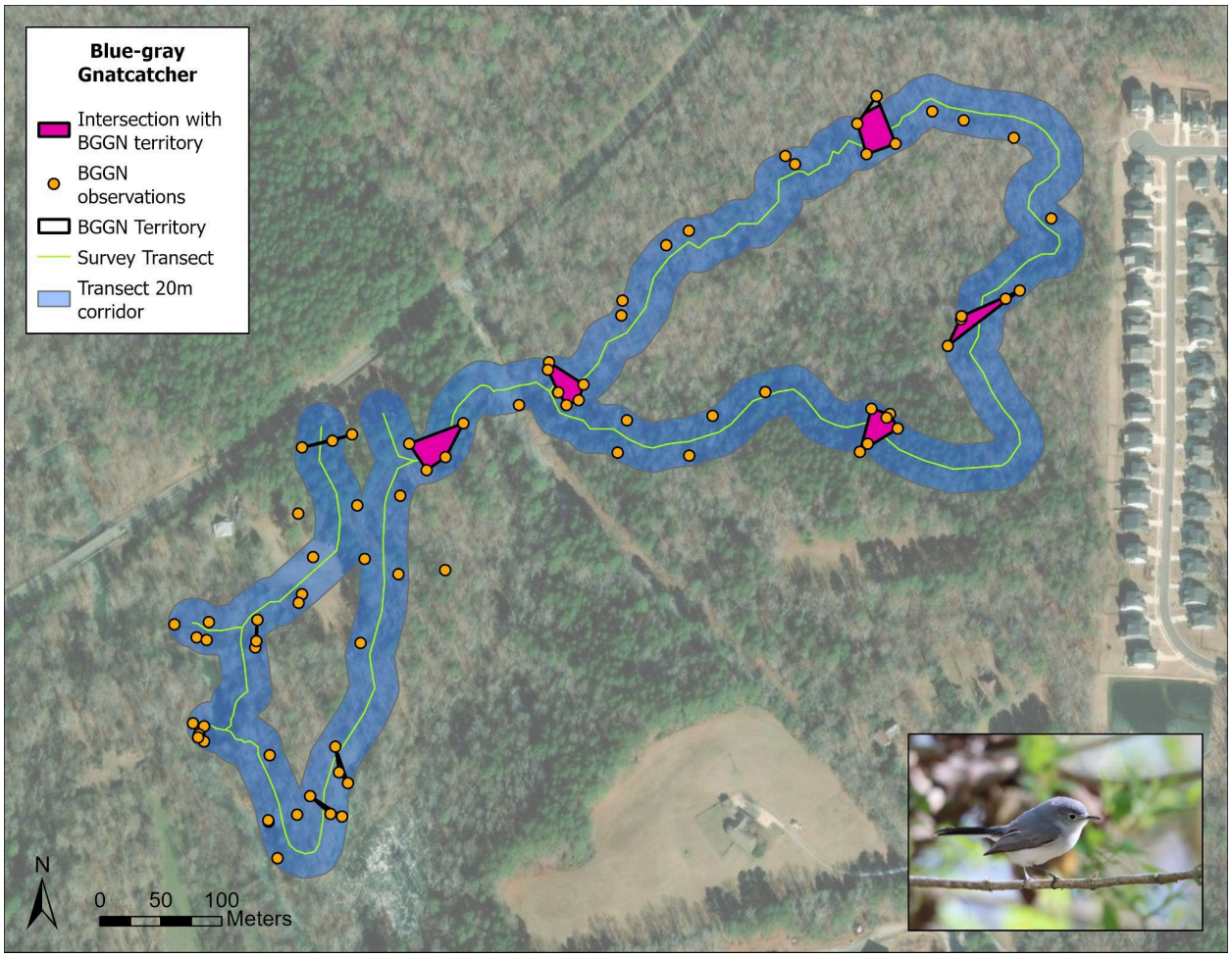
Breeding Bird Survey, Hollow Rock Nature Park, 2025

Jin Bai, Gail Boyarsky, Deborah Fowler, Ryland Bowman, Nick Ferguson, Rebekah Wofford (New Hope Bird Alliance)
Stephen Hall (North Carolina Biodiversity Project)
David Bradley (Durham County Open Space Program)

Report to the Durham Open Space Program, New Hope Bird Alliance, and North Carolina Biodiversity Project



Introduction

Across North America, many bird species have been declining at an alarming rate (Rosenberg et al., 2019), and even relatively common species could be declining locally. These changes are particularly concerning in our area where we are facing more development pressure that would result in more habitat loss and fragmentation. A recent survey at New Hope Bottomlands showed that several forest birds once commonly bred in the area are now completely missing or showing a decline in density (Hall et al., 2024). This shows that even for protected and managed natural areas, they are not safe from environmental stressors that negatively impact our local bird population. This year, we followed the protocol of the New Hope Bottomlands survey (Hall et al., 2024) and conducted another territory mapping survey at Hollow Rock Nature Park. By using the same methodology, we aim to compare territory density of various forest birds at Hollow Rock with density measures at Mason Farm Biological Reserve in the 1980s. The survey will help monitor bird density changes and guide future conservation decisions that help conserve and manage habitat in the New Hope Creek corridor.

Study Area

This survey was conducted in the late spring and early summer on two natural-surface pedestrian trails at Hollow Rock Nature Park. This 32-hectare (82-acre) preserve is jointly managed by Durham and Orange counties and includes parcels owned by Durham County, Orange County, and the Town of Chapel Hill. Hollow Rock Nature Park is bisected by Pickett Road, a gravel public road, and is bordered to the west by New Hope Creek and Orange County conservation land; to the north by Erwin Road and Duke Forest; to the northeast by the Solterra neighborhood; to the east by the recently-completed Starling Woods neighborhood; and to the south by two privately-owned parcels protected through Durham County-held easements as well as a school. The Park opened to the public in 2016 and sees high visitation.

Hollow Rock Nature Park is mostly forested, with the exception of the parking lot and two open areas – one on the western side of the park, which is mowed and maintained mainly for public recreational use, and another on the eastern side, which is mowed infrequently and not yet open to the public. Aerial imagery dating back to 1940 suggests the park area has been forested since the early 20th century and there are few indications of past extensive agricultural use; however, some areas appear to have been at some point replaced with stands of loblolly pine. Lying at the boundary of the Durham Triassic Basin and Carolina Terrane geological provinces, the Park's

topography includes a mix of low-lying wetland and floodplain along and near New Hope Creek and uplifted rolling topography. Hardpan soils typical of the Triassic Basin underlie much of the Park, though a small outcrop of more mafic diabase is found just east of Pickett Road.

The New Hope Biological Inventory (2021 – 2022) included what was at the time the entire Park area (30.4 hectares/75.0 acres; 3.0 hectares/7.4 acres were added to the Park in 2024). A more focused assessment of vegetation and habitat types was conducted on the area east of Pickett Road in 2024 (see Hall and Tingley, 2024). Both studies indicate that, in general, the forested area in the western portion of the park appears to be more disturbed, and likely younger, than that of the eastern section, with a greater prevalence of invasive plant species and comparatively fewer old hardwood trees. The findings of the latter study in particular indicate that at least the eastern portion of the park is likely a particularly large and unique occurrence of the Mixed-Moisture Hardpan Forest natural community type, considered a high priority for conservation (ranked S2/G2). As with other areas of the New Hope Creek Corridor, included the Bottomlands where a breeding bird survey was conducted in 2024, impacts from human-caused land uses changes – including artificial light, noise, stormwater runoff, pollution, deer overbrowsing, and invasive species – present significant threats to the biodiversity at Hollow Rock Nature Park.

The survey transect follows the course of the Hanging Rock Loop Trail (0.6 miles) and Headwaters Loop Trail (0.8 miles). The Hanging Rock Loop Trail begins at the main parking lot on Erwin Road, crosses the large mowed field on the western side of the park, and then follows a forested section along New Hope Creek and adjacent to a large wetland near the southwestern boundary of the park. The trail meanders through a mixed pine-hardwood forest before connecting with the Headwaters Loop Trail near the parking lot.

The Headwaters Loop Trail crosses Pickett Road and loops through the eastern portion of the park, which includes small streams and is where Hall and Tingley (2024) identified what is likely an occurrence of Mixed-Moisture Hardpan Forest. Along the eastern boundary of the park, the trail runs parallel to the Starling Woods neighborhood, built within the past couple of years. Durham County staff have noted an increase in runoff, a likely increase in the prevalence of invasive species like *Microstegium vimineum*, and an increase in artificial light resulting from the proximity of this new neighborhood. Staff and volunteers have installed new boardwalks on trail sections near Starling Woods that had been severely eroded. From here, the trail loops around through the forest in the northern part of the park, crosses back over Pickett Road, and ends at the parking lot.

The total length of the survey route is 2370 meters, and the 40-meter wide transect corridor centered on the trail covers 9.3 hectares (determined through GIS). This is smaller but still comparable to the total area of 12.03 hectares covered by the transect survey conducted at the New Hope Creek Bottomlands Trail in 2024, and smaller but still comparable to the total area of 25.6hectares covered by the census grid used in the breeding bird surveys conducted in the Big Oak Woods at Mason Farm Biological Preserve and the forests on the west side of the preserve.

Sampling Methods

The Hollow Rock Bird Survey followed the same procedure used in the New Hope Bottomlands survey (see detailed in Hall et al. 2024). Surveys were conducted by volunteers during the breeding season in early mornings from mid-May to late June with a total of 7 visits. Volunteers document all birds seen or heard, with a special focus on singing males to map breeding territories. We used a 40 meter wide buffer as the survey transect and mark each bird observation using 4-letter bird banding codes on Avenza Maps.The first survey was conducted on May 18, 2025 and the last survey was conducted on June 30, 2025.

Analytical Methods

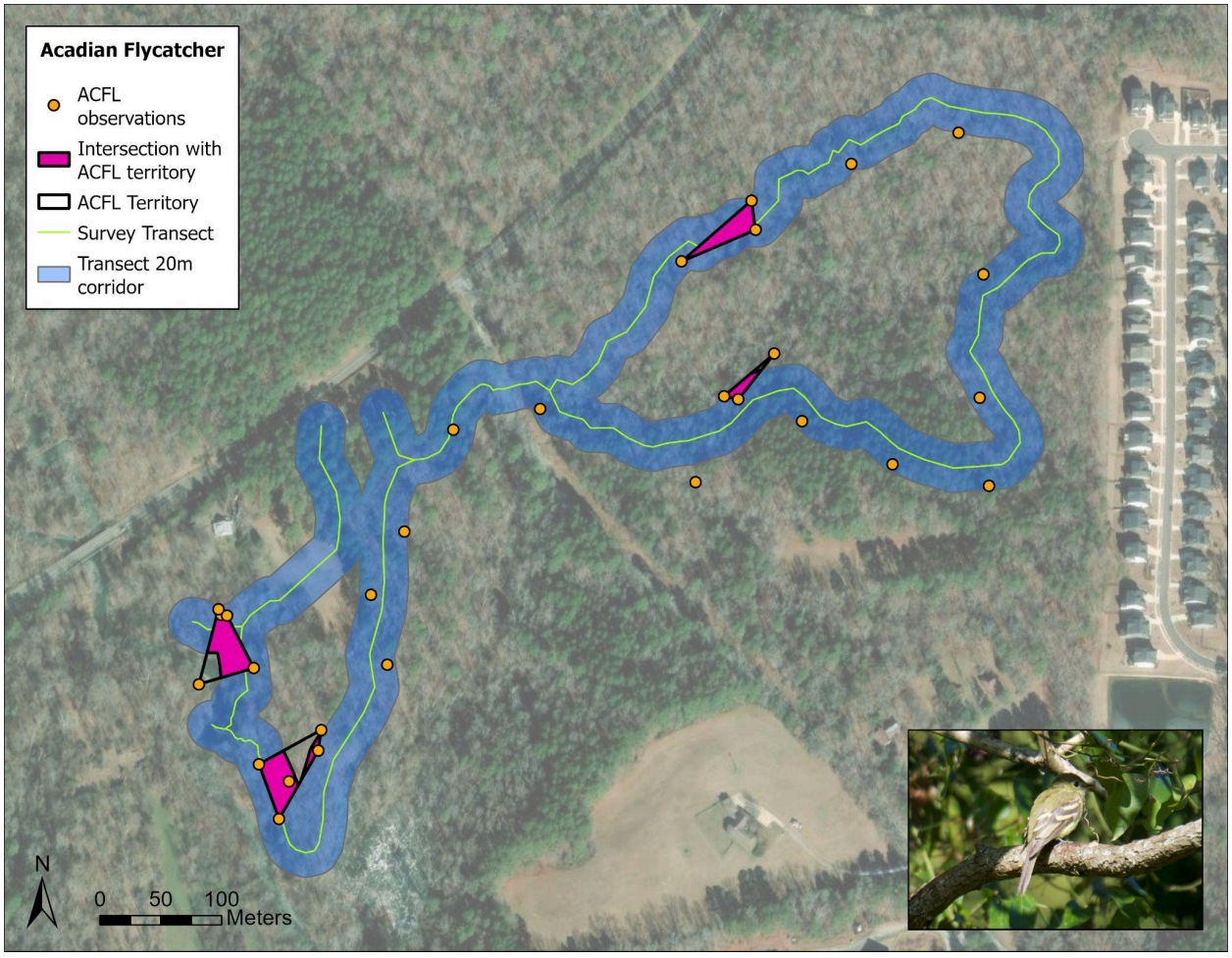
We followed the same procedure in calculating territory density as outlined in the New Hope Bottomlands bird survey report (see detailed in Hall et al. 2024). We first imported the spatial layer of each visit from Avenza Map into ArcGIS Pro and created individual species maps with observation points. These observation points had a symbology setting indicated by the survey date to differentiate each visit. We invited all volunteers to participate in the territory identification process and a total of 5 volunteers were part of the consensus process. For a cluster of points to be considered as a territory, there needs to be at least 3 points in proximity and they came from at least two different survey dates, which indicates birds likely established territories (see other requirements to be considered in Hall et al. 2024). Once a consensus is reached, for a given species, we calculated the proportion (range from 0 to 1) of each territory intersect with the 40-m transect and summed the total proportions. The total transect area is 9.3 hectares and the field area of the transect is 0.2 hectares. For most species considered, the relevant habitat transect area is 9.1 hectares. For Chipping Sparrows, given their preference for open habitat and their entire territory located within the field area, the relevant habitat transect area is 0.2 hectares. For Tufted Titmice, the species' territories occur in both the forested transect area and the open field transect area, and we used a total of 9.3 hectares as the relevant habitat transect area. We then calculated the territory density

as the sum of proportions divided by the relevant habitat transect area, which is expressed as the number of territories per hectare.

Results

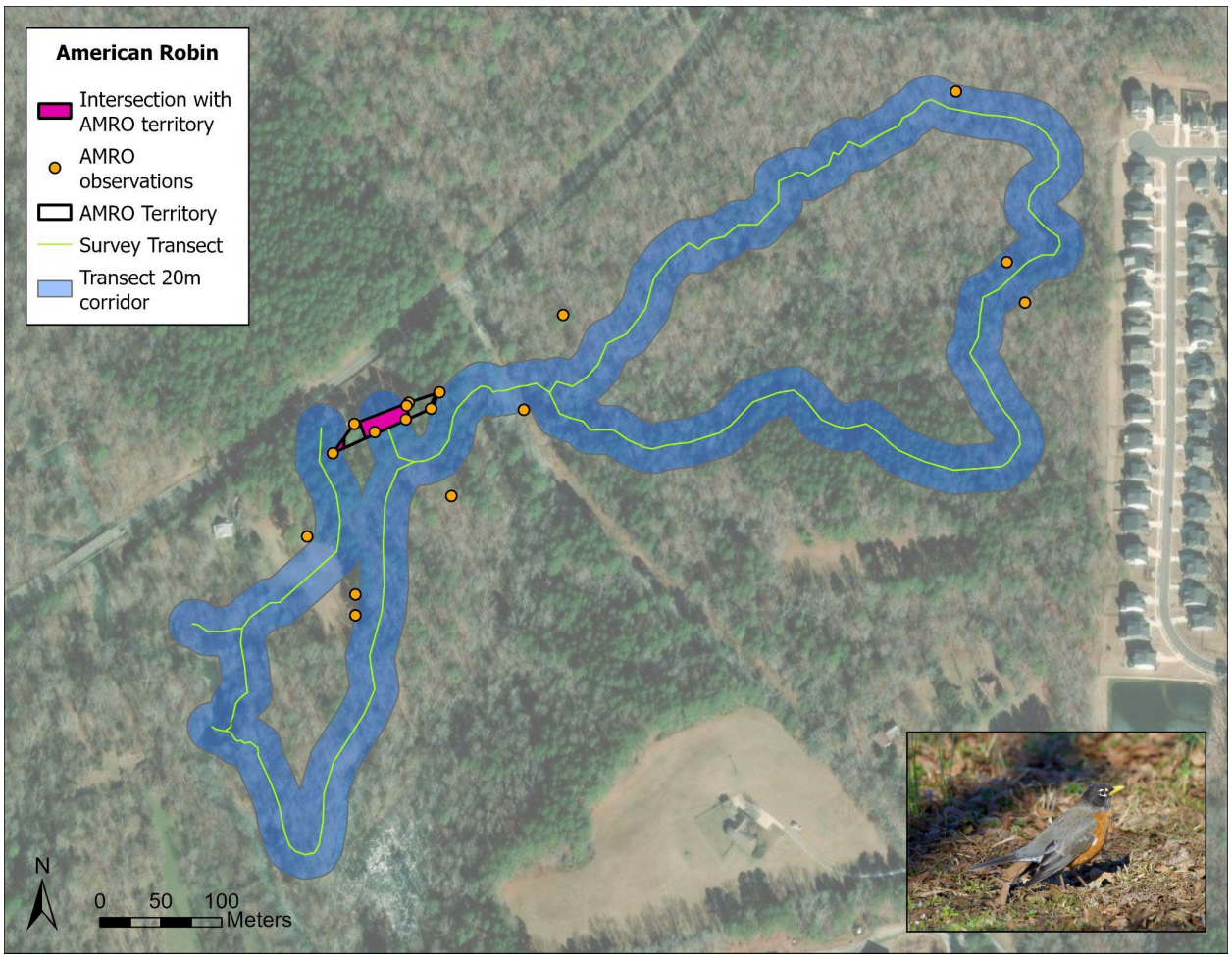
Individual Species Accounts

Acadian Flycatcher



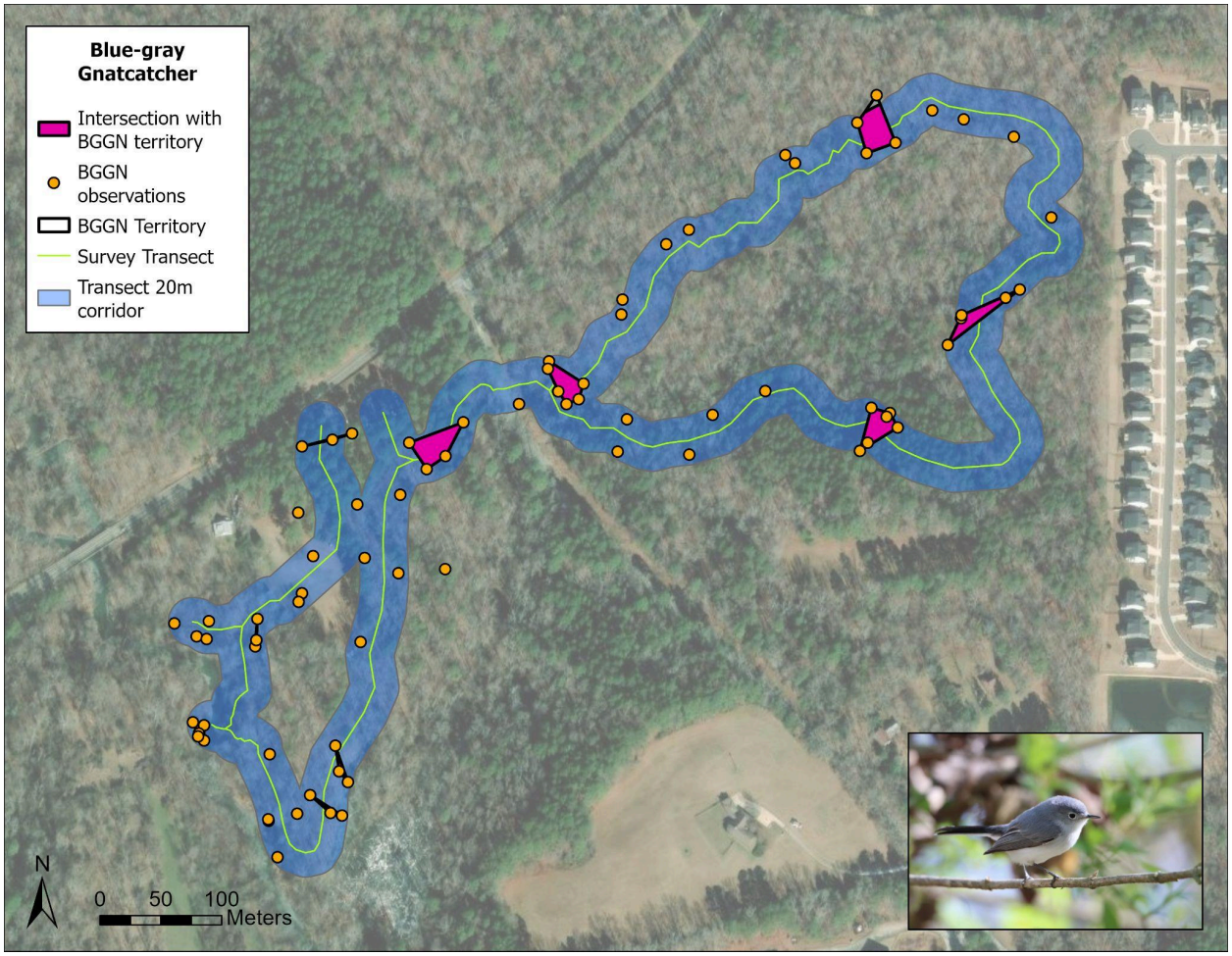
Acadian Flycatchers are a common bottomland species in North Carolina, they are often found in moist hardwood forests and nesting near creeks (LeGrand et al., 2025). We identified 4 territories with 2 near the creek on the west side of the park and 2 territories in the upland forests on the east side of the park. We estimated 0.363 territories per hectare at Hollow Rock Nature Park, which is roughly half of the territory density (0.679 territories per hectare) at Mason Farm in the 1980s including both Big Oak Woods and West Side Tract.

American Robin



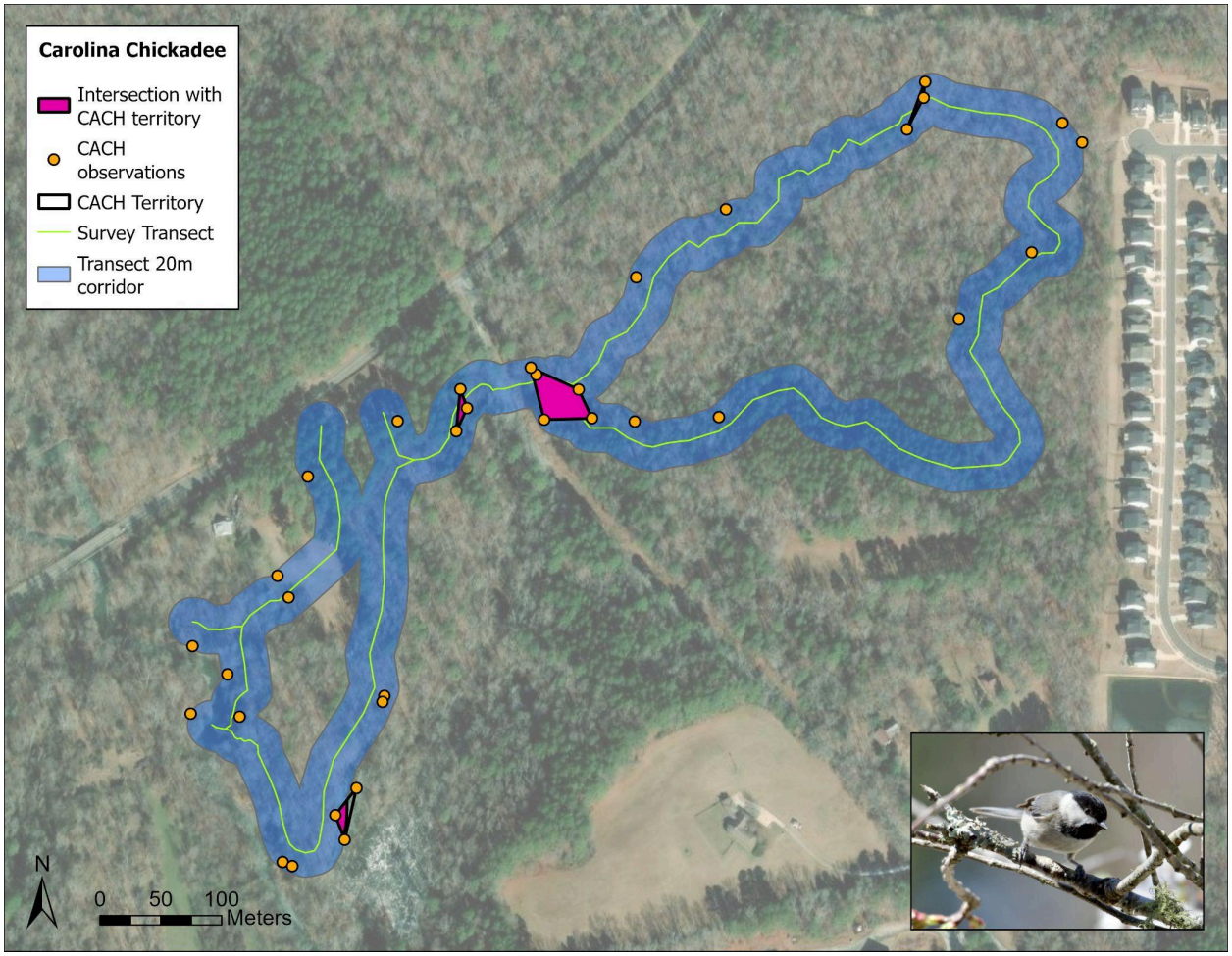
American Robins are widely distributed in North Carolina. They mainly breed around lawns in yards or farmyards and they do not nest in forested areas (LeGrand et al., 2025). We identified only 1 territory near the parking lot of Hollow Rock where there is lawn present. We estimated 0.062 territories per hectare at Hollow Rock but we do not have territory estimates from the Mason Farm survey in the 1980s. It could be that robins were specialized in northern coniferous forests in the 1980s and they were not adapting to human-modified environments at the time.

Blue-gray Gnatcatcher



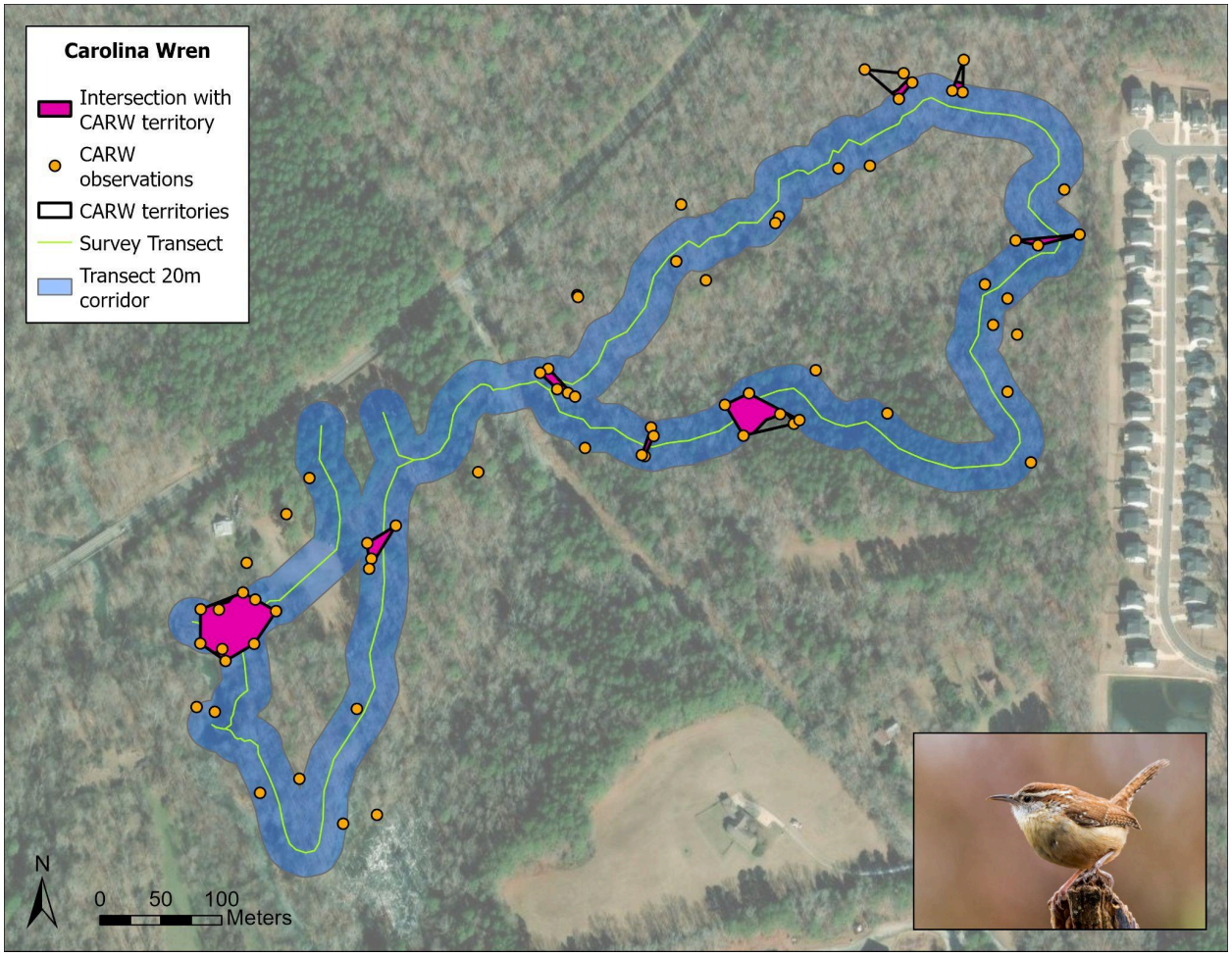
Blue-gray Gnatcatchers occur across the state in association with hardwood and mixed forests with a preference for moist forests (LeGrand et al., 2025). We observed a total of 10 territories with 6 on the west side and 4 on the east side of the park. We estimated 1.088 territories per hectare at Hollow Rock, which is roughly double the territory density (0.536 territories per hectare) at Mason Farm in the 1980s.

Carolina Chickadee



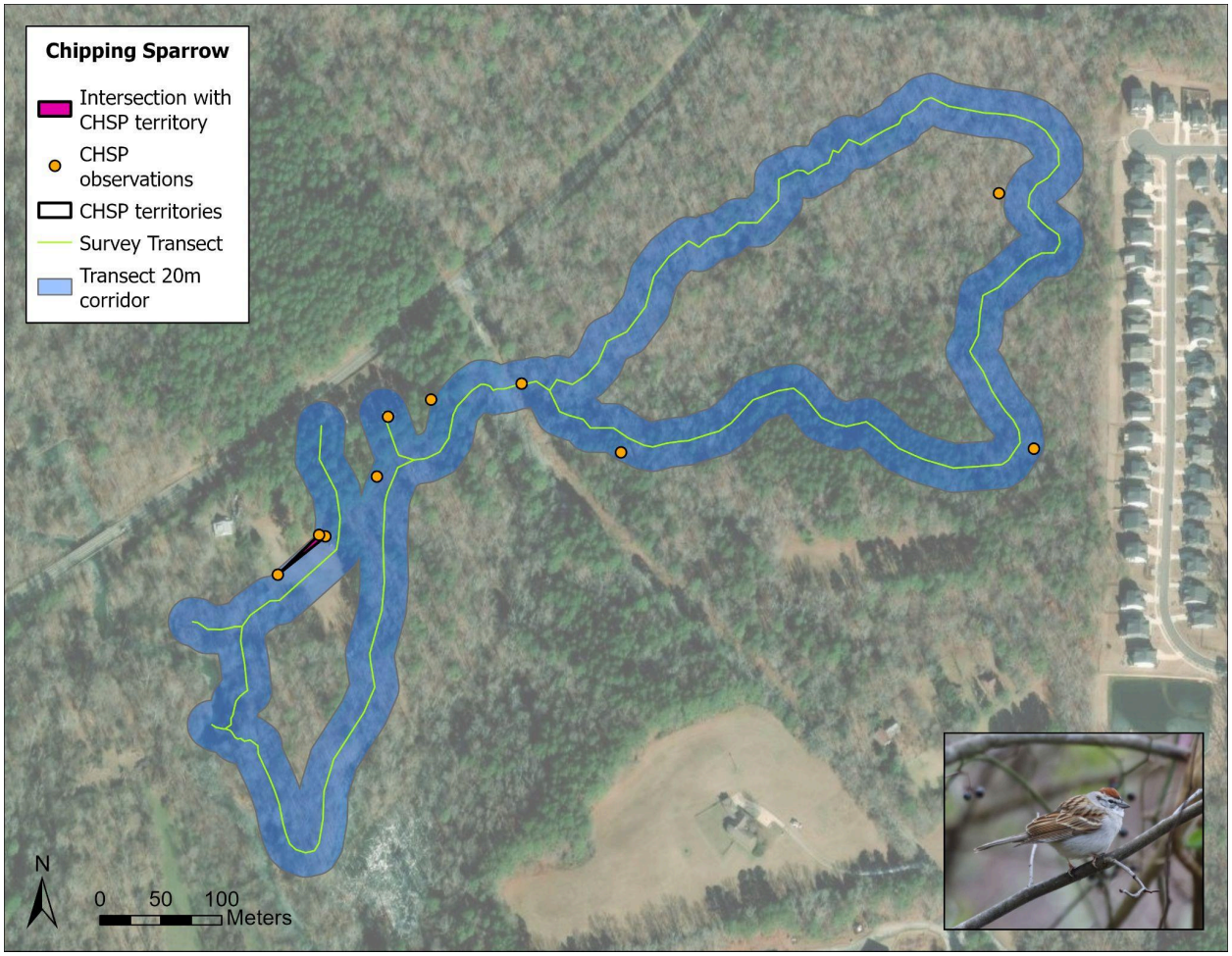
Carolina Chickadees occur in middle-aged to mature forests in both residential and rural areas in the state, requiring tree cavities for nesting (LeGrand et al., 2025). We identified a total of 4 territories with 2 on the west side and 2 on the east side of the park. We estimated 0.441 territories per hectare at Hollow Rock, which is higher than the Mason Farm territory density (0.266 territories per hectare) in the 1980s.

Carolina Wren



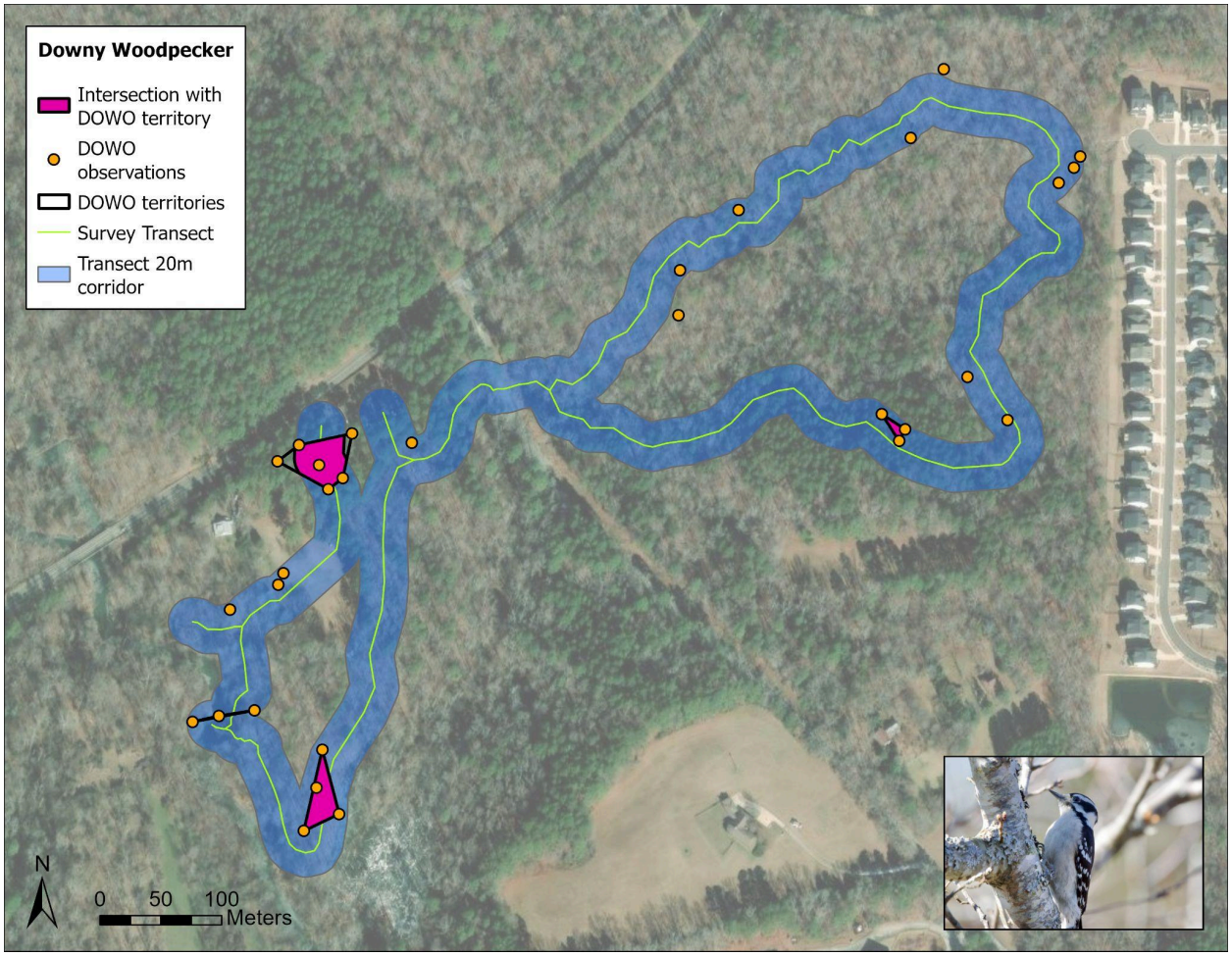
Carolina Wrens are one the most common birds in NC and they nest in forested or semi-forested areas with a preference for dense shrub/sapling layers (LeGrand et al., 2025). We identified 8 territories with 2 in the bottomland forests (west side) and 6 in the upland forests (east side). We estimated 0.714 territories per hectare at Hollow Rock, which more than doubled the territory density at Mason Farm (0.293 territories per hectare) in the 1980s.

Chipping Sparrow



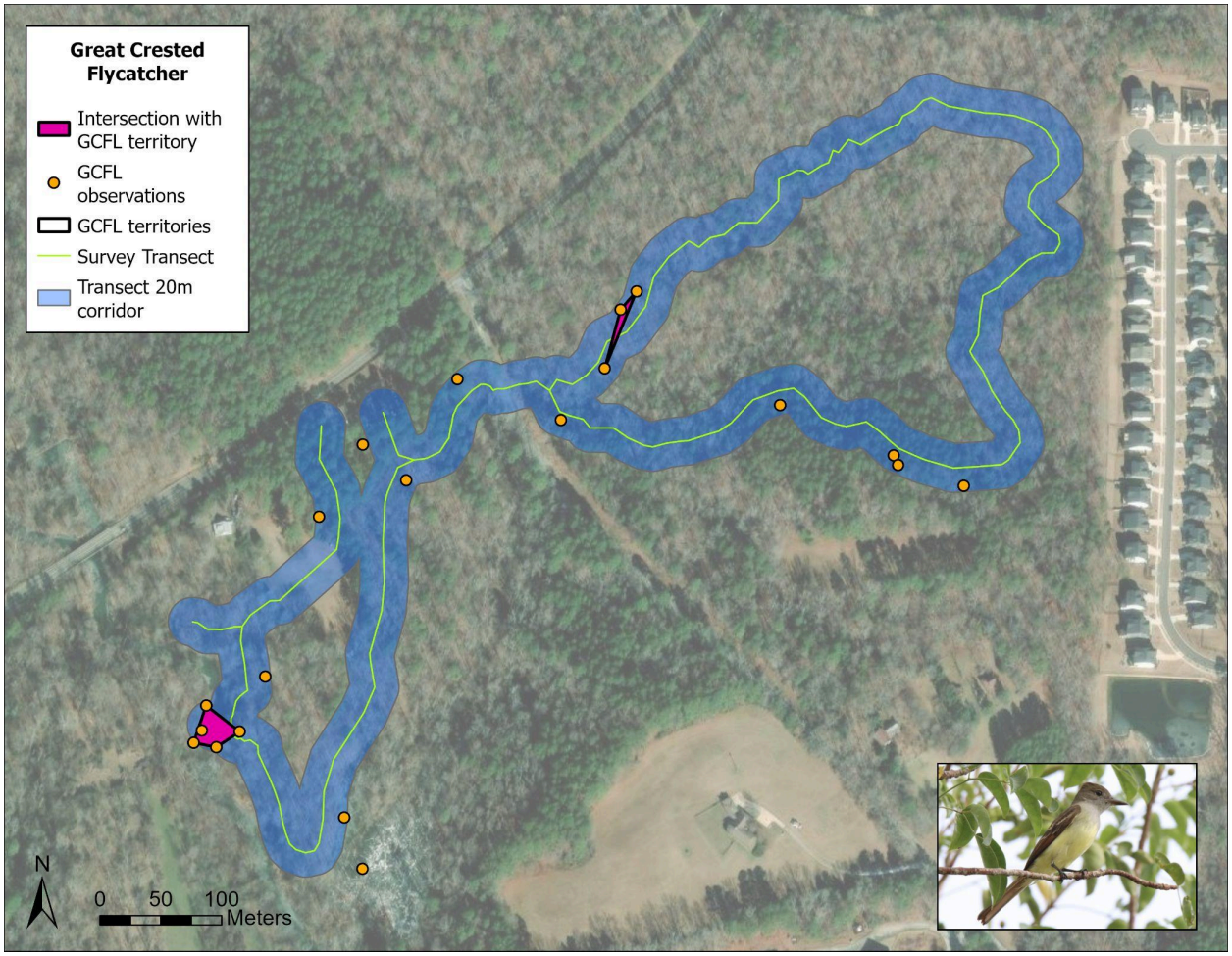
Chipping Sparrows are commonly distributed across the state and they have adapted to parks, golf courses, lawns, and open pinewoods with a preference for very short grasses (LeGrand et al., 2025). We only identified 1 territory at the open field at the west side of the park. We estimated 4.916 territories per hectare only considering the open field as suitable habitat excluding the rest of hardwood forests. Chipping Sparrows were not recorded in the 1980s Mason Farm survey.

Downy Woodpecker



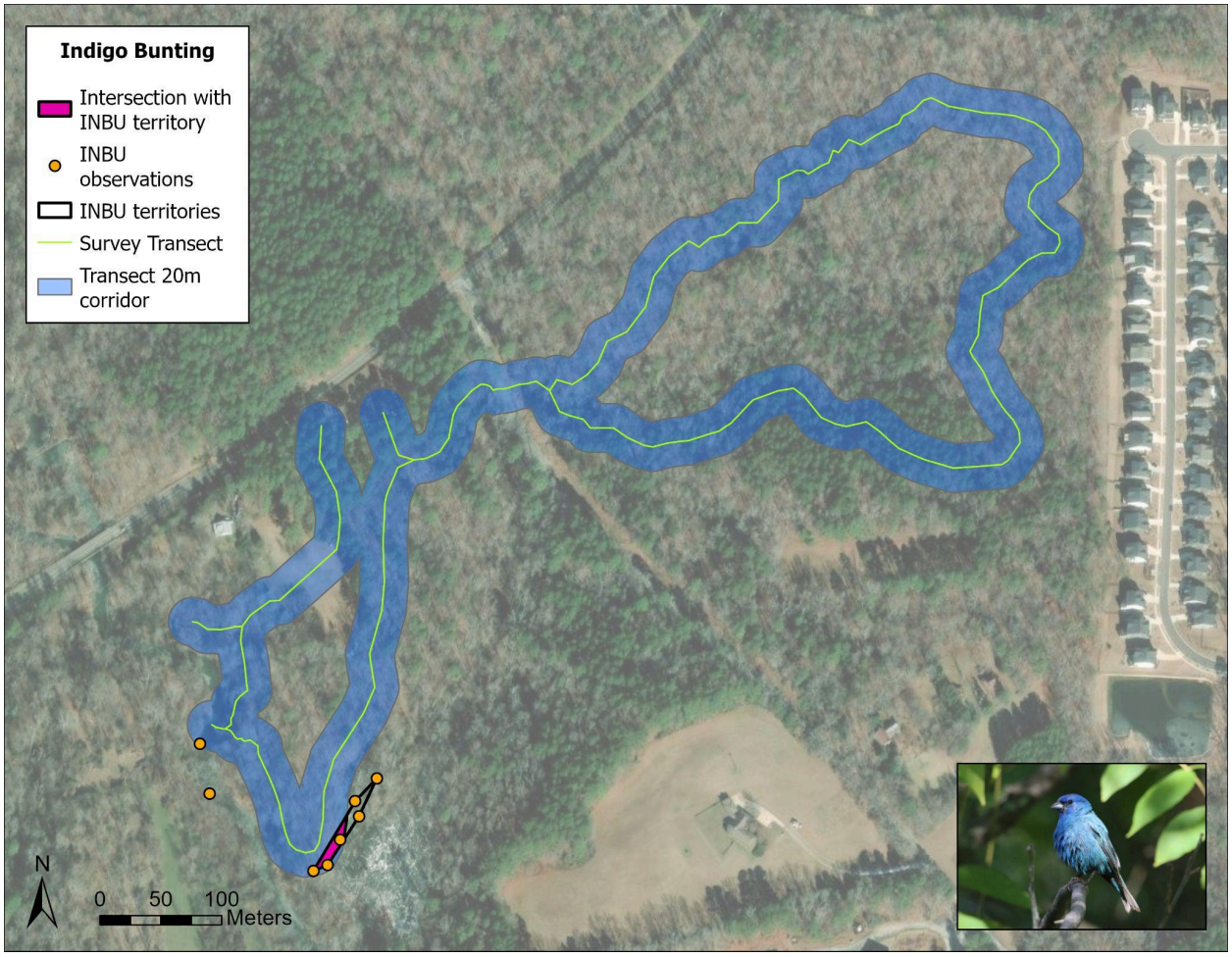
Downy Woodpeckers live primarily in middle-aged and mature hardwood forests across the state but occasionally use pine stands and mixed forests (LeGrand et al., 2025). We identified 4 territories with 3 in the bottomland forests and 1 in upland forests. We estimated 0.425 territories per hectare, which is much higher than Mason Farm territory density (0.180 territories per hectare) in the 1980s.

Great Crested Flycatcher



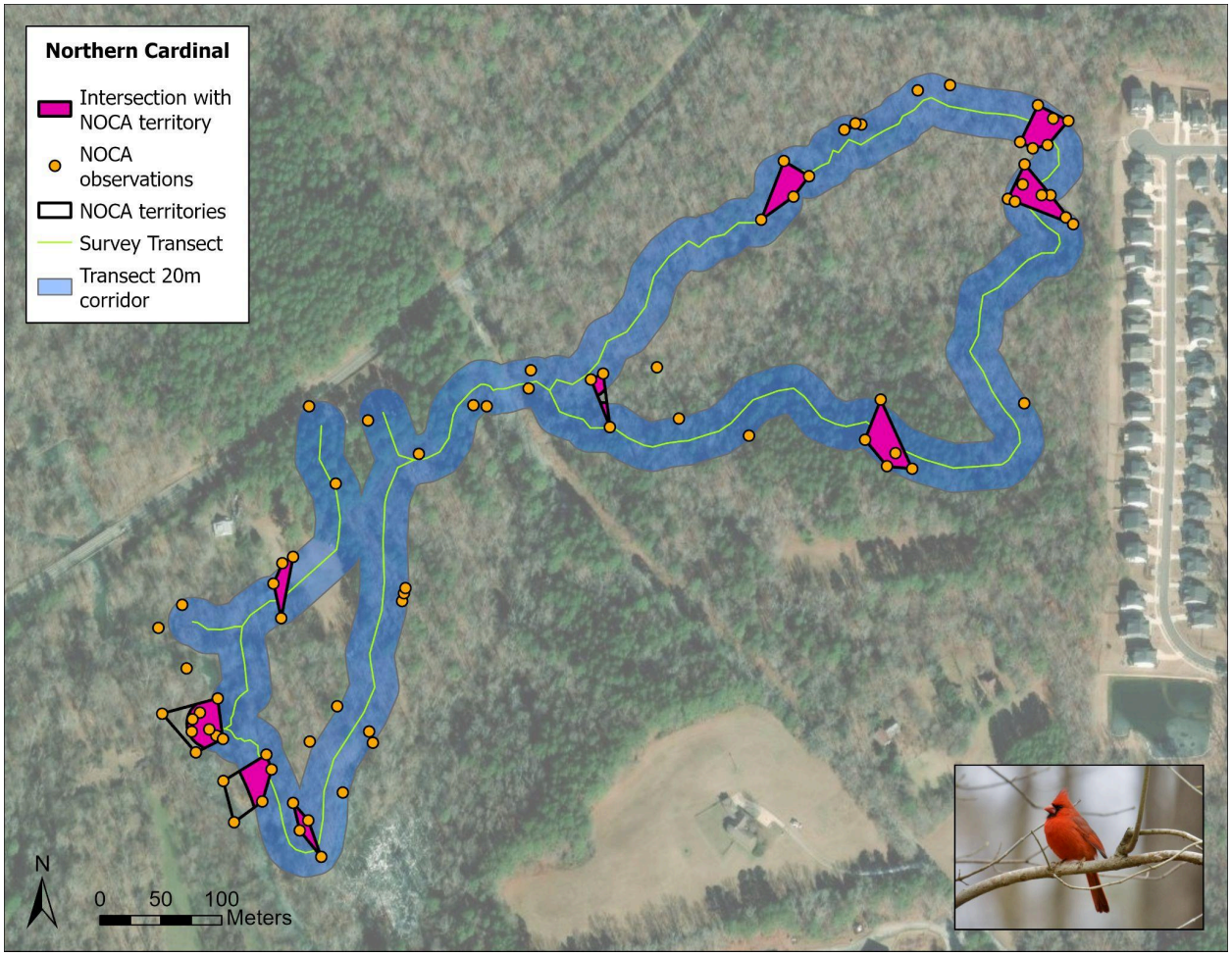
Great Crested Flycatchers are breeding residents throughout the state and they use old woodpecker cavities for nesting. They occur in a variety of forests including bottomland forests with a preference for drier habitats (LeGrand et al., 2025). We identified 2 territories with 1 in bottomland forest and the other in upland forest. We estimated 0.220 territories per hectare at Hollow Rock, which is more than doubled than Mason Farm territory density (0.074 territories per hectare) in the 1980s.

Indigo Bunting



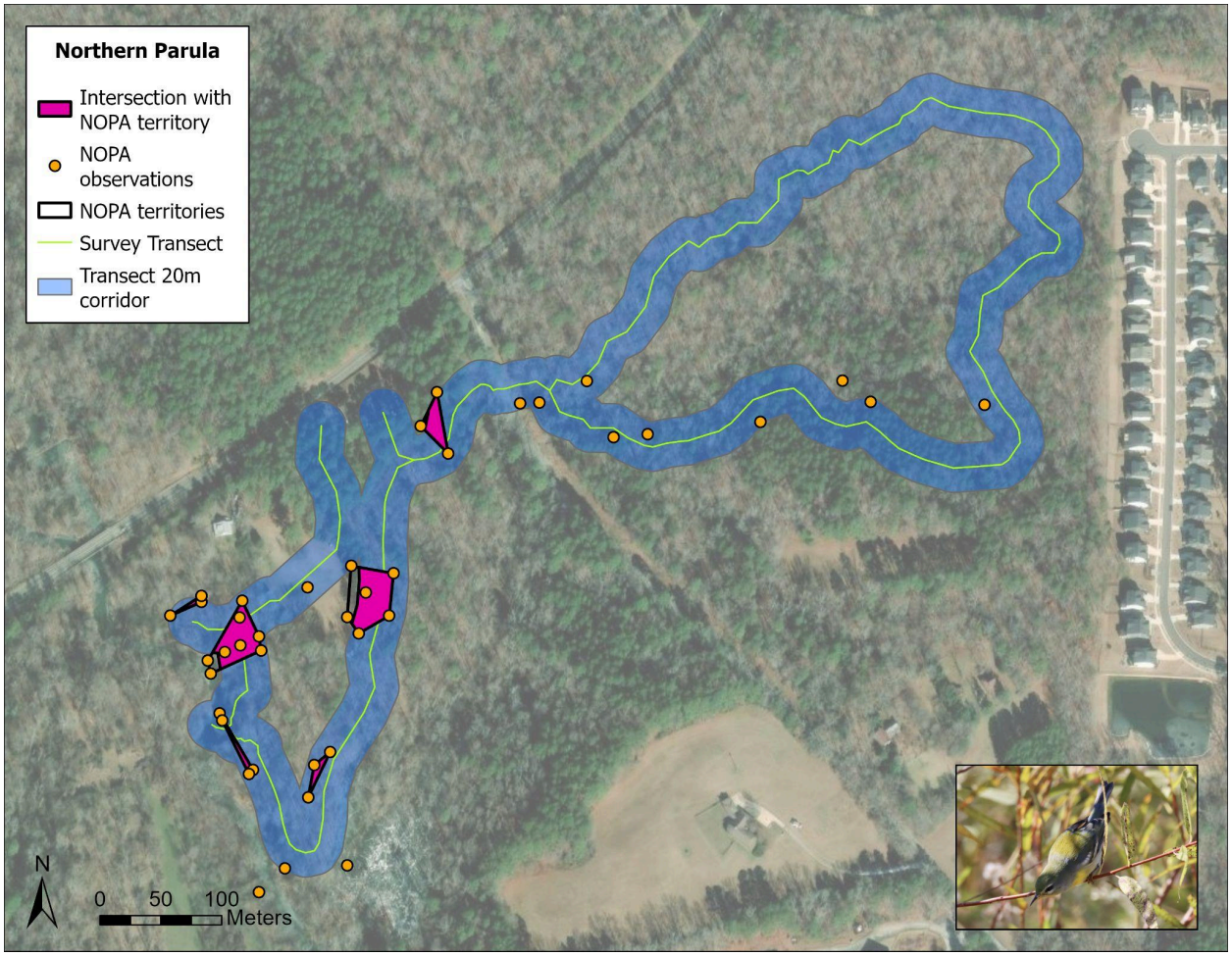
Indigo Buntings are associated with old fields and shrubby, semi-open habitats. We identified 1 territory in the wetland on Hanging Rock trail on the west side of the park. We estimated 0.056 territories per hectare at Hollow Rock, which is higher than Mason Farm estimates (0.004 territories per hectare) in the 1980s.

Northern Cardinal



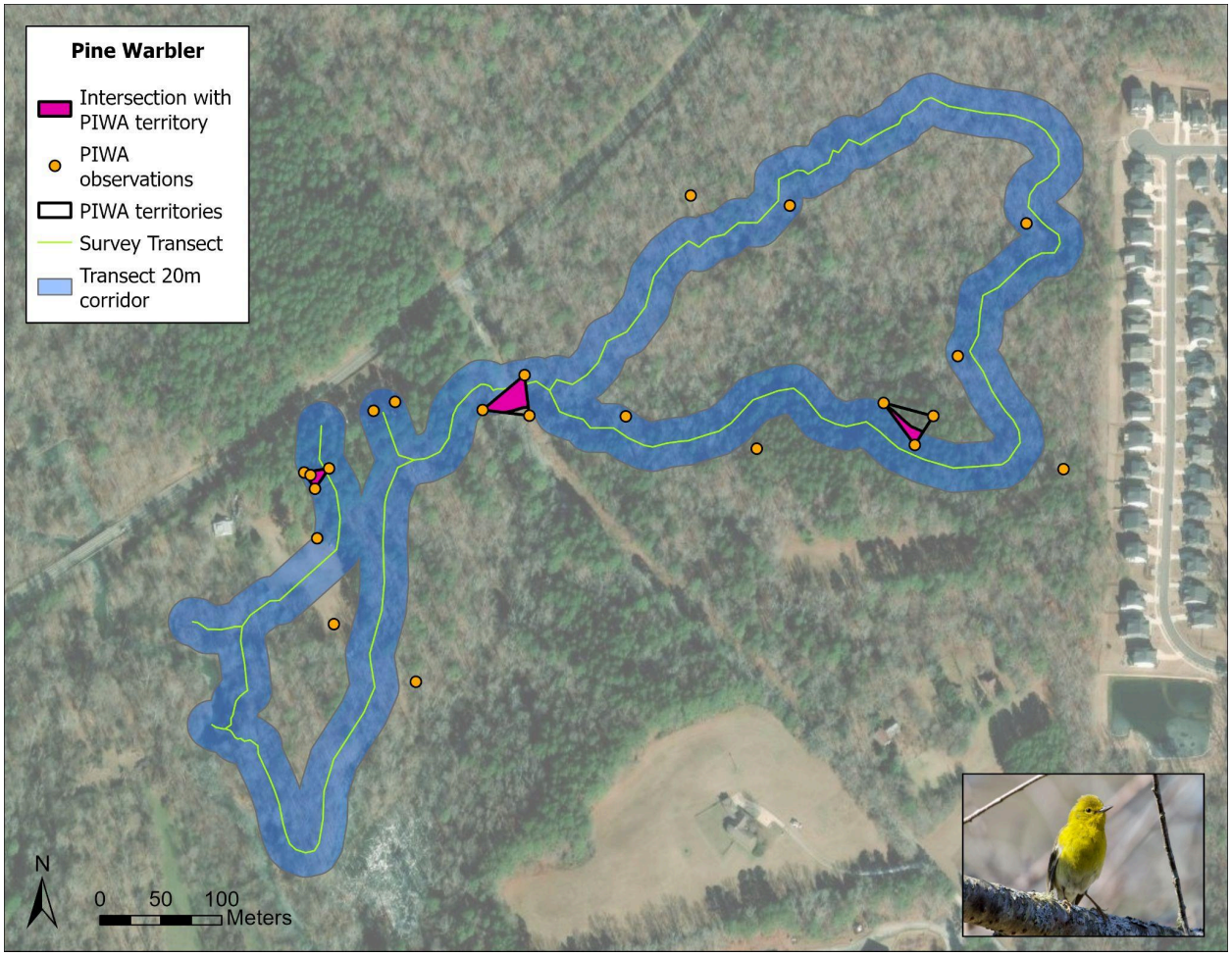
Northern Cardinals nest in forests, woodlands, and edges where there is abundant shrub and understory cover (LeGrand et al., 2025). We identified a total of 11 territories with 5 in the bottomland forest and 6 in the upland forest. We estimated 1.099 territories per hectare at Hollow Rock, which is much higher than Mason Farm territory density (0.282 territories per hectare) in the 1980s.

Northern Parula



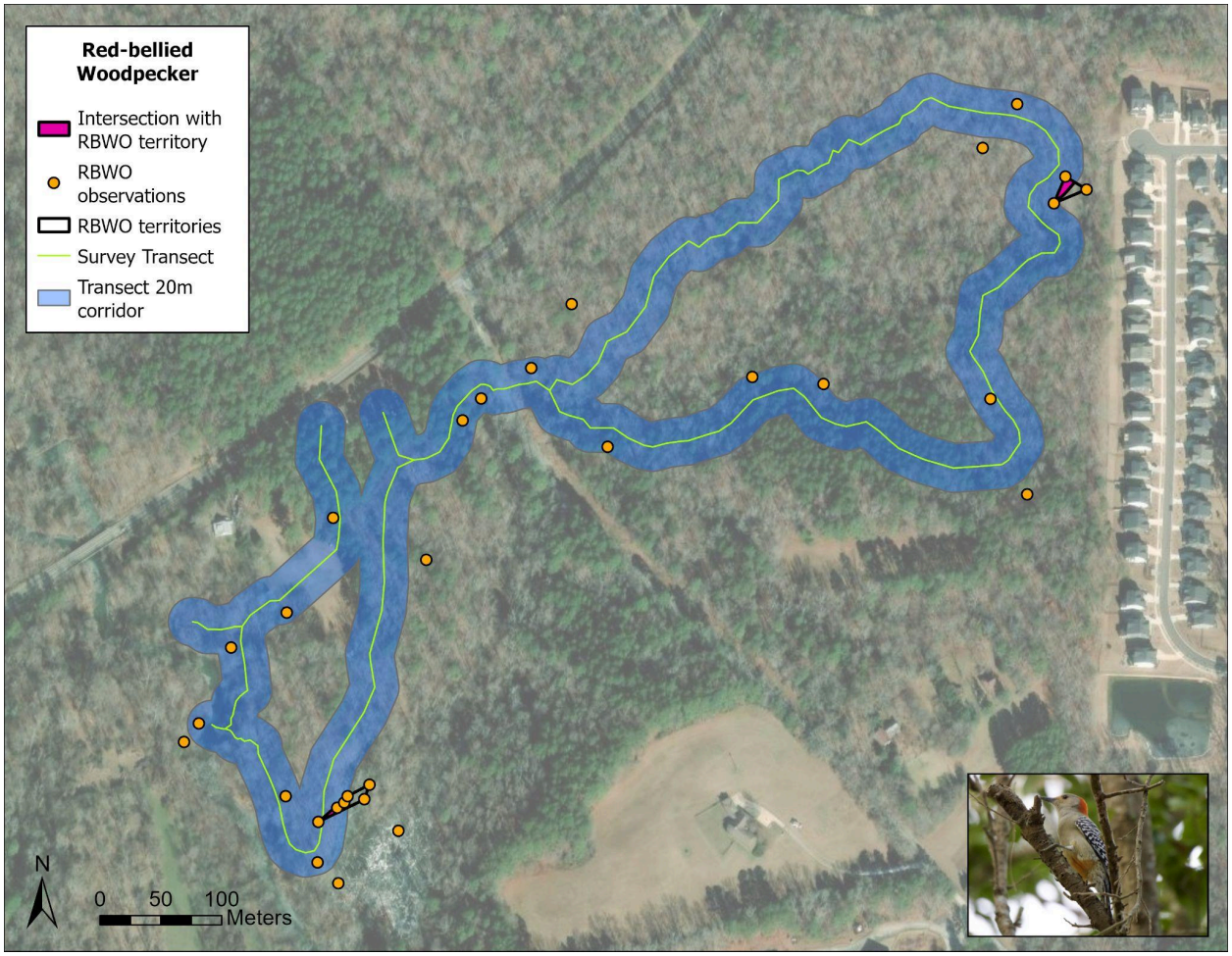
Northern Parula are a common bottomland species, where they often nest close to streams, swamps, or lakes with a preference where Spanish Moss or Usnea lichen for nesting resources (Moldenhauer and Regelski, 2020; LeGrand et al., 2025). We identified 6 territories all from the bottomland forest (west side of the park). We estimated 0.619 territories per hectare, which is much higher than the Mason Farm territory density (0.063 territories per hectare) in the 1980s.

Pine Warbler



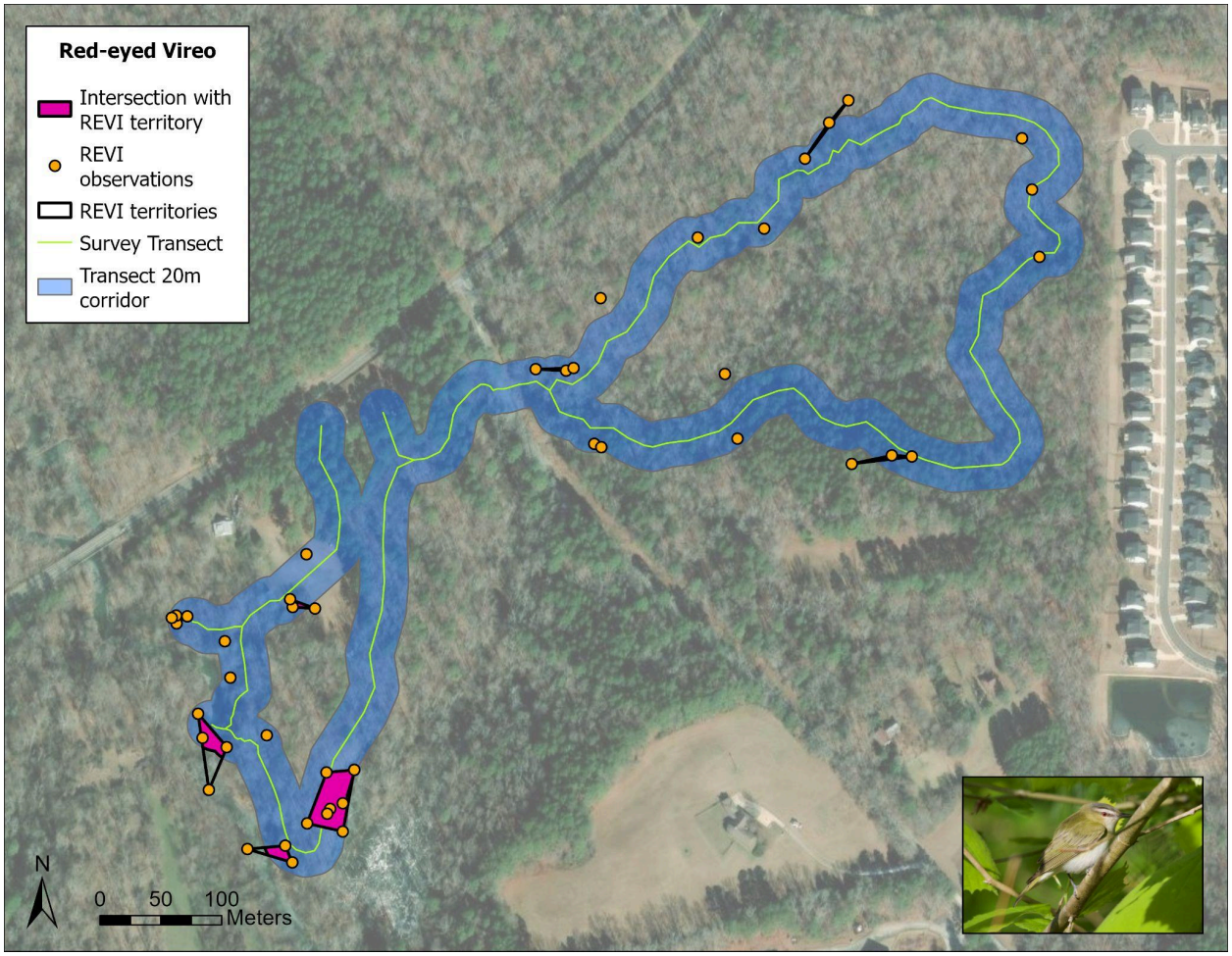
Pine Warbler is one of the most common warblers in NC and they are found in mature to middle-aged stands of pine forest with a preference for longleaf and loblolly pines (LeGrand et al., 2025). We identified 3 territories and estimated 0.249 territories per hectare at Hollow Rock, which is higher than Mason Farm territory density (0.061 territories per hectare) in the 1980s.

Red-bellied Woodpecker



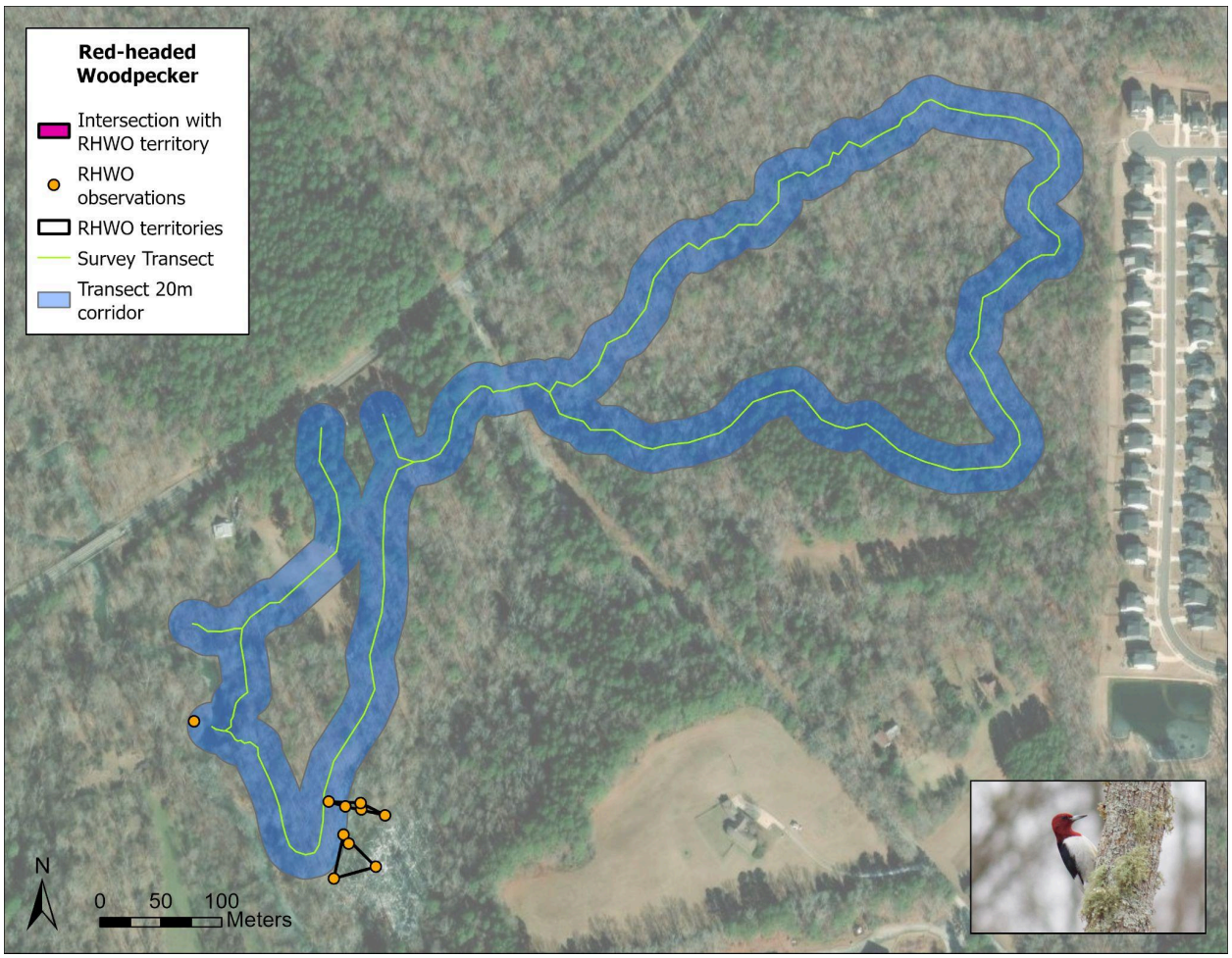
Red-bellied Woodpeckers are widespread in NC and they occupy mature hardwoods, bottomlands and swamps, and pine stands (LeGrand et al., 2025). We identified 2 territories and estimated 0.098 territories per hectare at Hollow Rock, which is lower than Mason Farm territory density (0.223 territories per hectare) in the 1980s.

Red-eyed Vireo



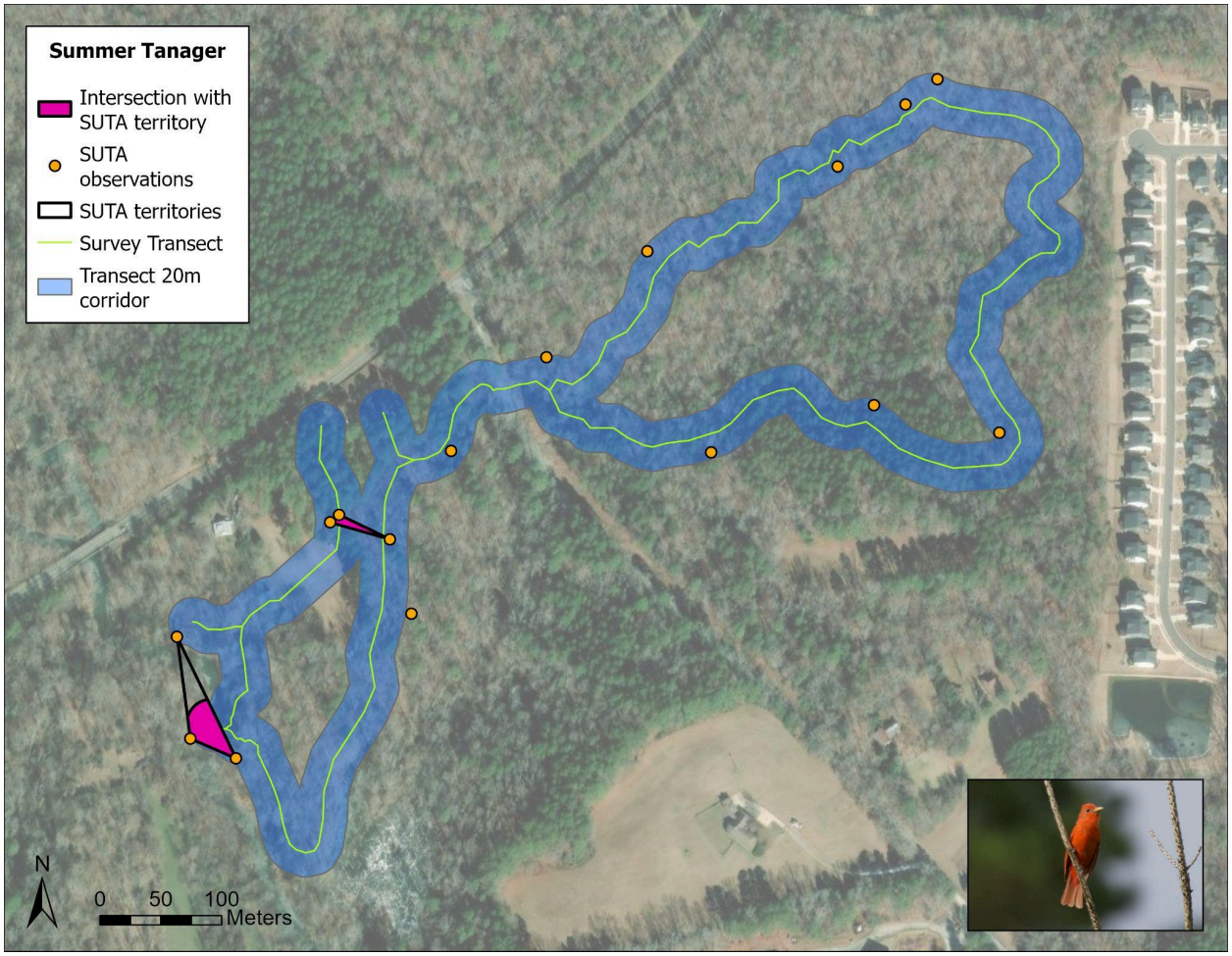
Red-eyed Vireos are common breeding birds in NC and are often heard singing during spring and early summer. They prefer middle-aged to mature hardwood forests, mesic and moist forests over dry forests (LeGrand et al., 2025). We identified a total of 8 territories with 5 of them close to New Hope Creek and we estimated 0.735 territories per hectare at Hollow Rock, which is lower than Mason Farm territory density (1.536 territories per hectare) in the 1980s.

Red-headed Woodpecker



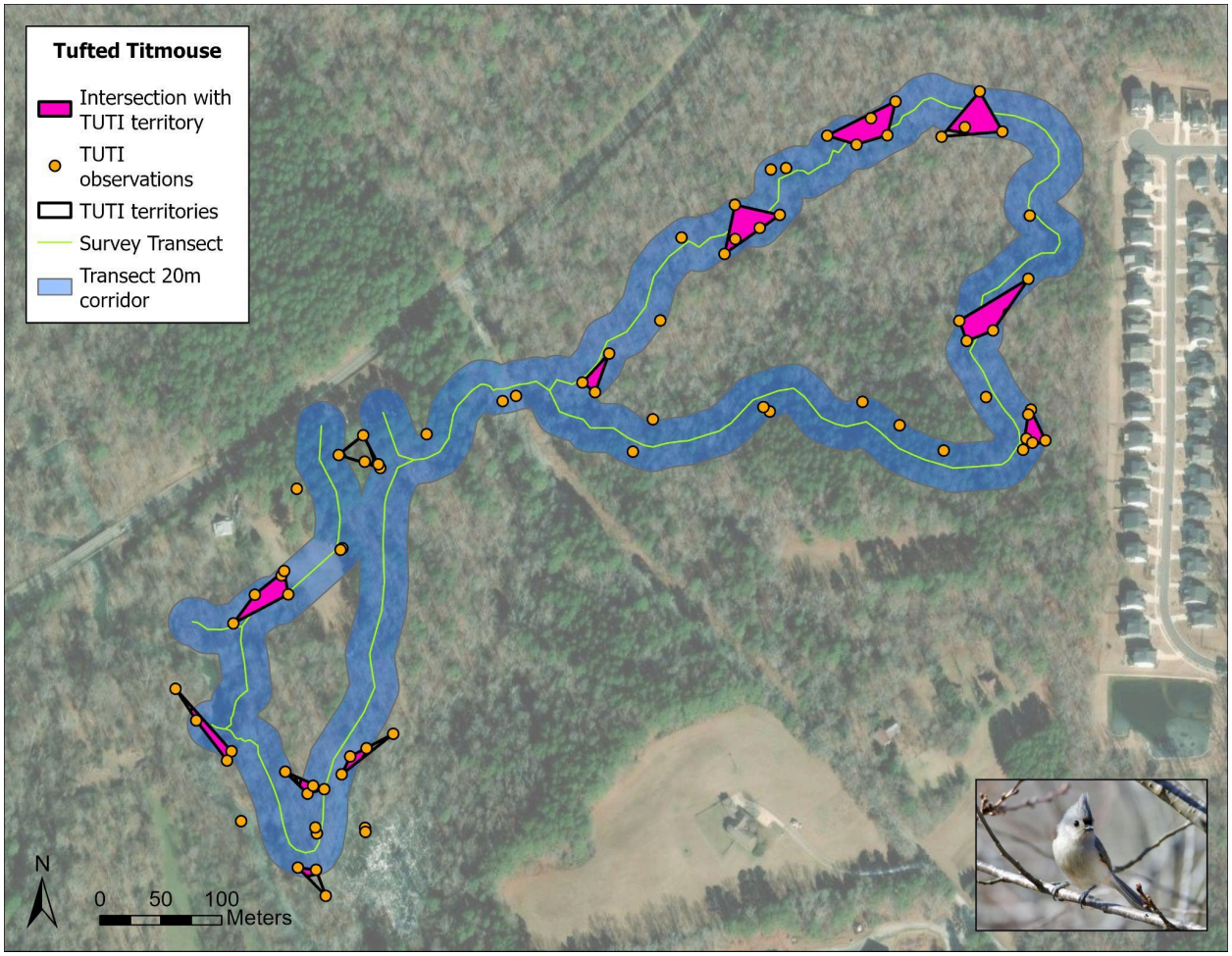
Red-headed Woodpeckers are fairly common in the piedmont of NC but they often have seasonal movements and may not be seen year-round in one habitat patch despite being a permanent resident. They prefer open stands of mature hardwoods, pines, and areas with abundance of dead trees (LeGrand et al., 2025). At Hanging Rock Loop Trail (west part of the park), there is a wetland area with many snags suitable for Red-headed Woodpeckers. We identified 2 territories in that wetland estimated at 0.0003 territories per hectare at Hollow Rock and the low number is due to a lack of overlap with the 20-m transect. This estimate is lower than Mason Farm territory density (0.0078 territories per hectare) in the 1980s.

Summer Tanager



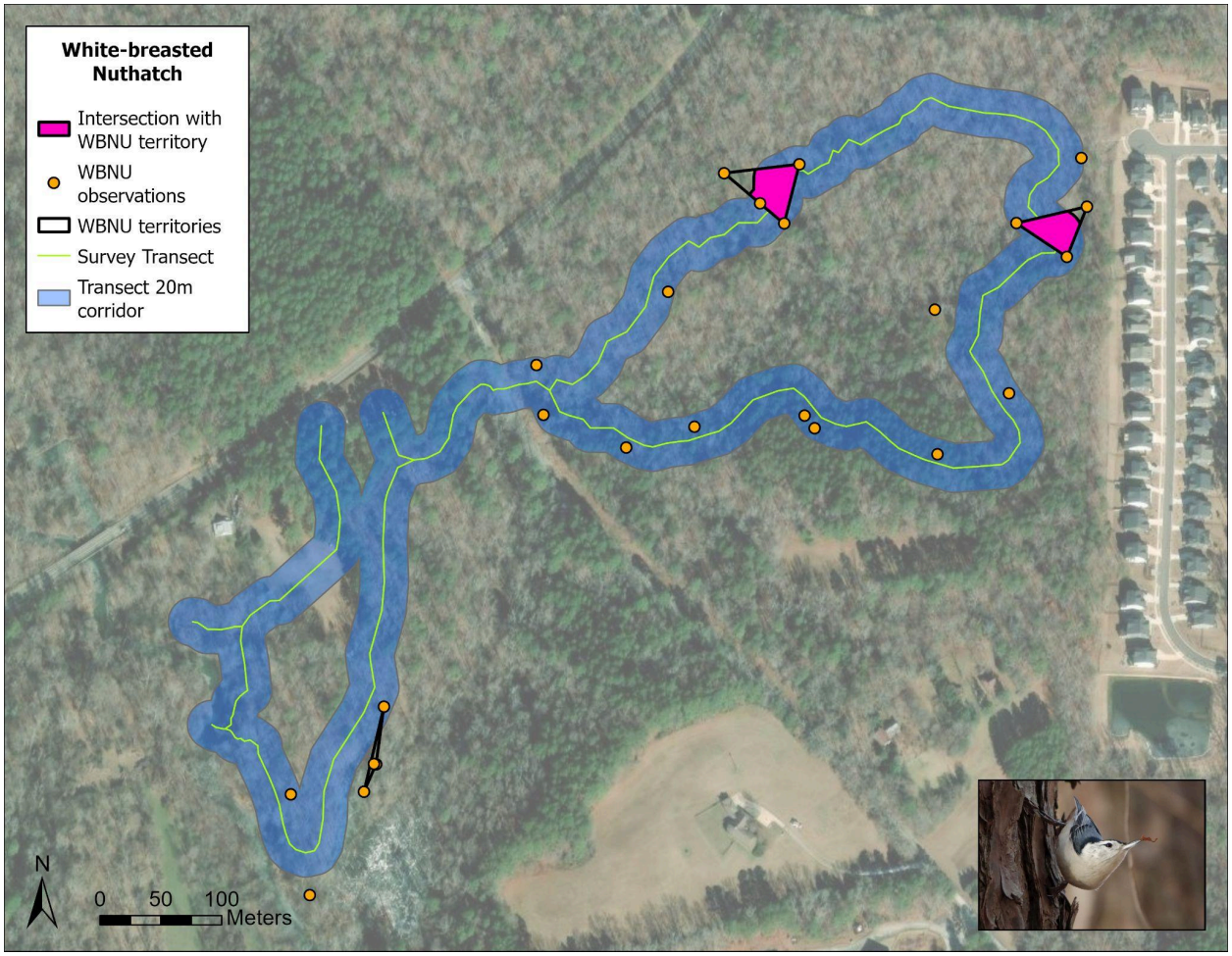
Summer Tanagers are common breeders in the piedmont of NC and they prefer dry to low mesic forests and open woods (LeGrand et al., 2025). We identified 2 territories and estimated 0.179 territories per hectare at Hollow Rock, which is higher than Mason Farm territory density (0.152 territories per hectare) in the 1980s.

Tufted Titmouse



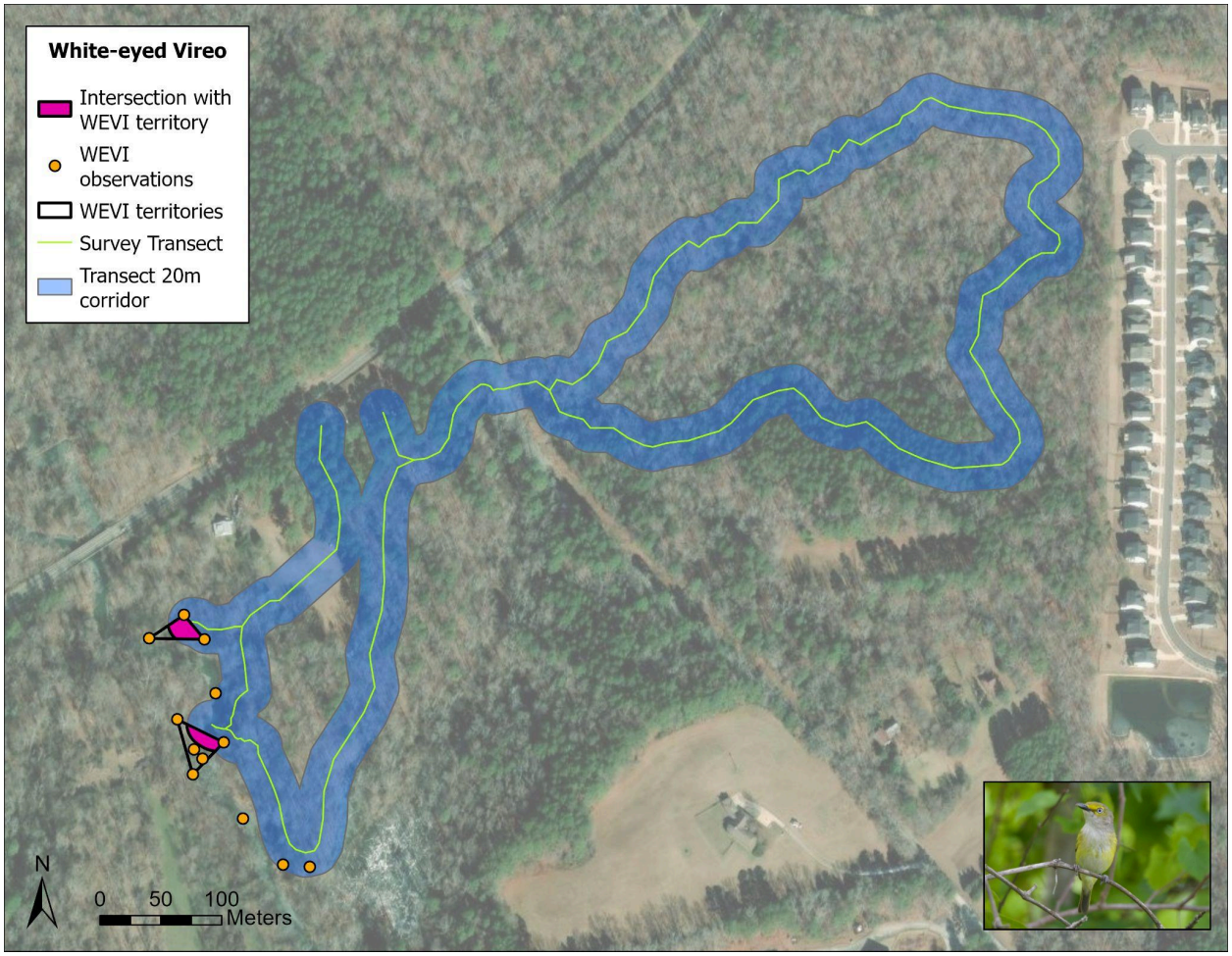
Tufted Titmice are common breeders throughout the state and they prefer hardwood or mixed forests (LeGrand et al., 2025). We identified 12 territories and estimated 1.066 territories per hectare at Hollow Rock, which is higher than Mason Farm territory density (0.456 territories per hectare) in the 1980s.

White-breasted Nuthatch



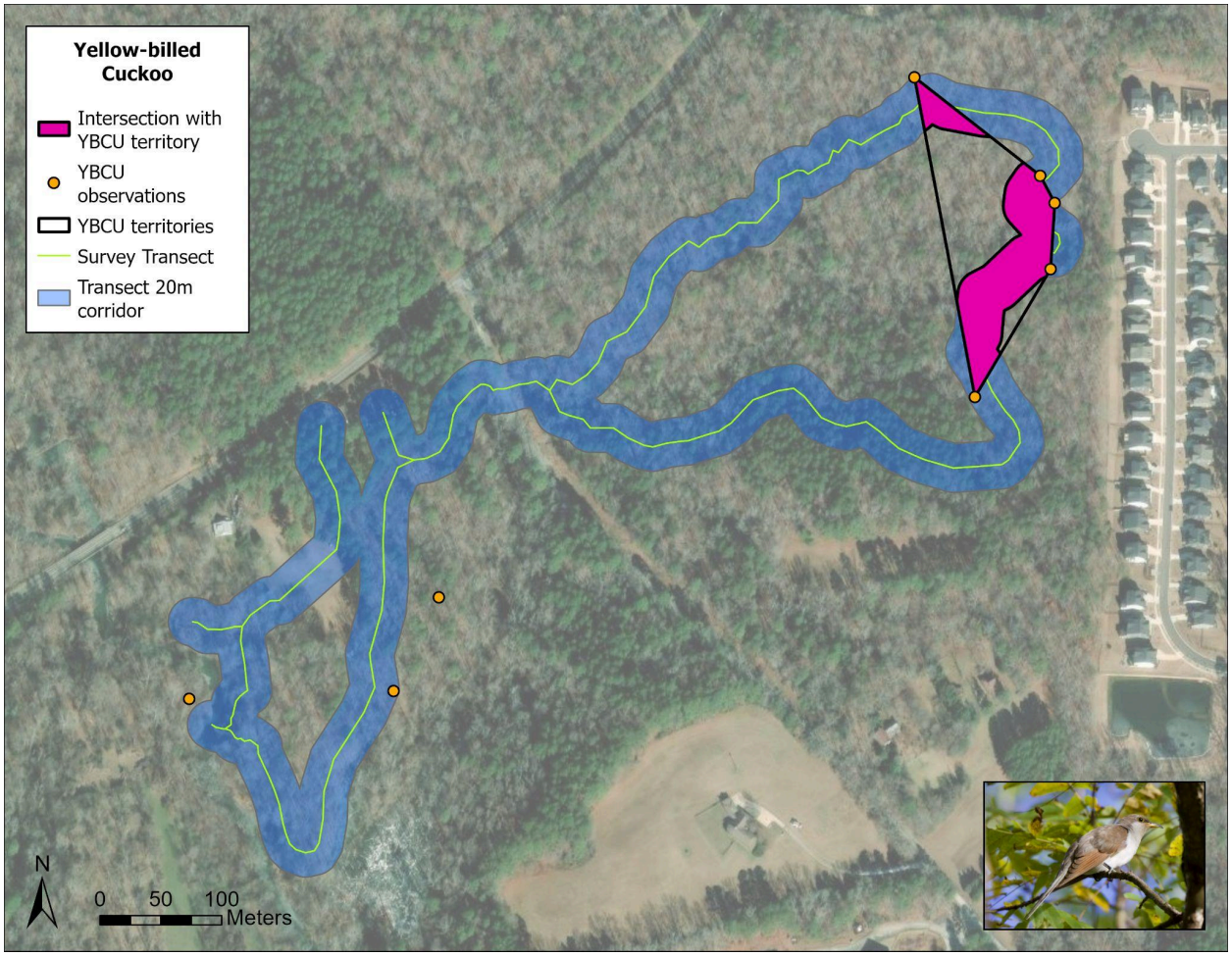
White-breasted Nuthatches are common breeders in NC and they prefer mature hardwood forests in wetlands and upland forests (LeGrand et al., 2025). We identified 3 territories and estimated 0.205 territories per hectare at Hollow Rock, which is higher than Mason Farm territory density (0.122 territories per hectare) in the 1980s.

White-eyed Vireo



White-eyed Vireos are common breeders in the piedmont of NC and they prefer thickets and other dense cover around water bodies (LeGrand et al., 2025). As expected, we only observed them in the bottomland forests near New Hope Creek. We identified 2 territories near the creek and estimated 0.127 territories per hectare at Hollow Rock, which is higher than Mason Farm territory density (0.039 territories per hectare) in the 1980s.

Yellow-billed Cuckoo



Yellow-billed Cuckoos prefer hardwood trees in somewhat moist environments, such as bottomlands, but also breed in swamps, upland hardwood and mixed forests (LeGrand et al., 2025). Because they have relatively large territory size, we combined the observation points in the upland forest into one polygon. We identified 1 territory in the upland forest and estimated 0.058 territories per hectare at Hollow Rock, which is lower than Mason Farm territory density (0.159 territories per hectare) in the 1980s.

Trends Among Specific Groups

We compared the territory density of birds at Hollow Rock Nature Park with density at the Big Oak Woods of Mason Farm and the west side of the property. We used both the big oak woods and the west side for comparison because Hollow Rock Nature Park consists of both bottomland and upland forests and this would allow for more comparable results. In summary, 69% of species in our survey showed a complete absence or declining trends whereas 31% of species showed increasing trends.

Table 1. Missing and Declining Species

	Territory density		
Species	Hollow Rock NP	Mason Farm 1980s	Difference
Red-eyed Vireo	0.735	1.536	-0.801
Wood Thrush	+	0.564	-0.564
Hooded Warbler	+	0.323	-0.323
Acadian Flycatcher	0.363	0.679	-0.316
Kentucky Warbler	0.000	0.262	-0.262
Scarlett Tanager	+	0.229	-0.229
Ruby-throated Hummingbird	+	0.221	-0.221
Ovenbird	+	0.186	-0.186
Yellow-throated Vireo	+	0.147	-0.147
Red-bellied Woodpecker	0.098	0.223	-0.125
Hairy Woodpecker	0.000	0.108	-0.108
Yellow-billed Cuckoo	0.058	0.159	-0.101
Eastern Wood-Pewee	0.000	0.086	-0.086
American Redstart	0.000	0.078	-0.078
Prothonotary Warbler	0.000	0.052	-0.052
Northern Flicker	+	0.049	-0.049

Louisiana Waterthrush	+	0.039	-0.039
Eastern Towhee	0.000	0.039	-0.039
Mourning Dove	+	0.027	-0.027
Yellow-throated Warbler	+	0.016	-0.016
American Crow	+	0.008	-0.008
Blue Jay	0.000	0.008	-0.008
Pileated Woodpecker	0.000	0.008	-0.008
Common Grackle	+	0.008	-0.008
Brown-headed Cowbird	+	0.008	-0.008
Red-headed Woodpecker	0.0003	0.0078	-0.0075
Eastern Bluebird	+	0.004	-0.004

Migratory species
Permanent Residents
+ Present but with no detected territories (scored as zero density)

As shown in Table 1, many migratory species suffered from declining territory density in areas where they were used to present. The highest decline comes from Red-eyed Vireo, Wood Thrush, Hooded Warbler, Acadian Flycatcher, and Kentucky Warbler. This finding is consistent with the New Hope Bottomland survey, which highlights the declining of many neotropical migratory species. Even though some of the declining species can be commonly observed in our area (e.g. red-eyed vireo), they are declining at an alarming rate.

Table 2. Increasing Species

	Territory density		
Species	Hollow Rock NP	Mason Farm 1980s	Difference
Northern Cardinal	1.099	0.282	0.817
Tufted Titmouse	1.066	0.456	0.610
Northern Parula	0.619	0.063	0.556

Blue-gray Gnatcatcher	1.088	0.536	0.552
Carolina Wren	0.714	0.293	0.421
Downy Woodpecker	0.425	0.180	0.245
Pine Warbler	0.249	0.061	0.188
Carolina Chickadee	0.441	0.266	0.175
Great Crested Flycatcher	0.220	0.074	0.146
White-eyed Vireo	0.127	0.039	0.088
White-breasted Nuthatch	0.205	0.122	0.083
Indigo Bunting	0.056	0.004	0.051
Summer Tanager	0.179	0.152	0.027

Migratory species
Permanent Residents

As shown in Table 2, several migratory and permanent resident species showed an increase in territory density. The highest increase comes from Northern Cardinal, Tufted Titmouse, Northern Parula, Blue-gray Gnatcatcher, and Carolina Wren. Aside from cardinals, titmice, and Carolina wrens thriving in our area, it is noteworthy that two migratory species (northern parula and gnatcatchers) are doing better than in the 1980s. There are several species we identified as increasing but not in the New Hope bottomlands including Blue-gray Gnatcatchers, Great Crested Flycatchers, and Indigo Buntings.

Discussion

Despite that Hollow Rock Nature Park has lower levels of environmental stressors, surrounded by less developments, the results indicate similar trends on missing and declining migratory bird species as we observed from the New Hope Bottomlands survey. We believe that there are several explanations for the local decline in territory density of migratory bird species, similar to the factors discussed in Hall et al (2024), including local habitat loss and several mechanisms of edge effects. The New Hope Creek watershed has gone through rapid developments since the 1980s. The loss of mature upland and bottomland deciduous forests is likely contributing to the missing and decline in territory density of bird species that rely on mature forest interior to meet their breeding needs. Species such as Wood Thrush, Ovenbirds, Hooded Warblers, and

Scarlet Tanagers would need such requirements for the park to be suitable for breeding. Because the park is surrounded by developments, particularly from the south and east sides, edge effects could also contribute to the decline of bird territory density. Open habitat near forest edges could increase predation by edge-tolerant species such as domestic cats, increase deer over-browsing (reduce understory habitats), increase brown-headed cowbird parasitism, increase cavity nest competition with European starling, increase strom runoff that could flood nests on the ground, and increase anthropogenic activities such as noise and light pollution.

Another important factor is the decline in prey population, particularly local insect population. Many declining migratory species rely on butterfly and moth caterpillars to raise their young. Without sufficient prey, Hollow Rock Nature Park may not provide a suitable nesting environment for those species. Based on the result of territory mapping at White Pines Nature Preserve in Chatham County of North Carolina, both the moth and bird population is thriving compared to the 1980s. This might suggest the prey population is playing a more significant role in sustaining the local breeding activities of migratory bird species. Understanding what is driving the decline in local moth population might provide guidance on local conservation actions to help sustain migratory bird species that breed in our local area.

References

Hall, S., Bradley, D., Bai, J., Boyarsky, G., Nebes, V., Anderson, D. (2024). Breeding Bird Survey, New Hope Bottomlands, 2024: Report to the Durham Open Space Program, New Hope Bird Alliance, and North Carolina Biodiversity Project.

LeGrand, H., J. Haire, N. Swick, and T. Howard. (2025). Birds of North Carolina: their Distribution and Abundance [Internet]. Raleigh (NC): North Carolina Biodiversity Project and North Carolina State Parks. Available from http://ncbirds.carolinabirdclub.org.

Moldenhauer, R. R. and D. J. Regelski (2020). Northern Parula (Setophaga americana), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca

Rosenberg, K.V., Dokter, A.M., Blancher, P.J., Sauer, J.R., Smith, A.C., Smith, P.A., Stanton, J.C., Panjabi, A., Helft, L., Parr, M. and Marra, P.P., (2019). Decline of the North American avifauna. Science, 366(6461), pp.120-124.