Breeding Bird Survey, New Hope Bottomlands, 2024

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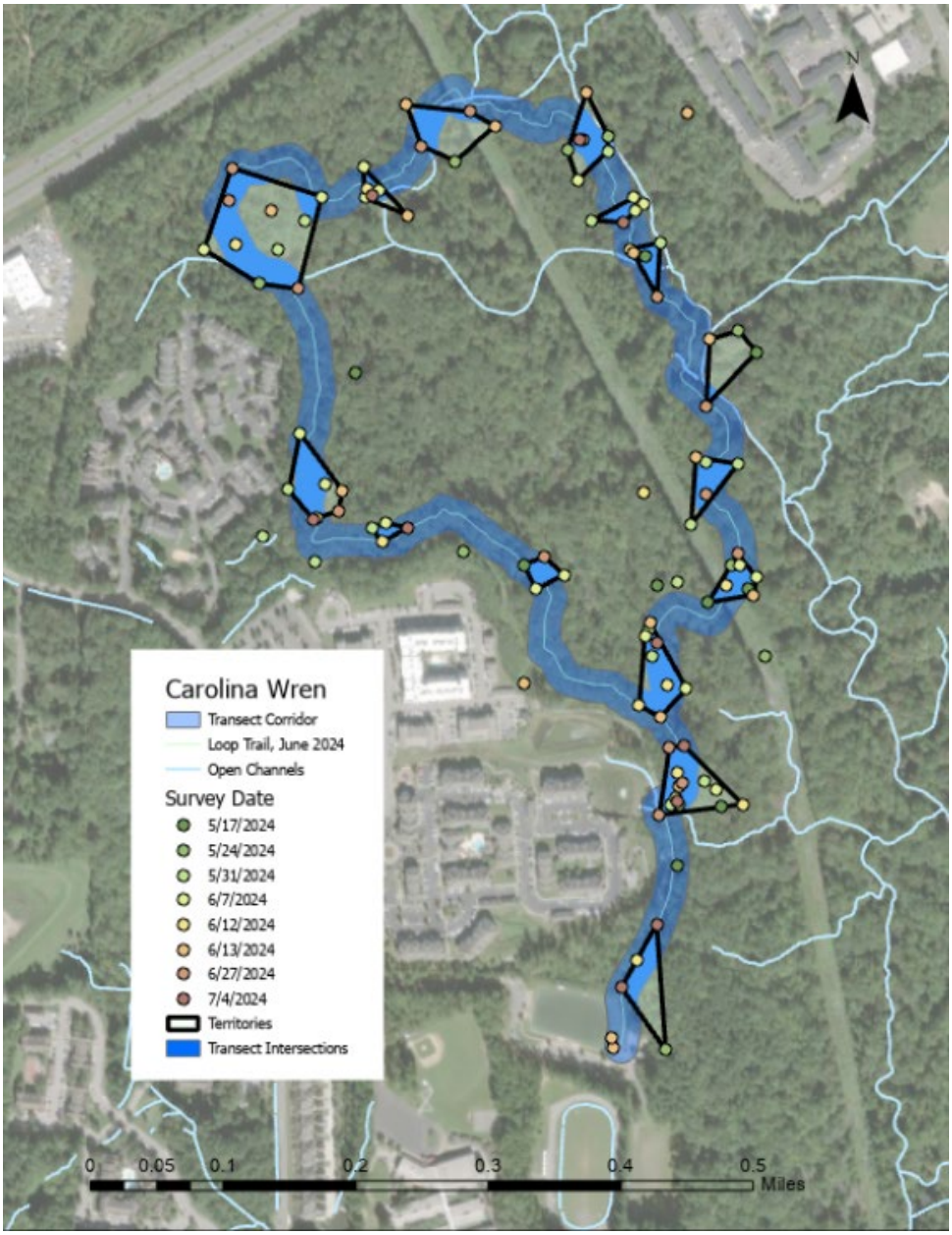
Report to the Durham Open Space Program, New Hope Bird Alliance, and
North Carolina Biodiversity Project



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Introduction

Drastic declines in bird species have been widely observed in North America (Rosenberg et al., 2019) and elsewhere around the world (Lees et al., 2022). This is consistent with the onset of a sixth mass extinction event, this one caused not by meteors, volcanic activity, or ice ages but by a single biological source, ourselves. Although the magnitude of these declines should be alarming to us all, the impact of these changes often hits home when we can actually see their effects in our own backyards. In the Triangle Area, for example, Mini-Breeding Bird Surveys – involving counts made along roadways throughout Orange, Durham, and Chatham Counties -- have documented strong declines of twenty-two species of birds over the past two decades (see https://minibbs.us/).

Particularly alarming are the declines or even outright extirpations that are showing up even in the heart of our best protected, most mature, and most extensive local natural areas – places that we have set aside specifically to conserve the best examples of our natural heritage. In the 2010s, Haven Wiley (pers. comm.) recorded the loss of both Hooded and Kentucky Warblers from the Mason Farm Biological Reserve, a site in Orange County where intensive surveys of breeding bird populations have been conducted since the late 1970s. In a 2022 survey conducted in the New Hope Bottomlands in Durham County, the North Carolina Biodiversity Project documented losses not only of those two species, but nine others that had previously been recorded as nesting species in that area (see Hall et al., 2022). Although the causes underlying these losses still need to be determined, there are reasons to suspect that changes in the local environment may be at least partly responsible. Whatever the cause, these losses themselves represent important changes to our local ecosystems. In any case, they should be major causes for concern – we are not as isolated from changes in the natural world as we might like to think. We really need to figure out what is going on now, just as much as we did when Rachel Carson first raised a similar alarm sixty years ago.

The current survey was done partly to confirm the findings obtained in the earlier surveys and to add a quantitative component not done in the previous project in this area, determining whether the numbers of individuals as well as the number of species are declining. We were also interested to see if there are quantitative differences between certain categories of species, especially migrants compared to permanent residents. Adding this quantitative component also allows more detailed comparisons to be made to both the Mini-Breeding Bird Surveys and the Mason Farm surveys[1]. Most importantly, we wanted to develop methods that can allow members of the local birding community to continue monitoring the status of the avian community of the New Hope Bottomlands and to extend this effort to include additional nature preserves in our area.

This survey partly represents a continued collaboration between the North Carolina Biodiversity Project (NCBP) and the Durham County Open Space Program, which owns and manages portions of the floodplain where this survey was conducted. The survey conducted by the NCBP in this area in 2021 and 2022 represented the first attempt by that group in conducting a biodiversity field survey focused on a particular site and covering an entire year. That model is

[1] We wish to thank Haven Wiley for sharing the compiled data from the Mason Farm breeding bird surveys, which were originally published in American Birds from 1976 to 1994.

currently being repeated in Chatham County at the White Pines Nature Preserve owned by the Triangle Land Conservancy. The results of that survey will provide yet another basis of comparison for the results previously obtained at New Hope Creek and Mason Farm, as well as that of the current survey.

The long history of conservation involvement by the Durham County Open Space Program is especially noteworthy. The Program supported the original natural area surveys in Durham County that determined the biodiversity significance of the New Hope Bottomlands (see Hall and Sutter, 1999). In 2020, the Program commissioned the North Carolina Biodiversity Project to bring our knowledge of the New Hope Bottomlands up to date. Following that effort, the Program is actively recruiting volunteers to keep the monitoring efforts ongoing, a critical need given the rapid pace of environmental change that we are now experiencing. As landowners of several key tracts along New Hope Creek and as conservation managers of still others, the Program is now in a position to develop management plans based on all of the accumulating information. helping to ensure that this area continues to keep its status as an Exceptional Natural Area (NC Natural Heritage Program, 2024).

For the current effort, the involvement of members of the New Hope Bird Alliance played a key role. Established in 1975 as a local chapter of the National Audubon Society, this group is composed of many expert birders that have had long experience in conducting bird censuses, particularly through their involvement in annual Christmas and spring bird counts. They have also played a major role in local habitat conservation. In the early 1980s for example, New Hope Audubon (as it was then called) was at the forefront in the successful efforts to protect the Mason Farm Biological Reserve from being bisected by a proposed parkway. Such involvement by a group of highly trained, well-informed citizen scientists is critical to both successful monitoring of our local natural areas but also in providing a major base of support for conservation efforts.

Study Area

This survey was conducted in the late spring and early summer along the New Hope Bottomlands Loop Trail, which was constructed and maintained by the Durham County Open Space Program. As shown in Figure 1, this trail runs from the Old Chapel Hill Road Park through the floodplain of New Hope Creek, including several tracts owned by Durham County and one privately owned tract where the Durham Open Space Program has obtained an easement for the trail.

Although not virgin forest, the stand of hardwoods that now covers most of the study area is one of the most mature found anywhere in the Piedmont. Trees larger than three to four feet in basal diameter are scattered throughout the site, one of which, the state champion Shellbark Hickory, is estimated to be over 300 years old (see Hall and Tingley, 2023). Historic aerial photographs indicate that the site has been covered with hardwoods since at least the 1940s and probably much longer than that.

The biological features of this site are now among the best studied in the state, due to the multi-taxa, year-long survey conducted in 2021-22 by the North Carolina Biodiversity Project. The results of this survey, including the project report, can be accessed on a website set up specifically for this purpose – see New Hope Creek Biodiversity Survey, 2021-22.

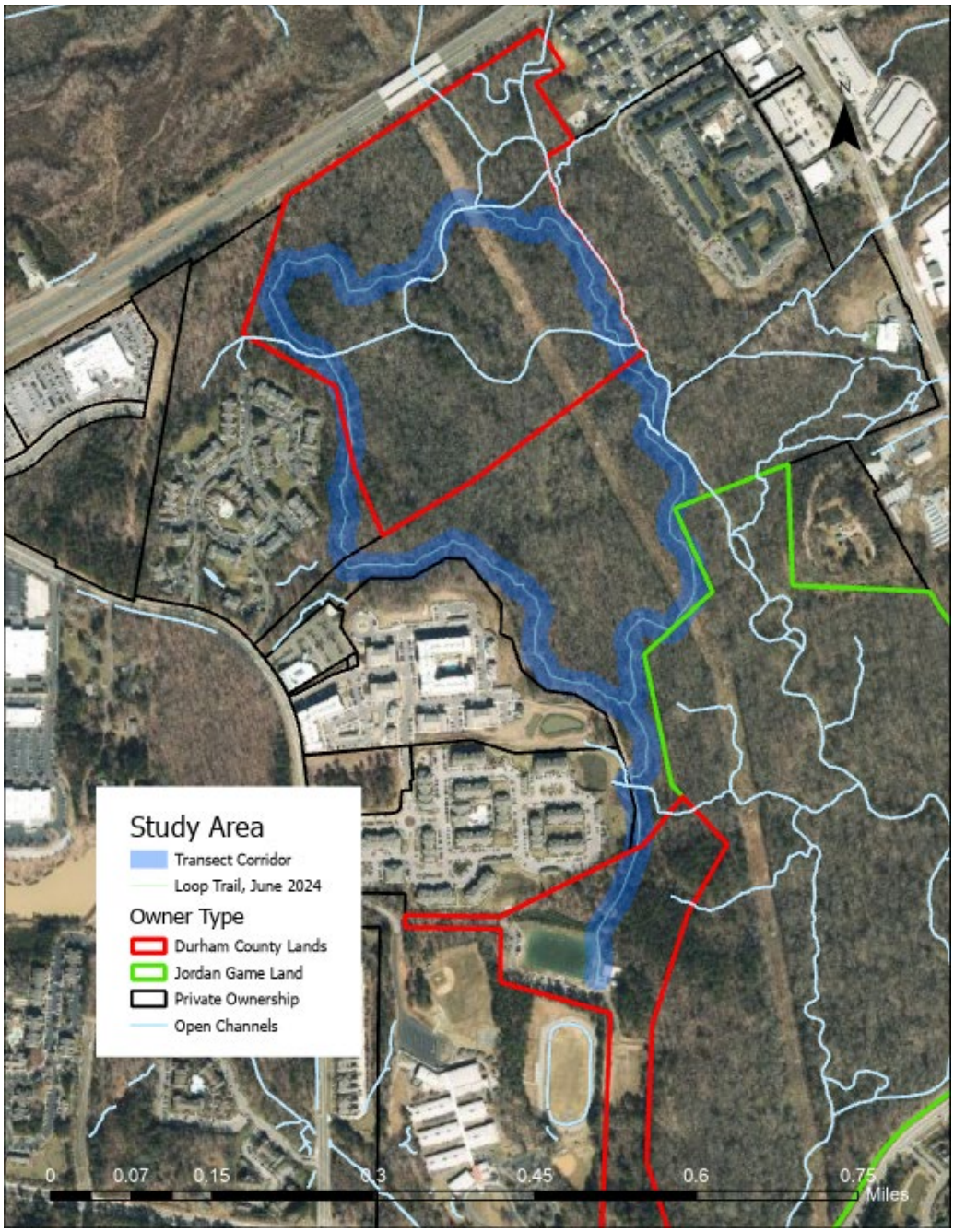


FIGURE 1. NEW HOPE CREEK BOTTOMLANDS

The survey transect follows the course of the Loop Trail, which was partially rerouted in 2024. The initial segment, beginning at the Old Chapel Hill Road Park to the entrance into the bottomlands, runs adjacent to the floodplain forest and partly through a regenerating stand of mixed pines and hardwoods. The majority of the trail, however, runs through mature, closed-canopy bottomland forest. At two points, the trail crosses a powerline right-of-way, which is kept clear of taller woody vegetation. A portion of the trail along the western side of study area also runs along the base and up onto to lower portion of the slope bounding the floodplain. The habitat in that section is still forested but includes species, such as Mockernut Hickory and

Black Gum, that are less tolerant of flooding but more tolerant of drier conditions than those restricted to the floodplain itself.

The total length of the Loop Trail is 3062 meters (1.9 miles) from the parking area at Old Chapel Hill Road Park, and the 40m wide transect corridor centered on the trail covers 12.03 hectares (determined through GIS). This is smaller but still comparable to the total area of 13 hectares covered by the census grid used in the breeding bird surveys conducted in the Big Oak Woods at the Mason Farm Biological Reserve.

Sampling Methods

The methods used in this study were chosen based on several criteria:

1. Methods need to be suitable for surveying individual natural areas
2. Methods need to produce quantitative data -- counts of individual birds by species -- as well as qualitative data (species checklists)
3. Methods need to be repeatable both within and between seasons. They also need to be standardizable across sites
4. The results need to be comparable to past surveys, particularly the rich, historic data from the Mason Farm Breeding Bird Surveys

The method we selected is a hybrid of the territory-mapping approach and the transect approach, both of which have been in long use for monitoring bird populations (see Gregory et al., 2004; Bibby et al., 2000). The transect approach – recording birds while walking along a linear route -- makes use of established trails instead of requiring off-trail bush-whacking. This makes it easier for more people to participate and protects the habitat integrity of off-trail areas of a preserve. The use of established trails also avoids the labor costs of setting up a fixed grid of staked points. Compared to the relatively few visits typical of transect surveys – usually aimed at surveying large regions, involving multiple sites -- we made multiple trips along the survey route with the goal of accumulating records of singing/territorial males to delineate individual territories.

In plotting these locations, we made use of both paper maps – traditional in territory mapping – as well as GPS units (including cell-phones with GPS capabilities). As in the territory mapping approach, we tried to differentiate records of simultaneously singing males and the movements of individual males from one location to another. However, this proved easier to do using the paper maps, although at least some GPS units allow notes to be entered along with the coordinates.

As in some forms of transect surveys (see Bibby et al.), we divided the transect area into two belts: an inner belt extending 20 meters to either side of the trail and an outer belt extending out to the limit to which singing males could be detected. Observations made within the inner belt were considered to be accurately plotted and only territories with at least one such record are included in the quantitative analysis (see below). In compiling species lists for the entire study area, however, all species that could be identified are included.

A total of eight survey visits were made, meeting the requirements given for territory mapping studies (see Svenson and Williamson, 1969). The first survey was conducted on May 17, after most migrants had passed through our area. The last was made on July 4, when territorial

activity was on the wane. All visits to the study area were begun within two hours following dawn, when singing behavior is at its peak.

Analytical Methods

Analysis follows the system used in territory mapping rather than the Density Sampling methods developed specifically for transect surveys (e.g., see Thomas et al., 2010). Essentially, we treat our transect corridor as a long, skinny study plot. As in traditional territory mapping, the goal is to count the number of territories within a given area. All territories that occur entirely within the study plot are given a score of 1, i.e., representing a single, whole territory, no matter what their size or shape.

Special rules are used to handle territories that are only partially included within the study plot, i.e., that staddle the edge of the plot. These are based on the proportion of the territory that is included. One method is to include all that have the majority of their area located within the plot and to exclude all others. Another is to give all territories that straddle the edges an average value of 0.5. We follow a third method, estimating the actual proportion of a territory that falls inside, e.g., 30%, 60%, etc. This is the method used in the Mason Farm surveys (H. Wiley, pers. comm.) and accordingly the one we adopted in this study for purposes of comparison to those surveys.

Identification of Territories

Territory mapping surveys depend on the ability of the researchers to recognize the location and extent of the territories occupied by individual males or mated pairs. In some cases, different points within a territory are identified by direct observation of moving individuals or, conversely, neighboring territories are identified through observation of simultaneously singing males or where the boundaries between territories are determined through observation of territorial interactions.

In most cases, however, the location and extent of territories are estimated based on clusters of points where singing males have been recorded. Several rules have been developed to help steer this process. Some of the original rules are listed in Svenson and Williams (1969) and others that have developed over the years are summarized in Bibby et al., (2000). For the most part, we follow these rules but add an additional process: density-based cluster analysis, a GIS method for separating sets of points that appear to represent true clusters and excluding points that appear to represent “noise”, i.e., that do not appear to show a strong spatial relationship to other points. Our approach to the identification of clusters/territories is as follows:

1. The minimum number of points for a cluster is set at three, following the rule given by Svenson and Williams where at least eight survey visits have been made.
2. Clusters of observation points are initially identified using the density-based cluster analysis provided in ArcGis Pro (see How Density-based Clustering works). In all cases, the minimum cluster parameter is set three. Of the three methods provided for this analysis, we try using first the Self-adjusting (HDBSCAN) version, which works automatically to find spatial clusters of points throughout the set of points observed for a given species. This method often fails, however, to identify any clusters or identifies only a small set out of all the points included in the analysis. Where those results are obtained, we try the Multi-scale (OPTICS) method, which adds a search distance

parameter and a cluster-sensitivity setting, both of which can be used to fine-tune the results based on trial-and-error. This method also fails on occasion to identify any clusters but in any case, the results of this analysis represent only a starting point, the results of which can be adjusted based on the following considerations.

3. For some species, territory size has been documented and especially where studies exist from the same geographic region and habitat types present in our study area, we use this information as a gauge for evaluating cluster size. For the most part, however, this method works for species that have very large territories and where the observation points are too widely scattered to register as clusters using the density algorithms.
4. In all cases, we aim at obtaining clusters that are similar in size. Those that are much bigger are candidates for splitting, while those that are much smaller are candidates for lumping.
5. Clusters must include at least two different survey dates, no matter how many points they may contain. Those represented by only a single date are discarded or pooled with another group
6. Small, adjoining clusters are merged where they represent different time periods but otherwise do not indicate use by more than one male.
7. Clusters that contain subclusters that have three or more dates in common are subject to splitting, the assumption being that individuals are usually recorded at just one location on a single date unless seen to be moving between these subareas.
8. Clusters are split based on observations of simultaneously singing males or of territorial interactions at a presumptive boundary.
9. All points located within the inner 20m belt of the transect are considered accurate and only clusters that include at least one such point are included in the analysis.
10. Points located outside the inner belt are given more consideration the closer they are to the trail. Distant points, especially when isolated, are left out of the quantitative analysis as too uncertain to be trusted. The species, however, are eligible for inclusion on the species list no matter how far out they appear to be, but only if they are located within the same habitat block as the survey transect.
11. Points located outside the habitat used by the species are excluded from consideration even where they fall within the inner belt.

Following identification of a cluster as a territory, we use the Minimum Bounding Geometry tool of ArcGis Pro to enclose the points within a minimum convex polygon (convex hull), representing areal extent of the territory. This allowed another check of the clusters: territories are expected to be spatially exclusive, with no overlapping points. Any overlap found following this procedure indicates a possible re-assignment of the overlapping points.

The size of each of these polygons is calculated using the standard Calculate Geometry method of ArcGis Pro and are used in the calculation of the proportional representation of edge territories, as described below. We also calculate the average value of these polygons for future reference, providing territory estimates that are more consistent with our particular methodology (although not necessarily more meaningful) than territories determined by a variety of other methods. This allows another basis for comparing results obtained between survey areas or between years at the same site.

Treatment of Edge Territories.

Following the standard procedures of territory mapping, only territories wholly or partially included within the inner 40m belt of the transect are included in the calculation of territory

density: at least one point of any cluster must fall within that zone. Also following the rules of territory mapping, all territories straddling the boundary of the 40m wide inner belt are treated as edge territories, and scored according to the proportion of their area that falls inside the inner transect (the method used in the Mason Farm surveys). The goal is to estimate the number of territories per area, expressed in units of whole territories.

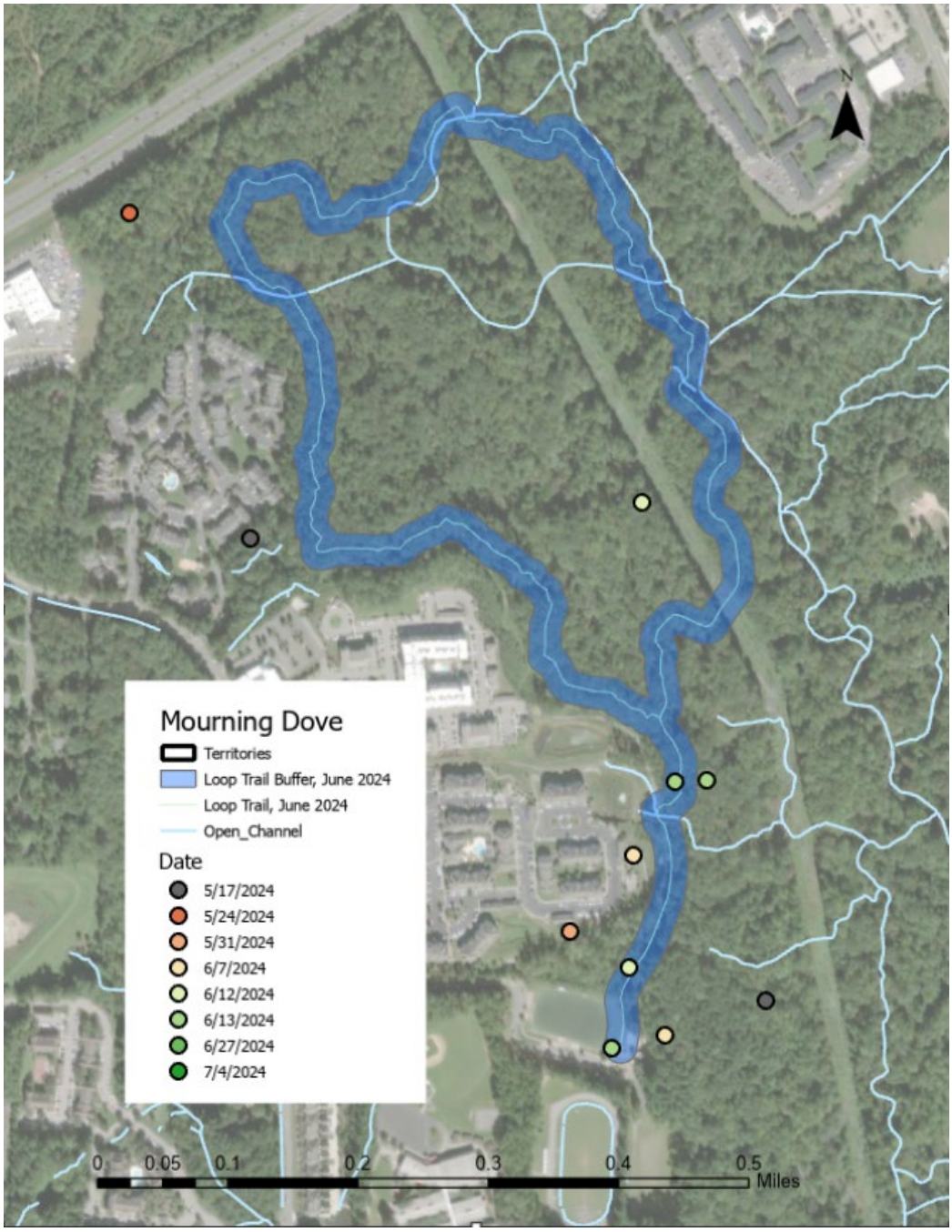
To calculate the proportions of the edge territories located inside and outside the transect, we used the Pairwise Intersection tool of ArcGis Pro to create polygons representing the intersection of a territory and the inner belt. The area of these polygons is then calculated and divided by the area of the territory as calculated above. The resulting values are then summed to calculate the total number of territories included within the transect. Division of that sum by the area included within the transect thus estimates the density of territories within the study area overall.

Results

Individual Species Accounts

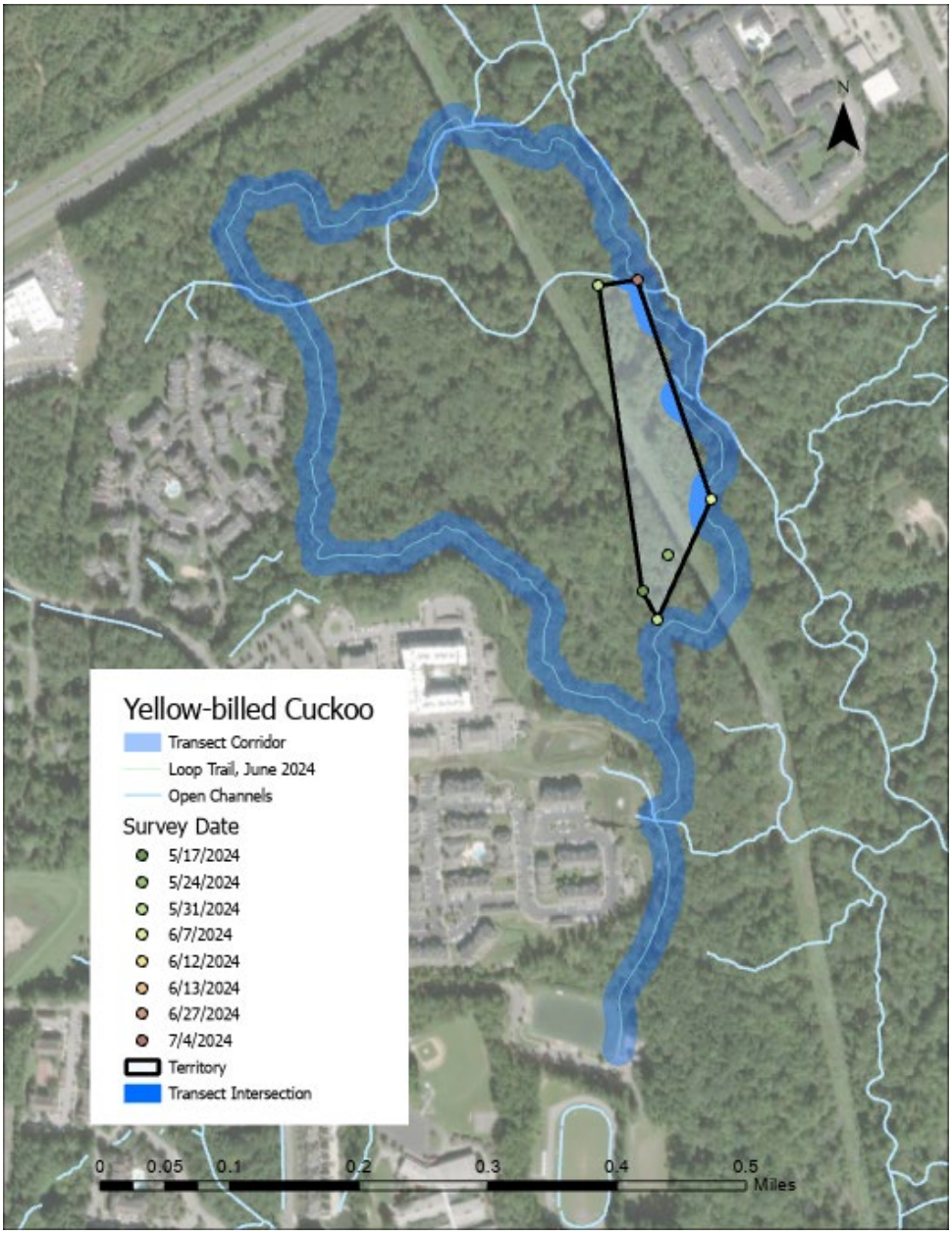
The following accounts show the observations for individual species – following order of the current AOU Checklist -- within the study area. The density of territories is given and compared to the results of the breeding bird surveys conducted in the Big Oak Woods at Mason Farm in the 1980s and to the more recent Mini Breeding Bird Surveys conducted in Orange, Durham, and Chatham Counties.

Mourning Dove



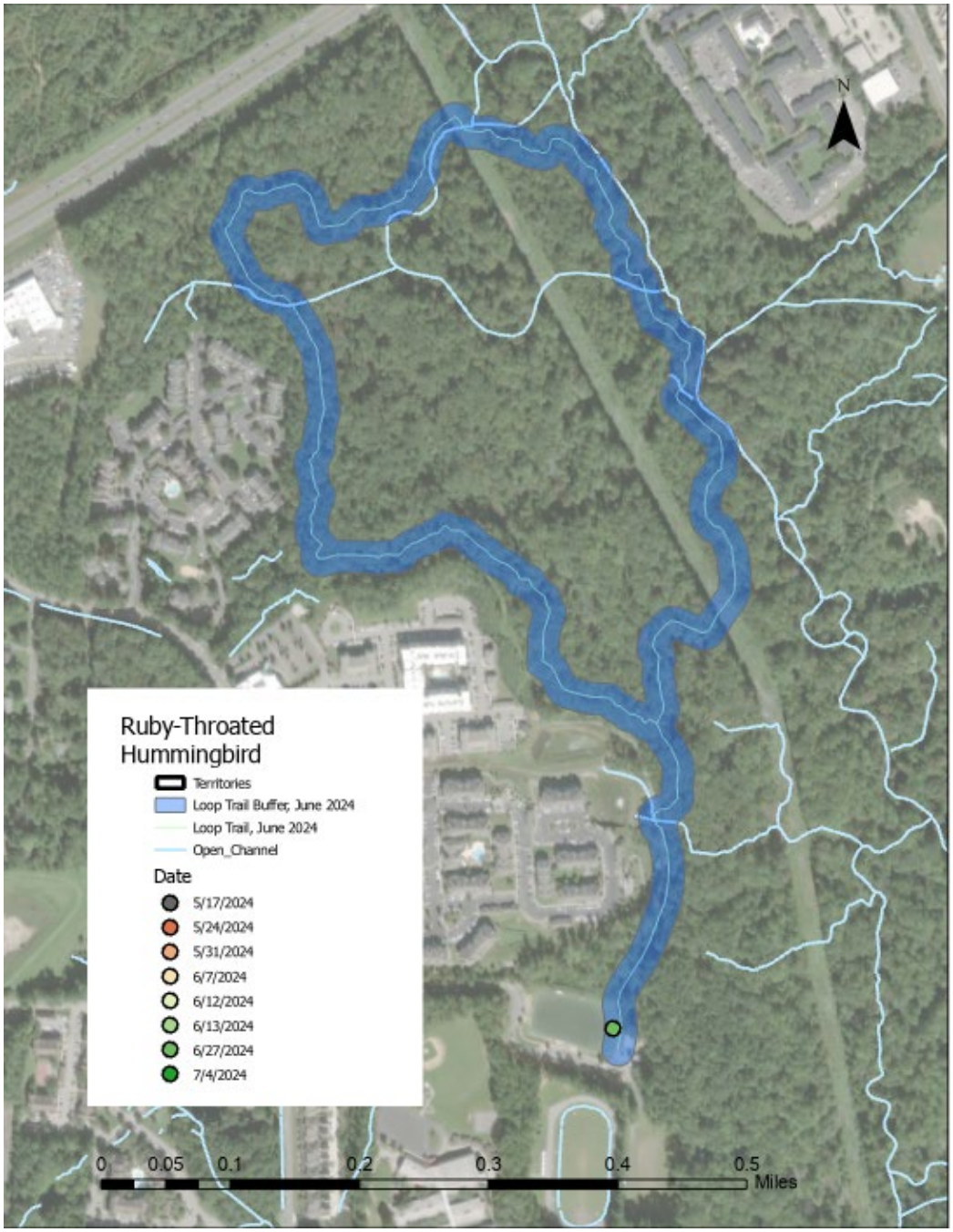
Mourning Doves are associated with open habitats to open woodlands and are only occasionally observed in closed-canopy forests. Most of our observations were made along edges or in neighboring open areas. No territories were identified although they may nest somewhere within the study area. A similarly low presence was recorded in the Big Oak Woods during the 1980s, where an average of 0.0031 territories per hectare was obtained. This species appears to be declining in the three counties included in the Mini Breeding Bird Survey (2024).

Yellow-billed Cuckoo



Yellow-billed Cuckoos are associated primarily with moist hardwoods, including bottomlands (LeGrand et al., 2024). Whether or not they defend territories is unclear, and the ranges of multiple individuals may overlap (Hughes, 2020). In the Southwest, home range size varied from 7.5–51 ha. This suggests that a single pair or multiple pairs could occupy the entire study area. Under that interpretation, all observations were combined to produce a single range polygon, which is 2.88 ha in extent. Based on the proportional rule for edge territories, the density of territories in the study area is estimated at 0.01per hectare. This is much smaller than the average of 0.17 per hectare observed in the Big Oak Woods in the 1980s. However, this species appears to be holding steady within the area covered by the Mini Breeding Bird Survey (2024).

Ruby-throated Hummingbird

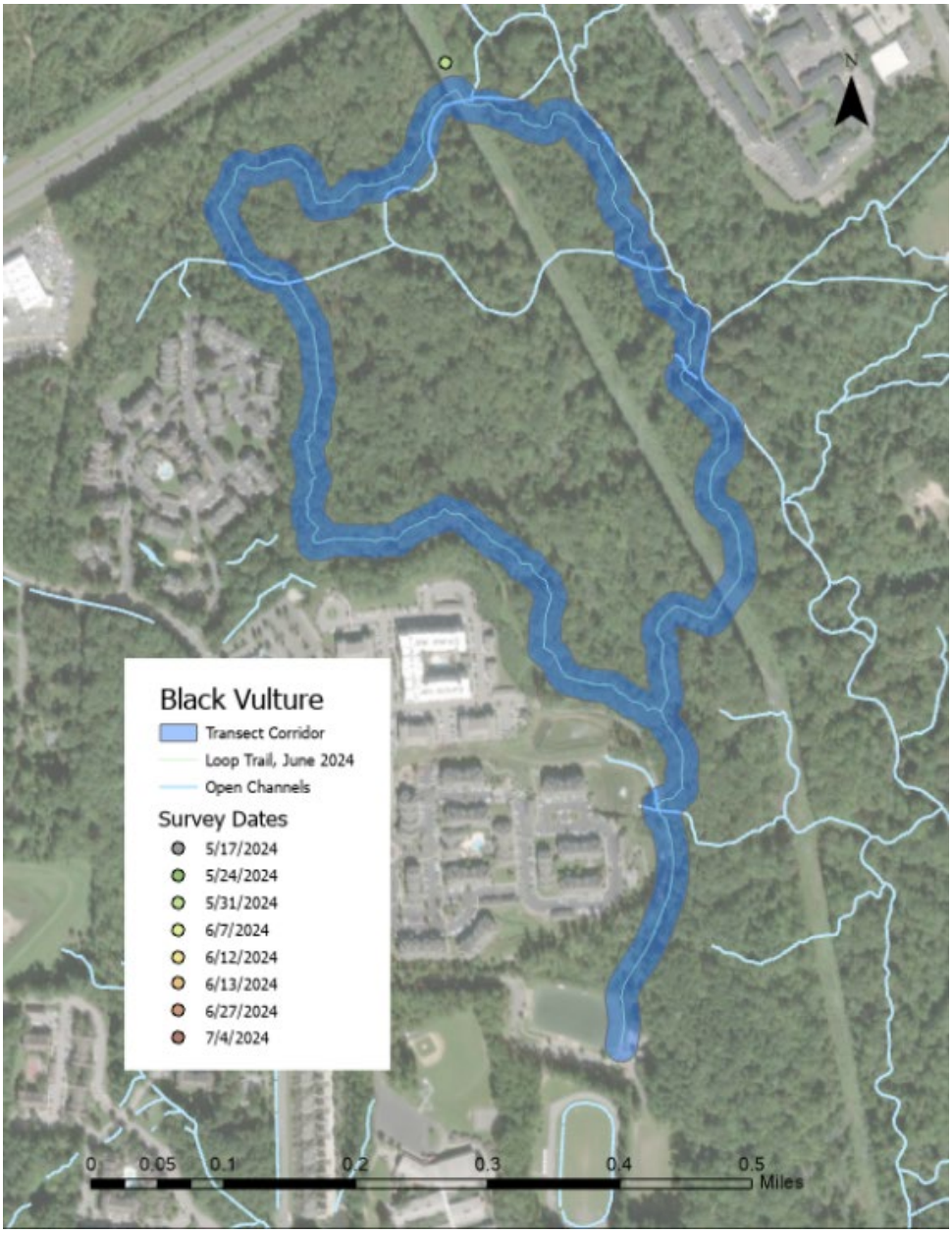


Ruby-throated Hummingbirds are associated with forest edges, groves, and semi-wooded residential areas; wet areas, including bottomlands, are preferred to drier sites (LeGrand et al., 2024). Only a single observation was made of this species during the survey, in an open, disturbed area rather than the bottomland forest. No territories could be identified, whereas an average of 0.25 territories per hectare was recorded in the Big Oak Woods during the 1980s. This species appears to be in moderate decline within the area covered in the Mini Breeding Bird Survey (2024).

Green Heron

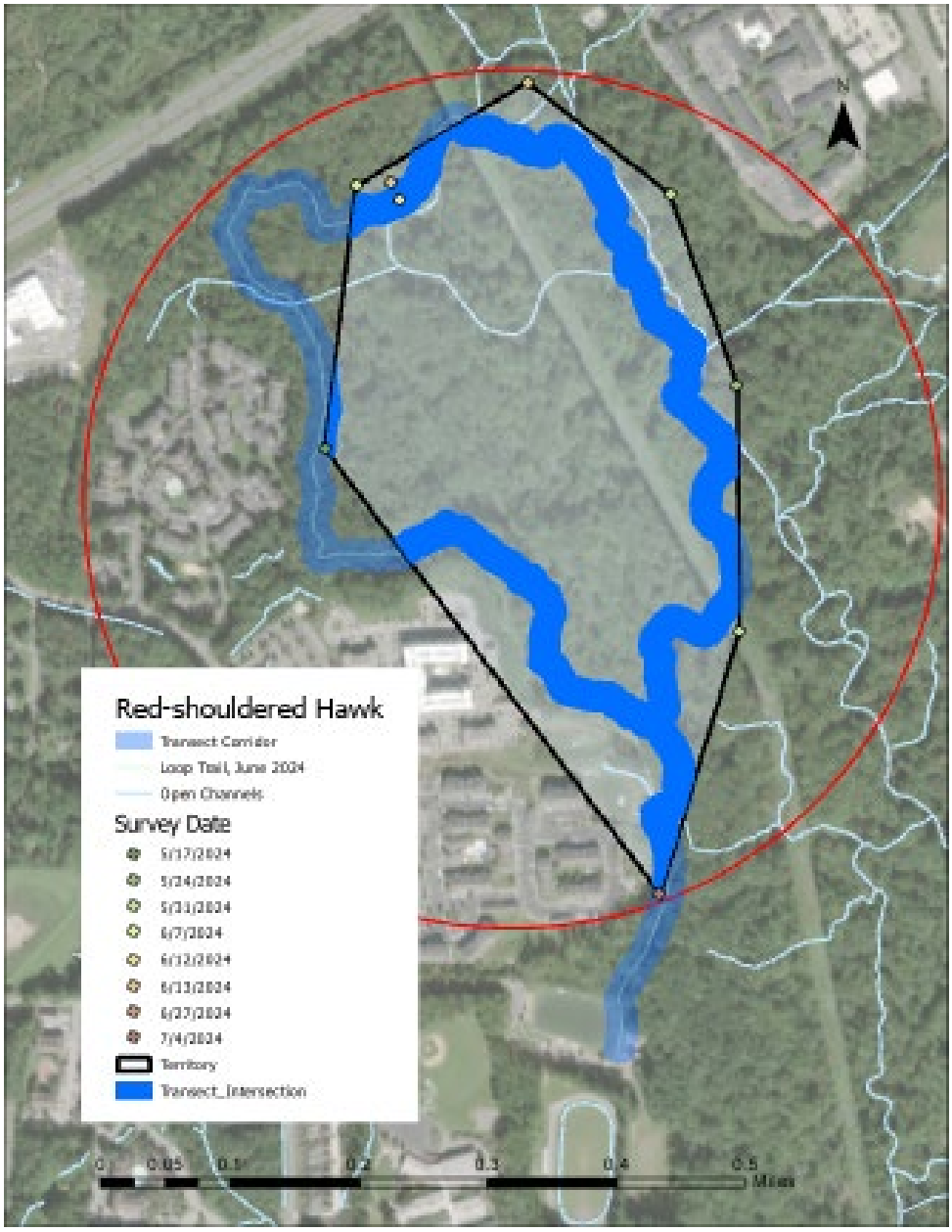
Green Herons are found throughout North Carolina in association with rivers, streams, ponds and lakes, nesting within adjoining areas of forest. This species is likely to forage in the areas of the New Hope floodplain that contain open sloughs and could nest within the study area. However, we made only one observation during the survey and are unable to identify any territories. Similar results were obtained for the Big Oak Woods where an average of only 0.0015 territories per hectare was recorded in the 1980s. This species appears to be in moderate decline within the area covered in the Mini Breeding Bird Survey (2024).

Black Vulture



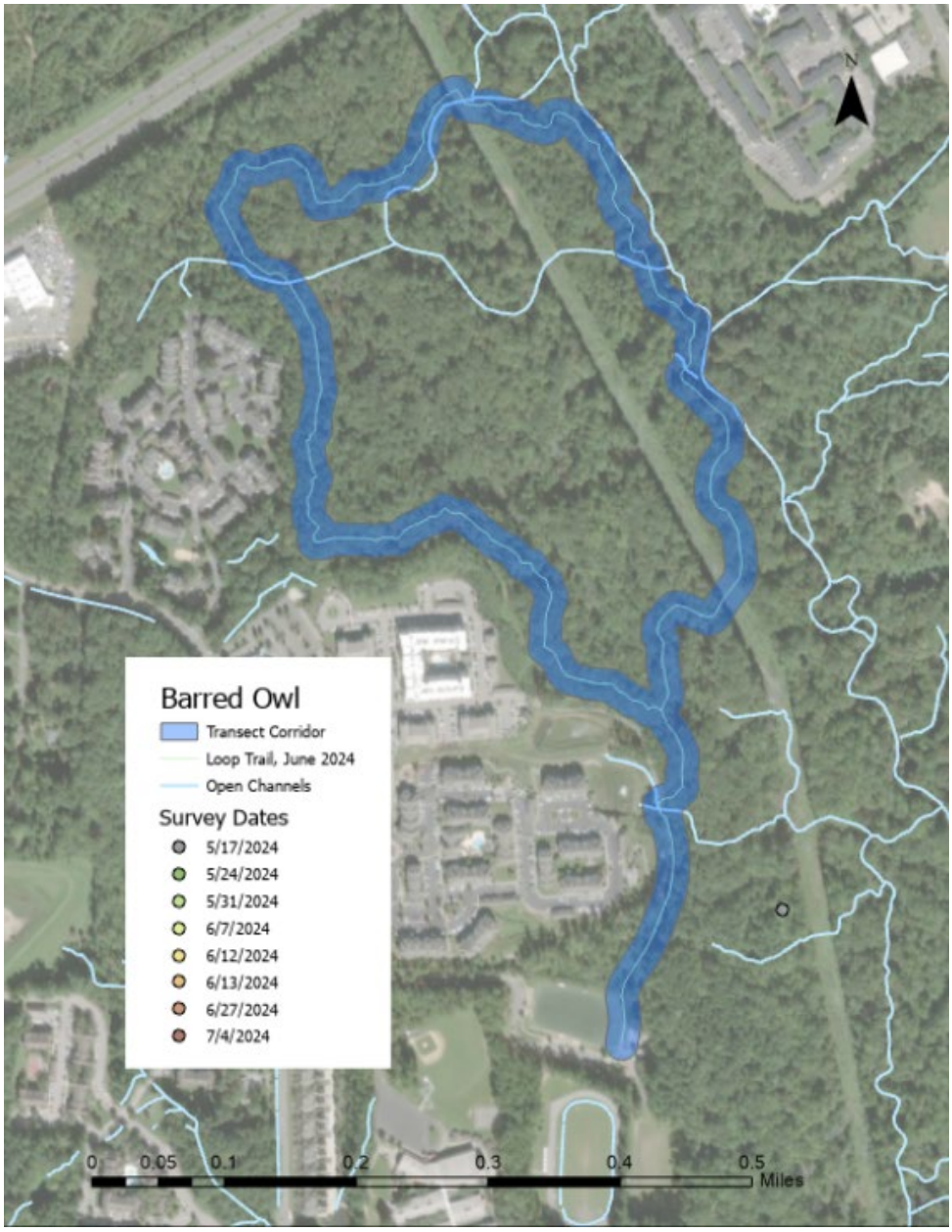
Black Vultures fly over the study area on a regular basis but have not been observed roosting or foraging within it; only a single observation was made during the survey. During the 1980s, this species was considered Significantly Rare by the Natural Heritage Program and none were recorded at Mason Farm during the breeding season during that decade. Their numbers have dramatically increased since that time, however, as shown in the Mini Breeding Bird Survey (2024). Roosting within the New Hope Bottomlands is at least a possibility.

Red-shouldered Hawk



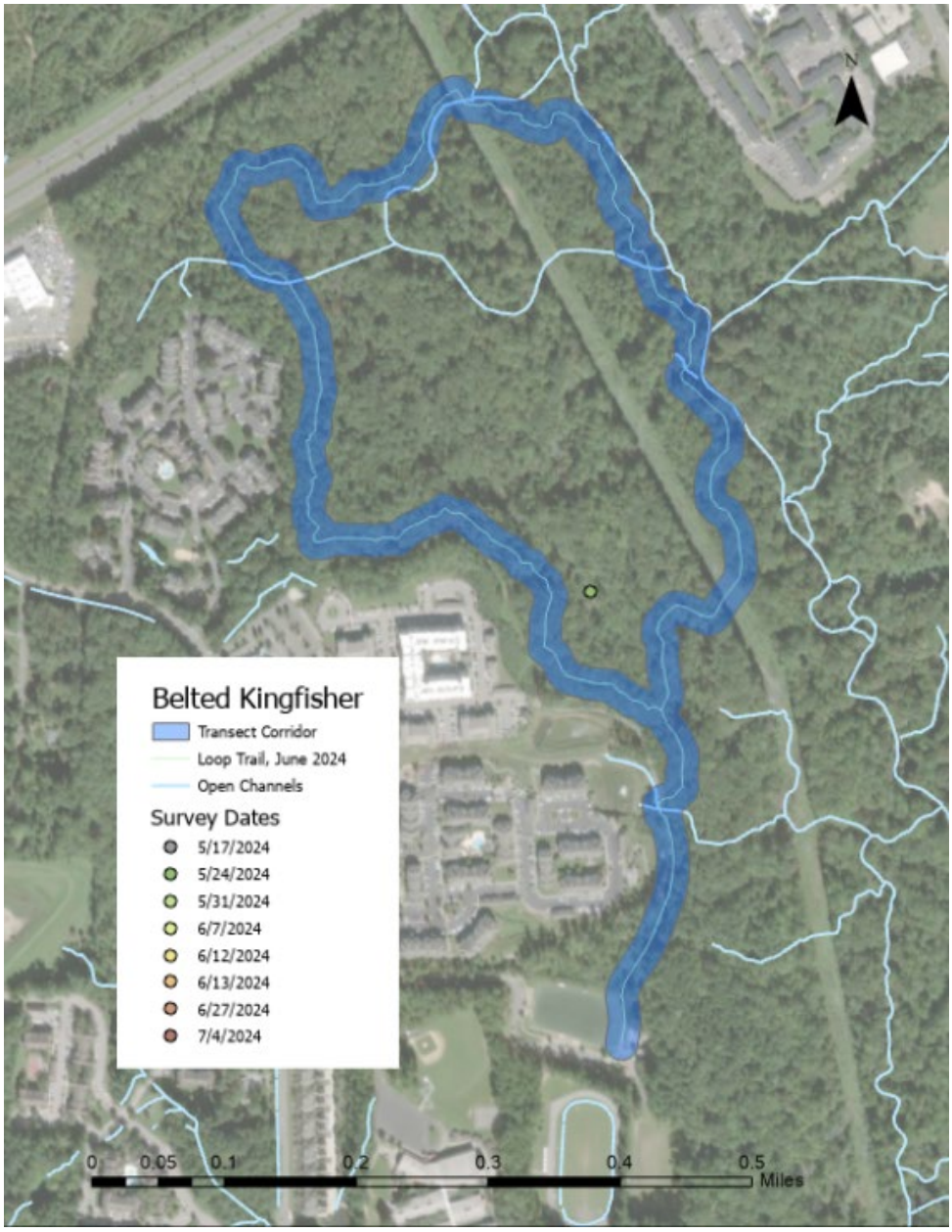
Red-shouldered Hawks are primarily associated with bottomland forests, swamps, lakeshores, and other wetlands. Home ranges vary in size from 90 to 200 hectares (Dykstra et al., 2020). As illustrated by the 90-hectare circle shown in red, only a single pair's territory is likely to exist within the study area. The convex polygon we used to estimate the territory within the study area is 33.05 hectares in extent and the territorial density we estimate using the proportional rule for edge territories is 0.02 per hectare. This is essentially the same as the average density of 0.01 per hectare was observed in the Big Oak Woods in the 1980s; in both cases, probably only a single pair was resident in the study area. This species appears to be increasing in the area covered by the Mini Breeding Bird Survey (2024). In some parts of its range, this species is moving into residential areas, far from bottomlands.

Barred Owl



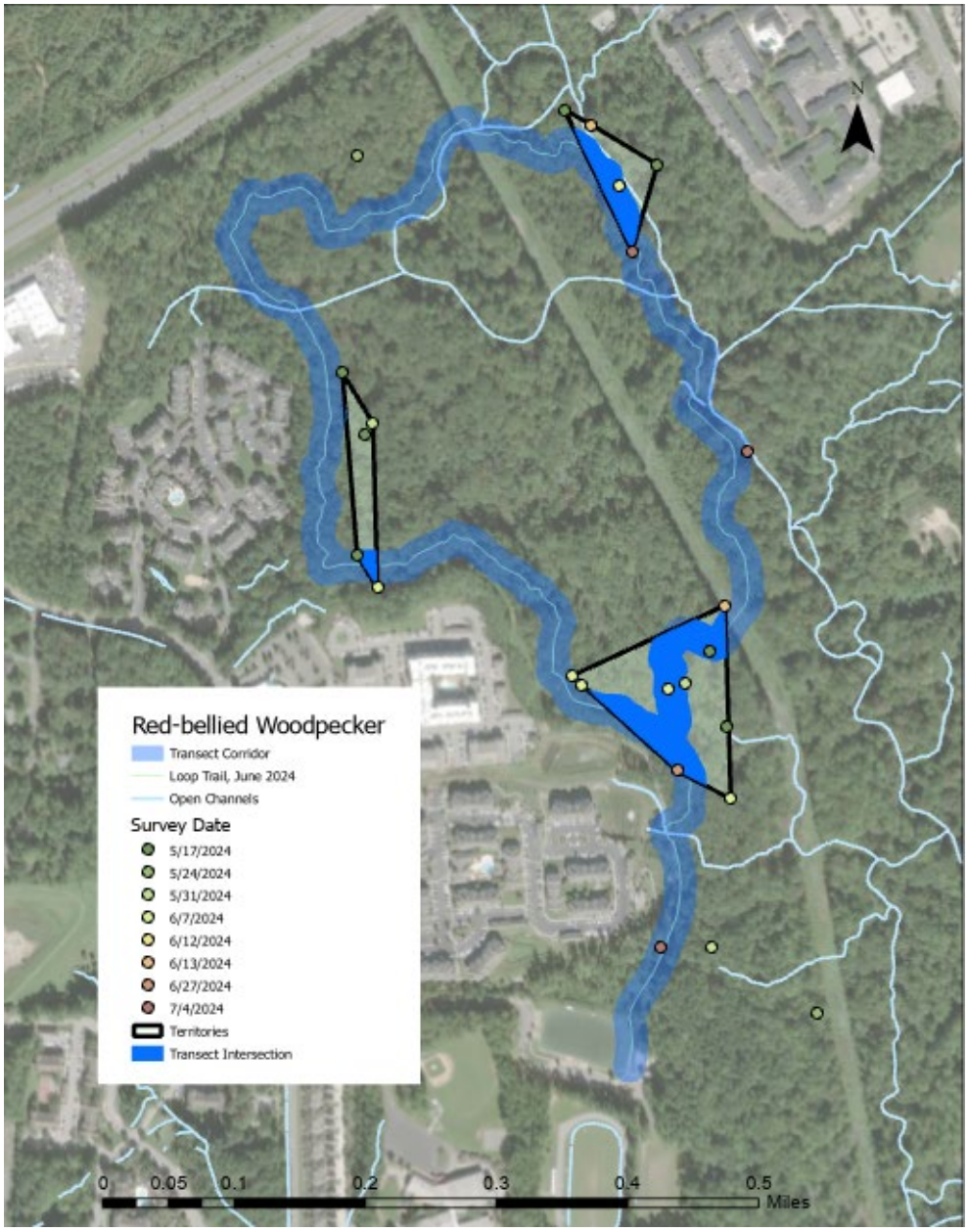
Barred Owls occur in association with floodplain forests throughout their range and are frequently heard calling in the New Hope Bottomlands. However, they call most frequently in late winter/early spring when they are nesting and we only heard them once at the beginning of the survey period. Given the large size of their strongly defended territories – estimates range from 273 hectares to over 1,000 hectares (Mazur and James, 2020) – only a single territory is likely to exist within the study area. Similar results were obtained in the Big Oak Woods in the 1980s, where the average density was given as 0.0038 per hectare. This species appears to be increasing within the area covered by the Mini Breeding Bird Survey (2024).

Belted Kingfisher



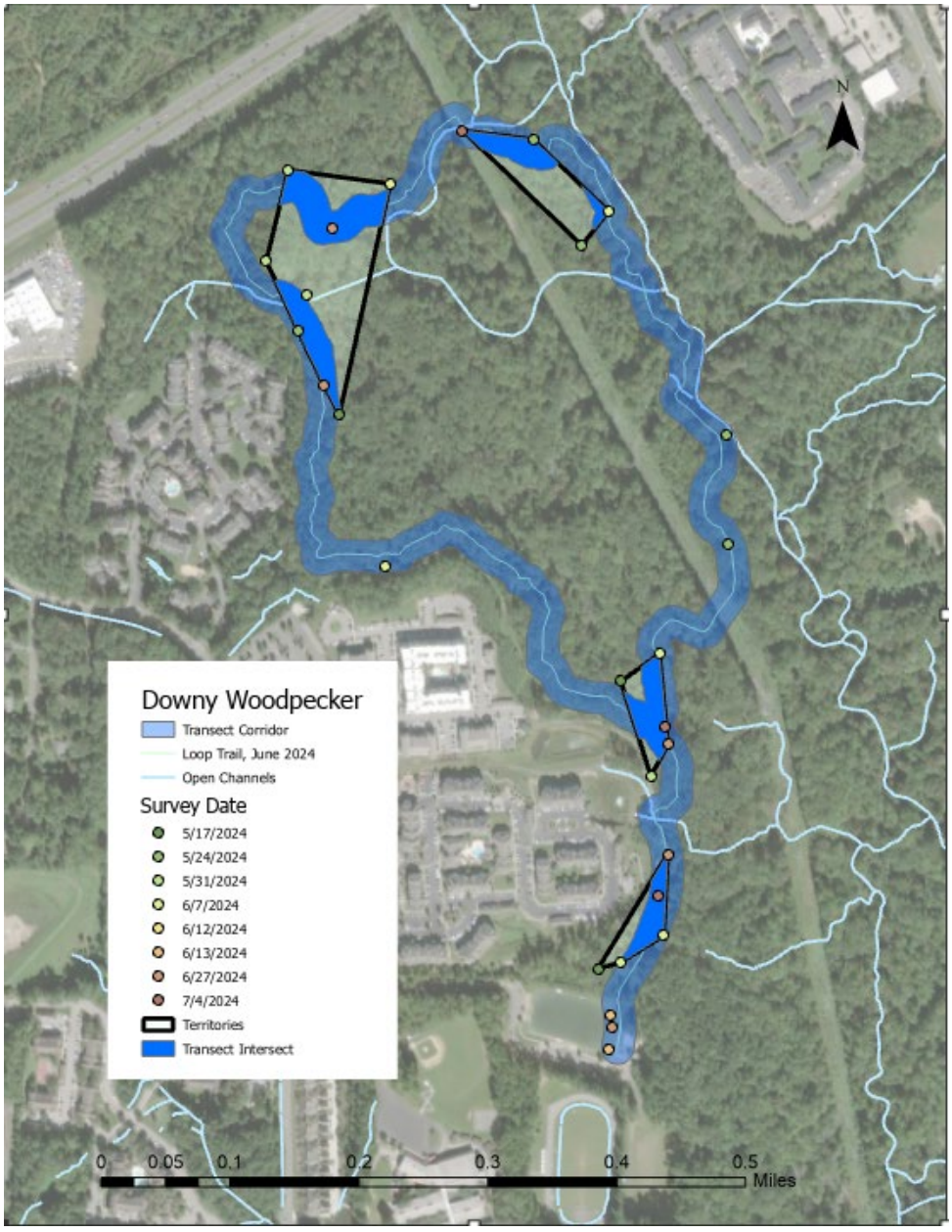
Belted Kingfishers forage along streams, rivers, lakes, and ponds throughout the state and nest in holes in steep banks. Although they are heard regularly within the study area, the stream banks in this area may be too low to be safe from frequent flooding. Only one was heard during the survey, probably foraging at one of the sloughs, and no territories were identified. None were recorded in the Big Oak Woods during the 1980 surveys. This species appears to be moderately strongly declining in the area covered by the Mini Breeding Bird Survey (2024).

Red-Bellied Woodpecker



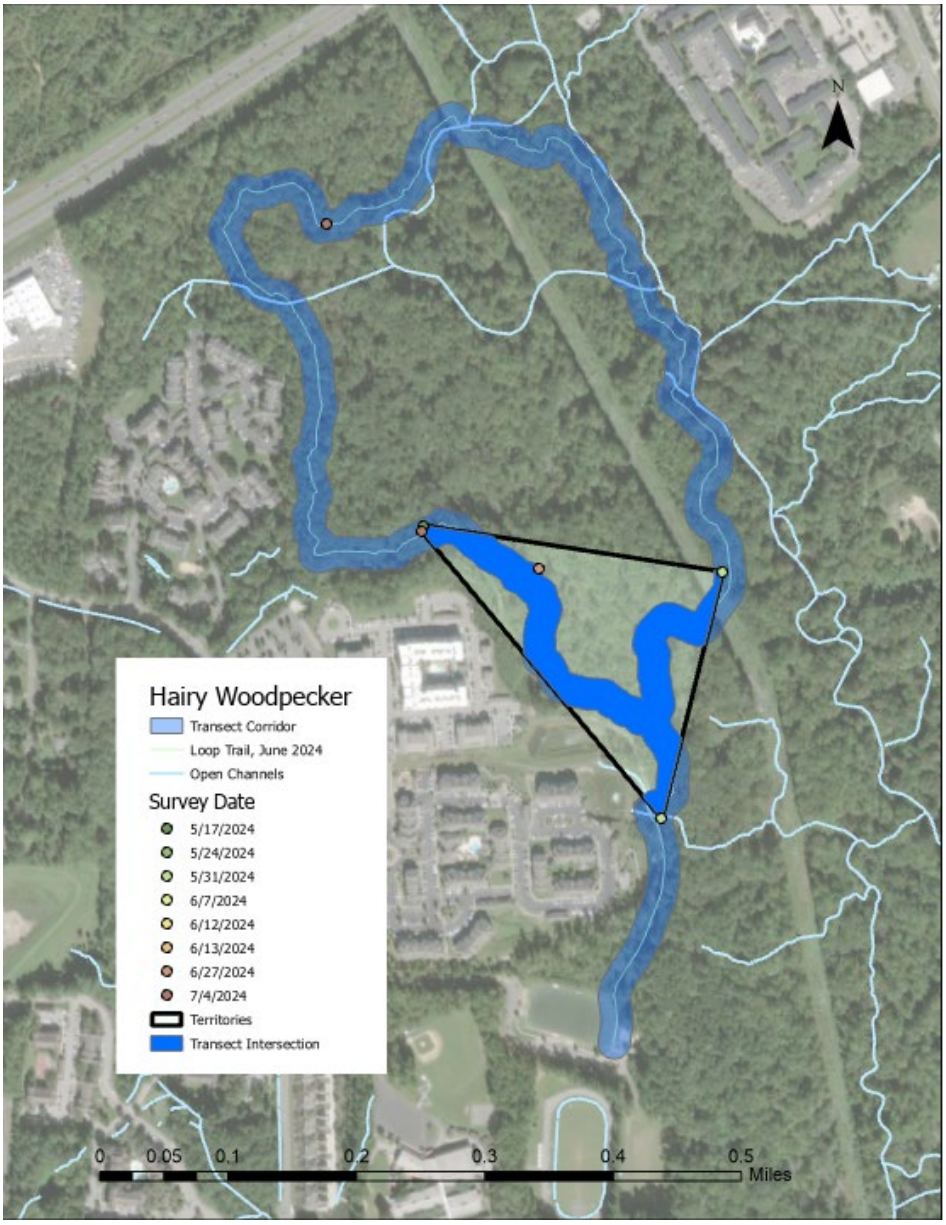
Red-Bellied Woodpeckers are permanent residents across North Carolina and as tree-cavity nesters, they occur in a wide variety of forests, woodlands, and semi-wooded residential areas. Although there is significant overlap of foraging areas between individuals, small areas around nesting cavities are actively defended against conspecifics (Miller et al., 2020); we interpret the clusters of observation points as representing these activity areas rather than as complete home ranges. The average area of the convex polygons we use to estimate the location and size of these activity areas is 1.24 hectares. Using the proportional rule for edge territories, we calculate their density as 0.9 territories per hectare. This is substantially larger than the average of 0.26 per hectare recorded in the 1980s in the Big Oak Woods. Based on the Mini Breeding Bird Survey (2024), our populations of this species are holding fairly steady.

Downy Woodpecker



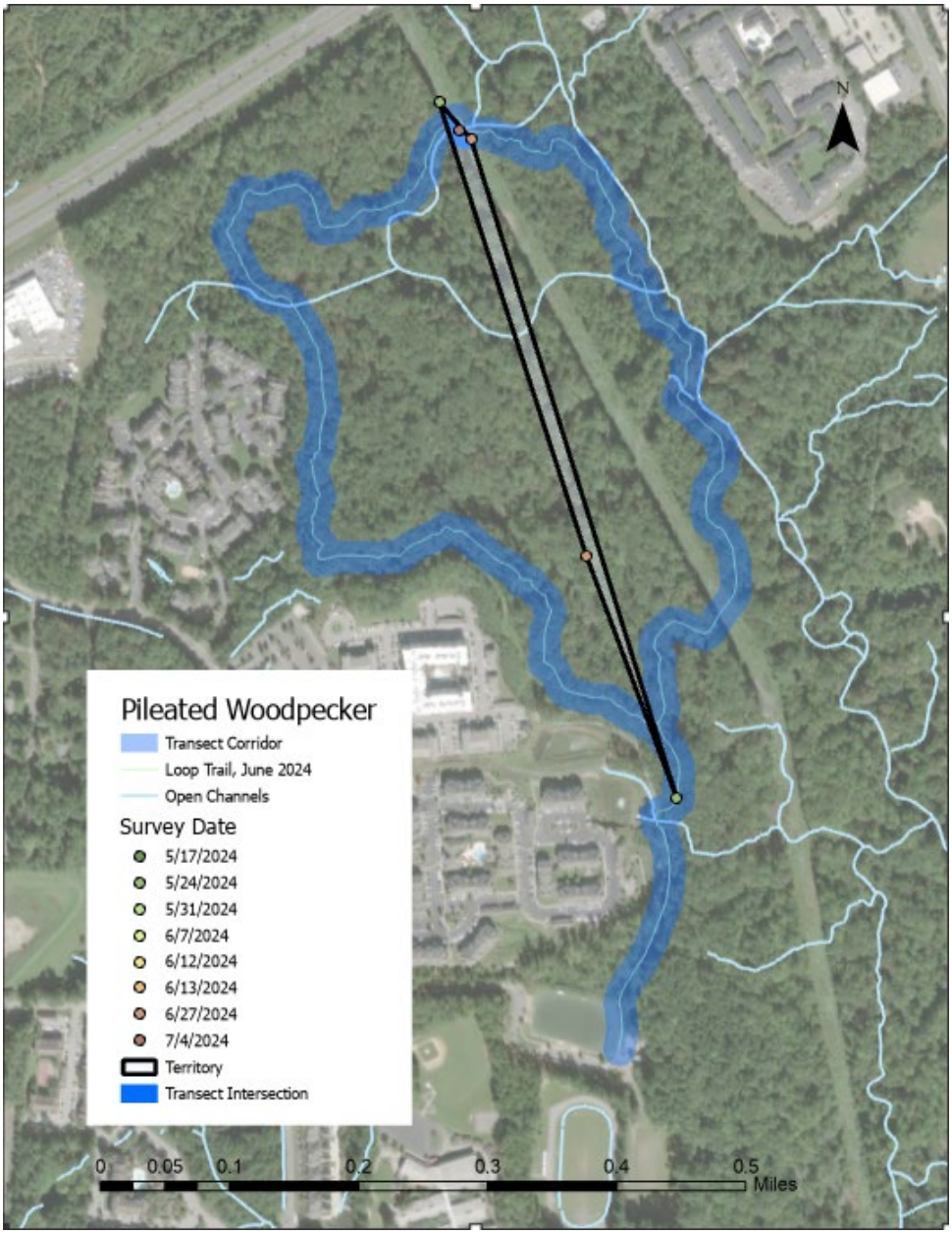
Downy Woodpeckers live primarily in hardwood forests and woodlands across the state but occasionally use pine stands and mixed forests (LeGrand et al., 2024). During the nesting season, they occupy non-overlapping season territories of between 4.5 to 5.5 hectares (Twomey, 1945; cited by Jackson and Ouellet, 2020). Four clusters of observations met our criteria for territories, with the convex polygons that we used to approximate the territories average only 1.12 ha, with the largest being 2.7 ha. Using the proportional rule for edge territories, the density is 0.18 per hectare. This is close to the average of 0.20 territories per hectare recorded for the Big Oak Woods in the 1980s. Downy Woodpeckers do not appear to be undergoing any change in abundance in our area, based on the Mini Breeding Bird Survey (2024).

Hairy Woodpecker



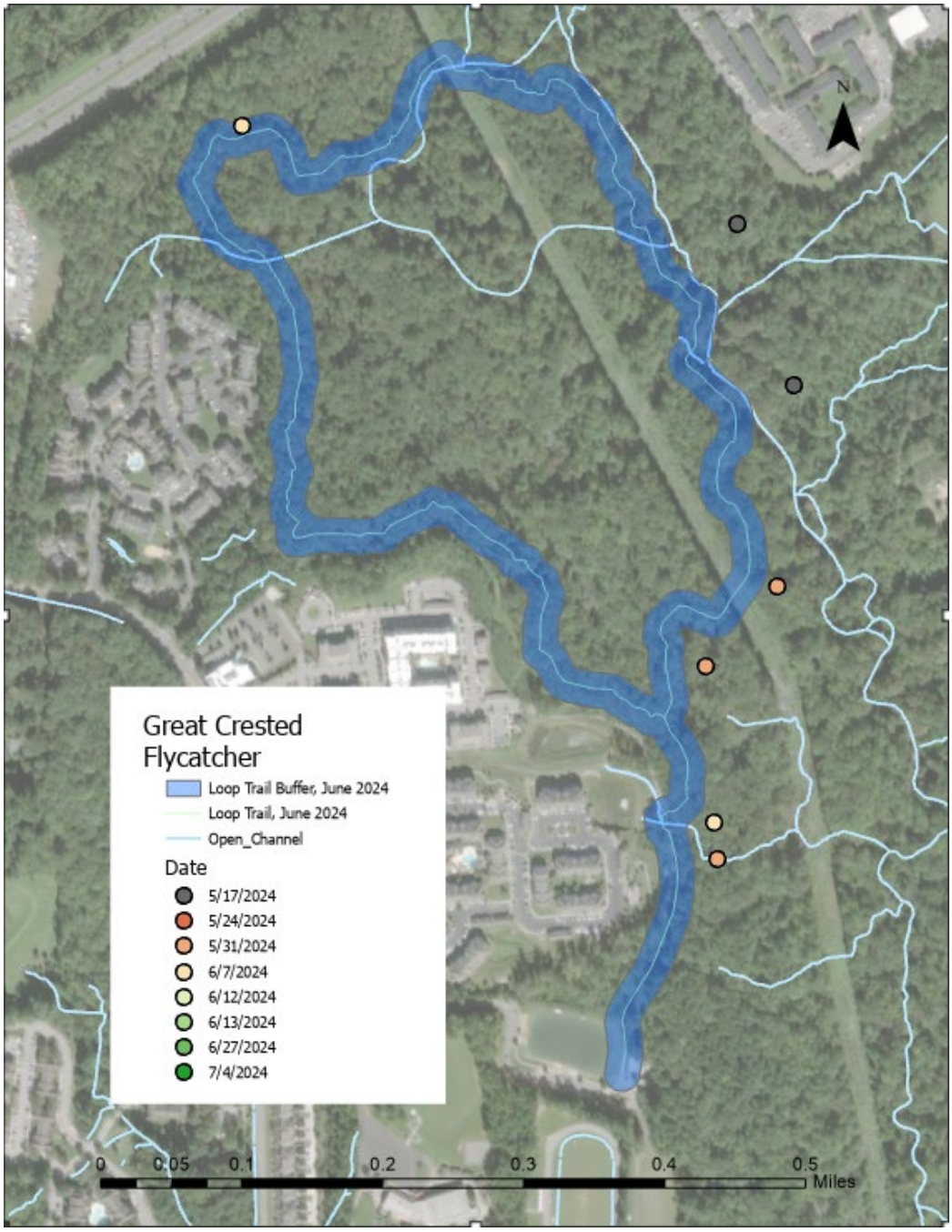
Hairy Woodpeckers are associated with large tracts of mature forest and nests have been observed within the study area (Hall, pers. obs.). Only a few observations were made during the current survey, however, but we estimate that at least one territory exists within the central portion of the study area. The convex polygon that we use to approximate this territory is 6.2 hectares, much larger the average of 1.05 ha found in a tract of bottomlands in Illinois (Allison, 1947; cited in Jackson et al., 2020). Using the proportional rule for edge territories, this produces a density estimate of 0.04 territories per hectare. This is somewhat less that the average of 0.09 territories per hectare recorded in the Big Oak Woods in the 1980s. This species appears to be somewhat declining in our area, according to the Mini Breeding Bird Survey (2024).

Pileated Woodpecker



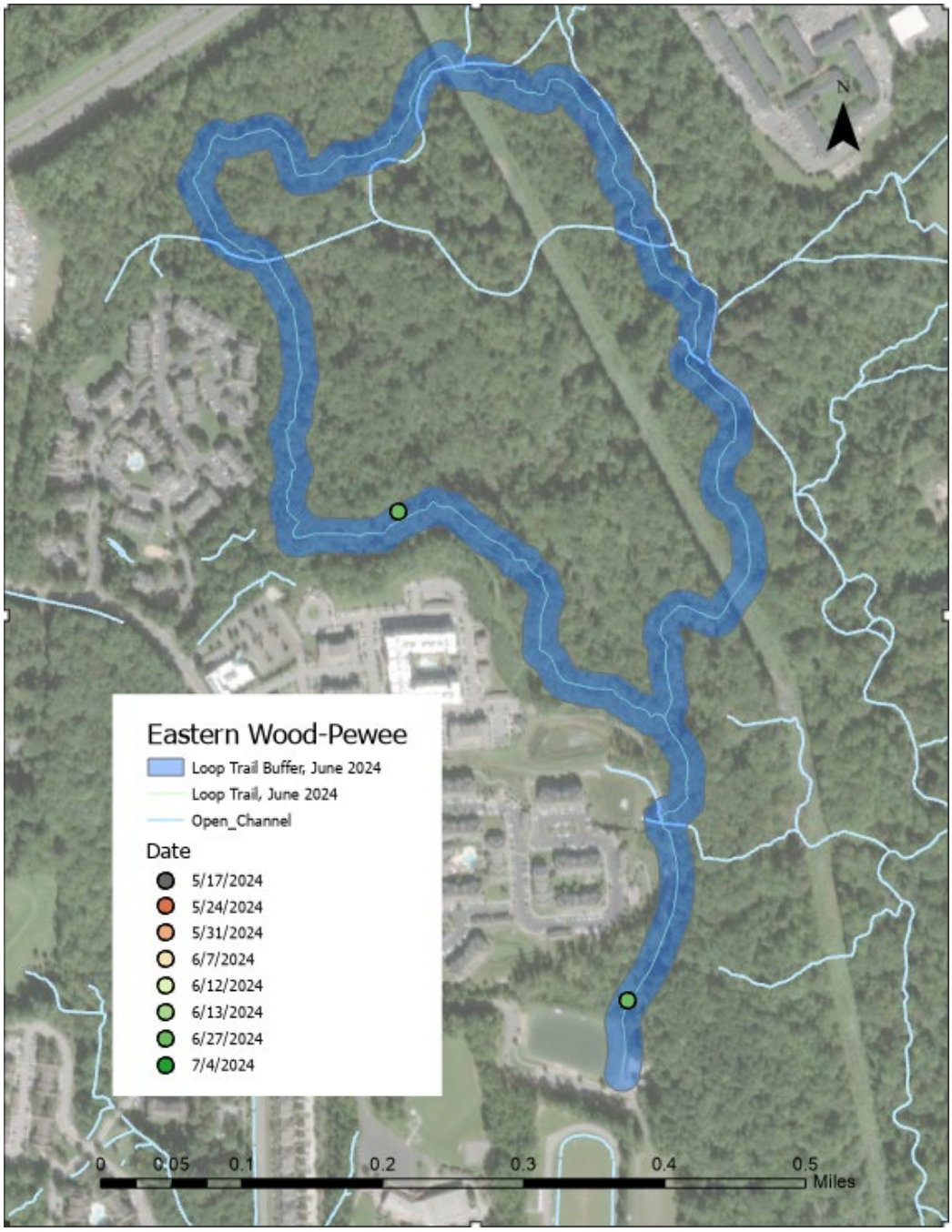
Pileated Woodpeckers occupy large tracts of hardwoods and mixed stands, particularly in bottomlands (LeGrand et al., 2024). Mated pairs of Pileated Woodpeckers defend their home ranges from conspecifics, with the average home range size in an Arkansas study equal to 55 hectares (B.L. Noel, cited by Bull and Jackson, 2020). Probably no more than one or two pairs, therefore, occupy territories that intersect the survey transect. Although we have too few records to adequately estimate the size of the territory, we used the available records to estimate a territorial density of only 0.08 per hectare. This is somewhat larger but comparable to the average of 0.01 per hectare estimated for the Big Oak Woods in the 1980s. Pileated Woodpeckers appear to be moderately increasing in our area (Mini Breeding Bird Survey, 2024).

Great Crested Flycatcher



Great Crested Flycatchers are breeding residents throughout the state, occurring in forests and woodlands, favoring drier sites but also occurring in floodplains (LeGrand et al., 2024). No territories of this species clearly intersected the survey transect, indicating at best a low nesting density within the New Hope floodplain. This result is similar to that obtained in the 1980s in the Big Oak Woods, where an average of only 0.05 territories per hectare was recorded. This species appears to be increasing in our area (Mini Breeding Bird Survey, 2024).

Eastern Wood-Pewee

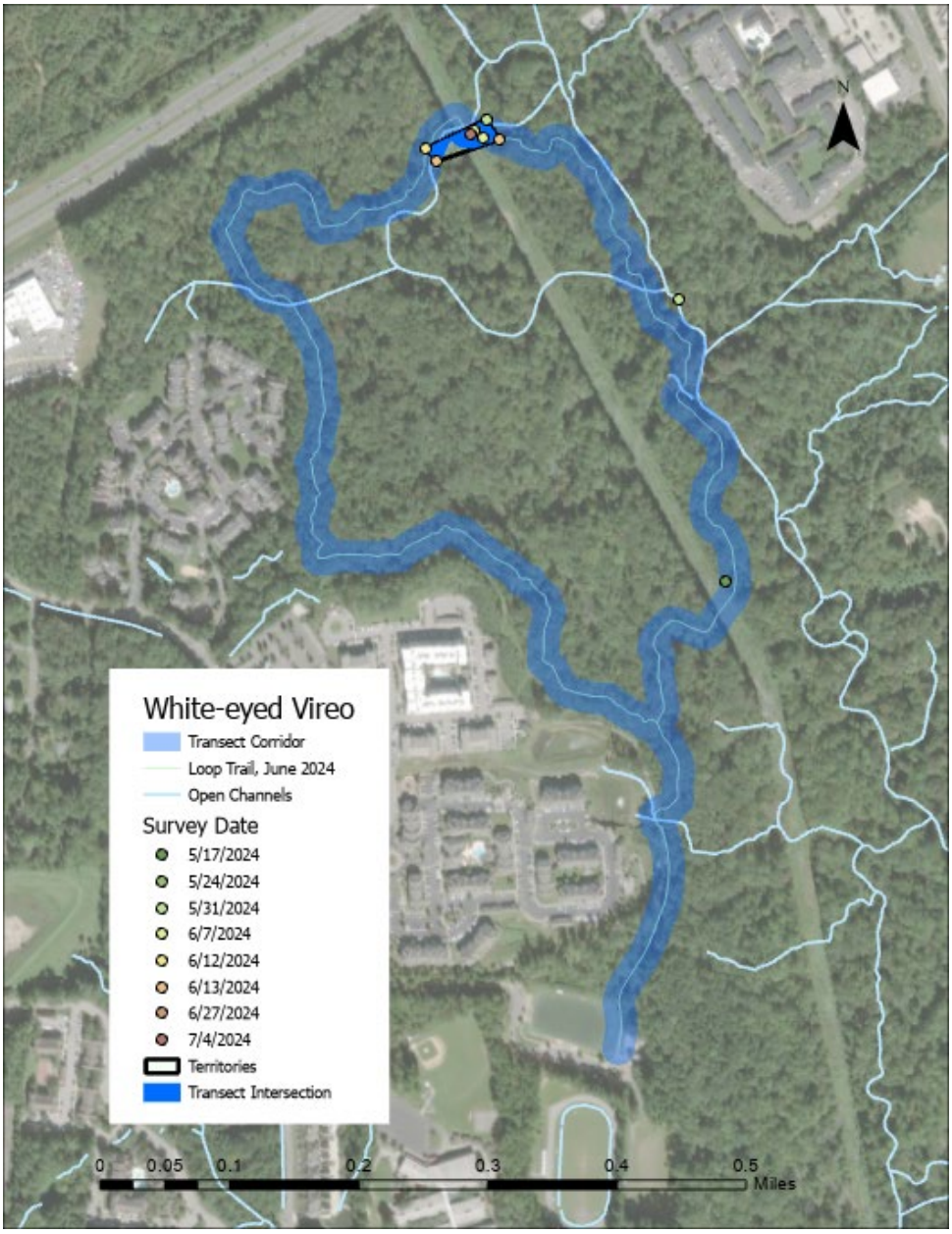


Eastern Wood-Pewees are associated mainly with open, dry-to-mesic stands of forests, including both hardwoods and pines (LeGrand et al., 2024). This species is likely to nest in some of the drier areas within the study area but we had too few observations to be sure of the location of its territories. This species is relatively uncommon in floodplain forests and only an average of 0.03 territories per hectare was recorded in the Big Oak Woods during the 1980s. This species appears to be slightly declining in our area based on the Mini Breeding Bird Survey (2024).

Acadian Flycatcher

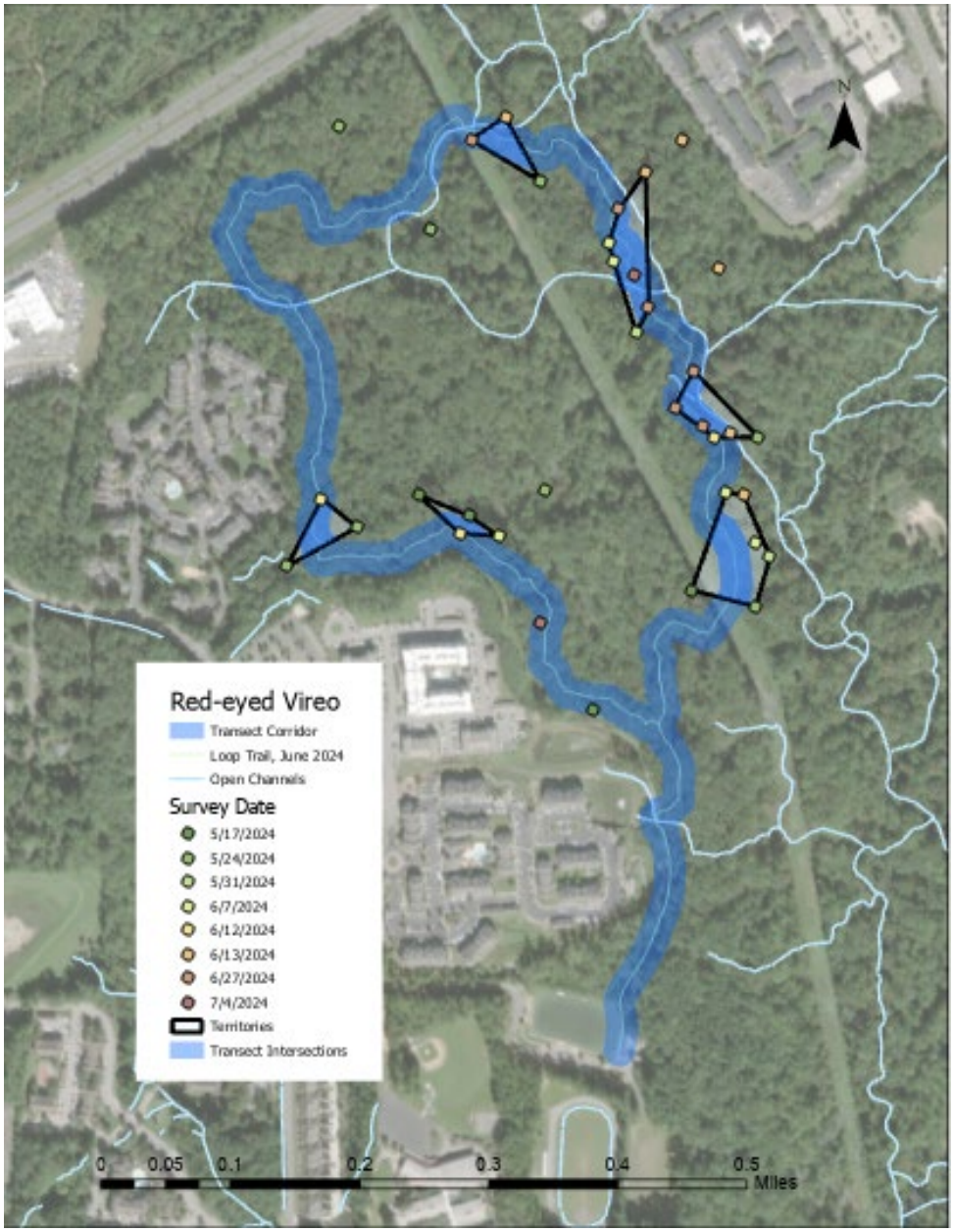
Acadian Flycatchers are a common bottomland species in North Carolina, often nesting near creeks (LeGrand et al., 2024). This species was observed at scattered locations throughout the study area but only three clusters of records met the criteria for inclusion as territories, all located close to watercourses. The convex polygons we used to represent the individual territories average 0.33 hectares in extent, with the largest 0.5 ha. These estimates are smaller than the approximately 1 ha territories surveyed in Pennsylvania (Woolfenden et al., 2005). Using the proportional rule for edge territories, a density of 0.16 territories per hectare was estimated within the study area. That is roughly half the average density of 0.31 per hectare recorded during the 1980s in the Big Oak Woods at Mason Farm. However, this species appears to be increasing in abundance in our area based on the Mini Breeding Bird Survey (2024).

White-eyed Vireo



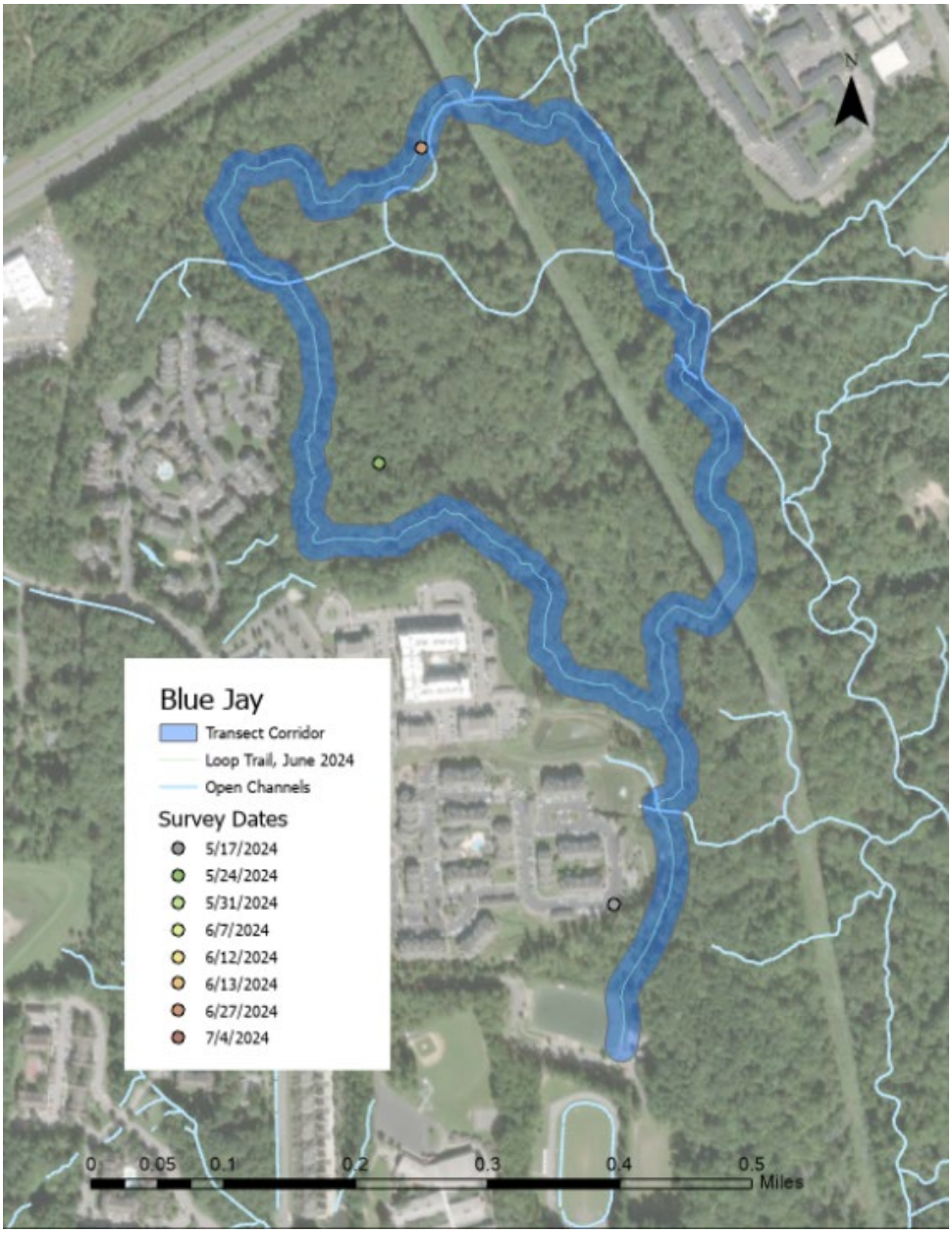
White-eyed Vireos inhabit brushy areas along forest edges, successional old fields, and other open to semi-open sites (LeGrand et al., 2024). This species defends territories during the nesting season that are estimated to be close to one hectare in size in several parts of its range (Hopp, 2022). Within the study area, only one cluster of records was observed, located where the trail crosses the powerline. The convex polygon for this cluster was 0.21 hectares in size and the density of territories we estimated using the proportional rule for edge habitats was 0.07 per hectare. This is larger than the average of 0.02 hectares recorded for the Big Oak Woods in the 1980s, which is consistent with the results of the Mini Breeding Bird Survey (2024) (2024)which indicate that this species is increasing in abundance in our area.

Red-eyed Vireo



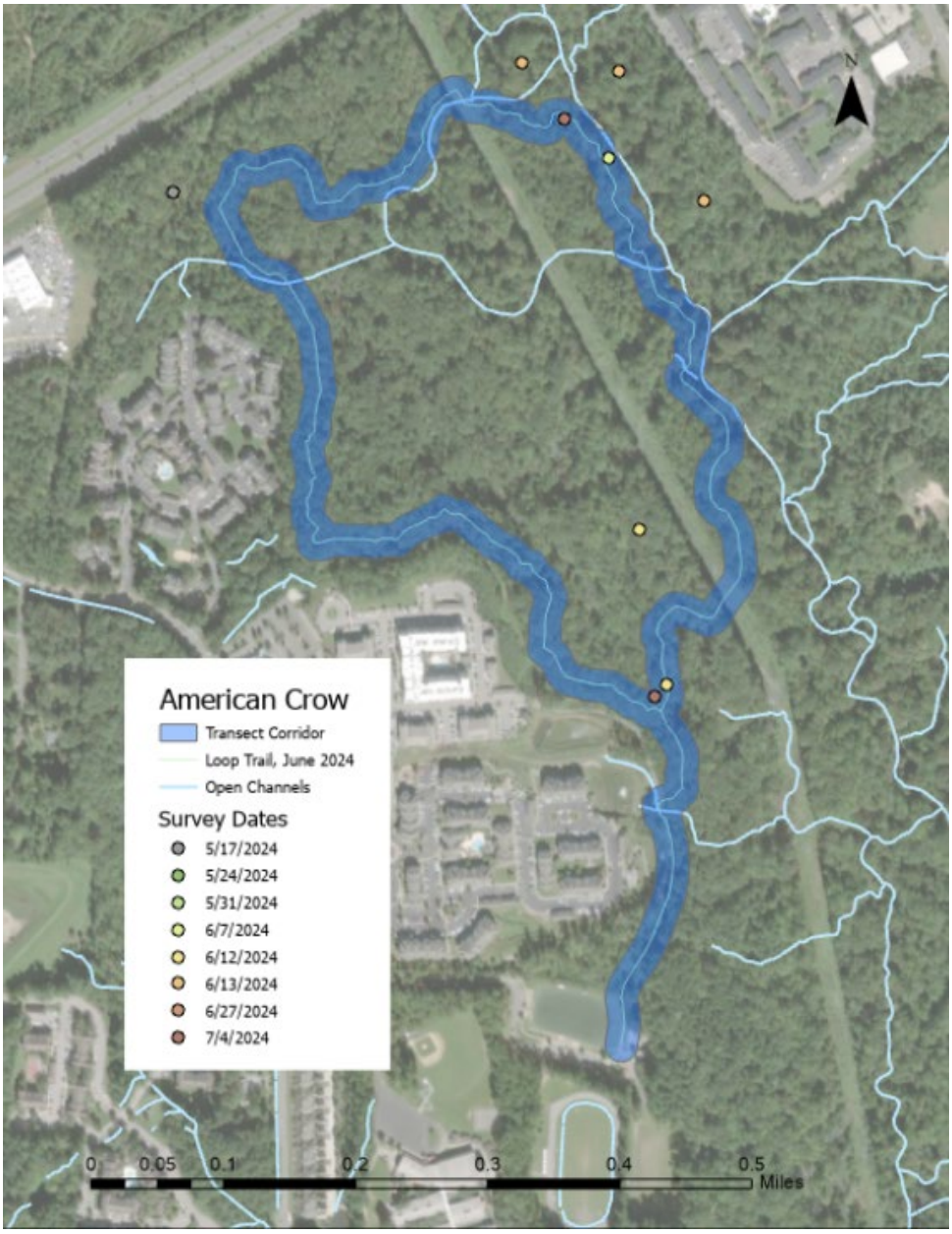
Red-eyed Vireos are among the most common birds in the state, occurring in a wide variety of forests and woodlands but showing a preference for mesic sites, including floodplains (LeGrand et al., 2024). This species inhabits fairly small breeding territories, with average size in several studies in the Mid-west around 0.69 hectares (Cimprich et al., 2020). The six convex polygons we used to represent territories average 0.41 hectares. Using the proportional rule for edge territories, the territorial density is 0.33 per hectare. This is much less than the average of 1.76 per hectare recorded in the 1980s in the Big Oak Woods. That matches the decline in abundance of this species found by the Mini Breeding Bird Survey (2024).

Blue Jay



Blue Jays occur across the state, nesting and foraging in hardwood forests. According to Smith et al. (2020), however, this species appears to prefer to nest along forest edges rather than deep forest, is not strongly territorial, and ranges over home ranges as large as 6 hectares. Although they may nest somewhere within the study area, they were recorded only on a few survey visits and insufficient evidence was obtained to determine the location or the number of their territories. Similar results were obtained in the 1980s in the Big Oak Woods at Mason Farm, where an average of only 0.008 territories per hectare was estimated. According to the results of the Mini Breeding Bird Survey (2024), this species is moderately declining in our area.

American Crow

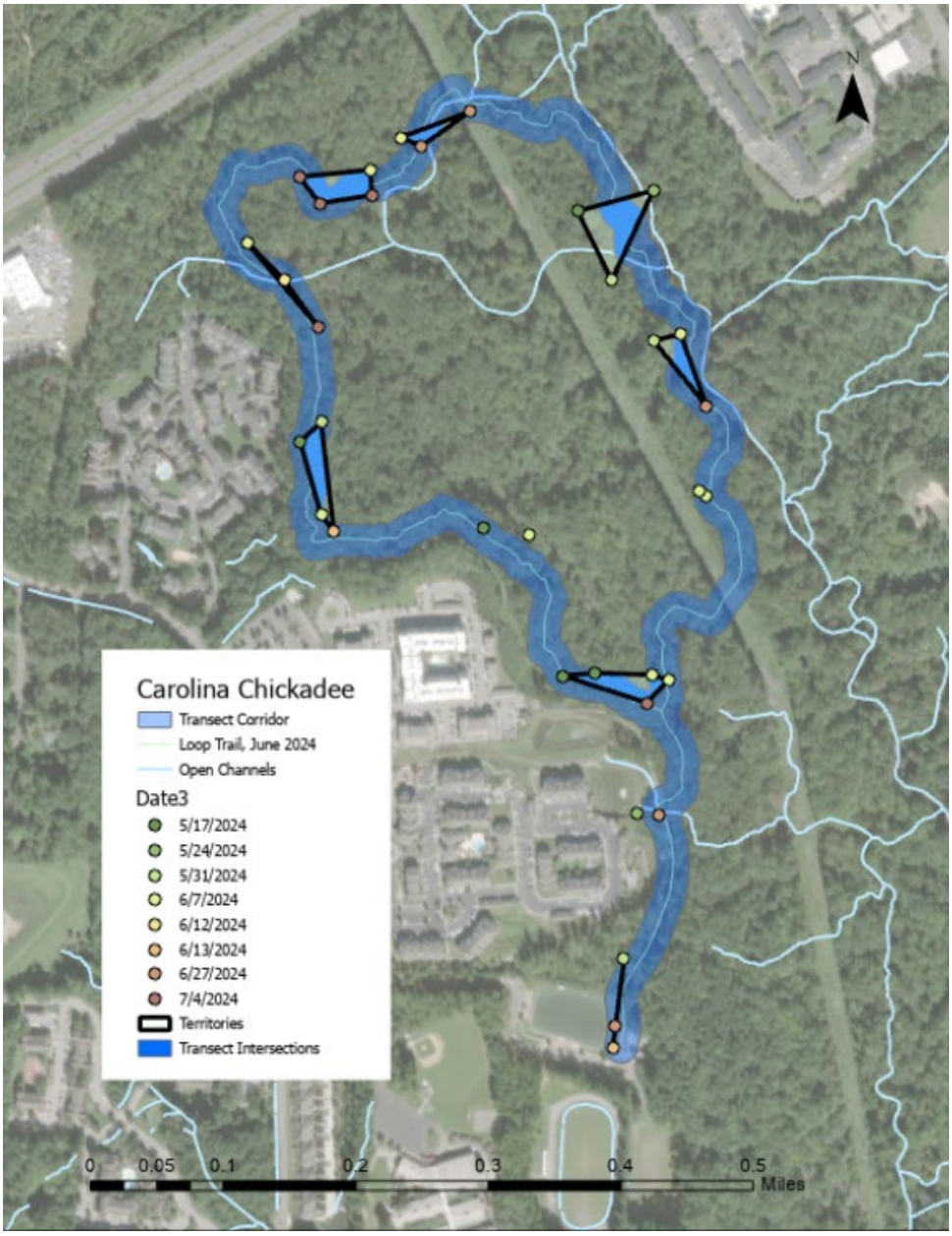


American Crows are secretive nesters with territory size varying widely (Verbeek and Caffrey, 2021). While they may nest somewhere within the study area – possibly up in the northeast corner where most of our observations were made – none of our records met the criteria for treatment as territories. Similar results were obtained in the Big Oak Woods in the 1980s, where an average of 0.006 territories was estimated per hectare. This species is showing only a small rate of decline in our area (Mini Breeding Bird Survey, 2024).

Fish Crow

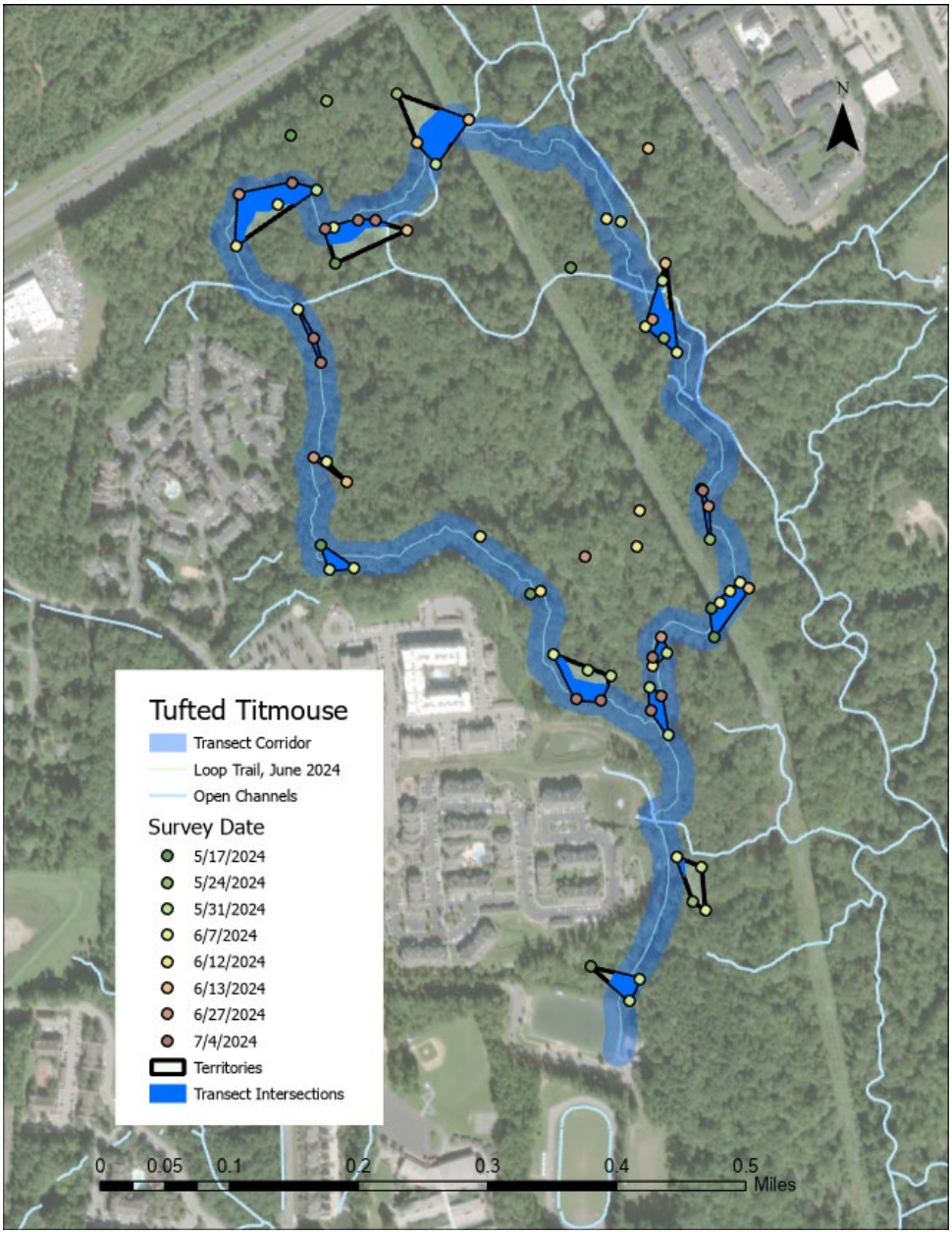
Fish Crows were once essentially confined to the Tidewater Region but have been moving inland since at least the 1960s (LeGrand et al., 2024). They nest in a variety of locations, including residential areas, and could possibly be nesting within the study area. None of our observations formed distinct clusters, however, and our records probably represent visitors rather than residents. This species was not recorded in the Big Oak Woods during the 1980s but showed up in 1990. According to the Mini Breeding Bird Survey (2024), this species is continuing to show a strong increase in our area.

Carolina Chickadee



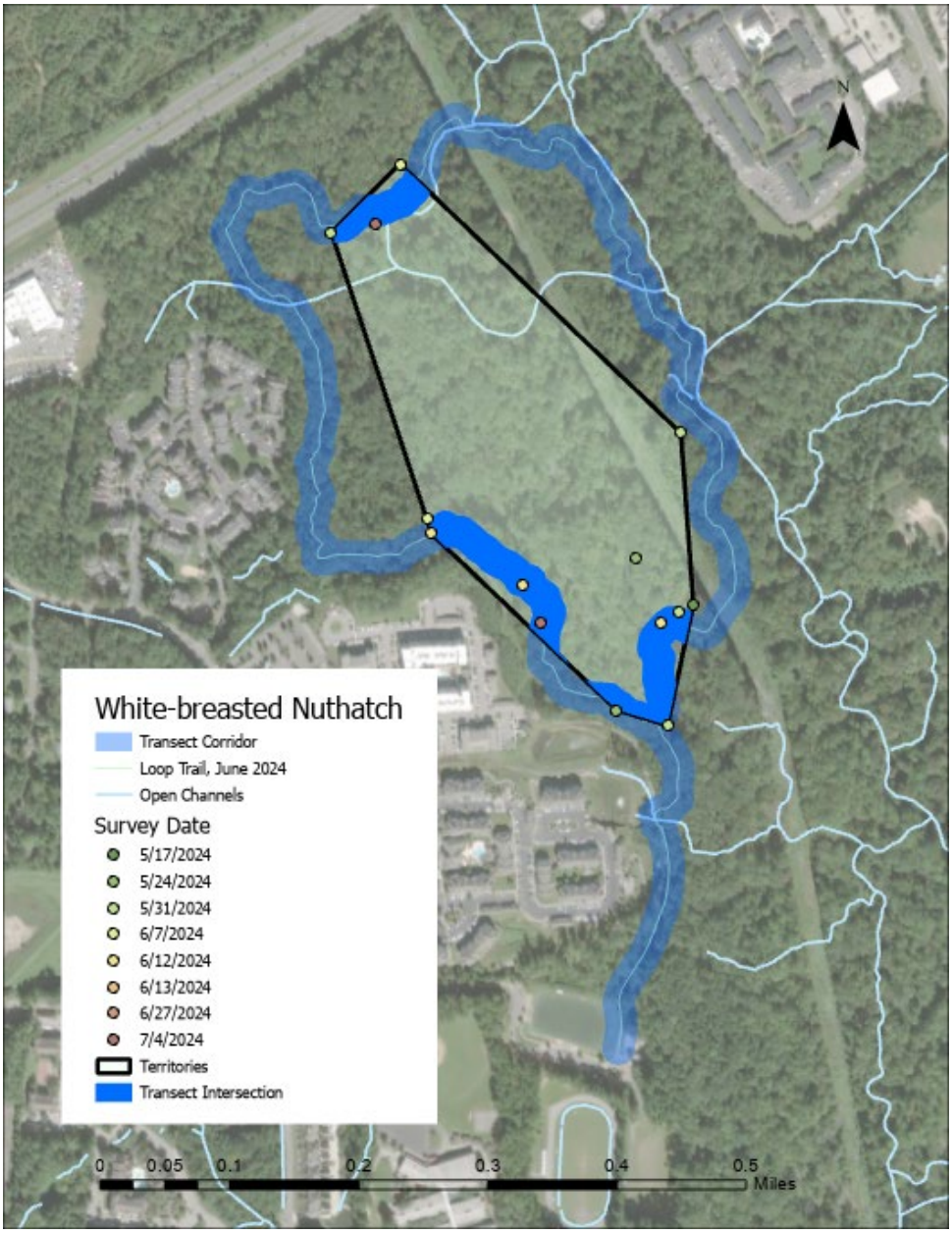
Carolina Chickadees occur in nearly all forested or semi-wooded areas in the state, requiring tree cavities for nesting. It appears to occur throughout the study area, with eight clusters of records meeting the requirements for territories. The average size of the convex polygons we used to approximate the territories is 0.18 ha, which is much smaller than the average 1.6–2.4 ha found by Brewer (1963) and Dixon (1963). The density of territories we observed is 0.55 per hectare, which is higher than the average of 0.26 per hectare found in the Big Oak Woods in the 1980s. This species appears to be holding steady based on the results of the Mini Breeding Bird Survey (2024).

Tufted Titmouse



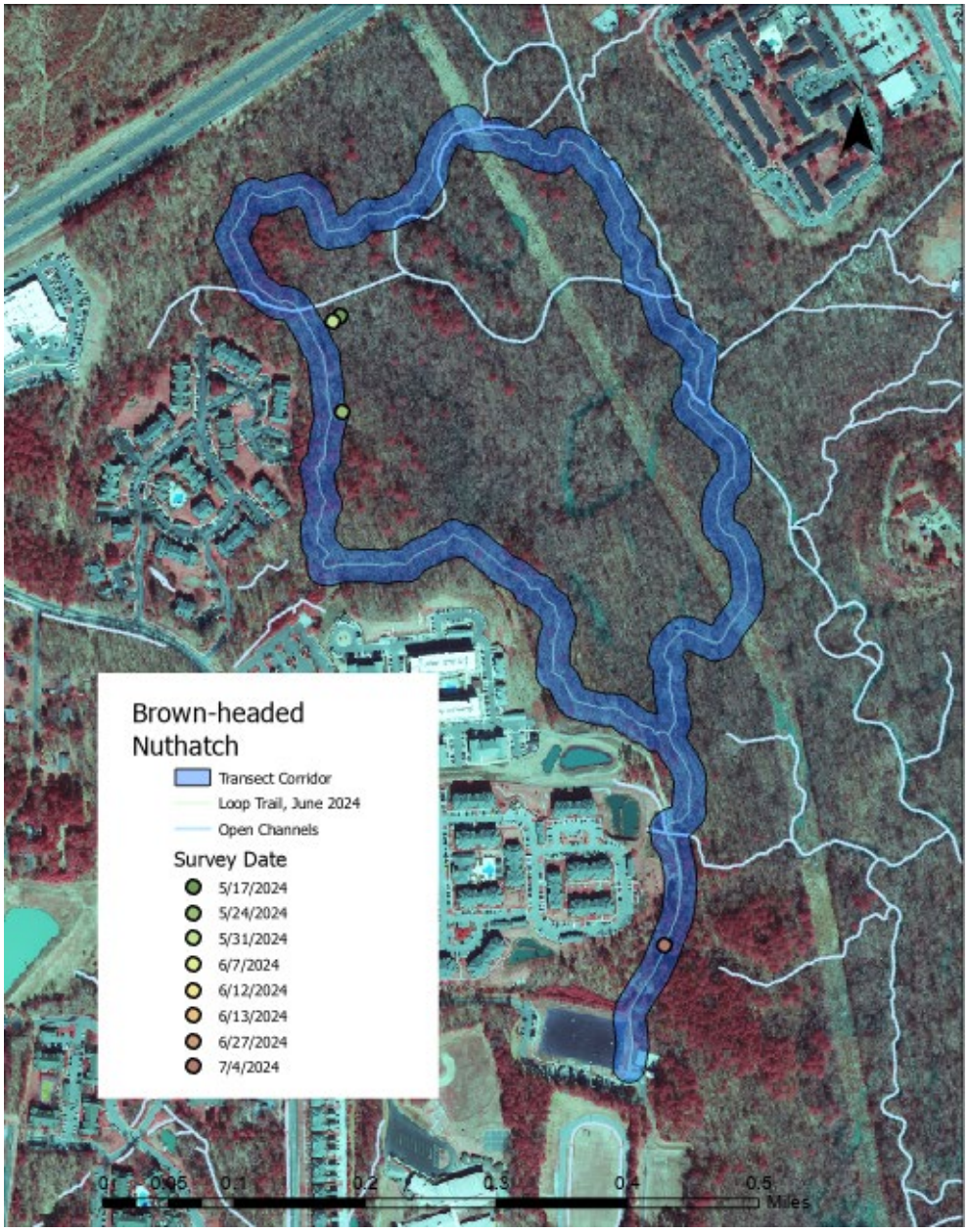
Tufted Titmouse is an abundant and ubiquitous tree-cavity-nesting species, occurring in hardwood forests and mixed stands across the state (LeGrand et a., 2024). During the breeding season, pairs defend territories, which in a Michigan study ranges in size from 3.2 to 5.0 ha, and averaging 4.2 ha (Pielou, 1957). The convex polygons we used to estimate territories are much smaller, averaging only 0.14 ha. Using the proportional rule for edge territories, the density of territories in the study area is 0.88. This is much larger than the 0.41 per hectare found in the 1980s at the Big Oak Woods. In general, this species appears to be slightly increasing in our area, based on the results of the Mini Breeding Bird Survey (2024).

White-breasted Nuthatch



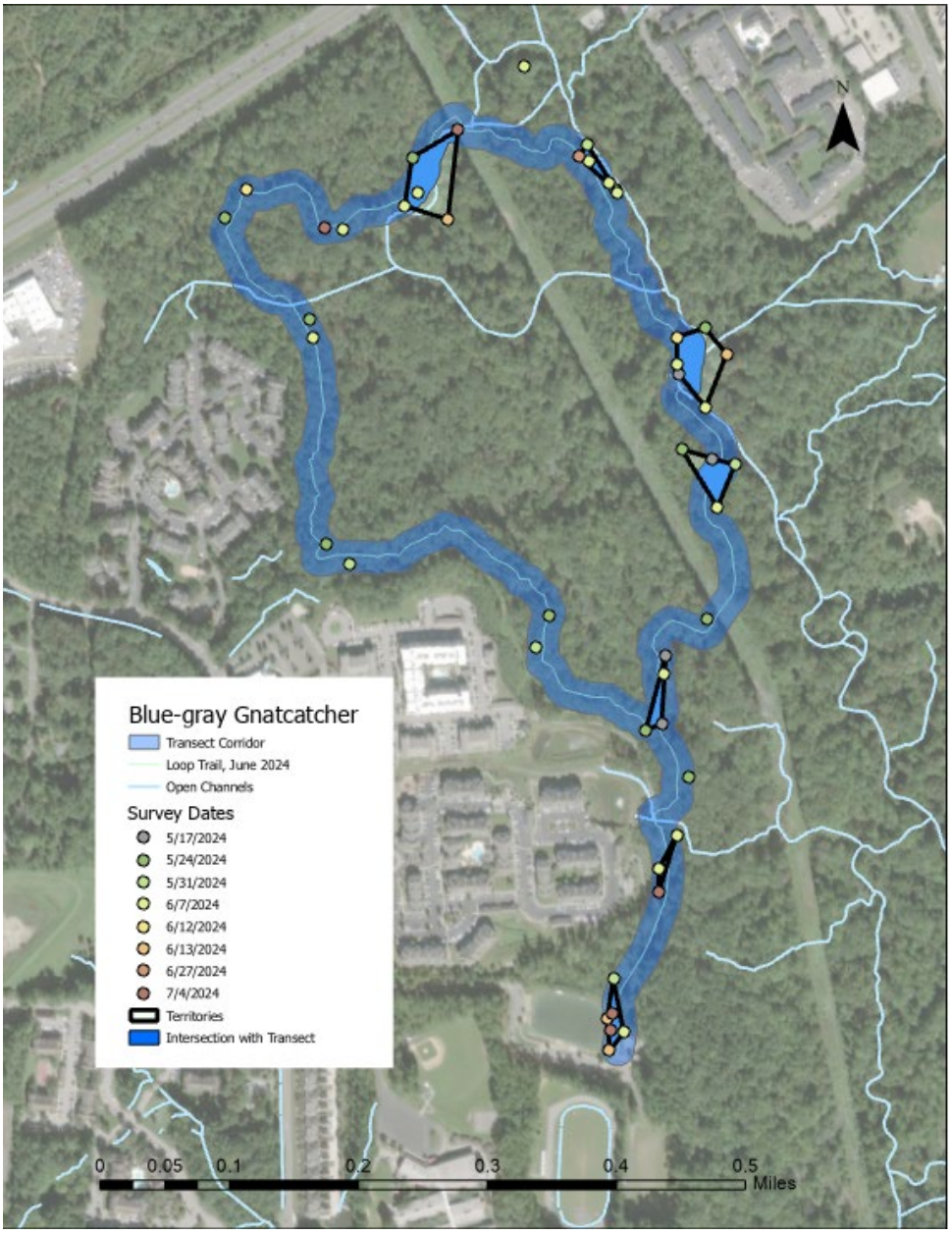
White-Breasted Nuthatches are tree-cavity-nesting species associated primarily with mature hardwood forests, including both upland and lowland stands; mixed stands and even pine woodlands are also used to a smaller extent (LeGrand et al., 2024). Nuthatches occupy large home ranges throughout the year; in a study conducted by Butts (1931), home range size varied from 10-15 ha. Based on those findings, only a single home range may exist within the study area. By treating all observation points as representing just one unit, the resulting convex polygon is 16.04 ha. Using the proportional rule for edge territories, the resulting density of territories is 0.09 per hectare, which is smaller than the average of 0.12 obtained in the 1980s in the Big Oak Woods. In our area, populations of this species appear to be holding steady (Mini Breeding Bird Survey, 2024).

Brown-headed Nuthatch



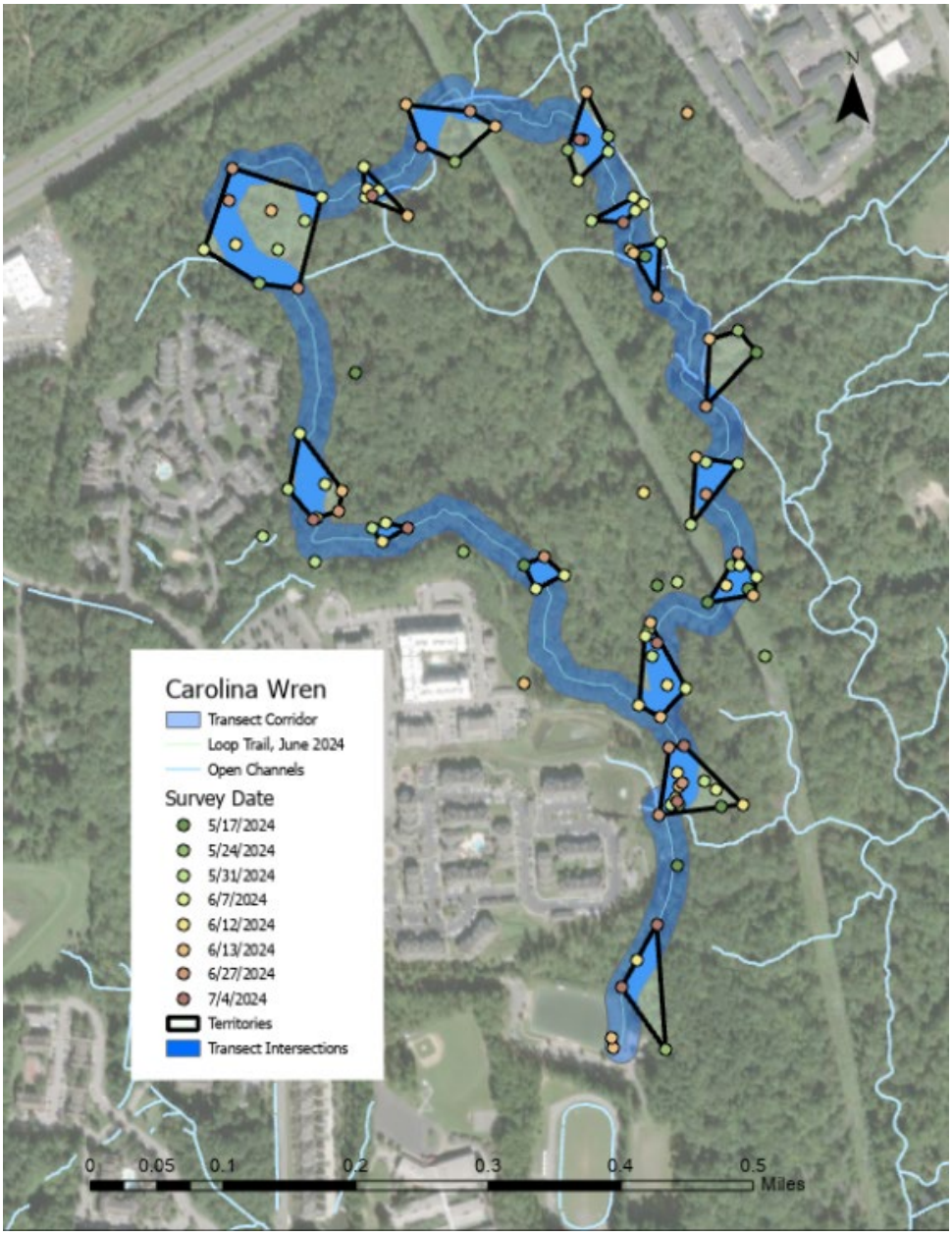
Brown-headed Nuthatches are strongly associated with stands of pines, which in the study area are restricted to just a few areas, shown as dark red in this color infrared map (see also results for Pine Warblers). Although this species almost certainly nests within these areas, none of the observation points meet the criteria for defining territories This species was not recorded in the Big Oak Woods during the 1980s, although a portion of that site contains a stand of Loblolly Pines. Populations of this species appear to be keeping steady in our area (Mini Breeding Bird Survey, 2024).

Blue-gray Gnatcatcher



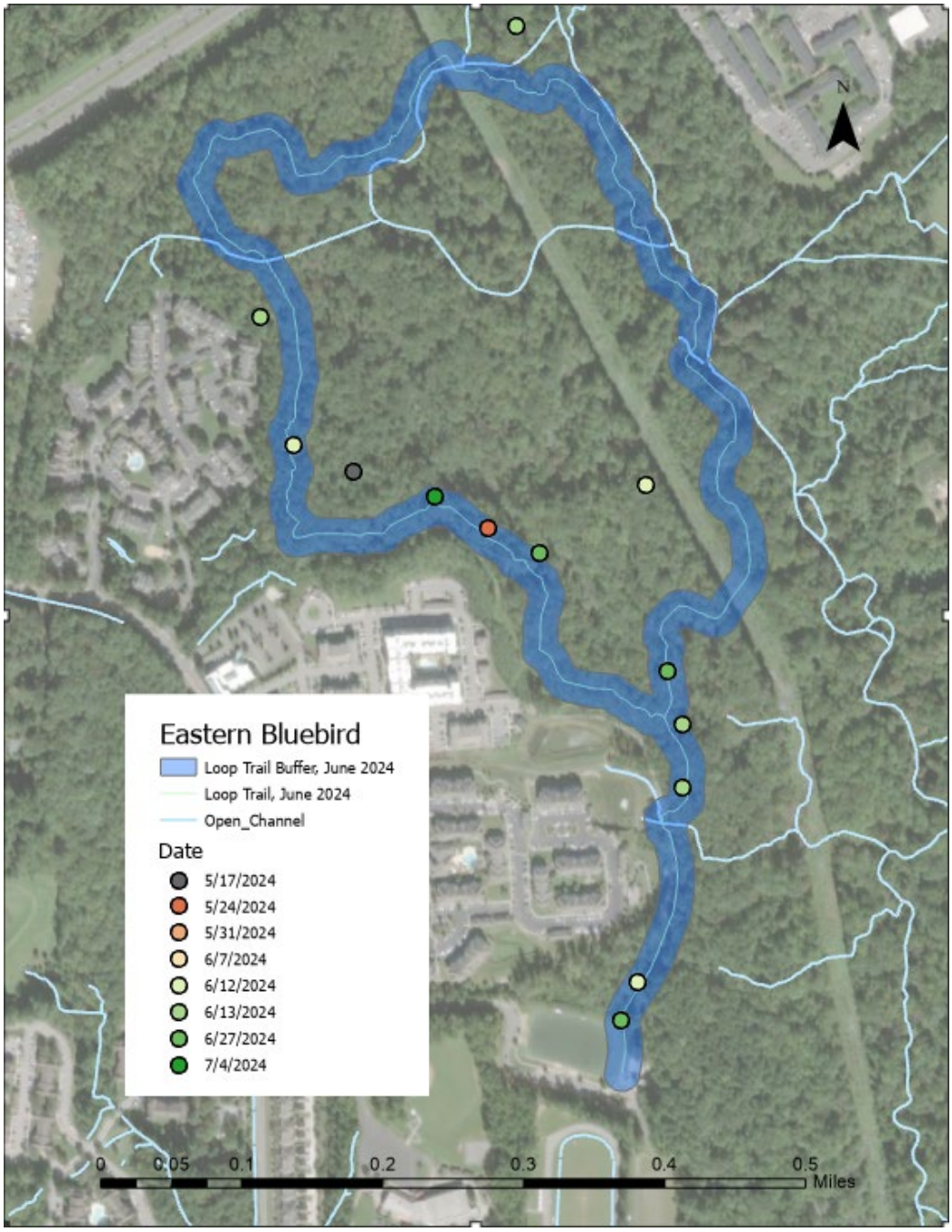
Blue-gray Gnatcatchers occur across the state in association with hardwood and mixed forests, including floodplains. We observed this species over the entire study area and with seven clusters of records meeting our criteria for territories. The average size of the convex polygons we used to estimate the territories is 0.19 ha, which is much smaller than the 0.7 ha found using song playbacks in Vermont (Ellison, 1991). Using the proportional rule for edge territories, the density of territories within the transect area is 0.49 per hectare. This is somewhat less than the average of 0.64 per hectare that was estimated for the Big Oak Woods in the 1980s. According to the Mini Breeding Bird Survey (2024), populations of this species are remaining fairly steady.

Carolina Wren



Carolina Wrens are one of our most common and ubiquitous birds and we observed them throughout the study area. Fifteen clusters fit the criteria for territories, the average size of which is 0.32 ha and the largest is 1.4 ha. This is much smaller than the average of 4.1 ha recorded in Tennessee using song playbacks to map territory boundaries (Morton, 1982). Using the proportional rule for edge territories, the territory density is 0.92 per hectare. This is larger than the average of 0.33 per hectare recorded in the Big Oak Woods in the 1980s. In our area, Carolina Wrens appear to be maintaining their abundance levels (Mini Breeding Bird Survey, 2024).

Eastern Bluebird

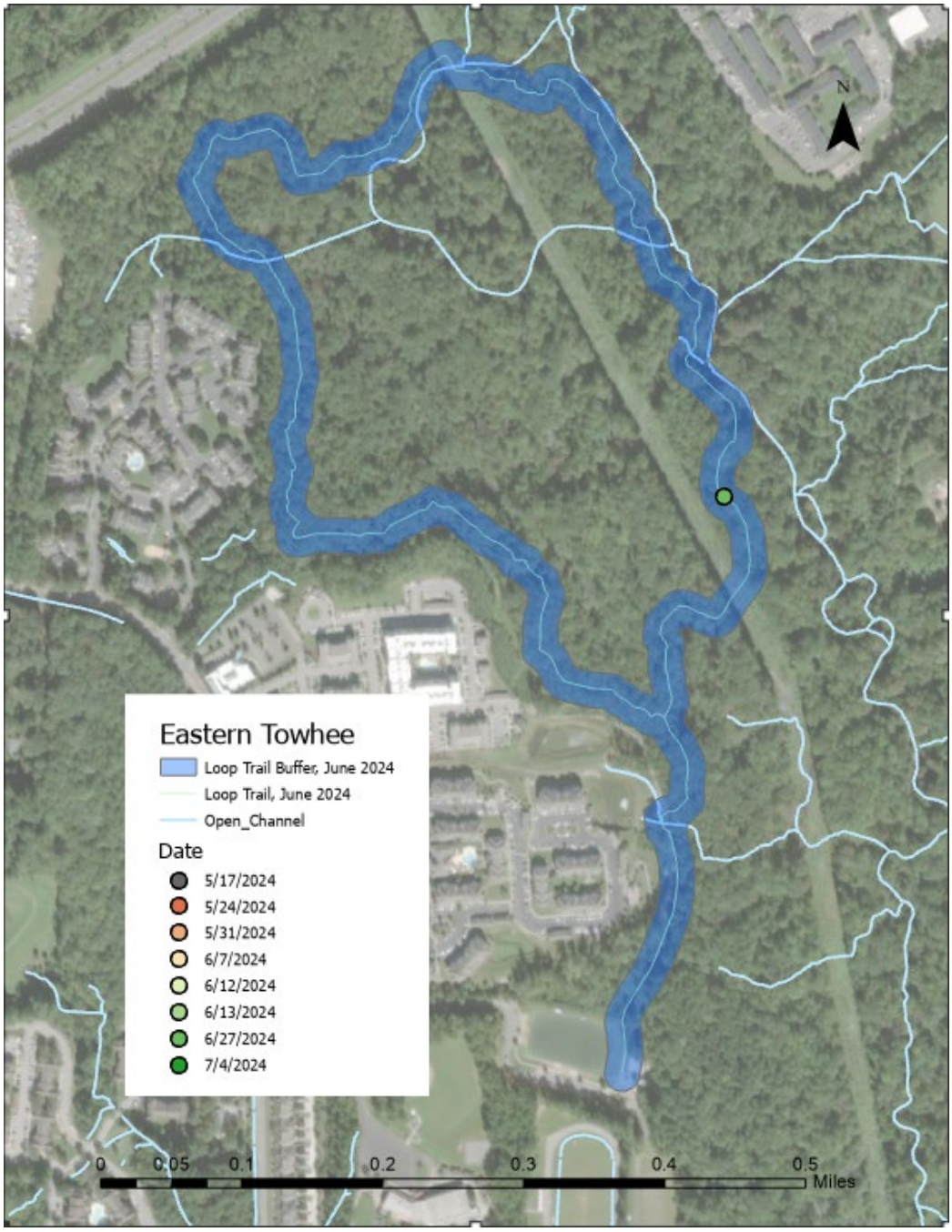


Eastern Bluebirds are associated primarily with forest edges or semi-open areas. Some the observations we made of this species during the survey are located in such areas, including the powerline corridor and edges of the developed areas. However, they were also observed on several occasions deeper within the forest, but probably only as visitors rather than as territory holders. None of the clusters of observations met our criteria for territories. This was also true in the Big Oak Woods surveys, where the average density in the 1980s was only 0.0008. Although there previously were concerns about the decline of this species, due to completion for nesting sites, they appear to be holding fairly steady now (Mini Breeding Bird Survey, 2024).

American Goldfinch

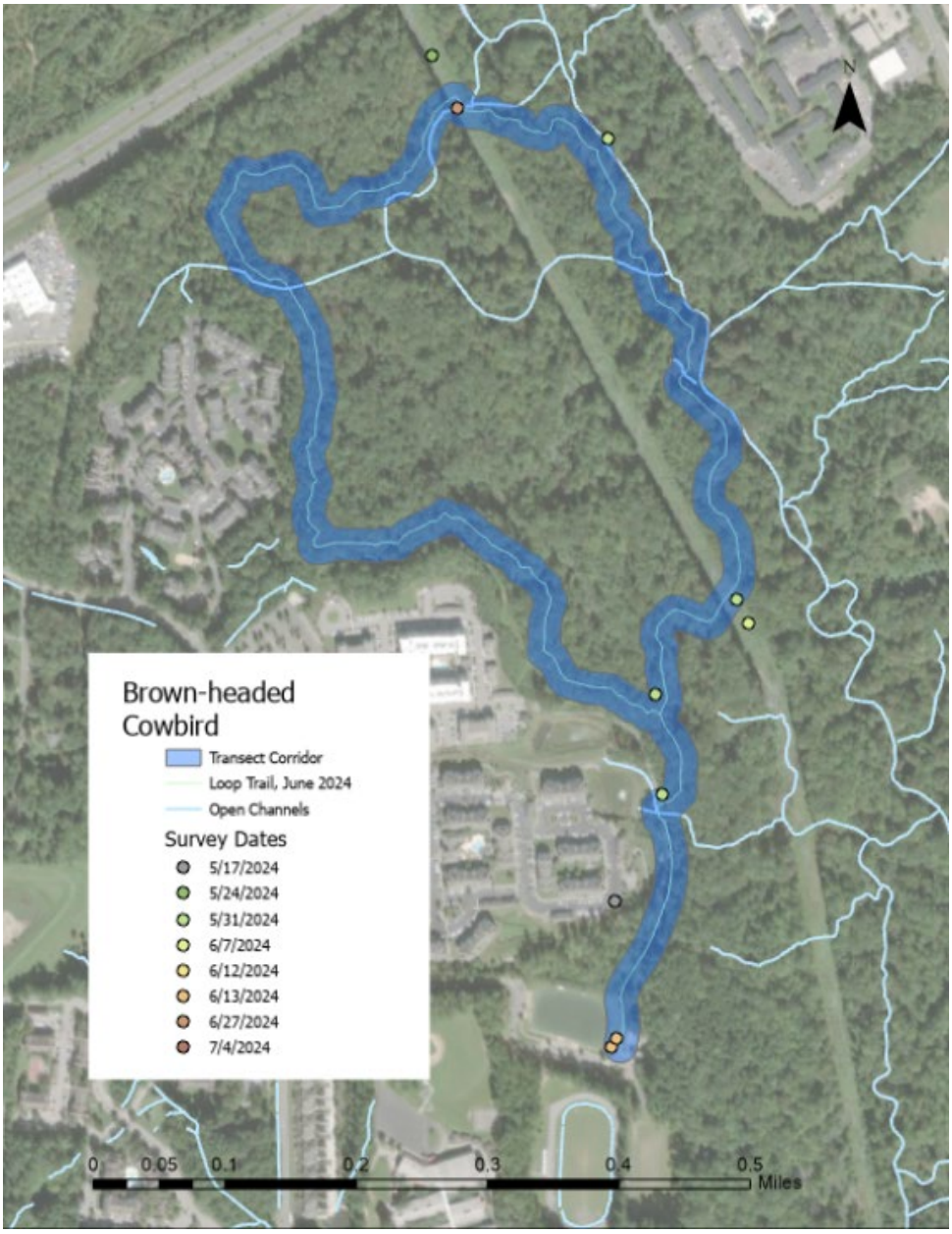
American Goldfinches are common throughout the state, occurring in both natural communities and in human-altered tracts such as farmlands and residential areas. Although they occur to some extent in forested areas, they prefer to use open, brushy areas for both foraging and nesting. They nest later than virtually all of our other songbirds, in July and August (LeGrand et al., 2024), long after most of our survey visits were made. None of our records meet the criteria for treatment as territories and none were recorded in the 1980s in the Big Oak Woods at Mason Farm. This species appears to be moderately declining in our area (Mini Breeding Bird Survey, 2024).

Eastern Towhee



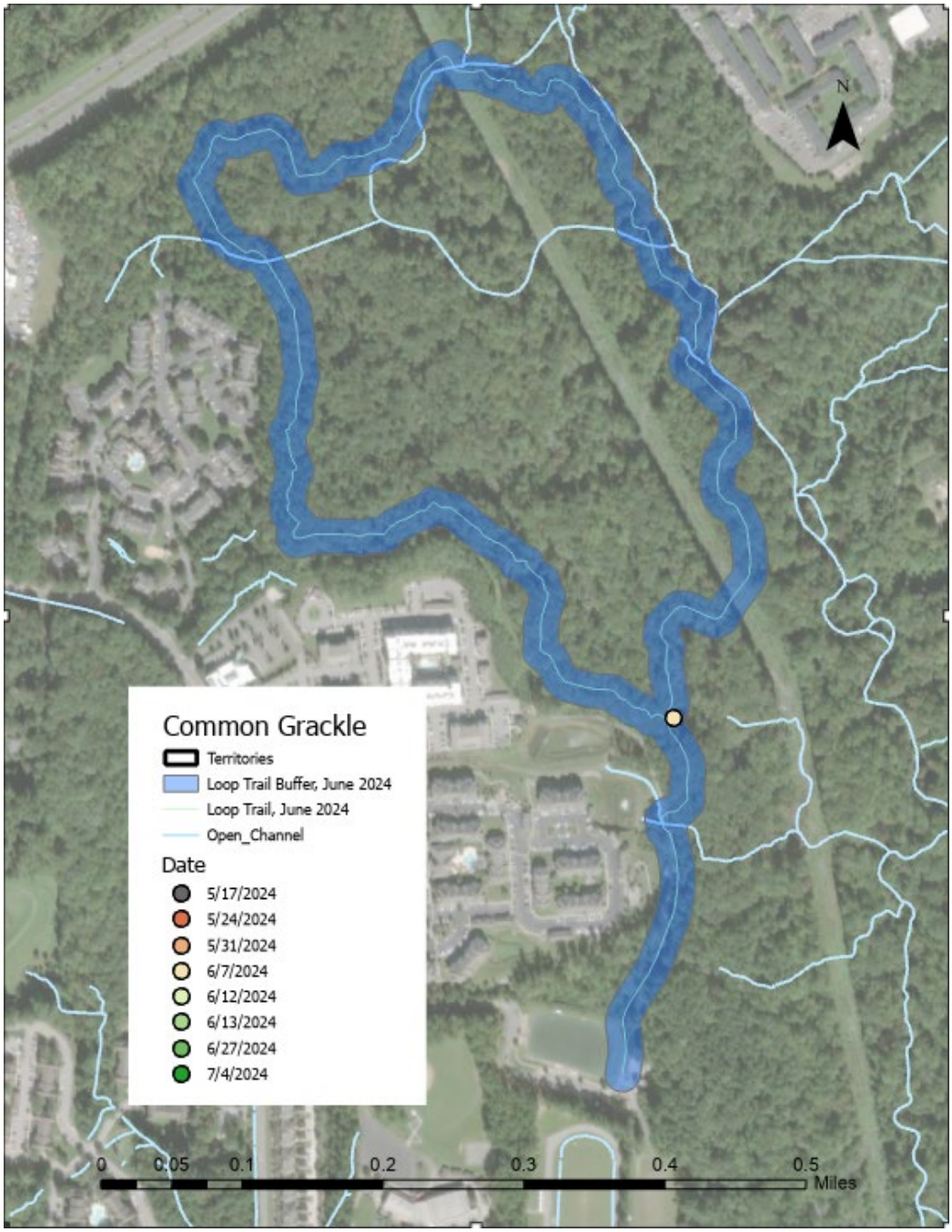
Eastern Towhees are associated with brushy areas, primarily along forest edges and other semi-open areas. The one observed during the survey probably had its territory located along the powerline corridor rather than one located within the bottomland forest. This species was also not recorded in the Big Oak Woods in the 1980s. Based on the results of the Mini Breeding Bird Survey (2024), this species appears to undergoing a moderate decline within our area.

Brown-headed Cowbird



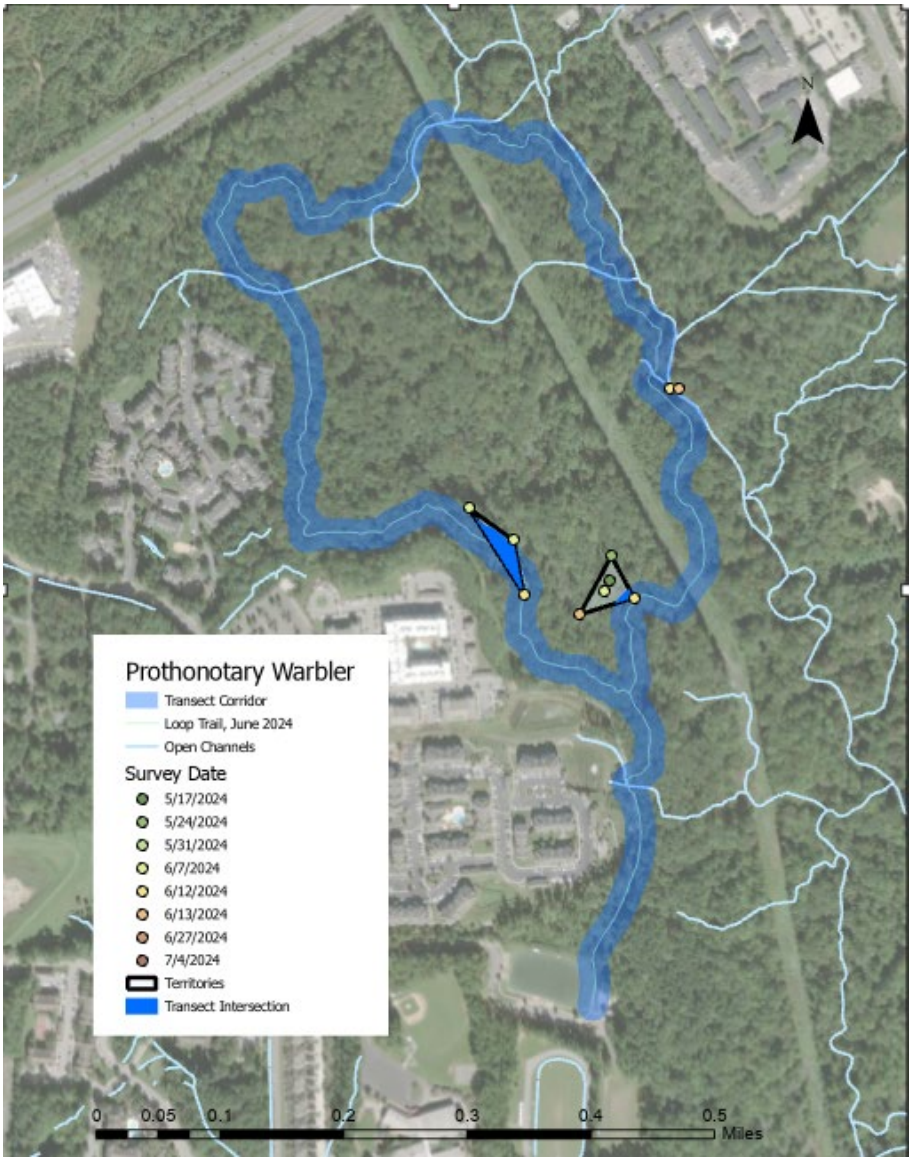
As nest parasites, Brown-headed Cowbirds do not defend breeding territories and as an originally prairie species, they spend most of their time in open habitats, venturing into forests primarily to look for nests to host their young. Most of our records were, in fact, made in open habitats – powerlines, playing fields, detention ponds, and developed areas -- where they forage. The few observations made within the forest, however, which may represent females searching for nests to parasitize. Although some of the host species parasitized by this species are decreasing strongly – e.g., the Wood Thrush – populations of Brown-headed Cowbirds appear to be holding steady or slightly increasing in our area (Mini Breeding Bird Survey, 2024).

Common Grackle



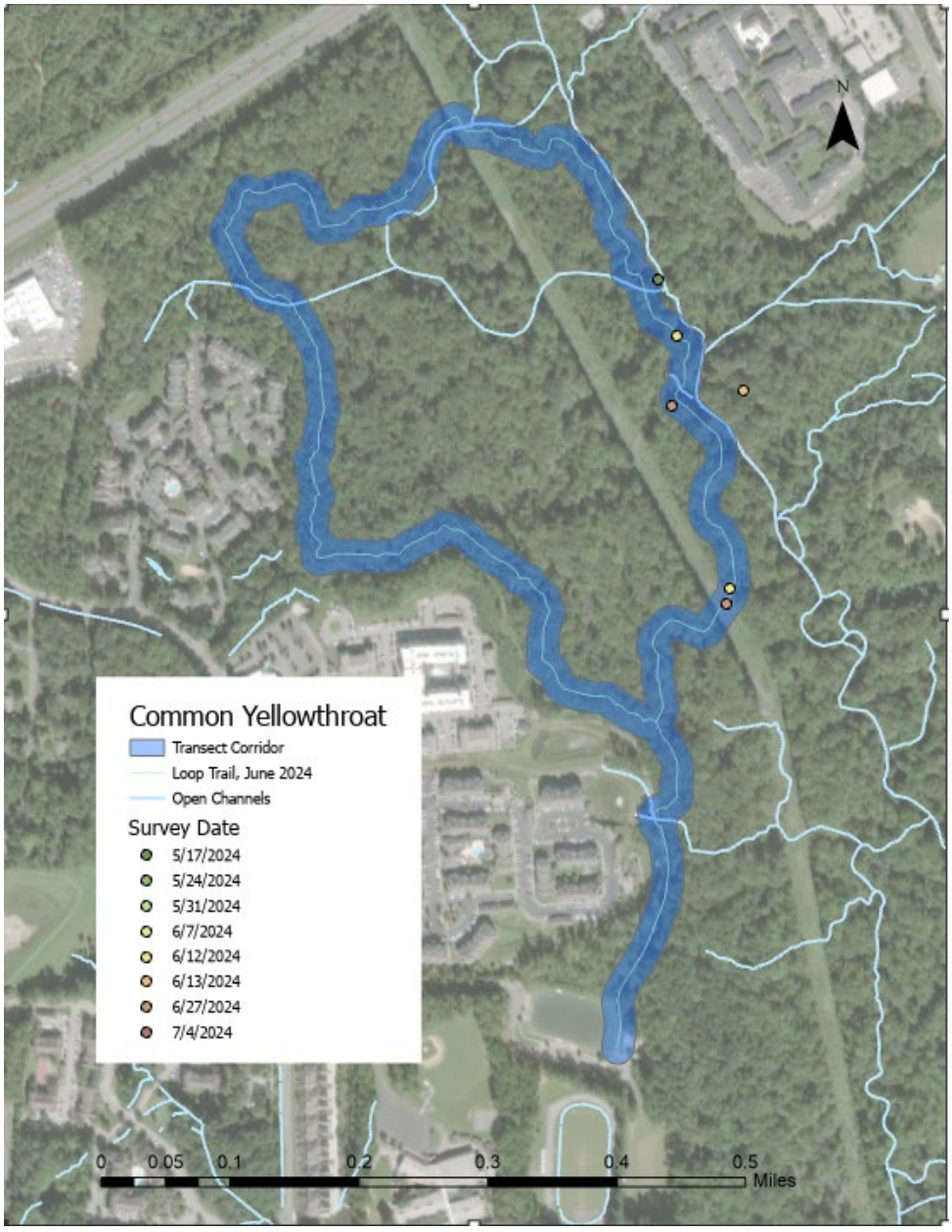
Although Common Grackles are abundant within the project area during the winter, they were observed only once during the breeding period survey, probably representing only a visitant. Most nesting by this species in North Carolina occurs in more developed areas or along edges and groves rather than within stands of hardwood forests. This species was also rarely recorded in the Big Oak Woods Surveys, where an average of 0.0038 territories per hectare was recorded in the 1980s. This species appears to be moderately strongly declining in our area, based on the results of the Mini Breeding Bird Survey (2024).

Prothonotary Warbler



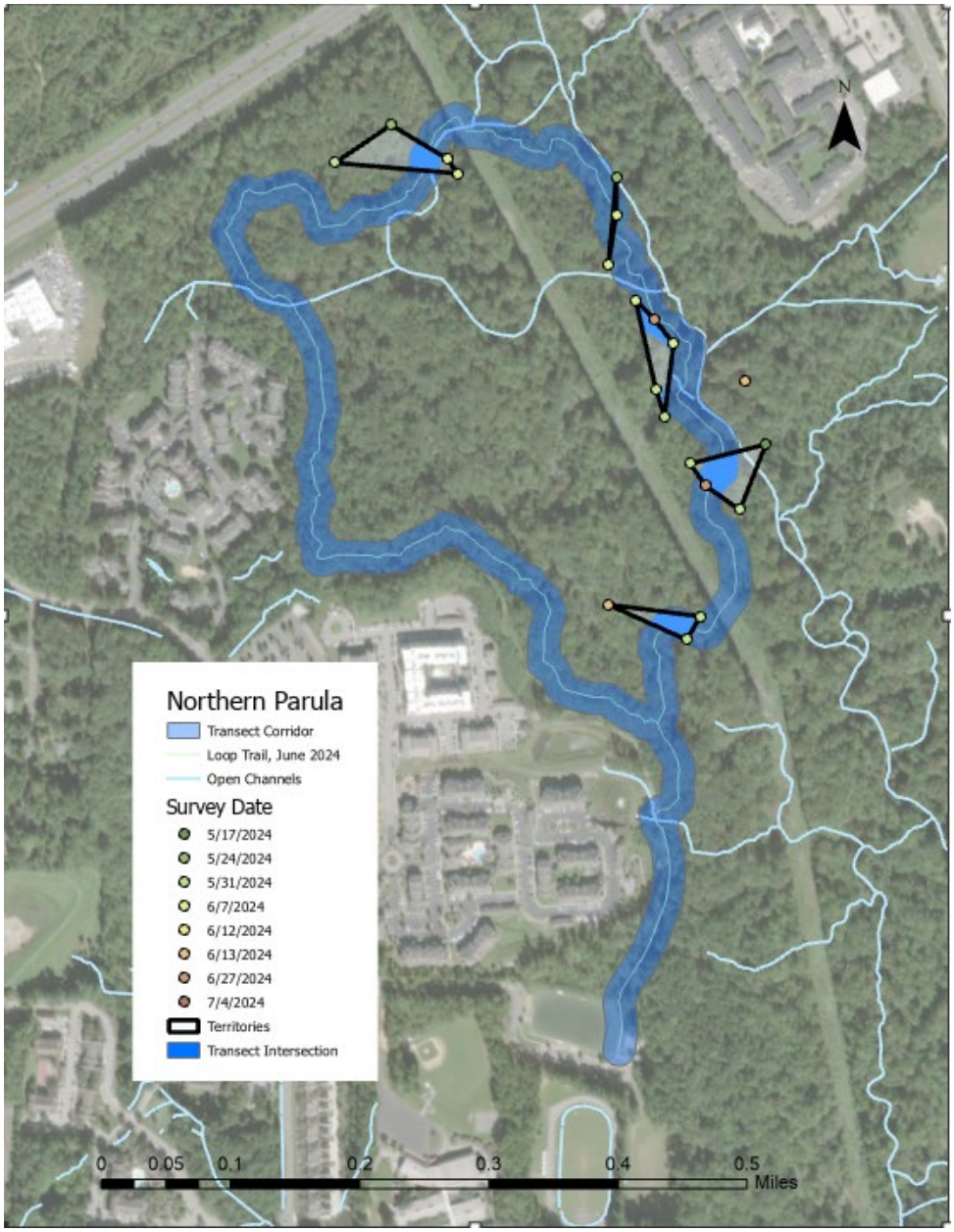
Prothonotary Warblers are strongly associated with bottomlands and swamp forests where mature trees with cavities are located close to pools or streams, habitat features that are well-represented in the study area. However, this appears to be the first year that this species has been recorded during the nesting period at this site; one was observed by Hall in 2022 within the eastern cluster of points but it apparently did not remain to nest. Two clusters of observation points meet the criteria for territory definition. The average size of the convex polygons is 0.2 hectares, which is smaller than the range of territory size of 0.5 ha to 1.5 ha reported by Petit (2020). Using the proportional rule for edge territories, we found a density of 0.08 territories per hectare, which is slightly larger than the average of 0.03 territories per recorded in the Big Oak Woods in the 1980s. According to the results of the Mini Breeding Bird Survey (2024), this species appears to be increasing in our area.

Common Yellowthroat



Common Yellowthroats characteristically inhabit dense, wet herbaceous growth in open areas, avoiding closed canopy forests. While several observations were made in an area along New Hope Creek where fallen Green Ash have created openings in the canopy, none of our records met the criteria for territories. They likely nest in the powerline corridor, however, where suitable habitat exists, but too few observations were made there to define a territory, and similarly, none were recorded in the Big Oak Woods in the 1980s. In our area, this species appears to be moderately declining based on the Mini Breeding Bird Survey (2024).

Northern Parula

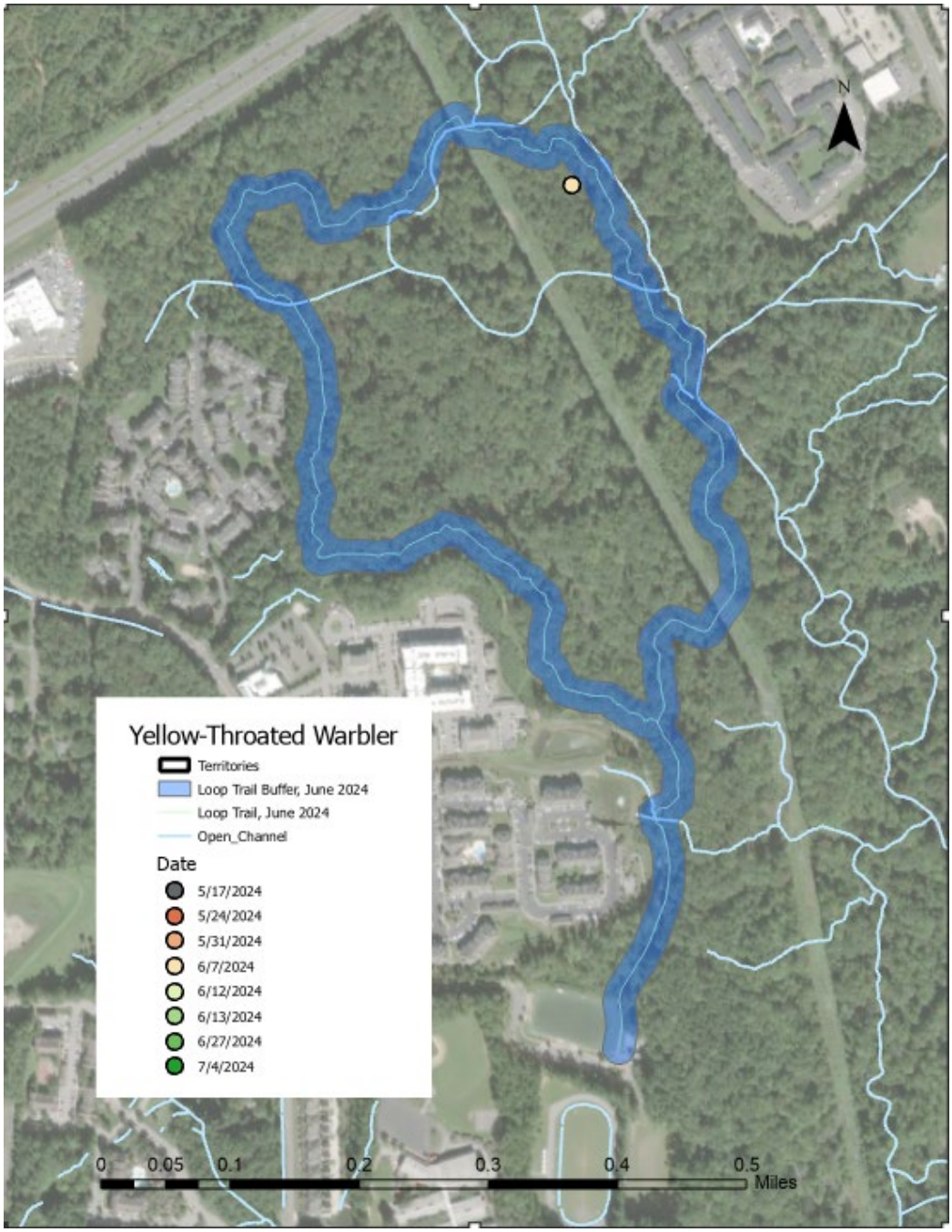


Northern Parulas are a common bottomland species, where they often nest close to streams, swamps, or lakes (Moldenhauer and Regelski, 2020). They were recorded in the breeding season in the 2022 NCBP survey and five territories were identified in the current survey, all close to watercourses. The average size of the convex polygons used to represent the territories is 0.26, which is much lower than the average of 0.4-hectare territories recorded for this species in Maine (Moldenhauer and Regelski, 2020). Using the proportional rule for edge territories, the density is 0.24 per hectare, which is over twice the average of 0.11 for the Big Oak Woods in the 1980s. This species appears to be moderately increasing in our area based on the results of the Mini Breeding Bird Survey (2024).

Pine Warbler

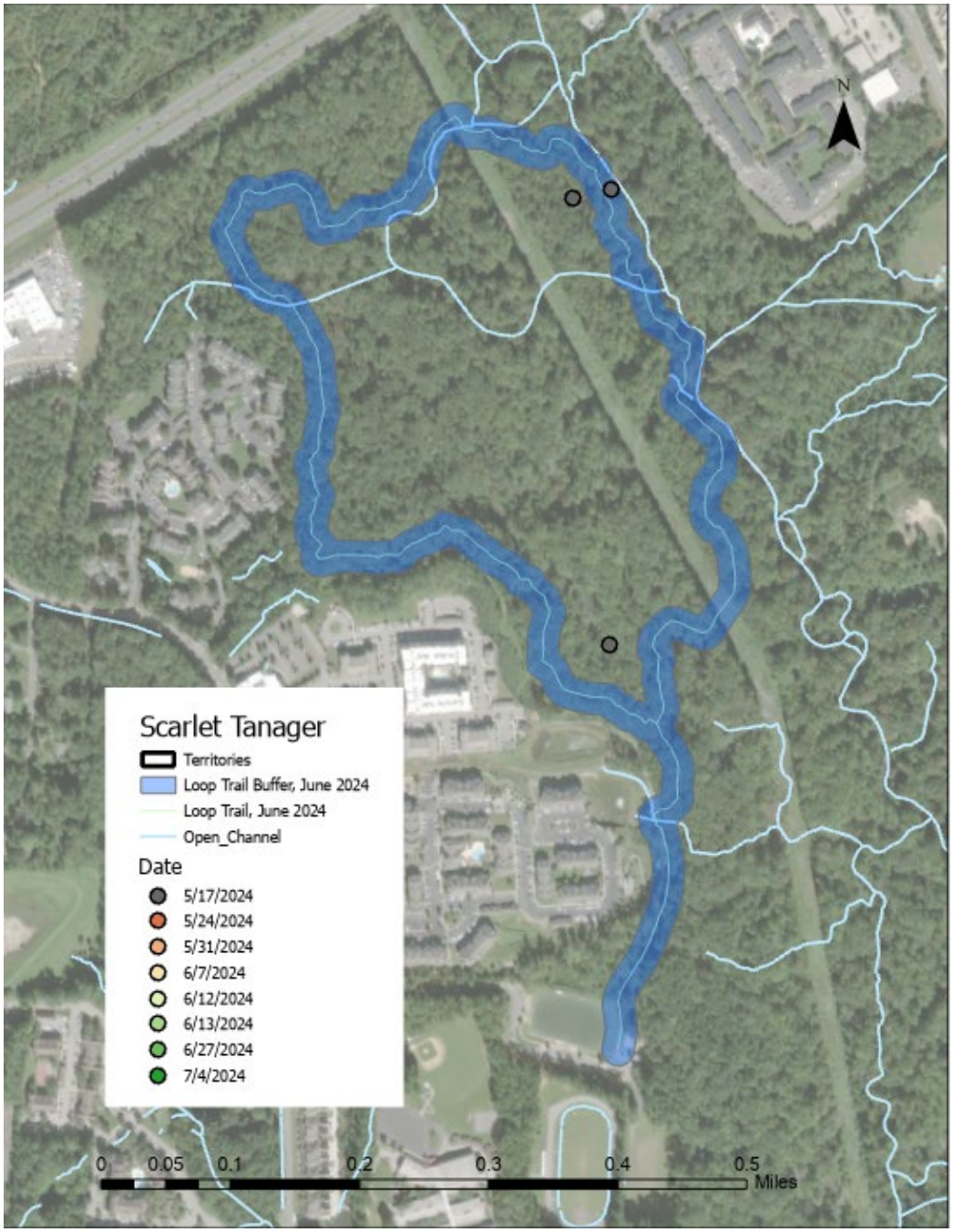
Pine Warblers are year-round residents in the study area and are always found close to stands of pine (shaded red on the map). Three clusters of observation points were recorded, with two meeting the criteria for territories. The average of the two is 0.87 hectares, which is in line with two territories of 0.9 hectares recorded in Arkansas (Rodewald et al., 2020). Using the proportional rule for edge territories and dividing the sum of the proportions by the total area of pine forest habitat included in the transect, the territorial density is 0.13 per hectare. This is larger than the average of 0.02 per hectare recorded in the Big Oak Woods in the 1980s. While still a common bird in our area, none were apparently recorded in the Mini Breeding Bird Survey (2024).

Yellow-throated Warbler



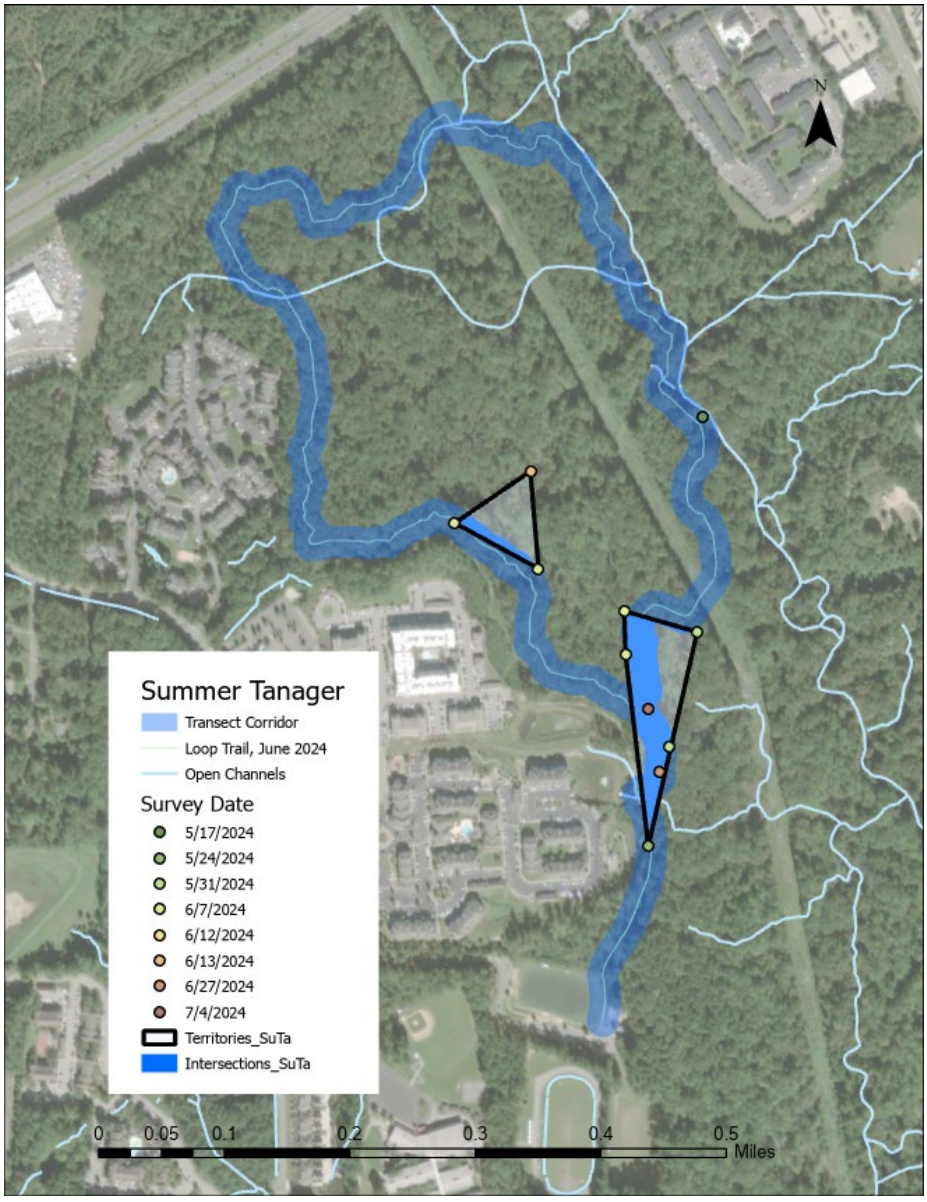
Yellow-throated Warblers are associated primarily with wet-to-mesic forests, often nesting near shorelines of ponds, lakes, and streams. This species was observed only once during the breeding period in 2024 and the location and size of its territory could not be determined. This species had an average territory density of 0.01 in the Big Oak Woods in the 1980s. Based on the results of the Mini Breeding Bird Survey (2024), this species appears to be fairly strongly increasing in our area.

Scarlet Tanager



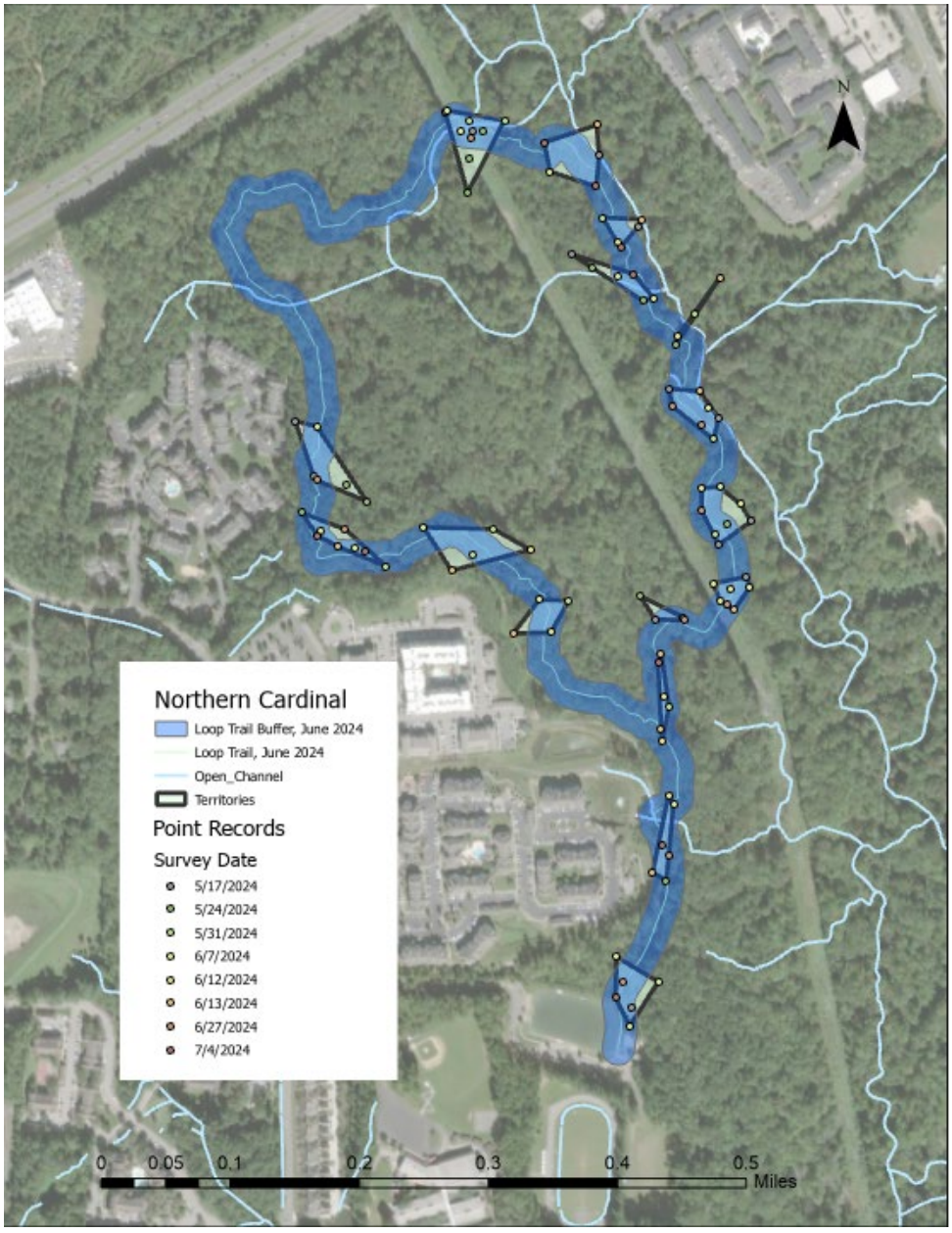
Scarlet Tanagers are associated with mature hardwood forests, preferring mesic sites, often on slopes, to drier woodlands. Bottomlands are used to some extent (LeGrand et al., 2024). This species was only observed early in the survey this year, however, and appears to have been just migrating through the area. In the 1980s in the Big Oak Woods, 0.22 territories were recorded per hectare. Based on the Mini Breeding Bird Survey (2024), this species is moderately strongly declining in our area.

Summer Tanager



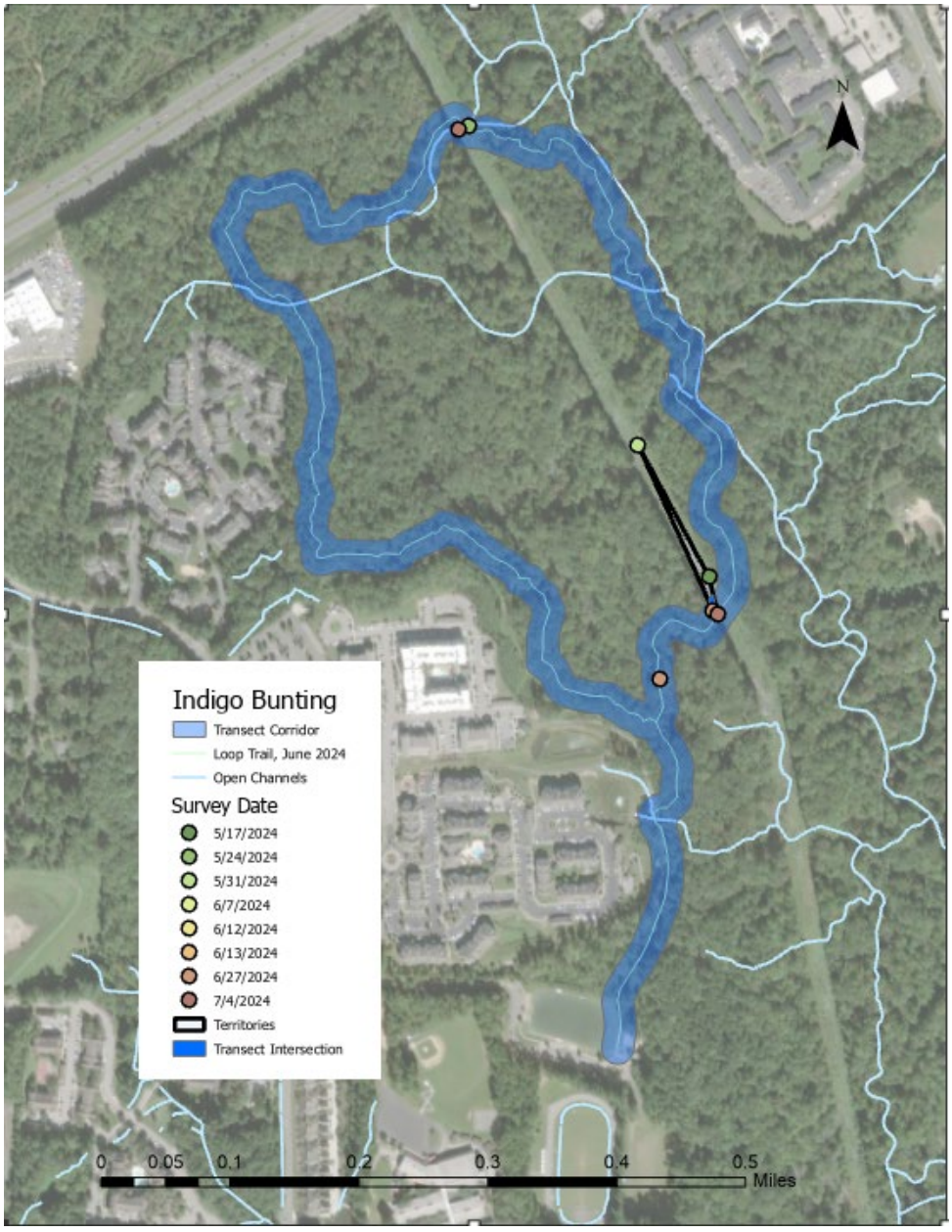
Summer Tanagers are associated with both open woodlands and dry-to-mesic forests (LeGrand et al., 2024) but occur less commonly in floodplain forests than Scarlet Tanagers. However, in the New Hope Bottomlands the opposite appears to be true: they were heard commonly in the 2021-2022 survey conducted by the North Carolina Biodiversity Project (Hall et al., 2022), when no Scarlet Tanagers were observed. The same is true for the current survey. No precise estimates appear to have been made of defended territories in this species, although it is reported to use up to 9 to 11 hectares per pair for foraging (Robinson, 2020). The average of the two convex polygons that approximate the territories found this year is 1.03 ha, which may be a better estimate of the activity areas surrounding their nests. Using the proportional rule for edge territories, the density of territories is estimated to be 0.07 per hectare, which is close to the average of 0.06 obtained in the 1980s in the Big Oak Woods. This species is moderately increasing in our area (Mini Breeding Bird Survey, 2024).

Northern Cardinal



Northern Cardinals are one of our most abundant and widespread birds. They nest in a wide variety of forests, woodlands, and edges where there is abundant shrub and understory cover (LeGrand et al., 2024). During the nesting season, they defend breeding territories that are estimated to range in size from 0.21 to 2.6 hectares (Halkin et al., 2021). The convex polygons we used to indicate the individual territories, however, average only 0.2 hectares in extent. This was the most abundant species recorded in the survey, with16 territories intersecting the transect corridor. Using the proportional rule for edge territories, this produced a density of 1.02 territories per hectare. That is substantially higher than the average of 0.31 per hectare recorded during the 1980s in the Big Oak Woods at Mason Farm. According to the results of the Mini Breeding Bird Survey (2024), however, this species may be slightly declining in our area.

Indigo Bunting



Indigo Buntings are associated with old fields and other shrubby, semi-open habitats. In the New Hope floodplain, they occur within the powerline that runs through the study area, with only one record, probably of a stray, located within the forest. Although at least two territories may exist within the powerline, only one has enough records to meet the criteria for territories. The size of that territory is 0.15 hectares, which is small compared to the average of 1.4 hectares observed in Michigan (George, 1952; cited in Paye, 2020). The transect we used contains too little of the powerline habitat within it to make a reasonable estimate of the territorial density of this species. In the 1980s, an average density of 0.0077 per hectare was recorded in the Big ak Woods. According to the Mini Breeding Bird Survey (2024), this species is undergoing a moderate decline in our area.

Trends Among Specific Groups

Based on data collected in the Big Oak Woods during the 1980s, twenty-seven species are expected as summer, breeding residents in the New Hope Bottomlands, which has very similar habitats, with both located in Triassic Basin floodplains and supporting mature stands of wet hardwood forest. However, over half of these species – 56% -- in the current survey, have lower densities than recorded in the previous surveys. The results for this group are described first, as having the greater interest for conservation, followed by the remaining 44% that show at least some degree of increased density[2].

Table 1. Missing and Declining Species

Species	Territory Density		
	New Hope Bottomlands	Mason Farm 1980s	Difference
Red-eyed Vireo	0.33	1.76	**-1.43**
Acadian Flycatcher	0.16	0.98	**-0.82**
Wood Thrush	0.00	0.58	**-0.58**
Hooded Warbler	0.00	0.38	**-0.38**
Kentucky Warbler	0.00	0.35	**-0.35**
Ruby-Throated Hummingbird	+	0.25	**-0.25**
Scarlet Tanager	0.00	0.22	**-0.22**
Yellow-Throated Vireo	0.00	0.17	**-0.17**
Yellow-billed Cuckoo	0.01	0.17	**-0.16**
Blue-gray Gnatcatcher	0.49	0.64	**-0.15**
Ovenbird	0.00	0.10	**-0.10**
American Redstart	0.00	0.06	**-0.06**
Hairy Woodpecker	0.04	0.09	**-0.05**
White-breasted Nuthatch	0.09	0.12	**-0.03**
Downy Woodpecker	0.18	0.20	**-0.02**

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

Seven species are missing completely (having zero territorial density). Based on density estimates from the Mason Farm surveys, this represents a loss of 22 breeding pairs (= ∑ Differences x 12.06 hectares). That number, furthermore, is nearly matched by the decline of Red-eyed Vireos. While the density of that species is still comparatively high, we estimate that over 17 pairs are missing for this species alone. Taking breeding birds

[2] Left out of the analysis are species that are only marginally present in these habitats or that are mainly nocturnal and not well-represented in the diurnal surveys included in these studies.

altogether, there are 57 fewer pairs than expected based on data recorded in the Big Oak Woods 40 years ago.

Of these species, those that need to migrate to our area for nesting are the most strongly affected. 80% of the species in Table 1 are breeding season migrants, representing 75% of the migrating species overall. Apart from their need to migrate, involving great risks and large expenditures of energy, these species are otherwise quite diverse in terms of their life styles. Most are insectivores, but hummingbirds feed primarily on nectar and Wood Thrushes feed heavily on snails in addition to other ground-dwelling invertebrates. Of the insectivores, Yellow-billed Cuckoos feed largely on lepidopteran caterpillars and Acadian Flycatchers on flying adult insects. Five of are canopy dwellers, two are understory species, and four are associated with shrubs or forage on the ground. All of the migrants are open nesters and the one odd group of permanent residents in Table 1 are all cavity-nesting species that feed by probing or gleaning from tree trunks or branches.

Table 2 reverses the situation, with the majority of species increasing in territorial density composed of permanent residents: 67% of the species in the table and 73% of the permanent residents overall.

Table 2. Increasing Species

	Territory Density		
Species	New Hope Bottomlands	Mason Farm 1980s	Difference
Northern Cardinal	1.02	0.31	**0.71**
Red-bellied Woodpecker	0.90	0.26	**0.64**
Carolina Wren	0.92	0.33	**0.59**
Tufted Titmouse	0.88	0.41	**0.47**
Carolina Chickadee	0.55	0.26	**0.29**
Northern Parula	0.24	0.11	**0.13**
Pine Warbler	0.13	0.02	**0.11**
Pileated Woodpecker	0.08	0.01	**0.07**
Prothonotary Warbler	0.08	0.03	**0.05**
White-eyed Vireo	0.07	0.02	**0.05**
Summer Tanager	0.07	0.06	**0.01**
Red-shouldered Hawk	0.02	0.01	**0.01**

Permanent Residents
Migratory Species

For the migrant species, the increases in their density results in a gain of 3 pairs of nesting birds, versus the gain of 38 pairs for the permanent residents. Taken all together, a gain of 41 pairs is produced, far too few to compensate for the loss of the

pairs in the first group; the net loss compared to the 1980s in the Big Oak Woods is 57 - 41 = 16 pairs.

As in the first group, the species in Table 2 are diverse in terms of their life-histories. Apart from the major differences between migratory species and permanent residents, more of these species are cavity nesters: five versus the three in Table 1. In addition to the one herp-feeding raptor, one is predominantly a seed-feeder, two are bark drillers, four feed on insects primarily in the canopy, two in the subcanopy, and two in the shrub and ground layers.

Discussion

Evaluation of Potential Biases

Apart from using a transect rather than a grid as the sampling unit, we used the same survey and analytical methods as in standard territorial mapping studies. One major difference, however, is that nearly all of the territories we plotted are “edge” territories, having a portion within the transect and a portion outside. While we used the same proportional method of calculating their contribution to density estimates as used in the standard method, edge territories pose problems even for grid-based surveys: compared to territories in the interior of the grid, which are examined from several sides, edge territories are typically viewed only from one side – from the interior of the study plot towards the outside. That means that they will be inherently less accurately plotted than the interior territories, with the degree of error increasing for observation points located further and further outside the plot. Given the large number of edge territories in a transect-based survey, the positional uncertainty of the edge territories has the potential for significantly biasing the density estimates, as follows.

If we were to erroneously treat observation points located well outside the transect as accurately plotted and belonging to a cluster that reaches all the way into the transect, this would lead to an overestimate of the proportion of the territory located outside the transect and, consequently an underestimate of the amount inside. This in turn would lead to an underestimate of the density estimate: smaller interior proportions sum up to a smaller number of territories estimated relative to the transect area. Under this scenario, the apparent declines in density observed in our study relative to the grid-based surveys done at Mason Farm could be due to this kind of bias rather than an actual reduction in the numbers of territorial breeding pairs.

However, the converse of this situation is more likely to be the case: birds singing at distant points from the edge of the transect are either likely to go undetected or are more likely to be discounted in the analysis of clusters as inaccurately plotted. The smaller estimates that would result of the proportion of the territories falling outside the transect would conversely lead to overestimates of the proportion falling inside, leading to an overestimate of territorial density.

If the second scenario is considered to be more probable, then the resulting bias should produce results counter to the declines we estimate to have occurred in the New Hope fauna compared to the fauna that existed in the Big Oak Woods several decades ago. If anything, the magnitude of the declines could actually be much greater if the bias in that direction is taken into account. On the other hand, the increases in territorial density estimated to have occurred among the permanent residents could be entirely due to this sort of bias.

More generally, the species that we are most concerned about are those with relatively small territories, with those intersecting the 40m wide transect likely to be well estimated both within and immediately adjacent to the transect boundary. For wide ranging or less clearly territorial species, such as Yellow-billed Cuckoos, Pileated Woodpeckers, or Red-shouldered Hawks, the problems of accurately plotting the observation points for individual birds is much greater and is a challenge even for large grid-based surveys (see Gregory et al., 2004). In considering the results of our survey, we focus mainly on those species whose territories we believe to be plotted with reasonable accuracy.

Comparison to Previous Surveys

At the very least, the results of this year's survey appear to confirm the qualitative results obtained in 2022 during the NCBP inventory. Apart from the Prothonotary Warbler, species that were missing from the study area during the nesting survey that year were not observed during the breeding season this year. These include Wood Thrush, Hooded Warbler, Kentucky Warbler, Scarlet Tanager, Yellow-throated Vireo, Ovenbird, Louisiana Waterthrush, and American Redstart. With the exception of the Redstart, all of these species were recorded during the nesting season by Hall in the floodplain forests along New Hope Creek[3] in the 1990s (Hall, 1995; Hall and Sutter, 1999). They now, however, appear to be completely missing from the breeding bird fauna of the New Hope Bottomlands.

Those findings – though striking -- were limited due to the qualitative nature of the previous survey. A species was scored only as present or absent and declines in abundance that have not yet led to extirpation could not be measured. This year, due to the inclusion of counts of individual singing males, quantitative measurement of trends could now be made. In particular, we were able to compare the abundances of individual species to the rich historic data collected in similar habitats at the nearby Mason Farm Biological Reserve in the 1980s. Based on these comparisons, we now believe that reductions in abundance have occurred in a number of additional species. Loss of territorial males among Red-eyed Vireos, Acadian Flycatchers, and Blue-gray Gnatcatchers are especially noteworthy, since these have historically been some of the most abundant breeding birds in our area. While these species were still some of the most common species in the New Hope Bottomlands, we estimate that reductions in these three species alone represent a loss of 29 pairs of nesting birds from the study area.

These trends are consistent with the findings in breeding bird populations across North America (Rosenberg et al., 2019; North American Bird Conservation Initiative, 2022), as well as around the world (Lees et al., 2022). As in our study, species that migrate long distances to reach their breeding grounds appear to be particularly susceptible. In North America, 58% of the 419 native species of migrants are estimated to be in decline. Overall, this groups has lost an estimated 2,548 million individuals since 1970, representing a 28% of their overall numbers. In contrast -- again consistent with our results – native resident species appear to have actually increased in abundance during this same period by up to 26.3 million individuals (Rosenberg et al.).

A large number of factors have been proposed to explain these declines, as well as the differences between migrants and residents. These include global factors, such as loss of habitats in both their winter and summer ranges in the case of migratory species, as well as global epidemics, such as bird flu, and the effects of climate change. We are more concerned,

[3] These areas included portions of the New Hope Creek floodplain just north of US 15-501 and south of Old Chapel Hill Road. Portions of the Jordan Game Land north of Old Chapel Hill Road were surveyed outside of the nesting period.

however, with the role local factors may play, since these are the ones that local conservation actions have the hope for addressing. These include two major categories:

Local Habitat Loss

Loss, degradation, and fragmentation of habitat is a major cause of bird decline both at the global and local levels. In our area, deciduous forests are the main habitat used by our native bird species and research since the 1970s have shown that many of our bird species are sensitive to both the size of forest tracts as well as their quality and degree of connectedness to other blocks of habitat. Given great amount of conversion of forests – especially mature stands – to agriculture, pine silviculture, and residential development that has taken place since the mid-1700s, it is not surprising that birds associated with these habitats have suffered major declines. Since the 1970s alone, an estimated 63.5% of species associated with eastern forests have suffered significant losses (Rosenberg et al., 2019).

In 1970, our local area was largely undeveloped outside the then widely separated municipalities of Durham, Chapel Hill, and Raleigh. The forests in this region were actually becoming both more extensive and more mature following recovery from the massive amount of timbering that had taken place around the turn of the 19th Century, and following the abandonment of former farmland during the Dustbowl period of the 1930s. The New Hope Bottomlands was particularly well-forested, as is evident in aerial photographs taken in 1940 (see New Hope Creek Biodiversity Survey). In the late 1980s, when a survey of natural areas and wildlife habitats was conducted in Durham County (Hall, 1995; Hall et al.,1999), 37 species of forest-nesting bird were recorded, nearly the entire complement expected for the area (five others have since been recorded in the nesting period at this site, leaving only Coopers Hawk, Eastern Screech Owl, and American Redstart species in this group still unrecorded as nesting species).

Following the construction of I-40 and the widening of US 15-501 in the 1980s, this formerly rural area has undergone rapid urbanization (see Figure 1). Shopping centers and other

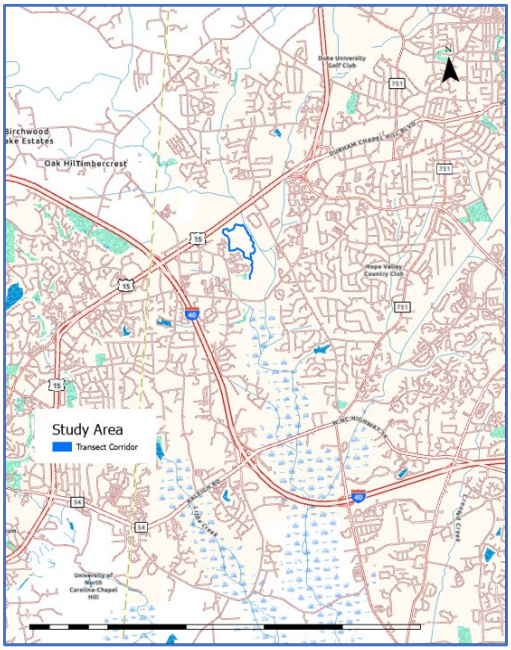


FIGURE 2. ROADS AND DEVELOPMENTS ADJOINING THE STUDY AREA

commercial development crowd the floodplain along US 15-501 and will soon occupy the remaining high ground next to the creek. Apartment complexes and residential neighborhoods come down to the edge of the New Hope Creek floodplain on both sides of the study area, with more developments recently proposed or approved for the remaining uplands within the Durham County lands adjoining the creek

Although the floodplain itself remains largely forested, most of the surrounding area is now no longer capable of supporting populations of species that require mature forest interiors. Migratory species such as Ovenbirds, Hooded Warblers, and Scarlet Tanagers that would have once nested throughout this area are particularly affected by this massive loss of habitat, being unable to nest successfully in even semi-wooded residential neighborhoods.

The one saving factor is that the floodplain itself resists direct development, due to its frequent and extensive flooding, although the privately owned portions are still subject to timber harvest and other forms of extractive uses. Thanks to the efforts of the Durham Open Space Program and the New Hope Creek Advisory Committee, a nearly continuous corridor of protected lands now exists along the creek, forming a link between the large area of upland forests within Duke Forest and the large area of bottomland forests located within the Jordan Lake Project lands. It is largely due to the presence of this corridor of protected forest that species such as the Prothonotary Warbler, Northern Parula, and Acadian Flycatcher maintain breeding populations in this area.

Edge Effects

Protecting large and numerous tracts of natural habitat is critical for maintaining native species in our area. However, simply acquiring tracts for biodiversity conservation is not enough in itself. Impacts related to human activities on adjoining lands do not recognize property lines; so-called “edge effects” spill across the boundaries and can penetrate up to 300 meters into a preserve (Kennedy, 2003).

For bird species, the following edge effects are believed to have major effects on their populations:

Predation by Edge-tolerant Species – This includes significant predation on birds by domestic cats straying into natural areas from adjoining residential areas. It also includes increased predation by human-tolerant invasive or established native predators, including coyotes, raccoons, opossums, American and Fish Crows, all of which are increasing due to subsidizing their natural foods with pet food or garbage left outside of homes located close to the edges of natural areas

Deer Over-browsing – White-tailed Deer have also become increasingly human-tolerant, with their populations building up along the interface of developed and natural areas. Released from their own predators, deer are responsible for major declines in the shrub and herb layers, with consequent impacts to low-nesting or ground foraging birds

Cowbird Parasitism – Brown-headed Cowbirds are an originally prairie species that has invaded the East due to the massive forest clearances that have taken place over the past several centuries. While the adult birds are still associated with open lands (or suburban areas with abundant bird feeders), they regularly invade forests to lay their eggs in the nests of our native forest birds. In some cases – e.g., Wood Thrushes – their parasitism has led to major population declines.

Starling Nest Competition – The introduced European Starling is another open or edge habitat species that has strongly affected native bird populations, in this case due to its aggressive competition for tree-cavity nesting sites.
Reduction of Prey Populations – Most forest bird species are insectivores and migratory species in particular rely on the presence of an abundant supply of lepidopteran caterpillars when they reach their nesting grounds. Insects, however, have their own set of impacts due to human activities, including the effects of light pollution, pesticides, and loss of their own food resources due to introduction of exotic species. In the 2021-22 survey conducted by the NCBP, a staggering decline in moth populations was detected which alone could account for the decline or loss of many bird species. Migrants are especially affected since they depend on the abundant supply of caterpillars that naturally occurs in the spring both for their own recovery from their long-distance travels and to supply the food needed for their nestlings.
Increased Stormwater Runoff – Construction of impervious surfaces in adjoining developments or roadways contributes to increased flooding in bottomlands. The New Hope Bottomlands do, in fact, appear to be more frequently and thoroughly flooded than in the past, which is likely to contribute to the loss of ground-nesting or ground-foraging species such as Ovenbird, Kentucky Warbler, and Wood Thrush.
Disturbances Related to Human Activity – Noise and light pollution from neighboring developed areas may affect both bird species directly or the insects upon which they depend. Human activity, in general, may affect bird behavior, including where they choose to nest.

Local Conservation Actions

Wherever the opportunity exists, further habitat losses should be prevented through conservation acquisition, securing conservation easements, or reaching management agreements with landowners. Protection or restoration of connections between blocks of habitat should be a high priority.

Land use planning by local governments should include incentives for preserving existing tracts of forests, allowing stands to reach maturity, and to permit succession to occur on former agricultural lands or pine plantations. Special attention needs to be given to the control of stormwater runoff from proposed developments; use of pervious surfaces should be encouraged.

To minimize edge effects, wide buffers should be maintained between developed areas and natural areas. Ideally, these buffers should be maintained as forests rather than as open areas requiring mechanical or chemical means of keeping them in that state. To limit the movements of wildlife out of natural areas and domestic or urban tolerant species into them, animal-proof fences should be constructed.

Within preserves, restoration of native vegetation should be a priority. This should involve control of deer populations and removal of invasive exotics that have little or no food value for native insects.

The Importance of Monitoring Breeding Bird Populations in Local Natural Areas

The conservation actions listed above require the support of a public that is both well informed and concerned about the threats facing the world's biodiversity as well as that of their own local environment. Bird surveys in particular have proven to be a highly popular and very effective

way to mobilize support for conservation, as evident in the enormous success of the Christmas Bird Counts that have now been taking place across the entire country for over a century.

Establishing the same level of enthusiasm, knowledge, and action for monitoring breeding populations has the potential for even more effective conservation, particularly when tied to efforts to protect and manage locally important natural areas. These are places typically viewed as possessing the best examples of natural habitats and functioning ecosystems present within a given area and where significant expenditures have been made to preserve their natural features. As such they are considered the most important jewels of our natural heritage. They are also prime hotspots for observing bird species.

Our main objective in this project has been to develop a method that can be used by local birding groups to monitor the status of breeding birds within their own favorite natural areas. We believe that territory mapping offers a quantitative approach that makes the best use of the expertise of the local birding community. While the traditional grid-based methods may be the optimal way of collecting data on nesting pairs, we feel that the transect method described in this report offers at least a reasonable alternative and one more easily implemented. What dedicated birder objects to walking their favorite trails during the spring and early summer, pursuing an activity that is both enjoyable and directly connects them to their local environment? What group is more qualified to carry out these projects or to support the conservation efforts needed to restore our bird populations?

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