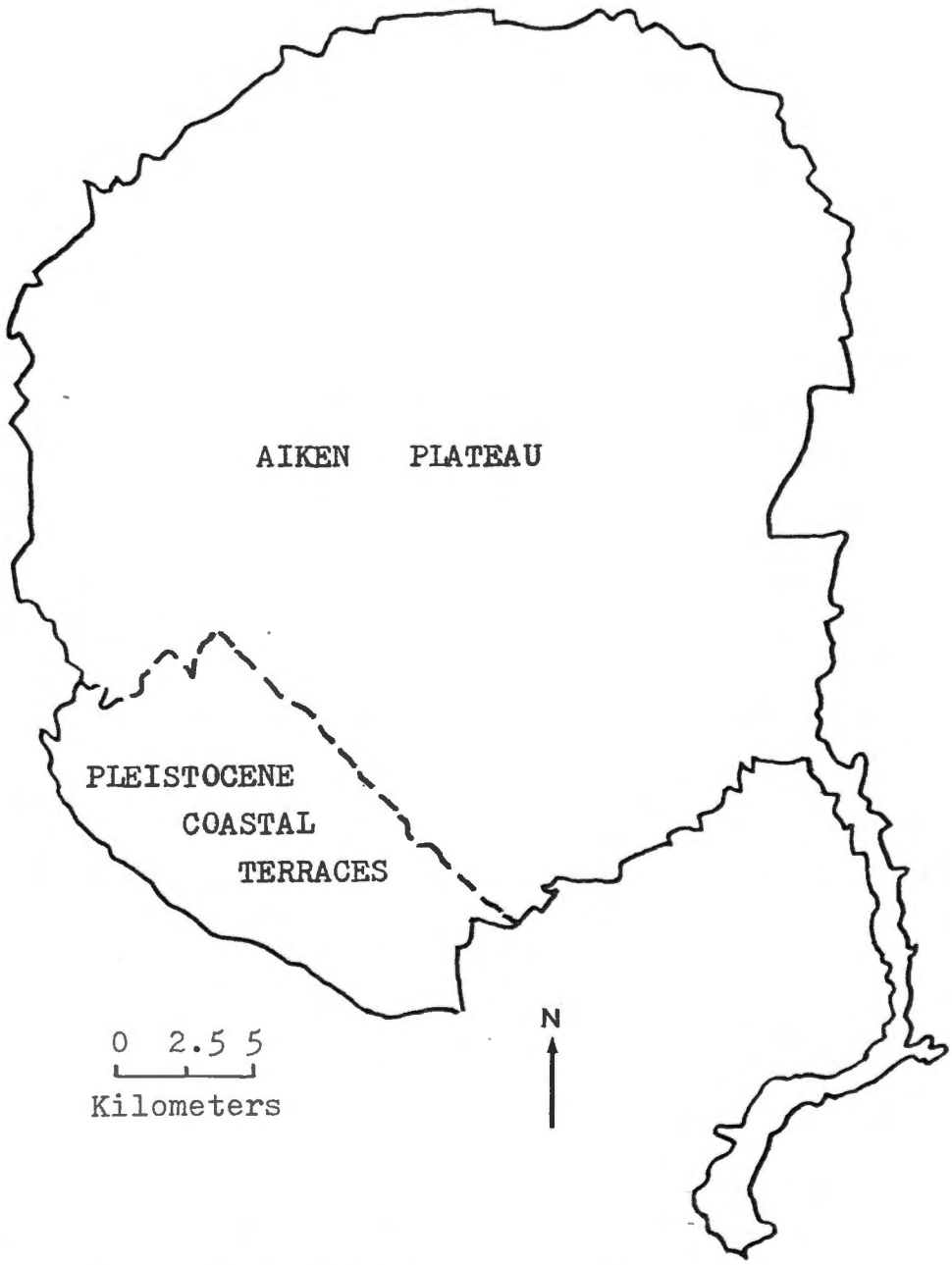

Figure 2. Physiographic Subregions of the Savannah River Plant

longleaf pine (Pinus palustris)-turkey oak (Quercus laevis) association, replaced in many areas by a scrub oak (Quercus spp.) mixture. The lower terraces consist of bottomland hardwood associations of baldcypress (Taxodium distichum)-water tupelo (Nyssa aquatica) in the swamp regions and yellow poplar (Liriodendron tulipifera)-sweet gum (Liquidambar styraciflua) forest types at higher elevations (Beavers et al. 1973). At these higher elevations, pine is a key component and may comprise up to 25 percent of the stands. Loblolly pine is predominant and is usually associated with many of the bottomland hardwood species (Pitts 1976).

History

The decision was made by the United States government in 1950 to build a facility for production of nuclear materials. The selected area had to meet certain standards: an area fairly isolated from major population centers but with access to adequate transportation routes, an area large enough to provide protection to the environment of surrounding lands and an area free from excessively harsh weather and natural disasters (Beavers et al. 1973).

The site chosen was an 81,000 hectare parcel of land adjacent to the Savannah River in west-central South Carolina. The site included about 1600 separate ownerships

with approximately 32,400 hectares, or 40 percent of the total area in unproductive old fields (Langley and Marter 1973). Improving the environment became one of the primary aims of the AEC and resulted in a cooperative effort with the USFS. Approximately 6000 people were forced to relocate by 1952 and on December 14, 1952, the site was closed to the public. The primary consideration then became the proper utilization of the land left behind by the former residents. Conversion of the abandoned old fields and poorly utilized forested lands to loblolly, slash (P. elliottii) and longleaf stands was begun.

By 1952 10 million trees were planted. By 1953 the SRP became the largest mechanized tree planting project in the United States and by 1968, the 100 millionth tree had been planted. Today's book value for timber products exceeds $29 million (Pitts 1976). Presently, of the 77,891 hectares comprising SRP, 71,140 hectares is forest land (Pitts 1976).

It is thought that when the land was acquired, many species of wildlife were near the vanishing point; however, many species such as the white-tailed deer (Odocoileus virginianus), gray fox (Urocyon cinereoargenteus) and raccoon (Procyon lotor), have since shown significant increases (Beavers et al. 1973). Man's influence on wildlife has been a direct result of the manipulation of

habitat, with various species adjusting to the general process of natural and artificial reforestation. This has occurred in the absence of hunting, stocking, and predator control.

In 1972 the SRP became the United States' first Environmental Research Park, and in January, 1975, plant operation was transferred to the newly formed Energy Research and Development Administration (ERDA) (Land Use Plan 1975).

Forest Management

> This section presents information from the Timber Management Plan (Pitts 1976) prepared for fiscal years 1976-1986.

Forest Management at the SRP is based on the manipulation of a group of forest types which have similar management needs and a common rotation. The forest of the SRP consists of six of these regulation groups:

> Longleaf Pine Regulation Group
> Loblolly Pine Regulation Group
> Upland Hardwood Regulation Group
> Bottomland Hardwood Regulation Group
> Low Intensity Management Regulation Group
> Red-cockaded Woodpecker Regulation Group

These six groups constitute 67,312 hectares of the plant's land area. The forest types comprising the groups are stands of similar character with physical and biological factors which differentiate them from other stands. Existing

stands of any forest type are managed until they qualify for regeneration. Regulated pine area on the SRP is approximately 43,740 hectares, 34,425 hectares of which is in groups ranging between 11 and 25 years of age.

All the regulated forest land is managed under even-aged silviculture systems with the ultimate objective of producing a forest containing all age classes in a mosaic of even-aged units or stands. Cutting methods are modified where necessary for stream protection, visual resource management, rare and endangered species management and other special objectives. Prescribed burning is important in the forest management of the SRP. It is used for site preparation, rough reduction and wildlife habitat treatment. Achievable annual goals range between 2025 and 4050 hectares.

Wildlife needs are a consideration in land management practices. Increased edge effect is achieved by avoiding nearly round or square stands. Stands are planned to be irregular in shape or two or three times longer than wide. In pine stands having a significant mast-producing component, regeneration areas are located where the least mast-producing component will be lost. Scattered snag trees are also left in regeneration cuts where needed as perch trees for birds.

Planting, thinning and prescribed burning to stimulate growth and fruiting of desirable vegetation, are some of the methods used at SRP for wildlife management. Stands are presently being planted in wide spacing in order to postpone

initial crown closure. Once crowns begin to close, thinning and reburning make it possible for sunlight to reach the forest floor. The understory plants grow faster and are, therefore, more readily available for those animals that feed on them.

The featured species concept (Wildlife Habitat Management Handbook 1971) is applied to the wildlife needs of the SRP. Guidelines based upon the habitat requirements of a given species direct the coordination of wildlife management. The featured species concept is expected to provide the necessary habitat for all native fauna by providing diverse habitats.

Climate

The SRP has a subtropical humid climate of mild winters and long summers. July, the warmest month, averages 27.0°C while January, the coldest month, averages 8.7°C. An average daily temperature variation of approximately 11°C can be expected. On the average, the last freeze day of the year is March 7 (Langley and Marter 1973).

From the years 1952 through 1972, the average annual rainfall was 1194 millimeters. Rainfall is normally greatest in March (130 mm) and least in November (56.9 mm) (Langley and Marter 1973). Despite fairly well distributed rainfall,

drought conditions may occur at any month of the growing season but are more likely to occur in May (Beavers et al. 1973).

Ice storms create considerable damage to some timber species and can be expected once every five years. Wind direction is southerly from April through July with damage from tropical storms occurring once about every 10 years (Beavers et al. 1973).

Instruments located at the SRP administration area recorded climatic data during censusing periods. Temperature averaged 23°C and ranged from an average low of 11.4°C in April to an average high of 31.8°C in July (Table 1). Precipitation totals are listed in Table 2 for the four months of the study and relative humidity averages for 0700 and 1900 hours are given in Table 3.

Study Plots

Location

Five study plots, consisting of three pine stands encompassing houseplaces and two without, were utilized for the data accumulated in this study. For effective censusing, houseplaces and pine stands were censused independently yielding a total of eight census plots. Where a pine stand

TABLE 1

RANGES IN MONTHLY TEMPERATURE (°C)
FROM APRIL 1976-JULY 1976, SRP

Month	Maximum	Minimum
April	24.1	11.4
May	27.7	16.1
June	31.3	20.1
July	31.8	21.7

TABLE 2

MONTHLY PRECIPITATION
(MILLIMETERS) FOR
APRIL 1976-JULY 1976, SRP

Month	Total
April	88.9
May	97.3
June	113.5
July	121.1

TABLE 3

AVERAGE RELATIVE HUMIDITY
(PERCENT) FOR 0700 AND
1900 HOURS FROM APRIL 1976-
JULY 1976, SRP

Month	0700	1900
April	77	56
May	77	59
June	79	64
July	83	69

accompanied a houseplace, it was necessary for the houseplace to be the dominant influence on its adjacent pine stand. To insure this, stands were selected which provided continuous pine habitat at least 50 meters beyond the census boundary. The two pine stands without houseplaces served as controls for evaluating the effects of houseplaces.

The five study plots were selected from within timber compartments (TC) 51 and 53 (Figure 3) since prescription inventories were being made there in fiscal years 1976 and 1977. The locations of the study plots were as follows:

Houseplace one (HP1) and pine stand one (PS1)
33°18'45"N, 81°34'25"W (TC 53)

Houseplace two (HP2) and pine stand two (PS2)
33°18'20"N, 81°36'15"W (TC 51)

Houseplace three (HP3) and pine stand three (PS3)
33°18'35"N, 81°37'05"W (TC 51)

Pine stand four (PS4)
33°17'40"N, 81°34'20"W (TC 51)

Pine stand five (PS5)
33°18'38"N, 81°33'50"W (TC 53)

Houseplaces

There are approximately 4000 houseplaces on the SRP which average about 0.4 hectare in size (Beavers et al. 1973). They are maintained by the Forest Service in an effort to provide food, edge effect and diversity for wildlife on the plant property. Within the houseplace bounda-

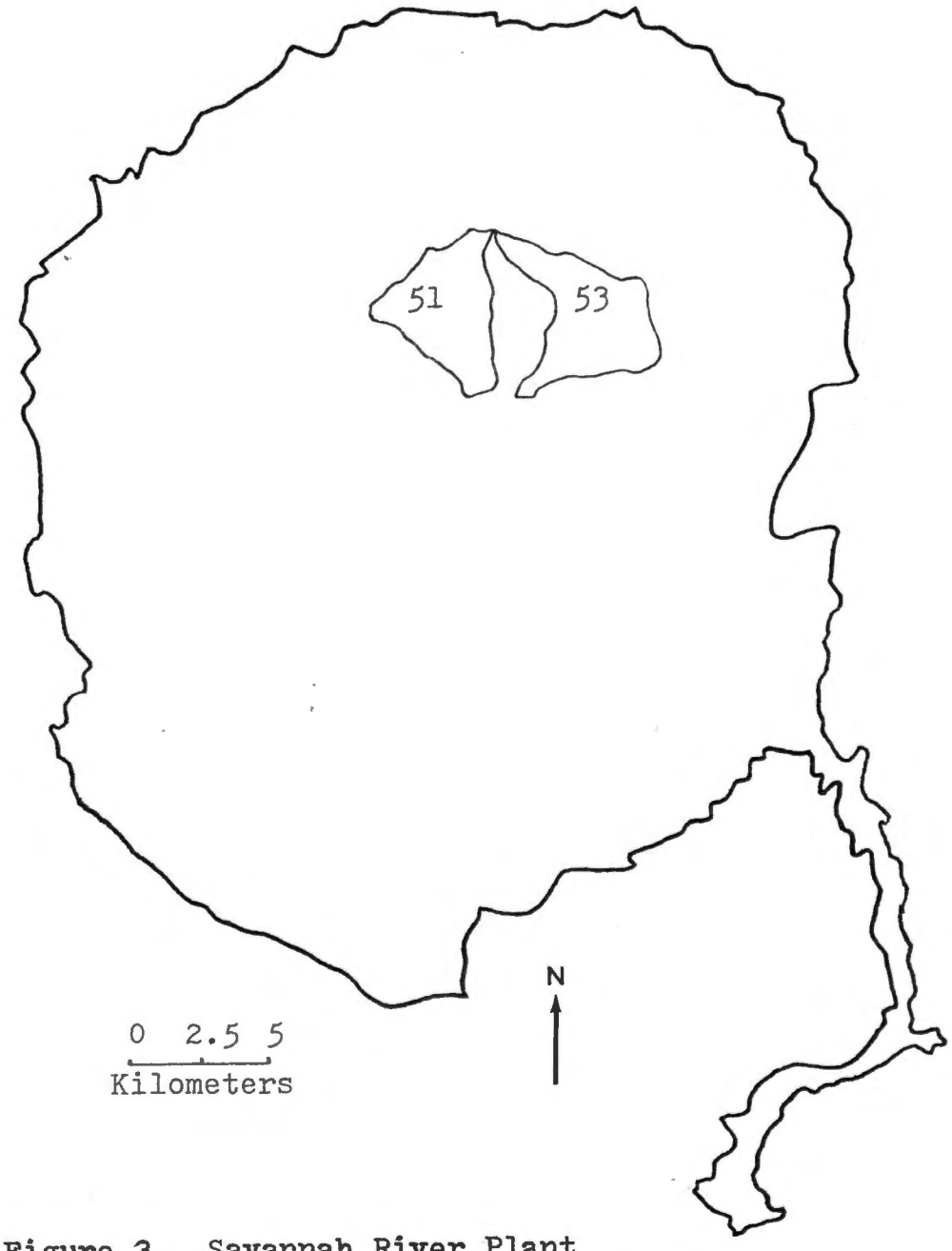

Figure 3. Savannah River Plant showing location of timber compartments 51 and 53.

ries, honeysuckle (Lonicera japonica) may be found covering all areas of a houseplace while ornamentals and fruit trees are often abundant.

Adjacent to and surrounding many of these houseplaces are even-aged pine monocultures. Protection of the houseplace site allows it to remain undisturbed until regeneration of the adjacent stand. At that time the houseplace is evaluated to determine if it should be retained, or destroyed and replanted in pine. Few of the approximately 200 evaluated each year have been lost (Beavers et al. 1973). During prescribed burning, fire breaks (Figure 4) are cut around each site in an effort to protect it (Stewart 1974).

Pine Stands

All pine study plots were established in the Loblolly Pine Regulation Group comprising 26,055 hectares of pine-hardwood forest types. The five plots were nine hectares each and were composed of slash pine. They all contained the Fuquay and Wagram soil type, a soil characterized by 5 to 10 cm of dark gray sand and 63 to 102 cm of pale brown sand that is underlain by yellowish-brown sandy clay loam within 102 cm (Aydelott 1971).

The sites for these five pine stands were once old fields with no associated hardwoods. Slash pine is not the preferred forest type for these areas. It is very susceptible

Figure 4. Fire break shown surrounding house-place 1 for protection against prescribed burn.

Photograph taken May 1976.

to ice storm damage, which occurred extensively on the plant site in 1972 and 1973. It is likely that the slash pine in these areas will eventually be replaced and the desired management type (loblolly pine) for these sites will be established. All sites are traversed by a jeep trail providing a narrow opening (two meters) across each stand.

CHAPTER III

METHODS

Botanical Description

The two well-defined vegetational structures found on the five study plots were the tree, shrub and ground vegetation of the houseplaces and even-aged pine monocultures. This made it necessary to utilize two distinct methods of habitat description as quantitative measures of vegetation.

The vegetation of the three houseplaces was studied using a modification of methods proposed by James and Shugart (1970). They sampled randomly selected small plots of 0.04 hectare and extrapolated the data for an entire area. However, due to the small size of the three houseplaces (less than one hectare) sample plots were not necessary; instead measurements were made of the entire houseplace.

Shrub and ground vegetation was identified and its density was calculated using the transect methods of James and Shugart (1970). Trees, however, dominate a forest community (Odum 1971); therefore, more extensive measurements of trees were taken. These included height, diameter

and number of stems greater than 7 cm diameter at breast height (dbh). Calculations using these results yielded data derived by formulas (Table 4) from Cox (1972). Canopy closure was determined according to the method of James and Shugart (1970).

The measurement of pine monocultures followed the standard procedures of the USFS. Age, height and dbh measurements were taken in random 0.04 hectare plots throughout each stand (equal to 10 percent of stand area). From these data site index and stand basal area were calculated. The Compartment Prescription Field Book of the USFS assisted in the calculation of site index while basal area was computed following the procedure described by Smith (1962). The methods of James and Shugart (1970) for determining crown closure and ground vegetation of the houseplaces were also utilized for the pine stands.

Census Stations

Five nine-hectare square plots were established to census birds. Three of these contained a houseplace near the center. A 60-meter grid was established on each plot, yielding 25 census stations (Figure 5). On the three plots containing houseplaces, the center station was eliminated. The houseplace was censused separately, with two to four

TABLE 4

FORMULAS USED FOR
CALCULATING CANOPY VEGETATION
OF THE HOUSEPLACES

$$\text{Relative Frequency} = \frac{\text{Number of stems for single species}}{\text{Number of stems for all species}} \times 100$$

$$\text{Density} = \frac{\text{Number of stems for single species}}{\text{Area sampled (hectare)}}$$

$$\text{Relative Density} = \frac{\text{Density for a single species}}{\text{Total density for all species}} \times 100$$

$$\text{Dominance} = \frac{\text{Basal area for a species}}{\text{Area sampled (hectare)}}$$

$$\text{Relative Dominance} = \frac{\text{Dominance for a single species}}{\text{Total dominance for all species}} \times 100$$

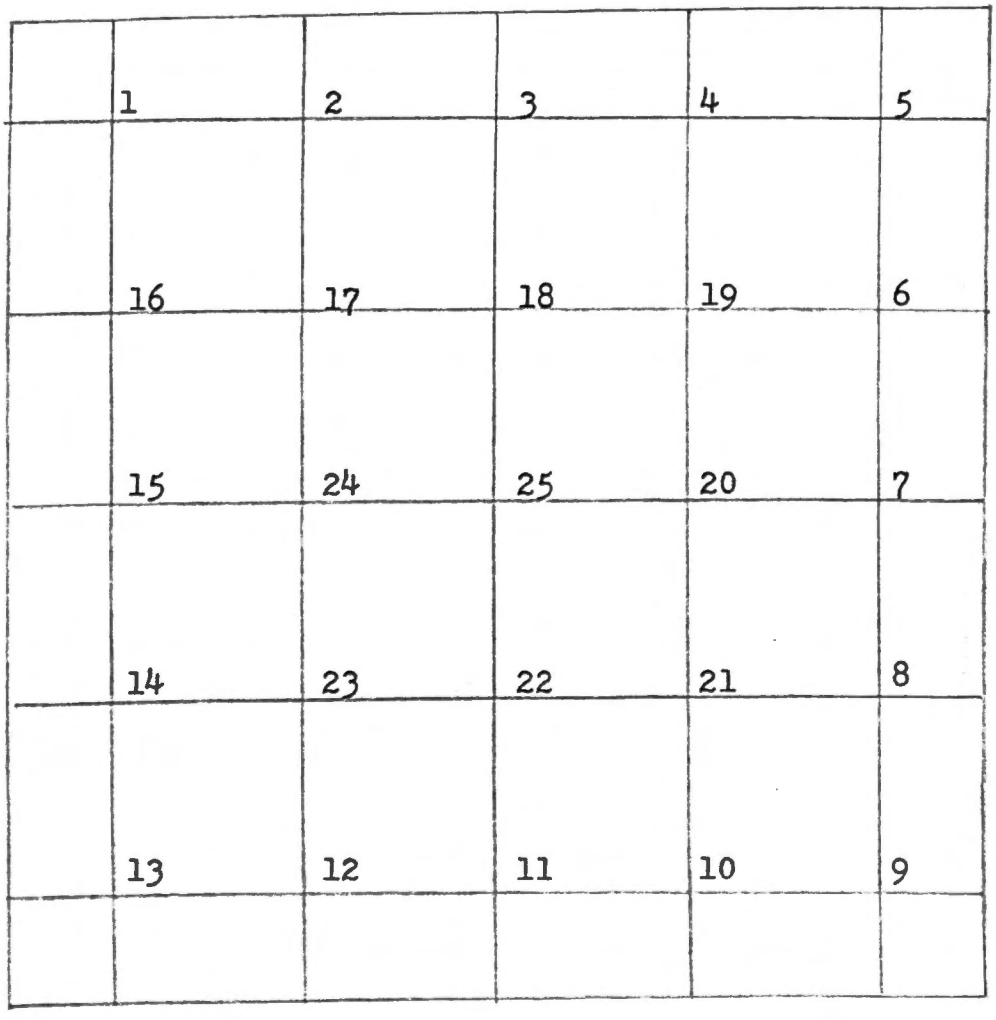

Figure 5. Grid map for pine stands four and five showing 25 census locations.

Scale 2.54 cm = 60 meters.

stations (Figure 6). The number of stations varied because the vegetation structure ranged from fairly open (HP1) to very dense (HP3).

Census Procedures

The Williams' spot-map method (1936, 1947) was utilized to determine total number of territorial males. A map of the area was taken into the field on each census trip. When a contact (visual or aural) was made, distance and direction from the recording station was noted and marked on the map. By compiling the maps from subsequent trips, an estimation of population and territories could be made.

Although this basic technique has been in use for many years, there has been some disagreement concerning its effectiveness. For example, Emlen (1971) believed the method to be too time consuming while Best (1972) stated that it gives an underestimation of the actual population. Standardization of the Williams' method (1936, 1947) has led to uniform procedures (Hall 1964, Robbins 1970) that can be utilized for all censuses.

Censusing began April 4, 1976, and continued 16 consecutive weeks until July 30, and was also conducted one week in August, August 9-13. Each plot was censused every week making a total of 17 visits. A late afternoon census

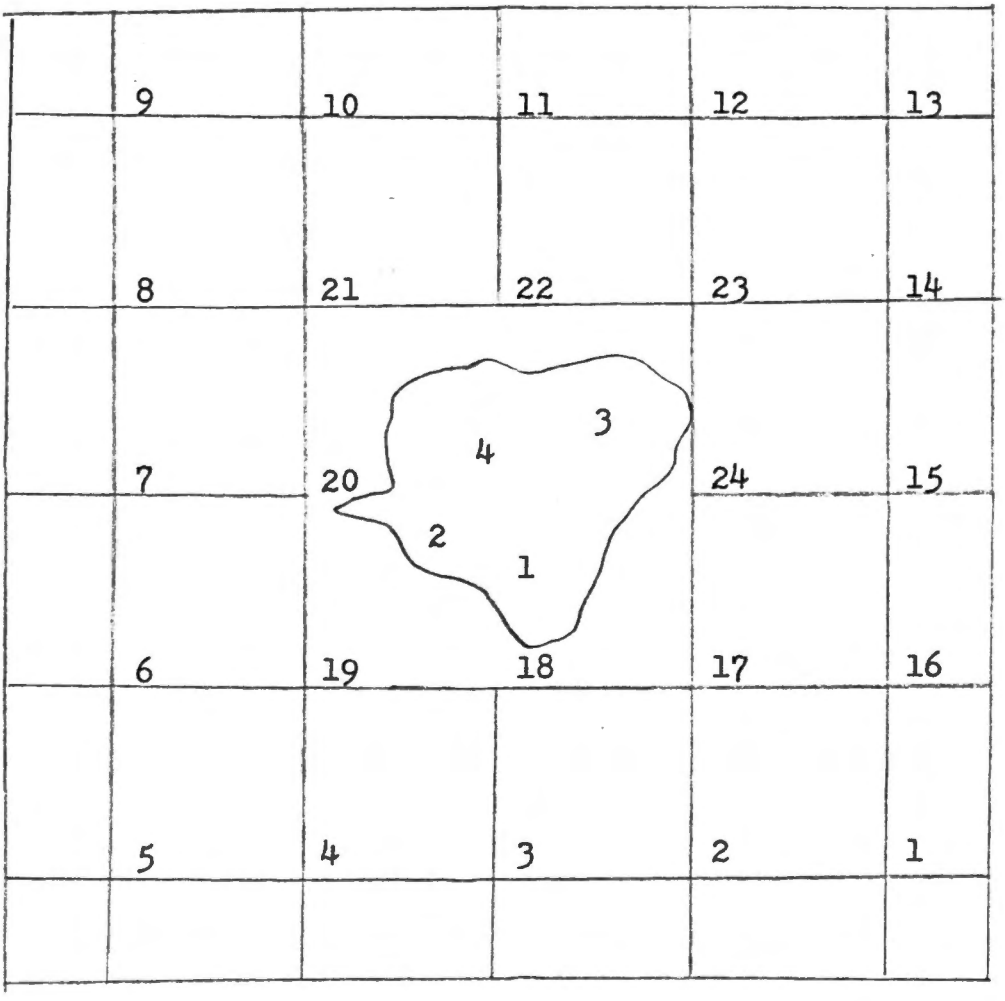

Figure 6. Grid map for houseplace three and pine stand three showing census locations in the houseplace and adjacent pine stand.

Scale 2.54 cm = 60 meters.

was also conducted on each plot once a month, April--July, adding four more visits. Daily censusing began at sunrise, normally about 0630 hours, and was concluded by 1000 hours.

Different routes were taken from station to station during a census so that an individual census station would be censused at several different times during the study. This was to compensate for any biases in the chances of detecting a species at various times of the morning.

Five minutes were spent at each station for recording contacts. Stations were located so that the observer covered 30 meters in all directions. Temperature and wind speed were recorded for each census day. Excessive wind speed or heavy and persistent precipitation resulted in cancellation of the census for that day.

Three contacts with a singing male constituted a territory (Robbins 1970). Each territorial male was considered to have a mate and each territory assigned a breeding pair.

A territory for a species was determined by connecting the outermost points recorded on a census map of a cluster of contacts. If two clusters were recorded, it was assumed that two territories were represented; however, data were compared periodically to insure that this was not the result of a position shift in one territory.

The small size of the individual study plots made it difficult to establish a complete territory within each plot.

Therefore, certain criteria, modified from Hall (1964), were outlined prior to the censusing, to indicate the number and location of territories within the entire study area:

(1) The location of a nest site on a study plot established a territory on that plot.

(2) If less than 25 percent of a territory lay outside the study plot, the territory was considered a complete territory.

(3) If one-half of the contacts were outside the study plot, the territory was considered a partial territory (0.5) and included in the total.

(4) If less than 25 percent of a territory lay inside the study plot, the territory was considered a partial territory and designated with the symbol '+', not included in the total.

Special Considerations

Certain considerations influenced the mapping and censusing techniques utilized in this study. Three factors in the study, the large number of visits per study area (21), the time spent at each station (5 minutes) and the distance between stations (60 meters), were somewhat unique when compared with other research requiring the censusing of a population. It was felt that by increasing the number of

visits, increasing the time spent at each station and decreasing the distance between stations, a more accurate and efficient census could be taken.

CHAPTER IV

RESULTS AND DISCUSSION

Vegetation

The study area consists of five study plots. Three of the study plots are represented by an abandoned houseplace and its adjacent pine stand. The two remaining study plots consist of pine stand habitat without houseplaces. Measurement of the houseplace and pine stand vegetation was conducted using the methods described on page 20. Special attention was given to the houseplace component of the three houseplace-pine stand study plots.

Three habitat types are represented in the study area:

1) abandoned houseplaces
2) PS4 and the pine stand component of the houseplace-pine stand study plots (managed)
3) PS5 (ice damage, unmanaged).

Houseplace-Pine Stand 1 (HPS1)

The houseplace component of this study plot is 0.7 hectare in size. It is a fairly open area with the remains of a house foundation within its boundaries (Figure 7).

Figure 7. Houseplace 1 showing an abandoned house foundation.

Photograph taken May 1976.

Herbaceous vegetation creates a 70 percent ground cover (Figure 8) except at the edges of the site where pine needle litter is relatively heavy. Predominant ground vegetation is muscadine (Vitis rotundifolia), honeysuckle, bramble (Rubus spp.) and greenbrier (Smilax rotundifolia).

Understory vegetation (less than 7 cm, dbh) is dominated by stems of black cherry (Prunus serotina), persimmon (Dyospyros virginiana), sassafras (Sassafras albidum) and slash pine. Shrub density varies at scattered locations on the site, covering about 20 percent of the area. It is composed primarily of wild plum (Prunus americana) and hawthorn (Crataegus spp.). Canopy species range in height from 10 to 23 m with a mean height of 14 m.

Crown closure of the houseplace is less than 50 percent. The vegetation measurements in HP1 (Appendix A, Table A1) reveal that black cherry and slash pine comprise the greatest number of stems within the houseplace, but pecan (Carya illinoensis) is by far the dominant species.

The pine surrounding this houseplace is a stand of even-aged slash pine, 20 years old. The stand averages 875 stems per hectare. The production capability of the stand (site index), based on age and height, is 60. Understory vegetation, below two meters, extends over an area of 20 percent by late summer with the remaining surface area covered with pine litter. This vegetation consists of Eupatorium spp., poison

Figure 8. Herbaceous vegetation in house-place 1.

Photograph taken May 1976.

ivy (Rhus radicans) and some saplings of sassafras and persimmon. No vegetation is found between the two meter level and the pine canopy.

Houseplace-Pine Stand 2 (HPS2)

The houseplace component of this study plot is 0.6 hectare in size. It consists of a moderately dense ground cover made up primarily of bramble and honeysuckle. Ground cover occupies 50 percent of this site; it is suppressed by the heavy litter from the hardwood and loblolly pine found there and from encroachment of slash pine from the adjacent stand.

Understory stems are almost exclusively black cherry with some mimosa (Mimosa pudica), slash pine, loblolly pine and persimmon. Shrub vegetation is extremely dense in some areas (Figure 9), occupying 40 percent of the site. It is predominantly hawthorn, but also contains greenbrier and cherokee rose (Rosa laevigata).

Black cherry is by far the most numerous canopy species comprising 43.2 percent of the stems surveyed; however, water oak (Quercus nigra) with five stems surveyed, demonstrates greater relative dominance on the site (Appendix A, Table A2). A unique feature of HP2 is the presence of dead trees (Figure 10). These provide HP2 with nest sites for

Figure 9. Shrub and midstory vegetation in houseplace 2.

Photograph taken May 1976.

Figure 10. Dead tree nest site of red-bellied woodpecker in houseplace 2.

Photograph taken May 1976.

the cavity nesting species which were not found on the other two houseplaces. Crown closure for the entire site is 60 percent; however, in areas dominated by the oaks (Quercus spp.), crown closure is 100 percent. Canopy species range in height from 11 to 22 m with a mean height of 15 m.

The pine surrounding the houseplace is similar to that found in HPS1. The stand consists of even-aged 20-year-old slash pine with an average of 882 stems per hectare. The site index for the stand is 60. Understory vegetation is similar to that in HPS1 with no vegetation found between the two meter level and the pine canopy.

Houseplace-Pine Stand 3 (HPS3)

The houseplace component of this study plot is 0.6 hectare in size and has one dominant vegetational characteristic. The presence of wisteria (Wisteria frutescens) makes large areas of the site impenetrable (Figure 11). There are only scattered areas of open ground on the site with a total ground coverage of 90 percent. In areas not influenced by wisteria, honeysuckle creates a formidable barrier (Figure 12).

Understory shrub vegetation, consisting of wild plum, sumac (Rhus vernix), hawthorn and greenbrier, comprises about 40 percent of the area but is totally dominated by

Figure 11. Houseplace 3 showing predominance of wisteria.

Photograph taken May 1976.

Figure 12. Honeysuckle and shrub vegetation in houseplace 3.

Photograph taken May 1976.

wisteria and honeysuckle. Wisteria and honeysuckle also dominate the persimmon, black cherry and slash pine found in the midstory level.

The dominant species of tree on this site is chinaberry (Melia azedarach), although slash pine comprises the largest number of stems (Appendix A, Table A3). Many of the deciduous trees in the area support wisteria. Canopy closure for the site is 65 percent. Canopy height ranges from 10 to 19m with a mean height of 14 m.

The pine adjacent to this houseplace is also similar to that found in HPS1. It consists of even-aged slash pine, 20 years old. The stand averages 877 stems per hectare with a site index of 60. No vegetation is found between the two meter level and the pine canopy.

Pine Stand 4 (PS4)

PS4 is a stand of even-aged 20-year-old slash pine (Figure 13). The stand averages 875 stems per hectare with a site index of 60. The characteristics of this stand are similar to the pine stands of HPS1, HPS2 and HPS3 with the exception of a houseplace component.

The understory below two meters is similar to the same ground and shrub vegetation described in HPS1. No measurable vegetation was found between the two meter level and the pine canopy.

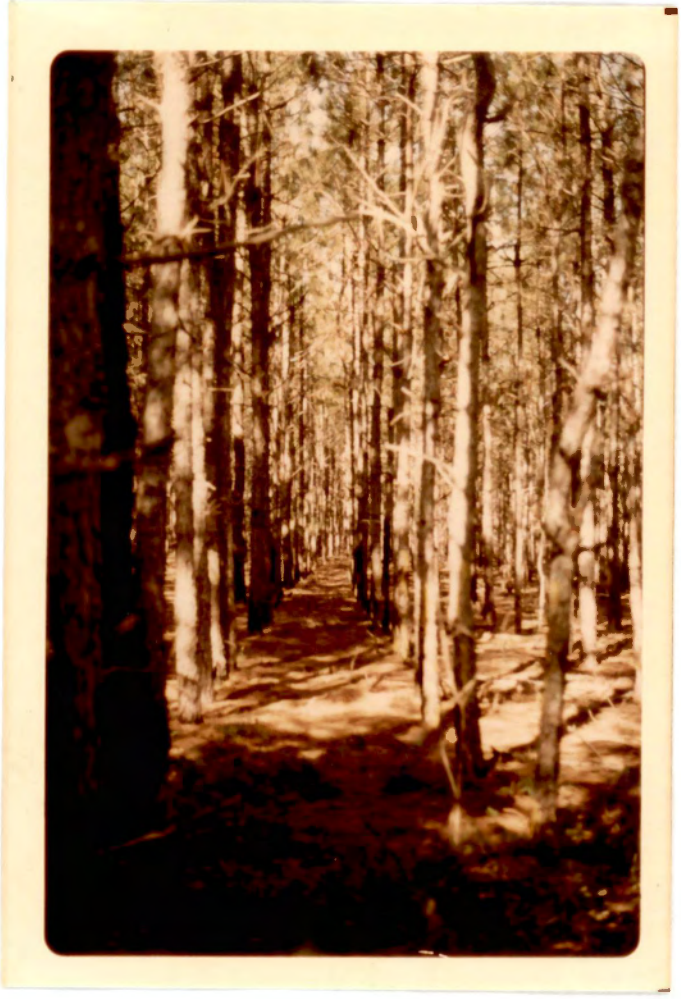

Figure 13. Twenty-year-old pine stand looking from houseplace 3.

Photograph taken May 1976.

Pine Stand 5 (PS5)

A slash pine area, not actively managed since heavy ice damage in 1972, was also included in the study. It represented pine habitat found in this region of the SRP and provided a second pine habitat utilized by avifauna. It was designated PS5.

Low wet sites in the stand created openings which allowed some shrub vegetation to occur. Dead trees with a basal area of 1.04 m^2/ha have also created openings which have encouraged the growth of shrub and ground vegetation on the site.

The shrub vegetation consists of wild plum, hawthorn, and sparkleberry (Vaccinium arboreum) with some ground cover of Eupatorium spp., poison ivy and lespedeza (Lespedeza spp.) (Figure 14).

Midstory hardwood vegetation is also present with persimmon and sassafras reaching measurable size (3 cm dbh). Scrub oak (Quercus spp.) species are also found scattered throughout the site.

Coefficient of Community

The similarity between the three habitats within the study area is stated as the coefficient of community, $C = 2W/A + B$, where W is the sum of importance value for

Figure 14. Herbaceous vegetation and ice damage in pine stand 5.

Photograph taken May 1976.

species shared by the two communities; A is the sum of the importance values for the A community; and B is the sum of the importance values for the B community (Bray and Curtis 1957). Importance value for species is computed by adding relative frequency, relative density and relative dominance (Table 4, page 22). A coefficient of 1.0 indicates total similarity between two communities, and a coefficient of zero indicates that there are no species in common.

Comparing PS4 to the pine stand components of HPS1, 2, and 3 study plots yields a coefficient of community of .988, demonstrating that the vegetation of pine stand 4 is essentially identical to the vegetation found in the pine stand components of the three study plots. However, if PS4 is compared to the houseplace-pine stand study plots, with the houseplace vegetation included, a coefficient of community is .463. This difference (.463 versus .988) indicates the dissimilarity in the vegetational characteristics of pine stands which have houseplace components and one which does not.

The third habitat type, as described above, is represented by PS5. The coefficient of community for PS4 and PS5 is .792, which indicates a similarity in the vegetation of the two study plots. This coefficient (.792) is less than expected for pine monocultures due to the midstory deciduous vegetation found in PS5 and the presence of dead trees.

Summary

The houseplace components of the three houseplace-pine stand study plots are distinguished by total basal area and shrub cover (Table 5). HP1 has a total basal area (stems greater than 7 cm) one-half that of HP2 and HP3. Also shrub cover of HP1 is one-half that of HP2 and HP3. There are two features that are not reflected in the table which have influenced the avian utilization of the habitat; they are the dead cavity trees found on HP2 and dense wisteria on HP3.

The abandoned houseplaces add a vegetation diversity to their respective pine stands which is not found in PS4. This diversity is reflected in the ground and shrub vegetation added to the houseplace-pine stand study plots (Table 5).

The vegetation in PS5 has been influenced by ice damage which has reduced crown closure and increased the shrub and ground cover in comparison with PS4 (Table 5). Dead trees are a component of PS5 which create a potential for cavity nesters not found in the other pine stands of the study area.

TABLE 5

VEGETATION STRUCTURE OF STUDY AREA, 1976

	HPS1[a]		HPS2[b]		HPS3[c]		PS	PS
Measurements	HP	PS	HP	PS	HP	PS	4	5
Ground Cover (%)	70	10	50	10	90	10	10	30
Shrub Cover (%)	20	10	40	10	40	10	10	30
Crown Closure (%)	50	90	60	90	65	90	90	65
Average Height (m)	14	15.5	15	15.5	14	15.0	15.5	13.0
Basal Area (m^2/ha)	6.4	23.2	12.3	23.6	14.6	23.3	23.2	21.1

[a]Houseplace-pine stand 1

[b]Houseplace-pine stand 2

[c]Houseplace-pine stand 3

Avifauna

Census Results

The 44 species observed in the study area consisted of permanent residents (23), summer residents (14), winter resident (1), transient visitants (5) and winter visitant (1) (Table 6). All species recorded were abundant or common on the plant site with the exception of the chestnut-sided warbler (Dendroica pensylvanica) which was considered uncommon (Table 6).

Thirty-six breeding pairs (15 species) were mapped for the 45 hectare study area (Table 7). Houseplace-pine stand 3 (HPS3) had the largest number of breeding pairs (10) while pine stand 4, the smallest number (3). Four nest sites were located within the houseplace component of HPS1, and one nest site was located in the pine stand portion of the study plot (Figure 15). The houseplace component of HPS2 contained five nest sites, and the pine stand portion contained one nest (Figure 16). No nest was located in the pine stand part of HPS3; however, five nests were observed within the houseplace boundary (Figure 17). No nest sites were located on PS4 (Figure 18), and six nest sites were found in scattered locations on PS5 (Figure 19). Individual territories are mapped and given in Appendix B, Figures B1-B32.

TABLE 6

SRP RESIDENT AND POPULATION STATUS FOR BIRD SPECIES OBSERVED IN THE STUDY AREA[a]
1976

Species[b]	Res Stat[c]	Pop Stat[d]
Red-tailed Hawk (Buteo jamaicensis)	PR	Com
Bobwhite (Colinus virginianus)	PR	Com
Mourning Dove (Zenaidura macroura)	PR	Com
Yellow-billed Cuckoo (Coccyzus americanus)	SR Apr 23-Oct 2[e]	Com
Barred Owl (Strix varia)	PR	Com
Common Nighthawk (Chordeiles minor)	SR Apr 23-Sept 7	Com
Common Flicker (Colaptes auratus)	PR	Com
Pileated Woodpecker (Dryocopus pileatus)	PR	Com
Red-bellied Woodpecker (Centurus carolinus)	PR	Com
Red-headed Woodpecker (Melanerpes erythrocephalus)	PR	Com
Downy Woodpecker (Dendrocopus pubescens)	PR	Com
Great Crested Flycatcher (Myiarchus crinitus)	SR Apr 9-Sept 16	Com
Acadian Flycatcher (Epidonax virescens)	SR Apr 14-Oct 5	Abd
Eastern Wood Pewee (Contopus virens)	SR Apr 20-Oct 13	Com
Blue Jay (Cyanocitta cristata)	PR	Com
Common Crow (Corvus brachyrhynchos)	PR	Abd

TABLE 6 (continued)

Species	Res Stat	Pop Stat
Carolina Chickadee (Parus carolinensis)	PR	Com
Tufted Titmouse (Parus bicolor)	PR	Com
Brown-headed Nuthatch (Sitta pusilla)	PR	Abd
Carolina Wren (Thryothorus ludovicianus)	PR	Com
Mockingbird (Mimus polyglottos)	PR	Abd
Brown Thrasher (Toxostoma rufum)	PR	Com
Wood Thrush (Hylocichla mustelina)	SR Apr 3-Oct 11	Com
Eastern Bluebird (Sialia sialis)	PR	Abd
Blue-gray Gnatcatcher (Polioptila caerulea)	SR Mar 20-Sept 21	Abd
White-eyed Vireo (Vireo griseus)	SR Feb 27-Oct 5	Com
Red-eyed Vireo (Vireo olivaceus)	SR Apr 5-Oct 27	Abd
Black-throated Blue Warbler (Dendroica caerulescens)	TV Apr 9-May 12, Sept 6-27	Abd
Yellow-rumped Warbler (Dendroica coronata)	WV Oct 13-May 7	Com
Chestnut-sided Warbler (Dendroica pensylvanica)	TV Ap 23-My 12, Ag 29-Oc 11	Ucm
Pine Warbler (Dendroica pinus)	PR	Abd
Prairie Warbler (Dendroica discolor)	SR Apr 2-Oct 5	Com
Palm Warbler (Dendroica palmarum)	WR Sept 12-Apr 21	Com
Ovenbird (Seiurus aurocapillus)	TV Mr 20-My 14, Sp 8-Oc 27	Abd
Hooded Warbler (Wilsonia citrina)	SR Apr 2-Oct 5	Com

TABLE 6 (continued)

Species	Res Stat	Pop Stat
American Redstart (*Setophaga ruticilla*)	TV Ap 17-My 28, Ag 19-Oc 18	Com
Orchard Oriole (*Icterus spurius*)	SR Apr 3-Aug 26	Com
Scarlet Tanager (*Piranga olivacea*)	TV Ap 7-My 2, Sp 26-Oc 10	Com
Summer Tanager (*Piranga rubra*)	SR Apr 7-Oct 5	Com
Cardinal (*Cardinalis cardinalis*)	PR	Abd
Indigo Bunting (*Passerina cyanea*)	SR Apr 19-Oct 27	Com
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	PR	Com
Bachman's Sparrow (*Aimophila aestivalis*)	PR	Com
Chipping Sparrow (*Spizella passerina*)	PR	Com

[a]Compiled from Norris (1963), Jenkins and Provost (1964) and Langley and Marter (1973)

[b]American Ornithologists' Union (1957, 1973)

[c]Resident Status: PR, Permanent Resident; SR, Summer Resident; WR, Winter Resident; WV, Winter Visitant; TV, Transient Visitant

[d]Population Status: Abd, Abundant; Com, Common; Ucm, Uncommon

[e]Dates of earliest arrival and latest departure

TABLE 7

BREEDING PAIRS IN THE STUDY PLOTS, 1976

Species	HPS1[a]	HPS2[b]	HPS3[c]	PS4[d]	PS5[e]	Total
Carolina Chickadee	1	1	1			3
Brown-headed Nuthatch	1	1	2	1+	1	6
Carolina Wren	1		1			2
Pine Warbler	1+	2+	1+	2+	2+	8
Summer Tanager	1+		1		1	3
Cardinal	1	1	1			3
Common Flicker		1				1
Red-bellied Woodpecker		1			1	2
Tufted Titmouse		1				1
White-eyed Vireo			1			1
Red-eyed Vireo			1			1
Rufous-sided Towhee			1		1	2
Downy Woodpecker					1	1
Eastern Bluebird					1	1
Prairie Warbler					1	1
Total Territories	6	8	10	3	9	36

[a]Houseplace-Pine Stand 1

[b]Houseplace-Pine Stand 2

[c]Houseplace-Pine Stand 3

[d]Pine Stand 4

[e]Pine Stand 5

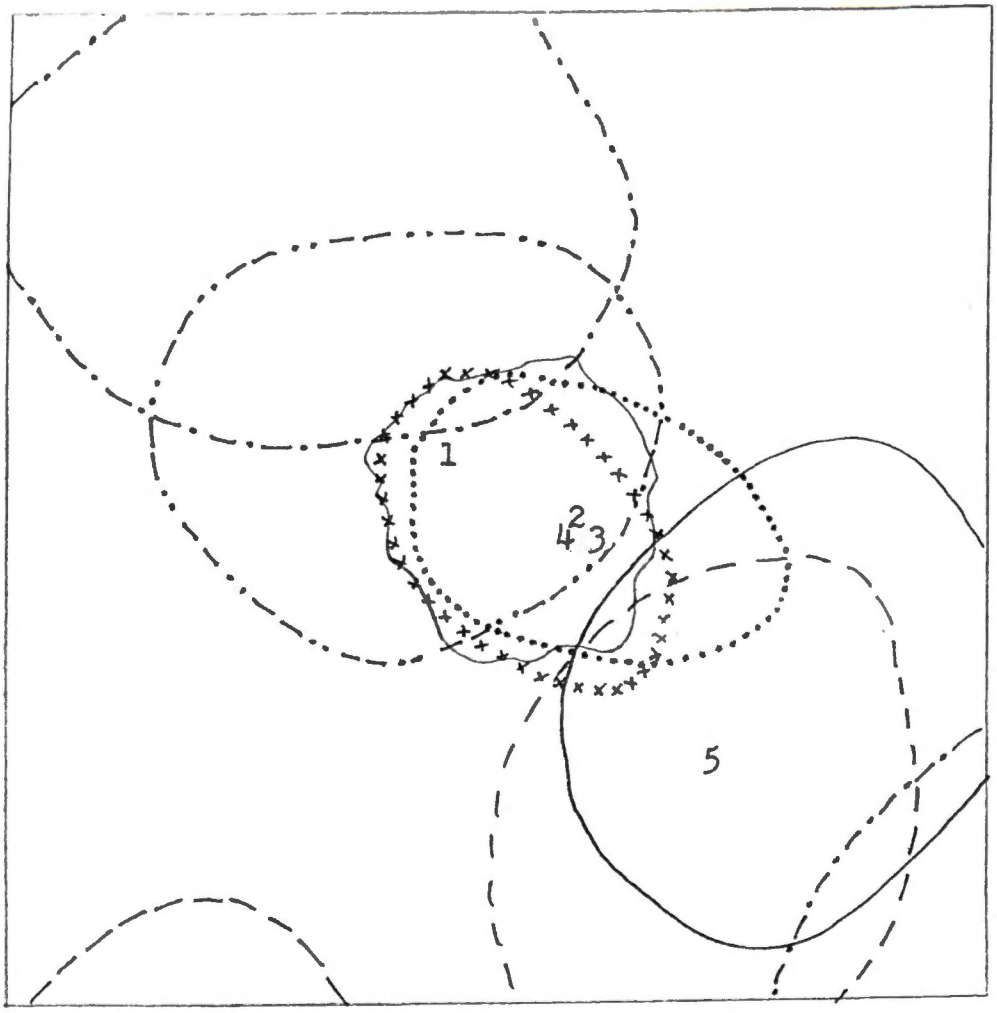

Figure 15. Territories of breeding pairs on HPS1 showing location of nest sites, 1976.

Six complete territories and two partial territories.

Brown-headed Nuthatch ——— Pine Warbler — — —

Carolina Chickadee —·—·—·— Cardinal ·····

Summer Tanager —·—· Carolina Wren ××××

Nest site 1: Carolina Chickadee, 2& 3: Carolina Wren, 4: Cardinal, 5: Pine Warbler

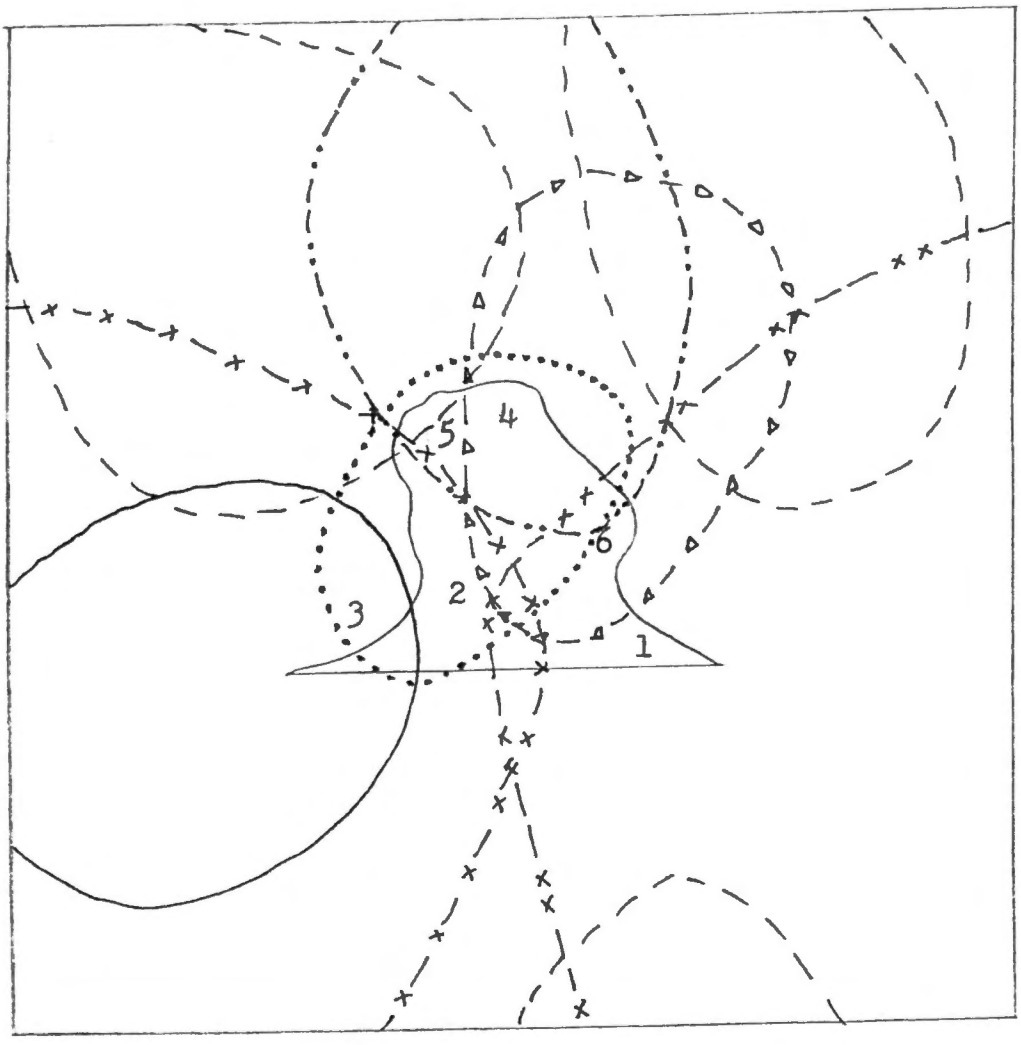

Figure 16. Territories of breeding pairs on HPS2 showing location of nest sites, 1976.

Eight complete territories and one partial territory.

Brown-headed Nuthatch—— Pine Warbler — — —

Carolina Chickadee — — · · — — Cardinal · · · ·

Red-bellied Woodpecker— — × × — — Common Flicker— × —×

Tufted Titmouse —△—△

Nest site 1: Red-bellied Woodpecker, 2: Common Flicker, 3: Brown-headed Nuthatch, 4: Carolina Chickadee, 5: Cardinal, 6: Tufted Titmouse

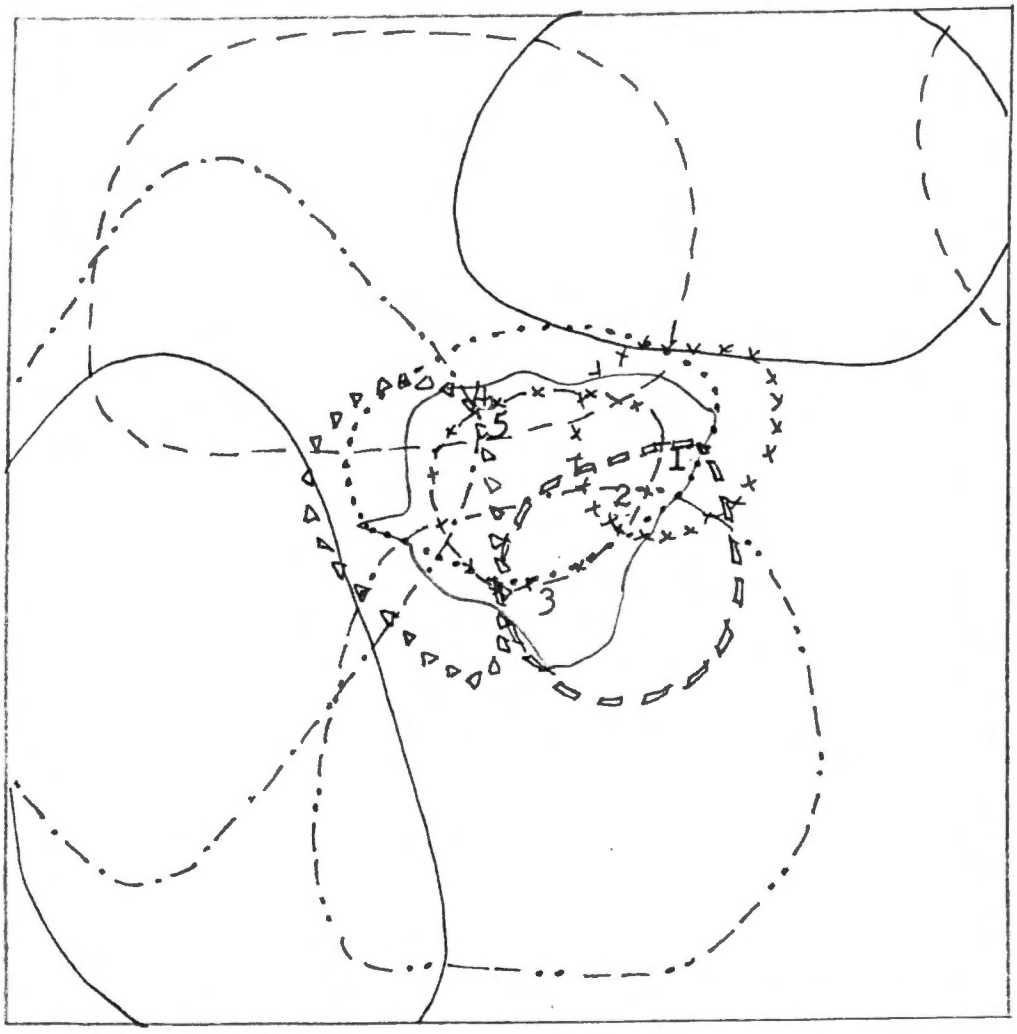

Figure 17. Territories of breeding pairs on HPS3 showing location of nest sites, 1976.

Ten complete territories and one partial territory.

Brown-headed Nuthatch ——— Pine Warbler — — —

Carolina Chickadee — — · · — — White-eyed Vireo — × — ×

Summer Tanager — · — · Red-eyed Vireo △ △ △

Rufous-sided Towhee ▭ ▭ ▭ Carolina Wren × × × ×

Nest site 1: Carolina Wren, 2: Rufous-sided Towhee, 3: Carolina Chickadee, 4 & 5: Cardinal

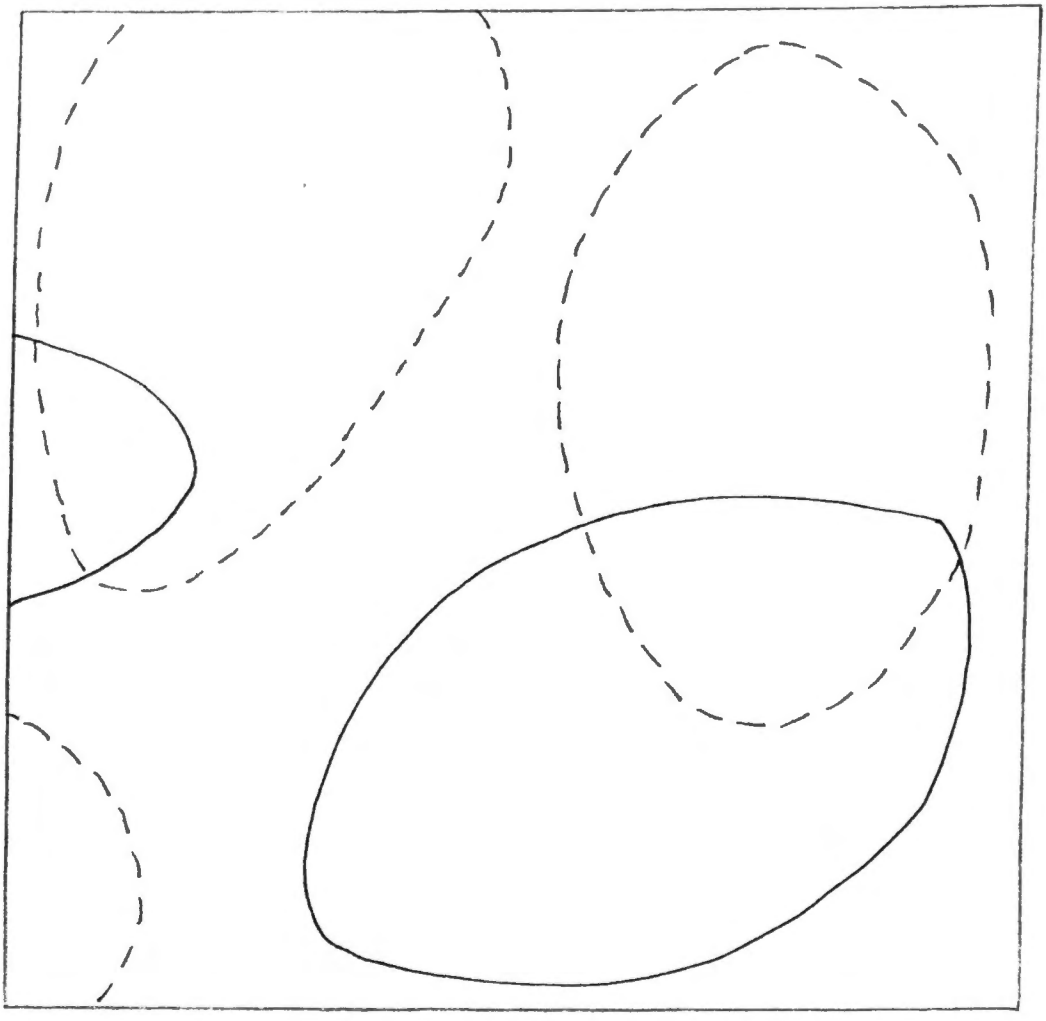

Figure 18. Territories of breeding pairs on PS4.

Three complete territories and two partial territories.

Brown-headed Nuthatch ———

Pine Warbler — — — —

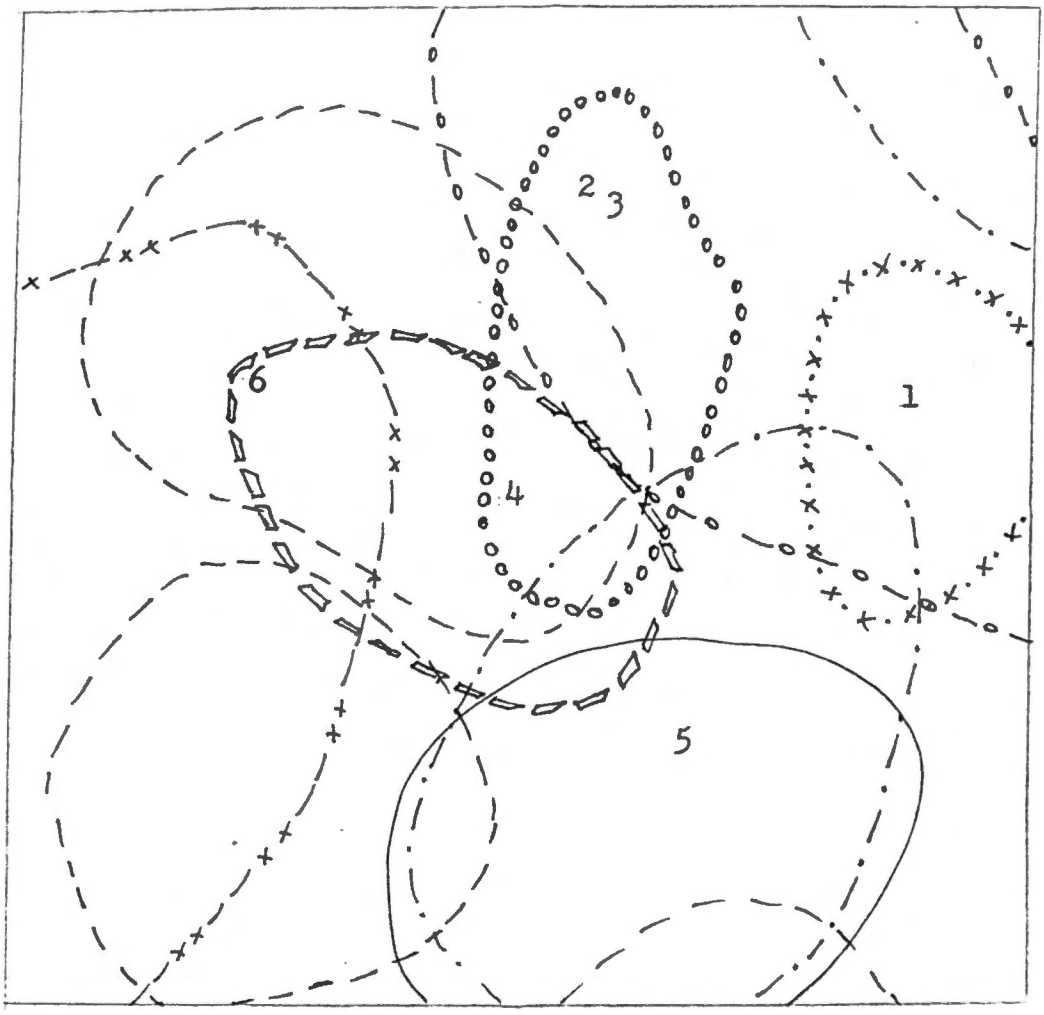

Figure 19. Territories of breeding pairs on PS5 showing location of nest sites, 1976.

Nine complete territories and one partial territory.

Brown-headed Nuthatch ——— Pine Warbler — — — —

Summer Tanager —.—. Prairie Warbler x.x.x

Downy Woodpecker —.—. Red-bellied Woodpecker x x — —

Eastern Bluebird .... Rufous-sided Towhee ▭ ▭

Nest site 1: Prairie Warbler, 2: Downy Woodpecker, 3: Eastern Bluebird, 4: Rufous-sided Towhee, 5: Summer Tanager, 6: Red-bellied Woodpecker

Species recorded in the study area as non-breeding are designated as visitants. Since the study area consisted of five separate study plots, a species breeding in one plot (e.g., PS4) may still be considered a visitant in a second plot (e.g., PS5). A fairly even numerical distribution of species was found throughout the study plots with the exception of PS4 with only five visitants recorded (Table 8). This difference may be attributed to the lack of habitat diversity in this study plot.

The five visitants observed in PS4 were also observed in other study plots. There were no bird species on PS4 unique to that study plot (Table 8). This is not true of the other plots. HPS1 had two species that were not observed nesting or breeding in any other area, the bobwhite and brown thrasher (Tables 7 and 8). These two species are not associated with the pine habitat of this region of the SRP (Norris 1963, Langley and Marter 1973).

The red-tailed hawk, blue jay, black-throated blue warbler and palm warbler are unique to HPS2 (Table 8). The hawk and blue jay are considered rare in this region of the SRP (Norris 1963); however, the two warblers are considered common to abundant during spring migrations in all parts of the plant site (Norris 1963, Langley and Marter 1973). Of the three species unique to HPS3 (hooded warbler, orchard oriole, indigo bunting), only the orchard oriole has been

TABLE 8

VISITANTS FOR EACH STUDY PLOT, 1976

Species	HPS1	HPS2	HPS3	P4	P5
Bobwhite	u[a]				
Yellow-billed Cuckoo	x[b]				x
Common Nighthawk	x	x		x	
Pileated Woodpecker	x		x		x
Red-bellied Woodpecker	x		x		
Red-headed Woodpecker	x			x	
Great Crested Flycatcher	x	x			
Eastern Wood Pewee	x		x		x
Common Crow	x		x	x	x
Mockingbird	x	x			
Brown Thrasher	u				
Wood Thrush	x		x		
Red-eyed Vireo	x				
Yellow-rumped Warbler	x		x		x
Prairie Warbler	x				
Mourning Dove		x	x	x	x
Acadian Flycatcher		x	x		
Blue Jay		u			
Carolina Wren		x			
Blue-gray Gnatcatcher		x			x
Black-throated Blue Warbler		u			
Palm Warbler		u			
Scarlet Tanager		x			x
Summer Tanager		x		x	

TABLE 8 (continued)

Species	HPS1	HPS2	HPS3	P4	P5
Red-tailed Hawk		u			
Chipping Sparrow		x	x		
Tufted Titmouse			x		
Hooded Warbler			u		
Orchard Oriole			u		
Indigo Bunting			u		
Barred Owl					u
Carolina Chickadee					x
Chestnut-sided Warbler					u
Ovenbird					u
American Redstart					u
Cardinal					x
Bachman's Sparrow					u
Total	15	14	13	5	15

[a]u-species unique to the plot

[b]x-species observed in more than one plot

observed in abandoned houseplaces and farm sites (Langley and Marter 1973). The other two species are known to prefer habitats not represented by the dry pine stands of this region (Burleigh 1958, Sprunt and Chamberlain 1970).

PS5 had the greatest number of species (5) that were not found nesting or visiting in the other study plots (Tables 7 and 8). Three of these species, the chestnut-sided warbler, ovenbird and American redstart, are transients in the area but reported to prefer broadleaf habitat (Langley and Marter 1973). The barred owl is a permanent resident and was also reported in habitat (flood plain timber) not found within the study area. Bachman's sparrow is a species associated with pine woods in this region of the country (Burleigh 1958, Norris 1963, Sprunt and Chamberlain 1970); however, only two individuals were observed in the entire study area.

Importance Value

A measurement was needed to express the relative importance of the bird species observed in the study area. Importance Value (IV) was chosen for this purpose. The IV was defined as the relative density per census plus the relative frequency. Relative density was defined as the percentage of individuals per census and relative frequency

as the percentage of censuses in which the species appeared. The maximum IV possible for any species was 200 (Kricher 1973).

The IV for each bird species observed in the total study area was computed. However, this figure tends to be misleading because of the diversity of habitats (houseplaces, managed pine monocultures, ice damaged pine) represented. Since the study area consisted of three distinct habitats, the IV of each bird species was also calculated according to habitat.

Total study area. The pine warbler was the most important species in the study area followed closely by the brown-headed nuthatch (Table 9). Nine of the 13 most important species were permanent residents at the SRP, and 4 (red-eyed vireo, white-eyed vireo, prairie warbler, and summer tanager) were summer residents. All 13 species nested in the study area. Four species (pine warbler, brown-headed nuthatch, summer tanager and prairie warbler) nested only in pine habitat, two species (red-bellied woodpecker and rufous-sided towhee) nested in both houseplace and pine habitats, and the remaining seven species were found nesting only within the houseplaces.

These 13 species constitute 81.7 percent of the total number of individuals counted during the census period. The pine warbler was the single most abundant species

TABLE 9

IMPORTANCE VALUE[a] FOR AVIFAUNA
RECORDED IN THE STUDY AREA, 1976

Species	HP[b]	PS[c]	PS5[d]	TA[e]
Pine Warbler	19.7	125.6*	113.4*	82.5*
Brown-headed Nuthatch	18.4	120.1*	106.7*	79.1*
Carolina Chickadee	114.3*	31.4*	6.3	59.3*
Cardinal	106.5*	25.0*	5.9	53.9*
Summer Tanager	26.4*	61.7*	96.7*	52.4*
Carolina Wren	82.2*	11.7	0	36.5*
Red-bellied Woodpecker	34.9*	9.5	79.1*	28.1*
Rufous-sided Towhee	37.8*	6.5	81.5*	17.4*
Red-eyed Vireo	37.8*	4.8	0	16.8*
Common Flicker	32.2*	6.0	0	15.0*
Tufted Titmouse	30.6*	6.0	0	14.4*
White-eyed Vireo	35.8*	0	0	13.6*
Prairie Warbler	0	4.8	83.2*	13.4*
Downy Woodpecker	0	0	86.3*	11.6
Mourning Dove	2.1	14.7	17.9	10.4
Eastern Bluebird	0	0	74.1*	9.9
Common Crow	0	13.9	18.5	9.0
Yellow-rumped Warbler	12.1	8.5	12.6	8.2
Eastern Wood Pewee	9.6	3.6	16.3	7.3
Great Crested Flycatcher	8.4	6.0	0	6.1
Wood Thrush	11.3	1.2	0	5.0
Common Nighthawk	0	9.2	0	4.3
Red-headed Woodpecker	0	7.2	0	3.6
Pileated Woodpecker	0	4.6	10.9	3.5

TABLE 9 (continued)

Species	HP[b]	PS[c]	PS5[d]	TA[e]
Blue-gray Gnatcatcher	3.7	0	10.9	2.9
Chipping Sparrow	4.4	0	0	1.8
Blue Jay	4.2	0	0	1.7
Yellow-billed Cuckoo	2.1	0	5.4	1.6
Acadian Flycatcher	3.9	0	0	1.6
American Redstart	0	0	11.3	1.6
Mockingbird	3.7	0	0	1.5
Ovenbird	0	0	10.9	1.5
Scarlet Tanager	1.9	0	5.4	1.5
Red-tailed Hawk	0	1.2	0	1.2
Bobwhite	2.1	0	0	0.8
Chestnut-sided Warbler	0	0	5.9	0.8
Orchard Oriole	2.1	0	0	0.8
Bachman's Sparrow	0	0	5.9	0.8
Barred Owl	0	0	5.4	0.7
Brown Thrasher	1.9	0	0	0.7
Black-throated Blue Warbler	1.9	0	0	0.7
Palm Warbler	1.9	0	0	0.7
Hooded Warbler	1.9	0	0	0.7
Indigo Bunting	1.9	0	0	0.7

[a]Importance value = Relative density + relative frequency (Maximum = 200)

[b]Houseplace, includes HP1, HP2 and HP3

[c]Pine stand, includes PS1, PS2, PS3 and PS4

TABLE 9 (continued)

[d]Pine stand 5

[e]Total Area, includes all eight census plots

*Indicates most important species, those species with importance value greater than the mean importance value of 21.2 for HP, 22.0 for PS, 37.8 for PS5 and 13.3 for TA

comprising 15.6 percent of the total individuals (Table 10). The brown-headed nuthatch (13.5 percent), Carolina chickadee (10.5 percent), summer tanager (9.3 percent) and cardinal (8.7 percent) were also among the most common species in the study area.

Transients do not comprise a major component of the avifauna in the study area, and only six visitants were recorded (Table 6, page 47). The yellow-rumped warbler was the most common transient in the area and was found in all three habitat types (Table 9). For the remaining transients, only one or two contacts for each were made early in the censusing period.

Houseplace habitat. This habitat consists of the three houseplace components of the houseplace-pine stand study plots and equals 1.9 hectares. In this habitat, ten species comprised 78.8 percent of all birds recorded. Three were summer residents at the SRP (white-eyed vireo, red-eyed vireo, summer tanager) while the remaining species were permanent residents. All ten species nested in the study area. The two most abundant species (Carolina chickadee--19.3 percent, cardinal--16.7 percent) were found in all three houseplaces (Table 10).

Managed pine stand habitat. This habitat is composed of PS4 (9 hectares) and the pine stand components of the

TABLE 10

PERCENT OF TOTAL INDIVIDUALS RECORDED FOR HABITATS OF THE STUDY AREA, 1976

Species	HP[a]	PSM[b]	PSU[c]	Tot[d]
Pine Warbler	5.4	26.6	13.4	15.6
Brown-headed Nuthatch	3.4	24.1	11.7	13.5
Carolina Chickadee	19.3	6.4	1.3	10.5
Summer Tanager	4.7	12.7	11.7	9.3
Cardinal	16.7	5.0	0.9	8.7
Carolina Wren	12.2	2.7	0	5.9
Red-bellied Woodpecker	4.9	1.5	9.1	4.2
Rufous-sided Towhee	4.5	1.5	6.5	3.6
Red-eyed Vireo	4.5	1.5	0	2.4
Common Flicker	3.9	1.0	0	1.9
Tufted Titmouse	3.9	1.0	0	1.9
White-eyed Vireo	0	0.8	8.2	1.9
Prairie Warbler	4.1	0	0	1.6

[a]Houseplace habitat

[b]Managed pine habitat

[c]Unmanaged pine habitat

[d]Total study area

three houseplace-pine stand study plots (25.1 hectares). Five important species were found in this habitat (Table 9). These species included 73.7 percent of all the individuals recorded in the four pine stands. Three species, the pine warbler (26.6 percent), brown-headed nuthatch (24.1 percent) and summer tanager (12.7 percent), were also the most abundant of all individuals counted (Table 10).

Ice damaged pine stand habitat. This habitat was confined to the PS5 study plot (9 hectares). Eight species were considered important in PS5 (Table 9). The eight species represented 80.1 percent of the total individuals observed in the pine stand. Pine warblers (13.4 percent), brown-headed nuthatches (11.7 percent) and summer tanagers (11.7 percent) were the most abundant species recorded on the census plot (Table 10).

The Houseplace-Pine Stand Unit

Houseplaces are a major component of wildlife management plans utilized by the USFS at the SRP. It is necessary, therefore, for the USFS to know the faunal composition of a houseplace. This can be difficult when dealing with species as mobile as birds.

In the parts of the study area in which a houseplace and pine stand were adjacent (HP1 and PS1, HP2 and PS2, HP3

and PS3), careful observations were made during the census trips to determine which habitat type (HP or PS) had the greatest influence on the avifauna found there (e.g., which habitat fulfilled the requirements for nest sites or food). To assist in this aim, censuses were conducted which treated these adjacent habitats as separate components.

The vegetational boundary between houseplace and pine stand was distinct; however, it did not restrict bird movement between habitats. With this in mind, consideration had to be given to the complete houseplace-pine stand association. The central management issue then became: how does a houseplace influence the avian composition of an adjacent pine stand? To answer this question, the houseplace was treated as a component of the pine stand that surrounded it and the houseplace-pine stand association viewed as a single unit (study plot).

Breeding pairs. Twenty-four breeding pairs occurred in the houseplace-pine stand study plots. Six breeding pairs occurred in HPS1, eight in HPS2, and ten in HPS3 (Table 7, page 50). The pine stand component of the three houseplace-pine stand study plots is represented by a similar habitat structure (Table 5, page 45) and the same three breeding species (the pine warbler, brown-headed nuthatch and summer tanager).

In the houseplace components, differences exist in the

habitat (page 44) and corresponding species composition of the breeding pairs. Three breeding pairs are found in HP1. These same three species (Carolina chickadee, Carolina wren and cardinal) were also found in HP3 with the Carolina chickadee and cardinal having nested in HP2.

The common flicker, red-bellied woodpecker and tufted titmouse occurred only within HP2, while the white-eyed vireo, red-eyed vireo and rufous-sided towhee were found only in HP3 (Table 7, page 50). The different breeding pairs for the three houseplaces may be attributed to variations existing in the nesting habitat available within the individual houseplace.

Houseplace 2 contains dead trees for cavity nesters which are not found in the other two houseplaces. These trees provided nest sites for the common flicker and the red-bellied woodpecker. Management practices have eliminated dead trees from the pine monocultures of the region, further reducing the nesting sites available for cavity-nesting birds. In fact, cavity trees appear to be a limited resource within the entire pine region of the study area. For example, the flicker pair nesting in HP2 contested its nest site location with a pair of great crested flycatchers for three days prior to establishing a nest site.

Houseplace 3 is unique among the three houseplaces studied because of the heavy concentration of wisteria and

honeysuckle. This provides HP3 with a greater percentage of ground and shrub cover than found in HP1 and HP2 (Table 5, page 45). Twice as many breeding pairs occurred in HP3 (6) as in HP1 (3), suggesting that this heavy undergrowth provides a greater amount of nesting habitat.

Two species, the white-eyed vireo and rufous-sided towhee, nesting in HP3 and not in HP1, often utilize heavy ground cover. Sprunt and Chamberlain (1970) describe the preferred habitat of the white-eyed vireo to be thickets, tangles of vines and shrubbery, an accurate description of HP3.

HP1 is the least complex habitat represented in the three houseplaces and contained the least number of breeding pairs. Shrub vegetation covers only 20 percent (Table 5, page 45) of the houseplace, providing minimal nest locations and food for ground-nesting species. Perhaps because of this, breeding territories in the houseplace may be larger than those found in habitat of more dense and diverse vegetation. This situation appeared to be true for Carolina wren territories in HP1 and HP3. In HP1 the wren was observed to utilize 0.7 hectare area, while in HP3, with greater vegetation complexity, the territory of the wren was measured to be 0.4 hectare.

Cardinal territories for the two houseplaces follow the same pattern. In HP1 the territory was measured to be 0.8 hectare, but in HP3, territory size was 0.6 hectare.

Importance value. The importance values (IV) computed for the houseplace component of the houseplace-pine stand study plots follow the pattern established by the breeding pairs. The Carolina chickadee and cardinal, nesting in all three houseplaces, are the most important species found in the houseplace habitat (Table 9, page 61). The Carolina wren found in two of the houseplace areas, was the third most important species observed.

Pine trees comprise a portion of the houseplace canopy vegetation (Appendix A, Tables A1-A3) which encouraged the presence of both pine warblers and brown-headed nuthatches; however, they were not observed in the houseplace habitat consistently enough to be considered important species. The summer tanager, which also nested in the adjacent pine habitat, did utilize the houseplace often enough to be considered an important species of the houseplace habitat. The summer tanager was also so distributed throughout the study area that it was the only species which could be considered important in all three habitat types. This was possibly because of the tanagers' ability to utilize both hardwood and pine habitat in feeding and nesting (Burleigh 1958).

Thirty-one species used the houseplace habitat during the four month study period; 21 of these were visitants. Fifteen of the 21 visitants were not observed in the adjacent pine stand, suggesting that houseplaces encouraged the pres-

ence of 15 species into the pine region that would otherwise not have occurred.

As expected, the most important species in the pine component of the houseplace-pine stand habitat were the pine warbler and brown-headed nuthatch (Table 9, page 61). Their value was almost twice that of the other nesting species of the pine habitat, the summer tanager.

The Carolina chickadee and cardinal were the two remaining important species in the pine. Their presence in pine was believed related to the presence of their nest sites in the adjacent houseplaces. Once again, the houseplace served as an influence on the avian composition of the pine habitat.

Pine Stand 4

The inclusion of PS4 in the study provided the opportunity to determine the role of houseplaces on pine stand habitat. The vegetation description of the pine stands in the study area demonstrated that PS4 was similar to the pine stand component of the three houseplace-pine stand study plots. PS4 represented a large portion of the habitat found in this region of the SRP.

Breeding pairs. Two species represent the three breeding pairs that were identified in PS4 (Table 7, page 50). These two species, the pine warbler and brown-headed nuthatch, repre-

sent most of the avian activity present in the pine monocultures of the region.

Both species are closely associated with pine habitat throughout their range (Parnell 1969, Morse 1970). Burleigh (1958) reported that the removal of pine timber from an area will result in the reduction or disappearance of the brown-headed nuthatch.

The nuthatch nests in cavities, preferring a rotten pine stub (Sprunt and Chamberlain 1970). The Forest Service systematically removes rotten stubs from pine stands and, in this way, has a greater influence on the nesting success of the nuthatch than on the pine warbler, which builds nests in tufts of pine needles on the outer ends of branches (Sprunt and Chamberlain 1970). The pine warbler also requires a well developed canopy for feeding (Anderson and Shugart 1974), a condition encouraged by forest management. No other breeding species was recorded in the stand, indicating that the habitat lacked the diversity to accommodate other avian feeding or nesting strategies.

Pine warblers and brown-headed nuthatches in pine with houseplaces were seen only in the portion of the houseplace containing pine trees. In all cases, these two species moved very quickly through and out of the houseplace component.

Houseplace-pine stand 1 (HPS1) contained six breeding

pairs per nine hectares, twice the number of breeding pairs in PS4. Houseplace-pine stand 2 (HPS2) contained five more breeding pairs per nine hectares, a 167 percent increase, and houseplace-pine stand 3 (HPS3) contained seven more breeding pairs, an increase of 234 percent over PS4. These data graphically demonstrate the influence of a houseplace when regarded as a component of its adjacent pine stand habitat.

Importance value. As expected, the pine warbler (IV = 139.1) and brown-headed nuthatch (128.3) were the two important species in this pine stand. The next most important species observed in the stand was the mourning dove (30.1). In all, only seven species of birds were observed in the stand and no visitants were recorded that were not present in the other study plots (Table 8, page 57).

Apparently, the stand lacks the vegetational diversity to attract a variety of avian species. This gives a strong indication of the importance of habitat diversity, as represented by a houseplace, for obtaining avian diversity.

Pine Stand 5

Pine stand 5 represents a unique habitat within the study area. The nine hectare stand contains a habitat diversity not found in PS4 but similar to that in the three

houseplace-pine stand study plots. The distinction between PS5 and the houseplace-pine stand plots is found in the distribution of the vegetation within the stand.

In the houseplace-pine stand plots, the plant diversity is contained in one isolated compartment comprising 0.6-0.7 hectare of the nine hectare stand. In PS5, ground, shrub and hardwood vegetation is dispersed throughout the study plot.

Breeding pairs. Eight species, comprising nine breeding pairs, were recorded in PS5 (Table 7, page 50). The eight species utilize three nesting strategies: canopy nesting, ground nesting and cavity nesting. These three strategies represent a condition seldom found in healthy pine stands of the SRP. Nest site availability is a result of the structural complexity of the habitat, a complexity lacking in pine monocultures (PS4) and available only in the houseplace components of the other stands.

Five cavity nesters were recorded in PS5. Three of these, the downy woodpecker, eastern bluebird and prairie warbler were unique to PS5. This may be due in part to the availability of cavity trees in PS5. With the exception of HP2, the dead trees in PS5 provided potential cavity nesting sites exceeding those offered in the remainder of the study plots. Norris (1963) reported a breeding season

density for the downy woodpecker of five pairs per 40 hectares in a pine-hardwood forest of the SRP and considers this species common; however, in this study the downy was only observed in PS5.

Shrub vegetation provided a nest site for the rufous-sided towhee, the only ground nesting species nesting outside the houseplace compartments. The territory in PS5 was 1.0 hectare while the territory of the towhee in HP3 was 0.5 hectare.

Importance value. Eight species were classified as important in PS5. These eight species were the breeding pairs recorded in this study plot. No visitants (non-breeders) were observed consistently enough to be designated as important.

The pine warbler and brown-headed nuthatch were again the most important species, followed closely by the summer tanager (Table 9, page 61). The mean importance value for PS5 (37.8) was higher than those of the other study plots. This was due to the greater number of species breeding in this habitat.

Habitat Interrelationships

Coefficient of Community

The similarity between the bird communities utilizing the five study plots within the study area was stated as the coefficient of community, $C = 2W/A + B$, where W is the sum of importance value for species shared by the two communities; A is the sum of the importance values for the A community; and B is the sum of the importance values for the B community. Importance value for bird species was defined as relative density plus relative frequency (page 55).

The coefficient of community was utilized to measure similarity in plant communities (Bray and Curtis 1957) (page 37); however, Kricher (1973) applied this measurement to avian communities at different stages of natural succession. As is true of plant communities, a coefficient of 1.0 indicates total similarity between two communities, and a coefficient of zero indicates that there are no species in common.

The bird communities of the three houseplace-pine stand study plots were compared with each other to determine similarity. The three houseplace-pine stand plots were then combined into a single unit and compared to PS4. This was done to indicate the influence of the houseplace component

on the avian composition of the pine stands. Finally, PS4 was compared to PS5.

The three houseplace-pine stand plots have a coefficient of community greater than 0.8 (Table 11). This indicates a definite similarity in the bird species utilizing the three study plots. The lack of complete similarity may be attributed to the differences which exist in the houseplace components of these three study plots (page 40).

When the bird community of the combined houseplace-pine stand study plots was compared to the bird community of PS4, the coefficient of similarity for the two communities was only .237 (Table 11). Since vegetation in these two areas was similar except for the houseplace component (page 39), the difference in bird communities may be attributed to the presence of houseplaces.

The coefficient of similarity for the bird communities in PS4 and PS5 was .425 (Table 11). Although this coefficient demonstrates a greater degree of similarity than the coefficient for the bird communities described above (.237), the two bird communities in PS4 and PS5 can still be considered only moderately similar. The management practices implemented for PS4, in conjunction with the ice damage in PS5, have created dissimilar habitats. In PS5 the understory, subcanopy and dead trees provided breeding locations which were not available in PS4 and, therefore, encouraged different species to make use of the area.

TABLE 11

COEFFICIENT OF COMMUNITY FOR THE AVIAN COMMUNITIES OF THE STUDY AREA, 1976[a]

Communities	COC[b]
HPS1[c]--HPS2[d]	.813
HPS1 --HPS3[e]	.842
HPS2 --HPS3	.831
HPS[f] --PS4[g]	.237
PS4 --PS5[h]	.425

[a]C = 2W/A + B; W = sum of importance value of species shared, A = sum of importance value of plot A, B = sum of importance value of plot B

[b]Coefficient of Community

[c]Houseplace 1-Pine stand 1

[d]Houseplace 2-Pine stand 2

[e]Houseplace 3-Pine stand 3

[f]the three houseplace-pine stand plots combined into a single unit

[g]Pine stand 4

[h]Pine stand 5

Avian Diversity

The Shannon-Wiener Information Formula was used to determine species diversity (MacArthur and MacArthur 1961). It measured the probability in predicting what the next species selected at random would be (Lloyd et al. 1968). The Shannon function was used in this study because it was least sensitive to sample size (Kricher 1972).

Results of the Shannon formula were influenced by the species richness (number of species) and the evenness of the spatial distribution of these species (Pianka 1966, Peet 1974). For summer bird communities, species diversity generally follows species richness and is not dependent on the distribution component of species, since distribution during the breeding season is based on the partitioning of the habitat into territories (Tramer 1969, Ambrose 1975).

The Shannon-Wiener formula is as follows:

$$H = -\sum p_i \log_2 p_i$$

where H is the diversity index, and p_i is the proportion of individuals of species i in the community (Cox 1972).

Diversity was computed for the five study plots of the study area. Two diversity indices were calculated for each unit (Table 12). The first index, breeding bird diversity (BD), was based on the 15 breeding pairs recorded in the study area. The second index, total diversity (TD),

TABLE 12

SPECIES RICHNESS AND DIVERSITY FOR THE FIVE STUDY PLOTS, 1976

	SR[a]	BD[b]	TD[c]
HPS1[d]	22	2.521	3.430
HPS2[e]	19	2.807	3.288
HPS3[f]	24	2.836	3.488
PS4[g]	7	.917*	2.102**
PS5[h]	23	2.946	3.811

[a]Species richness

[b]Breeding bird diversity

[c]Total diversity

[d]Houseplace 1-Pine stand 1

[e]Houseplace 2-Pine stand 2

[f]Houseplace 3-Pine stand 3

[g]Pine stand 4

[h]Pine stand 5

*$p < .01$

**$p < .05$

was based on all species recorded in the study area over the four month census.

Using analysis of variance procedures for bird species diversity described by Kricher (1973), the breeding bird diversity was significantly different at the .01 probability level for PS4 when compared to breeding bird diversities of the other four study plots. Total diversity for PS4 was significantly different at the .05 probability level from the total diversity computed for the other plots (Table 12).

The inclusion of the houseplaces in the pine stands has made one segment of the pine stands' habitat structurally more complex, a complexity lacking in PS4. The structural complexity of PS5 versus PS4 has already been established. This habitat complexity is generally believed to result in an increase in the number of species in a given area (Karr and Roth 1971, Emlen 1973). It has also been suggested that vegetation structure is the primary characteristic of a habitat that controls the density and diversity of the local avifauna (Gill et al. 1974).

Diversity measurements for this study area apparently support these theories. The houseplace components in HPS1, HPS2 and HPS3 represent the only variation in habitat from PS4. The houseplace structures seemingly attract birds into the region that would otherwise have sought other sites. This is true of both breeding birds and visitants.

PS5 shows a higher total diversity than that computed for the three houseplace-pine stand plots. This diversity appears to reflect the more even distribution of the vegetation in PS5, which represents an ideal habitat condition to encourage avifaunal diversity in a pine habitat. However, in pine stand management the habitat characteristics of PS5 appear difficult to maintain, and houseplace compartments then become an acceptable alternative for increasing diversity of habitat and avifauna.

Houseplace Concept

Although the unique houseplace-pine stand relationship of this study area was not reported in other studies, observations of similar habitats in other regions indicated the relationship between pine habitat and avian diversity to be similar to that shown in this study area.

Adams and Edington (1973) compared songbird populations in coniferous and broadleaf woods and found that the diversity was greater in hardwood habitat than in pines. In a 45-year-old managed loblolly pine stand of Louisiana, Noble and Hamilton (1975) reported a species composition similar to that found in PS5. Also noted in the Louisiana study was that diversity decreased in pine stands lacking developed understories. Noble and Hamilton (1975) indicate that the

Carolina wren and rufous-sided towhee are recorded in the loblolly stand only where small areas of understory have escaped burning. These small areas served the same function in that loblolly stand, but to a lesser degree, that houseplaces served in the slash pine stands of this study. They both serve to provide habitat diversity in habitats otherwise devoid of diversity and thus encourage occupancy by bird species not normally associated with managed pine plantations.

Essentially, houseplaces are the habitat diversity of a pine stand concentrated in one location within that stand. Houseplaces in the slash pine plantations of the SRP attracted breeding birds and visitants not present in similar stands without houseplaces. A wildlife management plan for increasing wildlife diversity in pine plantations must consider a method for providing increased food and cover. This study indicates that implementation of such a plan could incorporate the abandoned houseplace concept.

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APPENDICES

APPENDIX A

VEGETATION TABLES[a]

Symbol abbreviations for tree species are given alphabetically as follows:

BC - Black Cherry (*Prunus serotina*)
BO - Blackjack Oak (*Quercus marilandica*)
BW - Black Walnut (*Juglans nigra*)
CB - Chinaberry (*Melia azedarach*)
CL - Carolina Laurelcherry (*Prunus caroliniana*)
CM - Crepe Myrtle (*Lagerstroemia indica*)
DD - Dead
ER - Eastern Redcedar (*Juniperus virginiana*)
FD - Flowering Dogwood (*Cornus florida*)
HH - Hophornbeam (*Ostrya virginiana*)
LL - Longleaf Pine (*Pinus palustris*)
LO - Laurel Oak (*Quercus laurifolia*)
LP - Loblolly Pine (*Pinus taeda*)
PE - Pecan (*Carya illinoensis*)
PH - Peach (*Prunus persica*)
PO - Post Oak (*Quercus stellata*)
PR - Common Persimmon (*Diospyros virginiana*)
SP - Slash Pine (*Pinus elliottii*)
SS - Sassafras (*Sassafras albidum*)
TO - Turkey Oak (*Quercus laevis*)
WO - Water Oak (*Quercus nigra*)

[a]Authority for nomenclature E. L. Little (1968)

TABLE A1

DOMINANT TREE SPECIES OF HOUSEPLACE 1, JUNE 1976

Species[a]	FRE[b]	RFR[c]	DEN[d]	RDN[e]	BAR[f]	DOM[g]	RDM[h]
BC	24	31.2	34.3	31.2	.79	1.13	17.6
SP	21	27.3	30.0	27.3	.50	.71	11.1
CP	7	9.0	10.0	9.9	.17	.24	3.1
PE	6	7.8	8.6	7.8	1.91	2.73	42.6
CL	5	6.5	7.1	6.5	.13	.19	3.0
BO	5	6.5	7.1	6.5	.05	.07	1.1
FD	2	2.6	2.9	2.6	.05	.07	1.1
SS	2	2.6	2.9	2.6	.05	.07	1.1
PH	2	2.6	2.9	2.6	.05	.07	1.1
BW	1	1.3	1.4	1.3	.43	.61	9.5
CB	1	1.3	1.4	1.3	.36	.51	8.0
PO	1	1.3	1.4	1.3	.004	.006	0.1

[a]Abbreviations given on page 92 [b]Frequency [c]Relative frequency
[d]Density [e]Relative Density [f]Basal Area (square meters per hectare)
[g]Dominance [h]Relative Dominance

TABLE A2

DOMINANT TREE SPECIES OF HOUSEPLACE 2, JUNE 1976

Species[a]	FRE[b]	RFR[c]	DEN[d]	RDN[e]	BAR[f]	DOM[g]	RDM[h]
BC	48	43.2	80.0	43.2	1.40	2.33	18.9
SP	14	12.6	23.3	12.6	.83	1.38	11.2
LP	10	9.0	16.7	9.0	.72	1.20	9.7
CL	9	8.0	15.0	8.1	.38	.63	5.1
HH	6	5.4	10.0	5.4	.24	.40	3.2
WO	5	4.6	8.3	4.5	1.83	3.05	24.7
CP	4	3.6	6.7	3.6	.14	.23	1.9
FD	4	3.6	6.7	3.6	.13	.22	1.8
CM	4	3.6	6.7	3.6	.04	.07	.6
DD	3	2.7	5.0	2.7	.54	.90	7.3
BW	1	.9	1.7	.9	.39	.65	5.3
LO	1	.9	1.7	.9	.38	.63	5.1
CB	1	.9	1.7	.9	.25	.42	3.4
RC	1	.9	1.7	.9	.14	.23	1.9

[a]Abbreviations given on page 92 [b]Frequency [c]Relative Frequency
[d]Density [e]Relative Density [f]Basal Area (square meters per hectare)
[g]Dominance [h]Relative Dominance

TABLE A3

DOMINANT TREE SPECIES OF HOUSEPLACE 3, JUNE 1976

Species[a]	FRE[b]	RFR[c]	DEN[d]	RDN[e]	BAR[f]	DOM[g]	RDM[h]
SP	55	38.2	91.7	38.2	1.72	2.07	19.6
BC	34	23.6	56.7	23.6	.86	1.43	9.8
CP	15	10.4	25.0	10.4	.73	1.22	8.3
LL	6	4.2	10.0	4.2	.63	1.05	7.2
CL	6	4.2	10.0	4.2	.23	.38	2.6
CB	5	3.5	8.3	3.5	2.64	4.40	30.1
BO	5	3.5	8.3	3.5	.20	.33	2.3
CM	5	3.5	8.3	3.5	.08	.13	.9
SS	5	3.5	8.3	3.5	.07	.12	.9
BW	3	2.1	5.0	2.1	.91	1.52	10.4
TO	3	2.1	5.0	2.1	.14	.23	1.6
PO	2	1.4	3.3	1.4	.47	.78	5.3

[a]Abbreviations given on page 92 [b]Frequency [c]Relative Frequency
[d]Density [e]Relative Density [f]Basal Area (square meters per hectare)
[g]Dominance [h]Relative Dominance

TABLE A4

A LIST OF VASCULAR PLANTS FOR THE STUDY AREA, 1976[a]

Amaryllidaceae	
Narcissus jonquilla	Jonquil
Anacardiaceae	
Rhus copallina	Winged Sumac
Rhus radicans	Poison Ivy
Rhus vernix	Poison Sumac
Apiaceae	
Daucus carota	Queen Anne's Lace
Aquifoliaceae	
Ilex opaca	American Holly
Asclepiadaceae	
Asclepias viridiflora	Green Milkweed
Asclepias amplexicaulis	Sand Milkweed
Asteraceae	
Eupatorium album	Dog Fennel
Eupatorium rotundifolium	Dog Fennel
Gnaphalium obtusifolium	Rabbit Tobacco
Kuhnia eupatoroides	False Boneset
Marshallia obovata	Button Flower
Solidago odora	Goldenrod
Solidago pinetorum	Early Goldenrod
Betulaceae	
Ostrya virginiana	Hophornbeam
Bignoniaceae	
Campsis radicans	Trumpetcreeper
Caprifoliaceae	
Lonicera japonica	Japanese Honeysuckle
Sambucus canadensis	Elderberry

TABLE A4 (Continued)

Cornaceae	
Cornus florida	Flowering Dogwood
Ebenaceae	
Diospyros virginiana	Common Persimmon
Ericaceae	
Vaccinium arboreum	Sparkleberry
Fabaceae	
Lespedeza angustifolia	Lespedeza
Lespedeza hirta	Hairy Bushclover
Wisteria frutescens	Wisteria
Fagaceae	
Quercus laevis	Turkey Oak
Quercus laurifolia	Laurel Oak
Quercus marilandica	Blackjack Oak
Quercus nigra	Water Oak
Quercus stellata	Post Oak
Hypericaceae	
Hypericum gentianoides	Pineweed
Juglandaceae	
Carya illinoensis	Pecan
Juglans nigra	Black Walnut
Lauraceae	
Sassafras albidum	Sassafras
Liliaceae	
Smilax rotundifolia	Common Greenbrier
Lythraceae	
Lagerstroemia indica	Crape Myrtle
Meliaceae	
Melia azedarach	Chinaberry
Mimosaceae	
Mimosa pudica	Mimosa

TABLE A4 (Continued)

Pinaceae	
Juniperus virginiana	Eastern Redcedar
Pinus palustris	Longleaf Pine
Pinus taeda	Loblolly Pine
Pinus elliottii	Slash Pine
Poaceae	
Danthonia sericea	Oat Grass
Gymnopogon ambiguus	Beard Grass
Muhlenbergia capillaris	Muhly
Rosaceae	
Crataegus flava	Hawthorn
Crataegus uniflora	Dwarf Thorn
Prunus americana	Wild Plum
Prunus caroliniana	Cherry Laurel
Prunus persica	Peach
Prunus serotina	Wild Black Cherry
Rosa carolina	Wild Rose
Rosa laevigata	Cherokee Rose
Rubus cuneifolius	Sand Blackberry
Rubus trivialis	Southern Dewberry
Vitaceae	
Vitis rotundifolia	Muscadine

[a]Authority for nomenclature H. L. Blomquist and H. J. Oosting (1959)

APPENDIX B

BIRD TERRITORIES

Key to Symbols

Breeding territory - - - -

Nest site ⊠

Territories are listed according to study plots.

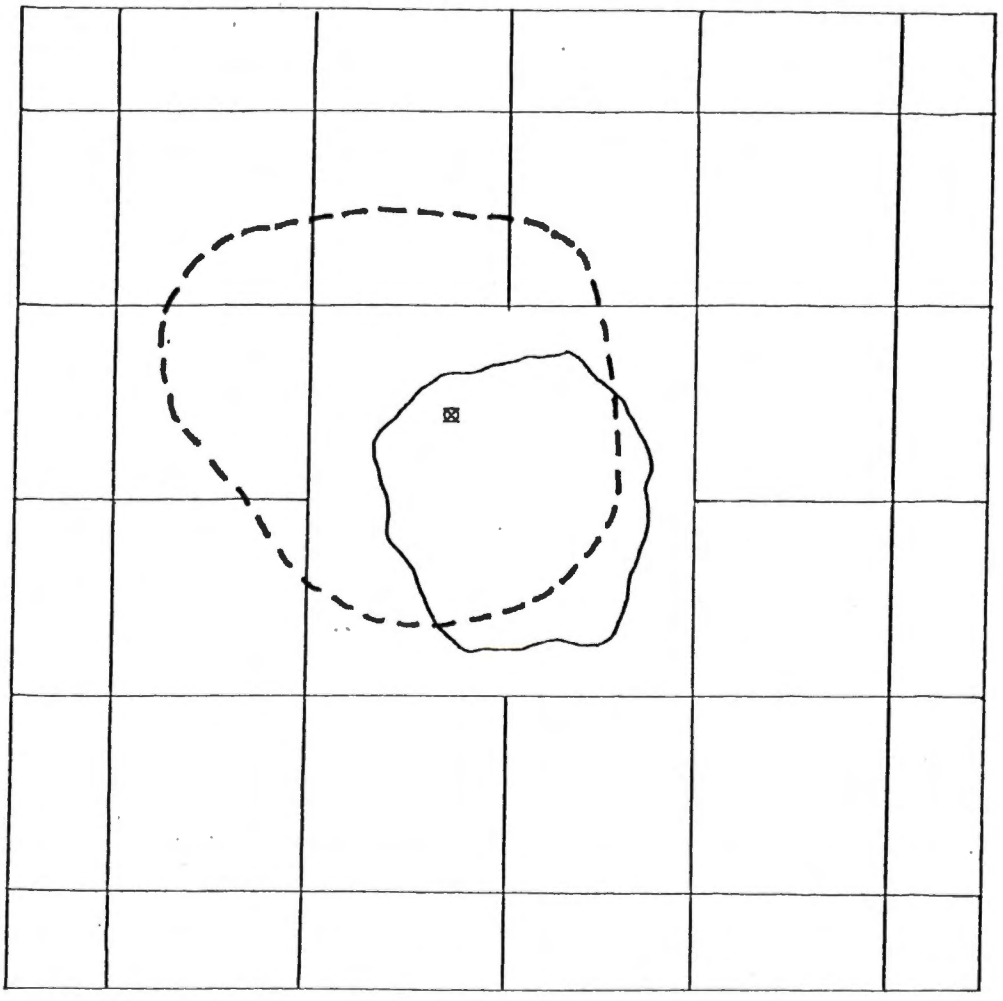

Figure B1. Territory of Carolina Chickadee in HP1 showing location of nest site, 1976.

One complete territory.

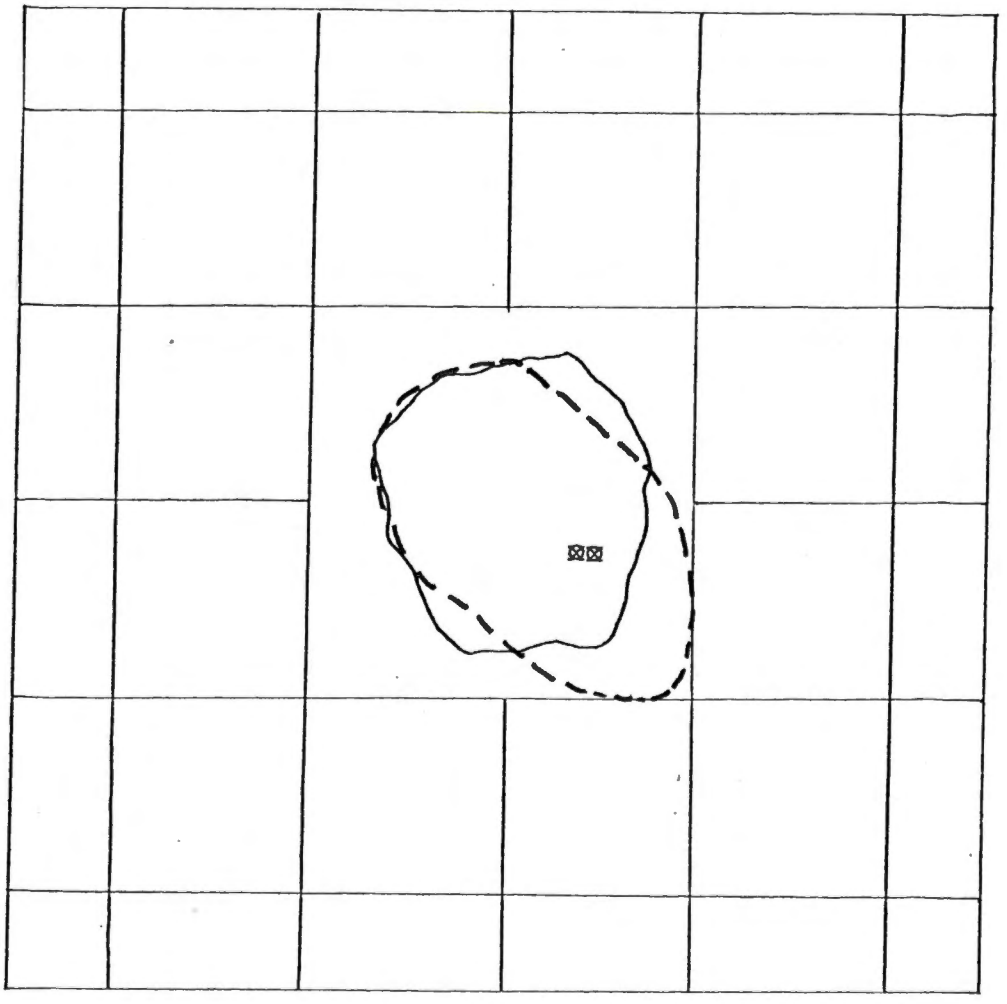

Figure B2. Territory of Carolina Wren in HP1 showing location of nest sites, 1976.

One complete territory.

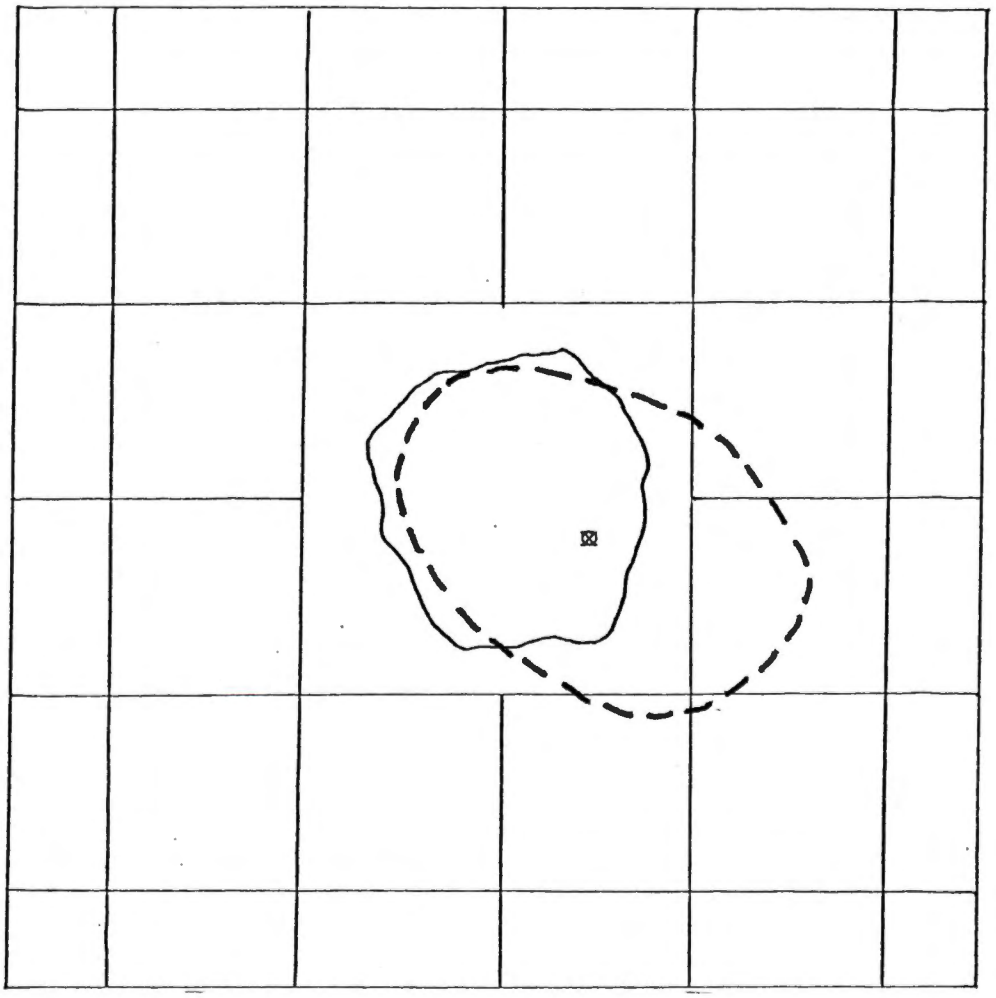

Figure B3. Territory of Cardinal in HP1 showing location of nest site, 1976.

One complete territory.

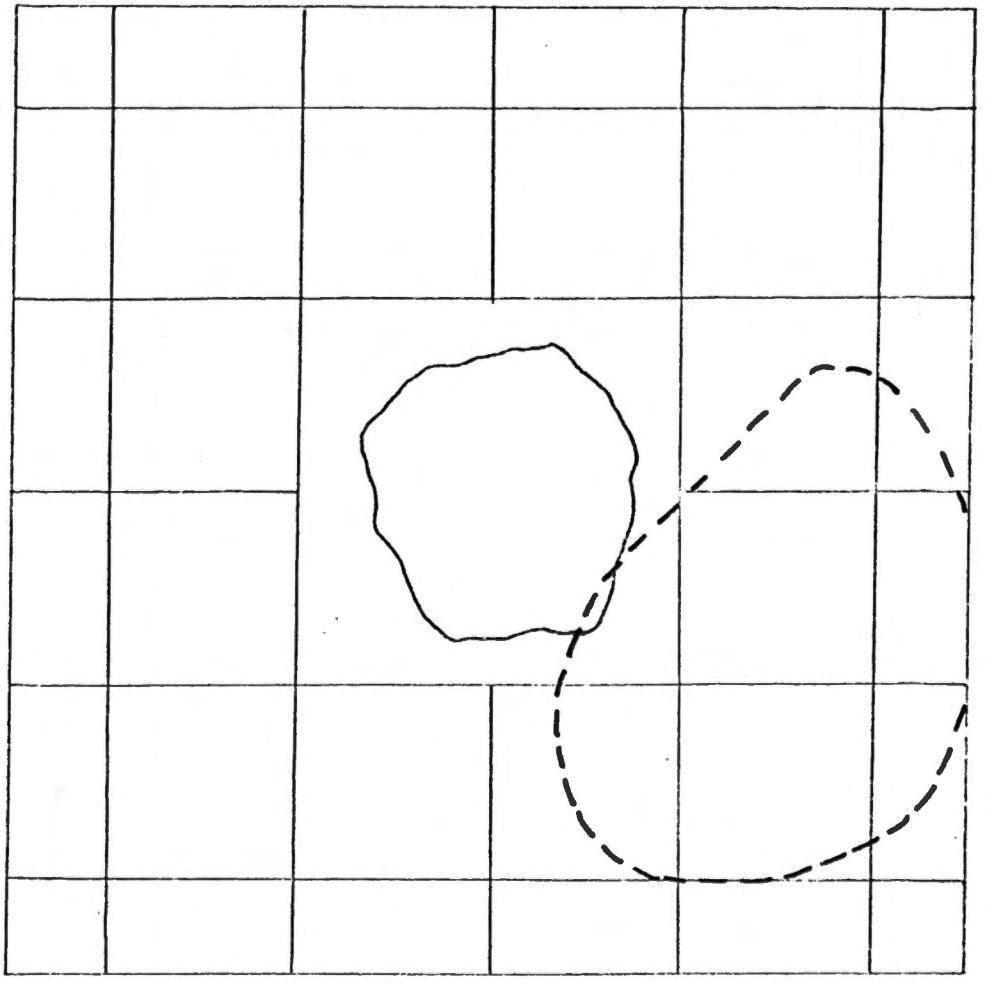

Figure B4. Territory of Brown-headed Nuthatch in PS1, 1976.

One complete territory.

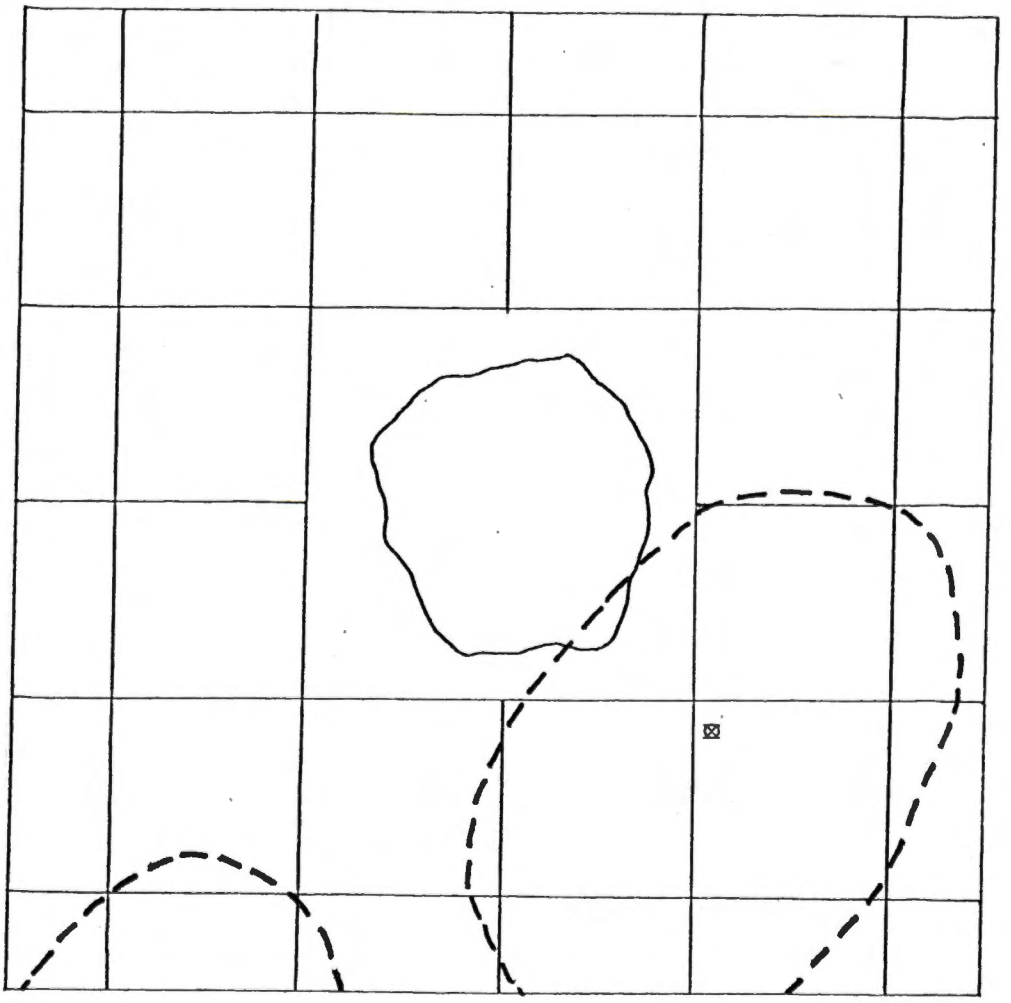

Figure B5. Territories of Pine Warbler in PS1 showing location of nest site, 1976.

One complete territory and one partial territory.

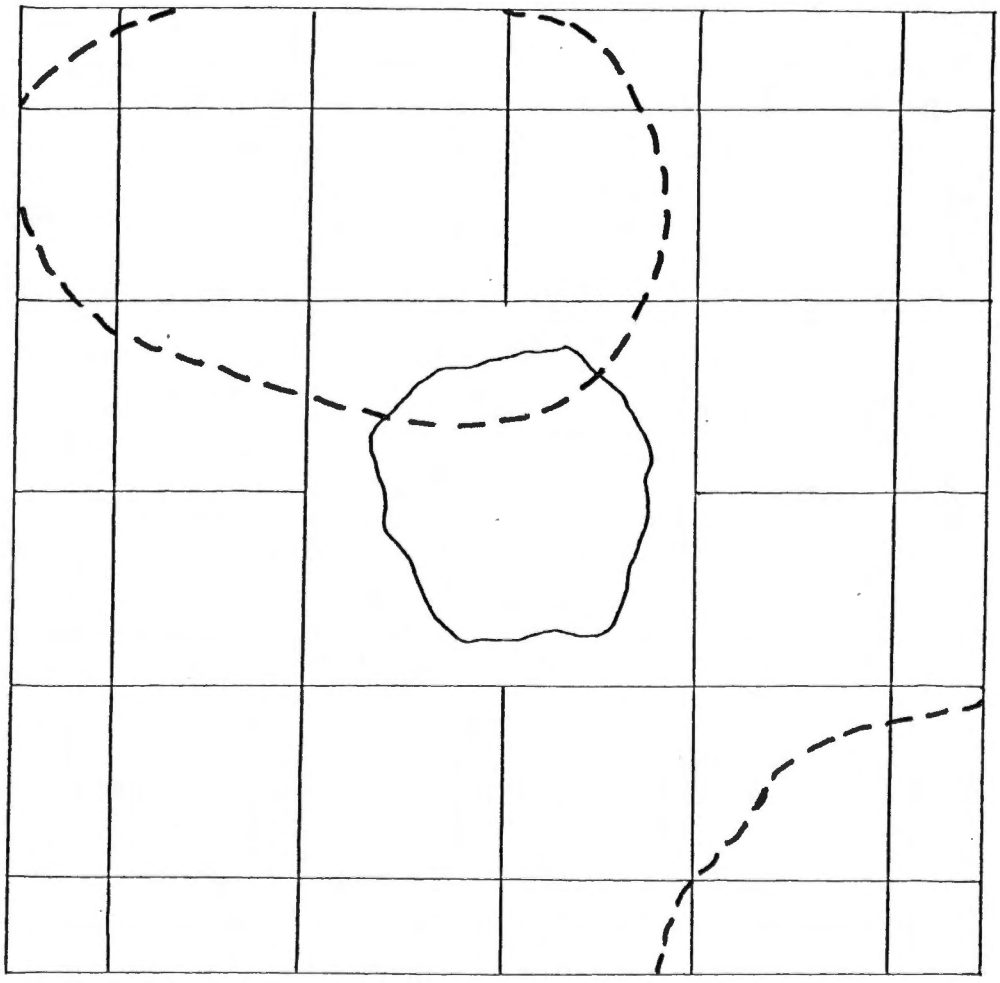

Figure B6. Territories of Summer Tanager in PS1, 1976.

One complete territory and one partial territory.

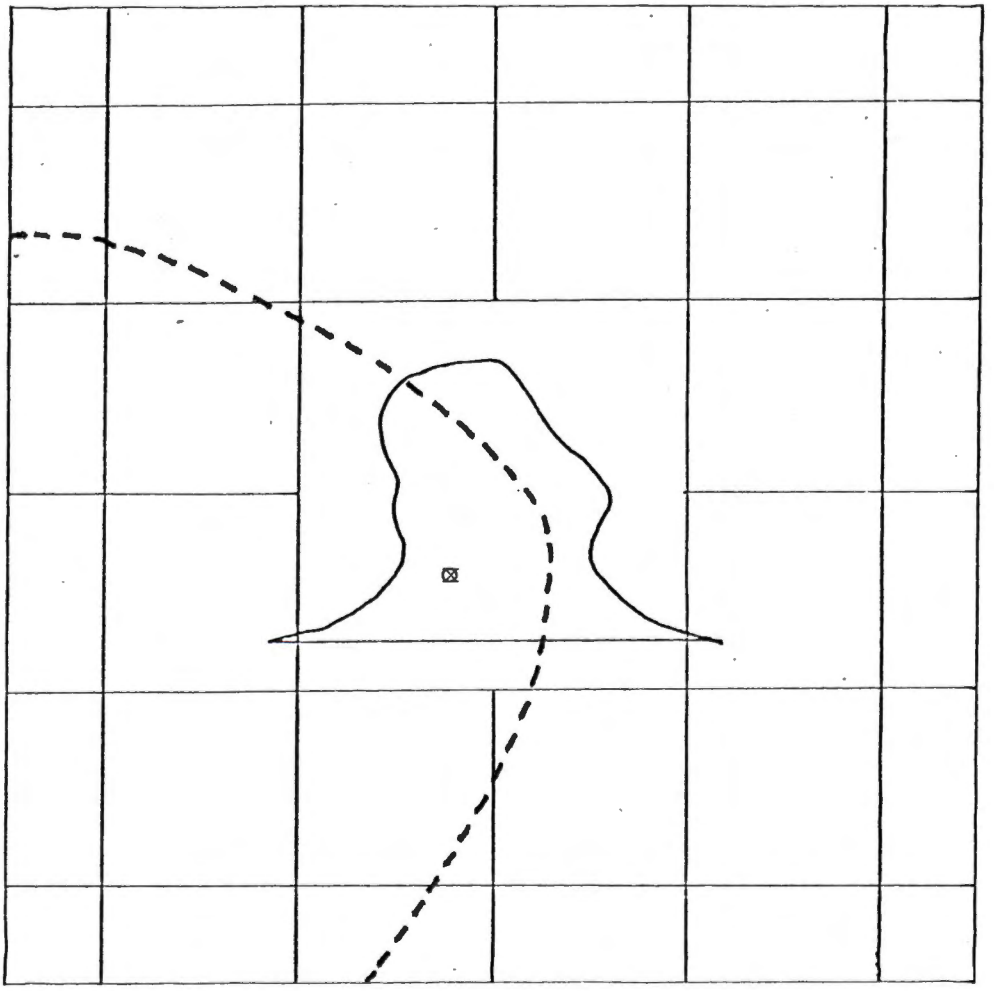

Figure B7. Territory of Common Flicker in HP2 showing location of nest site, 1976.

One complete territory.

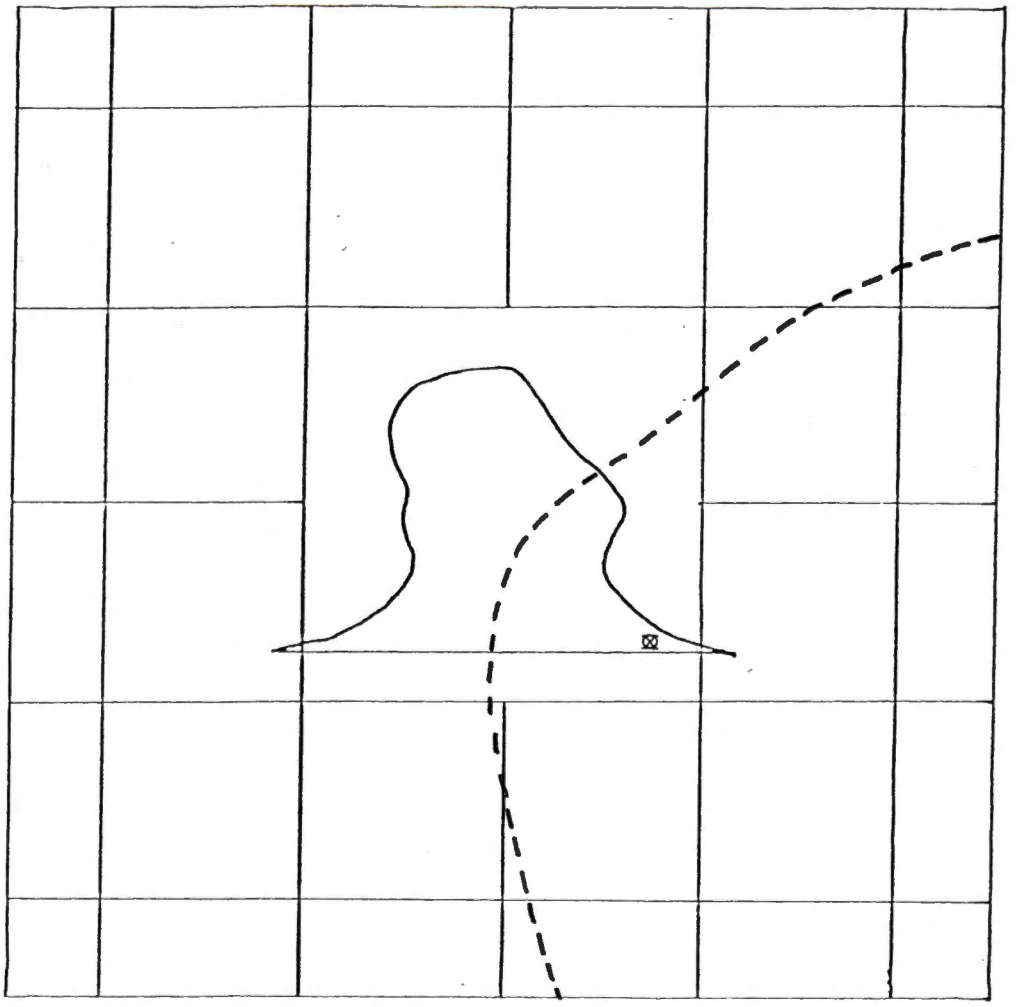

Figure B8. Territory of Red-bellied Woodpecker in HP2 showing location of nest site, 1976.

One complete territory.

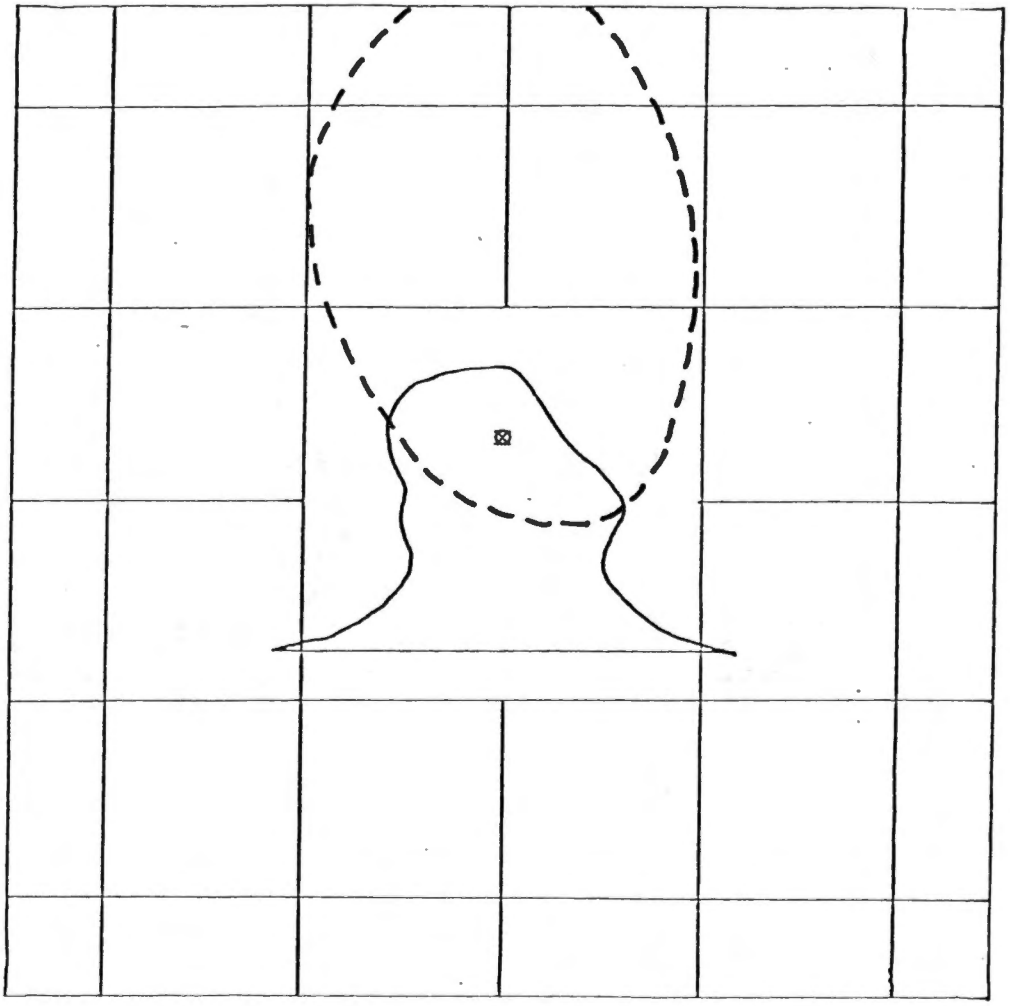

Figure B9. Territory of Carolina Chickadee in HP2 showing location of nest site, 1976.

One complete territory.

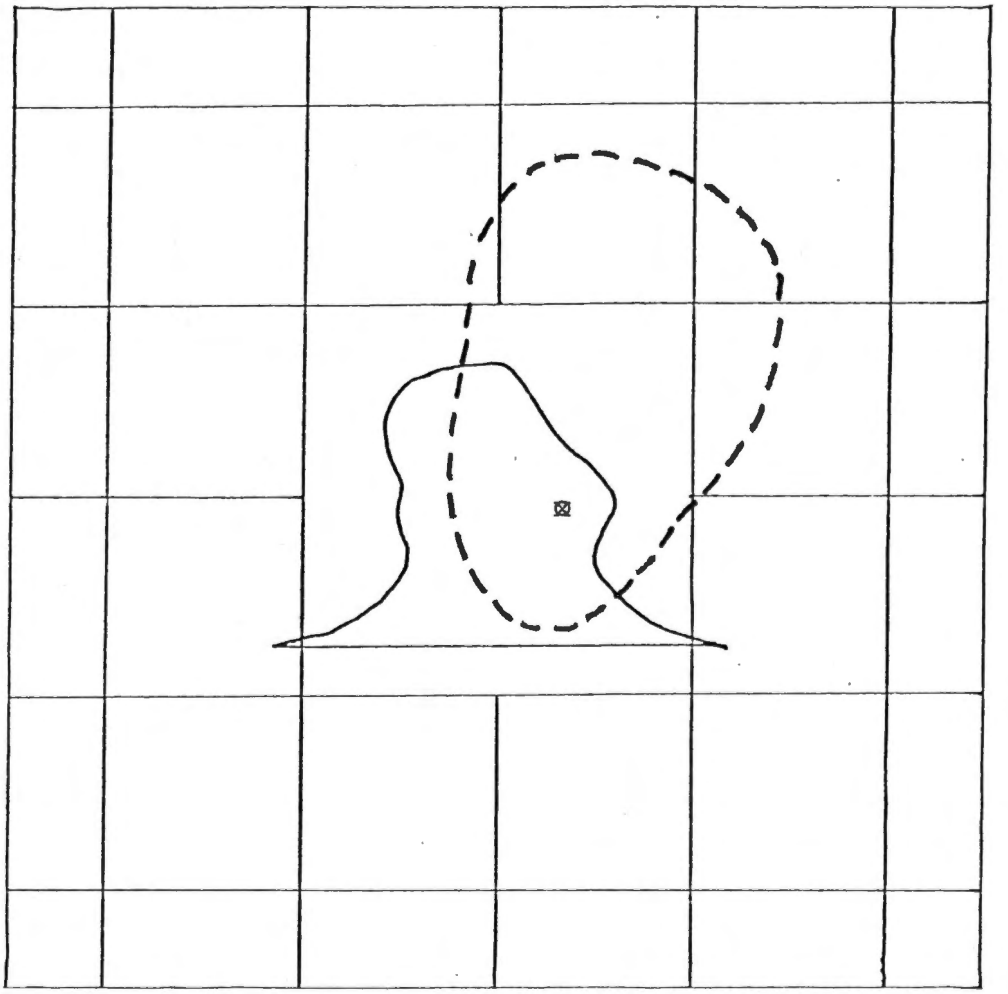

Figure B10. Territory of Tufted Titmouse in HP2 showing location of nest site, 1976.

One complete territory.

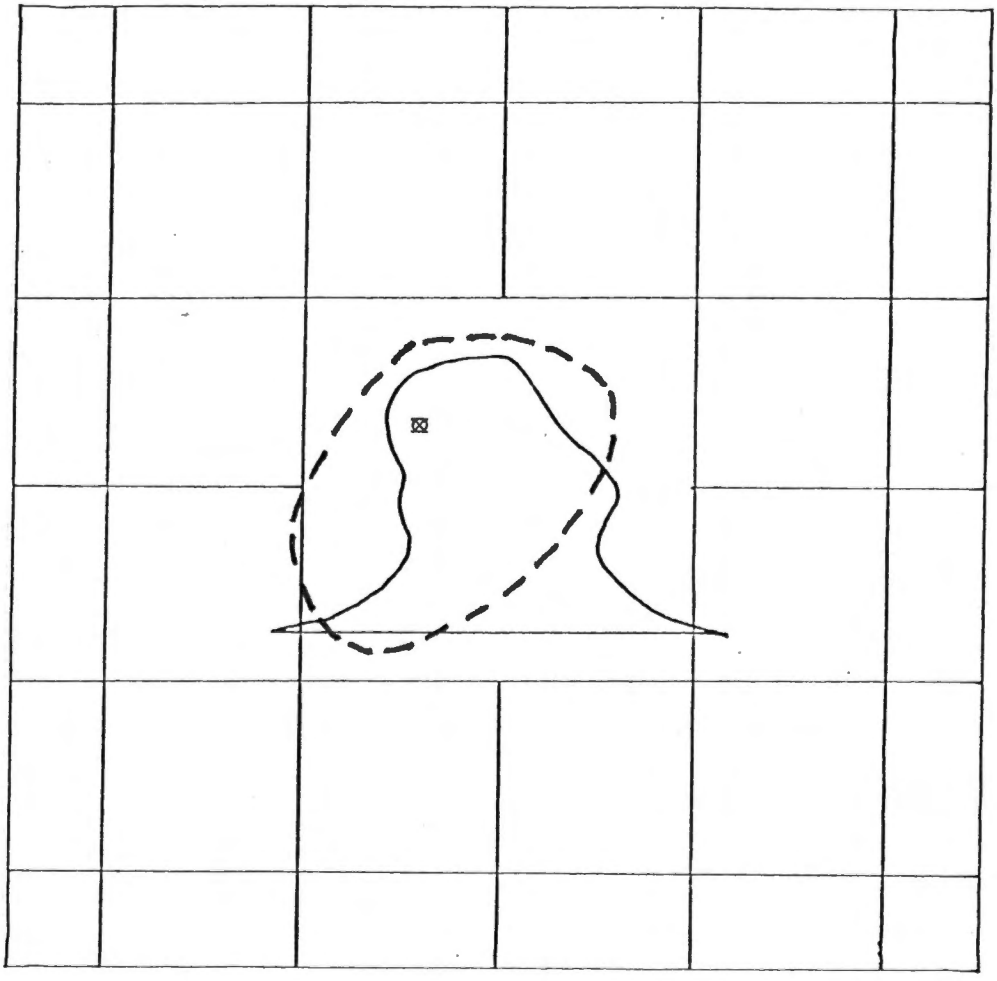

Figure B11. Territory of Cardinal in HP2 showing location of nest site, 1976.

One complete territory.

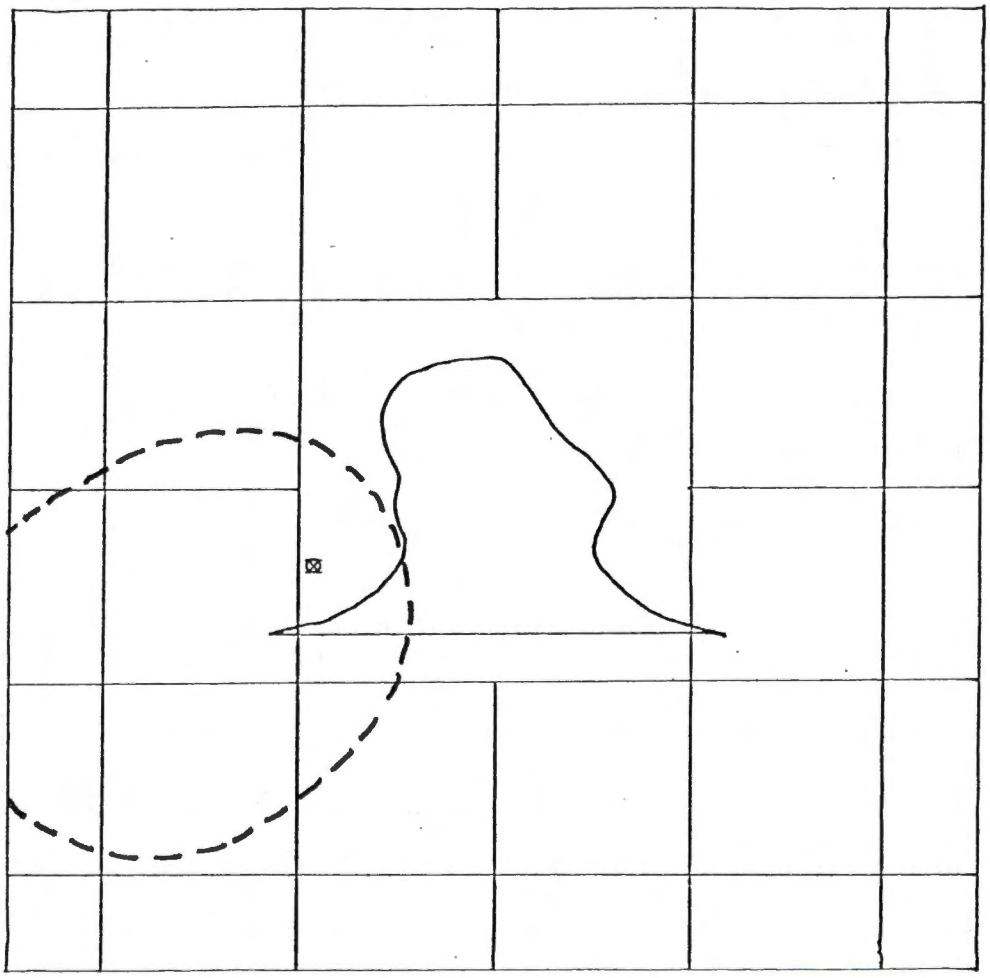

Figure B12. Territory of Brown-headed Nuthatch in PS2 showing location of nest site, 1976.

One complete territory.

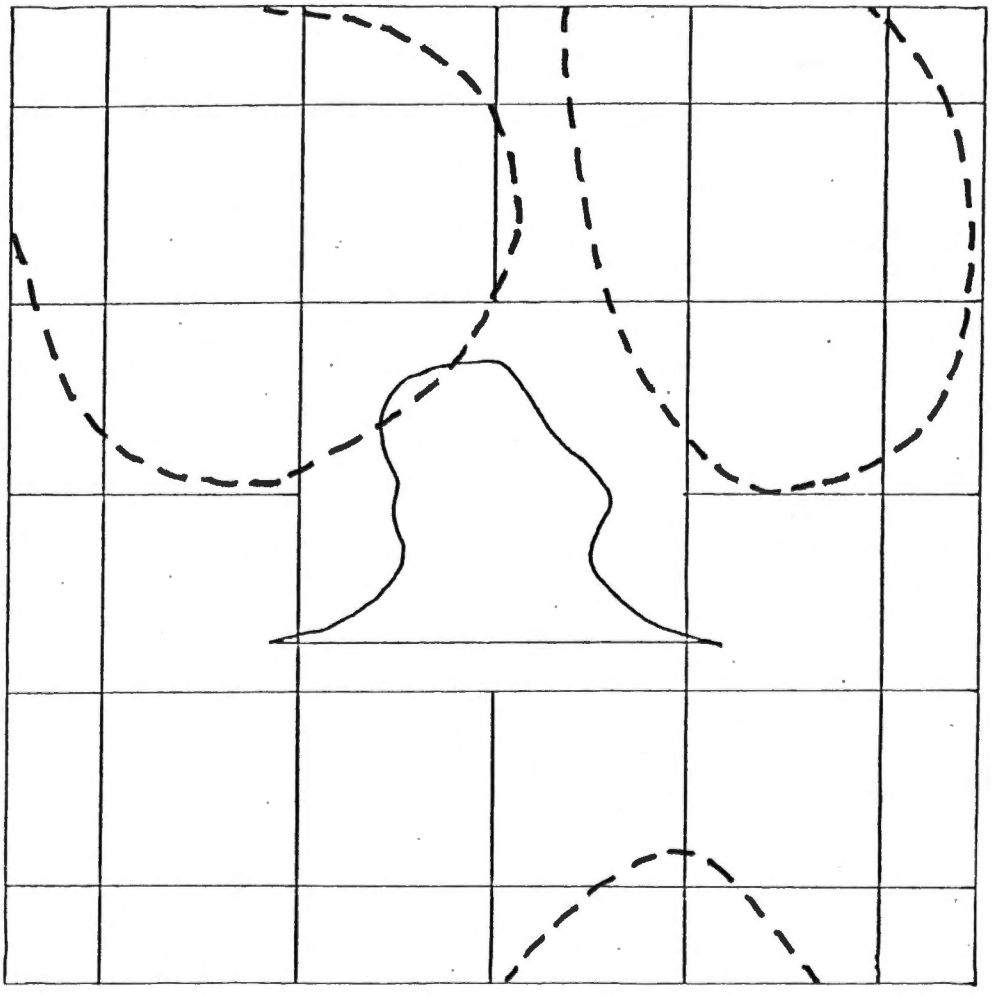

Figure B13. Territories of Pine Warbler in PS2, 1976.

Two complete territories and one partial territory.

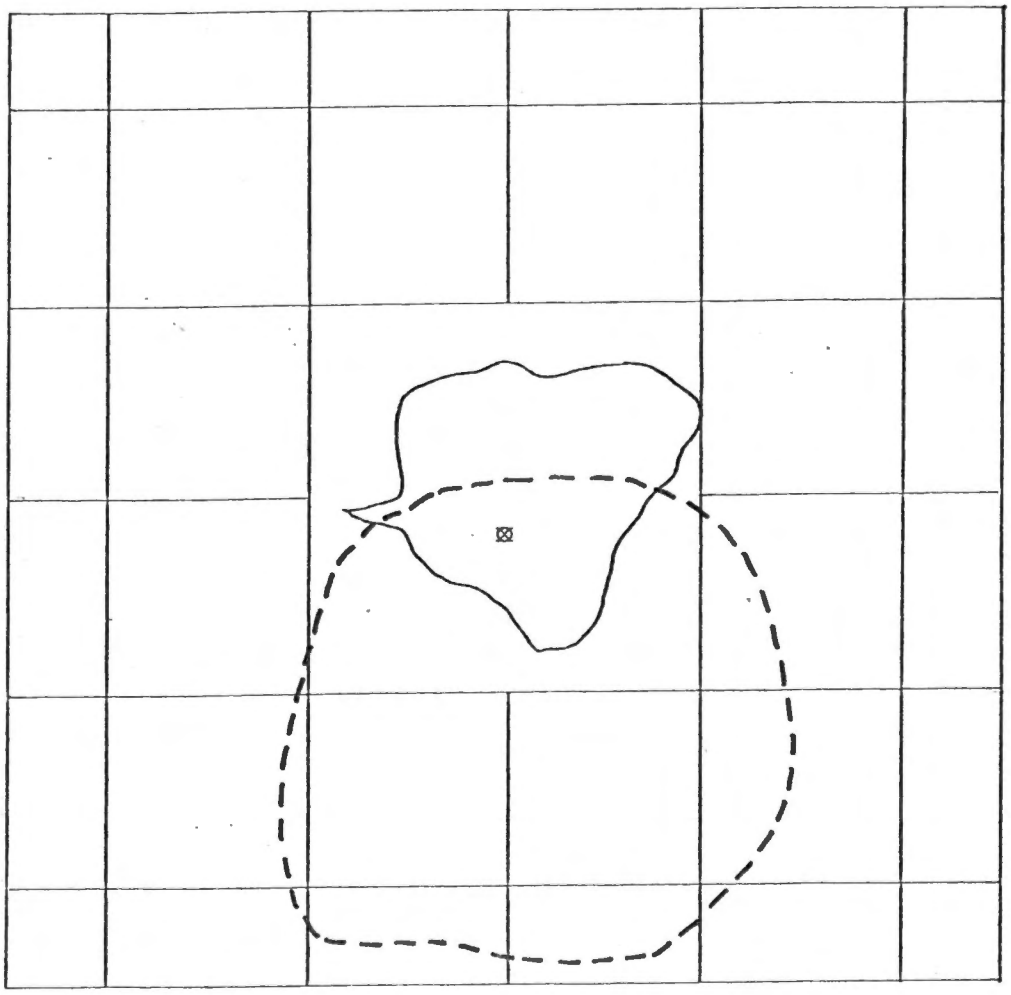

Figure B14. Territory of Carolina Chickadee in HP3 showing location of nest site, 1976.

One complete territory.

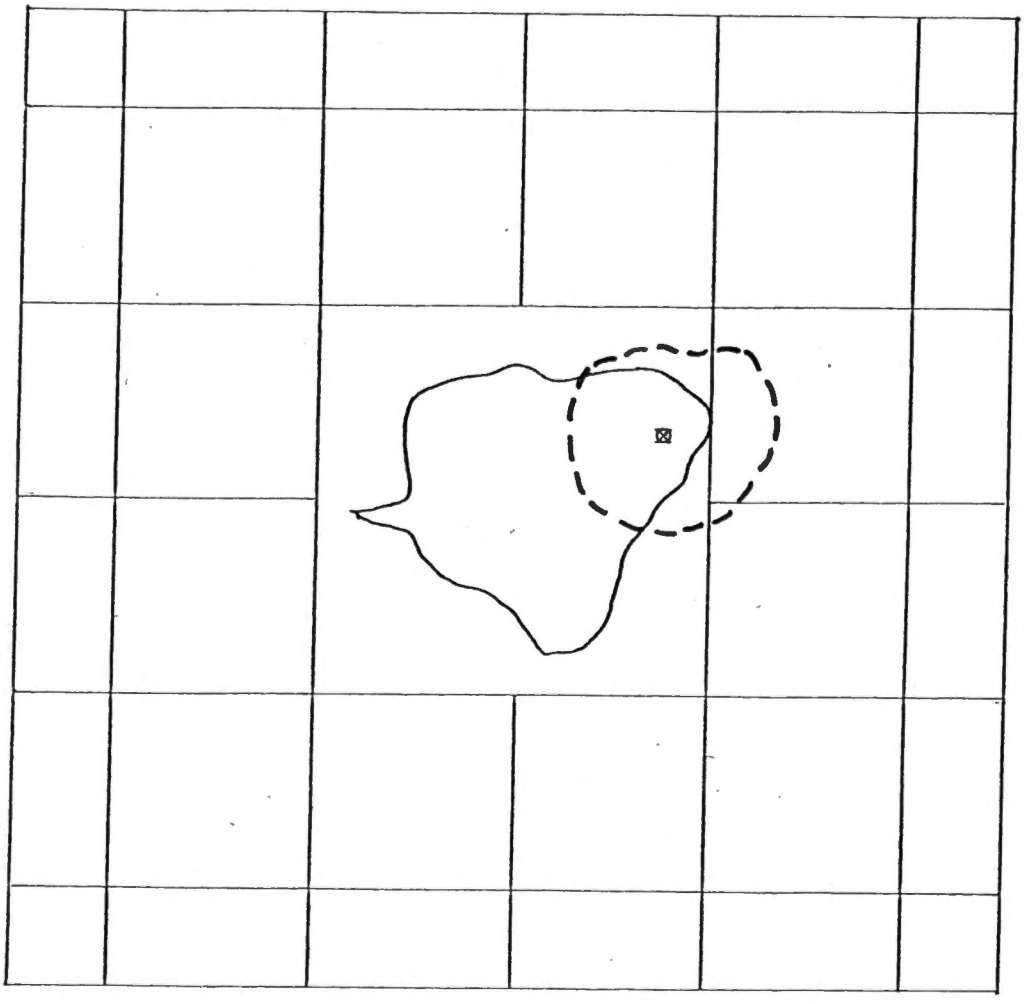

Figure B15. Territory of Carolina Wren in HP3 showing location of nest site, 1976.

One complete territory.

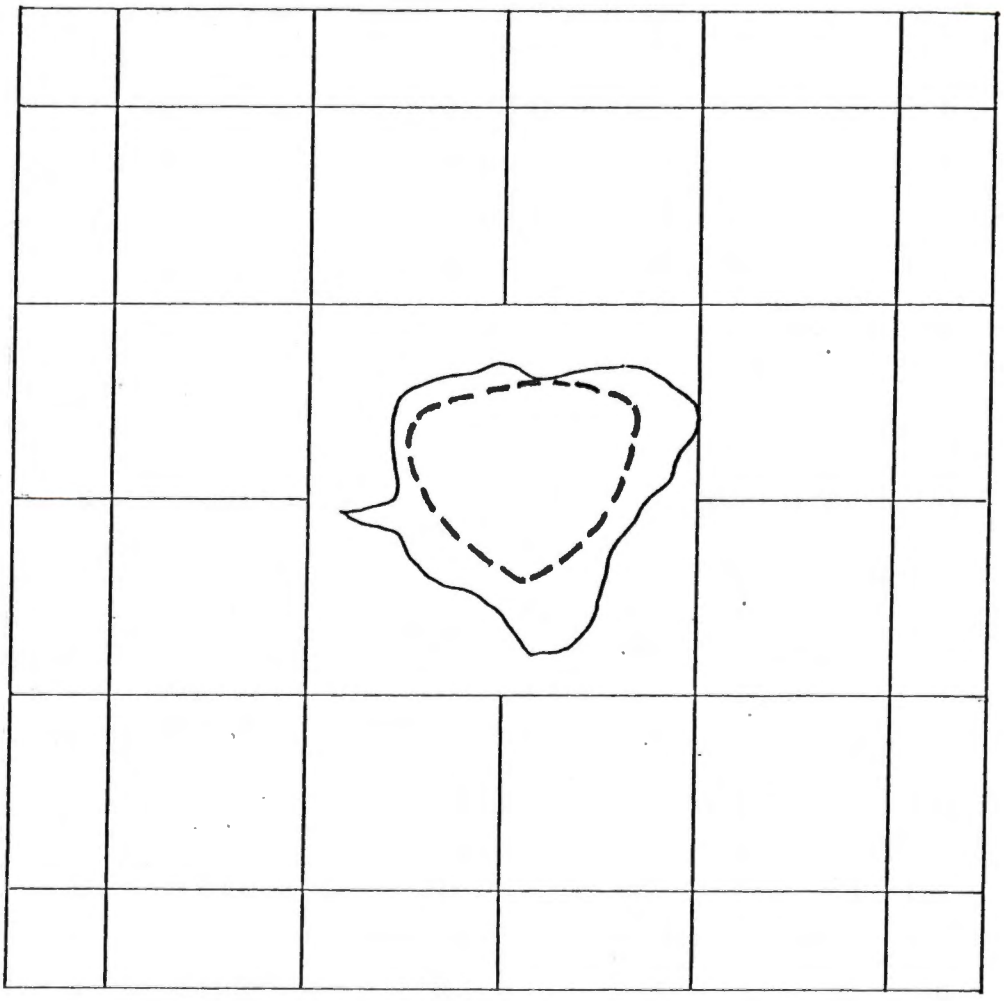

Figure B16. Territory of White-eyed Vireo in HP3, 1976.

One complete territory.

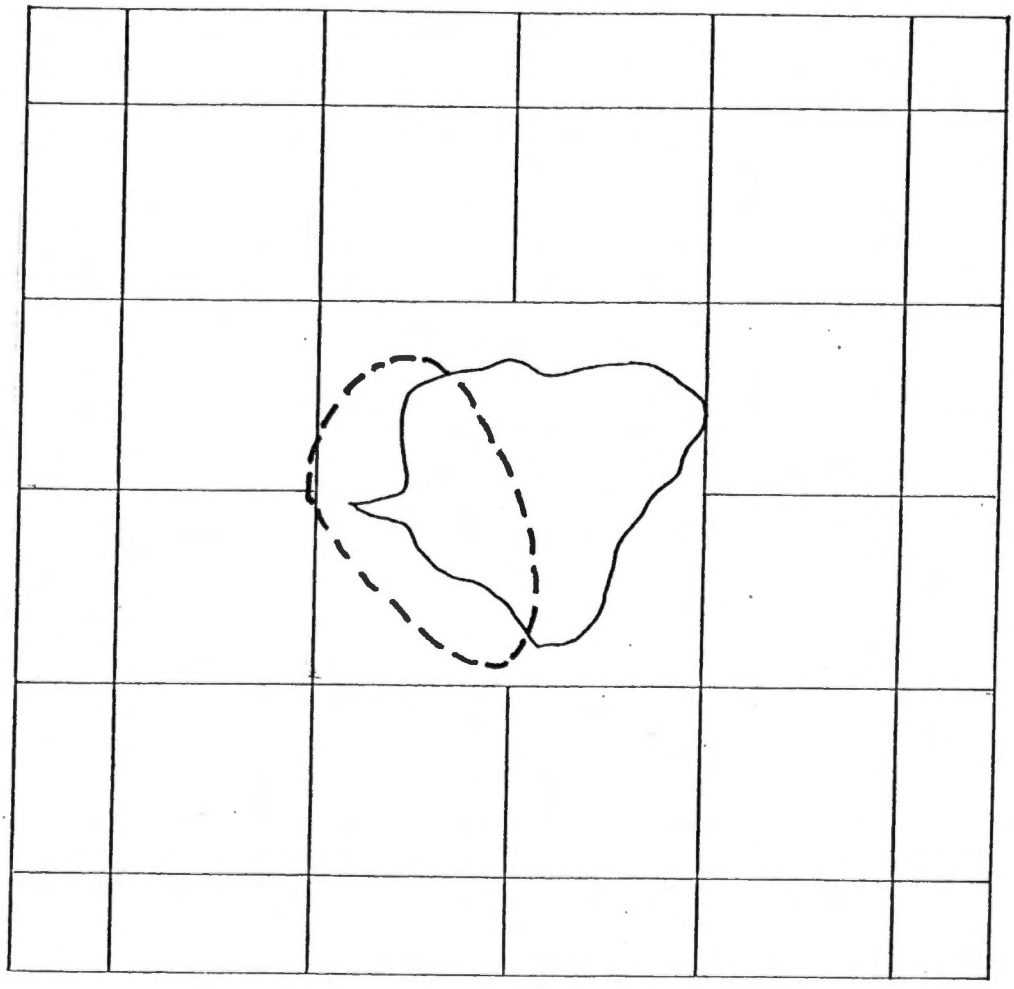

Figure B17. Territory of Red-eyed Vireo in HP3, 1976.

One complete territory.

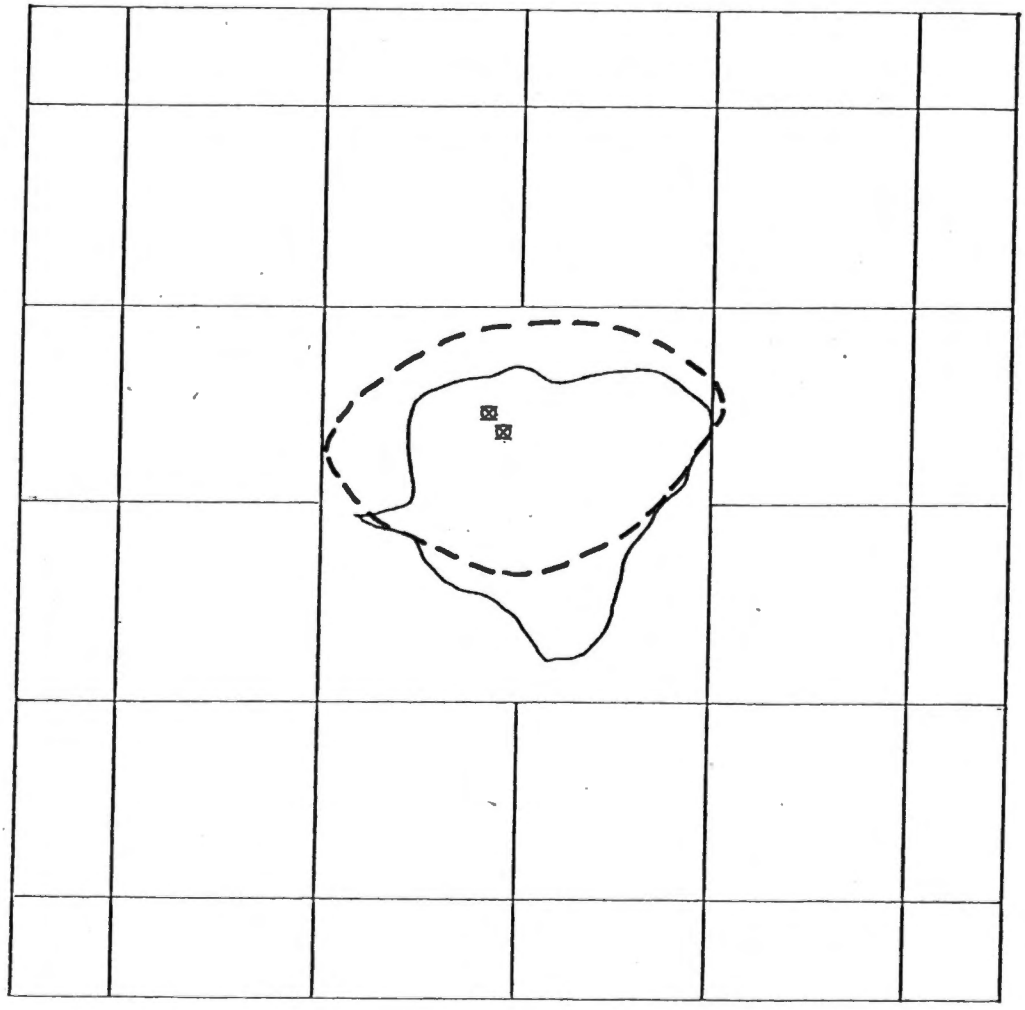

Figure B18. Territory of Cardinal in HP3 showing location of nest sites, 1976.

One complete territory.

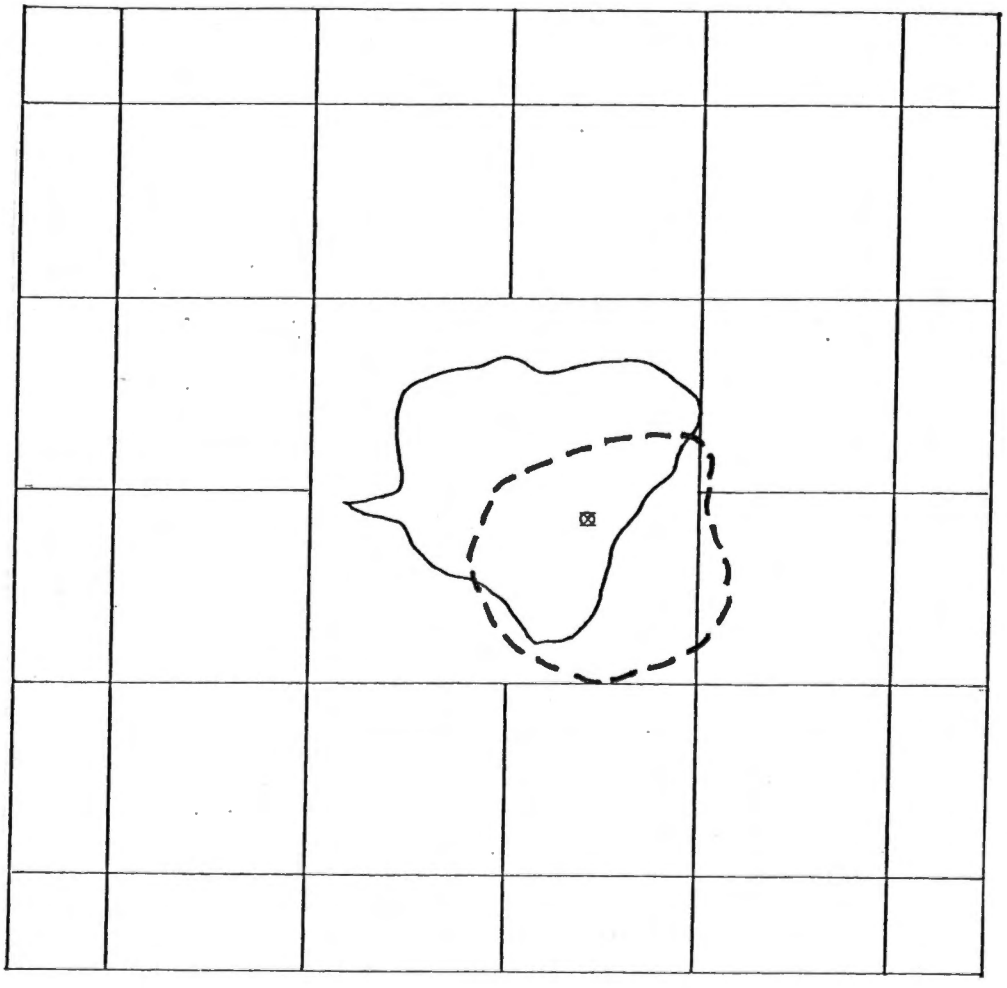

Figure B19. Territory of Rufous-sided Towhee in HP3 showing location of nest site, 1976.

One complete territory.

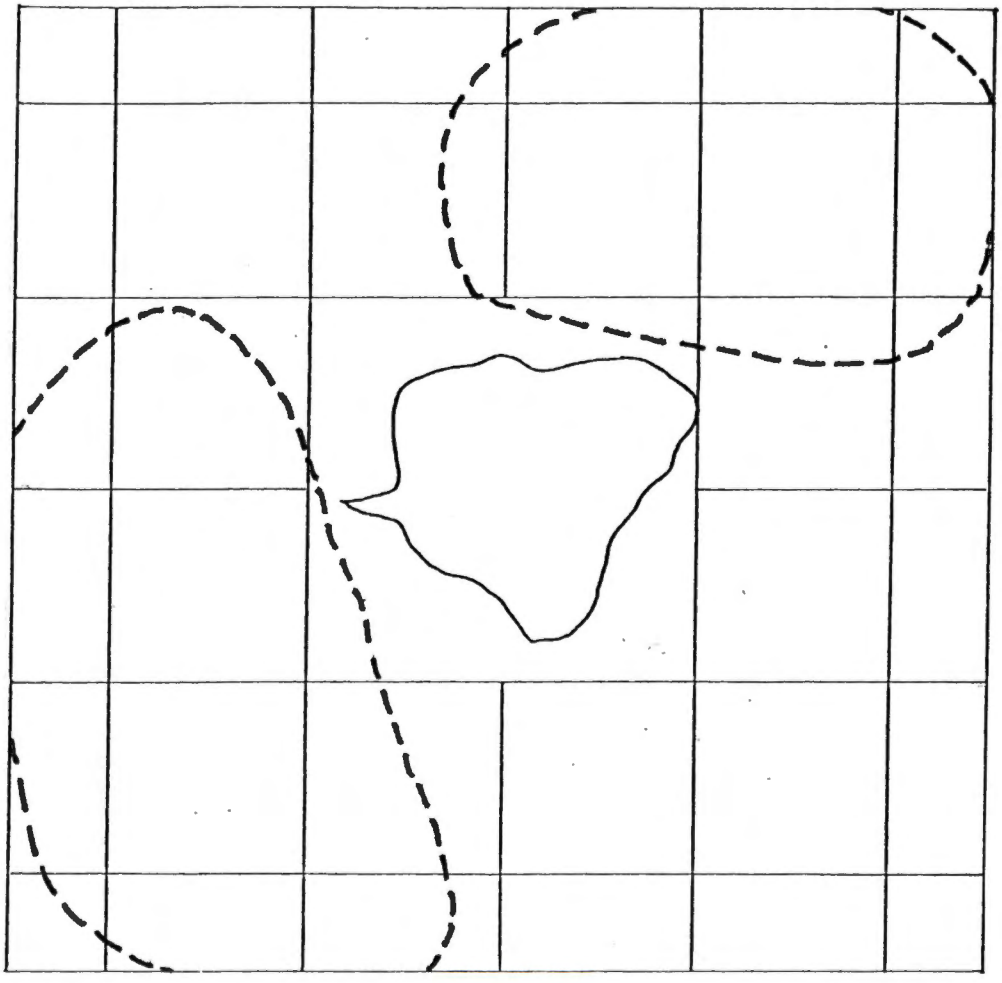

Figure B20. Territories of Brown-headed Nuthatch in PS3, 1976.

Two complete territories.

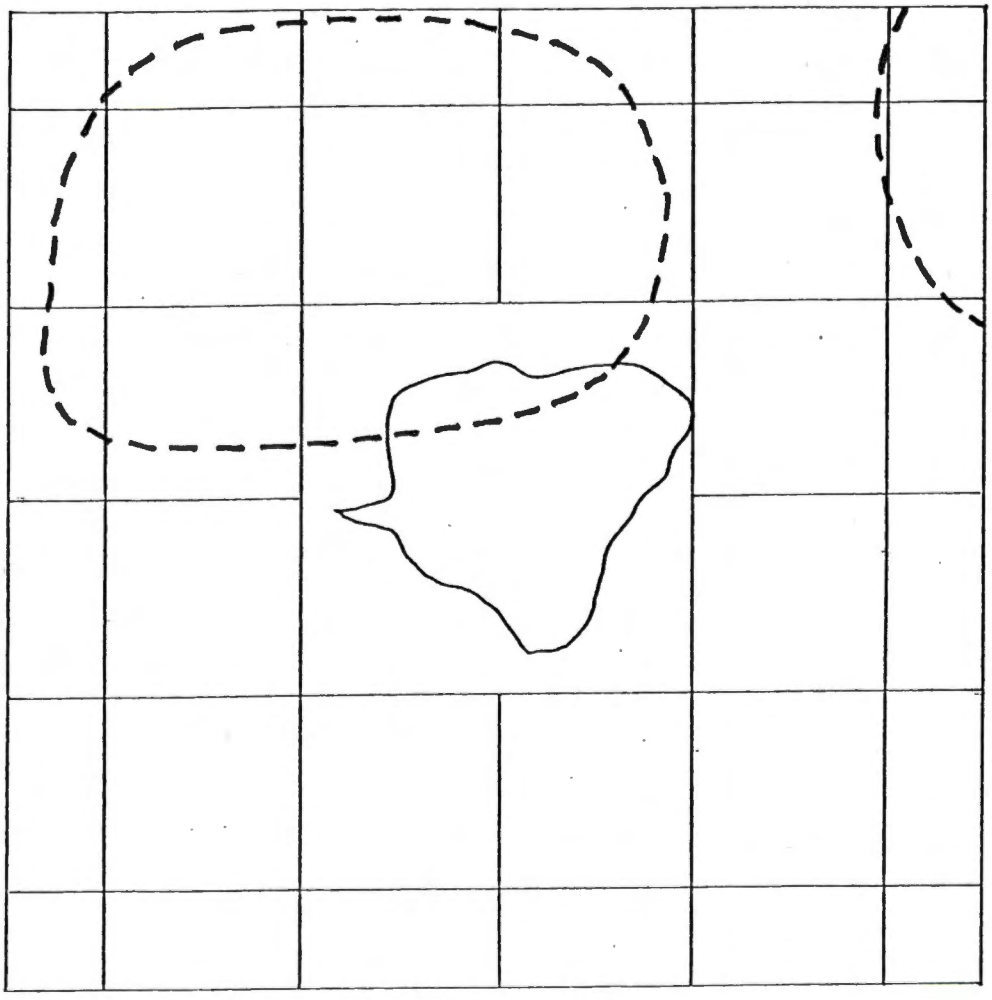

Figure B21. Territories of Pine Warbler in PS3, 1976.

One complete territory and one partial territory.

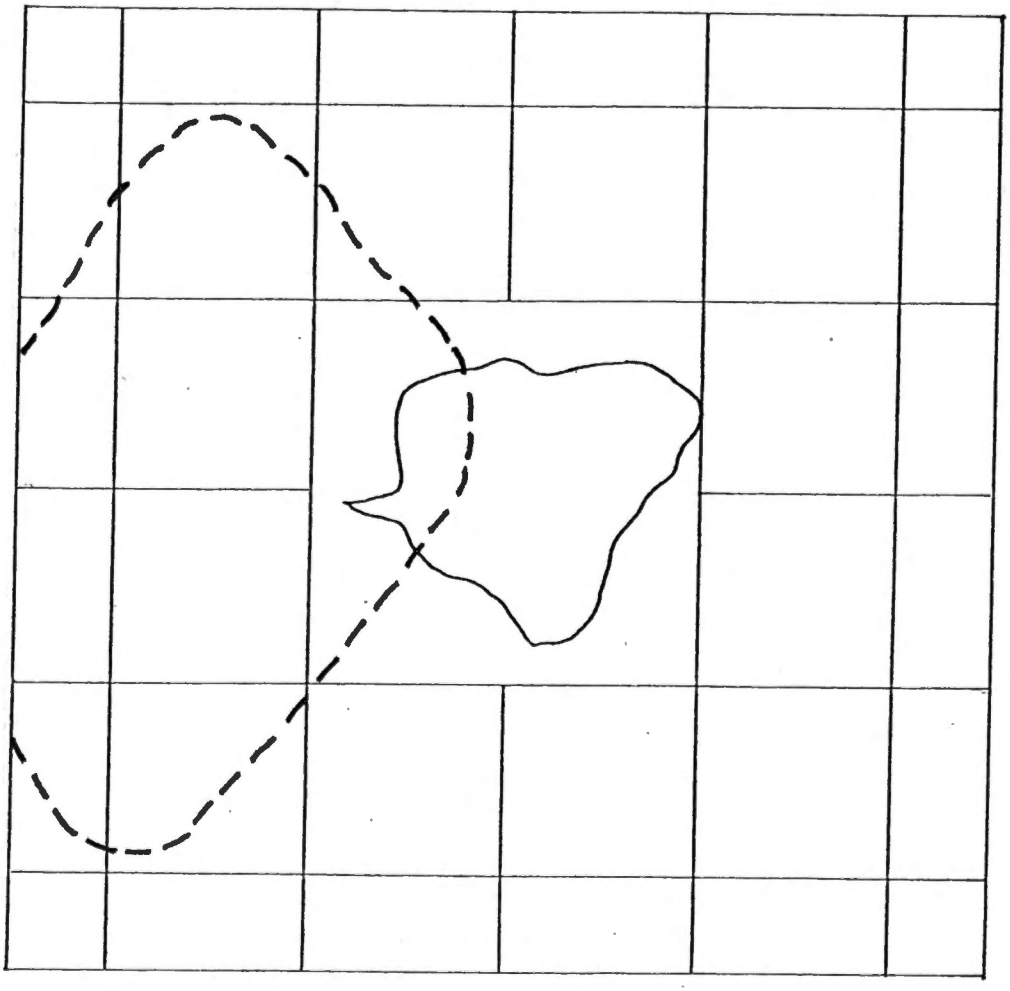

Figure B22. Territory of Summer Tanager in PS3, 1976.

One complete territory.

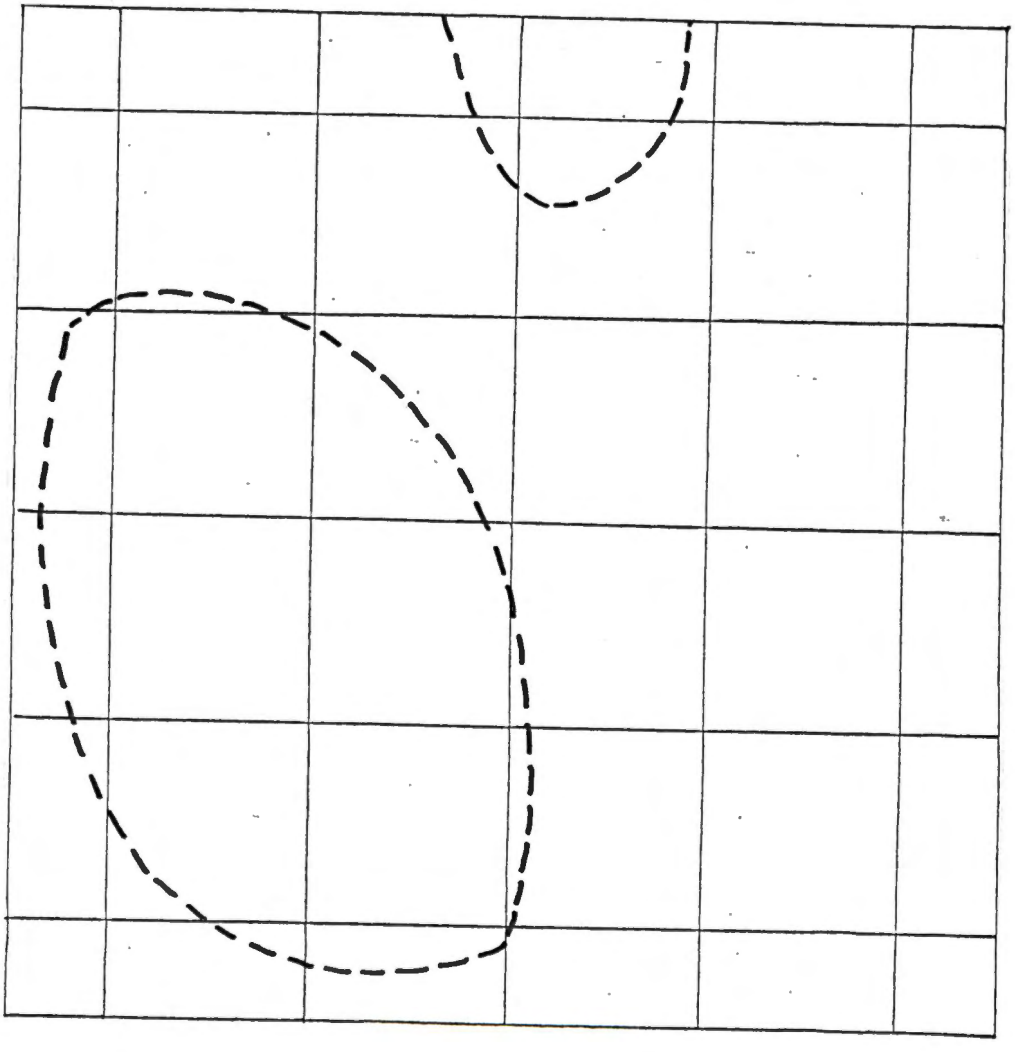

Figure B23. Territories of Brown-headed Nuthatch in PS4, 1976.

One complete territory and one partial territory.

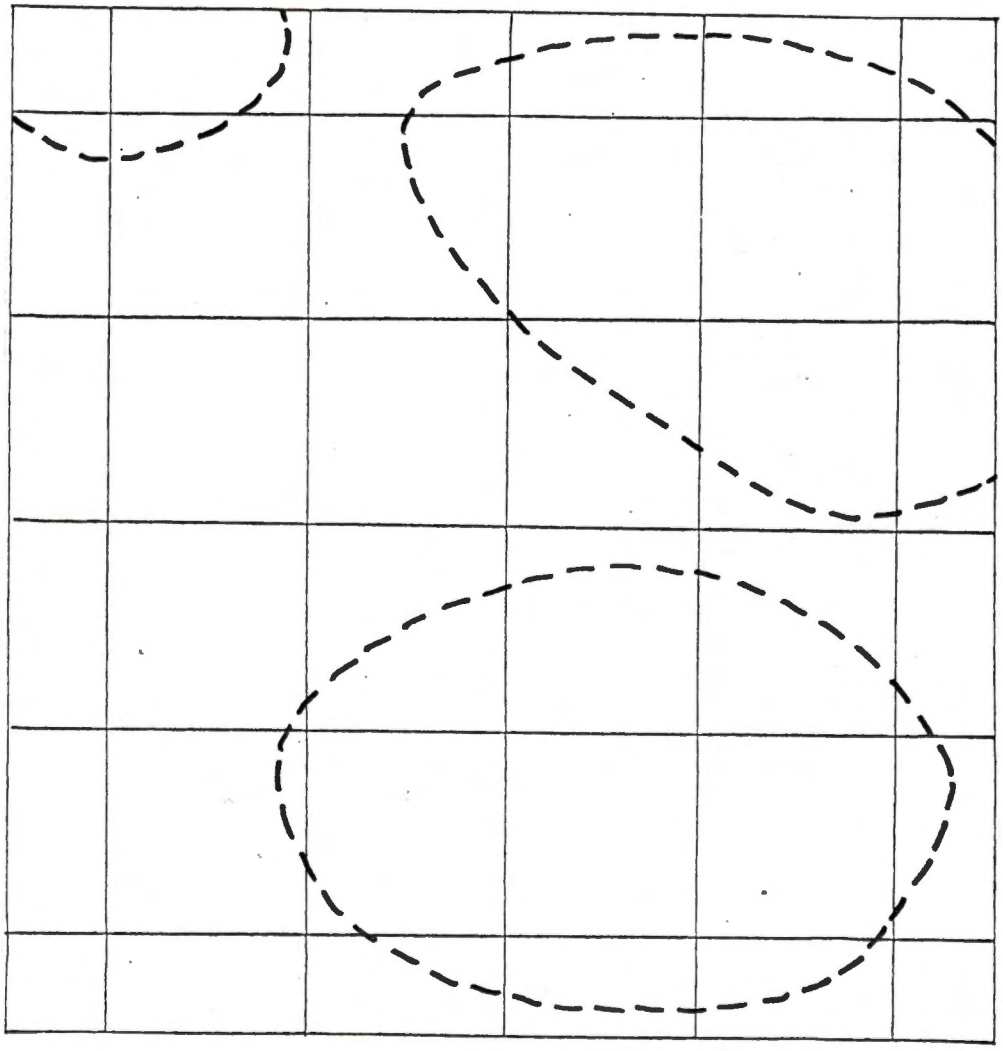

Figure B24. Territories of Pine Warbler in PS4, 1976.

Two complete territories and one partial territory.

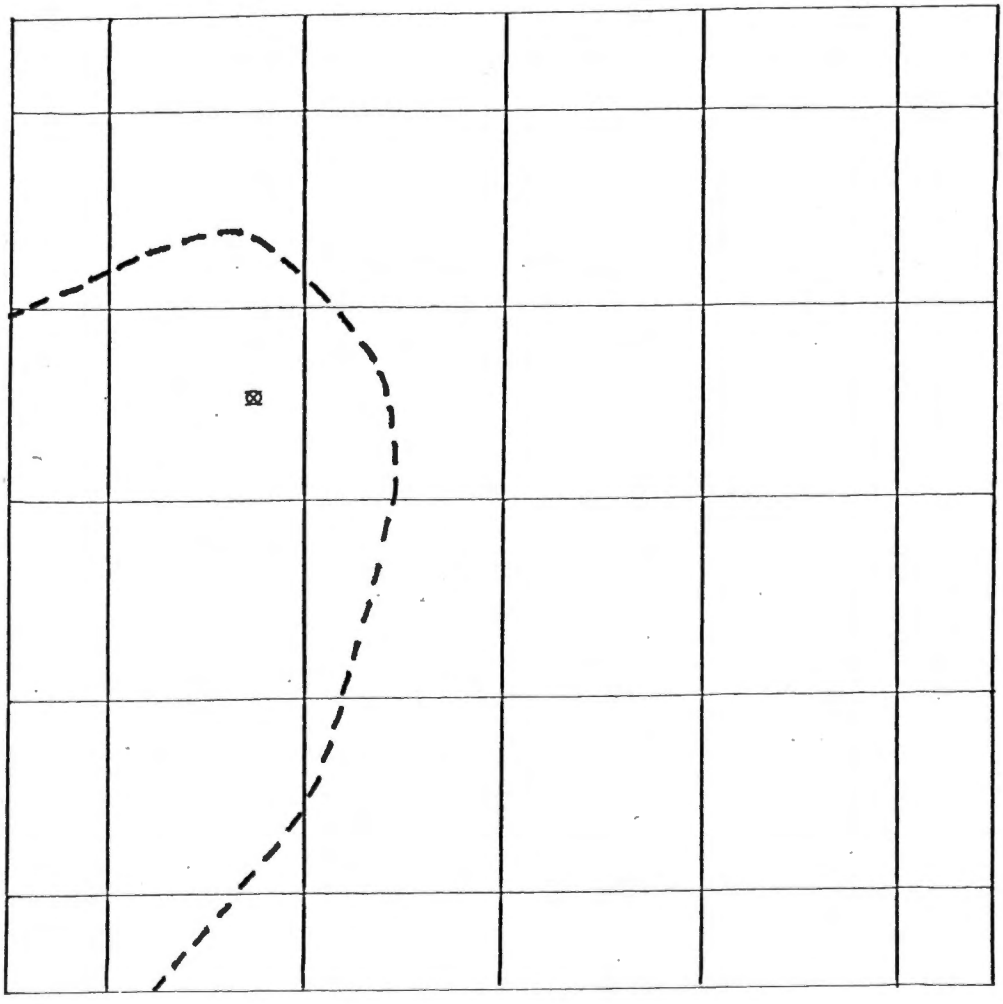

Figure B25. Territory of Red-bellied Woodpecker in PS5 showing location of nest site, 1976.

One complete territory.

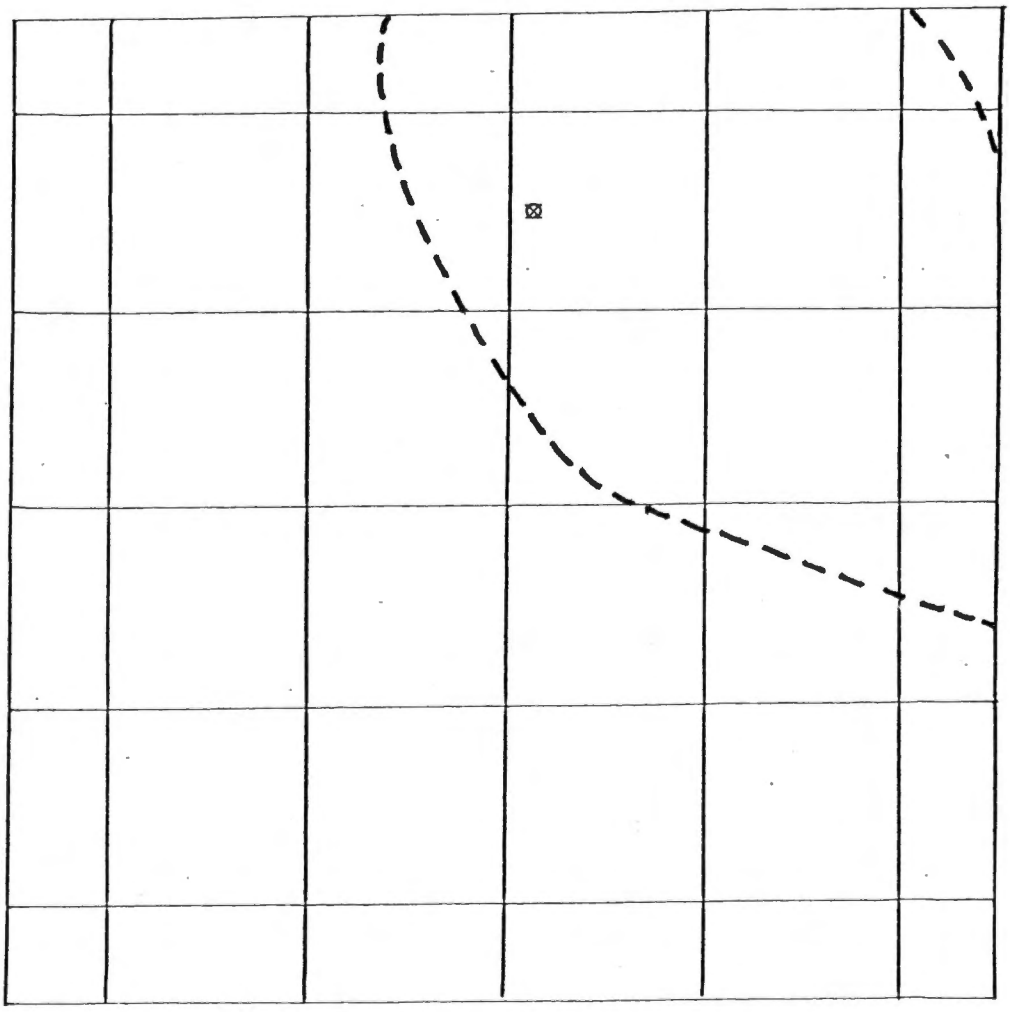

Figure B26. Territory of Downy Woodpecker in PS5 showing location of nest site, 1976.

One complete territory.

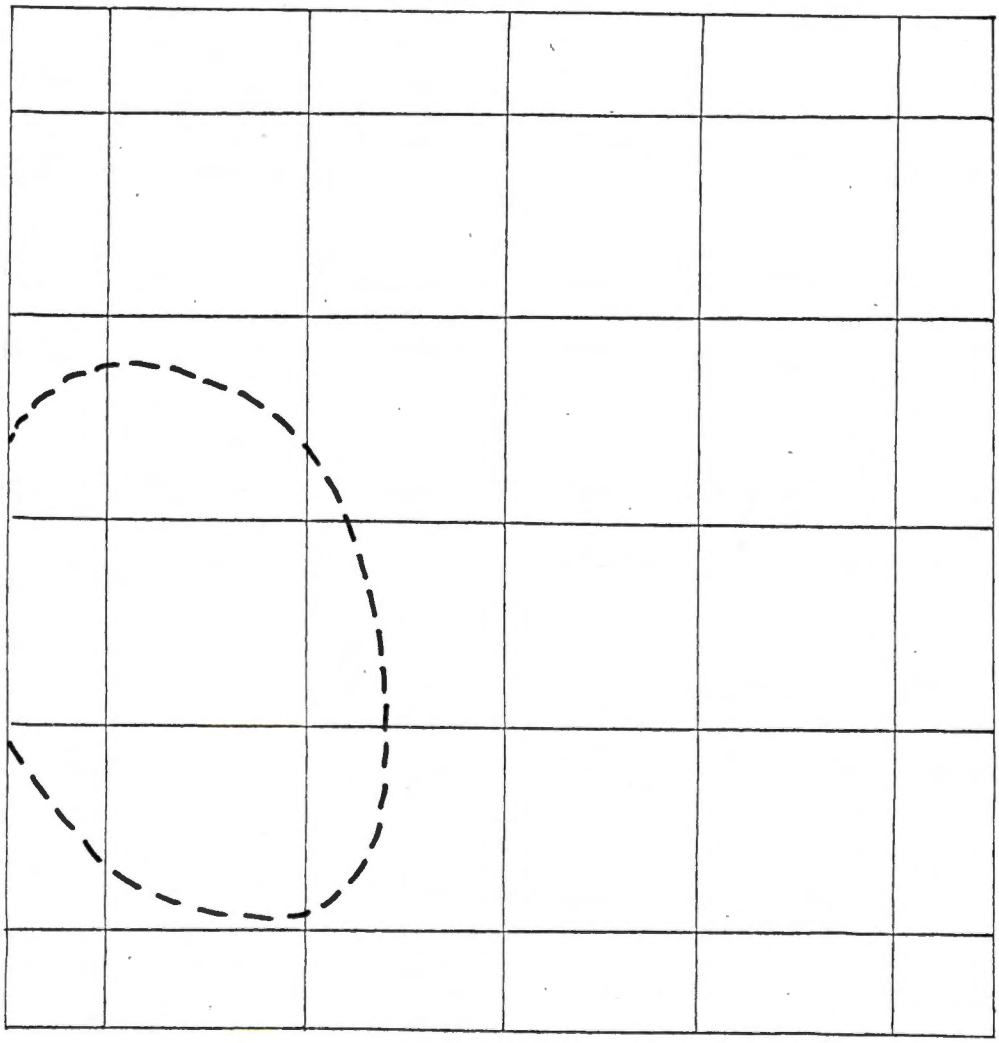

Figure B27. Territory of Brown-headed Nuthatch in PS5, 1976.

One complete territory.

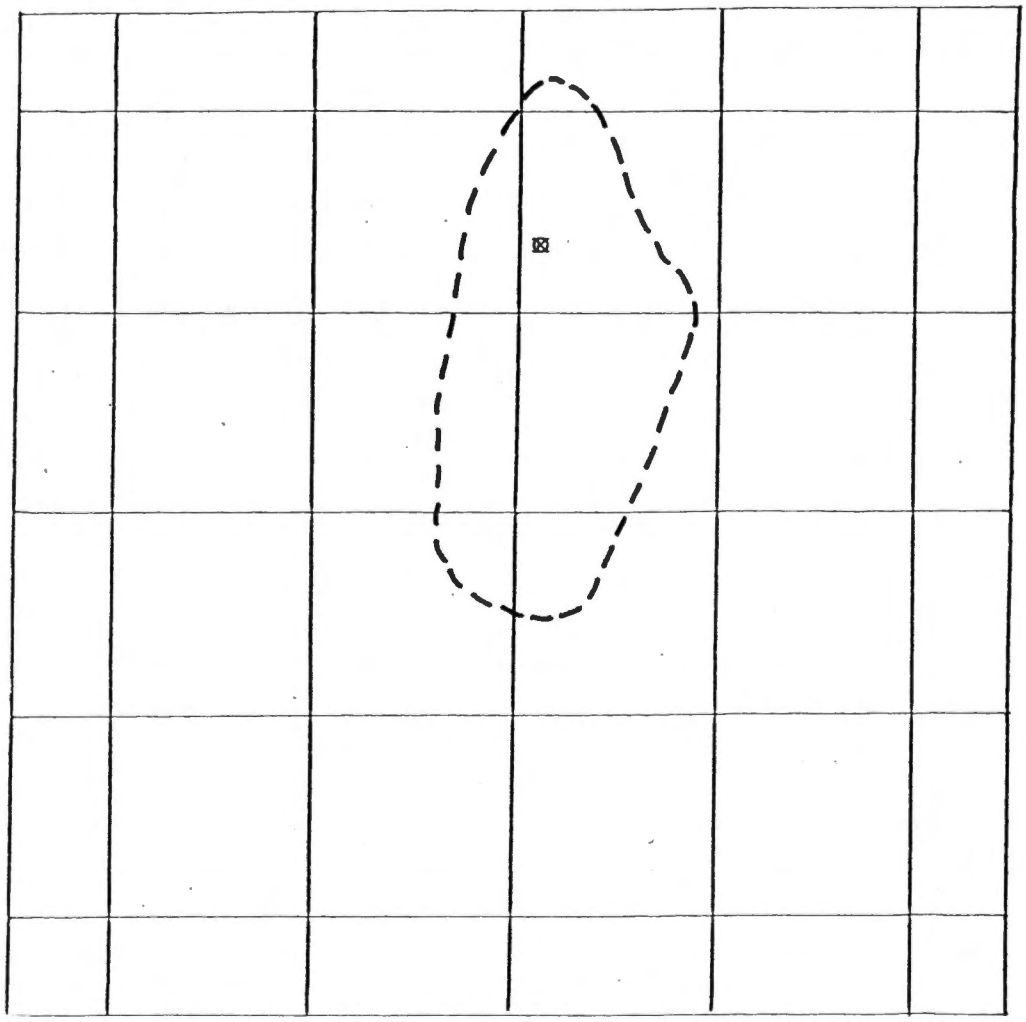

Figure B28. Territory of Eastern Bluebird in PS5 showing location of nest site, 1976.

One complete territory.

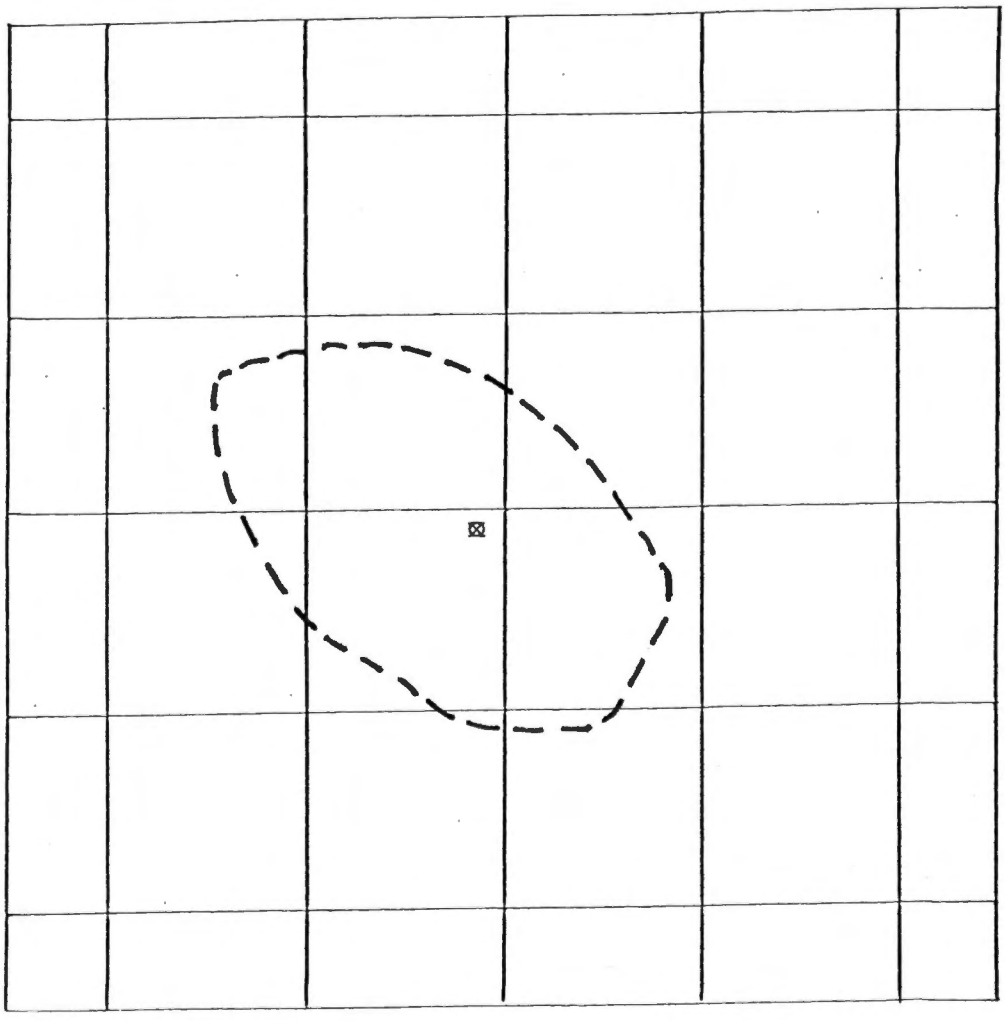

Figure B29. Territory of Rufous-sided Towhee in PS5 showing location of nest site, 1976.

One complete territory.

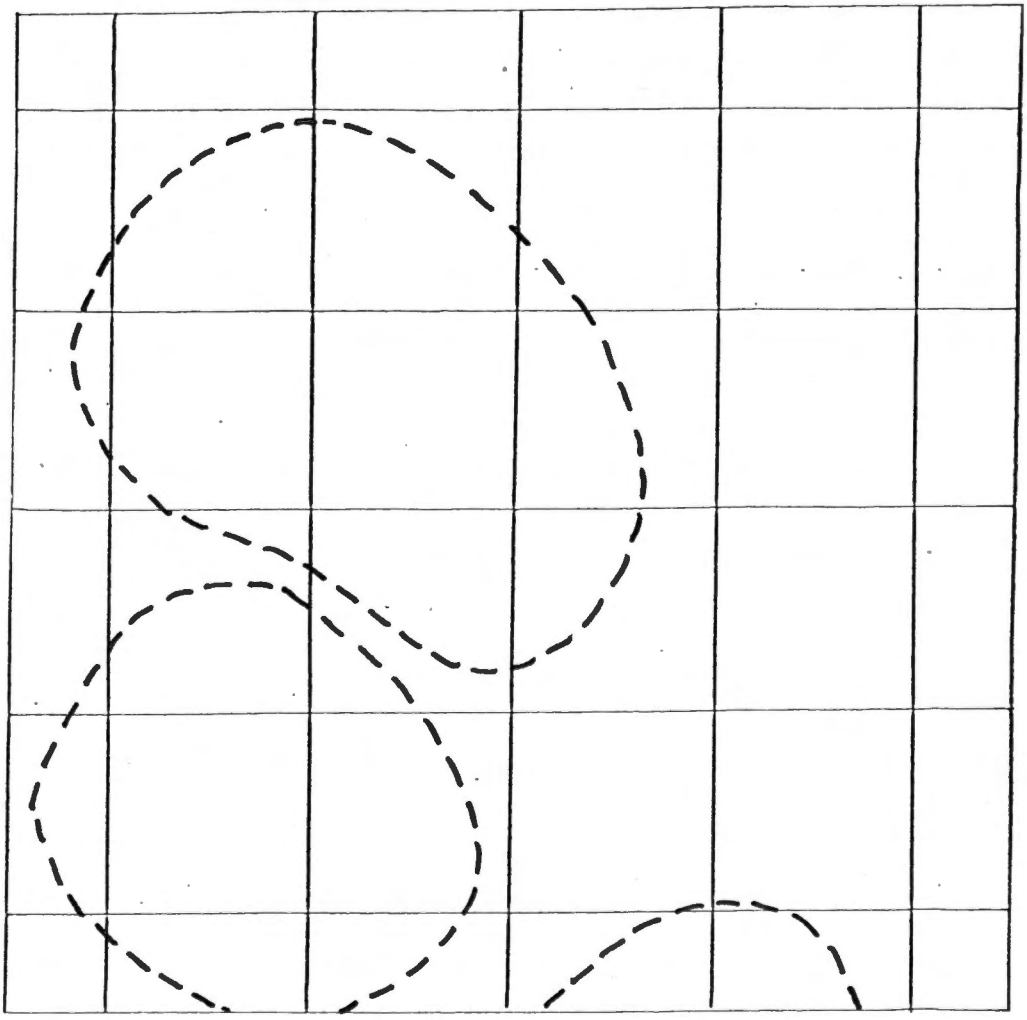

Figure B30. Territories of Pine Warbler in PS5, 1976.

Two complete territories and one partial territory.

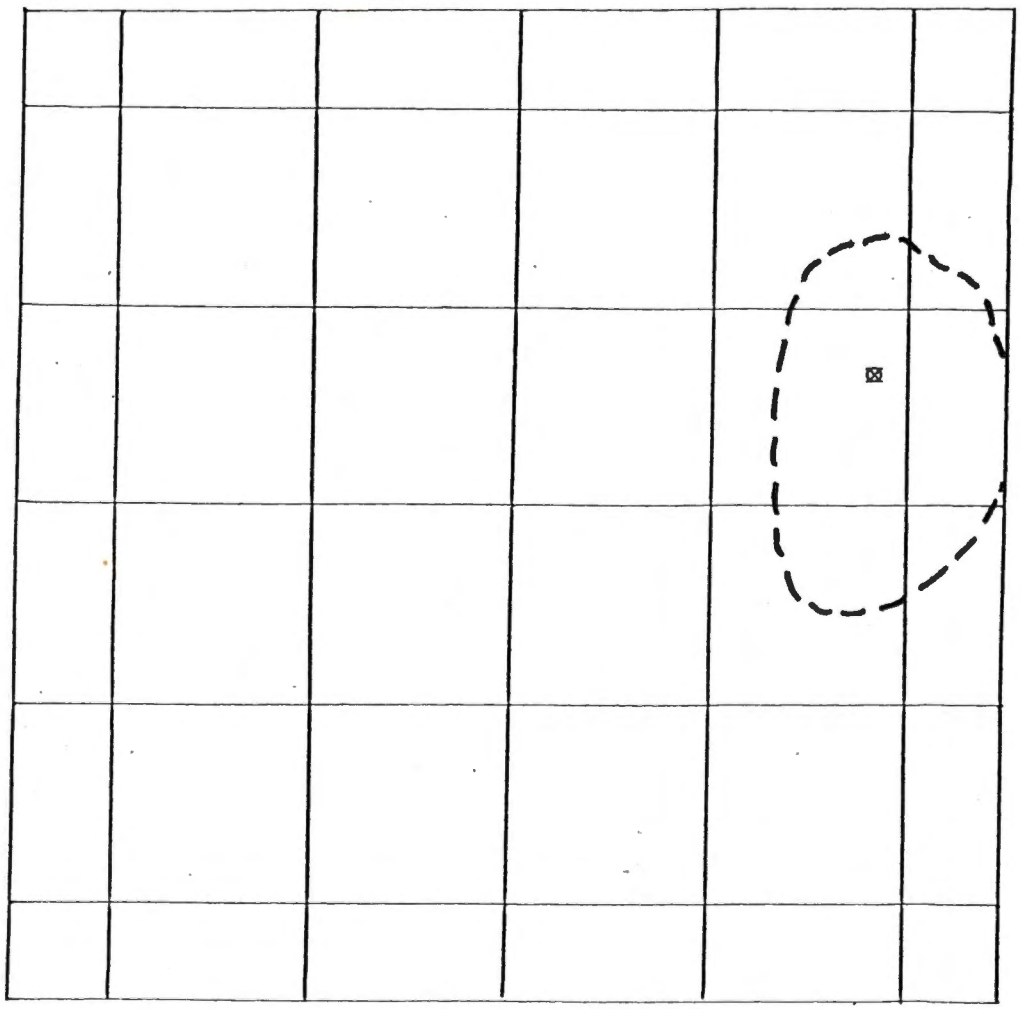

Figure B31. Territory of Prairie Warbler in PS5 showing location of nest site, 1976.

One complete territory.

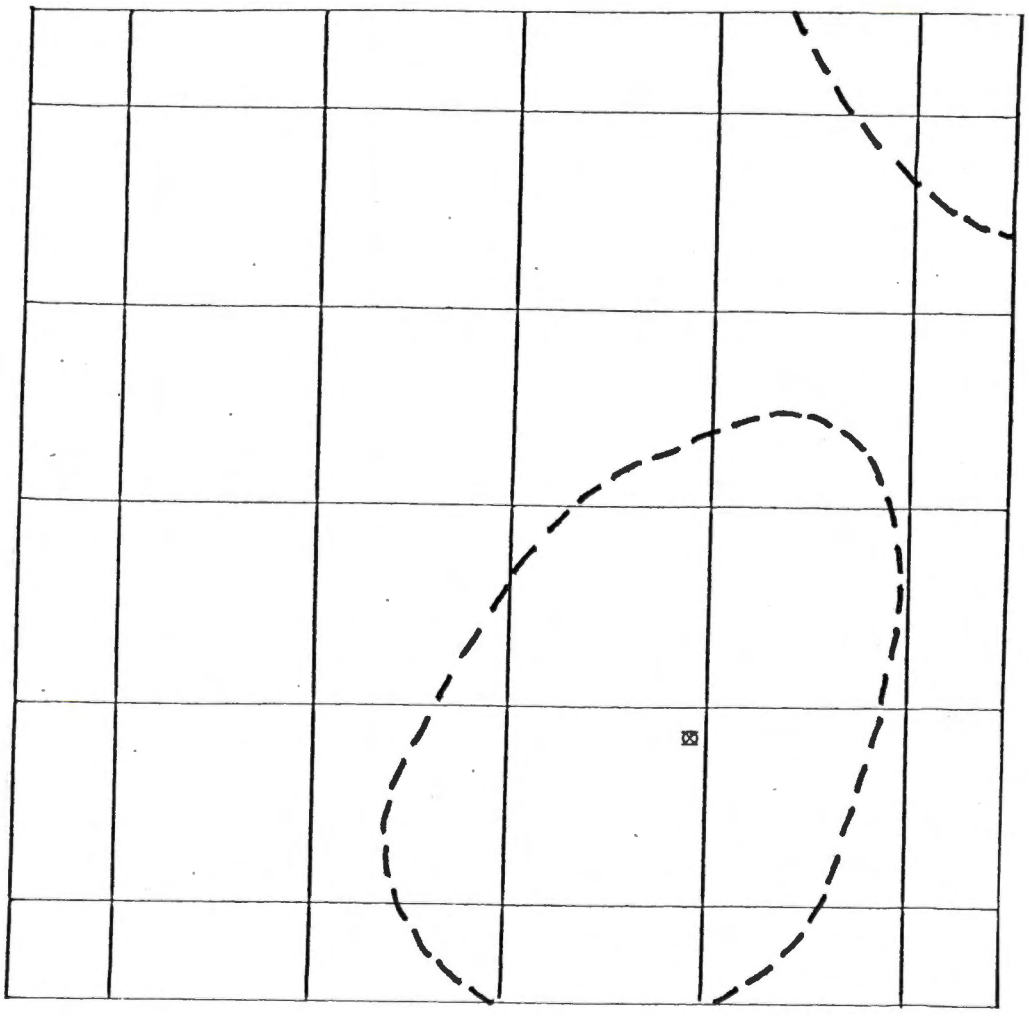

Figure B32. Territories of Summer Tanager in PS5 showing location of nest site, 1976.

One complete territory and one partial territory.

APPENDIX C

SPECIES ACCOUNTS

Accounts of nest information for breeding pairs, Savannah River Plant, 1976. Listed in phylogenetic order.

Common Flicker

HP2--five eggs found on April 29, observed four young on May 28
height--8 meters, dbh--18.3 cm
location--slash pine

Red-bellied Woodpecker

HP2--number of eggs unknown, observed four young on May 5
height--17 meters, dbh--27.3 cm
location--pine, species unknown, cavity entrances numbered five indicating repeated use

PS5--four eggs found on April 21, observed four young on May 20
height--6.8 meters, dbh--14.1 cm
location--slash pine with ice damage

Downy Woodpecker

PS5--number of eggs unknown, observed two young on June 4
height--9.7 meters, dbh--16.3 cm
location--pine (species unknown)

Carolina Chickadee

HP1--six eggs found on April 16, observed four young on April 28
height--2.7 meters, dbh--11.3 cm
location--black cherry

HP2--five eggs found on April 6, observed four young on April 29
height--2.0 meters, dbh--10.7 cm
location--loblolly pine

HP3--six eggs found on April 19, observed five young on May 6
height--3.1 meters, dbh--12.1 cm
location--persimmon

Tufted Titmouse

HP2--five eggs found on April 29, nest abandoned and partly destroyed on May 5
height--3.7 meters, dbh--16.3 cm
location--hophornbeam

Brown-headed Nuthatch

PS2--four eggs found on April 12, observed four young on May 11
height--1.5 meters, dbh--11.1 cm
location--pine (species unknown)

Carolina Wren

HP1 a) six eggs found on April 5, observed four young on April 22
b) five eggs found on May 20, observed four young on May 27
a) height--1.9 meters, b) height--1.3 meters
a) location--bramble, b) location--bramble

HP3-- six eggs found on April 21, observed three young on May 12
height--1.1 meters
location--honeysuckle

Eastern Bluebird

PS5--four eggs found on May 20, observed four young on June 14
height--2.5 meters, dbh--14.1 cm
location--slash pine

Prairie Warbler

PS5--number of eggs unknown, observed two young birds on May 13.
height--3 meters, dbh--13.2 cm.
location--slash pine

Summer Tanager

PS5--number of eggs unknown, nest gone on May 14
height--10.4 meters, dbh--17.9 cm
location--slash pine

Cardinal

HP1-- two eggs found on June 21, observed two young on July 13
height--1.9 meters
location--bramble

HP2-- four eggs found on April 23, observed three young on May 17
height--1.4 meters
location--greenbrier

HP3 a) three eggs found on April 13, observed three young on May 6
height--2.1 meters
location--sumac overgrown with honeysuckle

b) three eggs found on June 11, nest found destroyed on June 17. Found within two meters of nest 'a' in the same thicket

Rufous-sided Towhee

HP3--five eggs found on April 19, observed three young on May 6
height--0.4 meter
location--hawthorn shrub with honeysuckle

PS5--five eggs found on April 27, observed four young on May 3
height--0.8 meter
location--bramble shrub in moist depression

VITA

Peter George Poulos was born in Columbia, South Carolina, on June 1, 1947. He graduated from Dreher High School in June 1965, and the following September entered The University of South Carolina. In June 1968, he began a four year tour of duty with the United States Navy, serving at the United States Naval Academy and in the Republic of South Vietnam.

After the completion of his naval service, he entered Anne Arundel College, receiving an Associate Degree in General Studies in December 1973. In January 1974, he entered The University of Maryland and received a Bachelor of Science degree in Conservation and Resource Development in May 1975. In the fall of 1975, he entered The University of Tennessee to pursue a Master's degree in Wildlife Science. This degree was awarded in the fall of 1977. At The University of Tennessee, he served as a teaching assistant. His research was supported by a grant of the United States Forest Service.

Mr. Poulos is a member of Alpha Zeta, Phi Theta Kappa, The American Ornithologist Union and The Wildlife Society.