

STATUS AND HABITAT AFFINITY FOR  
CERULEAN WARBLER AND OTHER FOREST BIRDS  
IN OKLAHOMA

By

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Bachelor of Science in Fisheries and Wildlife

Michigan State University

East Lansing, Michigan

2004

Submitted to the Faculty of the  
Graduate College of the  
Oklahoma State University  
in partial fulfillment of  
the requirements for  
the Degree of  
MASTER OF SCIENCE  
December, 2008

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## ACKNOWLEDGMENTS

Financial support for this project was provided from State Wildlife Grants under Project T-31-P-1 of the Oklahoma Department of Wildlife Conservation and Oklahoma State University and administered through the Oklahoma Cooperative Fish and Wildlife Research Unit (Oklahoma Department of Wildlife Conservation, Oklahoma State University, United States Geological Survey, and Wildlife Management Institute cooperating). Additional support was provided by the Payne County Audubon Society. Particular thanks go to field assistants Jason Heinen, Jim Taulman and Allysa Lapine. Dan McGlenn and Mike Palmer provided helpful assistance on using canonical correspondence analysis.

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## CHAPTER I

### Distribution of breeding Cerulean Warblers (*Dendroica cerulea*) in Oklahoma

Abstract – Recent field work for Oklahoma’s Breeding Bird Atlas failed to locate Cerulean Warbler (Reinking 2004), raising concerns of range contraction for this former uncommon breeder in Oklahoma. In 2006 and 2007, we conducted point counts at 150 sites throughout the species’ historical range in Oklahoma. We located Cerulean Warblers at 5 (3.3%) of the sites surveyed. Those sites were located on north slopes in the Ouachita Mountains, near ridge tops between 641 and 721 m elevation. We encountered 8 adult males and 4 adult females at the 5 sites. We confirmed breeding from separate observations of pairs feeding fledglings in June 2006 on Lynn Mountain and in June 2007 on Rich Mountain, both locations in LeFlore County. Compared to sites where we did not encounter Cerulean Warblers, sites where they were detected supported a taller and more densely vegetated canopy and were restricted to the region’s highest ridges. The number of birds we observed represented a minimum population estimate, and other forested ridgetops that we were unable to survey may harbor additional breeding Cerulean Warblers. We recommend that these high-elevation forests in the Ouachita Mountains be managed to maximize forest patch size, canopy height, and canopy closure.

## Introduction

The Cerulean Warbler (*Dendroica cerulea*) is a small, insectivorous wood warbler that breeds in deciduous forests of eastern North America. Nearctic-Neotropical migrants, Cerulean Warblers make annual migrations between breeding areas concentrated in the east-central United States and wintering areas in northern South America (Hamel 2000a, 2000b). The species occupies a discontinuous breeding range from the eastern Great Plains to the Atlantic Coastal Plain, including areas from southern Arkansas to southern Quebec (Hamel 2000a). Population density varies greatly over the breeding distribution, with population centers in the central Appalachians of Ohio, West Virginia, and Kentucky; southern Wisconsin; southwestern Michigan; southern Missouri; and northwestern Arkansas (Hamel 2000b, Rosenberg et al. 2000). Cerulean Warblers winter primarily in the Andes Mountains in northern South America (Hamel 2000a), including parts of Colombia, Venezuela, Ecuador, Peru, and Bolivia (Hamel 2000a).

Based on data from the North American Breeding Bird Survey, the Cerulean Warbler has declined faster than almost any other species in North America (Hamel 2000a), suffering annual losses of at least 3% since 1966 (Link and Sauer 2002). The Cerulean Warbler is one of the highest conservation priorities for Partners in Flight (Rich et al. 2000, Jones et al. 2004) and was recently denied listing under the Endangered Species Act (USFWS 2006). Investigative work for possible listing has contributed much of the recent research on this species (Hamel et al. 2004, Jones et al. 2004, Hamel 2005, Rogers 2006), including a rangewide assessment of distribution and abundance (Rosenberg et al. 2000).



Cerulean Warblers generally require large forested tracts for breeding (Robbins et al., 1992; Hamel 2000a, 2000b). They normally are found in forests with relatively closed canopies, although the importance of canopy gaps has been noted (Robbins et al. 1992, Oliarnyk and Robinson 1996, Hyde et al. 2000, Hamel 2000a, Wood et al. 2005). Habitat selection varies throughout the breeding range, with forested slopes at relatively high elevation (>1000 m) used in some areas (e.g., Hamel 2000a, Hyde et al. 2000) and bottomland hardwood forest used in others (e.g., Robbins et al. 1992). Wintering habitat in the Neotropics includes mature broad-leaf and second-growth forest, and shade coffee plantations (Terborgh 1989, Robbins et al. 1992, Degraaf and Rappole 1995, Jones and Robertson 1997).

Loss of mature streamside and bottomland deciduous forest in the United States, whether to logging or to reservoir development, is thought to be a major cause of the decline of the Cerulean Warbler (Hamel 2000a). Significant areas of former breeding habitat also have been lost to surface mining operations in the Appalachians. Habitat loss on the wintering grounds and mortality during migration also may contribute to the decline (Hamel 2000a).

Despite the overall trend of a rangewide decline, the Cerulean Warbler has actually expanded its breeding range in recent years (Oliarnyk and Robertson 1996, Hamel 2000a), particularly in the Northeast. This apparent range expansion may be reclamation of former breeding range, as regenerating forests in the region mature. The expansion illustrates that conservation of this species may require attention to the edges of its range, not just the population center.

At the southwestern edge of its range, the Cerulean Warbler was formerly a widespread and locally abundant breeder in eastern Oklahoma (Woodhouse 1992, Sutton 1967). Carter (1967) determined that there were 2.9 pairs/40 ha in the McCurtain County Wilderness Area. The population in the State fell rapidly, however, following several reservoir construction projects that inundated former breeding areas. Isolated encounters were reported in the 1990s (e.g., Couch 1996), all restricted to LeFlore county. Despite multiple years of field effort for Oklahoma's Breeding Bird Atlas (Reinking 2004), no Cerulean Warblers were reported. Because the rangewide Cerulean Warbler Atlas Project (Rosenberg et al. 2000) did not include Oklahoma, it was not known if the lack of Ceruleans reported during Oklahoma's Atlas indicated that the species had been extirpated.

Due to the incomplete state of knowledge regarding population size and distribution of Cerulean Warbler at the edge of its range in Oklahoma, we conducted targeted surveys for this declining species within the State. Considering the species has reclaimed other former areas of its breeding range, we considered several counties in eastern Oklahoma as potentially providing breeding habitat for the species. Our objectives were to identify populations and confirm breeding of Cerulean Warblers in Oklahoma and to characterize occupied habitat.

## Methods

### Study Area

We focused field surveys on areas within the historical range of Ceruleans Warblers that support large tracts of forested land, primarily the Ouachita Mountains and the Ozark Highlands (Fig. 1). The Ouachita Mountains are characterized by a series of east-west ridges in western Arkansas and southeastern Oklahoma. The mountains occupy approximately 54,000 km<sup>2</sup> in 26 counties in Arkansas and 10 counties in Oklahoma (Rafferty and Catau 1991). The Ouachita region remains one of the largest and most contiguously forested areas in the eastern United States. More than 3,200 km<sup>2</sup> in this region are managed for mature or old-growth type forests (Chiple et al. 2003). Habitats in this area consist of upland sites containing shortleaf and loblolly pines, mixed pine-hardwood, and oak-hickory forests. Bottomland sites in the Ouachitas are dominated by oak (*Quercus*) gum (*Nyssa*) cypress (*Taxodium*) or elm (*Ulmus*) ash (*Fraxinus*) cottonwood (*Populus*) forests (Chiple et al. 2003).

The Ozark Highlands occupy parts of southern Missouri, northern Arkansas, and northeastern Oklahoma and cover approximately 21,000 km<sup>2</sup> (Brye et al. 2004). The region consists of low mountains that are dominated by oak-hickory forests (Brye et al. 2004). This area contains some of the most contiguous forested areas in central North America (Chiple et al. 2003).

#### Cerulean Warbler Surveys

Within the study area, we targeted survey areas with the greatest potential to harbor Cerulean Warblers and selected survey sites to represent a gradient of forested cover and different forest types. We specifically visited historical locations for the species identified in the Cerulean Warbler Atlas Project (Rosenberg et al. 2000) and other sources. Prior to the start of field work, we used Terrain Navigator software to construct

maps of sites to survey based on the presence of historical locations for Ceruleans Warblers, as well as sites that represented different characteristics of slope, aspect, and extent of forest cover. We specifically populated our surveys with multiple forested sites at high elevation and mature bottomland hardwood forest, the typical habitats used by the species elsewhere in its range (Hamel 2000a). We also selected some sites in the field, following site reconnaissance that revealed desirable cover types to sample such as riparian forest, second-growth hardwoods, pine plantation, agricultural areas, and urban-suburban areas

Each survey site consisted of 4 plots spaced 250 m apart on a 1-km transect (Fig. 2). We placed plots 250 m apart to avoid double counting most species of small land birds (Hutto et al. 1986). We sampled birds at each of the plots using 6-min, 100-m fixed radius point counts. We split 6-min counts into 3 equal bands of 2 min each to facilitate the application of *post-hoc* removal models to aid in the calculation of species-specific detection probabilities (Farnsworth et al. 2002). Counts took place from sunrise to approximately 1030 h CDT (Hutto et al. 1986, Ralph et al. 1995).

At the conclusion of each point count, we broadcast Cerulean Warbler song from a portable compact disk player and external speaker song for 1 min and listened for a response for an additional minute (Rosenberg et al. 2000). If Cerulean Warblers were detected in response to the song broadcast, we invested additional time to determine if breeding could be confirmed based on observation of an active nest, fledglings, or an adult carrying food (Reinking 2004). We also recorded multiple GPS locations for each male Cerulean Warbler encountered to attempt to delimit the territory. We surveyed 75 sites in 2006 and 75 sites in 2007.

## Habitat Sampling

We quantified site characteristics from three 5-m circular plots 15 m from point count center at 0, 120, and 240 degrees ( $N = 12$  plots/site) (Fig. 1). We used a modified version of the vegetation sampling protocol described by Martin et al. (1997). Within each plot, we estimated percent slope using a clinometer and recorded elevation from a hand-held GPS unit. For overstory trees, we visually estimated percent cover, measured canopy height with a clinometer, and estimated basal area using an angle gauge from the center of each plot. To determine tree species dominance, we identified to species and counted the number of stems  $> 10$  cm dbh within each plot. We visually estimated the percent cover of low ( $< 2$  m) and high ( $> 2$  m) woody shrubs and trees  $< 10$  cm dbh. We also visually estimated the relative percent ground cover occupied by grasses, forbs, and leaves in each plot. For all percent cover estimates, we used a standardized cover template for direct comparison. All variables estimated at the plots were averaged for the site.

To characterize general cover types in a larger area around each site, we first recorded the location of each point count in the field with a GPS unit and obtained coordinates for the midpoint of each sampling transect. From the midpoint, we created a 1-km buffer in ArcMap 9.2. We used a land-cover layer developed for the Oklahoma Gap Analysis Project (Fisher and Gregory 2001) to identify patches of forest and used Hawth's tools in ArcMap to calculate land-cover metrics within each buffer. For each site, we calculated the percent cover of mature forest, regenerating forest and shrubland, pasture and cropland, and urban land use within the 1-km buffer.

Statistical analyses involved the *post-hoc* identification of vegetation, land cover, and site condition differences between sites where we detected Cerulean Warblers and sites where we did not. Because of the disparity in sample size between those 2 categories, we were not able to apply standard parametric statistical tests. Instead, we compared variables with 95% confidence intervals and descriptions as appropriate.

## Results

We detected Cerulean Warblers at 5 of 150 (3.3%) of the sites surveyed (Fig. 3). All 5 sites were located in the Ouachita National Forest on the north slopes of Lynn and Rich mountains, both in Leflore County, Oklahoma. We encountered Cerulean Warblers exclusively near the near ridge tops at 641–721 m elevation in forested stands.

We detected 8 Cerulean Warbler male and 4 female Cerulean Warblers. Monitoring of those Cerulean Warblers in 2006 resulted in observations of 1 pair carrying food on Lynn Mountain. This same pair was later seen feeding fledglings, confirming breeding for that area. During the 2007 field season, a pair of Cerulean Warblers were observed feeding fledglings on Rich Mountain, confirming breeding for that location. Using our small sample size, our estimated detection probability for Cerulean Warbler in 2006 was 0.9978 and for 2007 it was 1.00. Using those probabilities, we estimated densities at these sites at 7.97 - 15.95 singing males/100 ha. Typically you need much larger sample size ( $n > 100$ ) to properly apply detection probabilities.

Mean canopy cover at our Cerulean Warbler sites was  $70\% \pm 6$  SD. Mean forest cover within the 1-km buffer for our Cerulean Warbler sites was  $99.75\% \pm 0.005$  SD.

For low and high understory cover, the means were  $60\% \pm 8$  SD and  $28\% \pm 17$  SD, respectively. The mean for elevation was  $691.1 \text{ m} \pm 30$  SD, and the mean slope was  $29.85\% \pm 12$  SD. Canopy height ranged from 16 to 21 m with a mean of  $18 \text{ m} \pm 2$  SD.

We counted all canopy tree stems greater than 10 cm dbh for each site with Cerulean Warblers. Average stem counts for sites on Lynn Mountain were mockernut hickory (*Carya tomentosa*) n=27, black walnut (*Juglans nigra*) n=21, white oak (*Quercus alba*) n=17, and northern red oak (*Quercus rubra*) n=9. On the Rich Mountain site stem counts for the site were mockernut hickory (*Carya tomentosa*) n=23, white oak (*Quercus alba*) n=19, black gum (*Nyssa sylvatica*) n=11, and sugar maple n=11 (*Acer saccharum*).

Even after discounting sites with  $< 50\%$  forest cover within the 1-km buffer around each site, sites where we saw Cerulean Warblers had 6 habitat variables that were higher than the 95% confidence intervals of non-Cerulean Warbler sites. These habitat variables included canopy cover, canopy height, elevation, forest cover, slope, and understory cover  $< 2$  m. (Tab. 1).

## Discussion

Recent research on forest songbirds often has been focused on habitat conditions and other potential sources of decline (Peterjohn and Rice 1991, Rappole and McDonald 1994, Robinson et al. 1995, Donovan et al. 2002). One important cause for declines in forest songbirds is forest loss or fragmentation. Fragmentation can result in increased amounts of nest predation from various predators and increased brood parasitism by the Brown-headed Cowbird (*Molothrus ater*) within an area (Hoover et al. 1995, Robinson et al. 1995, Darr et al. 1998, Ortega 1998, Rogers 2006). Certain species seem to be

especially sensitive to forest fragmentation. These forest interior species seem to be more severely effected by fragmentation and some may disappear when forests no longer have the necessary amounts of interior. Some of these forest interior species include species that reach their southwestern limit in Oklahoma. These include the Ovenbird (*Seiurus aurocapillus*), Kentucky Warbler (*Oporornis formosus*), Hooded Warbler (*Wilsonia citrine*), Worm-eating Warbler (*Helmitheros vermivora*), Acadian Flycatcher (*Empidonax virescens*) and the Cerulean Warbler (Kroodsma 1984).

Although there are undoubtedly other causes such as mortality during migration causing the decline of the Cerulean Warbler (Hamel 2000a), forest fragmentation on the breeding ground is at least partially responsible (Robbins et al. 1992, Hamel 2000a, Roth and Islam 2008). This is especially true for bottomland hardwood forest, favored by Cerulean Warblers in parts of their breeding range. Agricultural areas in the Midwest and the Mississippi Alluvial Valley have lost much of their extant mature bottomland hardwood forest (Robbins et al. 1992, Roth and Islam 2008).

Several sources indicate that Cerulean Warblers once used bottomland habitats in Oklahoma (Woodhouse 1992, Carter 1967, Sutton 1967). Many of our survey areas were located within current or former areas of extensive bottomland forests, including Little River National Wildlife Refuge (NWR) and along the Arkansas River in Sequoyah NWR, a site at least near the historical location discovered by Woodhouse (1992). We also surveyed bottomland hardwood forests along Spavinaw Creek, another historical location but did not find any Cerulean Warblers because the forests had disappeared or were heavily fragmented. We could not survey the historical location along the Mountain



Fork River where Carter (1967) studied in the 1960s because it now lies underneath Broken Bow Lake.

Cerulean Warblers still occur on the Ozark Plateau in Arkansas and Missouri. In fact, this area has been described as an area of high density for the species (Hamel 2000a). We did not, however, locate any Cerulean Warblers on the Oklahoma side of the Ozark Plateau. The apparent lack of Cerulean Warblers on the Ozark Plateau in Oklahoma may be due to the highly fragmented forest cover there (Fig. 4).

The high-elevation ridge tops where we located Cerulean Warblers are structurally similar to habitats described from West Virginia and other areas in the Appalachian region (Robbins et al. 1992, Hamel 2000a, Hamel 2000b, Weakland 2005). Our Cerulean Warbler sites also were similar to Cerulean Warbler breeding habitat described in other parts of the species range in that it had greater canopy cover, higher canopy height and a greater slope than other forested sites in the region (Roth and Islam 2008).

Our results indicate that suitable breeding habitat for Cerulean Warblers is limited in Oklahoma. Relative to 145 surveyed sites in forested landscapes where we did not encounter them, the 5 sites that supported Cerulean Warblers exhibited greater forest cover at the site scale, a taller more closed forest canopy, higher elevation, and higher percent slope. Of the 150 total sites surveyed, only 9 supported the combination of environmental variables within the 95% confidence interval of sites where we encountered Cerulean Warblers. The fact that we found the species at 5 of 9 sites with suitable habitat conditions points to a relatively high occupancy rate (55.6%) and

indicates that the species may very well be limited by the amount of available habitat in Oklahoma.

In Oklahoma, the Cerulean Warbler was reported to be an abundant species along the Arkansas River in the 1800s (Sutton 1967). Other reports indicate that Ceruleans were at least locally common in McCurtain County and other areas of the state into the 1960s (Kuhnert 2004). Fragmentation and clearing of most of the mature deciduous forests, however, seem to have eliminated the Cerulean Warbler from most of its historical range in Oklahoma (Kuhnert 2004). Most of the forest lands in Oklahoma have been changed or eliminated, leaving only a small percentage of suitable forest for breeding Cerulean Warblers (Kuhnert 2004).

Although we consider our Cerulean Warbler search to be thorough, it is difficult to completely search an entire region of a state; there are some areas that we could not get to that could support breeding Cerulean Warblers. Two of these areas are Blue Bouncer Mountain and Black Fork Mountain in Leflore County; both areas contain high-elevation forest with extensive northerly slopes. Lynn and Rich mountains also include areas of suitable habitat that were not included in our surveys. There were several other areas that we did survey and did not find Cerulean Warblers but that met some of the minimum requirements for suitable Cerulean Warbler habitat (Table 1). These areas include Cucumber Creek Nature Preserve in Leflore County, Little River NWR in McCurtain County, Cookson Hills WMA in Cherokee and Adair Counties, and Spavinaw WMA in Delaware County. Our high detection probability for Cerulean Warbler makes it unlikely that we missed them while surveying these areas but future monitoring of these areas could result in observations of Cerulean Warblers.

Figure 5 illustrates potential habitat for Cerulean Warblers in Oklahoma, based on the site characteristics where we found them in 2006–2007. Future surveys for the species in Oklahoma should specifically target these areas, and could lead to a more complete population assessment than was possible in this study. Such an assessment will be necessary to enhance conservation action for Cerulean Warblers in Oklahoma.

We determined in this study that Cerulean Warblers still occur in Oklahoma forests; and that they successfully fledged young in 2006 and 2007. In advance of additional demographic information on population demographics, we perceive any habitat used by a declining species like the Cerulean Warbler to be a conservation priority. We recommend that shaded areas in Fig. 5 be managed for maximum canopy height and canopy closure in native hardwoods.

#### Acknowledgements

Financial support for this project was provided from State Wildlife Grants under Project T-31-P-1 of the Oklahoma Department of Wildlife Conservation and Oklahoma State University and administered through the Oklahoma Cooperative Fish and Wildlife Research Unit (Oklahoma Department of Wildlife Conservation, Oklahoma State University, United States Geological Survey, United Fish and Wildlife Service, and Wildlife Management Institute cooperating). Additional support was provided by the Payne County Audubon Society. Particular thanks go to field assistants Jason Heinen, Jim Taulman, and Allysa Lapine, as well as to many Oklahoma birders who gave advice.

## Literature Cited

- Brye, K.R., C.P. West, and E.E. Gbur. 2004. Soil quality difference under native tallgrass prairie across a climosequence in Arkansas. *American Midland Naturalist* 152(2):214-230.
- Carter, W.A. 1967. Breeding birds of the McCurtain County Wilderness Area. *Wilson Bulletin* 79:259-272.
- Chipley, R.M., G.H. Fenwick, M.J. Parr, and D.N. Pashley. 2003. *The American bird conservancy guide to the 500 most important bird areas in the United States*. Random House, New York.
- Couch, J.R. 1996. Landscape level patterns in breeding bird distributions in the western Ouachita Mountains. Unpublished Ph.D. dissertation., Oklahoma State University, Stillwater.
- Darr, L.J., D.K. Dawson, and C.S. Robbins. 1998. Land-use planning to conserve habitat for area-sensitive forest birds. *Urban Ecosystems* 2:75-84.
- DeGraaf, R.M., and J.H. Rappole. 1995. *Neotropical migratory birds: natural history, distribution, and population change*. Comstock Publ. Assoc., Ithaca, New York.
- Donovan, T.M., C.J. Beardmore, D.N. Bonter, J.D. Brawn, R.J. Cooper, J.A. Fitzgerald, R. Ford, S.A. Gauthreaux, T.L. George, W.C. Hunter, T.E. Martin, J. Price, K.V. Rosenberg, P.D. Vickery, and T.B. Wigley. 2002. Priority research needs for the conservation of neotropical migrant landbirds. *Journal of Field Ornithology* 73:329-339.
- Farnsworth, G.L., K.H. Pollock, J.D. Nichols, T.R. Simmons, J.E. Hines, and J.R. Sauer. 2002. A removal model for estimating detection probabilities from point-count survey. *Auk* 119:414-425
- Fisher, W.L., and M.S. Gregory. 2001. *Oklahoma Gap Analysis Project. Final Report to the Oklahoma Cooperative Fish and Wildlife Research Unit*. Oklahoma State University, Stillwater.

- Hamel, P.B. 2000a. Cerulean Warbler (*Dendroica cerulea*). In The Birds of North America, No. 511 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia.
- Hamel, P.B. 2000b. Cerulean Warbler: status assessment. U.S. Fish and Wildlife Service.
- Hamel, P.B., D.K. Dawson, and P.D. Keyser. 2004. How we can learn more about the Cerulean Warbler (*Dendroica cerulea*). Auk 121:7-14.
- Hoover, J.P., M.C. Brittingham, and L.J. Goodrich. 1995. Effects of forest patch size on nesting success of Wood Thrushes. Auk 112:146-155.
- Hyde, D., Thomson, D., and J. Legge. 2000. Special animal abstract for *Dendroica cerulea* (Cerulean Warbler). Michigan Natural Features Inventory. Lansing MI. 4 pp.
- Hutto, R. L., S. M. Pletschet, P. Hendricks. 1986. A fixed-radius point count method for nonbreeding and breeding season use. Auk 103:593-602
- Jones, J., and R.J. Robertson. 1997. Abstract 75: Winter Ecology of the Cerulean Warbler in modified Venezuelan landscapes. Presented to the 115<sup>th</sup> stated meeting of the Am. Ornithol. Union, 13-16 Aug 1997. Minneapolis-St.Paul.
- Jones, J., J.L. Barg, T.S. Sillet, M.L. Veit, and R.J. Robertson. 2004. Minimum estimates of survival and population growth for Cerulean Warblers (*Dendroica cerulea*) Breeding in Ontario, Canada. Auk 121:15-22.
- Kroodsma, R.L. 1984. Effect of edge on breeding forest bird species. Wilson Bulletin 96(3):426-436.
- Kuhnert, N. 2004. Cerulean Warbler. In D. Reinking (Ed.). Oklahoma Breeding Bird Atlas. University of Oklahoma Press, Norman, OK.
- Link, W.A., and J.R. Sauer. 2002. A hierarchical analysis of population change with application to Cerulean Warblers. Ecology 83:2832-2840.

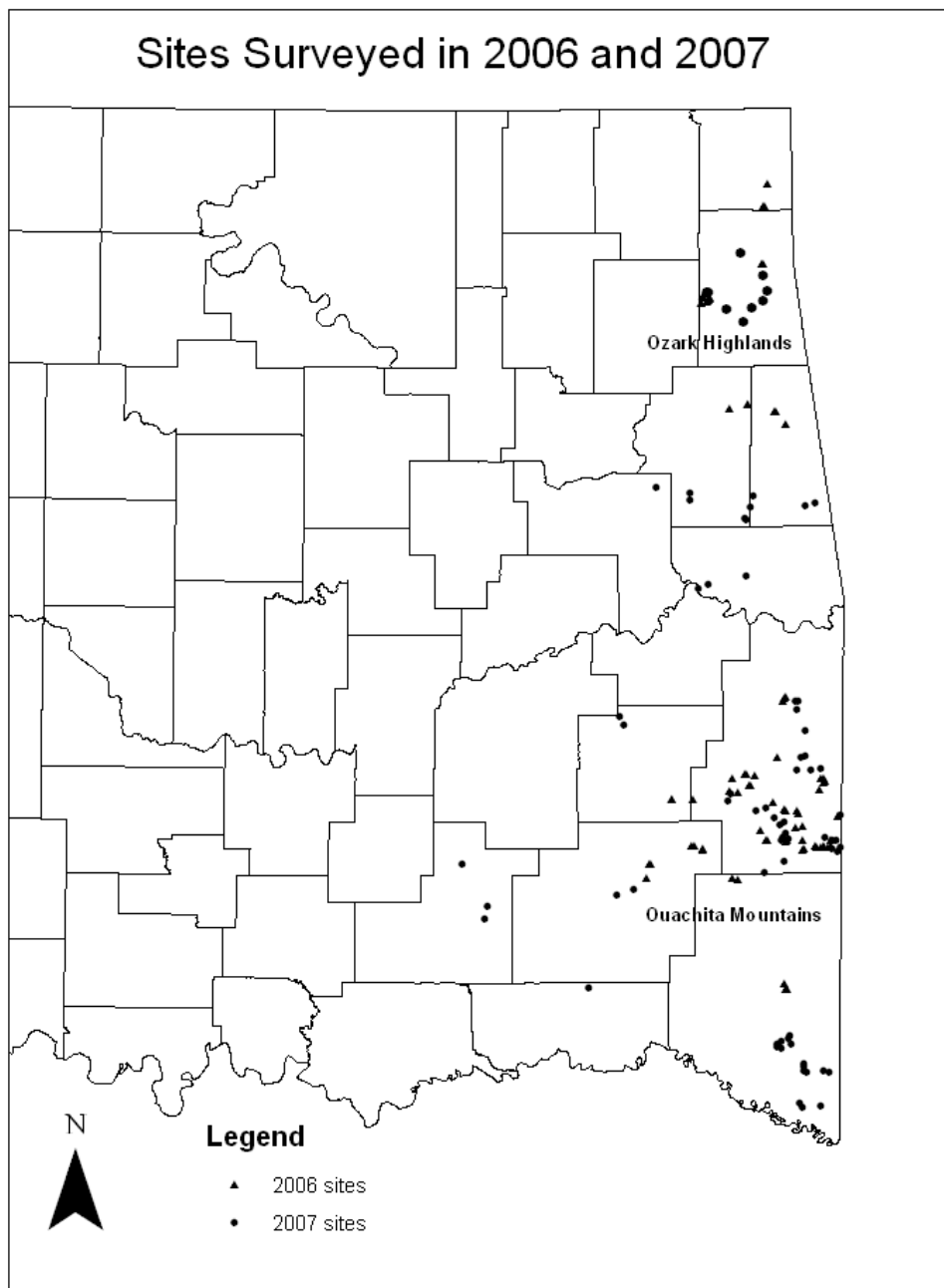
- Martin, T.E., C.R. Paine, C.J. Conway, W.M. Hochachka, P. Allen, and W. Jenkins. 1997. BBIRD Field Protocol. Montana Cooperative Wildlife Research Unit, University of Montana, Missoula.
- National Atlas of the United States. Accessed on September 20, 2008. [www.nationalatlas.gov](http://www.nationalatlas.gov).
- Oliarnyk, C.J., and R.J. Robertson. 1996. Breeding behavior and reproductive success of Cerulean Warblers in southeastern Ontario. *Wilson Bulletin* 108:673-684.
- Ortega, C.P. 1998. Cowbirds and other brood parasites. University of Arizona Press, Tucson.
- Peterjohn, B.G., and D.L. Rice. 1991. The Ohio breeding bird atlas. Ohio Department of Natural Resources, Columbus.
- Rafferty, M.D., and J.C. Catau. 1991. The Ouachita Mountains, a guide for fisherman, hunters, and travelers. University of Oklahoma, Norman.
- Ralph, C.J., J.R. Sauer, and S. Droege, technical editors. 1995. Monitoring bird populations by point counts. General Technical Report PSW-GTR-149. Albany, CA: Pacific U.S. Forest Service Southwest Research Station.
- Rappole, J.H., M.V. McDonald. 1994. Cause and effect in population declines of migratory birds. *Auk* 111:652-660.
- Reinking, D. 2004. Oklahoma breeding bird atlas. University of Oklahoma Press, Norman.
- Rich, T.D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, E.E. Inigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt, and T.C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca.
- Robbins, C.S., J.W. Fitzpatrick, and P.B. Hamel. 1992. A warbler in trouble: *Dendroica cerulea*. 549-562 in *Ecology and conservation of Neotropical migrant landbirds* (J.M. Hagen III, and D.W. Johnston, eds.). Smithsonian Institute Press, Washington D.C.
- Robinson, S.K., F.R. Thompson III, T.M. Donovan, D.R. Whitehead, and J. Faaborg. 1995. Regional forest fragmentation and the nesting success of migratory birds. *Science* 267:1987-1990.

- Rogers, C.M. 2006. Nesting success and breeding biology of Cerulean Warblers in Michigan. *Wilson Journal of Ornithology* 118:145-151.
- Rosenberg, K.V., S.E. Barker, and R.W. Rohrbaugh. 2000. An atlas of Cerulean Warbler populations. Final Report, Cornell Laboratory of Ornithology, Ithaca/
- Roth, K.L., and K. Islam. 2008. Habitat selection and reproductive success of Cerulean Warblers in Indiana. *Wilson Journal of Ornithology* 120:105-110.
- Sutton, G.M. 1967. Oklahoma birds: their ecology and distribution, with Comments on the avifauna of the Southern Great Plains. University of Oklahoma Press, Norman.
- Terborgh, J. 1989. *Where have all the birds gone?* Princeton University Press, Princeton, New Jersey.
- United States Fish and Wildlife Service. 2006. U.S. Fish and Wildlife Service finds Cerulean Warbler not warranted for Endangered Species Act listing. Web Page accessed, October, 13 2008.  
[http://www.fws.gov/midwest/eco\\_serv/soc/birds/cerw/cerw12mnthfindnr.html](http://www.fws.gov/midwest/eco_serv/soc/birds/cerw/cerw12mnthfindnr.html)
- Weakland, C.A. 2005. Cerulean Warbler (*Dendroica cerulea*) microhabitat and landscape-level habitat characteristics in southern West Virginia. *Auk* 122:497-508.
- Wood, P.B., J.P. Duguay, and J.V. Nichols. 2005. Cerulean Warbler use of regenerated clearcut and two-age harvests. *Wilson Bulletin* 33:851-858.
- Woodhouse, S.W. 1992. *A Naturalist in the Indian Territory: The Journals of S.W. Woodhouse 1849-1850.*

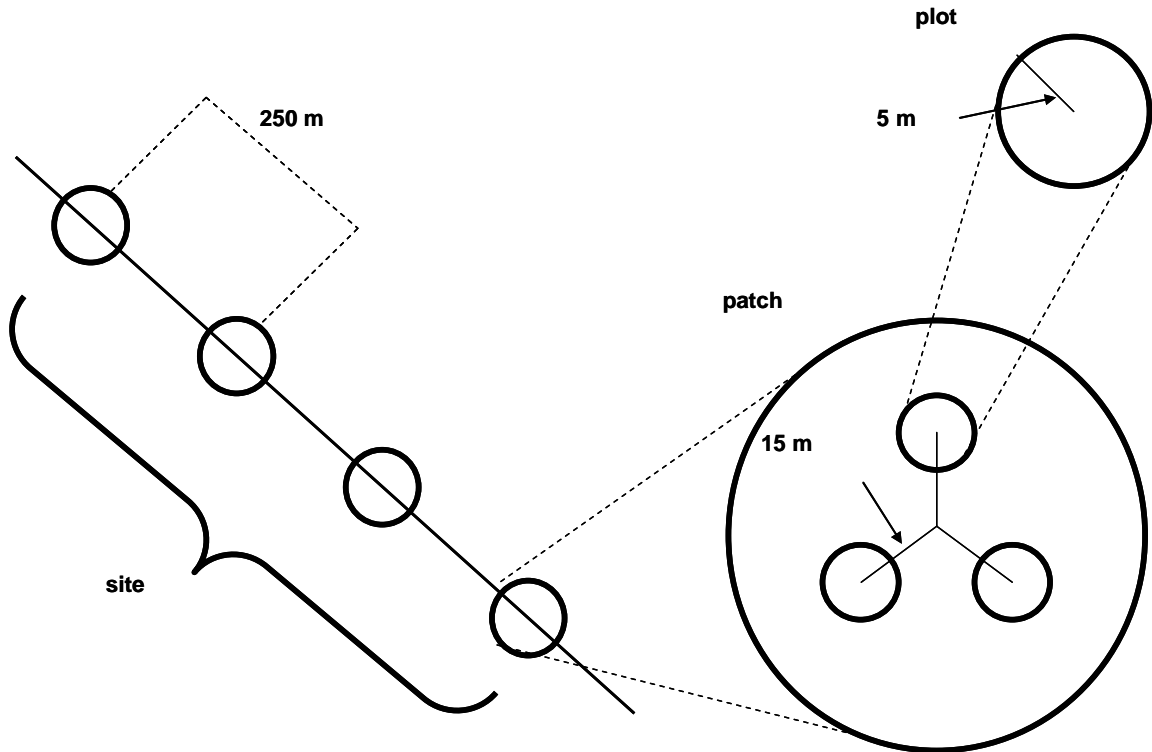
**Table 1. Each environmental variable shows a range of 95% confidence intervals around a mean value. The lower end of the 95% confidence interval for sites with CERW could be viewed as minimum requirements for Cerulean Warbler occupancy for Oklahoma habitats.**

<b>Environmental Variable</b>	<b>Sites without CERW</b>	<b>Sites with CERW</b>
Basal Area (m <sup>2</sup> /ha)	72.6 – 84.03	71.69 – 86.64
Canopy Cover %	54.8 – 60.73	64.14 – 75.13
Canopy Height (m)	13.22 – 14.6	16.36 – 19.75
Elevation (m)	332.8 – 386.02	665.03 – 717.17
Forest Cover %	80.1 – 84.46	99.31 – 100.00
Grass Cover %	11.35 – 15.36	6.28 – 36.46
Herbaceous Cover %	6.12 – 8.46	6.75 – 8.32
Leaf Cover %	58.28 – 64.14	39.04 – 72.51
Slope %	9.49 – 12.62	19.75 – 39.96
Understory Cover % > 2 m	23.76 – 28.9	13.44 – 43.00
Understory Cover % < 2 m	36.35 – 41.44	52.68 – 66.56

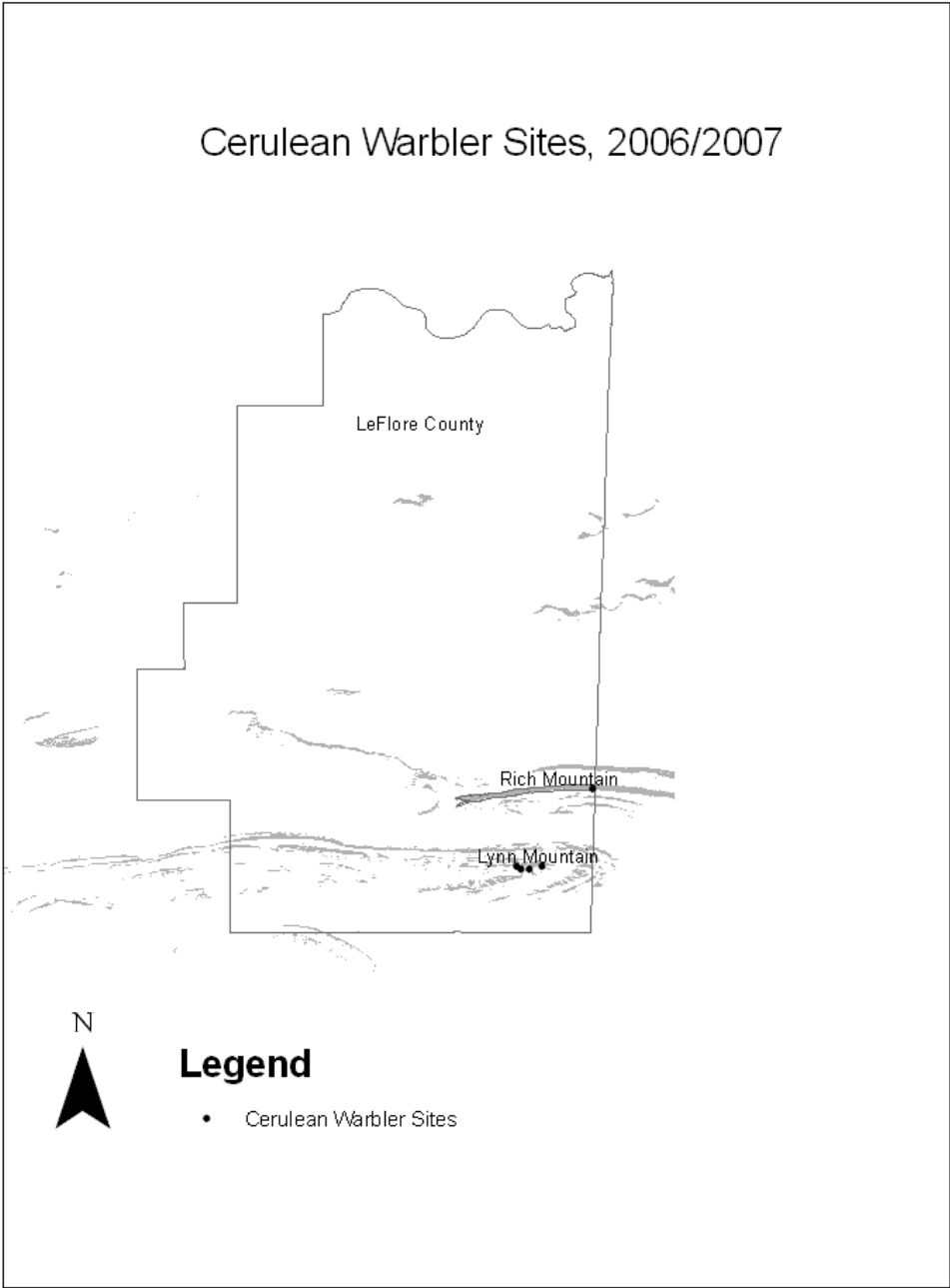




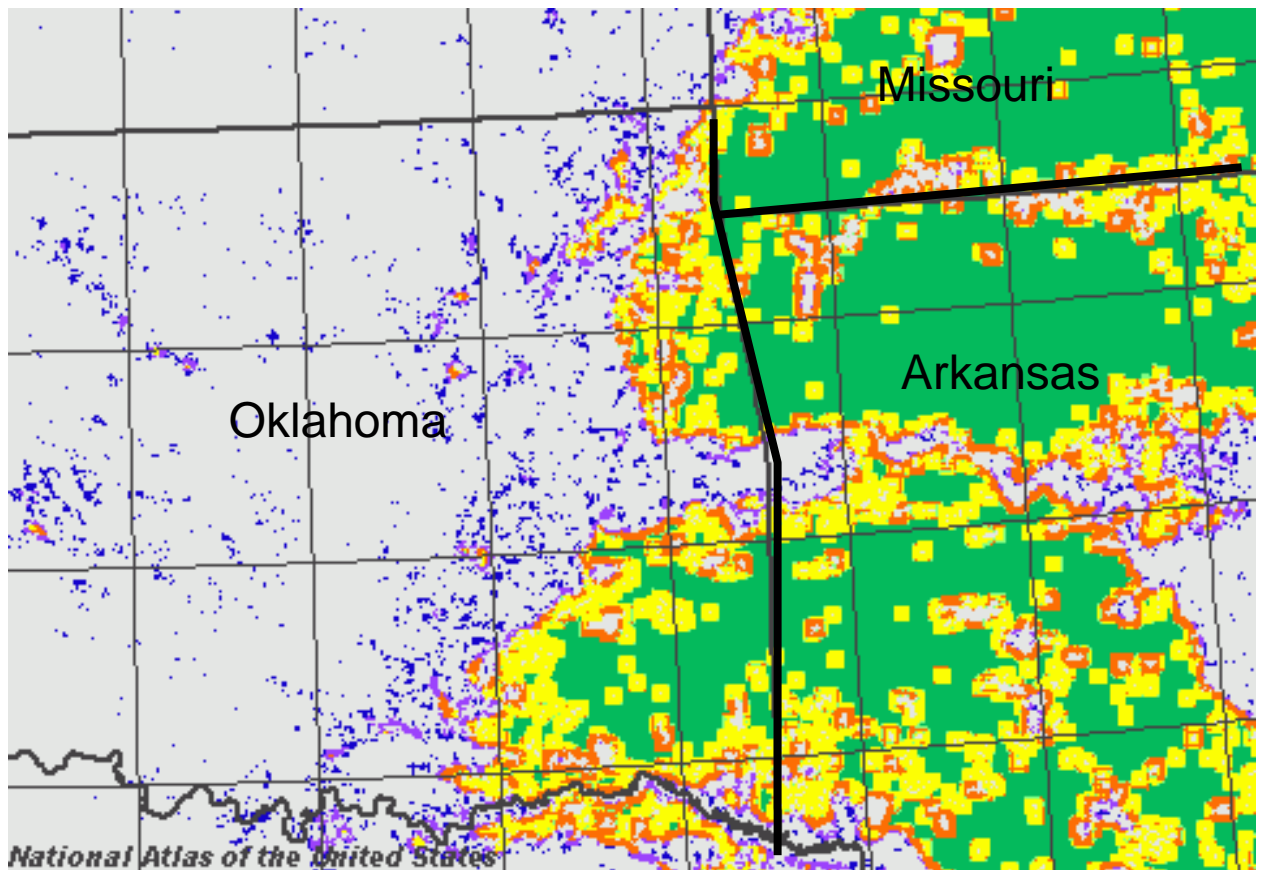
**Figure 1. Location of sites surveyed for Cerulean Warblers in eastern Oklahoma, 2006–2007.**



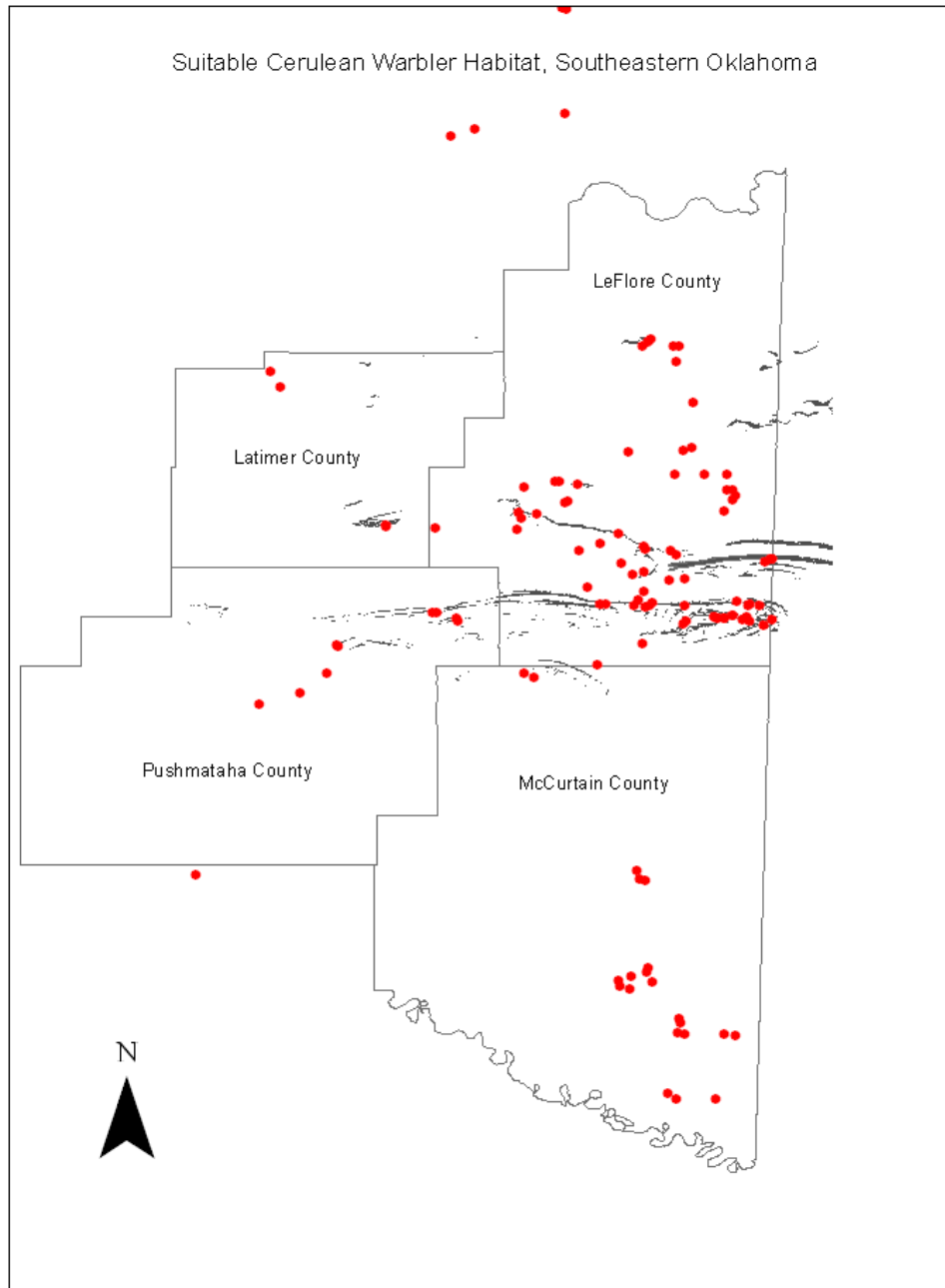
**Figure 2. Schematic representation of field sampling design; breeding birds were sampled in 4 patches along a 1-km transect; Within a patch, vegetation and site parameters were characterized in 3, 5-m radius plots.**



**Figure 3. Locations of Cerulean Warbler sites on, Rich and Lynn mountains in LeFlore County, Oklahoma.**



**Figure 4. Forest fragmentation map from the National Atlas (National Atlas of the United States 2008); Green represents areas of lower fragmentation, and yellow represents areas of higher fragmentation; much of the forest land in northeastern Oklahoma has been highly fragmented.**



**Figure 5. The shaded areas are > 500 m in elevation with a north facing slope; such areas are probable minimum requirements for Cerulean Warblers in this region; dots indicate our survey sites.**

## CHAPTER II

### A BIRD COMMUNITY ON THE EDGE: HABITAT USE OF FOREST SONGBIRDS IN EASTERN OKLAHOMA

Abstract. Several species of forest songbirds reach the western limit of their distributions in eastern Oklahoma. The relative influence of habitat variables on patterns of occurrence in this region may differ from those in the core of species' ranges. We examined the influence of 16 habitat variables on occurrence and density of forest songbirds. We sampled breeding birds with four, fixed radius point counts along 1-km transects at 75 forested sites in eastern Oklahoma in 2006 and 75 additional sites in 2007. Forest cover at fine scales varied structurally (e.g., canopy cover) and by species composition (e.g., pines vs. hardwoods). To examine bird habitat relationships, we performed Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA) ordinations using 16 environmental variables and 40 bird species. Forward Selection in CCA indicated that the most important structural variables affecting bird habitat relationships were percent broad-scale forest cover, canopy height, and elevation. We found that the Ouachita Mountains, likely because of their higher elevation and larger areas of contiguous mature forest, provided habitat for a larger spectrum of eastern forest songbirds than did the lower and more fragmented Ozarks.

Breeding densities for multiple species at the edge of their distribution in eastern Oklahoma forests were similar to estimates for the core of species distributions in the Appalachians, Midwest, and Northeast. Conservation in the region should focus on maintenance of large contiguous forest patches, especially mesic forests in bottomlands and along the ridgetops and north-facing slopes of the Ouachita Mountains.

### Introduction

Partners in Flight's (PIF) strategic planning for conservation has focused on developing objective criteria for ranking priority species and developing ecoregion-specific management prescriptions for those species (Bonney et al. 1999, Beissinger et al. 2000, Carter et al. 2000). Many species of forest birds in eastern North America occur predominantly in large forest tracts (e.g., Galli et al. 1976, Robbins et al. 1989, Freemark et al. 1995). Rich et al. (2004) identified an "Eastern Avifaunal Biome" in which 17 of 44 species of continental importance were dependent on mature deciduous forest. They called for "comprehensive forest planning on all public lands" to maintain these species (Rich et al. 2004). Broad conservation objectives for species at regional and continental scales, however, can be difficult to translate to the finer scale where land-use decisions are typically made (e.g. municipal and regional planning offices).

Management prescriptions for forest birds have been provided by Whitcomb et al. (1981), Lynch and Whigham (1984), Robbins et al. (1989), and Freemark and Collins (1992). Because of variability across the area over which forest birds breed in the eastern United States, it is difficult to generalize across entire species' distributions and untenable to assume that a relationship determined in one ecoregion can be applied to

another. In some studies variability in stand-level characteristics, weather conditions, or food availability exerted a greater influence on forest bird populations than did forest cover in the local landscape. In other studies broad-scale forest area, isolation, or pattern were important to maintaining quality habitat for forest birds (Hall 1984, Holmes and Sherry 1988, Rotenberry et al. 1995, Rodewald and Yahner 2000, Hagan and Meehan 2002, Lee et al. 2002, Nagy and Holmes 2005). O'Connell et al. (2000) described qualitative changes in forest bird communities related to forest extent in the local matrix, and Rodewald (2002, 2003) and Hagan and Meehan (2002) stressed the importance of considering the influence of the disturbance matrix type (e.g., agricultural or silvicultural) in non-forested landscapes. Even within a species, it is difficult to apply general management guidelines everywhere it occurs. For example, Trine (1998) surmised that Wood Thrush (*Hylocichla mustelina*) might need forested tracts >2,500 ha to support "source" populations in the Midwest, but Hoover et al. (1995) demonstrated high rates of nest success over a wide range of areas (approximately 127 to >10,000 ha) in forested tracts in Pennsylvania.

Approximately 30 forest birds from the eastern United States reach their western range limit in Oklahoma. These include the PIF priorities Ovenbird (*Seiurus aurocapillus*), Kentucky Warbler (*Oporornis formosus*), Hooded Warbler (*Wilsonia citrine*), Worm-eating Warbler (*Helmitheros vermivora*), Acadian Flycatcher (*Empidonax virescens*), and Cerulean Warbler (*Dendroica cerulea*) (Reinking 2004, Rich et al. 2004). Some of these species are confined to the easternmost counties while others (e.g., Black-and-White Warbler (*Mniotilta varia*), Northern Parula (*Parula Americana*), and Louisiana Waterthrush (*Seiurus motacilla*) breed > 400 km farther west (Reinking 2004).



There are no widely published studies that specifically focus on habitat relationships of forest songbirds in Oklahoma, and the ability of these species to occur in fragmented forests on the periphery of their breeding ranges illustrates that habitat use can differ from that closer to the core of their ranges. It is important to understand these relationships in the broad zone where eastern forests transition to western grasslands. Effective management for forest songbirds in Oklahoma requires a better understanding of the influence of broad- and fine-scale habitat attributes in Oklahoma ecoregions. We studied the influence of 16 environmental variables on the distribution and abundance of forest songbirds in eastern Oklahoma. Our objectives was to describe specific elements of vegetation structure and composition that provide suitable conditions for multiple forest breeding songbirds.

## Methods

### Study Area

We studied forest songbirds in the Ouachita Mountains and Ozark Highlands of eastern Oklahoma (Fig. 1). The Ouachita Mountains occupy approximately 54,000 km<sup>2</sup>, including portions of 26 Arkansas and 10 Oklahoma counties (Rafferty and Catau 1991). The range has an east-to-west orientation, with multiple ridges extending approximately 362 km east to west and 160 km north and south. The Ouachita region remains one of the largest and most contiguous forested areas in the eastern United States. More than 3,200 km<sup>2</sup> in this region are managed for mature or old-growth type forests (Chipley et al. 2003). Habitats in this area consist of upland shortleaf (*Pinus echinata*) and loblolly pine (*P. taeda*), mixed pine-hardwood, and oak (*Quercus*)-hickory (*Carya*) forests.

Bottomland forests are characterized by oak (*Quercus*)-gum (*Nissa*)-cypress (*Taxodium*) or elm (*Ulmus*)-ash (*Fraxinus*)-cottonwood (*Populus*) forests (Chipley et al. 2003). The unusual orientation of the ridges results in markedly different communities on either side of the ridgeline (mesic on north faces; xeric on south faces).

The Ozark Highlands occupy a extensive region in southern Missouri, Arkansas, and northeastern Oklahoma. The region consists of mountains that are dominated by oak-hickory forests (Brye et al. 2004). This area contains some of the most extensive forests in central North America (Chipley et al. 2003); the Oklahoma portion makes up the western edge of this approximately 21,000 km<sup>2</sup> ecoregion. (Brye et al. 2004).

#### Bird Surveys

We established and surveyed 75 forested sites in 2006 and an additional 75 sites in 2007. Each site consisted of 4 plots spaced 250m apart on a 1-km transect. We intentionally sampled from bottomland hardwoods, ridgetops, and slopes of different aspects so that we could address structural and compositional differences among forest types in our analyses.

We sampled birds once at each of the plots using 6-min, 100-m fixed-radius point counts. These counts took place from local sunrise to approximately 1030 h CDT (Hutto et al. 1986, Ralph et al. 1995). During point counts, we counted all singing males within 100 m of plot center and noted the time of first detection for each individual as within the first, middle, or final 2 min of the 6 min count. Recording data on singing males in discrete time bands allowed us to apply *post-hoc* removal models (Farnsworth et al. 2002, *online supplement*) to calculate an observer-specific probability of detection for each species. We then divided the raw number of each species detected on a count by the

observer-specific detection probability to derive a detection-adjusted estimate of abundance that would permit direct comparison among species and observers. We calculated breeding density at a site by dividing the detection-adjusted abundance by the total area sampled per site (13 ha).

### Site Characteristics

We quantified site characteristics from the four sampling points per site, and from three, 5-m circular plots established 15 m from each point count center at 0, 120, and 240 degrees ( $N = 12$  plots/site). We used a modified version of the vegetation sampling protocol described in Martin et al. (1997) to collect data on 16 environmental variables. Average percent canopy cover was assessed at each plot as a total percentage of leaf cover in the canopy and then averaged across all plots ( $N = 12$ ) for each site. We used an angle gauge (BAF 10) to estimate basal area of canopy trees using a plotless sample (Stoddard and Stoddard 1987) from the four point count center points at each site. We estimated canopy height at each plot ( $N = 12$ ) using either a clinometer or laser range finder. We identified all stems  $> 10$  cm dbh to species and characterized plots according to the most abundant species. This resulted in five nominal categories: pine, cross timbers oak, hickory, oak-hickory, and “other” (included plots where the most abundant species were non-oak-hickory hardwood species). We estimated elevation and slope at each plot with a hand-held GPS unit and clinometer, respectively. We visually estimated percent cover of low ( $< 2$  m) and high ( $> 2$  m) understory cover, and ground cover in grasses forbs, and leaves in each plot.

In addition to site and vegetation data collected from the ground, we characterized forest cover in the local landscape surrounding each site. We used a hand-held GPS unit

to obtain coordinates for the midpoint of each sampling transect. From the midpoint, we created a 1-km buffer in ArcMap 9.2. We overlaid a land-cover layer developed for the Oklahoma Gap Analysis Project (Fisher and Gregory 2001) to identify patches of forest and used Hawth's tools in ArcMap to calculate land-cover metrics within each buffer. For each site, we calculated the percent cover of mature forest, regenerating forest, urban development, and agricultural/herbaceous land within the 1-km buffer.

### Statistical Analysis

We used CANOCO (ter Braak and Smilaur 1988) to explore relationships among bird densities and habitat variables with Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA). Detrended Correspondence Analysis is an ordination technique that can be used for mapping species data along different environmental gradients. It can then be interpreted using known habitat associations and other cues (Kirk and Hobson 2001). Canonical Correspondence Analysis is a multivariate ordination technique for comparing species abundance data with multiple environmental factors (ter Braak 1986). We selected CCA for this analysis because it is an exploratory tool that is robust to analysis with multiple correlated variables (Palmer 1993) and provides a biplot for ease in visualization of relationships (MacFaden and Capen 2002). For the CCA we included 16 environmental variables, of which 11 were continuous and 5 (tree species identifiers) were nominal. With the exception of the rare and declining Cerulean Warbler, we excluded from analysis all species with fewer than 10 detections in the  $150 \times 4 = 600$  total point counts. We ultimately included detection-adjusted abundance and density estimates of 37 species in the DCA and CCA.

We were interested in the overall importance of each of the environmental variables in explaining bird species habitat relationships. To determine the relative importance of the variables, we used forward step-wise selection during the CCA in CANOCO. This process tested individual effects of each of the environmental variables (marginal effects) and the effect that each variable had in addition to the variables that had already been selected (conditional effects) (Leps and Smilauer 2003). To assess deviation from a randomly generated distribution, we applied Monte Carlo estimation (499 permutations) to the forward selection procedure (Leps and Smilauer 2003).

## Results

Sampled sites exhibited a range of forested condition from mature oak-hickory forests on north facing slopes in the Ozark and Ouachita Mountains to bottomland hardwood-cypress forests in extreme southeastern Oklahoma to short rotation pine plantation forestry in McCurtain, Pushmataha, and LeFlore counties. Some sites included forest edges with other land uses (e.g., pasture, residential development) represented. Elevation ranged from 135 m at Beaver's Bend State Park in McCurtain County to 716 m on Lynn Mountain in LeFlore County. Forest cover in each of the buffers varied from 18–100%. In sampled plots, canopy cover ranged from 14–75% and canopy height from 5–22 m.

We encountered 74 species during point counts at 75 sites in 2006. The five most abundant species were Red-eyed Vireo (*Vireo olivaceus*) (416), Indigo Bunting (*Passerina cyanea*) (208), Tufted Titmouse (*Baeolophus bicolor*) (154), Pine Warbler (*Dendroica pinus*) (133), and Carolina Chickadee (*Poecile atricapilla*) (111). In 2007, we encountered 83 species at 75 sites. The five most abundant species were Red-eyed Vireo

(333), Tufted Titmouse (183), Indigo Bunting (150), Northern Cardinal (*Cardinalis cardinalis*) (132), and Blue-gray Gnatcatcher (*Polioptila caerulea*) (100).

#### Detrended Correspondence Analysis

Detrended Correspondence Analysis indicated gradients of species abundance across both axes (Fig. 2). Axis 1 sorted species according to their association with forest cover, with forest species such as Scarlet Tanager (*Piranga olivacea*), Ovenbird, and Cerulean Warbler on the left grading to grassland and shrubland species such as Eastern Meadowlark (*Sturnella magna*) and Field Sparrow (*Spizella pusilla*) on the right. Axis 2 was not readily interpretable but may have been associated with moisture (e.g. soil moisture or relative humidity). A group of species associated with the larger trees and more mesic forests of riparian habitats such as Yellow-throated Warbler (*Dendroica dominica*), Acadian Flycatcher, and Kentucky Warbler occurred at the top left of the DCA, while a group more closely associated with more xeric habitats such as Yellow-breasted Chat (*Icteria virens*) and Prairie Warbler (*Dendroica discolor*) occur on the bottom right.

#### Canonical Correspondence Analysis

Canonical Correspondence Analysis indicated that 26% of the variance in species abundance was explained by 16 environmental variables. Eleven of those variables, representing a mix of site- and plot-scale vegetation structure, produced significant conditional effects (Table 3). Tree canopy cover explained a greater proportion of the variance in forest bird abundance than any other variable.

The CCA biplot (Fig. 3) illustrated primary axes related to gradients of forest cover and moisture. Species such as Ovenbird, Hooded Warbler, Cerulean Warbler, and

Scarlet Tanager tended to co-occur and were associated positively with elevation and forest cover. In contrast, Yellow-breasted Chat, Prairie Warbler, and Common Yellowthroat were associated positively with grass and herbaceous cover. The cluster of Prothonotary Warbler, Swainson's Warbler, Kentucky Warbler, Acadian Flycatcher, Yellow-throated Warbler, and Northern Parula was associated with bottomland hardwood forests, which tended to exhibit high plot-scale canopy cover and the highest canopy heights (> 20 m) of any sites surveyed.

### Discussion

To examine differences or similarities between select species of forest species at the edge of their respective ranges in Oklahoma compared with other areas, we examined densities of singing/territorial males between our sites and those found in the literature. We compared densities of four species of concern in Oklahoma; Kentucky Warbler, Worm-eating Warbler, Swainson's Warbler (*Limnothlypis swainsonii*), Hooded Warbler and another species that reaches the limit of its range in eastern Oklahoma, the Scarlet Tanager, with densities reported in the literature from other areas.

In general, we found that our densities were comparable to those found in other parts of these species ranges. Our calculated density for Worm-eating Warbler was 4.4 singing males/40 ha (1.1/10 ha), which was higher than the 3.1 males/40 ha calculated for the species in Illinois but lower than the 2.2 males/10 ha reported in Maryland (Hanners et al 1998). Our calculated density for Hooded Warbler was 0.2 males/ha, which was within the range of densities reported from both New York (0.1 - 0.3 males/ha) and Ontario (0.1 - 0.3 males/ha). It was lower than the numbers reported in Pennsylvania (0.4 - 0.7 males/ha) and Maryland (0.2 males/ha) (Ogden and Stuchberry

1994). We calculated a density for Kentucky Warbler of 1.8 males/10 ha, this falls within the range reported from Missouri of 0.9 – 1.8 males/10 ha (McDonald 1998). Our calculated density for Swainson's Warbler was 5.1 males/40 ha, within the range of a study of Swainson's Warbler densities between different habitat types, being higher than the 3.0/40 ha in mature oak-gum-cypress forest but lower than the 8.8/40 ha and 17.0/40 ha in cove hardwood forest and sapling oak-gum-cypress forest, respectively (Brown and Dickson 1994). Of the species we examined, only the breeding density of Scarlet Tanager was consistently lower than other examples in the literature. Our estimate of 1.6 males/10 ha was lower than the 4.2 males/10 ha in New Hampshire and 5.2 males/10 ha in West Virginia, though it approached densities in New York, 1.8 – 3.0 males/10 ha and in Illinois, 1.7 - 3.8 males/10 ha (Mowbray 1999).

Those comparisons indicate that, at least within appropriate habitat, neotropical forest songbirds in Oklahoma occur in similar breeding densities to similar habitats near the core areas of these species' distributions. This result is contrary to the prediction (Lomolino et al. 2006) that abundance within a species' distribution exhibits internal structure such that peripheral areas function as population sinks (Pulliam 1988). Future research on forest birds in Oklahoma should focus on features of demographics (e.g., reproductive success, annual variability in abundance, site fidelity) that would inform interpretations of these populations as sources or sinks.

Partners in Flight has developed a Bird Conservation Plan for the Ozark/Ouachitas with a list of conservation priority species for the region (Fitzgerald and Pashley 2000). Our study provides information about bird habitat relationships that has management implications for a number of these species. For example, several species in



this region have strong relationships with high-elevation forests. Some of these species such as the Cerulean Warbler, Ovenbirds, and Worm-eating Warbler are considered high conservation priorities for this region. Our results indicate that in eastern Oklahoma, the combination of high forest cover and high elevation is an important predictor of the occurrence and abundance of these species. Integrated management for PIF conservation priorities in the region should reflect this relationship, and we recommend maintaining large blocks of contiguous, mature forest at the highest elevations.

Our findings draw attention to concern that global warming could impact the future ranges of bird species in this region. These high-elevation species are found in areas that are comparatively cool and moist compared with surrounding lowland areas. These conditions maintain mesic forests that are more commonly found farther east and north where conditions are cooler and wetter. Such mature mesic forests support these high-priority songbirds. Some global warming forecasts predict that Oklahoma will be warmer and drier in the future (American Bird Conservancy 2006). This could alter conditions responsible for the growth of high-elevation mature mesic forests in Oklahoma and in turn eliminate some of these high-elevation bird species in the State (American Bird Conservancy 2006).

In contrast to the high elevation warblers, occurrence and abundance of Kentucky Warbler and Acadian Flycatcher, also high priority species for this region, was positively associated with canopy height and canopy closure but negatively associated with elevation. They also had a strong relationship with an increasing moisture gradient, suggesting their need for low-elevation mature deciduous forests, such as those found in bottomlands.

Our study area in eastern Oklahoma contained diverse forested landscapes in the Ozark and Ouachita mountains. Presence of contiguous areas of mature forest appears to be the most important factor driving habitat use by multiple conservation priority songbirds in this region of Oklahoma. The areas supporting the highest breeding density of specific priority species can be further characterized as forested landscapes at high elevations and in bottomlands. These two ends of an elevational gradient in the region should be the top priorities for maintenance of large blocks of tall, closed canopy hardwood forest.

#### Acknowledgements

Financial support for this project was provided from State Wildlife Grants under Project T-31-P-1 of the Oklahoma Department of Wildlife Conservation and Oklahoma State University and administered through the Oklahoma Cooperative Fish and Wildlife Research Unit (Oklahoma Department of Wildlife Conservation, Oklahoma State University, United States Geological Survey, and Wildlife Management Institute cooperating). Additional support was provided by the Payne County Audubon Society. Particular thanks go to field assistants Jason Heinen, Jim Taulman and Allysa Lapine. Dan McGlenn and Mike Palmer provided helpful assistance on using canonical correspondence analysis.

## Literature Cited

- American Bird Conservancy. 2006. Global warming and songbirds:Oklahoma. <http://www.abcbirds.org/newsandreports/globalwarming/Oklahoma.pdf>. Accessed July 20, 2007.
- Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. U.S. Geological Survey professional paper; 964.
- Beissinger, S. R., J. M. Reed, J. M. Wunderle, Jr., S. K. Robinson, and D. M. Finch. 2000. Report of the AOU conservation committee on the Partners in Flight species prioritization plan. *Auk* 117:549-561.
- Bonney, R., D. N. Pashley, R. Cooper, and L. Niles, editors. 1999. Strategies for bird conservation: The Partners in Flight planning process. Cornell Laboratory of Ornithology. [online] URL: <http://birds.cornell.edu/pifcapemay>.
- Brown, R. E. and J. G. Dickson. 1994. Swainson's Warbler (*Limnothlypis swainsonii*), The Birds of North America Online (A. Poole, Ed.). Ithaca.
- Brye, K.R., C.P. West, and E.E. Gbur. 2004. Soil quality differences under native tallgrass prairie across a climosequence in Arkansas. *The American Midland Naturalist* 152:214-230.
- Carter, M. F., W. C. Hunter, D. N. Pashley, and K. V. Rosenberg. 2000. Setting conservation priorities in the United States: the Partners in Flight approach. *Auk* 117:541-548.
- Chipley, R.M., G.H. Fenwick, M.J. Parr, and D.N. Pashley. 2003. The American bird conservancy guide to the 500 most important bird areas in the United States. Random House, New York.
- Farnsworth, G.L., K.H. Pollock, J.D. Nichols, T.R. Simmons, J.E. Hines, and J.R. Sauer. 2002. A removal model for estimating detection probabilities from point-count survey. *Auk* 119:414-425
- Fisher, W.L., and M.S. Gregory. 2001. Oklahoma Gap Analysis Project. Final Report to the Oklahoma Cooperative Fish and Wildlife Research Unit. Oklahoma State University, Stillwater.

- Fitzgerald, J.A., and D.N. Pashley. 2000. Partners in Flight Bird conservation plan for The Ozark/Ouachitas (Physiographic Area 19).
- Freemark, K.E., and B. Collins. 1992. Landscape ecology of birds breeding in temperate forest fragments. Pages 443-454 in Ecology and Conservation of Neotropical Migrant Landbirds (J.M. Hagan III and D.W. Johnston, Eds.). Smithsonian Institution Press, Washington, D.C.
- Freemark, K.E., J.B. Dunning, S.J. Hejl, and J.R. Probst. 1995. A landscape ecology perspective for research, conservation, and management. Pages 381-427 in Ecology and Management of Neotropical Migratory Birds (T.E. Martin and D.M. Finch, Eds.). Oxford University Press, New York.
- Galli, A.E., C.F. Leck and R.T.T. Forman. 1976. Avian distribution patterns in forest islands of different sizes in central New Jersey. *Auk* 93:356-364.
- Hagan, J. M. and A. L. Meehan. 2002. The effectiveness of stand-level and landscape-level variables for explaining bird occurrence in an industrial forest. *Forest Science* 48:231-242.
- Hall, G. A. 1984. Population decline of neotropical migrants in an Appalachian forest. *American Birds* 38:14-18.
- Hanners, Lise A. and Stephen R. Patton. 1998. Worm-eating Warbler (*Helmintheros vermivorum*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology.
- Holmes, R.T., and T.W. Sherry. 1988. Assessing population trends of New Hampshire forest birds: local vs. regional patterns. *Auk* 105:756-768.
- Hoover, J.P., M.C. Brittingham, and L.J. Goodrich. 1995. Effects of forest patch size on nesting success of Wood Thrushes. *Auk* 112:146-155.
- Hutto, R.L., S.M Pletschet, and P. Hendricks. 1986. A fixed-radius point count method for nonbreeding and breeding Season Use. *Auk* 103:593-602.
- Kirk, D.A., and K.A. Hobson. 2001. Bird-habitat relationships in jack pine boreal forests. *Forest Ecology and Management* 147:217-243.

- Lee, M., L. Fahrig, K. Freemark, and D.J. Currie. 2002. Importance of patch scale vs. landscape scale on selected forest birds. *Oikos* 96:110-118.
- Leps, J., and P. Similaur. 2003. *Multivariate analysis of ecological data using CANOCO*. Cambridge University, Cambridge.
- Lomolino, M. V., B. R. Riddle, J. H. Brown. 2006. *Biogeography* (3<sup>rd</sup> ed.) Sinauer Associates, Inc. Sunderland.
- Lynch, J. F., and D. F. Whigham. 1984. Effects of forest fragmentation on breeding bird communities in Maryland, USA. *Biological Conservation* 28:287-324.
- MacFaden, S.W., and D.E. Capen. 2001. Avian habitat relationships at multiple scales in a New England Forest. *Forest Science* 48:243-253.
- Martin, T. E., C. Paine, C. J. Conway, W. M. Hochachka, P. Allen, and W. Jenkins. 1997. BBIRD: field monitoring protocols. Technical report, USGS Biological Resources Division, Montana Cooperative Wildlife Research Unit, University of Montana, Missoula.
- McDonald, Mary Victoria. 1998. Kentucky Warbler (*Oporornis formosus*), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology.
- Mowbray, Thomas B. 1999. Scarlet Tanager (*Piranga olivacea*), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology.
- Nagy, L. R. and R. T. Holmes. 2005. Food limits annual fecundity of a migratory songbird: an experimental study. *Ecology* 86: 675-681.
- O'Connell, T. J., L. E. Jackson, and R. P. Brooks. 2000. Bird guilds as indicators of ecological condition in the central Appalachians. *Ecological Applications* 10:1706-1721.
- Ogden, L. J. and B. J. Stutchbury. 1994. Hooded Warbler (*Wilsonia citrina*), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology.
- Palmer, M.W. 1993. Putting things in even better order: The advantages of canonical correspondence analysis. *Ecology* 74:2215-2230.

- Pulliam, H. R. 1988. Sources, sinks, and population regulation. *American Naturalist* 132:652-661.
- Rafferty, M.D. and J.C. Catau. 1991. *The Ouachita Mountains, a guide for fisherman, hunters, and travelers.* University of Oklahoma, Norman.
- Ralph, C.J., J.R. Sauer, and S. Droege, technical editors. 1995. *Monitoring bird populations by point counts.* General Technical Report PSW-GTR-149. Albany, CA: Pacific U.S. Forest Service Southwest Research Station.
- Reinking, D. 2004. *Oklahoma Breeding Bird Atlas.* University of Oklahoma Press, Norman.
- Rich, T.D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, E.E. Inigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt, and T.C. Will. 2004. *Partners in Flight North American Landbird Conservation Plan.* Cornell Lab of Ornithology. Ithaca.
- Robbins, C.S., J.R. Sauer, R.S. Greenberg, and S. Droege. 1989. Population declines in North American Birds that migrate to the neotropics. *Proc. Natl. Acad. Sci.* 86:7658-7662.
- Rodewald, A. D. 2002. Nest predation in forested regions: Landscape and edge effects. *Journal of Wildlife Management* 66:634-640.
- Rodewald, A. D. 2003. The importance of land uses within the landscape matrix. *Wildlife Society Bulletin* 31:586-592.
- Rodewald, A. D. and R. H. Yahner. 2000. Influence of landscape and habitat characteristics on Ovenbird pairing success. *Wilson Bulletin* 112:238-242.
- Rotenberry, J. T., R. J. Cooper, J. M. Wunderle, and K. G. Smith. 1995. When and how are populations limited? The roles of insect outbreaks, fire, and other natural perturbations. Pages 55-84 *in* T. E. Martin and D. M. Finch, editors. *Ecology and Management of Neotropical Migratory Birds.* Oxford University Press, NY.
- Stoddard, C. H. and G. M. Stoddard. 1987. *Essentials of forestry practice.* 4<sup>th</sup> Ed. John Wiley & Sons, New York. 407 p.
- ter Braak, C.J.F. 1986. Canonical Correspondence Analysis: A new eigenvector technique for multivariate direct analysis. *Ecology* 67:1167-1179.

ter Braak, C.J.F., Smilauer, P., 1998. CANOCO reference manual and user's guide to Canoco for Windows. Software for Community Ordination, Version 4. Microcomputer Power, Ithaca, NY.

Trine, C. L. 1998. Wood Thrush population sinks and implications for the scale of regional conservation strategies. *Conservation Biology* 12:576-585.

Whitcomb, R. F., S. S. Robbins, J. F. Lynch, B. L. Whitcomb, M. K. Klimkiewicz, and D. Bystrak. 1981. Effects of forest fragmentation on avifauna of the eastern deciduous forest. Pages 125-205 *in* R. L. Burgess and D. M. Sharpe, editors. *Forest Island Dynamics in Man-Dominated Landscapes*. Springer, New York.

**Table 2. Plot- and site-level environmental variable included in the CCA.**

<b>Environmental variable</b>	<b>Abbreviation</b>
Average percent canopy cover	Av Pr CC
Basal area	BASAR
Canopy height	Canht
Cross timber oak forest	cross
Elevation	elev
Hickory forest	hick
Oak-hickory forest	oakhick
Other type of hardwood forest	other
Percent forest cover	per Fc
Percent grass ground cover	pergrco
Percent herbaceous ground cover	perheco
Percent high understory cover	hunco
Percent leaf ground cover	perleco
Percent low understory cover	pr lunco
Pine	pine
Slope	slope

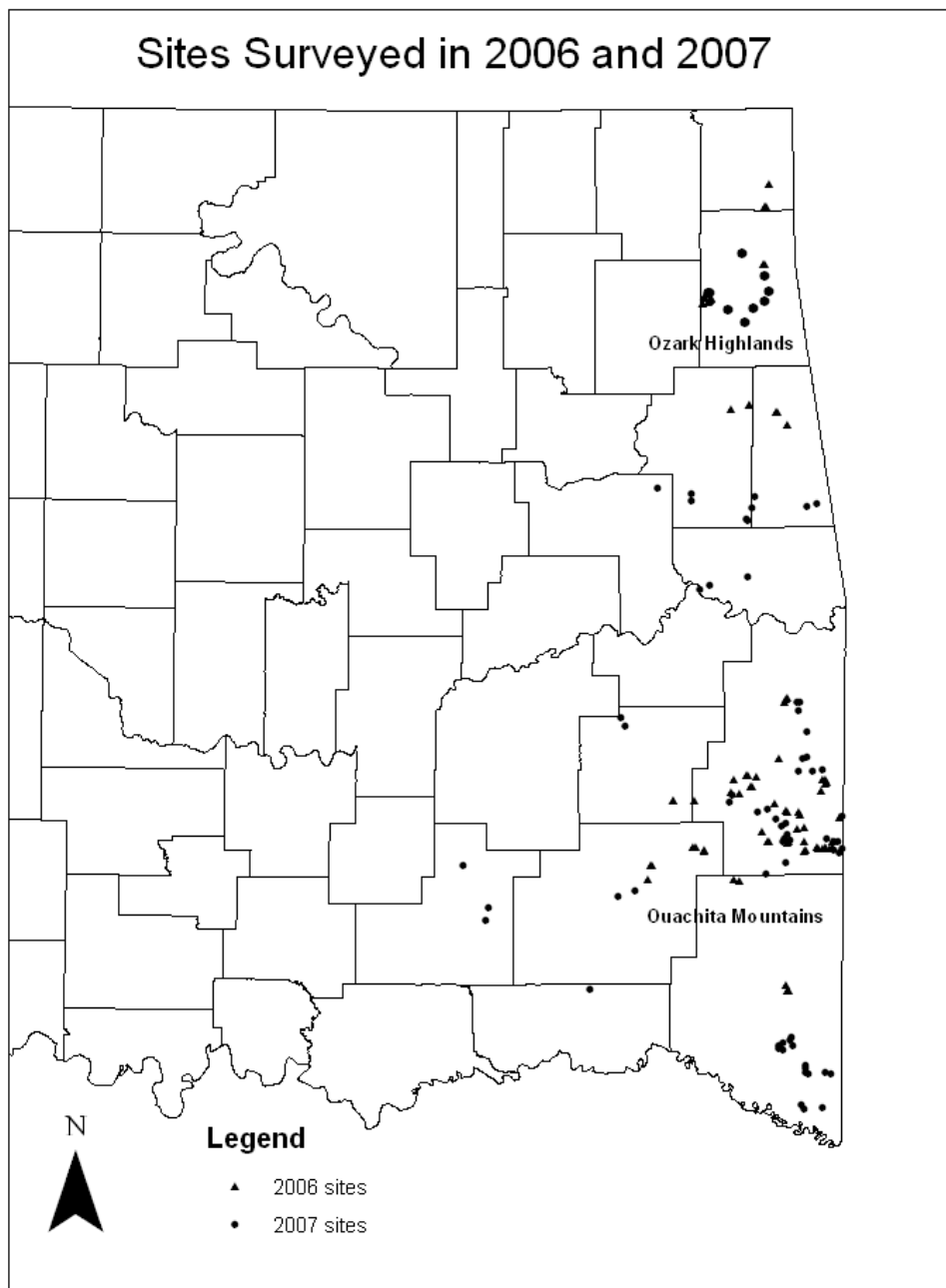


**Table 3. List of 40 species included in the CCA in descending order from most detections to least.**

<b>Species</b>	<b>Scientific Name</b>	
Red-eyed Vireo	<i>Vireo olivaceus</i>	REVI
Indigo Bunting	<i>Passerina cyanea</i>	INBU
Tufted Titmouse	<i>Baeolophys bicolor</i>	TUTI
Pine Warbler	<i>Dendroica pinus</i>	PIWA
Carolina Chickadee	<i>Poecile atricapilla</i>	CACH
Ovenbird	<i>Seiurus aurocapillus</i>	OVEN
Summer Tanager	<i>Piranga rubra</i>	SUTA
Black-and-White Warbler	<i>Mniotilta varia</i>	BAWW
Carolina Wren	<i>Thryothorus ludovicianus</i>	CARW
Northern Cardinal	<i>Cardinalis cardinalis</i>	NOCA
Blue-gray gnatcatcher	<i>Poliophtilla caerulea</i>	BGGN
Yellow-breasted Chat	<i>Icteria virens</i>	YBCH
Northern Parula	<i>Parula americana</i>	NOPA
Scarlet Tanager	<i>Piranga olivacea</i>	SCTA
Eastern Wood-pewee	<i>Contopus virens</i>	EWPE
White-eyed Vireo	<i>Vireo griseus</i>	WEVI
Kentucky Warbler	<i>Oporornis formosus</i>	KEWA
Acadian Flycatcher	<i>Empidonax virescens</i>	ACFL
White-breasted Nuthatch	<i>Sitta carolinensis</i>	WBNU
Prairie Warbler	<i>Dendroica discolor</i>	PRWA
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>	RBWO
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	YBCU
Common Yellowthroat	<i>Geothlypis trichas</i>	COYE
Hooded Warbler	<i>Wilsonia citrina</i>	HOWA
Field Sparrow	<i>Spizella pusilla</i>	FISP
Brown-headed Cowbird	<i>Molothrus ater</i>	BHCO
Northern Bobwhite	<i>Colinus virginianus</i>	NOBO
Yellow-throated Warbler	<i>Dendroica dominica</i>	YTWA
American Goldfinch	<i>Carduelis tristis</i>	AMGO
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	GCFL
Blue Jay	<i>Cyanocitta cristata</i>	BLJA
Pileated Woodpecker	<i>Dryocopus pileatus</i>	PIWO
Downy Woodpecker	<i>Picoides pubescens</i>	DOWO
Chipping Sparrow	<i>Spizella passerina</i>	CHSP
Eastern Meadowlark	<i>Sturnella magna</i>	EAME
Worm-eating Warbler	<i>Helmitheros vermivora</i>	WEWA
Louisiana Waterthrush	<i>Seiurus motacilla</i>	LOWA
Prothonotary Warbler	<i>Protonotaria citria</i>	PROW
Swainson's Warbler	<i>Limnothlypis swainsonii</i>	SWWA
Cerulean Warbler	<i>Dendroica cerulea</i>	CERW

**Table 4– Conditional effects from Monte Carlo estimation of forward selection in CCA. The CCA explained 26 percent of total variance in abundance of 40 bird species.**

<b>Variable</b>	<b>Order in model</b>	<b>Eigenvalue</b>	<b>F</b>	<b>P</b>	<b>Explained variance (%)</b>
% Canopy Cover	1	0.24	12.72	0.002	26
Elevation (m)	5	0.16	8.93	0.002	17
% Grass Cover	13	0.09	5.26	0.002	10
% Pine overstory	6	0.08	4.46	0.002	9
% Shrub cover (< 2m)	3	0.07	4.14	0.002	8
% Forest cover	2	0.04	2.86	0.004	4
% Leaf litter cover	15	0.05	3.03	0.002	5
% Other sp. overstory	10	0.05	2.67	0.002	5
Basal area (m <sup>2</sup> /plot)	16	0.03	2.34	0.004	3
% Shrub cover (> 2m)	4	0.04	2.23	0.002	4
% Mean slope	11	0.02	1.28	0.15	2
% Oak-Hick overstory	8	0.02	1.19	0.216	2
% Cross-timb overstory	7	0.03	2.18	0.006	3
% Hickory overstory	9	0.03	2.05	0.004	3
% Herbaceous cover	14	0.02	1.21	0.172	2
Canopy height (m)	12	0.02	1.03	0.32	2



**Figure 6. Map of the study area in Eastern Oklahoma.**

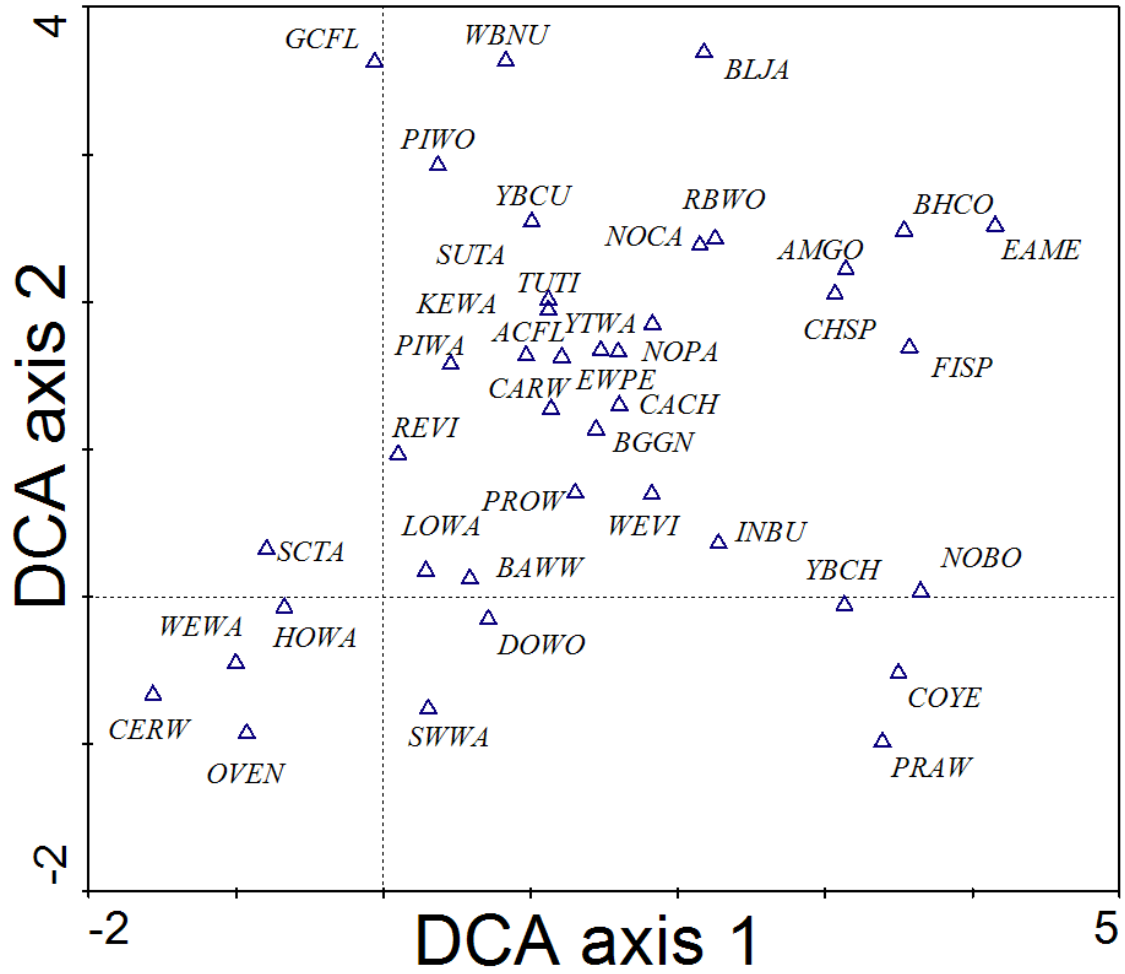


Figure 7. Biplot of bird species abundance data (alpha codes for species names in Table 3).+

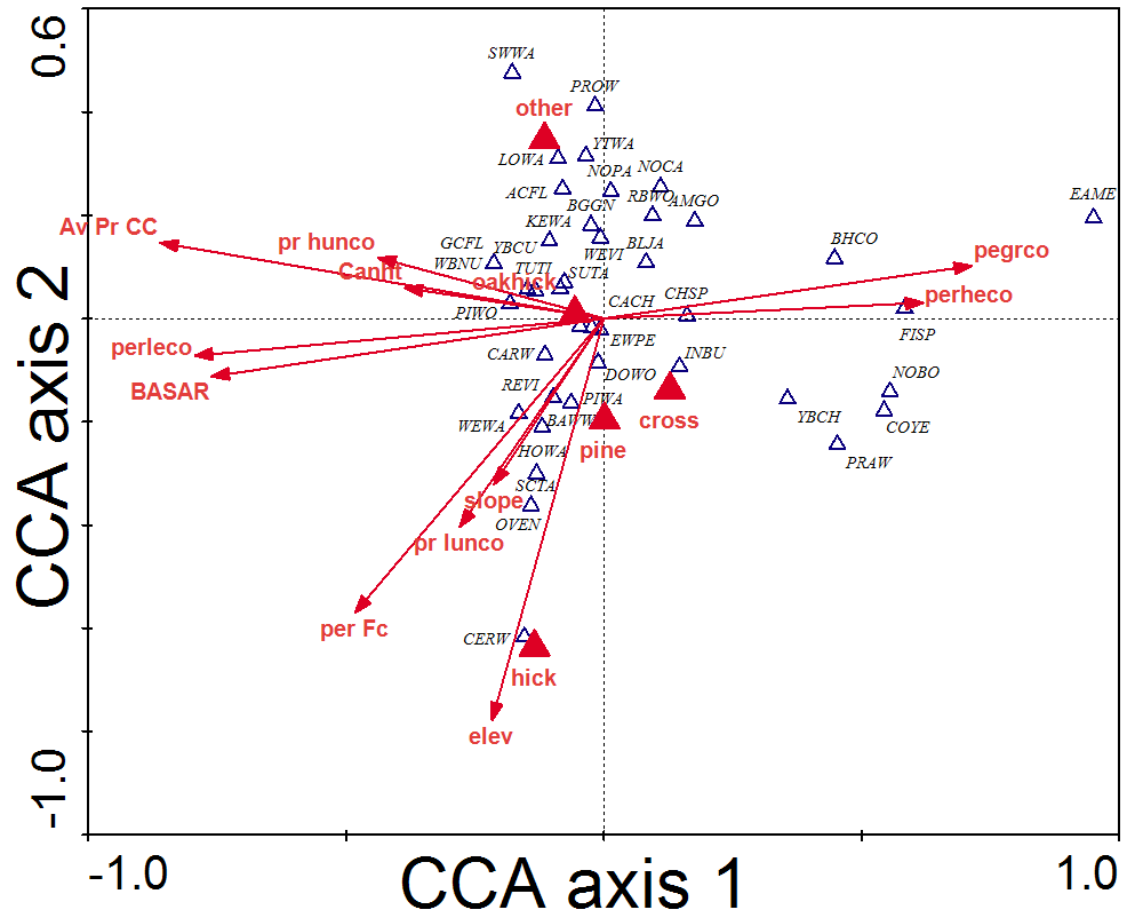


Figure 8. Biplot of ordination between bird species abundance and 16 environmental variables (abbreviations for environmental variables are listed in Table 2).

## APPENDICES

## Appendix I.

Information about each of our surveyed sites: Each site description includes a site name, GPS coordinates given in UTM, a brief site description giving more specific location information and a general description of land cover type, and finally a table with the species and count for each species seen or heard doing point counts at each site.

### Site Information

#### Site 2006 - 1

GPS Location: 0322187 3852247

Site Description: Mature hillside oak-hickory and pine mixed forest in the Ouachita National Forest north of Talihena in LeFlore County.

Bird Survey Results:

BAWW	1
BLJA	3
GCFL	1
INBU	2
NOBO	1
NOCA	2
NOFL	2
PIWA	4
REVI	9
SUTA	4
TUTI	4
WBNU	1
YBCU	1

**Site 2006 – 2**

GPS Location: 0326023 3850186

Site Description: South facing slope of Winding Stair Mountain in the Ouachita National Forest, LeFlore County. Principally mature pine and “cross-timber” oak forest.

Bird Survey Results:

BAWW	4
BLJA	2
CACH	2
CHSP	1
EATO	1
INBU	1
NOCA	1
OVEN	3
REVI	8
SCTA	2
TUTI	3

**Site 2006 – 3**

GPS Location: 0328763 3849377

Site Description: North facing slope of Winding Stair Mountain in the Ouachita National Forest, LeFlore County. Principally mature oak-hickory forest but some pine component as well.

Bird Survey Results:

BGGN	2
CARW	2
DOWO	1
GCFL	1
INBU	5
NOBO	1
OVEN	4
PIWA	3
REVI	5
SCTA	2
TUTI	1
WEVI	1



**Site 2006 – 4**

GPS Location: 0342043 3845366

Site Description: North facing slope of Winding Stair Mountain in the Ouachita National Forest, LeFlore County. Principally mature oak-hickory forest but some pine component as well.

Bird Survey Results:

BAWW	1
CHSP	1
DOWO	1
REVI	7

**Site 2006 – 5**

GPS Location: 0346215 3842533

Site Description: North facing slope of Winding Stair Mountain in the Ouachita National Forest, LeFlore County. Principally mature oak-hickory forest but some pine component as well.

Bird Survey Results:

CACH	2
CARW	1
FICR	1
OVEN	5
PIWA	2
REVI	3
SCTA	1

**Site 2006 – 6**

GPS Location: 0346111 3842787

Site Description: South facing slope of Winding Stair Mountain in the Ouachita National Forest, LeFlore County. This site is mainly mature pine.

Bird Survey Results:

BAWW	3
CACH	1
OVEN	2
PIWA	2
REVI	9
SCTA	2

**Site 2006 – 7**

GPS Location: 0365714 3839641

Site Description: This site is located on the south slope of Rich Mountain, very close to the Arkansas border in LeFlore County. Although it is a south slope this location is one of the wettest in all of Oklahoma and is dominated by mature oak-hickory and Black Gum forest.

**Bird Survey Results:**

BAWW	4
BLJA	3
CARW	1
INBU	1
NOCA	1
OVEN	4
PIWA	1
PIWO	1
RBGR	4
REVI	8
SCTA	2
TUTI	1
WOTH	1

**Site 2006 – 8**

GPS Location: 0336881 3835449

Site Description: Mature bottomland forest along a small creek south of the Kiamichi River in LeFlore County; composed principally of Sycamore, Bitternut Hickory, Sugar Maple and Sweet Gum.

**Bird Survey Results:**

BAWW	2
BGGN	5
BTNW	1
HOWA	1
KEWA	2
LOWA	1
NOCA	2
RBWO	1
REVI	9
SUTA	3
TUTI	3
WAVI	1
WBNU	1
WEVI	1
WEWA	1

**Site 2006 – 9**

GPS Location: 0349846 3836280

Site Description: This site is located in the Ouachita National Forest in the valley between Rich Mountain to the north and the Kiamichi Ridge to the south in LeFlore County. It is primarily mature Short-leaf Pine with some oak-hickory

Bird Survey Results:

BAWW	2
INBU	2
OVEN	4
PIWA	7
REVI	10
SUTA	2
TUTI	1

**Site 2006 – 10**

GPS Location: 0327277 3854845

Site Description: This site is located in the Ouachita National Forest in what is known locally as the "Holson Valley" in LeFlore County. This site is dominated by mature Short-leaf Pine with a smaller component of "cross-timbers" oaks.

Bird Survey Results:

AMRO	1
BAWW	1
CARW	1
DOWO	1
INBU	1
NOCA	1
OVEN	4
PIWA	8
RBWO	1
REVI	6
SUTA	4

**Site 2006 – 11**

GPS Location: 0351408 3841109

Site Description: This site is located within the Robert S. Kerr Botanical Reserve within the Ouachita National Forest, located between Rich Mountain and Winding Stair Mountain in LeFlore County. It is a mature mixed Black Gum, oak-hickory and pine forest.

Bird Survey Results:

CACH	4
CEDW	2
LEFL	1
OVEN	3
PIWA	3
RBGR	2
REVI	8
SUTA	2
TUTI	1

**Site 2006 – 12**

GPS Location: 0350159 3842150

Site Description: This site is located in the Ouachita National Forest in LeFlore County and is composed mostly of mature Short-leaf Pine.

Bird Survey Results:

BLJA	2
CACH	1
CARW	1
CEDW	1
DOWO	1
HOWA	1
OVEN	3
PIWA	6
REVI	4
SCTA	1
SUTA	1

**Site 2006 – 13**

GPS Location: 0344182 3861504

Site Description: This site is located on the Wister WMA in LeFlore County. In low areas this site is dominated by Sweet Gum and White Oak, while in drier areas it is primarily composed of cross-timbers oaks.

**Bird Survey Results:**

ACFL	3
BAOW	1
BGGN	5
CACH	1
COYE	1
EWPE	1
FISP	3
INBU	5
KEWA	1
LOWA	1
NOCA	6
PIWO	2
RBWO	1
REVI	2
SUTA	2
TUTI	3
WEVI	1
WODU	1
YBCH	2
YBCU	1

**Site 2006 – 14**

GPS Location: 0344502 3777815

Site Description: This site is located in Beaver's Bend State Park in McCurtain County and is heavily covered in mature pine forest, with smaller amounts of oak-hickory forests.

Bird Survey Results:

AMGO	1
BAWW	3
BGGN	2
CACH	6
CARW	1
GCFL	1
PIWA	6
PIWO	1
REVI	5
SUTA	4
TUTI	4
WEWA	1

**Site 2006 – 15**

GPS Location: 0345198 3777843

Site Description: This is another site located within Beaver's Bend State Park in McCurtain County, this site however is a more even mix of Short-leaf Pine and hardwood species such as Sweet Gum, White Oak and Mockernut Hickory

Bird Survey Results:

BGGN	5
CACH	5
INBU	2
KEWA	1
NOPA	4
PIWA	2
REVI	4
SUTA	2
TUTI	3
WBNU	1
WEWA	1

**Site 2006 – 16**

GPS Location: 0343940 3779614

Site Description: The final site surveyed at Beaver's Bend State Park in McCurtain County. This site was more heavily dominated by Short-leaf Pine with smaller amounts of hardwood species. It should be noted that proximity to the Mountain Fork River made it difficult to hear birds singing during surveys.

Bird Survey Results:

BWWA	1
CARW	3
NOPA	3
REVI	9

**Site 2006 – 17**

GPS Location: 0327038 3818551

Site Description: This site located in northwest McCurtain County, is composed almost entirely of pine but is relatively open and savannah like.

Bird Survey Results:

BAWW	2
CARW	2
COYE	3
FISP	1
GCFL	1
INBU	5
OVEN	3
PIWA	5
PRAW	5
REVI	2
SUTA	2
YBCH	3
YBCU	1

**Site 2006 – 18**

GPS Location: 0328225 3817622

Site Description: This site located on the north slope of a smaller mountain in northwest McCurtain County is primarily mature Oak-hickory forest with smaller amounts of Sugar Maple and pine. There was is a nearby clear-cut that was in part of the count circle.

**Bird Survey Results:**

ACFL	1
BAWW	5
BGGN	3
CACH	3
CARW	2
FISP	1
HOWA	3
INBU	2
KEWA	1
NOBO	1
NOCA	4
NOPA	1
OVEN	1
PIWA	1
PRAW	1
REVI	5
TUTI	1
WEVI	2
YBCH	2
YBCU	1



**Site 2006 – 19**

GPS Location: 0357298 3828952

Site Description: This site is located on the north slope of Lynn Mountain in LeFlore County. It is composed of mature oak-hickory forest with no pine component on a very steep slope.

**Bird Survey Results:**

ACFL	1
BAWW	2
BGGN	1
CACH	2
CARW	2
CERW	2
DOWO	1
EWPE	5
HAWO	1
HOWA	4
INBU	2
NOFL	1
OVEN	10
REVI	8
SCTA	2
TUTI	2
YBCH	1

**Site 2006 – 20**

GPS Location: 0357495 3828956

Site Description: This site is located on the north slope of Lynn Mountain in LeFlore County. It is composed of mature oak-hickory forest with no pine component on a very steep slope.

**Bird Survey Results:**

BAWW	1
BTNW	1
CACH	3
CARW	2
CERW	1
COYE	1
EWPE	4
GRCA	1
HOWA	2
INBU	4
OVEN	4
REVI	6
SUTA	1
TUTI	2
WBNU	2
WEVI	1
YBCH	3

**Site 2006 – 21**

GPS Location: 0362533 3829195

Site Description: This site is located in a valley between Lynn Mountain to the west and Cow Creek Mountain to the east in LeFlore County. It is a mature mixed pine-hardwood forest with a fairly even component of pine and hardwood species like White Oak, Post Oak and Sweet Gum.

Bird Survey Results:

ACFL	2
AMGO	3
BGGN	4
BHCO	1
CACH	2
CARW	1
EWPE	1
FISP	1
INBU	3
KEWA	1
NOCA	2
NOPA	2
PRAW	1
REVI	1
SCTA	1
SUTA	1
TUTI	3
WEVI	3
YBCH	4

**Site 2006 – 22**

GPS Location: 0362559 3831324

Site Description: This site is located on the north face of Cow Creek Mountain in eastern LeFlore County. It is composed primarily of hardwood species like Black Walnut, White Oak and Black Gum.

Bird Survey Results:

BAWW	1
HOWA	1
INBU	5
NOBO	2
OVEN	3
REVI	10
SCTA	3
TUTI	6
WEVI	1
WEWA	1

**Site 2006 – 23**

GPS Location: 0360307 3853751

Site Description: This site located on Walker Mountain in eastern LeFlore County is composed mostly of mature pine-oak forest.

Bird Survey Results:

BAWW	2
BGGN	1
CACH	2
INBU	4
PIWA	3
PRAW	1
REVI	5
SUTA	3
YBCH	2
YBCU	2

**Site 2006 – 24**

GPS Location: 0359961 3853702

Site Description: This site located on Walker Mountain in eastern LeFlore County is composed mostly of mature pine-oak forest.

Bird Survey Results:

AMCR	1
BAWW	3
CARW	2
EWPE	2
GCFL	1
INBU	3
PIWA	7
PIWO	2
PRAW	3
REVI	3
SUTA	1
TUTI	1
YBCH	1
YBCU	1

**Site 2006 – 25**

GPS Location: 0360795 3852596

Site Description: This site located south of Hontubby in eastern LeFlore County, is composed primarily of mature pine-oak forest.

Bird Survey Results:

BAWW	4
BGGN	1
CACH	3
GCFL	1
INBU	3
KEWA	1
OVEN	1
PIWA	3
PIWO	1
PRAW	3
REVI	7
RTHU	1
SUTA	1
TUTI	2
WEVI	1
YBCH	4
YBCU	1

**Site 2006 – 26**

GPS Location: 0346560 3831365

Site Description: This site located near the ridge line on Kiamichi Mountain in southern LeFlore County is a mixed forest composed of stunted oak-hickory and a smaller amount of mature pine.

Bird Survey Results:

BGGN	2
CARW	2
DOWO	1
GCFL	1
INBU	5
NOBO	1
OVEN	4
PIWA	3
REVI	5
SCTA	2
TUTI	1
WEVI	1

**Site 2006 – 27**

GPS Location: 0346436 3831267

Site Description: This site located near the ridge line on Kiamichi Mountain in southern LeFlore County is a mixed forest composed of stunted oak-hickory and a smaller amount of mature pine.

Bird Survey Results:

BAWW	1
CARW	1
HOWA	2
INBU	2
OVEN	3
PIWA	1
REVI	5
SCTA	1
YBCU	1

**Site 2006 – 28**

GPS Location: 0339119 3831873

Site Description: This site located near the ridge line on Kiamichi Mountain in southern LeFlore County is a mixed forest composed of stunted oak-hickory and a smaller amount of mature pine.

Bird Survey Results:

ACFL	1
BAWW	1
CACH	1
COYE	2
INBU	4
OVEN	2
REVI	7
SCTA	2
TUTI	2

**Site 2006 – 29**

GPS Location: 0339395 3831850

Site Description: This site located near the ridge line on Kiamichi Mountain in southern LeFlore County is a mixed forest composed of stunted oak-hickory and a smaller amount of mature pine.

Bird Survey Results:

BAWW	3
CARW	1
COYE	1
INBU	3
OVEN	2
REVI	7
SCTA	1

**Site 2006 – 30**

GPS Location: 0304873 3847566

Site Description: This site is located on Buffalo Mountain in eastern Latimer County. It is composed primarily of oak-hickory forest with smaller amounts of pine.

Bird Survey Results:

BAWW	2
BHCO	1
BLJA	1
CACH	7
GCFL	1
INBU	3
MODO	3
PRAW	1
REVI	5
SCTA	1
SUTA	2
TUTI	2
YBCU	2

**Site 2006 – 31**

GPS Location: 0304879 3847749

Site Description: This site is located on Buffalo Mountain in eastern Latimer County. It is composed primarily of oak-hickory forest with smaller amounts of pine.

**Bird Survey Results:**

BAWW	2
BHCO	1
BLJA	1
CARW	3
DOWO	1
INBU	2
OVEN	1
PIWO	1
RBGR	1
REVI	10
SCTA	2
SUTA	1
WBNU	1
YBCU	1



**Site 2006 – 32**

GPS Location: 0312390 3847150

Site Description: This site is actually within the municipality of Talihena, LeFlore County. It consists of suburban backyard habitats with shade trees backing up along a large hayfield.

Bird Survey Results:

AMCR	1
AMRO	2
BAWW	1
BGGN	2
BRTH	2
CACH	5
CARW	3
CEDW	1
DICK	2
EAME	2
ECDO	1
EUST	1
FICR	1
GCFL	2
HOFI	2
NOCA	4
NOMO	4
PUMA	1
RBWO	1
TUTI	3
WEVI	1

**Site 2006 – 33**

GPS Location: 0296033 3824425

Site Description: This site is located on Cripple Mountain in northwestern Pushmataha County. It consists primarily of mature pine-oak forest.

Bird Survey Results:

AMCR	1
BAWW	4
CACH	2
CARW	1
INBU	2
NOBO	3
PIWA	4
REVI	5
TUTI	3
YBCH	1
YBCU	2

**Site 2006 – 34**

GPS Location: 0296203 3824292

Site Description: This site is located on Cripple Mountain in northwestern Pushmataha County. It was recently clear-cut but had some standing mature pine.

Bird Survey Results:

AMCR	1
BAWW	3
CARW	2
COYE	1
FISP	2
INBU	1
NOCA	2
PRAW	6
REVI	2
WEVI	3
WITU	1
YBCH	5

**Site 2006 – 35**

GPS Location: 0294492 3819511

Site Description: This site was located along Cripple Creek in northwest Pushmataha County. It consists of a mix of Short-leaf Pine away from the creek and Sweet Gum and oak species closer to the creek.

Bird Survey Results:

AMRO	1
BAWW	1
BHCO	1
CARW	2
COYE	2
EAKI	1
EAPH	2
EWPE	1
INBU	5
NOCA	3
PIWO	1
RBWO	1
REVI	1
SUTA	3
TUTI	3
WEVI	3
YBCH	3
YBCU	1

**Site 2006 – 36**

GPS Location: 0333663 3851904

Site Description: This site in central LeFlore County was located partly in an early successional old field and partly in a mature pine-oak forest.

**Bird Survey Results:**

ACFL	1
AMCR	2
BAWW	1
BGGN	2
BHCO	1
CARW	1
COYE	1
EAME	2
EAPH	1
HOWA	1
INBU	3
NOBO	2
NOCA	3
NOPA	1
PIWO	1
RBWO	1
REVI	3
TUTI	1
WEVI	2
YBCH	3
YBCU	3

**Site 2006 – 37**

GPS Location: 0334126 3851946

Site Description: This site in central LeFlore County was located partly in an early successional old field and partly in a mature pine-oak forest.

Bird Survey Results:

BAWW	1
BEWR	1
BHCO	1
CACH	1
CARW	2
EAPH	2
GCFL	1
INBU	2
KEWA	1
NOPA	1
PIWA	4
REVI	8
SUTA	2
TUTI	2
WBNU	2
YBCH	2

**Site 2006 – 38**

GPS Location: 0332020 3855616

Site Description: This site located on the steep north face of Blue Mountain in central LeFlore County is composed of mature pine-oak forest.

Bird Survey Results:

BAWW	1
CACH	3
INBU	3
PIWA	4
REVI	9
SCTA	2
SUTA	3
TUTI	3
WEWA	1
YBCU	1

**Site 2006 – 39**

GPS Location: 0332454 3855671

Site Description: This site located on the steep north face of Blue Mountain in central LeFlore County is composed of mature pine-oak forest.

Bird Survey Results:

BAWW	2
BLJA	1
EWPE	1
INBU	4
NOCA	1
PIWA	2
RBWO	2
REVI	5
SUTA	2
TUTI	4
WBNU	1
YBCU	5

**Site 2006 – 40**

GPS Location: 0335403 3855136

Site Description: This site located on the steep north face of Blue Mountain in central LeFlore County is composed of mature pine-oak forest.

Bird Survey Results:

BAWW	4
CARW	1
GCFL	1
HAWO	2
HOWA	1
INBU	5
OVEN	6
PIWA	7
REVI	8
SCTA	5
TUTI	2
WBNU	1

**Site 2006 – 41**

GPS Location: 0311970 3830614

Site Description: This site is located in northwest Pushmataha County and consists of a mature pine-oak forest.

Bird Survey Results:

BAWW	5
CACH	6
INBU	4
PIWA	4
REVI	4
SUTA	3
TUTI	3

**Site 2006 – 42**

GPS Location: 0312272 3830630

Site Description: This site is located in northwest Pushmataha County and consists of a mature pine-oak forest.

Bird Survey Results:

CACH	3
CARW	1
COYE	2
INBU	3
NOBO	1
NOCA	1
PIWA	4
PRAW	2
RBWO	2
REVI	3
TUTI	1
YBCH	3
YBCU	1

**Site 2006 – 43**

GPS Location: 0315815 3829131

Site Description: This site is located in northwest Pushmataha County and consists of a large clear-cut bordering on a mature pine-oak forest.

Bird Survey Results:

AMRO	1
BAWW	1
BRTH	1
CACH	3
CARW	2
CHSP	1
COYE	3
EABL	2
FISP	1
INBU	2
PRAW	3
REVI	2
TUTI	2
WBNU	1
WEVI	1
YBCH	4

**Site 2006 – 44**

GPS Location: 0315826 3829277

Site Description: This site is located in northwest Pushmataha County and consists of a recent clear-cut bordering on a mature oak-hickory forest.

Bird Survey Results:

AMCR	1
BGGN	2
CACH	3
COYE	5
EWPE	1
INBU	3
OVEN	2
PIWA	1
PRAW	4
RBWO	1
REVI	3
SUTA	1
WBNU	1
WEVI	1
YBCH	5
YTVI	1

**Site 2006 – 45**

GPS Location: 0352449 3836307

Site Description: This site located in eastern LeFlore County consists of mature pine-oak forest.

Bird Survey Results:

BAWW	1
CACH	2
CARW	2
DOWO	1
INBU	1
OVEN	7
PIWA	6
REVI	7
SCTA	1
SUTA	2
TUTI	4
WEWA	3
WOTH	4

**Site 2006 – 46**

GPS Location: 352755 3831302

Site Description: This site on the steep north face of Lynn Mountain in LeFlore County consists of mature oak-hickory forest.

Bird Survey Results:

BAWW	1
CARW	2
HOWA	4
INBU	1
OVEN	5
REVI	10
WEVI	1
YBCH	1



**Site 2006 – 47**

GPS Location: 0361778 3828593

Site Description: This site on the south slope of Lynn Mountain in LeFlore County consists of mature pine-oak forest.

Bird Survey Results:

BAWW	1
BGGN	1
CACH	4
CARW	1
EWPE	1
INBU	3
NOBO	1
OVEN	4
PIWA	8
REVI	7
SUTA	4
TUTI	4

**Site 2006 – 48**

GPS Location: 0360442 3828814

Site Description: This site on the steep north face of Lynn Mountain in LeFlore County, consists of mature oak-hickory forest.

Bird Survey Results:

BTNW	1
CACH	1
CARW	2
CERW	2
DOWO	1
EWPE	1
HOWA	3
INBU	3
KEWA	4
OVEN	3
PRAW	1
REVI	5
SCTA	1
WEVI	2
YBCH	1

**Site 2006 – 49**

GPS Location: 0358504 3828573

Site Description: This site on the steep north face of Lynn Mountain in LeFlore County consists of mature oak-hickory forest.

Bird Survey Results:

BAWW	3
CACH	1
CARW	1
CERW	1
HOWA	2
INBU	3
KEWA	2
NOCA	1
OVEN	2
PIWO	1
REVI	7
SCTA	2
TUTI	2
WBNU	1
WOTH	2

**Site 2006 – 50**

GPS Location: 0360613 3852070

Site Description: This site located in eastern LeFlore County north of Haw Creek is primarily a mature pine-oak forest.

Bird Survey Results:

AMRO	1
BAWW	3
BGGN	3
CACH	5
CARW	1
INBU	4
KEWA	1
OVEN	1
PIWA	6
REVI	10
SUTA	5
TUTI	3
WEVI	1
YBCH	2

**Site 2006 – 51**

GPS Location: 0359118 3849876

Site Description: This site located on Haw Creek in eastern LeFlore County consists primarily of bottomland hardwood species like Sycamore, Ash species and Sweet Gum. This site also bordered some pastureland.

**Bird Survey Results:**

BHCO	1
CACH	1
CARW	1
COYE	3
DICK	1
EAME	1
INBU	3
KEWA	1
LOWA	1
NOBO	1
NOCA	3
PIWO	1
REVI	4
STFL	1
SUTA	1
TUTI	2
WEVI	3
YBCU	1

**Site 2006 – 52**

GPS Location: 0346742 3882020

Site Description: This site located on top of Cavanal Hill north of Poteau in LeFlore County is fairly open with scattered oaks and Black Walnuts.

Bird Survey Results:

AMRO	1
BAWW	2
BHCO	2
BLGR	1
CARW	1
DOWO	1
EWPE	2
GRCA	1
HAWO	1
INBU	7
NOCA	2
OVEN	1
REVI	4
SCTA	2
YBCH	5
YBCU	1

**Site 2006 – 53**

GPS Location: 0347133 3882622

Site Description: This site located on top of Cavanal Hill north of Poteau in LeFlore County is fairly open with scattered oaks and Black Walnuts.

Bird Survey Results:

BAWW	2
CARW	2
INBU	8
NOCA	1
REVI	8
SCTA	2
TUTI	1
YBCU	2

**Site 2006 – 54**

GPS Location: 0347865 3883685

Site Description: This site located on the north slope of Cavanal Hill north of Poteau in northern LeFlore County consists primarily of mature pine-oak forest.

Bird Survey Results:

BAWW	2
CACH	2
INBU	4
NOCA	1
PIWA	2
PIWO	1
RBWO	2
REVI	6
SCTA	4
SUTA	1
TUTI	4
WEWA	1

**Site 2006 – 55**

GPS Location: 0351929 3827621

Site Description: This site located in the Nature Conservancy's Cucumber Creek Preserve in LeFlore County, consists of mature oak-hickory and very large Sweet Gums.

Bird Survey Results:

ACFL	1
BAWW	1
BGGN	1
BTNW	2
CACH	1
CARW	1
DOWO	1
EWPE	1
HOWA	2
KEWA	1
OVEN	3
REVI	10
SCTA	1
TUTI	3

**Site 2006 – 56**

GPS Location: 0352467 3828006

Site Description: This site located in the Nature Conservancy's Cucumber Creek Preserve in LeFlore County, consists of mature oak-hickory and very large Sweet Gums.

Bird Survey Results:

ACFL	2
BAWW	1
BGGN	4
CACH	2
INBU	1
KEWA	1
NOCA	1
NOPA	2
OVEN	5
REVI	13
TUTI	2
YTVI	1

**Site 2006 – 57**

GPS Location: 0347092 4068823

Site Description: This site located in Ottawa County was located along the shore of Grand Lake and consists of mature oak, ash and Sycamores.

Bird Survey Results:

ACFL	3
AMGO	3
BGGN	4
BHCO	1
CACH	1
CARW	3
GCFL	1
INBU	2
KEWA	3
LOWA	1
NOCA	1
NOPA	4
RBWO	2
REVI	1
RTHU	2
SUTA	1
TUTI	7
WBNU	2
WEVI	1
YTVI	1

**Site 2006 – 58**

GPS Location: 0345254 4060984

Site Description: This site located in south-central Ottawa County near the Grand Lake consists of mature hardwood species including several different oak and ash species.

Bird Survey Results:

AMGO	3
BGGN	3
EWPE	2
GCFL	1
INBU	2
NOCA	2
NOPA	2
PIWO	1
REVI	5
SUTA	2
TUTI	5
WBNU	1
YTVI	1

**Site 2006 – 59**

GPS Location: 0345469 4061035

Site Description: This site located in south-central Ottawa County near the Grand Lake consists of mature hardwood species like several different oak species.

Bird Survey Results:

ACFL	2
BHCO	1
CACH	1
CARW	1
EWPE	3
INBU	3
NOCA	1
NOPA	1
RBWO	1
REVI	2
RTHU	1
SUTA	3
TUTI	4
TUVU	1
WBNU	1

**Site 2006 – 60**

GPS Location: 0344154 4039919

Site Description: This site located in Delaware County south of Grove, consists of a fragmented forest of Sycamore and Oak species intermixed with pasture lands.

**Bird Survey Results:**

ACFL	1
AMCR	3
BAWW	1
BGGN	1
BHCO	1
BLJA	1
CACH	2
CARW	4
DOWO	1
EAME	1
EWPE	1
FICR	1
INBU	4
LOWA	1
NOCA	6
NOPA	2
RBWO	2
TUTI	1
YBCU	2
YTWA	1



**Site 2006 – 61**

GPS Location: 0344457 4039917

Site Description: This site located in Delaware County south of Grove, consists of a fragmented forest of Sycamore and Oak species intermixed with pasture lands.

**Bird Survey Results:**

ACFL	2
BGGN	2
BLJA	1
CACH	1
CARW	1
CHSP	2
DICK	2
DOWO	1
EABL	1
EAME	4
EAPH	1
EWPE	2
FISP	2
GCFL	1
GRSP	1
INBU	3
NOCA	4
NOFL	1
NOMO	1
RBWO	3
REVI	3
SUTA	3
TUTI	6
WBNU	3
YBCU	2

**Site 2006 – 62**

GPS Location: 0324405 4028386

Site Description: This site is located within Spavinaw WMA in Delaware County and consists primarily of mature oak-hickory forest with a smaller component of pine.

**Bird Survey Results:**

ACFL	3
BGGN	5
BHCO	1
CACH	3
CARW	1
CHSP	1
EWPE	1
INBU	3
KEWA	3
NOCA	1
NOPA	4
RBWO	2
REVI	3
SUTA	4
TUTI	3
WEVI	1
YTWA	1

**Site 2006 – 63**

GPS Location: 0324480 4028168

Site Description: This site is located within Spavinaw WMA in Delaware County and consists primarily of mature oak-hickory forest.

Bird Survey Results:

ACFL	2
BHCO	1
CACH	1
CARW	2
CHSP	1
EWPE	1
GCFL	2
INBU	9
KEWA	2
NOCA	3
NOPA	4
RBWO	1
REVI	2
SUTA	2
TUTI	2
WBNU	1
WEVI	2

**Site 2006 – 64**

GPS Location: 323323 4027080

Site Description: This site is located within Spavinaw WMA in Delaware County and consists primarily of mature oak-hickory forest.

Bird Survey Results:

ACFL	1
AMGO	1
BAWW	1
BGGN	2
CACH	1
CARW	1
CHSP	1
COYE	2
EWPE	2
INBU	4
KEWA	2
NOCA	3
NOPA	5
REVI	9
SUTA	2
WBNU	1
WEVI	2
YTWA	1

**Site 2006 – 65**

GPS Location: 0323620 4027065

Site Description: This site is located within Spavinaw WMA in Delaware County and consists primarily of mature oak-hickory forest with a smaller component of pine.

**Bird Survey Results:**

BHCO	1
BLJA	1
CACH	2
CARW	1
EWPE	1
INBU	3
NOPA	1
PIWA	2
RBWO	3
REVI	6
RTHU	1
SCTA	2
SUTA	3
TUTI	2
WBNU	3
YTWA	2

**Site 2006 – 66**

GPS Location: 0322116 4028665

Site Description: This site is located within Spavinaw WMA in Delaware County and consists primarily of mature oak-hickory forest with a smaller component of pine.

**Bird Survey Results:**

ACFL	1
BGGN	1
BHCO	1
CACH	1
CARW	3
EWPE	3
INBU	4
KEWA	1
MODO	1
NOPA	1
PIWA	4
RBWO	2
REVI	3
SCTA	1
SUTA	3
TUTI	5
WBNU	3

**Site 2006 – 67**

GPS Location: 0322235 4028451

Site Description: This site is located within Spavinaw WMA in Delaware County and consists primarily of mature oak-hickory forest with a smaller component of pine.

Bird Survey Results:

ACFL	3
BHCO	1
CARW	2
EWPE	1
NOCA	1
NOFL	1
NOPA	4
PIWA	1
RBWO	3
REVI	5
SCTA	2
SUTA	3
TUTI	4
WBNU	4
YBCU	1
YTWA	2

**Site 2006 – 68**

GPS Location: 0321177 4026827

Site Description: This site is located within Spavinaw WMA in Delaware County and consists primarily of mature oak-hickory forest with a large component of bottomland hardwoods like Sycamore and ash species.

Bird Survey Results:

ACFL	3
AMGO	2
CACH	2
CARW	1
INBU	4
KEWA	5
NOCA	1
NOPA	4
REVI	8
SUTA	3
TUTI	2
WBNU	2
WEVI	2
YTWA	4

**Site 2006 – 69**

GPS Location: 0321021 4026636

Site Description: This site is located within Spavinaw WMA in Delaware County and consists primarily of mature oak-hickory forest with a smaller component of pine.

**Bird Survey Results:**

ACFL	3
BHCO	1
CARW	2
EWPE	1
NOCA	1
NOFL	1
NOPA	4
PIWA	1
RBWO	3
REVI	5
SCTA	2
SUTA	3
TUTI	4
WBNU	4
YBCU	1
YTWA	2



**Site 2006 – 70**

GPS Location: 0337226 3989294

Site Description: This site is located within the Nature Conservancy's Nickel's Preserve in Cherokee county. It consists of a savannah like mix of old field and large Black Walnuts and oak species.

**Bird Survey Results:**

ACFL	1
AMGO	1
BHCO	3
CHSP	2
COGR	1
COYE	4
DICK	1
EABL	3
EAKI	1
EAME	1
EATO	2
EWPE	1
FISP	5
INBU	6
KEWA	1
MODO	1
NOBO	1
NOPA	2
OROR	2
PRAW	3
RBWO	1
SUTA	1
YBCH	6
YTWA	1

**Site 2006 – 71**

GPS Location: 0336989 3989405

Site Description: This site is located within the Nature Conservancy's Nickel's Preserve in Cherokee county. This site is fairly open with a scattering of mature pine, oaks and hickories.

**Bird Survey Results:**

AMGO	1
BGGN	1
CACH	1
CARW	2
CHSP	1
COYE	4
DICK	1
EABL	1
EAPH	1
EWPE	1
FISP	2
INBU	8
KEWA	1
NOBO	4
NOCA	1
NOPA	2
PIWA	1
PRAW	2
REVI	1
RTHU	1
TUTI	1
WEVI	1
YBCH	4
YBCU	1
YTWA	1

**Site 2006 – 72**

GPS Location: 0330630 3988173

Site Description: This site is located within the Nature Conservancy's Nickel's Preserve in Cherokee county. It consists of mature oak-hickory forest.

Bird Survey Results:

ACFL	1
BGGN	2
EWPE	1
HAWO	1
NOPA	5
PIWO	1
RBWO	1
REVI	8
RTHU	1
SUTA	3
WBNU	1
YTVI	2
YTWA	2

**Site 2006 – 73**

GPS Location: 0346846 3986512

Site Description: This site is located in central Adair County. It consists of mature oak-hickory forest.

Bird Survey Results:

ACFL	2
AMGO	3
BGGN	4
BHCO	1
CACH	2
CARW	1
EWPE	1
FISP	1
INBU	3
KEWA	1
NOCA	2
NOPA	2
PRAW	1
REVI	1
SCTA	1
SUTA	1
TUTI	3
WEVI	3
YBCH	4

**Site 2006 – 74**

GPS Location: 0347003 3986382

Site Description: This site is located in central Adair County. It consists of mature oak-hickory forest.

**Bird Survey Results:**

ACFL	2
BAWW	1
BGGN	1
CACH	3
CARW	2
FISP	3
GCFL	1
INBU	6
KEWA	1
NOCA	2
NOPA	2
PRAW	1
RBWO	1
SUTA	2
TUTI	5
WEVI	2
YBCH	3
YBCU	1

**Site 2006 – 75**

GPS Location: 0350818 3981638

Site Description: This site is located in central Adair County. It consists of a mix of fragmented mature oak-hickory forest amid old fields.

**Bird Survey Results:**

AMGO	2
BGGN	2
CARW	1
EABL	1
EWPE	1
FISP	2
INBU	3
KEWA	2
NOCA	6
NOPA	2
RBWO	3
REVI	6
RHWO	1
RTHU	1
SUTA	2
TUTI	2
WEVI	1
WITU	1
YBCH	1
YBCU	1
YTVI	1

**Site 2007 – 1**

GPS Location: 0349193 4038952

Site Description: This site is located in central Delaware County and consists of mature oak-hickory forest.

**Bird Survey Results:**

ACFL	4
AMCR	1
AMGO	2
BAWW	2
BGGN	5
BHCO	1
BLJA	1
CACH	1
CARW	3
EWPE	3
FICR	1
INBU	4
KEWA	1
NOCA	2
NOPA	4
PIWO	1
REVI	3
SUTA	3
TUTI	6
WEVI	1
YBCH	1

**Site 2007 – 2**

GPS Location: 0345145 405145

Site Description: This site is located in central Delaware County and consists of mature oak-hickory forest with a smaller component of sapling aged pine.

**Bird Survey Results:**

AMGO	2
BGGN	2
BHCO	6
CHSP	1
EAKI	1
EAME	2
EWPE	3
FISP	1
GCFL	2
INBU	3
NOCA	3
NOMO	2
NOPA	2
RBWO	2
REVI	1
SUTA	2
TUTI	6
YBCH	2

**Site 2007 – 3**

GPS Location: 0344293 4035796

Site Description: This site is located in central Delaware County and consists of a mixed of well-managed pastureland intermixed with sapling aged forest.

**Bird Survey Results:**

AMGO	1
AMRO	1
BHCO	6
CACH	1
CHSP	2
EABL	1
EAKI	1
EAME	2
EAPH	1
EUST	2
EWPE	1
FISP	4
GRSP	1
INBU	3
KEWA	1
NOCA	3
NOMO	3
RBWO	1
YBCH	1



**Site 2007 – 4**

GPS Location: 0336248 4044526

Site Description: This site is located in central Delaware County and consists of mature pine-oak forest.

Bird Survey Results:

ACFL	2
AMGO	1
BAWW	3
BGGN	3
CARW	1
CEDW	6
EWPE	4
GCFL	1
NOPA	2
PIWA	3
REVI	4
SUTA	2
TUTI	7
YTWA	1

**Site 2007 – 5**

GPS Location: 0336513 4019247

Site Description: This site located in southern Delaware County and consists of mature pine-oak forest.

Bird Survey Results:

AMGO	1
BAWW	2
BGGN	3
BHCO	1
CARW	1
EWPE	2
GCFL	3
INBU	3
KEWA	1
NOPA	1
PIWA	5
REVI	5
SUTA	4
TUTI	1
WBNU	1

**Site 2007 – 6**

GPS Location: 0330080 4024279

Site Description: This site is located in southern Delaware County and consists of both mature and pine-oak forest and areas of regenerating pine forest.

**Bird Survey Results:**

ACFL	1
AMGO	1
BAWW	2
BGGN	2
CACH	1
CEDW	2
EWPE	3
FISP	3
GCFL	1
INBU	1
KEWA	1
NOCA	2
OVEN	1
PIWA	4
PRAW	3
REVI	3
SUTA	4
TUTI	3
WBNU	1
WEVI	1
YBCH	2
YTWA	1

**Site 2007 – 7**

GPS Location: 0339982 4024383

Site Description: This site located in southern Delaware County along Spavinaw Creek consists of mature bottomland hardwood species like Sycamore and ash.

**Bird Survey Results:**

BAWW	1
BGGN	6
CACH	1
CARW	1
CEDW	1
COYE	1
DOWO	1
GCFL	1
INBU	3
KEWA	1
LOWA	1
PIWA	1
PROW	1
REVI	4
WEVI	4
YTWA	1

**Site 2007 – 8**

GPS Location: 0343778 4026909

Site Description: This site located in southern Delaware County along and near Spavinaw Creek consists of mature bottomland hardwood species like Sycamore and ash as well as mature oak-hickory forest.

**Bird Survey Results:**

AMGO	2
BGGN	3
BHCO	1
CACH	1
CARW	1
GCFL	1
KEWA	2
NOCA	1
NOPA	2
PIWA	1
PROW	1
RBWO	2
REVI	2
SUTA	5
TUTI	5
WEVI	3
YBCH	1
YTWA	1

**Site 2007 – 9**

GPS Location: 0323553 4030653

Site Description: This site located in southern Delaware County along Spavinaw Creek consists of mature bottomland hardwood species like Sycamore and ash.

**Bird Survey Results:**

ACFL	1
AMRE	6
BAOR	1
BGGN	2
BHCO	1
CACH	1
CARW	1
CEDW	5
DOWO	1
EAKI	1
EAPH	1
EWPE	2
GCFL	1
INBU	2
KEWA	4
LOWA	1
NOCA	8
NOPA	5
PROW	6
RBWO	1
REVI	5
SUTA	2
WEVI	4
YBCH	1
YTWA	5

**Site 2007 – 10**

GPS Location: 323827 4030520

Site Description: This site located in southern Delaware County along Spavinaw Creek consists of mature bottomland hardwood species like Sycamore and ash.

**Bird Survey Results:**

ACFL	1
AMRE	2
BAWW	1
BGGN	6
CARW	1
EWPE	1
GCFL	2
INBU	1
KEWA	1
LOWA	1
NOCA	3
NOPA	2
PIWA	1
RBWO	2
REVI	2
SUTA	1
TUTI	5
WEVI	2

**Site 2007 – 11**

GPS Location: 0360720 3832399

Site Description: This site located northeast of Lynn Mountain in LeFlore County consists of mature forest of Black Gum, oak-hickory and some mature pine.

Bird Survey Results:

ACFL	4
BAWW	2
BGGN	1
CARW	3
HOWA	1
INBU	1
KEWA	2
LOWA	2
NOPA	1
OVEN	5
PIWA	5
REVI	9
SCTA	1
TUTI	1
WEVI	1
WOTH	1

**Site 2007 – 12**

GPS Location: 0362584 3831354

Site Description: This site is located on the north face of Cow Creek Mountain in eastern LeFlore County. It consists of mature oak-hickory forest with a large component of Black Walnut.

Bird Survey Results:

BTNW	1
CACH	1
CARW	1
EWPE	2
HOWA	4
INBU	5
KEWA	3
OVEN	3
REVI	5
SCTA	3
TUTI	2
WEVI	1
WOTH	1
YBCH	3

**Site 2007 – 13**

GPS Location: 0364225 3831057

Site Description: This site is located on Walnut Mountain in eastern LeFlore County. It consists of mature oak-hickory forest with a large component of Black Walnut and Black Gum.

Bird Survey Results:

ACFL	1
BAWW	1
BGGN	1
DOWO	1
EWPE	3
HOWA	5
INBU	1
KEWA	3
OVEN	7
REVI	12
SCTA	2

**Site 2007 – 14**

GPS Location: 0366575 3828804

Site Description: This site is located on the south slope of Walnut Mountain in eastern LeFlore County. It consists of a mature oak-hickory forest with a smaller component of mature pine.

Bird Survey Results:

BAWW	1
EWPE	2
HOWA	3
INBU	7
KEWA	1
NOCA	2
OVEN	5
PIWA	1
REVI	12
RTHU	1
SCTA	5
TUTI	1



**Site 2007 – 15**

GPS Location: 0314563 3958096

Site Description: This site is located in Cherokee WMA in Cherokee County. It consists of mature oak-hickory and Sycamore along Greenleaf Creek.

Bird Survey Results:

ACFL	3
BAWW	2
BGGN	5
BHCO	1
CARW	1
EAPH	1
INBU	1
LOWA	2
NOCA	3
NOPA	8
PIWO	1
PROW	1
REVI	6
RTHU	1
SUTA	3
TUTI	2
WBNU	1
WEVI	2
YBCU	1
YTVI	1
YTWA	2

**Site 2007 – 16**

GPS Location: 0314792 3955451

Site Description: This site is located in Cherokee WMA in Cherokee County. It consists of mature oak-hickory forest.

Bird Survey Results:

ACFL	2
AMGO	1
BAWW	2
BGGN	4
DOWO	1
GCFL	1
INBU	1
KEWA	1
NOPA	1
REVI	4
SUTA	1
TUTI	2
WEVI	1
YBCU	1

**Site 2007 – 17**

GPS Location: 0320749 3924566

Site Description: The site is located in the Sequoyah NWR in Sequoyah County. It consists of bottomland hardwoods like Sycamore, Water Oak and ash species.

Bird Survey Results:

BAWW	1
BGGN	1
BHCO	1
CACH	1
CARW	2
EAPH	1
EWPE	1
GCFL	2
INBU	5
NOCA	5
NOPA	1
PROW	1
REVI	5
RWBL	1
SUTA	1
TUTI	2
YTWA	1

**Site 2007 – 18**

GPS Location: 316564 3923792

Site Description: The site is located in the Sequoyah NWR in Sequoyah County. It is a mix of mature bottomland hardwoods like Sycamore and Eastern Cottonwood and old fields.

**Bird Survey Results:**

BAOR	1
BAWW	1
BGGN	4
BLGR	1
CARW	1
FISP	2
INBU	7
NOCA	3
NOPA	4
RBWO	3
STFL	1
SUTA	1
YBCH	1
YBCU	2

**Site 2007 – 19**

GPS Location: 0334573 3947995

Site Description: This site is located in Cookson Hills WMA in Cherokee County. It is a mature oak-hickory forest.

**Bird Survey Results:**

ACFL	5
BAWW	1
BGGN	2
BHCO	2
CARW	3
DOWO	1
INBU	3
KEWA	1
LOWA	1
NOCA	2
NOPA	4
OVEN	1
RBWO	1
REVI	3
SCTA	1
SUTA	2
TUTI	6
WBNU	1
WEVI	3
YBCH	1
YBCU	1
YTVI	2
YTWA	1

**Site 2007 – 20**

GPS Location: 0342594 3759544

Site Description: This site is located in Little River NWR in McCurtain County. It consists of one of the most intact mature bottomland hardwood forests in Oklahoma.

**Bird Survey Results:**

ACFL	3
AMGO	1
BAWW	2
BGGN	5
CACH	2
CARW	1
DOWO	1
EWPE	1
HOWA	2
INBU	2
KEWA	3
NOCA	4
PIWO	1
RBWO	2
REVI	4
TUTI	5
WEVI	5
YBCH	1
YBCU	1
YTVI	1

**Site 2007 – 21**

GPS Location: 0340911 3758105

Site Description: This site is located in Little River NWR in McCurtain County. It consists of one of the most intact mature bottomland hardwood forests in Oklahoma.

**Bird Survey Results:**

ACFL	2
BAWW	1
BGGN	3
CACH	3
CARW	1
DOWO	2
HOWA	2
KEWA	1
NOCA	3
NOPA	1
PROW	1
REVI	10
SUTA	1
SWWA	1
TUTI	4
WEVI	5
YBCU	2
YTWA	1

**Site 2007 – 22**

GPS Location: 0340942 3756973

Site Description: This site is located in Little River NWR in McCurtain County. It consists of one of the most intact mature bottomland hardwood forests in Oklahoma.

Bird Survey Results:

ACFL	2
BGGN	7
CACH	1
CARW	2
GCFL	2
HOWA	2
INBU	2
KEWA	2
NOCA	4
NOPA	2
REVI	9
SUTA	2
SWWA	1
TUTI	5
WEVI	7
YTWA	1

**Site 2007 – 23**

GPS Location: 0345558 3759789

Site Description: This site is located near Little River NWR in southern McCurtain County. It consists of a mature Loblolly Pine plantation.

Bird Survey Results:

BAWW	1
BGGN	3
BHCO	1
CARW	2
COYE	1
DOWO	1
EWPE	2
INBU	2
NOCA	2
PIWA	9
PRAW	1
REVI	4
SUTA	5
TUTI	1
YBCH	2
YBCU	2

**Site 2007 – 24**

GPS Location: 0345395 3761055

Site Description: This site is located near Little River NWR in southern McCurtain County. It is a large clear-cut area.

Bird Survey Results:

BGGN	1
BHCO	2
CACH	1
CARW	3
COYE	3
FISP	4
INBU	7
NOCA	2
PRAW	5
REVI	1
YBCH	9

**Site 2007 – 25**

GPS Location: 345909 3758146

Site Description: This site is located in Little River NWR in McCurtain County. It consists of one of the most intact mature bottomland hardwood forests in Oklahoma.

Bird Survey Results:

ACFL	2
BGGN	7
CACH	5
CARW	1
DOWO	1
HOWA	1
INBU	1
KEWA	2
LOWA	3
NOCA	3
NOPA	1
PROW	1
REVI	8
SUTA	2
SWWA	3
TUTI	3
WEVI	5
YTWA	3



**Site 2007 – 26**

GPS Location: 0342577 3756604

Site Description: This site is located in Little River NWR in McCurtain County. It consists of one of the most intact mature bottomland hardwood forests in Oklahoma.

**Bird Survey Results:**

ACFL	3
BGGN	1
CACH	1
CARW	3
DOWO	1
HOWA	1
INBU	3
KEWA	3
NOCA	2
NOPA	1
PROW	1
RBWO	1
REVI	10
SUTA	1
SWWA	2
TUTI	1
WEVI	3
WOTH	1
YTVI	1
YTWA	1

**Site 2007 – 27**

GPS Location: 0365443 3827449

Site Description: This site is composed of mature pine-oak forest.

Bird Survey Results:

BAWW	2
CARW	2
DOWO	1
HOWA	1
INBU	5
KEWA	1
NOCA	1
OVEN	1
PIWA	3
REVI	10
SCTA	6
TUTI	1
WEVI	3
YBCU	1

**Site 2007 – 28**

GPS Location: 0363296 3828256

Site Description: This site is primarily a mature oak-hickory forest but has a pine component as well.

Bird Survey Results:

BGGN	2
CARW	2
HOWA	5
KEWA	1
LOWA	1
NOPA	1
OVEN	1
REVI	11
SCTA	4
YTVI	1

**Site 2007 – 29**

GPS Location: 0366646 3840135

Site Description: This site is located on the steep north slope of Rich Mountain in eastern LeFlore County. It consists of mature oak-hickory forest.

Bird Survey Results:

BAWW	3
BTNW	3
CACH	4
CERW	2
DOWO	1
HOWA	5
INBU	1
KEWA	2
OVEN	2
REVI	8
SCTA	2

**Site 2007 – 30**

GPS Location: 0346026 3824101

Site Description: This site is located north of Octavia in southern LeFlore County. It consists of a large clear-cut and some adjacent mature pine forest.

Bird Survey Results:

AMGO	1
BLGR	1
COYE	5
INBU	4
LASP	1
NOBO	1
NOCA	1
NOPA	1
PIWA	1
PRAW	3
REVI	2
TUTI	2
WEVI	2
YBCH	7

**Site 2007 – 31**

GPS Location: 0335431 3927838

Site Description: This site is located west of Sallisaw in Sequoyah County. It consists of managed pasture lands.

Bird Survey Results:

AMGO	1
BHCO	2
BRTH	1
DICK	1
EABL	4
EAKI	2
EAME	5
GTGR	2
HOSP	1
LASP	2
LOSH	1
NOBO	1
NOMO	5
RWBL	1
STFL	3
YBCU	1

**Site 2007 – 32**

GPS Location: 0351466 3881528

Site Description: This site was a residential neighborhood in Heavener, LeFlore County.

Bird Survey Results:

AMRO	4
BLJA	4
CACH	1
CEDW	3
EAPH	1
ECDO	2
EUST	23
GRCA	1
HOFI	2
HOSP	9
NOCA	5
NOMO	5

**Site 2007 – 33**

GPS Location: 0352202 3882004

Site Description: This site was a residential neighborhood in Heavener, LeFlore County.

Bird Survey Results:

AMRO	6
BGGN	2
BLJA	2
CACH	2
COGR	1
ECDO	2
EUST	5
EWPE	1
HOSP	5
MODO	1
NOCA	5
NOMO	6
PUMA	2
TUTI	2

**Site 2007 – 34**

GPS Location: 0351819 3879228

Site Description: This site was a residential neighborhood in Poteau, LeFlore County.

Bird Survey Results:

AMRO	5
BHCO	1
BLJA	1
CACH	1
CEDW	1
COGR	3
COHA	1
ECDO	1
EUST	10
HOSP	12
INBU	2
MODO	1
NOCA	4
NOMO	6
STFL	1
TUTI	1
WEKI	1

**Site 2007 – 35**

GPS Location: 0352776 3861814

Site Description: This site was a residential neighborhood in Poteau, LeFlore County.

Bird Survey Results:

AMRO	6
BAOR	1
BLJA	3
ECDO	5
EUST	9
GRCA	1
HOSP	7
NOCA	2
NOMO	5
RBWO	1
TUTI	1

**Site 2007 – 36**

GPS Location: 0354140 3861576

Site Description: This site was a residential neighborhood in Poteau, LeFlore County.

Bird Survey Results:

AMRO	3
BLJA	1
COGR	5
EAPH	2
ECDO	4
EUST	11
HOSP	8
NOCA	4
NOMO	7
STFL	1

**Site 2007 – 37**

GPS Location: 0354878 3871003

Site Description: This site is located in eastern LeFlore County and consists of pasturelands.

Bird Survey Results:

AMGO	1
AMRO	1
BASW	1
BHCO	1
BLGR	1
BLJA	2
COGR	1
DICK	1
EABL	2
EAKI	1
EAME	8
EUST	11
MODO	1
NOBO	1
NOCA	1
NOMO	6
STFL	2

**Site 2007 – 38**

GPS Location: 0356267 3856461

Site Description: This site is located in eastern LeFlore County and consists of pasturelands.

Bird Survey Results:

AMRO	4
BHCO	1
BLGR	2
BLJA	1
CACH	2
COGR	2
DICK	3
EABL	1
EAME	5
EAPH	2
ECDO	2
EUST	5
NOBO	1
NOMO	5
RWBL	1
STFL	1

**Site 2007 – 39**

GPS Location: 0359613 3856515

Site Description: This site is located in eastern LeFlore County and consists of pasturelands.

Bird Survey Results:

AMRO	2
BHCO	2
BLGR	1
CACH	2
COGR	1
COYE	2
DICK	2
EABL	1
EAKI	2
EAME	4
EAPH	1
FISP	2
HOSP	3
INBU	2
MODO	3
NOBO	3
NOMO	8
PABU	1
PIWA	2
STFL	1



**Site 2007 – 40**

GPS Location: 0351543 3857092

Site Description: This site was located near Hodgen, LeFlore County and consists of mature bottomland hardwood forest along the Poteau River.

Bird Survey Results:

BGGN	1
BHCO	1
BLJA	1
CACH	2
CARW	2
COYE	2
EAPH	1
HOWA	1
KEWA	4
NOCA	5
NOPA	1
PIWO	1
REVI	2
SUTA	2
TUTI	2
WEVI	3

**Site 2007 – JT1**

GPS Location: 0346392 3838331

Site Description: This site was located on Rough Mountain in LeFlore County. It consists of mature pine-oak forest.

Bird Survey Results:

BLJA	1
CACH	3
GCFL	1
HAWO	1
INBU	1
MODD	3
PIWA	3
REVI	6
TUTI	3
YBCU	4

**Site 2007 – JT2**

GPS Location: 0343879 3837040

Site Description: This site was located near Simmons Mountain in LeFlore County. It consists of mature pine and oak-hickory forest.

Bird Survey Results:

BGGN	1
CACH	3
CARW	2
INBU	1
NOCA	1
PIWA	4
REVI	6
RTHU	1
SCTA	2
TUTI	1

**Site 2007 – JT3**

GPS Location: 0342642 3839709

Site Description: This site was located near Carver Mountain in LeFlore County. It consists of mature pine and oak-hickory forest.

Bird Survey Results:

AMCR	1
CACH	1
HAWO	1
INBU	3
PIWA	1
PIWO	1
REVI	8
SCTA	1
SUTA	1
YBCU	2

**Site 2007 – JT4**

GPS Location: 0338596 3843691

Site Description: This site is located on the south slope of Winding Stair Mountain in LeFlore County. It consists of mature pine and oak-hickory forest.

Bird Survey Results:

GCFL	1
HOWA	1
PIWA	1
REVI	6
SCTA	2
TUTI	2
YBCU	1

**Site 2007 – JT5**

GPS Location: 0335341 3842587

Site Description: This site is located on the south slope of Winding Stair Mountain in LeFlore County. It consists of mature pine and oak-hickory forest.

Bird Survey Results:

BLGR	1
CACH	3
GCFL	1
PIWA	4
PIWO	1
REVI	5
SCTA	1
TUTI	2

**Site 2007 – JT6**

GPS Location: 0325879 3846512

Site Description: This site is located on the south slope of Winding Stair Mountain in LeFlore County. It consists of mature pine and oak-hickory forest.

Bird Survey Results:

BLJA	1
BWWA	1
GCFL	1
INBU	2
MODO	2
NOCA	1
OVEN	1
PIWA	7
REVI	4
SCTA	1
SUTA	2
TUTI	3
YBCU	1

**Site 2007 – JT7**

GPS Location: 0326620 3849024

Site Description: This site is located on the south slope of Winding Stair Mountain in LeFlore County. It consists of mature pine and oak-hickory forest.

Bird Survey Results:

BGGN	1
CACH	2
HAWO	2
INBU	2
OVEN	2
PIWA	2
PIWO	1
REVI	2
SCTA	1
SUTA	4
TUTI	2

**Site 2007 – JT8**

GPS Location: 0344627 3832499

Site Description: This site is located on the north slope of the Kiamichi Ridge in LeFlore County. It consists of mature oak-hickory with a smaller pine component.

Bird Survey Results:

BLJA	1
BWWA	2
CARW	1
CHSW	2
HOWA	1
INBU	1
MODO	1
PIWA	1
PIWO	3
REVI	7
SCTA	2
SUTA	1

**Site 2007 – JT9**

GPS Location: 0346385 3834174

Site Description: This site is located on the north slope of the Kiamichi Ridge in LeFlore County. It consists of mature oak-hickory with a smaller pine component.

Bird Survey Results:

BWHA	1
BWWA	1
CACH	2
CARW	2
GCFL	2
INBU	1
KEWA	1
NOCA	2
OVEN	2
PIWA	4
PIWO	2
REVI	5
SCTA	1
SUTA	2
TUTI	2
WEVI	3
YBCH	2
YBCU	2

**Site 2007 – JT10**

GPS Location: 0344017 3831542

Site Description: This site is located on the Kiamichi Ridge in LeFlore County. It consists of mature oak-hickory with a smaller pine component.

Bird Survey Results:

BLJA	1
CACH	2
CARW	3
CHSW	2
COYE	1
INBU	5
KEWA	1
MODO	3
OVEN	2
REVI	4
RTHU	1
SCTA	1
TUTI	2
WEVI	2

**Site 2007 – JT11**

GPS Location: 0347699 3831373

Site Description: This site is located on the Kiamichi Ridge in LeFlore County. It consists of mature oak-hickory with a smaller pine component.

Bird Survey Results:

CACH	1
CARW	1
COYE	1
HOWA	1
INBU	4
KEWA	1
PRAW	1
REVI	5
WEVI	2
YBCH	3

**Site 2007 – JT12**

GPS Location: 0288610 3874925

Site Description: This site is located in Robber's Cave WMA in Latimer County. It consists of mature pine and oak-hickory forest.

Bird Survey Results:

AMCR	2
BLJA	2
CARW	1
GCFL	1
INBU	1
KEWA	1
NOCA	1
PIWA	1
PIWO	1
REVI	1
RWBL	1
SUTA	2
TUTI	2
WBNU	2
YBCU	1

**Site 2007 – JT13**

GPS Location: 0286278 3878507

Site Description: This site is located in Robber's Cave WMA in Latimer County. It consists of mature pine and oak-hickory forest.

Bird Survey Results:

BGGN	1
BLJA	1
BWWA	1
CACH	3
INBU	2
NOCA	1
PIWA	4
REVI	4
TUTI	10
TUVU	1
YBCU	2

**Site 2007 – JT14**

GPS Location: 0338147 3956714

Site Description: This site is located in Cookson Hills WMA in Cherokee County. It consists of mature oak-hickory forest.

Bird Survey Results:

BWWA	2
CARW	3
INBU	1
KEWA	2
NOCA	1
NOPA	1
REVI	9
SCTA	1
TUTI	4
TUVU	1

**Site 2007 – JT15**

GPS Location: 0335226 3947510

Site Description: This site is located in Cookson Hills WMA in Cherokee County. It consists of mature oak-hickory forest.

Bird Survey Results:

BGGN	1
BWWA	1
CACH	4
CARW	3
EWPE	2
INBU	2
KEWA	1
REVI	2
SUTA	1
TUTI	6
WEVI	1



**Site 2007 – JT16**

GPS Location: 0338527 3819755

Site Description: This site is located southwest of Octavia on the LeFlore/McCurtain County line. It consists of mature pine and oak-hickory forest.

Bird Survey Results:

AMCR	3
BGGN	1
BLJA	4
BWWA	1
CARW	1
EWPE	1
GCFL	1
HOWA	2
OVEN	1
REVI	9
SCTA	2
TUTI	1
WBNU	1
YBCH	1

**Site 2007 – JT17**

GPS Location: 0358943 3747311

Site Description: This site is located near Caney Creek in south McCurtain County. It consists of areas of mature pine and also areas with mature bottomland hardwood species like Water Oak, Sweet Gum and other oak and hickory species.

Bird Survey Results:

ACFL	2
AMCR	1
HOWA	3
NOCA	3
OVEN	1
PIWA	1
REVI	10
TUTI	2
WEVI	1
YBCU	2

**Site 2007 – JT18**

GPS Location: 0357135 3747879

Site Description: This site is located near Caney Creek in south McCurtain County. It consists of areas of mature pine and also areas with mature bottomland hardwood species like Water Oak, Sweet Gum and other oak and hickory species.

**Bird Survey Results:**

AMCR	1
CARW	3
DOWO	1
EWPE	1
HOWA	4
INBU	3
KEWA	2
MODO	5
NOCA	1
PIWA	3
PIWO	1
REVI	5
SUTA	3
TUTI	4
WEVI	1
YBCH	3
YBCU	4

**Site 2007 – JT19**

GPS Location: 0348611 3736257

Site Description: This site is located within Red Slough WMA. It consists of a mature pine forest intermixed with bottomland hardwood species.

Bird Survey Results:

ACFL	4
AMCR	1
BGGN	1
CACH	1
EWPE	1
GCFL	1
HERON	2
KEWA	2
MODO	2
NOCA	3
PIWO	3
RBWO	1
REVI	10
SUTA	1
TUTI	6
WEVI	4
YBCU	4

**Site 2007 – JT20**

GPS Location: 0349584 3735190

Site Description: This site is located with Red Slough WMA. It consists of mature bottomland hardwoods.

Bird Survey Results:

AMCR	3
BWWA	1
CACH	1
CARW	1
DOWO	1
GCFL	1
KEWA	2
NOCA	10
PIWO	2
REVI	5
SUTA	2
TUTI	7
WEVI	6
YBCU	2
YTVI	2

**Site 2007 – JT21**

GPS Location: 0356029 3735445

Site Description: This site is located near Tom in southern McCurtain County. It consists of a mature pine forest intermixed with bottomland hardwood species.

Bird Survey Results:

ACFL	1
CARW	3
COYE	1
EWPE	2
HOWA	1
INBU	2
KEWA	2
MODO	3
NOCA	3
PIWA	1
RBWO	1
REVI	4
SUTA	2
TUTI	1
YBCH	1

**Site 2007 – JT22**

GPS Location: 0236345 3811403

Site Description: This site is located in McGee Creek WMA in Atoka County. It consists of a mixed mature pine and oak-hickory forest.

Bird Survey Results:

AMCR	1
BLJA	4
CACH	2
CARW	1
GCFL	1
MODO	1
NODO	1
PIWA	2
PIWO	3
RBWO	2
REVI	1
RSHA	1
SUTA	2
WBNU	2
YBCU	1

**Site 2007 – JT23**

GPS Location: 0234665 3806837

Site Description: Site Description: This site is located in McGee Creek WMA in Atoka County. It consists of a mixed mature pine and oak-hickory forest.

Bird Survey Results:

BLJA	1
CARW	1
MODO	2
NOBO	1
NOCA	1
PIWA	2
SUTA	2
TUTI	5
YBCU	1

**Site 2007 – JT24**

GPS Location: 0290447 3815534

Site Description: This site is located in Honobia Creek WMA on north slopes south of Nashoba in Pushmataha County. It consists of mixed mature pine and oak-hickory forest.

Bird Survey Results:

BLJA	1
CARW	1
GCFL	1
MODO	1
PIWO	1
REVI	9
RSHA	1
SCTA	1
SUTA	2

**Site 2007 – JT25**

GPS Location: 0283911 3818671

Site Description: This site is located in Honobia Creek WMA on north slopes south of Nashoba in Pushmataha County. It consists of mixed mature pine and oak-hickory forest.

Bird Survey Results:

BGGN	1
CARW	3
CHSW	1
INBU	1
KEWA	1
MODO	3
NOCA	5
PIWO	1
REVI	5
SUTA	1
SWALLOW	2
TUTI	4
WEVI	2
YBCH	5
YTVI	1

**Site 2007 – JT26**

GPS Location: 0226604 3826285

Site Description: This site is located in Atoka WMA in Atoka County. It consists of mature bottomland hardwood forest.

Bird Survey Results:

ACFL	2
AMCR	1
CARW	3
GCFL	1
KEWA	1
NOPA	2
REVI	7
RSHA	1
TUTI	5
YBCU	1
YTVI	2

**Site 2007 – JT27**

GPS Location: 0272583 3779460

Site Description: This site is located in Hugo WMA in Choctaw County. It consists of mature bottomland hardwood forest.

Bird Survey Results:

ACFL	2
AMCR	1
BGGN	4
BLJA	1
CACH	5
DOWO	1
EWPE	1
GCFL	1
INBU	3
KEWA	2
NOCA	4
PROW	1
REVI	3
SUTA	3
SWWA	1
TUTI	12
WEVI	1
YBCH	1
YBCU	4
YTVI	1

**Site 2007 – JT28**

GPS Location: 0357436 3951882

Site Description: This site is located on Kester Mountain in southern Adair County. It consists of mature oak-hickory forest.

Bird Survey Results:

ACFL	1
AMCR	6
BGGN	1
INBU	2
REVI	6
SUTA	1
TUTI	5
YBCH	1
YTVI	1

**Site 2007 – JT29**

GPS Location: 0360364 3953005

Site Description: This site is located in Ozark Plateau WMA in southern Adair County. It consists of mature oak-hickory forest.

Bird Survey Results:

BGGN	2
BLGR	2
CAWR	1
EAPH	1
FISP	1
INBU	3
NOCA	1
PIWO	1
REVI	3
SCTA	1
SUTA	1
TUTI	4
WEVI	1
YBCH	2

**Site 2007 – JT30**

GPS Location: 0302058 3960397

Site Description:

Bird Survey Results: This site is located in Gruber WMA in Muskogee County. It consists of mature oak-hickory forest.

ACFL	1
BGGN	2
CARW	3
INBU	1
KEWA	2
NOCA	5
OVEN	1
REVI	3
RSHA	1
SUTA	3
TUTI	4
TUVU	2
WEVI	4
YBCH	1
YBCU	1
YTVI	1



**Site 2007 – JT31**

GPS Location: 0336604 3951834

Site Description: This site is located in Cookson hills WMA near the Cherokee and Adair County line. It consists of mature oak-hickory forest.

Bird Survey Results:

BGGN	2
BLJA	1
CARW	1
EWPE	4
INBU	3
MODO	1
NOCA	1
REVI	3
SUTA	2
TUTI	5
TUVU	1
YBCU	1
YTVI	1

**Site 2007 – TO1**

GPS Location: 0350858 3747855

Site Description: This site is located in southern McCurtain County and consists of a mixed age Loblolly Pine plantation.

Bird Survey Results:

AMCR	1
BHCO	1
BLJA	2
COYE	1
HOWA	3
KEWA	1
MODO	1
NOBO	1
PIWA	4
PRAW	1
RBWO	1
REVI	4
WEVI	3
YBCH	3
YBCU	1

**Site 2007 – T02**

GPS Location: 0349822 3748469

Site Description: This site is located in southern McCurtain County and consists of a mixed age Loblolly Pine plantation.

Bird Survey Results:

BHCO	2
BLGR	1
CARW	1
COYE	6
DICK	2
DOWO	2
EAKI	1
FISP	2
INBU	4
MODO	3
NOBO	1
NOCA	1
NOMO	1
PRAW	3
REVI	2
WEVI	2
YBCH	9

**Site 2007 – T03**

GPS Location: 350539 3750053

Site Description: This site is located in southern McCurtain County and consists of a mixed age Loblolly Pine plantation.

Bird Survey Results:

BLGR	4
COYE	4
FISP	3
INBU	12
NOMO	2
PRAW	7
YBCH	6

**Site 2007 – TO4**

GPS Location: 0350310 370233

Site Description: This site is located in southern McCurtain County and consists of recent clear-cut.

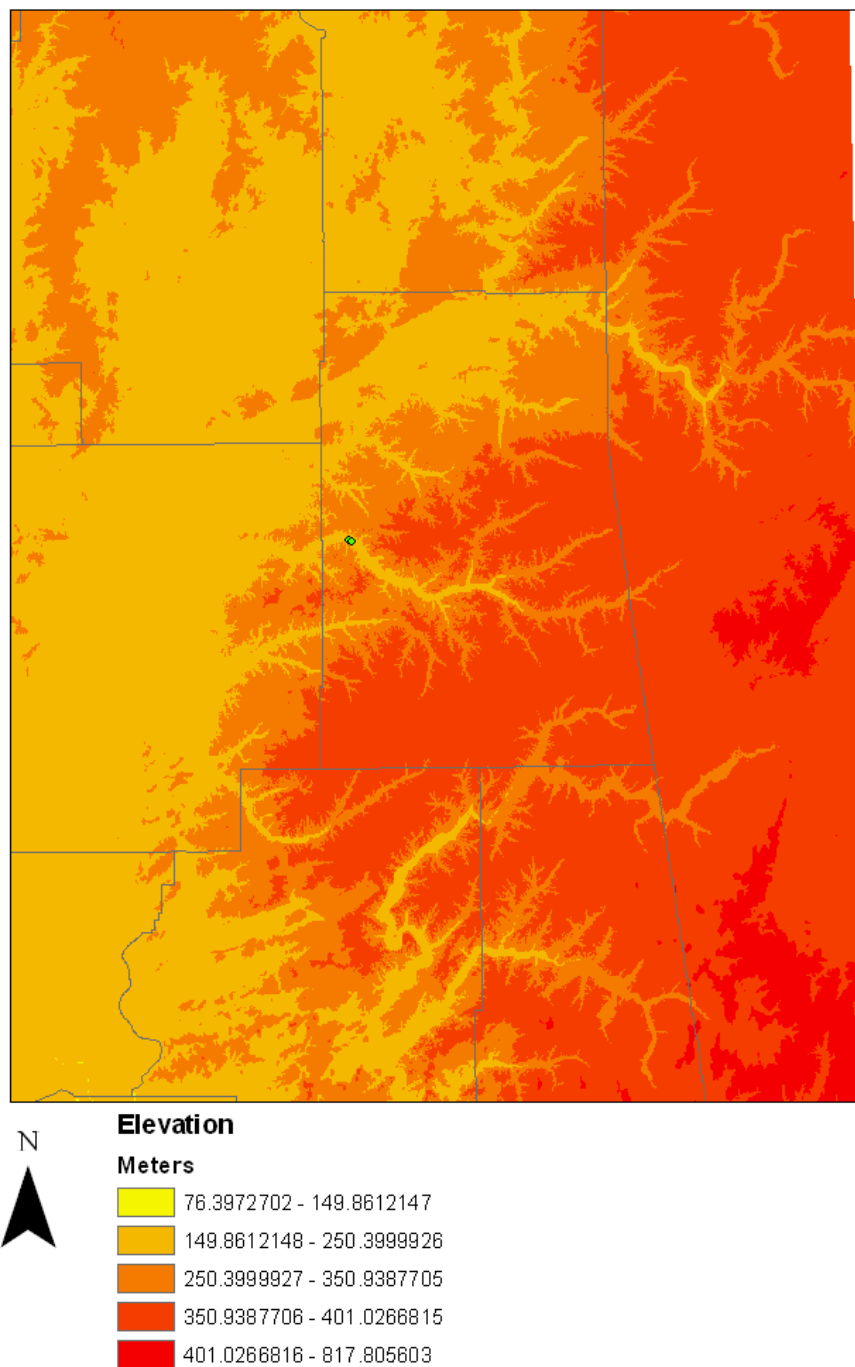
Bird Survey Results:

BLGR	3
COYE	5
DICK	5
EAKI	1
FISP	2
INBU	10
MODO	2
NOBO	4
NOCA	1
OROR	1
PRAW	3
WEVI	1
YBCH	6

## Appendix II.

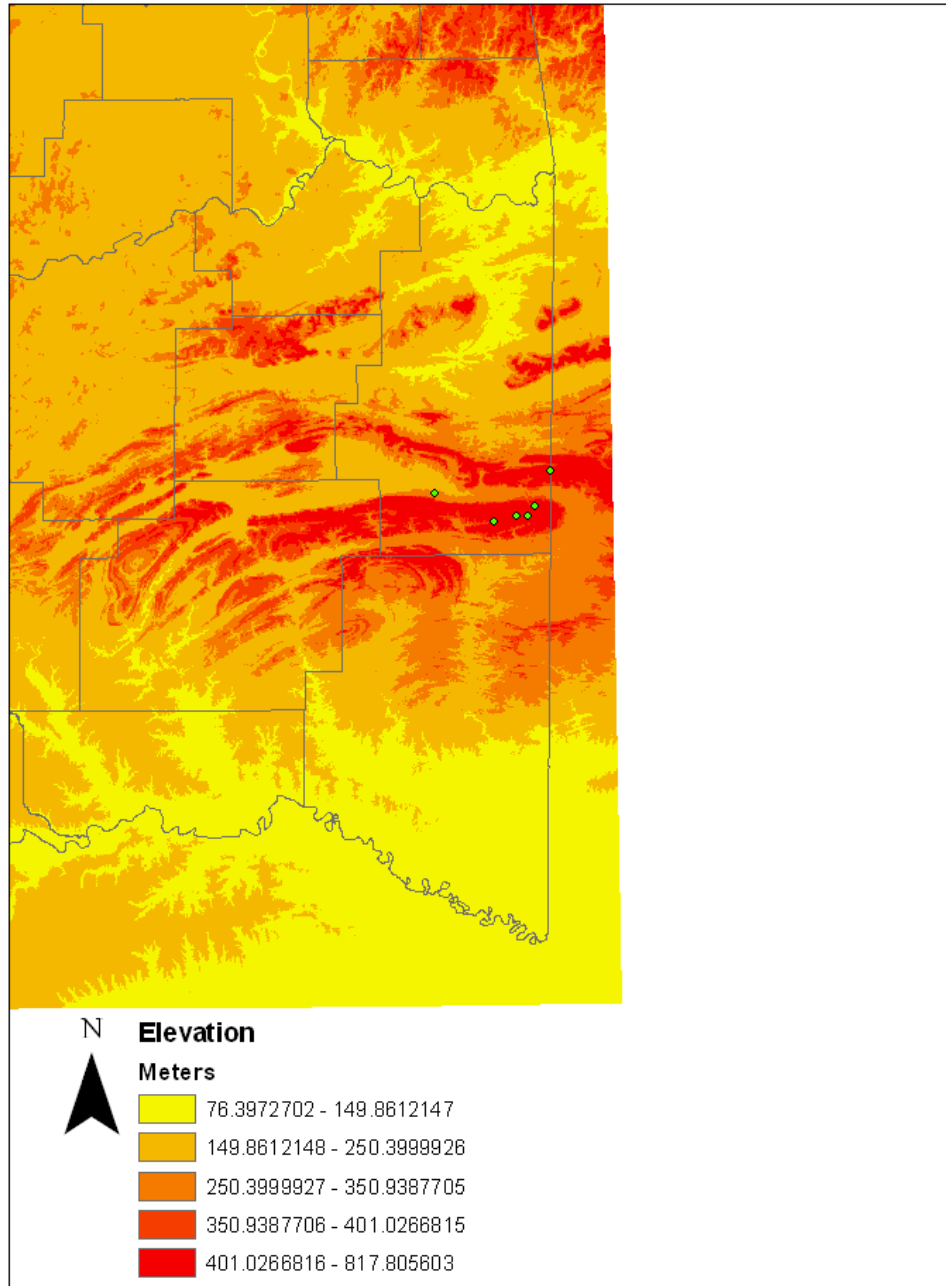
This consists of maps of Species of Special Concern and other Selected Species in Oklahoma.

## American Redstart Locations



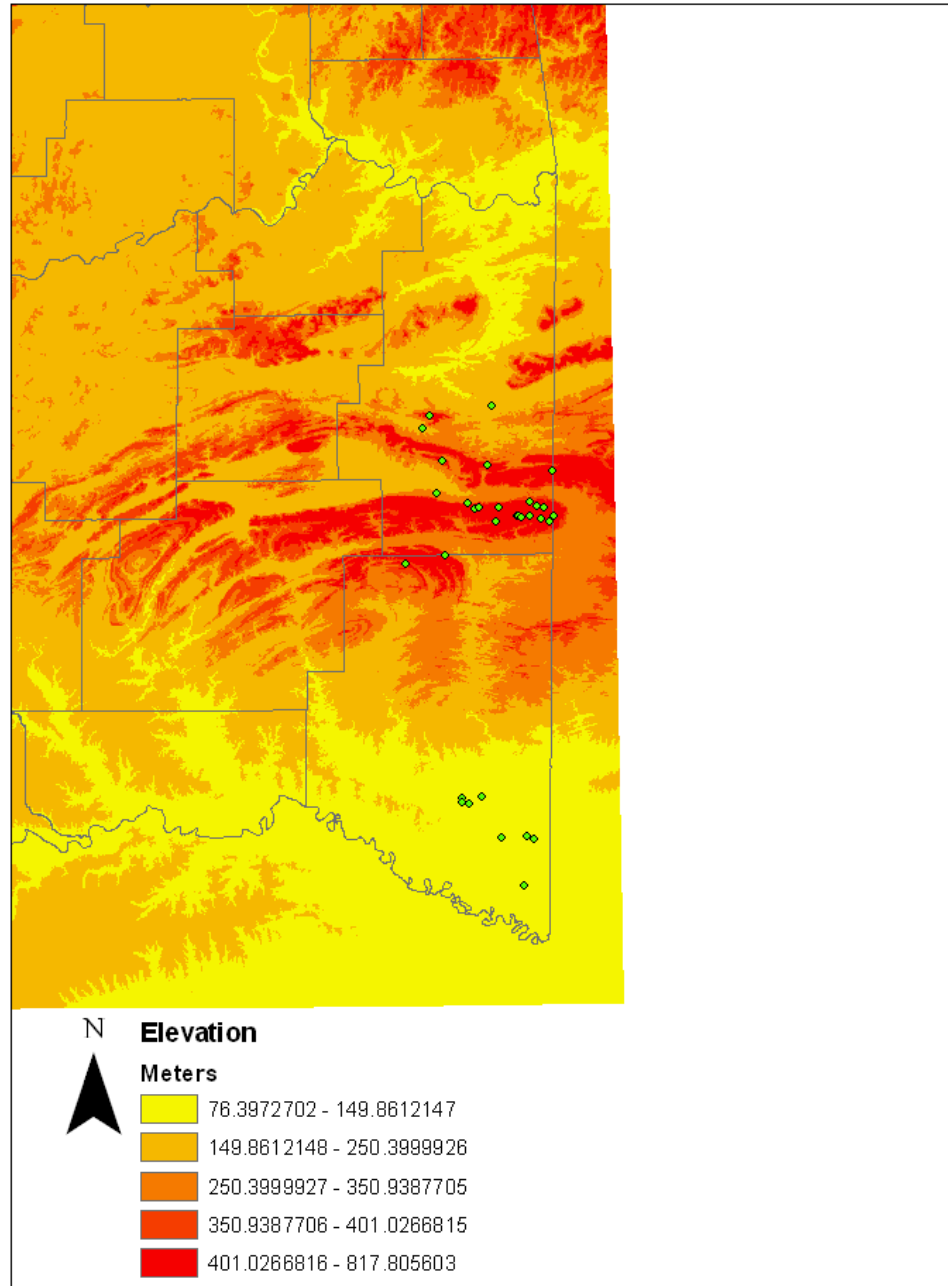
**Figure 3. Our only two American Redstart locations were located along Spavinaw Creek between Spavinaw Lake and Lake Eucha. This appears to be the location listed in the Oklahoma Breeding Bird Atlas for a nesting confirmation prior to the atlas.**

## Black-throated Green Warbler Locations



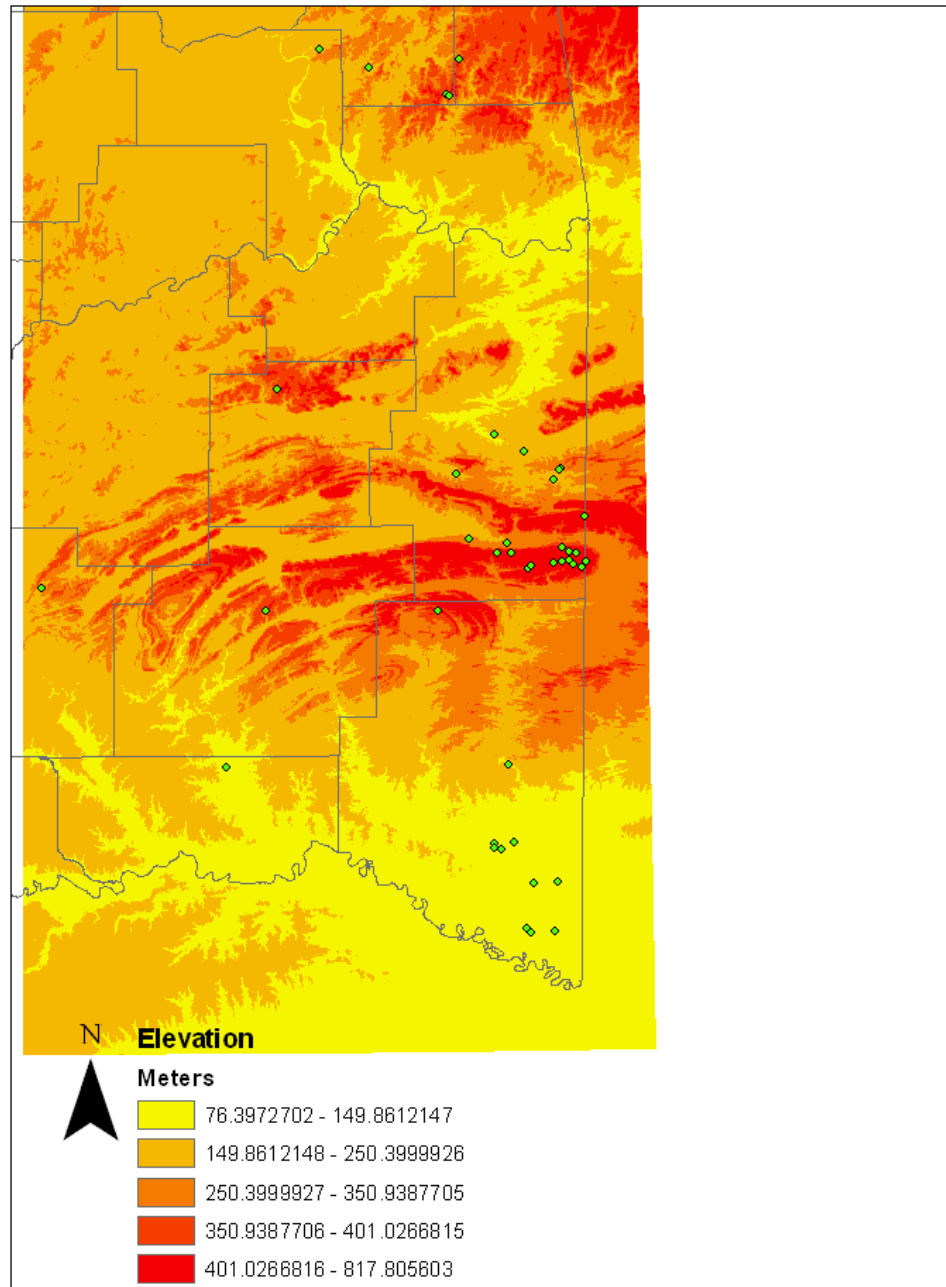
**Figure 4.** The Black-throated Green Warbler appears to be a new addition to the breeding birds of Oklahoma. All of our Black-throated Green records come from mature deciduous forests at high elevations in LeFlore County.

## Hooded Warbler Locations



**Figure 5. Hooded Warblers were widespread in southeastern Oklahoma but absent from northeastern areas. They were located in both mature deciduous forests at high elevations and within mature bottomland hardwood forests at places like Little River NWR. It seemed like Hooded Warblers were more intolerant of forest fragmentation than Kentucky Warbler.**

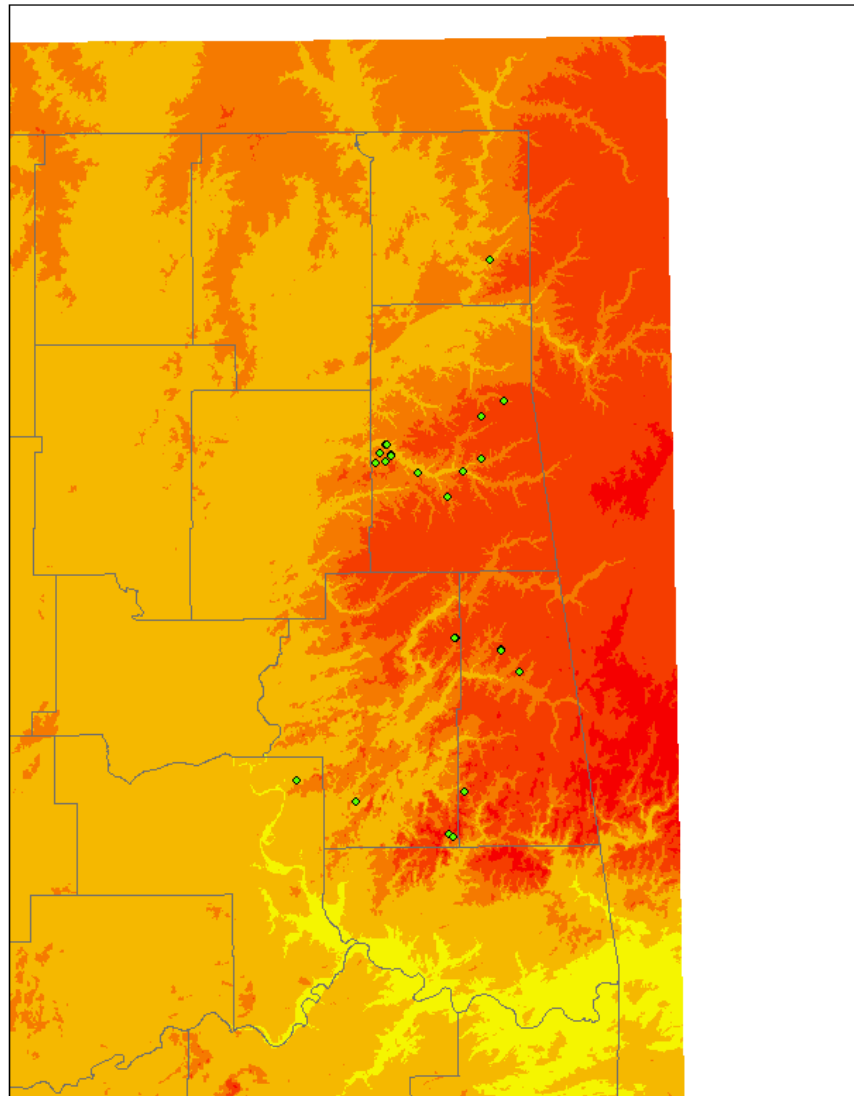
## Kentucky Warbler Locations, Southern Half



**Figure 6. Kentucky Warblers were the most widespread of the species of concern found at nearly half of sites surveyed. Kentucky Warblers were found at many fragmented sites and also sites with a higher pine component than Hooded Warblers.**








## Kentucky Warbler Locations, Northern Half

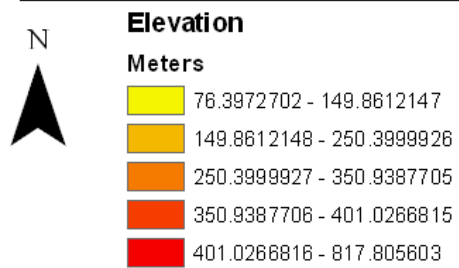
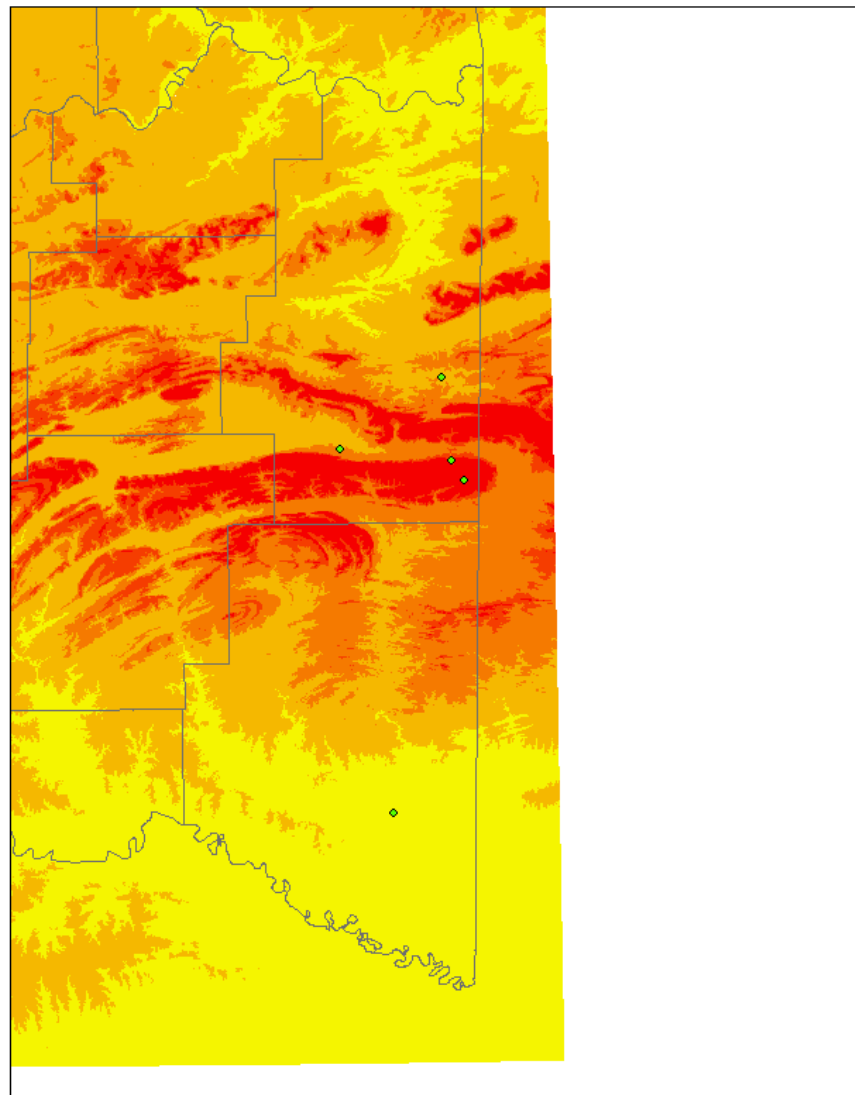


### Elevation

#### Meters

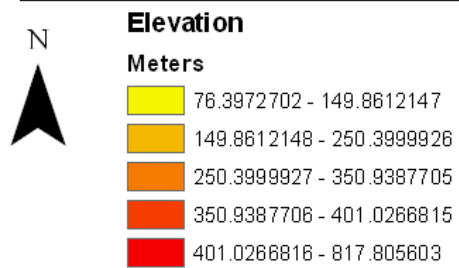
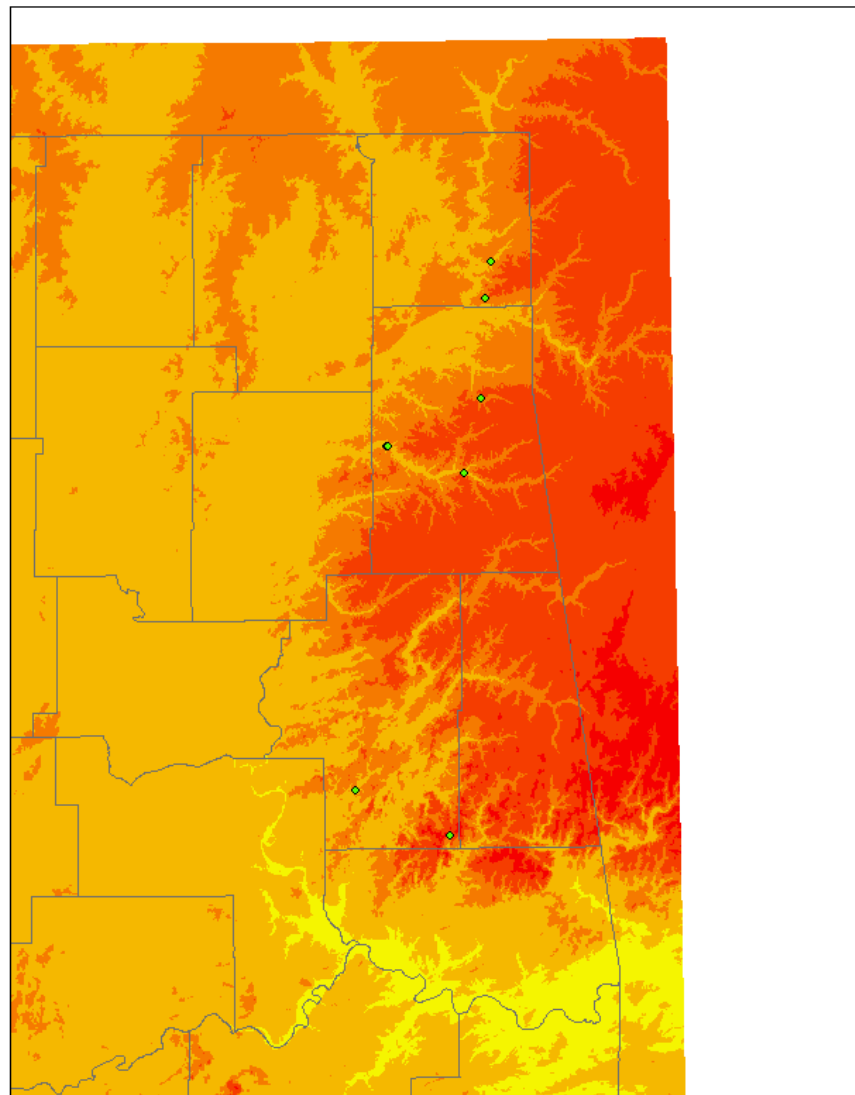
	76.3972702 - 149.8612147
	149.8612148 - 250.3999926
	250.3999927 - 350.9387705
	350.9387706 - 401.0266815
	401.0266816 - 817.805603

## Louisiana Waterthrush Locations, Southern Half

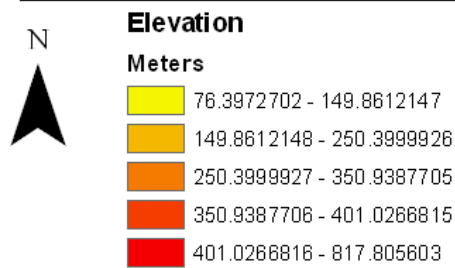
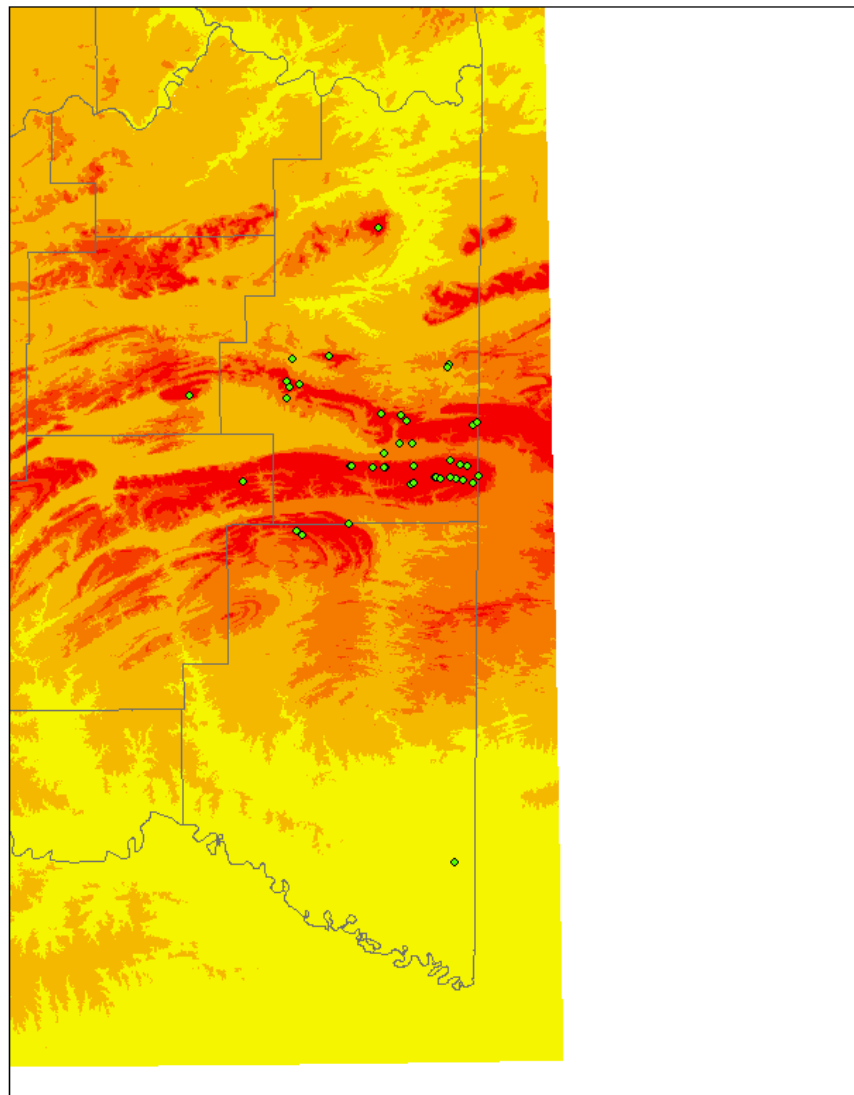


**Figure 7. Louisiana Waterthrushes were found throughout the study area. They were primarily limited to sites near permanent streams and rivers.**

## Louisiana Waterthrush Locations, Northern Half

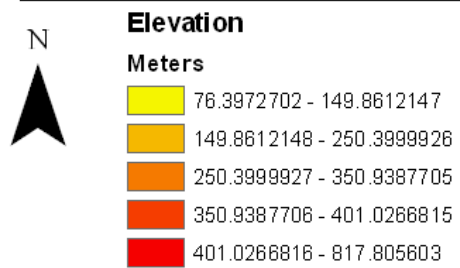
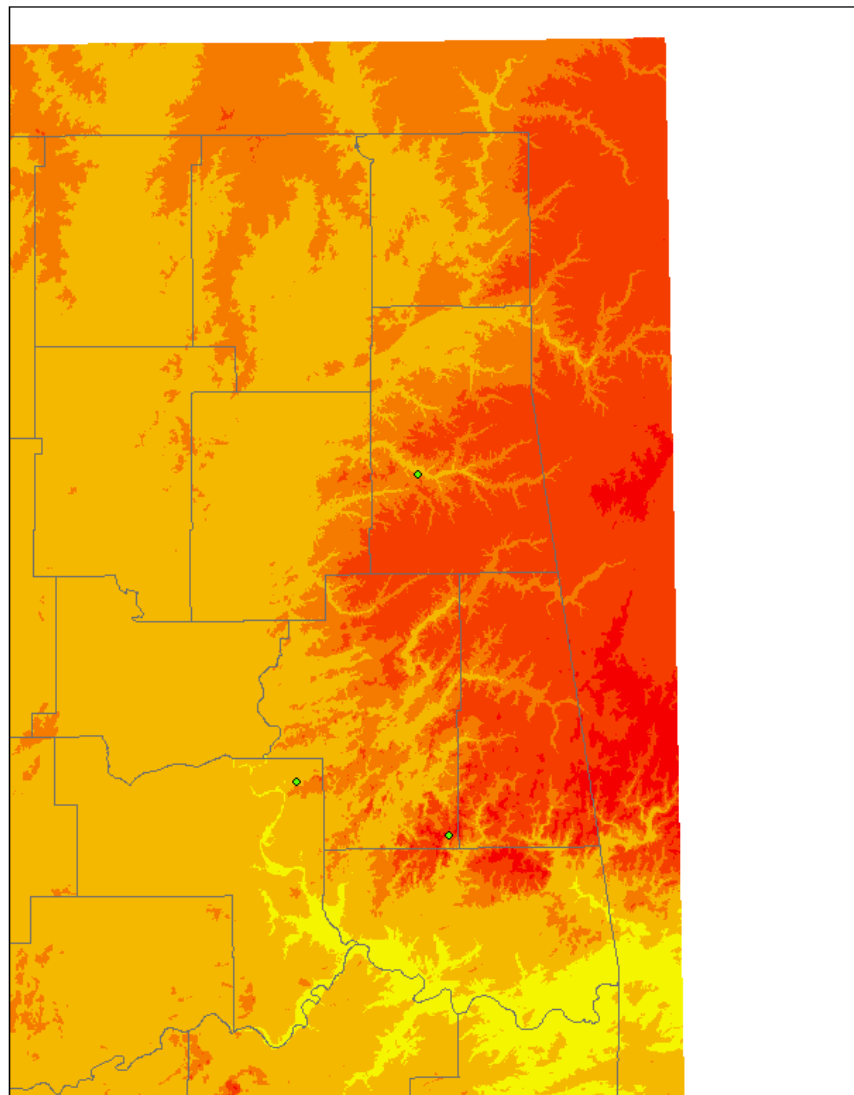


## Ovenbird Locations, Southern Half

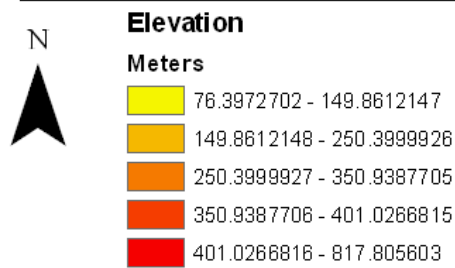
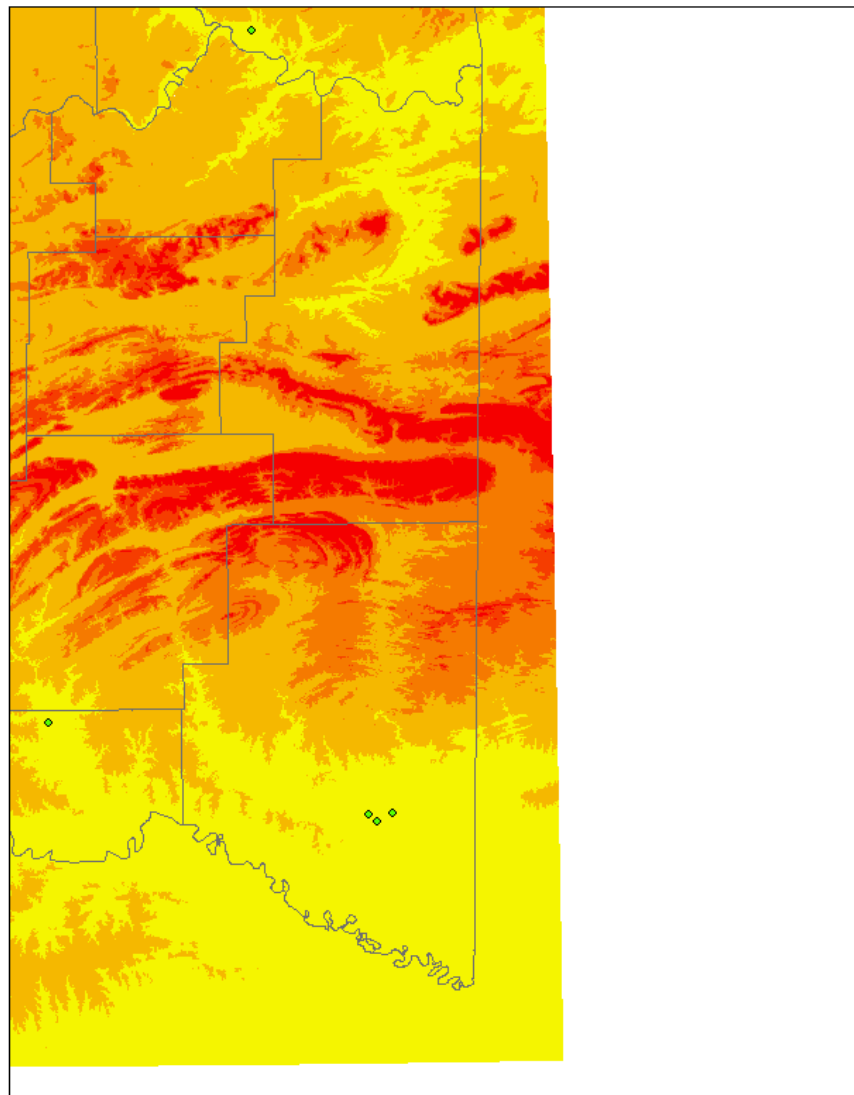


**Figure 8.** We included Ovenbird in this section because they were found at relatively few sites during the Breeding Bird Atlas period. We found them to be one of the most common species at higher elevation sites in the Ouachita Mountains.

## Ovenbird Locations, Northern Half

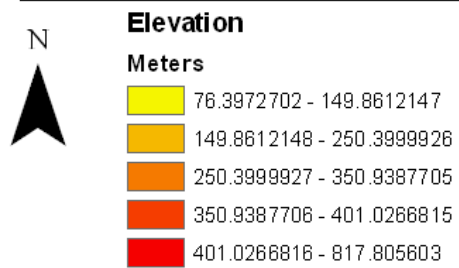
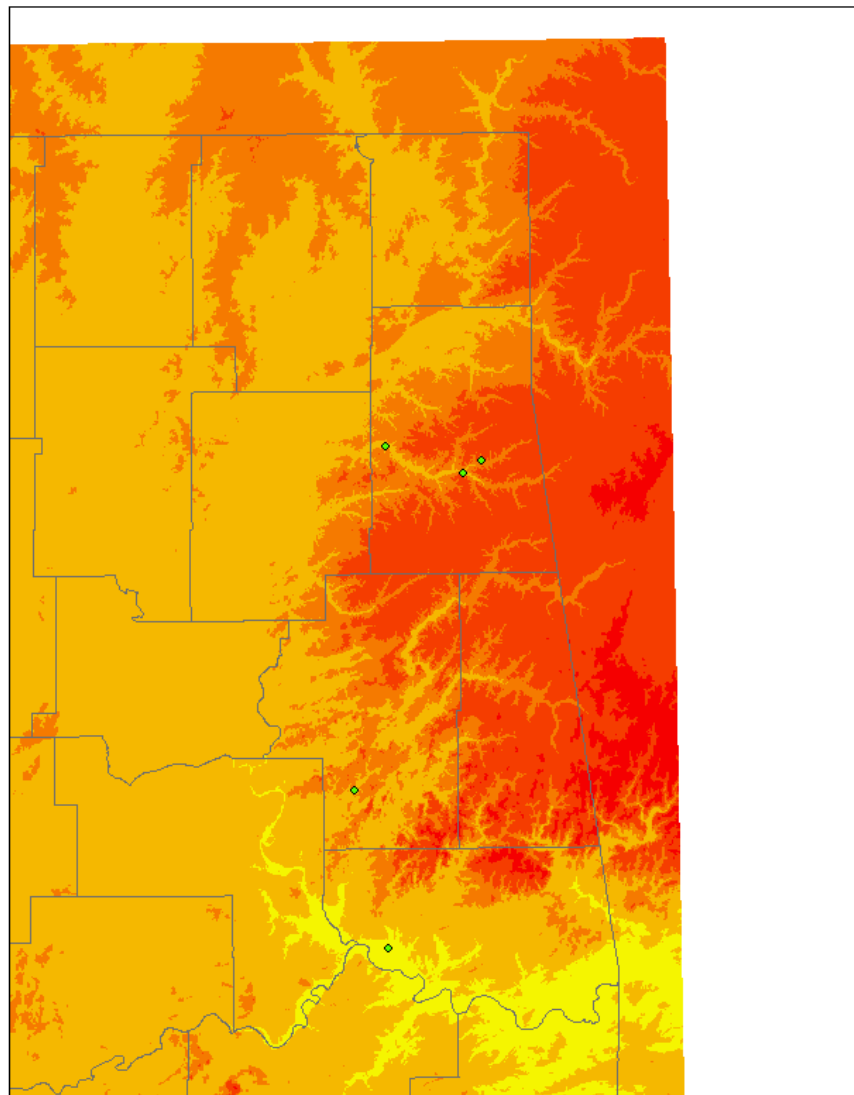


## Prothonotary Warbler Locations, Southern Half

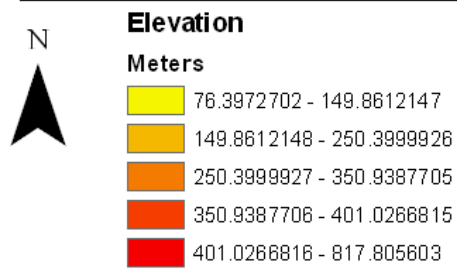
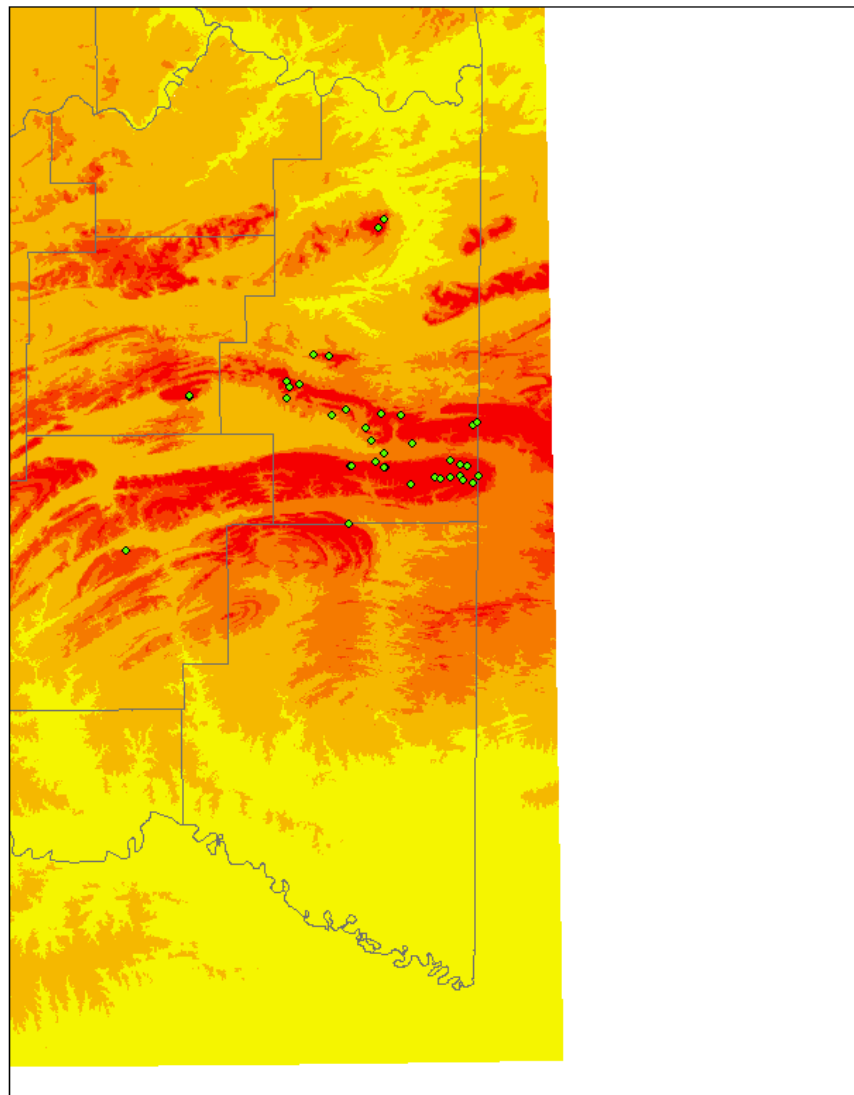


**Figure 9.** We found Prothonotary Warblers at sites with bottomland hardwood forests such as Little River NWR, Hugo WMA, Sequoyah NWR and along Spavinaw Creek.

## Prothonotary Warbler Locations, Northern Half



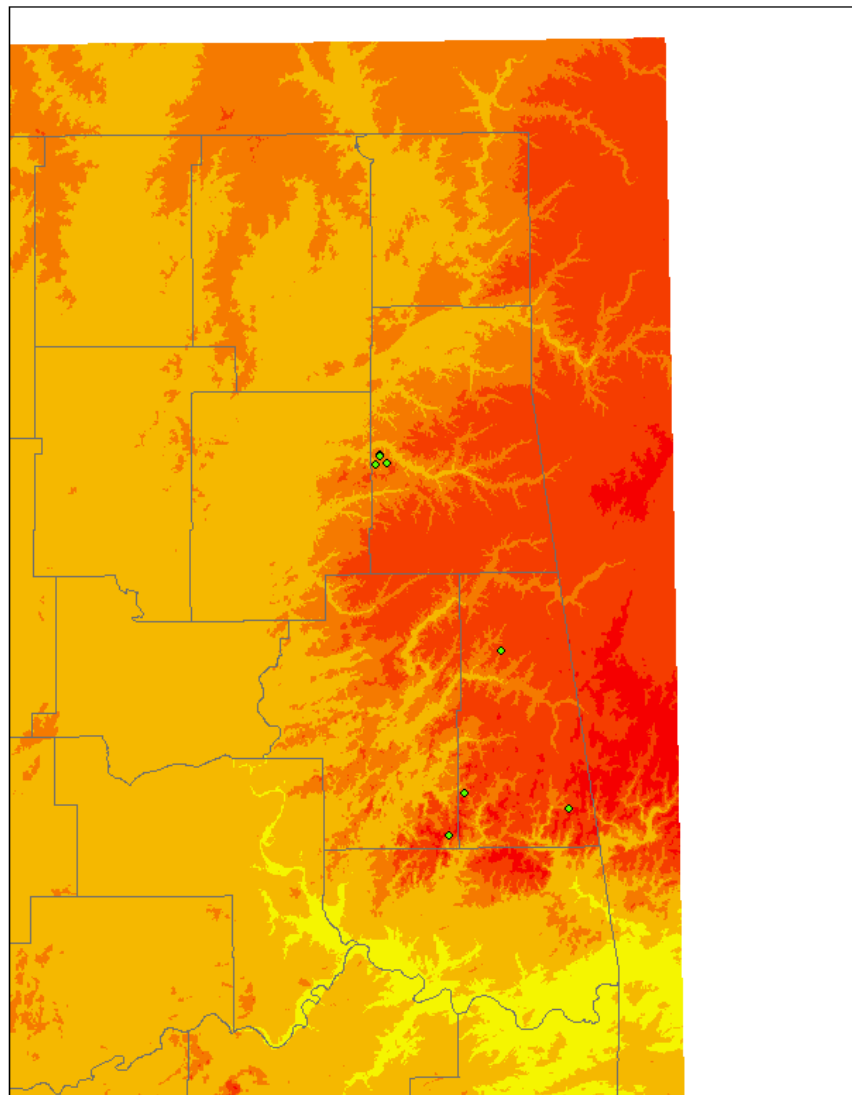
## Scarlet Tanager Locations, Southern Half



**Figure 10.** We found Scarlet Tanagers to be a relatively widespread and common species wherever there was mature oak-hickory forest.








# Scarlet Tanager Locations, Northern Half

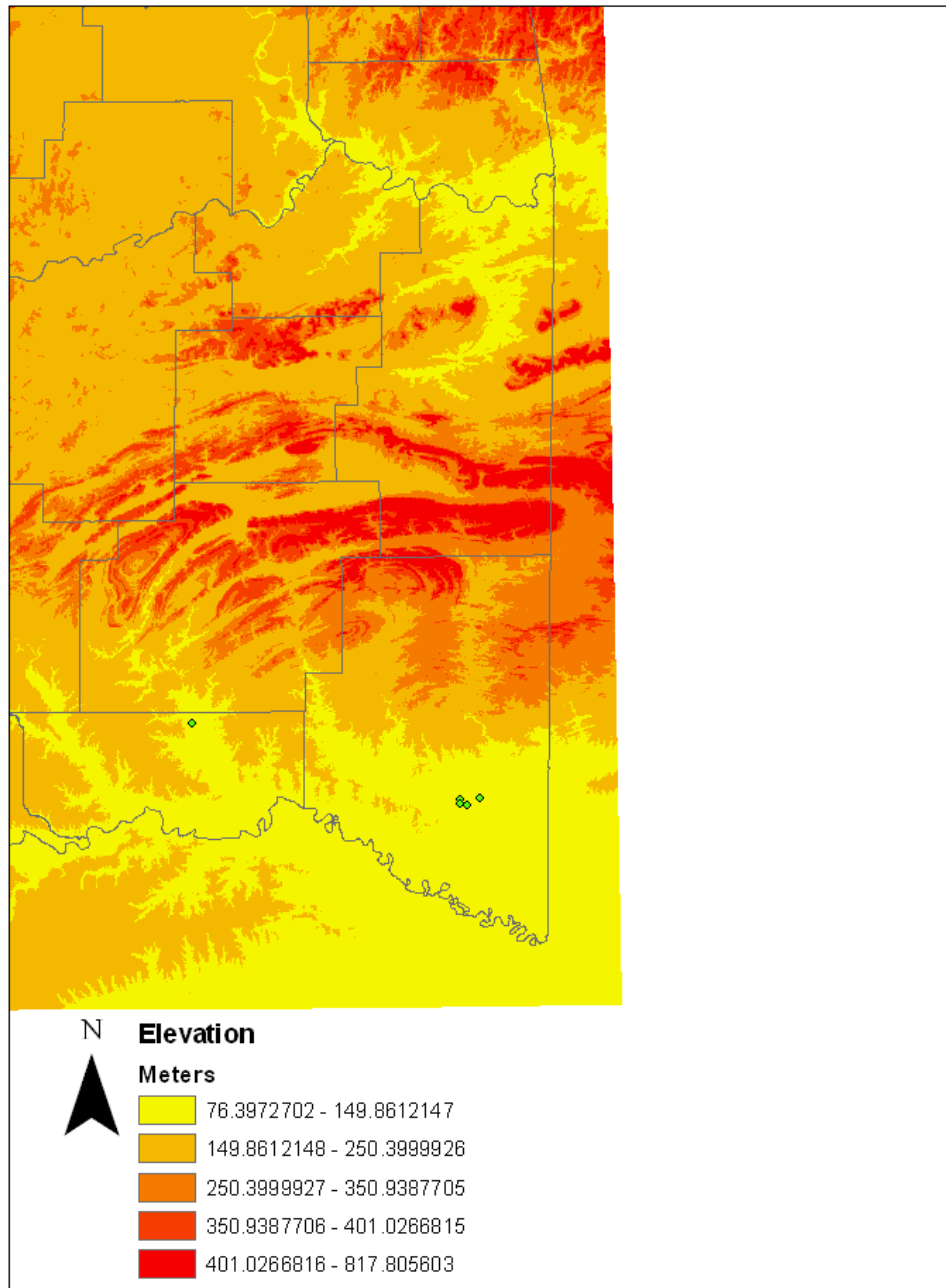


## Elevation

### Meters

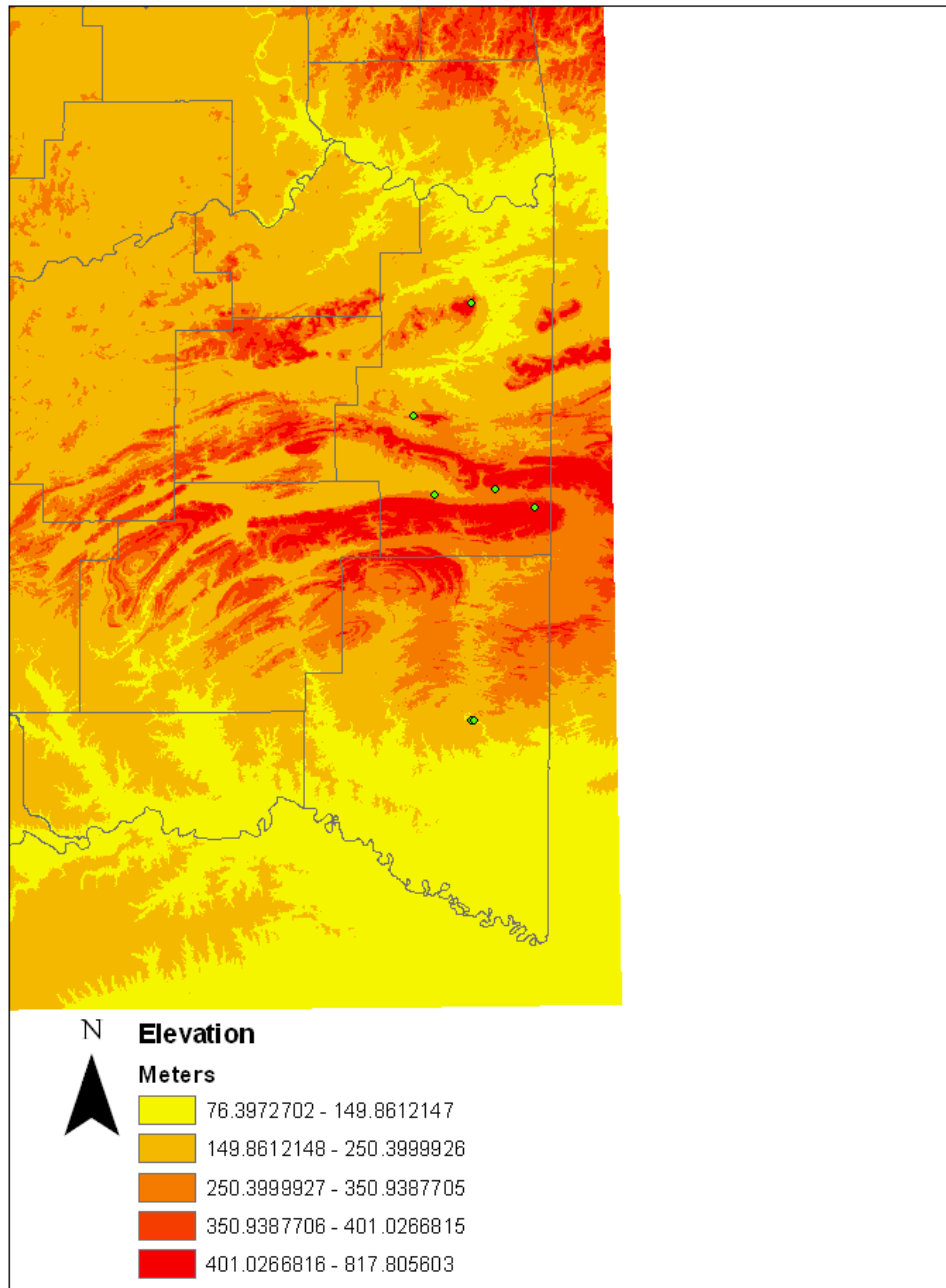
	76.3972702 - 149.8612147
	149.8612148 - 250.3999926
	250.3999927 - 350.9387705
	350.9387706 - 401.0266815
	401.0266816 - 817.805603

## Swainson's Warbler Locations



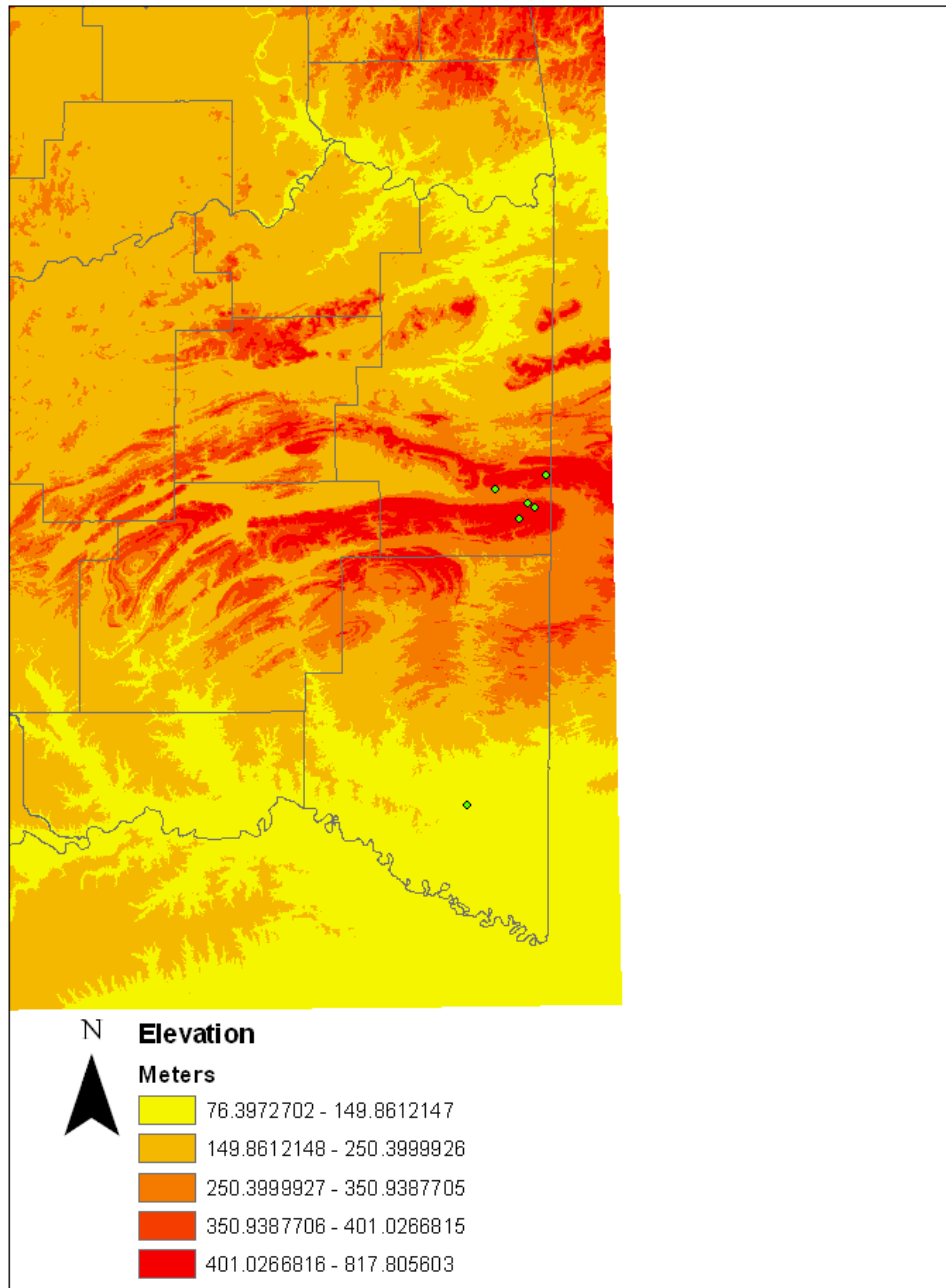
**Figure 11.** We found Swainson's Warblers to be locally common at Little River NWR and also found one at Hugo WMA in Choctaw County. We did not find any outside of these two relatively intact bottomland forest systems.

## Worm-eating Warbler Locations



**Figure 12. Very few Worm-eating Warblers were found during the Breeding Bird Atlas. Although still rare we found Worm-eating Warblers across much of LeFlore and McCurtain counties, especially in areas with high elevations and steep slopes**

## Wood Thrush Locations



**Figure 13.** We found Wood Thrush at only six locations. Most of these were at high elevations in the Ouachita Mountains but we also had one at Little River NWR. This species seemed to be more widespread during the Breeding Bird Atlas project.

## Study Area 2006 and 2007

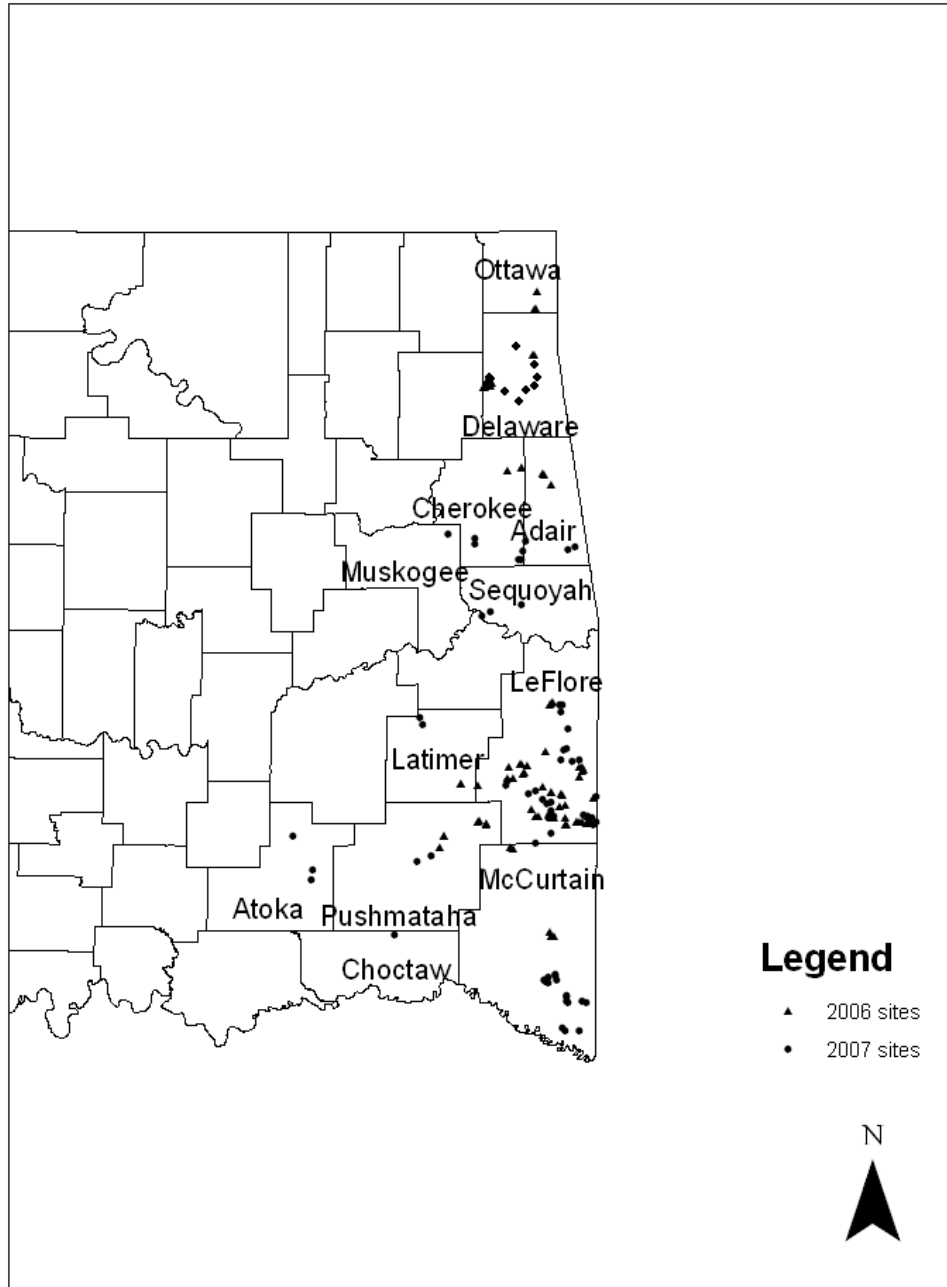


Figure 14. Map of our study area.

## VITA

Vincent Stephen Cavalieri

Candidate for the Degree of

Master of Science

Thesis: STATUS AND HABITAT AFFINITY FOR CERULEAN WARBLER AND  
OTHER FOREST BIRDS IN OKLAHOMA

Major Field: Natural Resource Ecology and Management

### Biographical:

Personal Data: Born in Iron Mountain, MI on October, 15 1981, the son of  
Stephen and Debra Cavalieri

Education: Graduated from Iron Mountain High School in Iron Mountain, MI  
in May, 2000; received a Bachelor of Science Degree in Fisheries and  
Wildlife from Michigan State University, East Lansing, MI in  
December, 2004. Completed the requirements for the Master of Science  
degree with a major in Natural Resource Ecology and Management at  
Oklahoma State University, Stillwater, Oklahoma in December, 2008.

Experience: Birder from the age of 8 years old, first began working bird  
research field jobs in high school; employed by several Universities  
including Michigan Technological University, The University of  
Michigan and Mississippi State University; as well as by the United  
States Forest Service and United State Fish and Wildlife Service; studied  
many different species in several states across the country.

Professional Memberships: The Wildlife Society; The Wilson Ornithological  
Society; The American Ornithologist's Union.

Name: Vincent Stephen Cavalieri

Date of Degree: December, 2008

Institution: Oklahoma State University

Location: Stillwater, Oklahoma

Title of Study: STATUS AND HABITAT AFFINITY FOR CERULEAN WARBLER  
AND OTHER FOREST BIRDS IN OKLAHOMA

Pages in Study: 159

Candidate for the Degree of Master of Science

Major Field: Natural Resource Ecology and Management

Scope and Method of Study: Several species of breeding birds in the Eastern Deciduous Forest reach the southwestern limit of their distribution in the mountains of eastern Oklahoma. One of these species is the declining Cerulean Warbler, once reported as at least a locally common breeder in portions of Oklahoma. Recent work for Oklahoma's (1997-2001) breeding bird atlas however, did not document any breeding Cerulean Warblers in the state. Our objective was to search areas of potentially suitable habitat within the historical range of Cerulean Warbler in Oklahoma, and determine if the species still breeds within the state. We conducted point counts at 150 sites in both the Ozark Highlands and the Ouachita Mountains in Eastern Oklahoma in 2006 and 2007

Findings and Conclusions: We located Cerulean Warblers at 5 out of 150 (3.3%) of the sites surveyed. These sites were located on north slopes in the Ouachita Mountains, near ridge tops between 641 and 721 m elevation. We encountered 8 adult males and 4 adult females at the 5 sites. We confirmed breeding in Oklahoma from separate observations of one pair carrying food and feeding fledglings in June 2006 on Lynn Mountain, Leflore County and another pair feeding fledglings in June 2007 on Rich Mountain, Leflore County.

ADVISER'S APPROVAL: Dr. Timothy J. O'Connell

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