Henslow's Sparrow Distribution, Relative Abundance and Habitat Selection in the Central Hardwoods Bird Conservation Region

CHRISTOPHER M. LITUMA, TIFFANY A. BEACHY and DAVID A. BUEHLER

Department of Forestry, Wildlife and Fisheries

University of Tennessee

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INTRODUCTION

North American prairies and savannahs have undergone substantial changes since European settlement (Samson and Knopf 1994, Askins 1999). These changes can be attributed to increased row crop farming, increased cattle range expansion, suppressed fire regimes, urbanization and exotic grass species introduction (Askins 1999, Conner et al. 2001, Samson et al. 2004). State, federal and private conservation agencies have developed a variety of programs aimed at reversing the trend of native prairie and early successional habitat loss. Federal programs promoting grassland and early successional habitat management and restoration include the Conservation Reserve Program (CRP), established by the U.S.D.A. Natural Resource Conservation Service (NRCS), and the Landowner Incentive Program (LIP), administered by the U.S. Fish and Wildlife Service.

There have also been wildlife-specific programs developed, such as the National Bobwhite Conservation Initiative (NBCI), which specifically targets restoring and managing areas for Northern Bobwhites (*Colinus virginianus*)(Dimmick et al. 2002). The North American Bird Conservation Initiative (NABCI) developed bird conservation regions that have focused bird conservation on ecologically distinct regions within North America. The Central Hardwoods Bird Conservation Region (CHBCR) extends from central Tennessee and Kentucky across the Mississippi River to eastern Oklahoma, and western Arkansas and Missouri (Figure 1). Twenty-six avian species of conservation concern breed in the CHBCR, of which 4 are grassland associated species and 6 are early successional species (Burger et al. 2006).

Grassland birds are declining more than any other avian guild in North America (Herkert 1995, Patterson and Best 1996, Brennan and Kuvlesky 2005). Thirteen species have shown significant declines in the past 4 decades, and 9 of 14 grassland and early successional species that occur east of the Mississippi River have shown at least a 2% population decline over that

same time period (Askins et al. 2007). Many of these declines can be attributed to a loss of breeding habitat within the breeding ranges of these species (Wiens 1985, Vickery et al. 1999, Winter and Faaborg 1999). Some grassland bird species respond to CRP management at the practice level (Wiens 1985, Patterson and Best 1996, Hughes et al. 1999, McCoy et al. 1999, Vickery et al. 1999, Winter and Faaborg 1999). There are few research projects that have assessed species-specific population changes and their associations with conservation practices at the programmatic level (Best et al. 1997, Boyce 2006, Herkert 2007a). The North American Breeding Bird Survey (BBS) organized by the Patuxent Wildlife Research center, through the U.S. Geological Survey (USGS) is a programmatic level roadside based survey method used to track bird population changes through time (Sauer et al. 1997). Although the methodologies used by the BBS are criticized because of a variety of potential biases (Keller and Scallan 1999), BBS represents the only comprehensive monitoring database for evaluating broad-scale population change for species of conservation concern.

Surveys along roads can potentially bias abundance and occupancy estimates because roadsides can either attract or repel certain species (Keller and Scallan 1999). Over the last decade, detection probabilities have increasingly been used to adjust abundance and occupancy estimates (MacKenzie 2005, Royle et al. 2005, Alldredge et al. 2006, Kissling and Garton 2006). It is important to understand how detection probabilities for rare and low detectability species along roadsides vary compared to off-road counts within the same landscape. Roadside-based methods used to generate population estimates such as an index of abundance, or occupancy, will provide more reliable estimates once a species-specific correction factor can be used to adjust for detectability (MacKenzie et al. 2002, Diefenbach et al. 2003, Royle and Nichols 2003).

Based on analysis of BBS data, Henslow's Sparrow (*Ammodramus henslowii*) populations were declining faster than any other species in the United States (Herkert 1997). There has been an 8.5% decline from 1966 – 1993 in New York, Michigan, Ohio, and Wisconsin. In Illinois the breeding populations declined by 7.1% from 1978 – 1999 (Herkert 1997). Recent range–wide trends suggest that the populations have stabilized, and may even be increasing in certain areas (Cooper 2007, Herkert 2007b). Despite recent population trends, there is still concern about Henslow's Sparrow populations. The Henslow's Sparrow is a United States Fish and Wildlife (USFWS) national species of concern (USFWS 2008).

Much of the research related to Henslow's Sparrow conservation has focused at the practice scale (Robins 1971, McCoy et al. 1999, Cully and Michaels 2000, Ingold 2002, Herkert et al. 2003). Typical Henslow's Sparrow habitat includes tall, mixed species grasslands with dense vegetation, and few trees and shrubs (Robins 1971, Cully and Michaels 2000, Cooper 2007). Henslow's Sparrows also breed on reclaimed coal surface mines, and have increased in abundance in Illinois associated with CRP plantings (Bajema et al. 2001, McCoy et al. 2001, Scott et al. 2002, Herkert 2007a). Landscape-scale models to predict Henslow's Sparrow abundances have been constructed for the Prairie Hardwood Transition Bird Conservation Region (PHTBCR). The models were created using landscape-level GIS data to predict abundances based on BBS Henslow's Sparrow detections (Thogmartin et al. 2006, Murray et al. 2008). However, Henwlow's Sparrow detections were very low, and no confirmatory data were collected on habitat associations. The researchers focused on the PHTBCR because it is an area of immediate management action for Henslow's Sparrows, and is estimated to contain 13% of the breeding population (Thogmartin et al. 2006, Murray et al. 2008).

We focused surveys in the CHBCR because 18% of the breeding population of Henslow's Sparrows occurs in this region, and is in need of management attention (Cooper 2007). Two conservation action items outlined in the Henslow's Sparrow conservation plan were to: "determine the current status and distribution of the Henslow's Sparrow throughout its breeding range, and improve the understanding of Henslow's Sparrow population demographics and how they are affected by differing habitat management regimes and landscape changes across the species breeding range" (Cooper 2007). Our project had three specific objectives. First, we summarized Henslow's Sparrow distribution and relative abundance data from multiple sources (BBS and Breeding Bird Atlas [BBA]) and enhanced those data with atlas and roadside survey data of our own for the Central Hardwoods BCR. Second, we used systematic roadside surveys in focal areas to document Henslow's Sparrow habitat associations for the CHBCR. Finally, we conducted a study to document differences in occupancy and detection between roadside and off-road areas to assist in understanding biases associated with roadside counts of Henslow's Sparrows.

Henslow's Sparrow historical distribution in the CHBCR

In Illinois, the BBS yielded a total of 80 individual Henslow's Sparrows since the survey began in 1966, with 55 (68.8%) of those being recorded in the last ten years (2000-2009) (USGS 2010). They were found on 16 different routes (of an average 61 routes per year in the state) in 15 counties: Bureau, Calhoun, Christian, Henderson, Henry, Jo Daviess, Lee, Livingston, Marion, Ogle, Pope, Tazewell, Vermilion, Will, and Winnebago. There were 25 breeding Henslow's Sparrows in 22 blocks across the state as part of a BBA project (Kleen et al. 2004). Of the blocks where Henslow's Sparrows were reported, 8 were possible breeding, 7 were probable breeding, and 7 were confirmed breeding. Their state population status was changed

from threatened to endangered in 1994. Although they are still in decline, Henslow's Sparrows appear to be more widespread and common in Illinois today than during the last two decades (Kleen et al. 2004).

In Indiana, the BBS reported 350 individuals from 1966-2009, with 202 (57.7%) of these having been recorded in the last ten years (USGS 2010). They were found on 28 different routes (of an average of 30 routes per year in the state) in 25 counties: Benton, Clay, Delaware, Dubois, Franklin, Hamilton, Harrison, Jackson, Kosciusko, Lake, Lawrence, Martin, Newton, Owen, Porter, Rush, Scott, Shelby, Starke, Steuben, Vanderburgh, Vigo, Warrick, Washington, and White. Henslow's Sparrows were reported on 60 blocks across the state as part of the BBA project from 1985 ─ 1990 (Castrale et al. 1998). There were 38 individuals reported in high priority blocks, and 60 individuals reported in non-priority and high priority blocks. There were a total of 23 possible breeding reports, 31 probable breeding reports, and 6 confirmed breeding reports in all of the blocks (Castrale et al. 1998). BBA surveys were also conducted from 2005 ─ 2010. During this second BBA survey, there were 72 high priority blocks in which a Henslow's Sparrow was reported breeding, and 109 blocks including non-priority blocks (Castrale et al. 2010). There were a total of 31 possible breeding reports, 70 probable breeding reports, and 8 breeding confirmed reports in non-priority and high priority blocks (Castrale et al. 2010).

In Kentucky, the BBS reported 122 individuals since 1966, with 86 (70.5%) of those being recorded in the last ten years (USGS 2010). They were found on 14 different routes (of an average of 29 routes per year in the state) in the following 12 counties: Anderson, Calloway, Grayson, Hardin, Livingston, Monroe, Muhlenburg, Oldham, Shelby, Taylor, Webster, and Woodford. Henslow's Sparrows are considered locally distributed summer residents in

Kentucky (Palmer-Ball 1996). Historical records indicate that they have been found in the following areas: Boone, Clinton, Jefferson and Oldham counties, east to Carter, Lewis and Morgan counties, and west to Crittenden and Caldwell counties (Palmer-Ball 1996). The largest colony, made up of 6 singing males, was found in Pendleton county. Henslow's Sparrows were reported breeding on 34 high priority blocks during the Kentucky BBA surveys conducted from 1985─ 1991 (Palmer-Ball 1996). There were a total of 19 possible breeding reports, 12 probable breeding reports, and 3 confirmed breeding reports in high priority blocks (Palmer-Ball 1996).

No Henslow's Sparrows were recorded in Tennessee from 1966-2009 on BBS routes (USGS 2010). Historic records report sporadic sightings in Roane County (1957) and Cheatham County (1994, Nicholson 1997). A large breeding population was discovered on Fort Campbell Military Reservation in the late 1990's (Moss 2001).

No Henslow's Sparrows have been reported by the BBS or BBA efforts in Arkansas (Smith 2009, USGS 2010).

In Missouri, the BBS reported 369 individuals since 1966, with 185 (50.1%) of these recorded in the last ten years (USGS 2010). They were found on 19 different routes (of an average of 33 routes per year in the state). Henslow's Sparrows are considered uncommon, local, and declining in Missouri (Wilson and Jacobs 1992). Previously, they bred in native grasslands throughout the Midwest (Herkert 1994) and were considered locally common breeders in wet meadows across the Osage Plains and Ozark Border natural divisions of Missouri (Widmann 1907 *in* Wilson and Jacobs 1992). Today, their range is restricted to remnant prairie patches, hayfields, and grassy pastures with standing dead vegetation (Wilson and Jacobs 1992). Henslow's Sparrows were reported in 32 (2.7%) of the 1,207 BBA blocks in Missouri, mostly scattered across western and northern regions of the state (Wilson and Jacobs 1992). Henslow's

Sparrows were reported breeding on 32 high priority blocks during the Missouri BBA surveys conducted from 1986─ 1992 (Wilson and Jacobs 1992). There were a total of 11 possible breeding reports, 15 probable breeding reports, and 6 confirmed breeding reports in high priority blocks (Wilson and Jacobs 1992). Counties where Henslow's Sparrows have been reported include: Barton, Callaway, Cedar, Daviess, Dekalb, Harrison, Henry, Jasper, Lafayette, Macon, Monroe, Newton, Pike, Polk, Putnam, Randolph, Rates, Robinson, St. Clair, Saline, Sullivan, Vernon, Webster, and Wright.

In Oklahoma, the BBS reported 155 individuals since 1966, with 44 (28.4%) of these recorded in the last ten years (USGS 2010). They were found on 3 different routes (of an average of 37 routes per year in the state). Henslow's Sparrows were not reported on any BBA surveys (Reinking 2004).

STUDY AREA

Roadside Atlas and Point Count Surveys

We conducted roadside atlas and point-count surveys throughout the CHBCR (Figure 1). The Central Hardwoods was historically characterized by open tall grass prairie intermixed with oak and pine woodlands. It encompasses 29,815,052 ha across 10 central and mid-south states. More than 50% of the land post-European settlement has been converted to non-native grass pasture, hay, and range production, typically tall fescue (*Festuca arundinacea*), and planted into crops such as, corn (*Zea mays*), soybeans (*Glycine max*), sorghum (*Sorghum bicolor*), and wheat or oats (*Triticum aestivum* and *Avena sativa*)(Nuzzo 1985, Dimmick et al. 2002).

Our monitoring approach was based on surveying focal counties. Focal regions were originally identified from a Northern Bobwhite habitat potential model developed by Burger et

al. (Figure 2). Focal areas were then further defined during individual state workshops as part of the NBCI plan revision. In general, we selected eight counties per state, unless the CHBCR region in the state was limited. Focal counties represented the best regions in a given state for grassland bird and Northern Bobwhite restoration, based on the opinion of the biologists and managers that participated in the NBCI workshops in each state (Figure 1).

In 2008 we conducted surveys in CHBCR states east of the Mississippi River; in 2009 we conducted surveys in CHBCR states west of the Mississippi River. In 2010 we resurveyed all focal counties previously selected across the entire CHBCR. In 2008, we surveyed a broad region within the CHBCR that included parts of middle Tennessee, western Kentucky, southern Indiana, and southern Illinois. We expanded the surveyed region in 2009 by conducting routes in Arkansas, Missouri, and Oklahoma. Counties were considered the experimental units. In 2008, we surveyed nine counties in Tennessee (Coffee, Franklin, Giles, Lawrence, Lincoln [1 route], Maury, Montgomery, Robertson, Sumner), eight counties in Kentucky (Breckinridge, Butler, Hart, Livingston, Logan, Ohio, Warren, Webster), and four counties in Indiana (Orange, Ripley, Sullivan, Warrick) and Illinois (Franklin, Hamilton, Jackson, White) for a total of 25 counties in four states (Table 1). In 2009, we surveyed three counties in Arkansas (Boone, Fulton, Marion), eight counties in Missouri (Cape Girardeau, Dent, Howard, Howell, Lawrence, Moniteau, Pettis, Wright), and one county in Oklahoma (Delaware) for a total of 12 counties in four states (Table 1).

Off-road Point Count Surveys

We conducted off-road surveys on Peabody Wildlife Management Area (PWMA), an 18,854 ha state wildlife area located in Ohio, Muhlenberg and Hopkins counties, Kentucky. PWMA is a reclaimed coal surface mine planted with exotic, invasive species, such as *Sericia*

lespedeza, and native warm-season grasses, such as big bluestem (*Andrpogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum nutans*), and switch grass (*Panicum virgatum*). It is managed by the Kentucky Department of Fish and Wildlife. Elevation ranges from 100-200 m above sea level. Mixed deciduous forest comprises 27.2% (5,137 ha) for which neither deciduous nor evergreen species comprise greater than 75% of the total canopy. Open land comprises 23% (4,336 ha) of the habitat. We sampled in fields that were dominated by native grasses, as well as those that had some early successional habitat (i.e., <25% woody cover).

METHODS

County Roadside Survey Sampling Regime

Within each of the focal counties, we randomly located five 24.1 km (15-mile) routes along rural, secondary roads that crossed appropriate open land habitats (Figure 3). Our reasons for using the county scale for the sampling framework were largely information based. States report agricultural and other land use information at the county level, counties are relatively similar in size, and conservation practices are administered at the county scale by state and federal agencies.

To determine route starting locations we used a 3 × 5 grid transparency of 6 × 6 mile blocks and overlaid that onto each county map. We adjusted the grid as needed so that it covered the county. We used a random numbers table and selected 5 random numbers between 1 and 15, each random number corresponded to the block with the same number on the overlay. If the selected block had >50% open habitats and had sufficient room to locate a 15 mi route (i.e., not covered by towns, cities, forest, or water), the route was surveyed. If a given block looked

marginal in terms of suitability, we selected another one. If a given block was suitable, we selected a starting point within 1.6 km (1 mile) of the northeast corner on a secondary road and traced a route around the block. Surveying 5 routes per county ensured that most of the open habitat within each county was effectively surveyed. Along each route we placed point count stations every 805 m (Figure 4). Each route had 30 point count stations, and each route was surveyed once per breeding season.

Roadside Point Counts

Surveys were conducted 15 May-15 July, 2008-2010. At each point we conducted a 5-minute, 500-m radius point count recording all Henslow's Sparrows encountered. We placed birds in distance bands using range finders: 0─25 m, 26─50 m, 51─100 m, >100 m (Figure 5). Most passerine species have high detectability in open habitat to 50 m (Diefenbach et al. 2003). We surveyed routes beginning at 30 min before sunrise, and continued until the route was completed, usually less than four hours after sunrise.

Atlasing Procedures

We conducted Henslow's Sparrow atlas searches in 2008-09 in the focal counties in which the roadside surveys were conducted. Atlasing took place after the point-count surveys were completed. Observers sought out additional, unsurveyed potential habitat along roadsides in the general area of the 6 x 6 mile block in which the point-count survey took place. When potential habitat was encountered, the observer conducted a 10-minute point count at that site. The first five minutes of the count were similar to methods outlined above. The last five minutes involved 3 minutes of playing taped recordings of Henslow's Sparrow male songs, followed by an additional 2 minutes of listening.

Vegetation Sampling Procedures

We recorded the percent cover of habitat types (Table 2) at each point within a 100-m radius of the point center (Figure 6). We also recorded the habitat type where each individual bird was first observed. For individuals detected along the road, we recorded the adjacent habitat type (past 10 m) on both sides of the road. For birds in an isolated patch (usually forest within an open field), we recorded the type of habitat that the isolated patch represented, and recorded the surrounding habitat. Edge represented a change between two habitat types, and was usually linear in shape (i.e., along the border of a field).

We used three habitat parameters to describe habitat use. If the bird was first detected within a homogenous habitat type (e.g. in the middle of a pasture), only habitat parameter #1 was recorded with the appropriate habitat code (Table 2). A homogenous habitat was defined as having >70% cover of the habitat in question. If the bird was located in an edge, fencerow, isolated patch or roadside habitat (e.g. fencerow with pasture on one side and corn field on the other), then habitat parameters 1-3 were recorded with these guidelines:

Parameter #1: Edge was recorded if birds were within 10 m of a fencerow, isolated patch, or roadside.

Parameters #2 and 3: We recorded the habitat type on either side of the edge.

Off-road Point Counts

We conducted surveys on PWMA beginning along a secondary road, and extending into the habitat matrix (Figure 7). We spaced transects 300 m apart, extending perpendicularly for 600 m into the habitat to avoid repeat detections of individuals, and spatial autocorrelation (Hutto et al. 1986, Fletcher and Koford 2002, Alldredge et al. 2006). We located 3 points on 18 transects with point counts beginning on the road and then extending 300 m away from the road and 600 m away from the road (Figure 7). At each point we stopped and conducted a 100-m

fixed radius point count listening for and recording all Henslow's Sparrows detected within 5 minutes (Figure 5). We placed birds in distance bands using range finders ranging from: 0-25 m, 26-50 m, 51-100 m, >100 m. To enable occupancy estimation, we sampled each point three times (Diefenbach et al. 2003, MacKenzie 2005).

Analysis

BBS. — We used BBS data to calculate Henslow's Sparrow abundance as the number of individuals detected divided by the total number of routes surveyed in each Central Hardwoods state. We calculated an abundance index for each year from 1966 ─ 2009, and then calculated a mean abundance (± SD) by averaging abundances across years (Table 3).

We analyzed BBS surveys and Henslow's Sparrow detections located exclusively within the CHBCR. For each state in which a Henslow's Sparrow was detected, we calculated an abundance index as the total number of Henslow's Sparrow detections per year divided by the number of survey points (50 points/route). We then calculated an overall abundance by averaging abundances across years. Each year, we only used points from routes in which a Henslow's Sparrow was detected at least once for the abundance calculations. Because the BBS and our methods had a different number of point counts per route, we standardized Henslow's Sparrow abundance by dividing Henslow's Sparrow detections by the number of points surveyed each year.

CHBCR Roadside and Off-road Surveys. — We calculated an index of relative abundance for each state by using the number of Henslow's Sparrow detections divided by the total number of points, which we calculated by using the mean number of points/route/year, and only included routes on which a Henslow's Sparrow was detected. We compared relative abundances between BBS and our methods on routes located within the CHBCR. We also calculated occupancy and

detection probabilities from the off-road point count surveys using the occupancy module in program MARK (White and Burnham 1999). We considered all points on the road as one group, all points 300 m away from the road as the second group, and all points 600 m away from the road as a third group, to model a group effect of distance from road. The models determined a priori included a model with constant detectability and constant occupancy, detectability changing by distance from road with constant occupancy, occupancy changing by distance from road with constant detectability and both detectability and occupancy changing by distance from road.

Resource Selection Function. — A Resource Selection Function (RSF) technique developed by Arthur et al. (1996) allows for habitat types and availabilities to change among observations. Arthur's method adjusts habitat use and availability for each observation, therefore multiple habitat types and availabilities can be used in the model (Arthur et al. 1996). This is important because available habitat changes annually in agricultural landscapes. There are a number of biases associated with misclassifying a habitat as unused or a habitat type changing from unused to used during the duration of a study. These biases are minimized with Arthur's method because used and unused are determined at the time of each observation (Arthur et al. 1996). This index provides another method of assessing habitat selection for avian species through an adjusted point count methodology. A habitat selection function can be calculated for an observation of an individual, detected during a specified time period as long as habitat types at each point count are recorded and categorized.

We used Arthur's (1996) habitat selection index to calculate habitat selection for Henslow's Sparrows using the roadside point count data from the CHBCR from 2008 ─ 2010. Each detection was treated as an independent observation. We analyzed each year (2008, 2009,

2010) separately to determine if there were differences between years. We also pooled all of the years together to generate a habitat selection index among years for the entire CHBCR. Observations were pooled across the study area within years. To generate the selection index, Arthur recommended using an iterative process, until $b_j = w_j$ where b_j is the habitat selection index value (Arthur et al. 1996). We used six iterations to generate an approximate habitat index value. We also calculated maximum likelihood estimates for the sixth iteration of each selection index.

RESULTS

BBS

Henslow's Sparrows were detected on BBS routes in 21 states (Figure 8). Currently there are 151 BBS routes located within the CHBCR, of those routes, 25 are located in counties identified as focal counties for the CHBCR project in 5 states (AR, IN, IL, KY, MO, TN, OK). Of the states included in the CHBCR, Henslow's Sparrows were most abundant in Missouri, and Indiana (Table 3). Henslow's Sparrows showed an increasing abundance trend from 1991─2009 in 4 of the 5 Central Hardwood's states (Figure 9). During this time period, Henslow's Sparrow abundance increased six-fold in Indiana, and doubled in Missouri and Kentucky. Mean Henslow's Sparrow abundance across years was greatest in Indiana ($\bar{x}$ = 0.25 HESP/route ± 0.23) and Missouri ($\bar{x}$ = 0.21 HESP/route ± 0.16) and lowest in Illinois ($\bar{x}$ = 0.026 HESP/route ± 0.031; Table 3).

There are 151 BBS routes located within the CHBCR, of which 40 had Henslow's Sparrow detections from 1966 ─ 2009 (Figure 10). Henslow's Sparrows were detected in five states (IL, IN, KY, MO, OH) on BBS routes located within the CHBCR. Because OH had a very

limited area in the CHBCR, we did not survey in Ohio and we excluded it from the yearly abundance trend figure and calculations. Henslow's Sparrows were not detected on BBS routes in AL, AR, TN, or OK in the CHBCR. There were 509 Henslow's Sparrow detections on routes in the four CHBCR focal states (IL, IN, KY, MO), from 1966 ─ 2009 (Table 4). Indiana had the largest number of detections (n = 263), and the highest relative abundance ($\bar{x}$ = 0.04 ± 0.038 Birds/Point) of Henslow's Sparrows, and Illinois had the fewest detections (n = 17), and the lowest relative abundance ($\bar{x}$ = 0.01 ± 0.02 Birds/Point)(Table 5). Also, Henslow's Sparrows were detected on 68% of the BBS routes located in Indiana in the CHBCR, and only detected on 8% of the routes in Illinois (Table 4). Overall abundance trends within the CHBCR mirrored those of the state trends (Figure 9, Figure 11). Henslow's Sparrow abundances began to increase in 1996 and continued to increase until 2009. In Indiana, Henslow's Sparrow abundances increased by 67% from 1998 ─ 2003, but then decreased by 60% from 2003 ─ 2009 (Figure 11). In Kentucky, Henslow's Sparrow abundances increased by 72% from 2006 ─ 2007, but then decreased by 42% from 2008 ─ 2009 (Figure 11). In Missouri, Henslow's Sparrow abundances increased by 67% from 1999 ─ 2008, but then decreased by 39% from 2008 ─ 2009 (Figure 11).

Central Hardwoods Surveys

In 2008 we surveyed 122 routes in 4 states: IN, IL, KY, and TN. In 2009 we surveyed 60 routes in 3 states: AR, MO and OK. In 2010 we surveyed 196 routes in 7 states: AR, IN, IL, KY, MO, OK and TN. Henslow's Sparrows were detected in 5 states, IN, IL, KY, MO and TN. In 2008, we detected 108 Henslow's Sparrows on 32 routes in IN, IL, KY and TN (Figure 12), in 2009 we detected 33 Henslow's Sparrows on 9 routes in MO (Figure 12), and in 2010 we detected 74 Henslow's Sparrows on 29 routes in all 5 states, (Table 6, Figure 13). The relative abundance of Henslow's Sparrows decreased in 4 of the 5 states from 2008 ─ 2009 to 2010

(Table 5). In 2010, Henslow's Sparrows were not detected in one focal county in IL, two focal counties in MO, three focal counties in KY and three focal counties in TN in which they had been detected the previous years (Figure 12 and Figure 13). In 2010, we detected one Henslow's Sparrow in one new county in KY (Webster County). In 2008 we detected Henslow's Sparrows in 10 of 26 different available habitat types; in 2009 we detected Henslow's Sparrows in 5 of 13 different available habitat types; and in 2010 we detected Henslow's Sparrows in 13 of 24 different available habitat types (Table 7). Available habitat types changed between years because the presence of a habitat types at the time of detection changed between observations and years. We detected Henslow's Sparrows in grass mixture and cool-season grass habitat types 56% of the time across years (n = 177), although those habitat types comprise 37.3% of the total habitat coverage on points with a Henslow's Sparrow detection (Table 8).

Resource Selection Function

We used 177 Henslow's Sparrow detections to calculate an RSF using Arthur's (1996) method. In 2008 and 2009 there was selection for four habitat types and in 2010 there was selection for six habitat types (Table 7). The habitat selection index results after 6 iterations, for 2008, 2009, 2010, and all of the years pooled showed that Henslow's Sparrows selected native warm season grasses over all other available habitat types (Table 7). The other prominent habitat types selected for were old field, grass-forb mixture, and cool-season grasses. These four habitat types accounted for 69% of the selection index when the years were pooled (Table 7).

Off-road Surveys

The model in program MARK that had the greatest support was based on constant occupancy and constant detection; models incorporating distance from road for occupancy and detection had more limited support (Table 9). The occupancy and detection parameter estimates

were generally lower on roadside points, although confidence intervals were broad and overlapped across all distance categories (Tables 10-12). On average, 65.9% of the point counts stations had Henslow's Sparrows present with an average detection of 40.3% (Table 13).

ATLAS

Henslow's Sparrow detections from surveys conducted in 2008 and 2009 using the ATLAS survey protocol were lower than the number of detections using the standard roadside point counts (Table 6), although, the ATLAS surveys provided additional locations of Henslow's Sparrows in 2008 and 2009. In 2008, there were 108 Henslow's Sparrows detected using the CHBCR roadside survey method, and 48 Henslow's detected using the ATLAS protocols. In 2009 the same number of Henslow's Sparrows were detected by each method (n = 33).

DISCUSSION

Distribution and Relative Abundance

Based on evaluation of BBS and BBA data, Henslow's Sparrow distribution has remained relatively consistent during the last 40+ years. Henslow's Sparrows have expanded west into Oklahoma, and there have been some records in counties where they had previously not been detected in North Carolina, and Maryland (Figure 8). Henslow's Sparrows were detected on BBS routes across their entire range (Figure 9). Current population trends from analysis of BBS data show that in most CHBCR, Henslow's Sparrows have increased in abundance from 1966 ─ 2009 (Figure 9). These trends are dissimilar from previous range wide population trends which suggested a decline in Henslow's Sparrow populations from 1966 – 1993 (Herkert 1997, Cooper 2007). In states in the Central Hardwoods, Henslow's Sparrows are most abundant on BBS routes in Indiana, Missouri and Kentucky (Table 3). Over the past 2

decades the abundance in these states has increased by 6 times in Indiana, and doubled in Missouri and Kentucky (Figure 9). Unlike other states in the CHBCR, Henslow's Sparrow populations in Illinois showed a slight increase in abundance until 2001, in which the population seemed to stabilize, and then abundance decreased by 72% from 2008 ─ 2009 (Figure 9). On BBS routes located exclusively in the CHBCR, Henslow's Sparrow abundances have increased from 1966 ─ 2009, and there were more dramatic increases during the last decade (Figure 11). In Indiana, Henslow's Sparrows were detected on the greatest percentage of BBS routes located within the CHBCR and had the largest mean abundance across years, when compared with Illinois, Kentucky and Missouri (Table 4 and Table 5). Henslow's Sparrows were only detected once on a BBS route in Missouri, from 1967 – 1989, after which there were 103 detections on 8 different routes.

We efficiently mapped the distribution of Henslow's Sparrows and other priority grassland and scrub-shrub species using stratified roadside-based sampling at the focal county scale in the CHBCR. This effort was based on one full-time observer for two months per state. Each observer covered eight counties, conducted 40 routes and ~1200 points at a cost of ~$7,500 for field expenses. The entire field expenses of the monitoring program for the CHBCR cost ~$37,500/year. Additional costs were incurred for project coordination, analysis of the data, and preparation of annual and final reports by UT research associates and a Ph.D. student.

In 2008 and 2009 on routes located within the CHBCR, there were more Henslow's Sparrow detections, and a higher relative abundance from our stratified survey methodologies compared to BBS and ATLAS methods (Table 6). Our standardized roadside survey methods used for the CHBCR were equally as effective at detecting Henslow's Sparrows as the ATLAS methods, where we opportunistically sought out likely habitats for inventory. Also, because the

roadside methods were standardized, comparisons can be made across points and routes across the region and for different monitoring programs (e.g., BBS). We documented Henslow's Sparrows in a number of new counties across the study area where they were previously unrecorded by BBS or BBA surveys (Figure 10, Figure 12 and Figure 13). In 2008, we found them to be present in four new counties in Illinois (Franklin, Hamilton, Jackson, White, Figure 12), three new counties in Indiana (Orange, Ripley, Sullivan, Figure 12), five new counties in Kentucky (Breckinridge, Butler, Hart, Logan, Ohio, Figure 12), and three new counties in Tennessee (Coffee, Lawrence, Robertson, Figure 12). In 2009, we found them to be present in five new counties in Missouri (Cape Girardeau, Howard, Howell, Moniteau, Pettis, Figure 12). In 2010, the surveys reaffirmed Henslow's Sparrow presence in 11 of those new counties (Figure 13).

Henslow's Sparrow abundances decreased in 4 of the 5 states in which they were detected during CHBCR focused surveys (Table 4). The steepest decline in abundance from 2008 ─ 2009 to 2010 occurred in Tennessee. The one state that showed an increase in Henslow's Sparrow abundance from 2008 ─ 2009 to 2010 was Illinois. These results cannot yet be compared with BBS data because 2010 BBS survey information is unavailable. However, according to BBS data, Henslow's Sparrow abundances decreased in Indiana and Missouri from 2008 to 2009 (Figure 11). If these trends continue in 2010, they will mirror our CHBCR survey results. Caution is needed in interpretation of these trend data because our CHBCR routes have only been surveyed for 2 years. If these declines are real, the causes of the declines are unknown at this time although decreases in the availability of grassland habitats in response to increasing commodity prices for corn and soybeans may be implicated.

Resource Selection Function

Recent increases in Henslow's Sparrow abundances are often attributed in part to establishment of native grasslands by CRP and other conservation programs. In fact, increases in Henslow's Sparrow abundance roughly coincided with the inception of CRP in 1985 (USDA 2008). Evidence suggests that at the practice level, CRP plantings of native warm-season grasses can positively influence local Henslow's Sparrow populations (Herkert 1997, McCoy et al. 2001, Cooper 2007, Herkert 2007a). However, BBS and state atlas data do not link changes in distribution and relative abundance to changes in land use or habitat availability.

We calculated a resource selection function for habitat selection of Henslow's Sparrows in the CHBCR. This selection function provides comparative results for all of the cover types that were evaluated in the field in association with point count stations. The results demonstrated strong selection by Henslow's Sparrows for grass-dominated habitats in general, and native-warm season grasses specifically in each year, and all years pooled (Table 7). Henslow's Sparrows used other grassland habitat types such as grass mixtures, and cool-season grasses, but the selection for these types was much weaker than for native warm-season grasses. The habitat selection index results confirm that Henslow's Sparrows consistently selected for native warm-season grass habitats among other available habitats at the Bird Conservation Region scale, despite the fact that native warm-season grasses were very rarely encountered across the landscape (Table 8). These results support the body of literature suggesting that native warm-season grass CRP plantings positively influence Henslow's Sparrow populations (Herkert 1994;1997, McCoy et al. 2001, Cooper 2007, Giocomo et al. 2008).

Arthur's index is an effective method for determining habitat selection indices for Henslow's Sparrows by using traditional point count techniques. This technique appears to work

well for point count studies across large extents because it does not require repeat measures of locations of individuals and it allows for habitat availabilities to change for each observation or point count. Also, it is easy to define an area that is available to an individual at the time of the point count, and then classify habitat types and their availabilities within the defined point count area (Figure 6). To our knowledge, this is the first instance in which this technique has been applied to point count data.

Occupancy and Detection

Occupancy and detection probability of Henslow's Sparrows may differ between roadside and off-road point counts. Although the model with constant occupancy and detection was best supported by the data, there was some support for models that included distance from road as a grouping variable. Occupancy and detection appeared to be greater away from roadsides. We plan on further testing these relationships with additional data from other sites in 2011. Accurate and precise estimation of occupancy and detection rates is important for conservation planning to assist with regional population estimation and for tracking population trends over space and time. If a roadside bias does exist, then Henslow's Sparrow populations would tend to be under-estimated based on roadside counts. Because most of the Henslow's Sparrow range is privately owned, roadside surveys are the most practical means to surveys large areas for monitoring populations. Correcting for this apparent bias is important when BBS data or other regional monitoring databases are used to develop population estimates.

CONSERVATION IMPLICATIONS

We summarized the distribution and relative abundance of Henslow's Sparrows within the CHBCR. Recent trends in BBS, state Atlas, and our data suggested that Henslow's Sparrow

populations have been increasing in abundance and expanding in distribution in the Central Hardwoods BCR. The apparent decline in populations in 2010 warrants further investigation.

We used a habitat selection index method to document Henslow's Sparrow breeding habitat selection across the region and showed that Henslow's Sparrows across the CHBCR select for native warm-season grass habitats over other available habitat types. In spite of the relative rarity of native grass habitat across the region (<1% of available habitat), this habitat type still showed the strongest selection. This suggests that Henslow's Sparrows are still seeking out native grasslands over other alternatives and suggests providing additional native grasslands would be an important component of any conservation strategy for this species.

Henslow's Sparrows are one of the highest conservation priorities in the region but BBS is inadequate for monitoring population trends for this species at any resolution finer than the BCR scale. We demonstrated that our focused, roadside point count method yielded enough data for this conservation target that could be used for tracking population trends across finer scales and could also be used for assessing the effectiveness of conservation actions. Of course, this approach would yield even more accurate and precise abundance estimates for other priority grassland species that are not as rare (e.g., Grasshopper Sparrow, Dickcissel, Prairie Warbler, etc.).

We also evaluated the potential bias associated with roadside surveys for Henslow's Sparrow based on both occupancy and detection. The results suggested that there may be some bias that would need to be documented to accurately estimate population.

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Table 1. Counties selected for surveying from May through July, 2008 ─ 2010 in the Central Hardwoods Bird Conservation Region. Counties were selected using the Northern Bobwhite Conservation Initiative priority areas developed by Burger et al.

Central Hardwoods		Central Hardwoods	
State	Counties	State	Counties
MO	Howard	**OK**	Delaware
	Moniteau	**KY**	Logan
	Pettis		Webster
	Cape Girardeau		Livingston
	Dent		Breckenridge
	Howell		Warren
	Lawrence		Ohio
	Wright		Butler
AR	Fulton		Hart
	Boone	**TN**	Coffee
	Marion		Franklin
IL	Jackson		Giles
	Franklin		Lawrence
	Hamilton		Lincoln
	White		Maury
IN	Orange		Montgomery
	Ripley		Robertson
	Sullivan		Sumner
	Warrick		

Table 2. Habitat types used to classify Henslow's Sparrow habitat during surveys conducted from May through July, 2008 ─ 2010 in the Central Hardwoods Bird Conservation Region.

Habitat Code	Habitat Type	Description
CR	Corn	Corn for grain or silage
SO	Soybeans	Soybeans
SG	Sorghum	Sorghum
TO	Tobacco	Tobacco
WO	Wheat/Oats	Winter wheat, oats or other cereal grains - usually grow thick and appear grasslike
CT	Cotton	Cotton
OC	Other row crop	Other row crop - specify type
MF	Mowed field	Unknown grass type because it's too short to tell
NT	No till	Field where the 'no till' method is implemented - sprayed grasses and forbs where a crop is planted w/o plowing
NG	NWSG	Field dominated by native warm season grasses - >70%
CG	Cool season grass field	Un-mowed field dominated by cool season grasses, (e.g. fescue, alfalfa, etc): >70%
FB	Fescue with forbs	Field with a mixture of 30-70% fescue (or other cool season grass) and forbs
GM	Grass mixture	Field with a mixture of 30-70% NWSG, cool season grasses, or forbs
PA	Pasture	Active pasture for livestock - evidence: cows, poo, short grass
FF	Fallow field	Fallow this year, typically in grasses and forbs - can tell that it was farmed in the past (exposed soil, etc)
OF	Old field	Field left abandoned undergoing succession, limited saplings, often with blackberry, thistle, etc.
SC	Scrub-Shrub	Abandoned fields that are dominated by woody saplings and shrubs
PL	Plowed field	Field with bare ground showing, no crops identifiable yet
FO	Forest	Mature forest with closed canopy, well-developed under and midstory
WD	Woodland	Not quite a savannah, more forested (~50% canopy cover); widely spaced trees with significant understory
IP	Isolated patch	Isolated patch of habitat within an otherwise homogenous setting - e.g. woodlot, scrub-shrub island in a corn field or NWSG field - include birds in this category if they are w/in 10 m of an IP
SV	Savannah	Rare habitat type; widely-spaced trees with grass and scrub in between
YF	Young forest	Area dominated by dense saplings
CE	Cedar glade	Cedars surrounded by grasses and scrub
NB	NWSG field buffer	Field buffer planted in NWSG – usually for CP33 – 10-20ft wide
CB	Cool season grass buffer	Field buffer planted in cool season grasses – usually for CP33 - 10-20 ft wide
RI	Riparian	Area with running or standing water.
UR	Urban/developed	Residential area, small town, etc.
FE	Fencerow	Fencerow b/w two fields with significant veg. surrounding it (not just a fence with nothing growing around it)
ED	Edge	Major, linear edge between two completely different habitat types - eg. between forest and row crop
RD	Roadside	Roadside between two habitat types
OT	Other	Indicate in the comments what this habitat type is.

Table 3. Henslow's Sparrow Breeding Bird Survey data collected from 1966 ─ 2009 in states in the Central Hardwoods Bird Conservation region. Abundance calculations are described in text.

State	Total Detections	Total Routes	Mean Abundance	SD
IL	80	2723	0.026	0.031
IN	350	1359	0.254	0.225
KY	122	1292	0.087	0.132
TN	0	1757	0	0
MO	369	1483	0.214	0.162
AR	0	1236	0	0
OK	155	1635	0.074	0.137

Table 4. Henslow's Sparrow Breeding Bird Survey data from 1966 ─ 2009, from routes located exclusively within the states in the Central Hardwoods Bird Conservation region.

State	Number of Detections	Number of Routes	Routes with a Detection	Percent of Routes with HESP
IL	17	13	1	7.7
IN	263	21	14	66.7
KY	122	45	17	37.8
MO	107	30	8	26.7
Total	509	109	40	

Table 5. Henslow's Sparrow survey data from routes located exclusively in the Central Hardwoods Bird Conservation Region. Abundance is calculated as Individual detections/Total number of points. NS represents routes Not Surveyed that year.

State	CHBCR Abundance			BBS Abundance		Mean BBS Abundance	SD
Year	2008	2009	2010	2008	2009	1966-2009	
IL	0.07	NS	0.08	NS	0	0.010	0.024
IN	0.15	NS	0.05	0.09	0.06	0.040	0.038
KY	0.10	NS	0.04	0.05	0.06	0.021	0.020
TN	0.16	NS	0.05	0	0	0	0
AR	NS	0	0	0	0	0	0
MO	NS	0.13	0.12	0.02	0.01	0.036	0.048
OK	NS	0	0	0	0	0	0

Table 6. Henslow's Sparrow survey data from the Central Hardwoods Bird Conservation Region. BBS data was collected separately from ATLAS and Central Hardwoods survey data. Abundance is calculated as Individual detections/Total number of routes.

State	Number of Detections		ATLAS Detections	BBS Detections
Year	**08 & 09**	**2010**	**08 & 09**	**08 & 09**
IL	17	7	4	0
IN	24	17	12	17
KY	45	7	29	18
TN	22	5	3	0
AR	0	0	0	0
MO	33	38	33	11
OK	0	0	0	0
Total	141	74	81	46

Table 7. Henslow's Sparrow resource selection function developed using Arthur's method. Henslow's Sparrow survey data is from the Central Hardwoods Bird Conservation Region. Values presented are for b_j after six iterations. Maximum likelihood estimates are presented below. NA represents a habitat type not present during any Henslow's Sparrow detections for a particular survey year.

Habitat Types	Pooled	2008	2009	2010
NG	0.369	0.289	0.646	0.315
CG	0.113	0.143	0.141	0.084
OF	0.101	0.172	0.020	0.253
GM	0.102	0.208	0.116	0.054
FB	0.040	0.046	NA	NA
PL	0.039	NA	NA	0.034
CR	0.030	0	NA	0.042
YF	0.032	0.044	NA	NA
SC	0.034	0	NA	0.029
NT	0.024	0	NA	0.049
SV	0.029	0.039	NA	NA
MF	0.031	0	0.078	0.078
SO	0.014	0.011	NA	0.021
PA	0.013	0.036	0	0
RD	0.012	0.012	0	0.011
FF	0.008	NA	NA	0.009
UR	0.007	0	0	0.021
CB	0	0	NA	0
CD	0	NA	NA	NA
CR	0	0	NA	NA
ED	0	0	0	0
FE	0	0	0	NA
FO	0	0	0	0
IP	0	0	0	0
MF	0	0	NA	NA
NT	0	0	NA	NA
OC	0	NA	NA	NA
OT	0	0	NA	NA
RI	0	0	0	0
SC	0	0	NA	NA
SG	0	0	NA	0
TO	0	0	NA	NA
WD	0	0	NA	0
WO	0	0	NA	0
Log Liklihood	3.58E-60	8.7E-14	0.0198	2.1E-12
Deviance	273.76	60.1542	7.84381	53.8198

Table 8. Percent habitat cover given as a percentage of all of the survey points pooled, and corresponding Henslow's Sparrow detections in the Central Hardwoods Bird Conservation Region. "NA" represents a habitat type not present during any Henslow's Sparrow detections for a particular survey year.

	Pooled		2008		2009		2010	
	Percent Cover	Detections	Percent Cover	Detections	Percent Cover	Detections	Percent Cover	Detections
CB	0.14	0	0.06	0	NA	NA	0.36	0
CE	0.20	0	NA	NA	NA	NA	0.64	0
CG	15.65	46	18.48	27	10.30	6	14.27	13
CR	3.33	6	1.24	0	NA	NA	8.73	6
ED	0.79	0	0.84	0	1.36	0	0.36	0
FB	8.09	16	16.09	16	NA	NA	NA	NA
FE	0.25	0	0.39	0	0.30	0	NA	NA
FF	1.75	2	NA	NA	NA	NA	5.64	2
FO	4.86	0	6.35	0	1.82	0	4.27	0
GM	21.62	53	11.99	19	52.12	20	18.91	14
IP	0.34	0	0.12	0	0.61	0	0.55	0
MF	4.44	6	3.48	0	8.64	3	3.45	3
NG	3.16	13	4.27	9	4.09	3	0.82	1
NT	1.78	3	1.01	0	NA	NA	4.09	3
OC	0.11	0	NA	NA	NA	NA	0.36	0
OF	3.33	10	4.44	7	3.18	1	1.64	2
OT	0.14	0	0.28	0	NA	NA	NA	NA
PA	4.77	3	4.78	3	6.52	0	3.73	0
PL	2.32	4	NA	NA	NA	NA	7.45	4
RD	10.28	5	10.22	3	10.61	0	10.18	2
RI	0.59	0	0.67	0	0.30	0	0.64	0
SC	1.81	3	0.45	0	NA	NA	5.09	3
SG	0.65	0	1.01	0	NA	NA	0.45	0
SO	1.61	2	1.74	1	NA	NA	2.36	1
SV	1.33	2	2.64	2	NA	NA	NA	NA
TO	0.14	0	0.28	0	NA	NA	NA	NA
UR	2.68	1	3.76	0	0.15	0	2.45	1
WD	1.41	0	1.12	0	NA	NA	2.73	0
WO	1.16	0	1.80	0	NA	NA	0.82	0
YF	1.24	2	2.47	2	NA	NA	NA	NA

Table 9. Summary of model selection procedure results for detection (ρ) and occupancy (ψ) using off-road point counts conducted in 2010, in 3 different distance from road categories on Peabody Wildlife Manageme.nt Area., KY.

Model	AICc	Delta AICc	AICc Weight	Model Liklihood	No. of Parameters	Deviance
ρ(Constant)ψ(Constant)	186.086	0	0.2877	1	2	24.908
ρ(Constant)ψ(Group)	188.72	2.64	0.0769	0.2672	4	22.967
ρ(Group)ψ(Constant)	188.946	2.866	0.0686	0.2386	4	23.193
ρ(Group)ψ(Group)	193.388	7.308	0.00745	0.0259	6	22.664

Table 10. Detection probability (ρ) and occupancy (ψ) parameter estimates from the model with constant detection probability, and occupancy grouped by distance from road, using the off-road counts conducted in 2010, from Peabody Wildlife Management Area, KY.

Parameter	Estimate	Standard Error	Lower C.I.	Upper C.I.
1:ρ	0.403	0.071	0.275	0.545
2:ψ (roadside)	0.494	0.153	0.227	0.765
3:ψ	0.776	0.164	0.353	0.957
4:ψ	0.706	0.163	0.339	0.918

Table 11. Detection probability (ρ) and occupancy (ψ) parameter estimates from the model with constant occupancy, and detection probability grouped by distance from road, using the off-road counts conducted in 2010, from Peabody Wildlife Management Area, KY.

Parameter	Estimate	Standard Error	Lower C.I.	Upper C.I.
1:ρ (roadside)	0.276	0.097	0.128	0.497
2:ρ	0.435	0.098	0.260	0.627
3:ρ	0.432	0.108	0.243	0.642
4:ψ	0.694	0.114	0.441	0.867

Table 12. Detection probability (ρ) and occupancy (ψ) parameter estimates from the model with occupancy, and detection probability grouped by distance from road, using the off-road counts conducted in 2010, from Peabody Wildlife Management Area, KY.

Parameter	Estimate	Standard Error	Lower C.I.	Upper C.I.
1:ρ (roadside)	0.338	0.142	0.128	0.640
2:ρ	0.409	0.112	0.217	0.632
3:ρ	0.439	0.117	0.236	0.665
4:ψ (roadside)	0.548	0.217	0.179	0.871
5:ψ	0.770	0.185	0.302	0.963
6:ψ	0.674	0.168	0.316	0.903

Table 13. Detection probability (ρ) and occupancy (ψ) parameter estimates from the model with constant occupancy, and constant detection probability, using the off-road counts conducted in 2010, from Peabody Wildlife Management Area, KY.

Parameter	Estimate	Standard Error	Lower C.I.	Upper C.I.
1:ρ	0.403	0.071	0.275	0.545
2:ψ	0.659	0.107	0.432	0.831

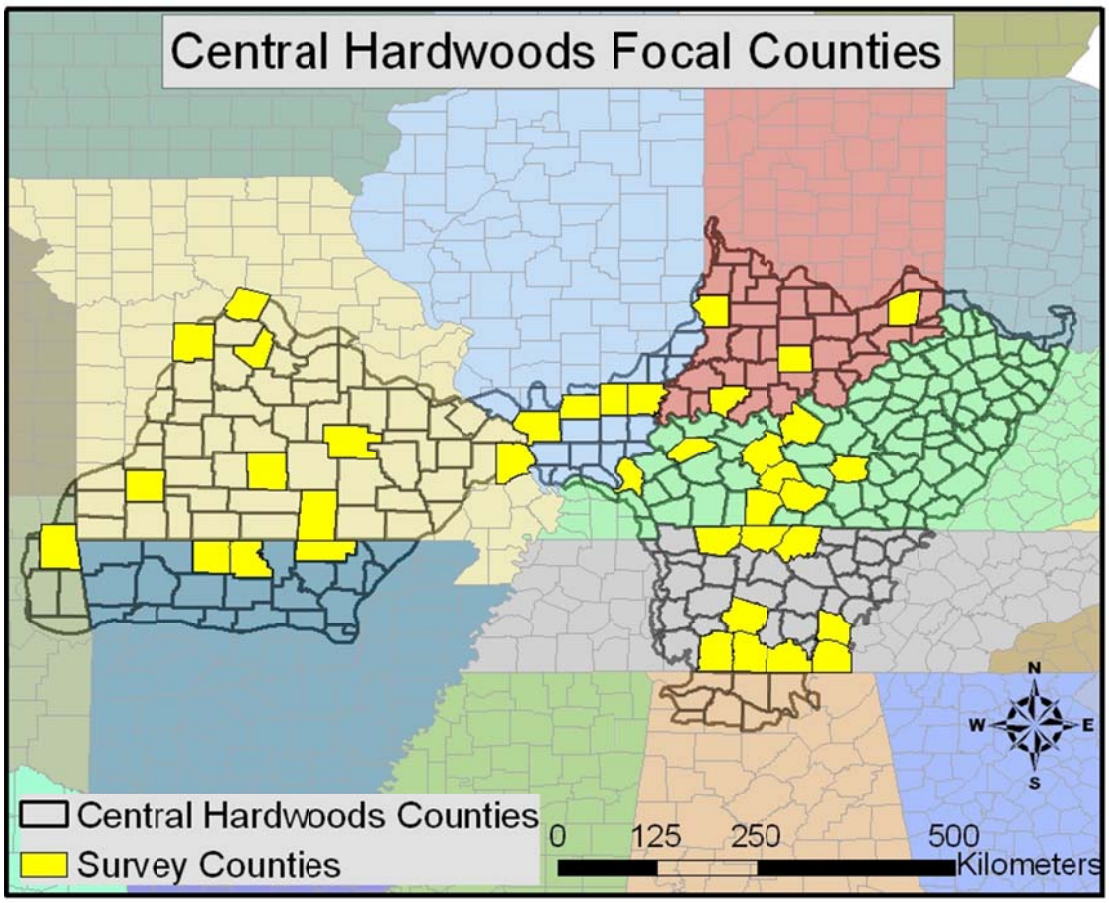

Figure 1. Central Hardwoods Bird Conservation Region and focal counties for roadside surveys conducted from May—July, 2008-10.

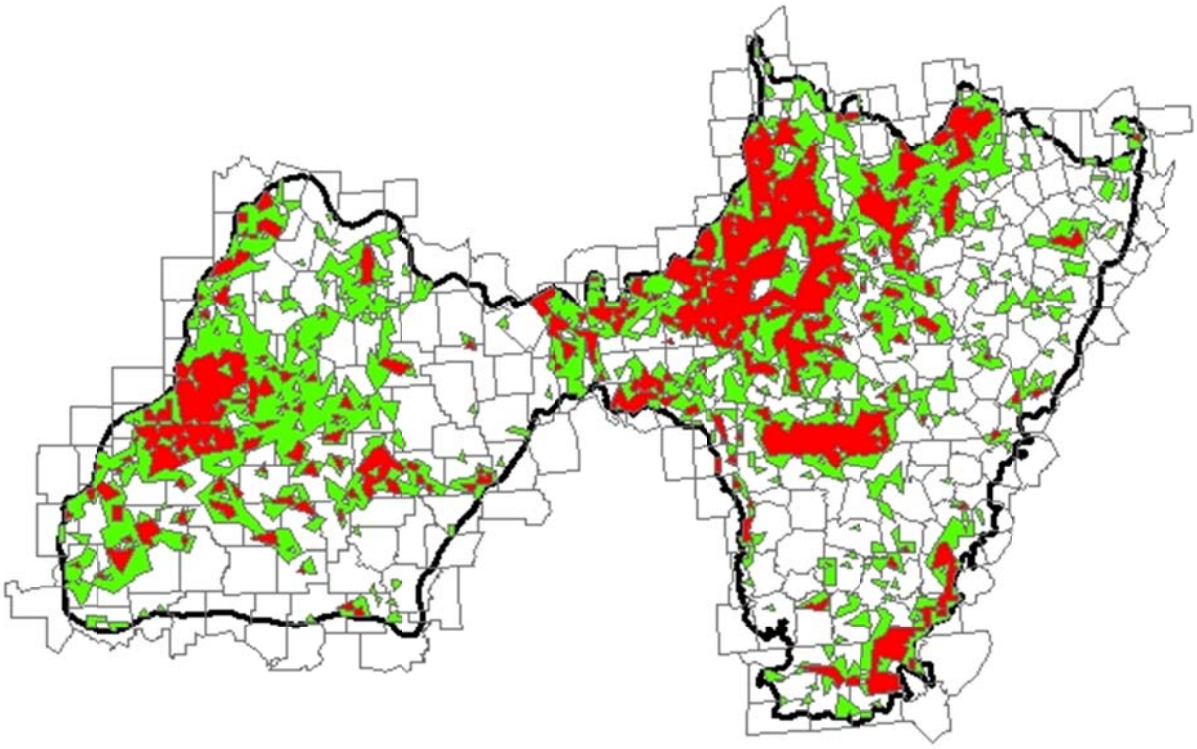

Figure 2. Focal areas identified for the Northern Bobwhite Conservation Initiative by Burger et al. in the Central Hardwoods Bird Conservation Region.

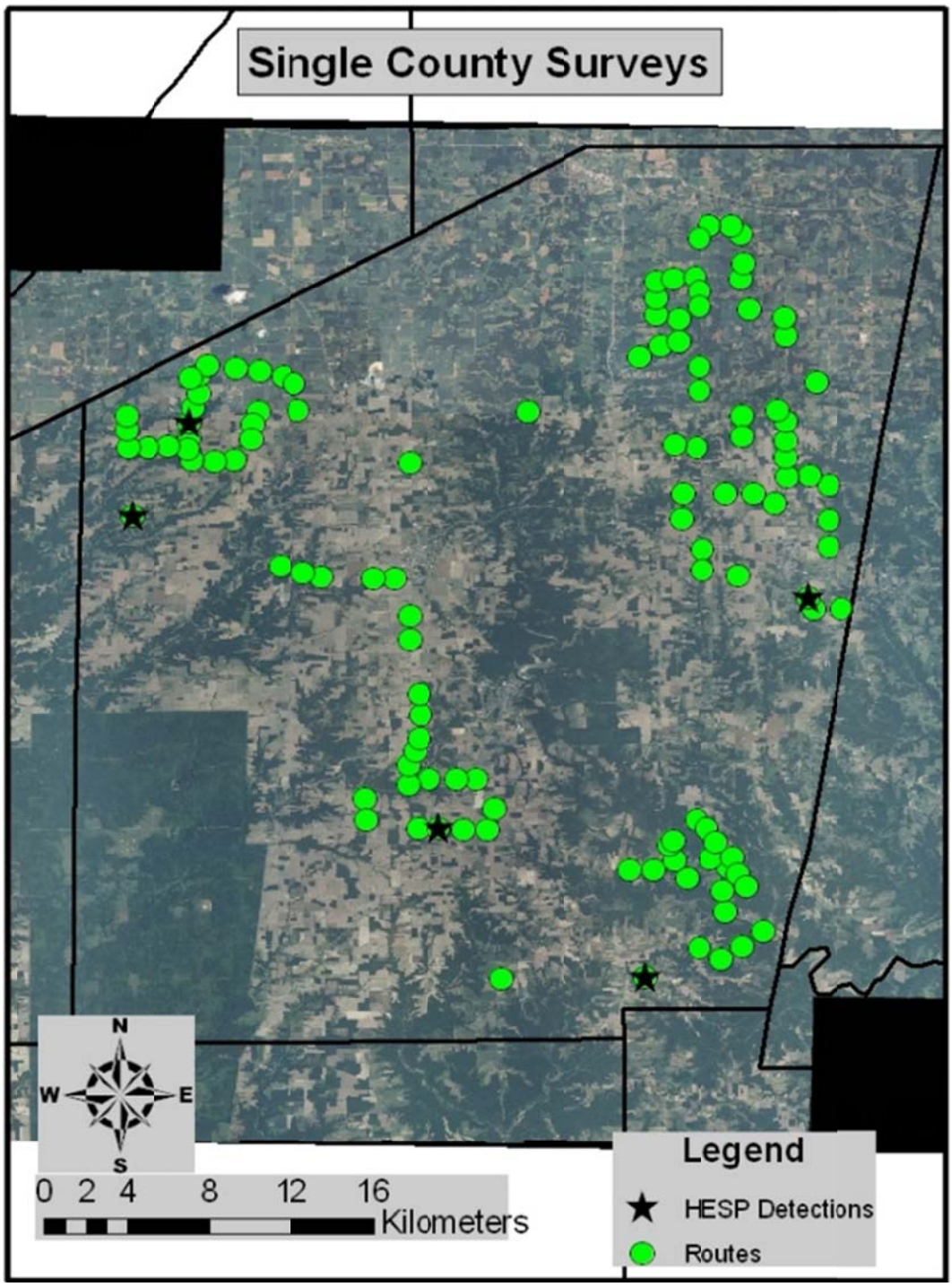

Figure 3. An example of five roadside survey routes with Henslow's Sparrow detections, conducted in 2010 in Ripley County, IN, in the Central Hardwoods Bird Conservation Region.

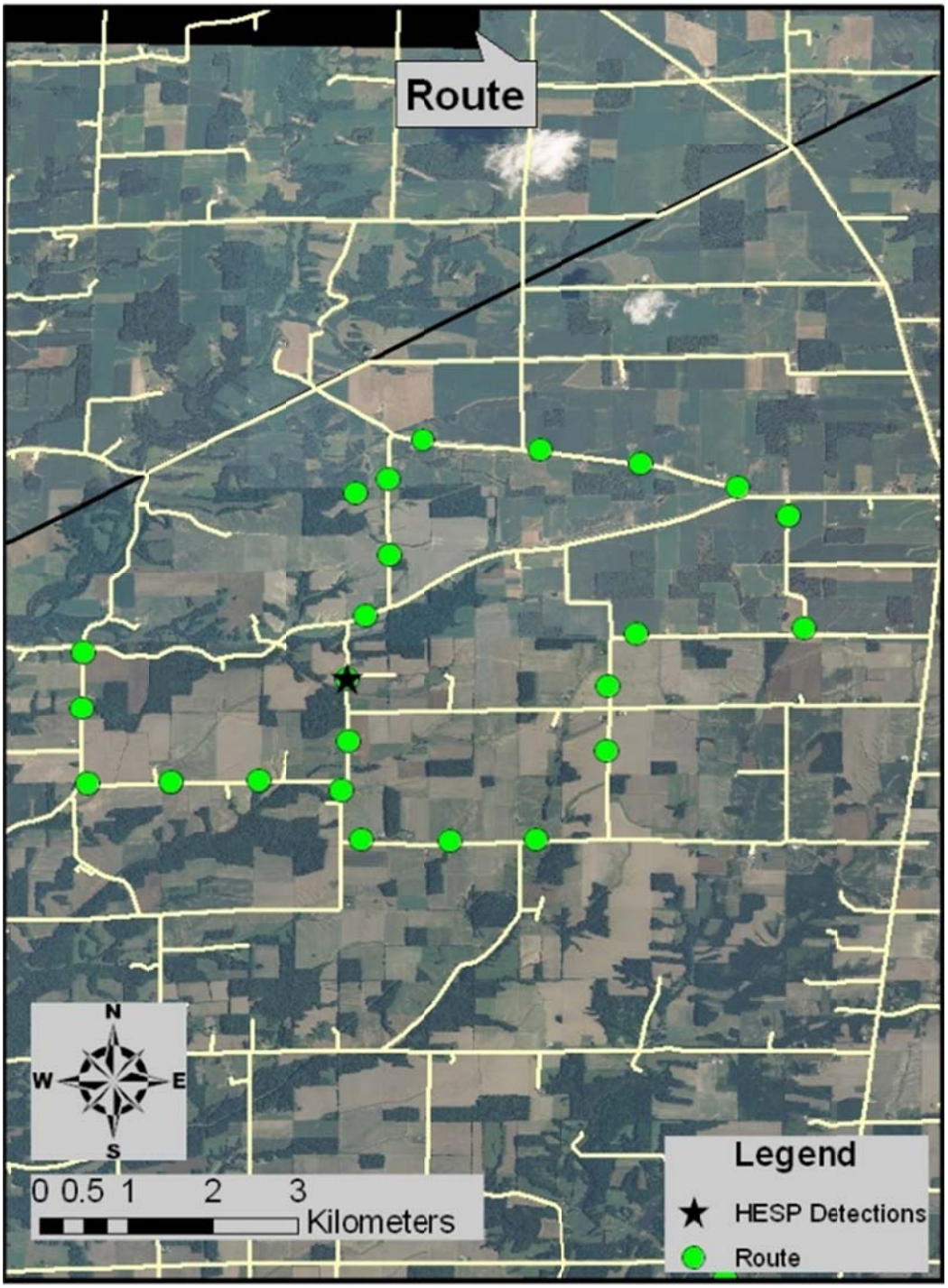

Figure 4. An example of a roadside route with a Henslow's Sparrow detection, conducted in 2010 in Ripley County, IN, in the Central Hardwoods Bird Conservation Region.

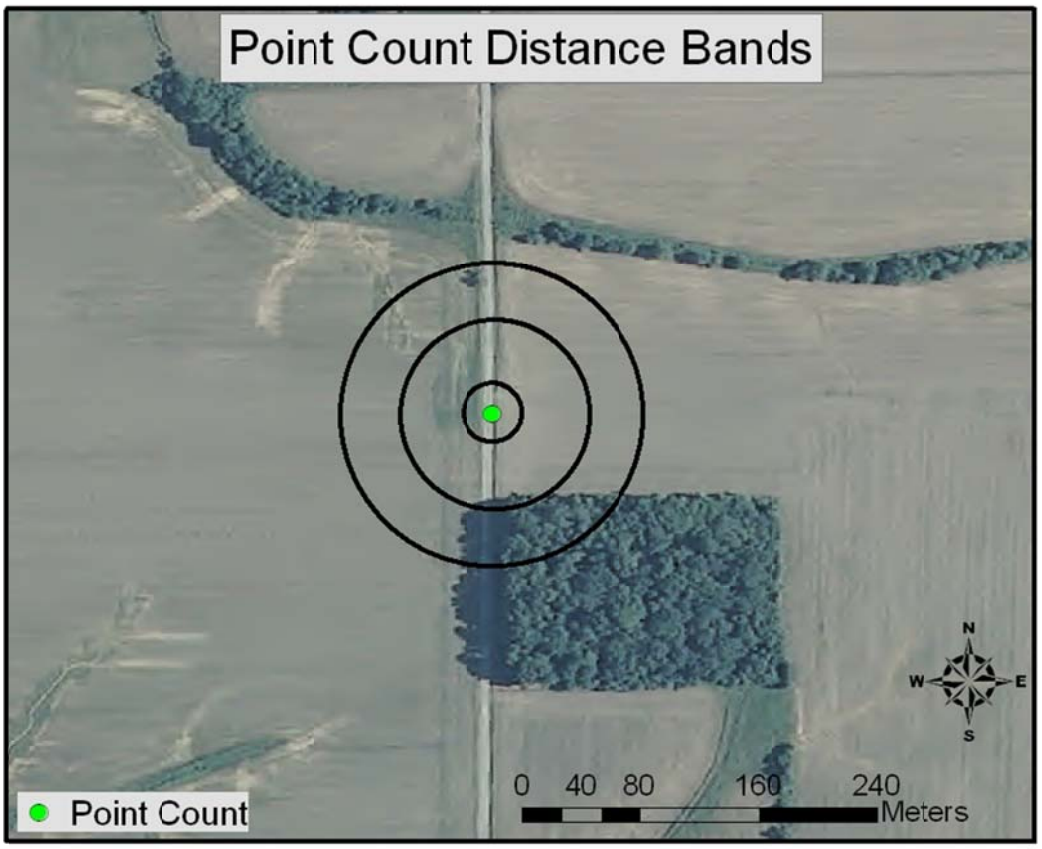

Figure 5. An example of the 100-m radius point count survey for Henslow's Sparrows that was conducted 30 times along each route from 2008—2010 in the Central Hardwoods Bird Conservation Region.

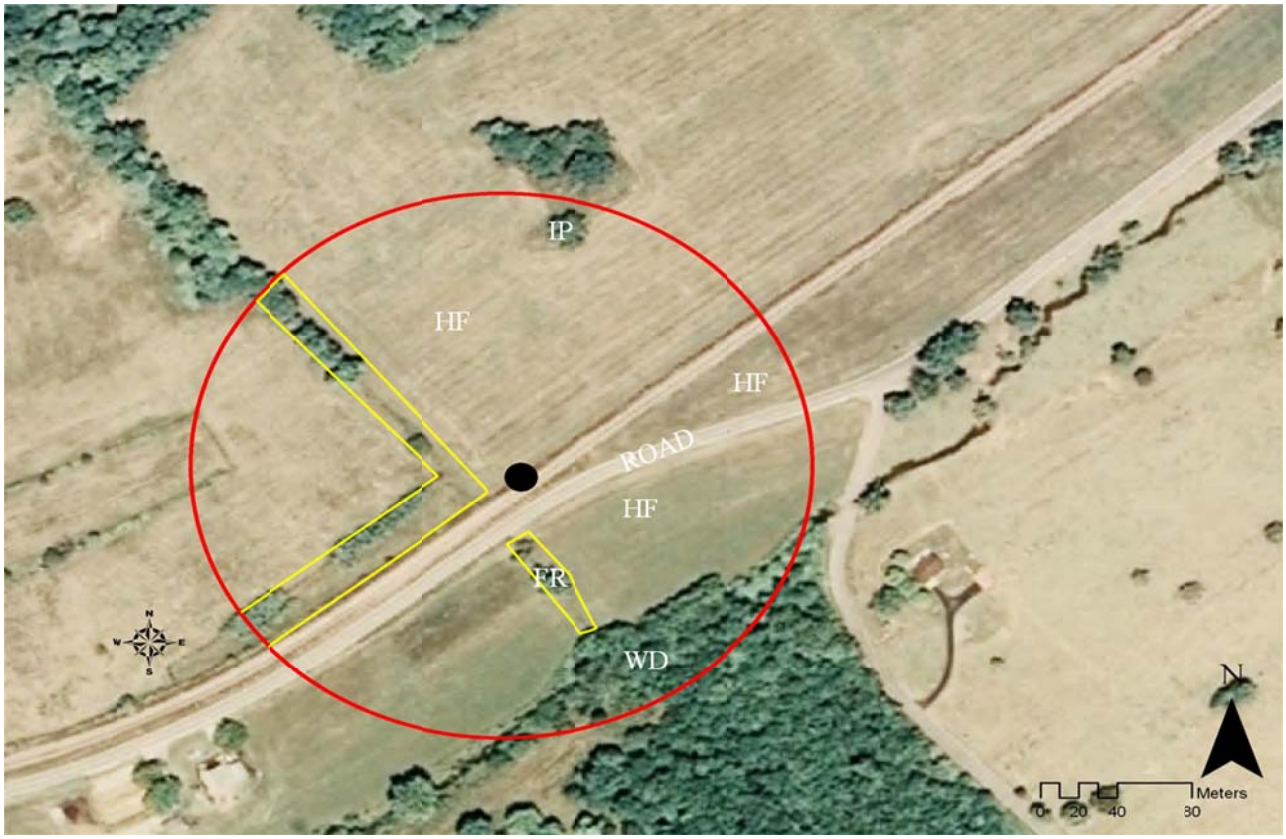

Figure 6. An example of the 100m radius habitat categorization survey that was conducted at each point count location from 2008—2010 in the Central Hardwoods Bird conservation Region.

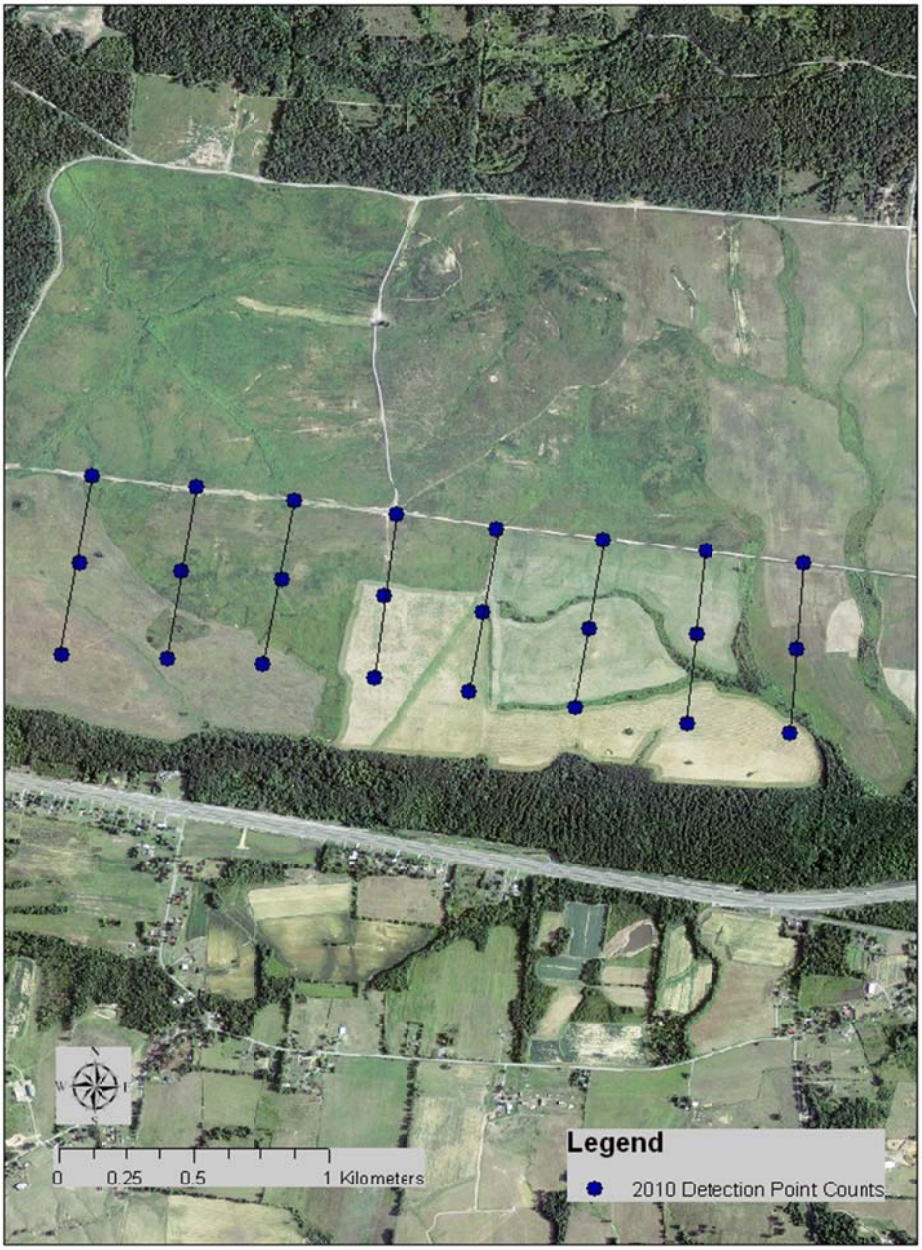

Figure 7. An example of the off-road point counts conducted in 2010, to determine Henslow's Sparrow occupancy and detection probability with distance from road on Peabody Wildlife Management Area in KY.

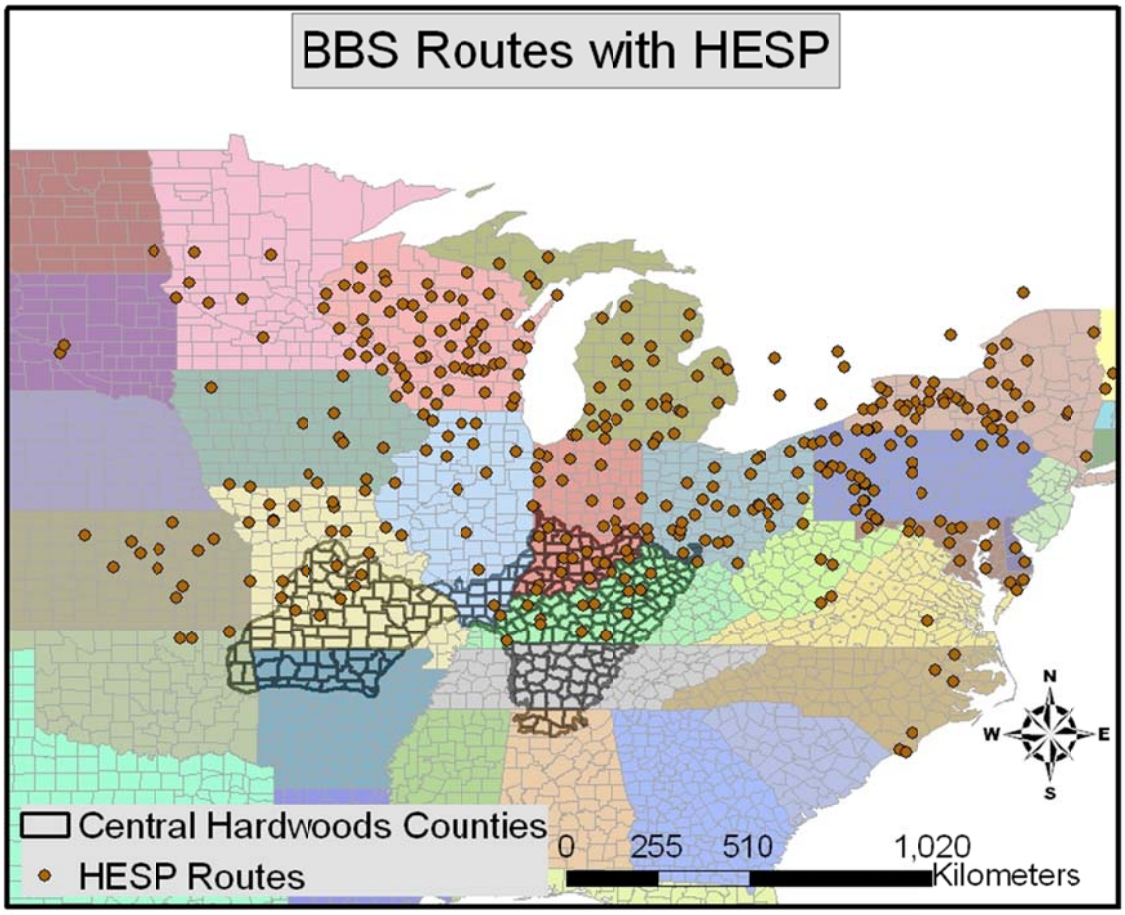

Figure 8. North American Breeding Bird Survey routes with Henslow's Sparrow detections from 1996 ─ 2006 across the entire breeding range.

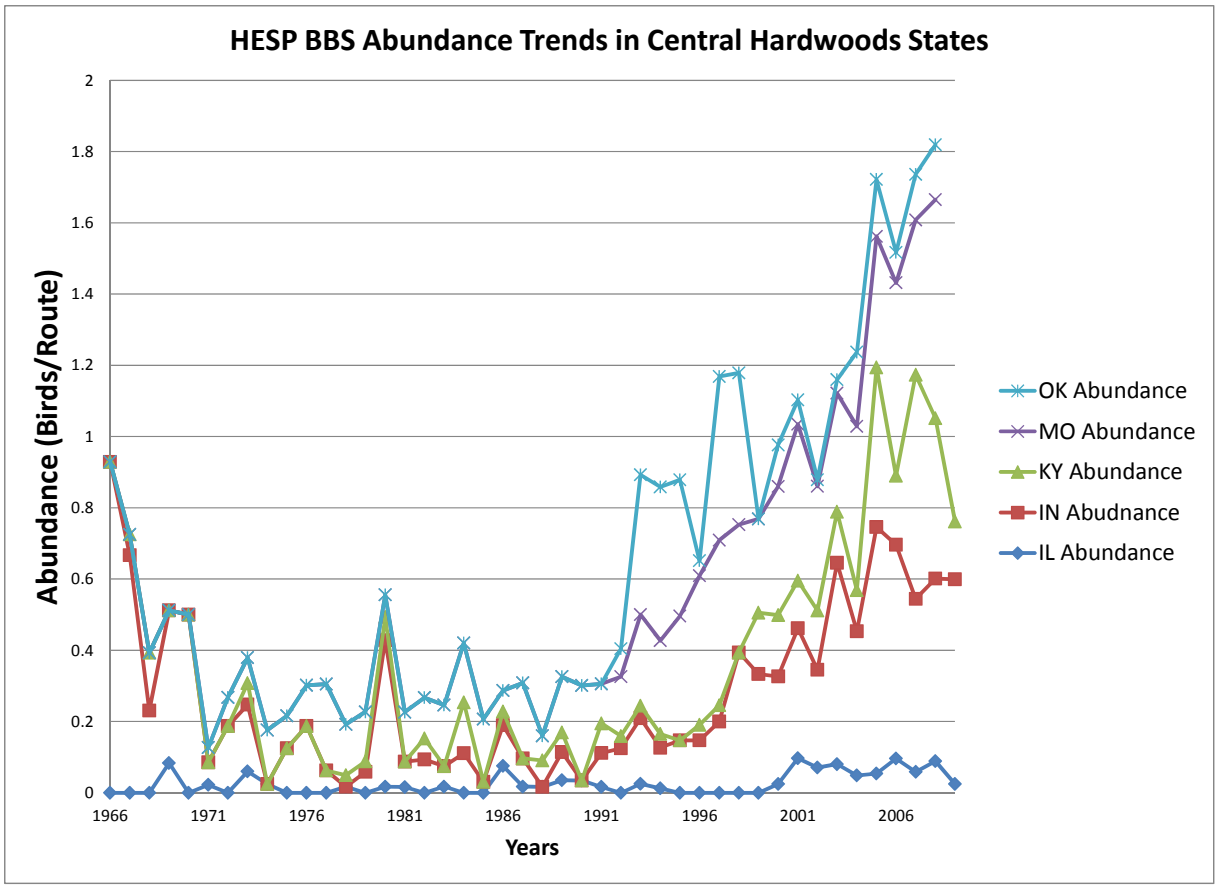

Figure 9. Henslow's Sparrow abundance trends from BBS data, from 1966 ─ 2009, for each state located in the Central Hardwoods Bird Conservation Region.

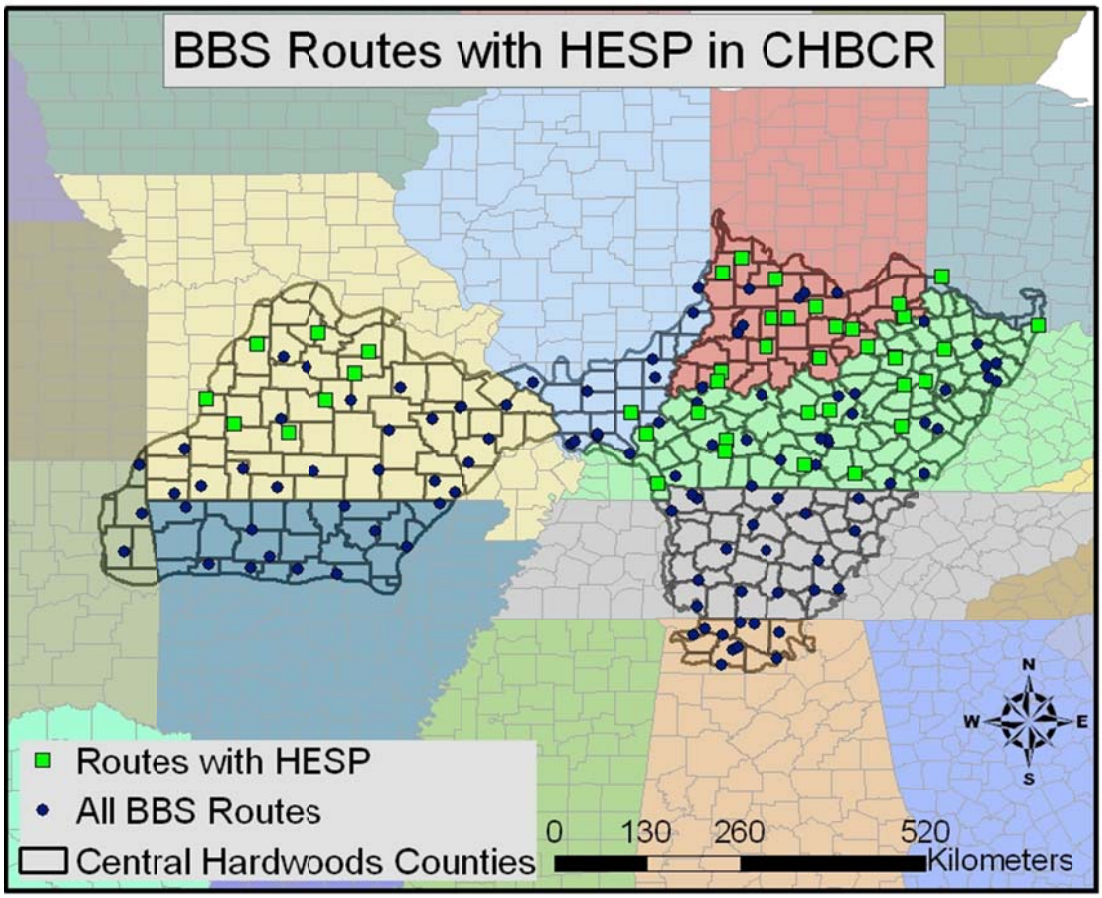

Figure 10. Henslow's Sparrow detections from 1996 ─ 2006 on BBS routes located exclusively within the Central Hardwoods Bird Conservation Region.

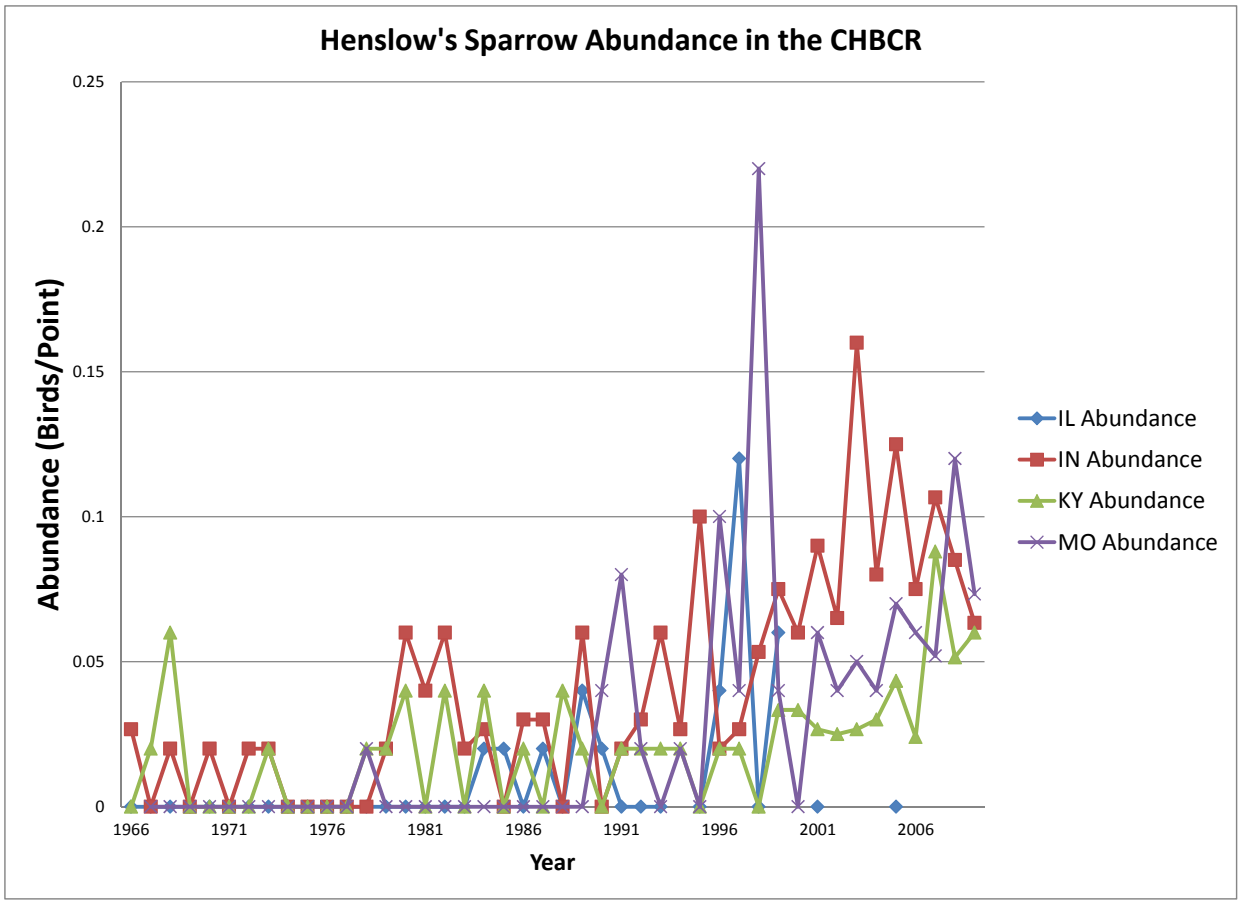

Figure 11. Henslow's Sparrow abundance trends from 1966 ─ 2009, from BBS routes located exclusively in the Central Hardwoods Bird Conservation Region.

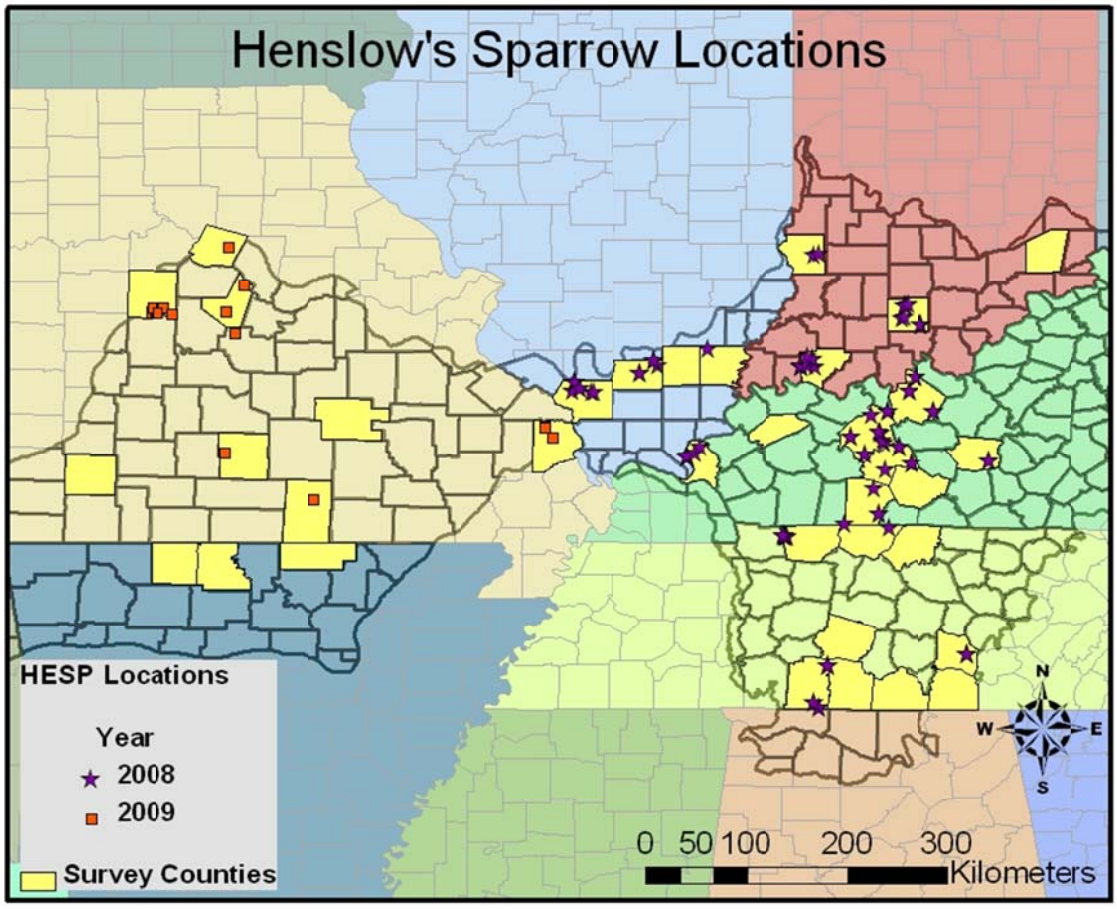

Figure 12. Henslow's Sparrow detections from roadside point counts conducted from May ─ July, 2008 and 2009, in the Central Hardwoods Bird Conservation Region.

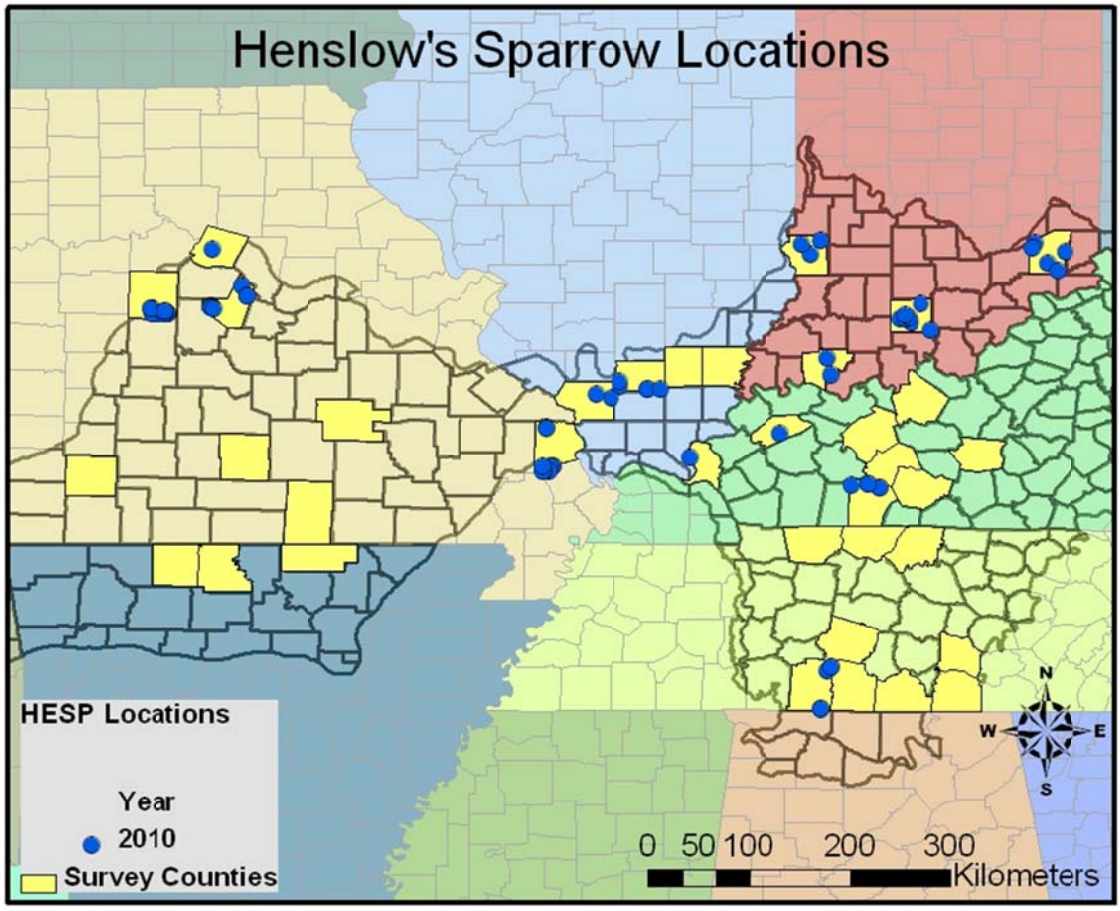

Figure 13. Henslow's Sparrow detections from roadside point counts conducted from May ─ July, 2010, in the Central Hardwoods Bird Conservation Region.