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Natural Resource Stewardship and Science

Bird Monitoring at Effigy Mounds National Monument, Iowa

Status Report 2009–2017

Natural Resource Report NPS/HTLN/NRR—2019/1874

ON THE COVER
Prairie and forest at Effigy Mounds National Monument
Photograph by NPS/Heartland Inventory and Monitoring Network

Bird Monitoring at Effigy Mounds National Monument, Iowa

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Natural Resource Report NPS/HTLN/NRR—2019/1874

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Executive Summary

In 2009, the Heartland Inventory and Monitoring (I&M) Network) initiated breeding bird surveys on Effigy Mounds National Monument (NM), Iowa, to address two objectives: (1) to monitor changes in bird community composition and abundance, and (2) to improve our understanding of relationships between breeding birds and habitat and the effects of management actions on such relationships. This report evaluates trends in the park's breeding bird populations in the context of trends observed within the North American Bird Conservation Initiative's (NABCI) Prairie Hardwood Transition Bird Conservation Region, the bird conservation region in which the park is located. By doing so, we can assess the influence of habitat management by the park on bird populations with an understanding of regional population trends that are outside the influence of natural resource management activities at Effigy Mounds NM.

One hundred and two species of birds were recorded during May and June site visits in the nine years since initiating monitoring. Ninety of the species are considered breeding species because they are permanent or summer residents. Eight of the breeding species recorded on Effigy Mounds NM are species of concern for the Prairie Hardwood Transition Bird Conservation Region. Twenty-three species were observed during the survey period in sufficient numbers to calculate annual abundances and trends with some degree of statistical confidence.

The American Redstart (*Setophaga ruticilla*), American Robin (*Turdus migratorius*), Baltimore Oriole (*Icterus galbula*), and Blue-gray Gnatcatcher (*Polioptila caerulea*) were the most abundant and widespread species on the park. However, American Redstart was the only species that had a strong increase in population size over the nine years of monitoring. The Brown-headed Cowbird (*Molothrus ater*), Common Yellowthroat (*Geothlypis trichas*), Red-winged Blackbird (*Agelaius phoeniceus*), and Rose-breasted Grosbeak (*Pheucticus ludovicianus*) had moderate increases in population size. One species, Eastern Wood-pewee (*Contopus virens*), had a stable population. For 14 species we were unable to detect with certainty either positive or negative population trends, and three other species had unreliable trend estimates.

Regional trends reported for the Prairie Hardwood Transition Bird Conservation Region were uncertain for 11 of the 23 species, including the Rose-breasted Grosbeak. Seven species, including the American Redstart, had populations that were increasing within the region. Five species, including three with positive trends on the park (Brown-headed Cowbird, Common Yellowthroat, and Red-winged Blackbird), had populations that were declining within the region.

This report provides current regional and local trends for breeding birds for future comparisons with bird data collected as part of the long-term monitoring efforts at Effigy Mounds NM. This information will help park staff plan management objectives, and assess the effectiveness of management alternatives. These monitoring data also provide park staff with additional information for interpreting natural resources.

Acknowledgments

We would like to thank the staff of Effigy Mounds NM, Iowa, for allowing us access to the park during our site visit. We would also like to thank park staff and volunteers who assisted with bird surveys on the park: Emily K. Groom, Darwin D. Koenig, Jon W. Stravers, Jessica A. Salesman, Dennis Kirshbaum, Kat M. Busse, Jeanette R. Mueller, and Paul D. Blom Skrade.

Introduction

Birds are an important component of park ecosystems, as their high body temperature, rapid metabolism, and high ecological position in most food webs make them good indicators of the effects of local and regional changes in ecosystems. It has been suggested that management activities intended to preserve habitat for bird populations, such as for neotropical migrants, can have the added benefit of preserving entire ecosystems and their attendant ecosystem services (Karr 1991; Maurer 1993). Moreover, birds have a tremendous following among the public and many parks provide information on the status and trends of birds through their interpretive programs.

Effigy Mounds National Monument (NM), Iowa, is located in the south-central section of the Prairie Hardwood Transition Bird Conservation Region (Figure 1). This bird conservation region is one of 67 regions identified in the North American Bird Conservation Initiative (NABCI). Started in 1999, the NABCI is a coalition of government agencies and private organizations in the United States working to ensure the long-term health of North American native bird populations (NABCI 2012).

Prairies once dominated this region in the west and south and beech-maple forest in the north and east,

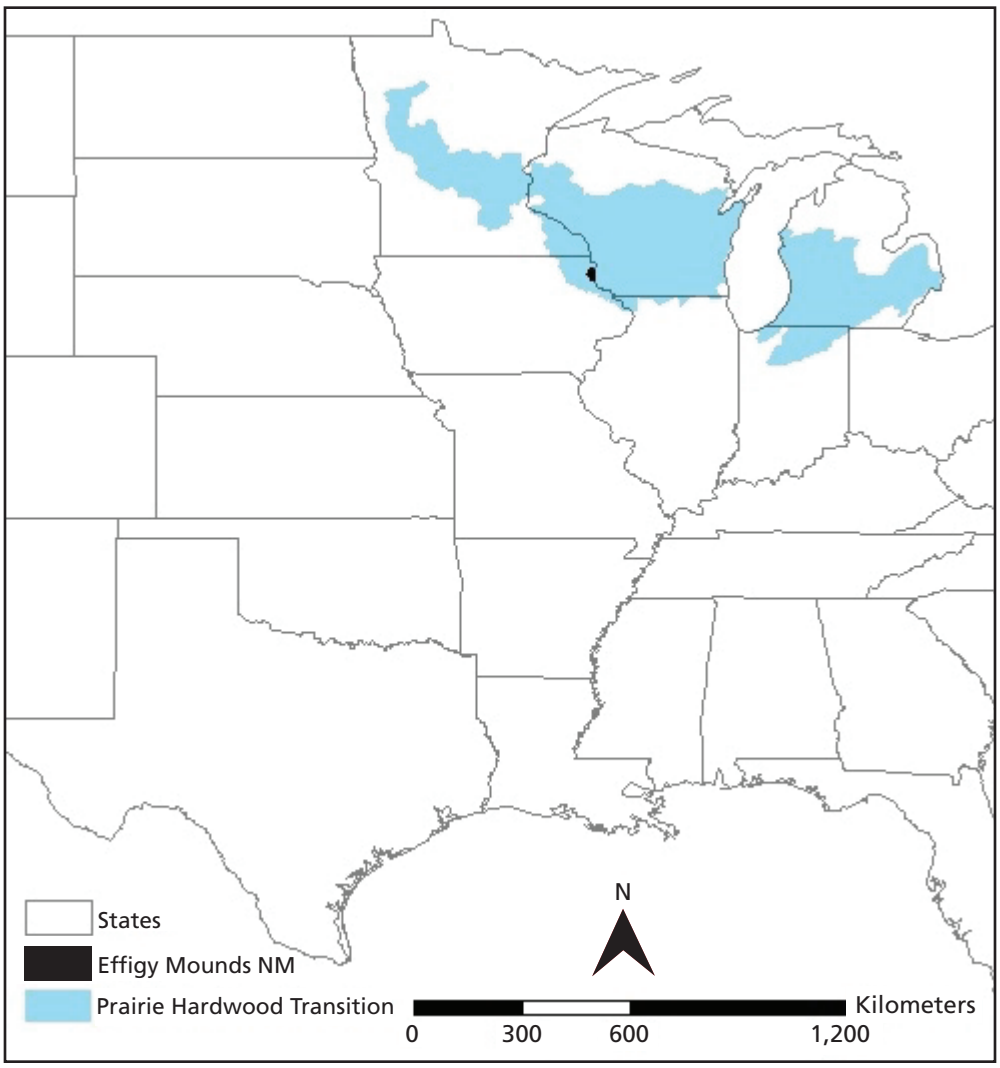

Figure 1. Location of Effigy Mounds NM, Iowa, within the Prairie Hardwood Transition Bird Conservation Region.

separated by an oak savanna (NABCI 2012). Glaciation has resulted in numerous pothole-type wetlands and shallow lakes, and the Great Lakes' coastal estuaries. Many rivers can be found in this region with the Mississippi River being the largest. This region is second only to the Prairie Pothole region in terms of high densities of breeding waterfowl.

Both early successional and mature woodlands provide habitat to numerous bird species as well. Approximately 133 species of breeding birds can be found in the prairie-hardwood habitat of the area around Effigy Mounds NM (Jackson et al. 1996). Habitat on the park lacks the extensive prairie component found in parts of the region, but the mix of deciduous trees, shrubs, permanent and seasonally flooded areas, and brushy openings (Hop et.al. 2005) is similar to other parts of the region. The diverse mix of habitat (structural composition) on the park is important for the species of regional concern, as their microhabitat requirements vary (Pashley and Barrow 1993).

Data collected during the U.S. Geological Survey's annual North American Breeding Bird Surveys (BBS) between 2005 and 2015 indicate that a number of bird species with potential to occur at Effigy Mounds NM show evidence of population decline (Sauer et al. 2017). In fact, 53–56% of the species have populations reported to be in decline, with species such as the Common Moorhen (*Gallinula chloropus*), Grasshopper Sparrow (*Ammodramus savannarum*), Northern Bobwhite (*Colinus virginianus*), Purple Martin (*Progne subis*), Savannah Sparrow (*Passerculus sandwichensis*), Sedge Wren (*Cistothorus platensis*), and Western Meadowlark (*Sturnella neglecta*) declining at alarming rates.

Long-term trends in community composition and abundance of breeding bird populations provide one measure for assessing the ecological stability, and conversely, changes in a system. We will use trends in the composition and abundance of bird populations as long-term indicators of ecosystem stability at Effigy Mounds NM. *Ecosystem stability* is defined here as the system's capability to support and maintain a balanced, community of birds having a species composition, diversity, and functional organization comparable to that of the natural habitats of the region. Research has demonstrated that birds serve as good indicators of changes in ecosystems (Cairns et al. 2004; Mallory et al. 2006; Wood et al. 2006). Therefore, changes in the numbers and composition of bird communities may reflect the effectiveness of management actions taken to restore and maintain the landscape at the park.

There are two primary objectives for monitoring breeding birds at Effigy Mounds NM:

- Identify significant temporal changes in the species composition and abundance of bird communities that occur at the park during the breeding season.
- Improve our understanding of relationships between breeding birds and habitat and the effects of management actions (such as prairie restorations or prescribed fire) on bird populations by examining potential correlations between changes in specific habitat variables (e.g., vegetation structure and ground cover) and changes in bird community composition and abundance.

As a first step in meeting monitoring objectives, this report summarizes species composition and population trends for birds recorded during the nine years (2009–2017) of monitoring.

Methods

Monitoring locations or 'plots' were selected by overlaying a systematic grid of 400 x 400-meter cells (originating from a random start point). The orientation of the grid was rotated 8 degrees to prevent monitoring sites from being influenced by man-made features (roads, fences, etc.) located along cardinal directions. We established 52 plots in total (Figure 2). However, for various reasons the number of plots sampled ranged from 21 to 45 (Table 1). Four plots were in the Yellow River and four in ponds. These sites were only sampled in 2010 and 2015 using a boat. Four plots are located on slopes too steep (>40%) to sample safely when wet, and two plots fell in sensitive areas and were dropped from sampling most years. Eleven plots in areas prone to flooding were only sampled in years when water levels permitted. Flood conditions in 2013 prevented accessibility to four additional upland plots that were sampled in other years. Only 27 plots (1-6, 8, 9, 13-18, 24-27, 33, 37, 38, 42, 43, 45, 47, 50, 52) were sampled frequently enough (>7 years) for inclusion in trend analysis for this report (Appendix A). Nineteen of the plots were in upland wooded habitat, six in shrubby wetland habitat, and two in shrub-invaded grassland habitat.

During bird surveys in 2009, monitoring plots were located using navigation waypoints (Peitz et al. 2010) in a Trimble Geo XT GPS unit and temporarily marked with 36-inch pin flags to aid in relocating the plots for habitat assessment, eliminating the need for permanent plot markers. We collected pin flags from each plot once the habitat work was completed. In 2013 and 2017, the habitat assessment crews worked either directly with or completely independent of the birder, and monitoring plots were located using a GPS unit but not marked with pin flags. During bird surveys in 2010–2012 and 2014–2016, years when habitat assessments were not conducted, monitoring plots were located using a GPS unit and were not marked with pin flags.

Bird Surveys

Bird surveys followed methods outlined in the bird monitoring protocol by Peitz et al. (2008) and summarized in this report. Variable circular plot counts, a point count methodology that incorporates a measure of detectability into population estimates, were used to survey birds present (Fancy 1997). All birds seen or heard at plots during 5-min sampling periods were recorded along with their corresponding distance from observer. For most species, we recorded each individual bird as a separate observation. For species that usually occur in clusters or flocks, the units recorded were cluster or flock size, and not the individual bird. During analysis, each individual in a cluster or flock was treated as a separate observation. After completing a count

Table 1. Number of plots sampled and sampling dates for breeding bird surveys conducted at Effigy Mounds NM, Iowa, by year. Also listed are observer(s) who conducted the surveys and whether or not habitat data were collected during the survey year.

Year	Sampling Dates	Number of Plots Sampled	Observer(s)	Habitat Data Collected
2009	May 29 – June 1	34	D.G. Peitz[1]	Yes
2010	May 20 – June 10	45	E.K. Groom, D.D. Koenig and J.W. Stravers	No
2011	May 24 – June 19	39	J.A. Salesman and J.W. Stravers	No
2012	May 20 – June 20	35	J.W. Stravers	No
2013	May 29 – June2	21	D.G. Peitz[1]	Yes
2014	May 20 – June 6	38	E.K. Groom, D. Kirshbaum and J.W. Stravers	No
2015	May 21 – June 23	40	K.M. Busse, J.R. Mueller, P.D. Blom Skrade and J.W. Stravers	No
2016	May 20 – June 14	39	J.W. Stravers	No
2017	May 20 – May 22	36	D.G. Peitz[1] and D.W. Marcum[1]	Yes

[1] Heartland Inventory & Monitoring Network staff

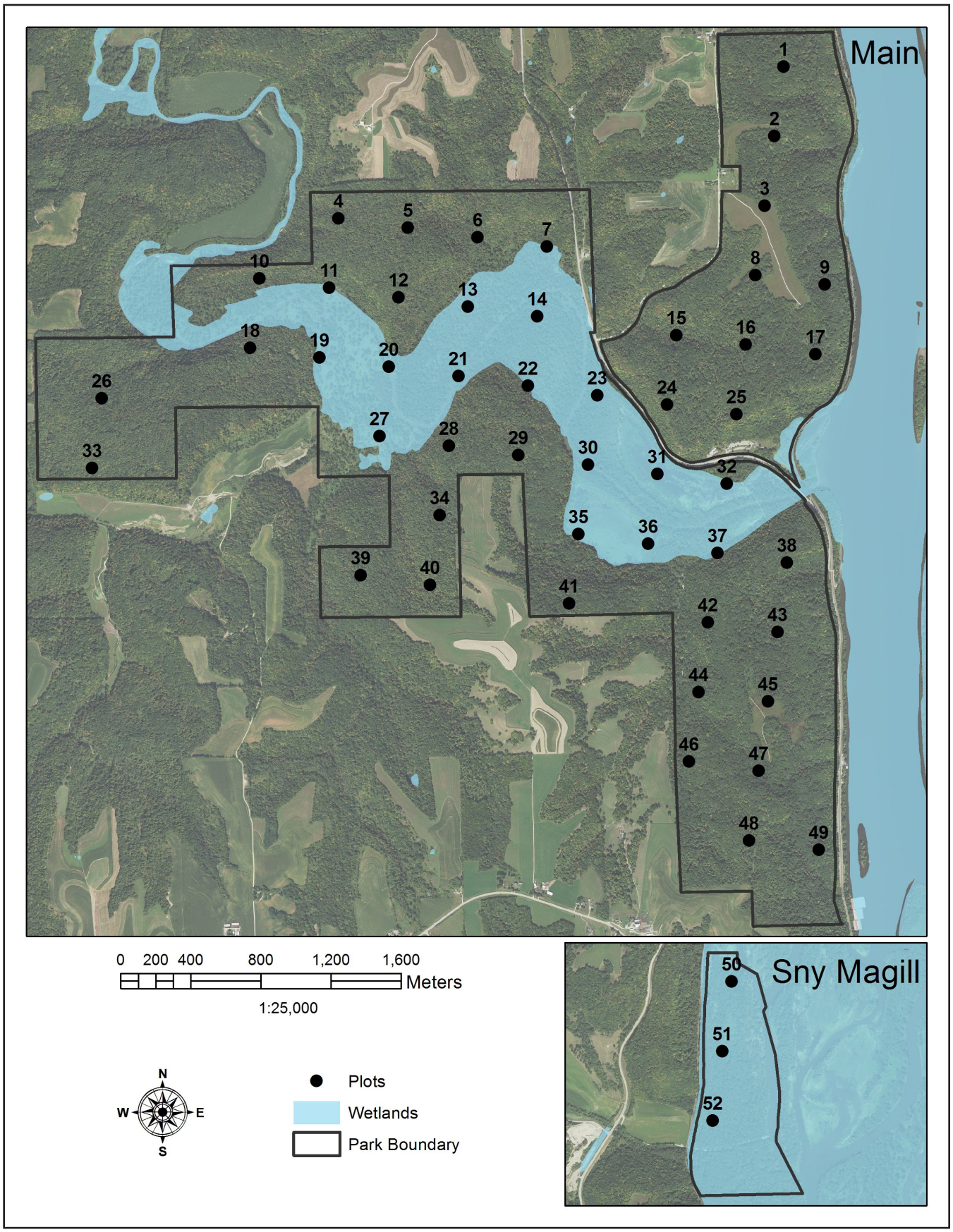

Figure 2. Bird plot locations on Effigy Mounds NM, Iowa.

at a plot and filling out the data sheet, the observer navigated to the next plot using a GPS unit. While traveling between plots, the observer was vigilant for the presence of species not recorded during timed surveys. These species help formulate a more complete species list for the park by identifying species missed during timed surveys. However, these observations were not included in any analysis as they did not directly relate to any individual plot. We sampled birds in the morning during a period when it was light enough to observe birds to four hours after sunrise.

Variable circular plot counts were conducted in an attempt to get an "instantaneous count" of all birds present. The observer recorded birds flushed from a plot when approached and the counts were started as soon as the observer reached plot center. We recorded all birds seen or heard, including flyovers, along with distance from the observer when possible. For this report, all birds seen or heard during the 5-min survey are included.

Data Analysis

Prior to summary analysis, the residency status (migrant, permanent resident, summer resident, and transient) of each bird species recorded was determined (seeTable 2 in Results section). Identifying the residency of each species helps to exclude migrants and transients from analysis of breeding birds within Effigy Mounds NM. The park's vegetation is primarily upland woodlands. As such, all plots were grouped as a single data set for analysis. The proportion of plots occupied by each bird species was calculated (total number of plots occupied by an observed species [uncorrected for imperfect detection]/plots surveyed) and reported in Appendix B and C. By doing so we can assess how widespread each individual species is across the park. However, plots with undetected individuals would not be counted as occupied, therefore our estimated proportion of plots occupied is a conservative estimate.

For species with greater than 60 observations recorded (23 species), Distance software (Distance 6.0 Release 2) was used to determine the park-wide abundance of each (Buckland et al. 2001). A central part of the analysis in Distance is the modeling of a detection function to account for individuals present but not observed before calculating species abundance. Four candidate functions (half-normal

The American Robin (*Turdus migratorius*) is a summer resident at Effigy Mounds NM. NPS

+ cosine, uniform + cosine, half-normal + hermite polynomial, and hazard-rate + simple polynomial) plus series expansion were considered in determining the detection function of each species, and the most robust models were selected by Distance based on the lowest Akaike Information Criteria (AIC) values.

The hazard-rate + simple polynomial function was selected for eight species: Acadian Flycatcher (*Empidonax virescens*), American Redstart (*Setophaga ruticilla*), Blue-gray Gnatcatcher (*Polioptila caerulea*), Brown-headed Cowbird (*Molothrus ater*), Common Yellowthroat (*Geothlypis trichas*), Eastern Wood-pewee (*Contopus virens*), Ovenbird (*Seiurus aurocapilla*), and Yellow-throated Vireo (*Vireo flavifrons*). The uniform + cosine function was selected for nine species: American Goldfinch (*Spinus tristus*), Blue Jay (*Cyanocitta cristata*), Downy Woodpecker (*Picoides pubescens*), House Wren (*Troglodytes aedon*), Indigo Bunting (*Passerina cyanea*), Northern Cardinal (*Cardinalis cardinalis*), Pileated Woodpecker (*Dryocopus pileatus*), Red-winged Blackbird (*Agelaius phoeniceus*), and White-breasted Nuthatch (*Sitta carolinensis*). The half-normal + cosine function was selected for six species: American Robin (*Turdus migratorius*), Baltimore Oriole (*Ictus galbula*), Rose-breasted Grosbeak (*Pheucticus ludovicianus*), Red-bellied Woodpecker (*Melanerpes carolinus*), Red-eyed Vireo (*Vireo olivaceus*), and Song Sparrow (*Melospiza melodia*). For species with fewer than 60 observations, park-wide abundance was calculated by first deriving a species density from observations

The Song Sparrow (*Melospiza melodia*) is a year-round resident at Effigy Mounds NM. NPS

recorded within a 200-m radius (12.58 ha) around each plot center and then calculating abundance based on average plot densities.

For species with adequate abundance, those with greater than 60 observations, trends were calculated by regressing abundances against survey years using a loglinear model (Poison regression) in the statistical software TRIM Version 3.54 (Pannekoek and van Strien 2005). TRIM is a program developed for the analysis of count data obtained from wildlife population monitoring. It analyzes time series of counts using Poisson regression and produces estimates of yearly indices and trends. We employed a linear trend model with changepoints selected by a stepwise procedure. Serial correlation in count data among years and over dispersion are taken into account with this software. Although TRIM has the capacity to estimate missing data, we restricted our regression analysis to 27 plots that were surveyed in most years (Appendix A). By doing this we analyzed a consistent ratio of upland and wetland plots across years.

For this report we also obtained regional breeding bird trends for the Prairie Hardwood Transition Bird Conservation Region during the period 2005–2015 from the Breeding Bird Survey (BBS) website of the USGS Patuxent Wildlife Research Center (Appendix E; Sauer et al. 2017). It is possible to determine trends for many bird species, and many regions of interest for periods ranging from 1966 to 2015 by using the interactive calculator available at: https://www.mbr-pwrc.usgs.gov/bbs/trend/tf15.html. However, we chose the last 10 year period of available data to maximize the accuracy of regional trend results without going too far beyond the sampling period at Effigy Mounds NM.

We compared regional trends with those calculated using TRIM for Effigy Mounds NM populations (Figure 3). Regional trends with a confidence interval that straddled zero were classified as uncertain for comparison with results from Effigy Mounds NM. It should be noted that trends determined by the BBS were calculated using a different methodology. Due to limitations in the BBS field data collections, hierarchical modeling was used to produce an annual index of abundance, and trends were then estimated as constant annual rates based only on the first and last years of the intervals selected. Since all but the first and last year indices are ignored in this approach, trends based on BBS data tend to display variability when compared among different broadly overlapping intervals, and interpretation of BBS results should be made with caution.

Trends in the diversity, richness, and species distribution evenness of the breeding bird community on the park were assessed by regressing each metric against survey years in the add-in statistical software of Microsoft Excel 2010, and then graphing the results. Prior to trend analysis, bird community diversity values were calculated annually using the Shannon Diversity Index:

$$H' = -\sum(n_1/N)\ln(n_1/N)$$

where n_1/N is the proportion of the total number of individuals in a population consisting of the ith species (Shannon 1949). Species richness values were determined as the total number of bird taxa recorded annually. Species distribution evenness values were calculated using Pielou (J):

$$J' = H'/Hmax$$

where H' is the Shannon Diversity Index and Hmax is the maximum possible diversity for a given number of species if all species are present in equal numbers (ln(annual species richness)). J' is a measure of how evenly individuals are distributed within a community when compared to the equal distribution and maximum diversity a community can have (Pielou 1969).

Because not all species occurring in an area may actually be observed in a survey (i.e., rare species may be missed), recorded species richness is often an underestimate. Statistical species richness estimators utilize the information in species distribution and abundance patterns to produce an estimate of true species richness. Species richness estimators are also useful in comparing surveys with unequal sampling effort (e.g., different numbers of plots) since more species are usually discovered with greater sampling effort. Different species richness estimators will produce varying estimates, however, and no single estimator is consistently superior to others.

Nonparametric statistical estimators have generally performed better than parametric types (Walther and Moore 2005). Reese et al. (2014) recently reviewed nonparametric species richness estimators; two coverage-based estimators, the ACE (Abundance Coverage-based Estimator) and ICE (Incidence Coverage-based Estimator) were found to provide less biased and more accurate estimates than many of the others. Thus, we employed these two species richness estimators and report estimated species richness along with observed species richness. The software application EstimateS (Colwell 2013) was used to calculate the ACE and ICE estimators.

Results

Bird Surveys

Between 2009 and 2017, 21 to 45 plots on Effigy Mounds NM were surveyed annually for breeding birds (Table 1). During this nine year period, 327 cumulative plots were surveyed and 102 different bird species were recorded, 90 of which are species with the potential to breed within the park (Table 2; Jackson et al. 1996). Two breeding species, Chimney Swift (*Chaetura pelagica*) and Northern Rough-winged Swallow (*Stelgidopteryx serripennis*), were only observed outside 5-min survey periods. Eight of the breeding species recorded, Bald Eagle (*Haliaeetus leucocephalus*), Black-billed Cuckoo (*Coccyzus erythropthalmus*), Blue-winged Warbler (*Vermivora pinus*), Brown Thrasher (*Toxostoma rufum*), Cerulean Warbler (*Setophaga cerulea*), Dickcissel (*Spiza americana*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), and Willow Flycatcher (*Empidonax traillii*) are considered species of regional concern for the Prairie Hardwood Transition Bird Conservation Region (U.S. Fish and Wildlife Service 2008).

Table 2. Bird species recorded during breeding bird surveys at Effigy Mounds NM, Iowa, from 2009 through 2017. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Species names are valid and verified names taken from the Integrated Taxonomic Information System web site (ITIS 2017).

Common name	Species name	AOU code	Residency[1]
Acadian Flycatcher	*Empidonax virescens*	ACFL	SR
Alder Flycatcher[2]	*Empidonax alnorum*	ALFL	M
American Crow	*Corvus brachyrhynchos*	AMCR	R
American Goldfinch	*Spinus tristis*	AMGO	R
American Redstart	*Setophaga ruticilla*	AMRE	SR
American Robin	*Turdus migratorius*	AMRO	SR
Bald Eagle[3]	***Haliaeetus leucocephalus***	**BAEA**	**R**
Baltimore Oriole	*Icterus galbula*	BAOR	SR
Barn Swallow	*Hirundo rustica*	BARS	SR
Belted Kingfisher	*Megaceryle alcyon*	BEKI	R
Black-and-white Warbler	*Mniotilta varia*	BAWW	SR
Black-billed Cuckoo[3]	***Coccyzus erythropthalmus***	**BBCU**	**SR**
Black-capped Chickadee	*Poecile atricapillus*	BCCH	R
Blackpoll Warbler[2]	*Setophaga striata*	BLPW	M
Black-throated Green Warbler	*Setophaga virens*	BTNW	M
Blue Jay	*Cyanocitta cristata*	BLJA	R
Blue-headed Vireo[2]	*Vireo solitarius*	BHVI	M
Blue-gray Gnatcatcher	*Polioptila caerulea*	BGGN	SR
Blue Grosbeak	*Passerina caerulea*	BLGR	T
Blue-winged Warbler[3]	***Vermivora pinus***	**BWWA**	**SR**
Brown Creeper	*Certhia americana*	BRCR	R
Brown Thrasher[3]	***Toxostoma rufum***	**BRTH**	**SR**

[1] M = migrant through the area; R = year around resident; SR = summer resident; T = transient; According to Jackson et al. (1996).

[2] Species recorded only while traveling between survey plots or at other times outside of 5-min survey periods.

[3] Species of regional concern for the Prairie Hardwood Transition Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

Table 2 (continued). Bird species recorded during breeding bird surveys at Effigy Mounds NM, Iowa, from 2009 through 2017. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Species names are valid and verified names taken from the Integrated Taxonomic Information System web site (ITIS 2017).

Common name	Species name	AOU code	Residency[1]
Brown-headed Cowbird	*Molothrus ater*	BHCO	SR
Canada Goose	*Branta canadensis*	CAGO	R
Canada Warbler[2]	*Cardellina canadensis*	CAWA	M
Carolina Wren	*Thryothorus ludovicianus*	CARW	R
Cedar Waxwing	*Bombycilla cedrorum*	CEDW	SR
Cerulean Warbler[3]	***Setophaga cerulean***	**CERW**	**SR**
Chimney Swift[2]	*Chaetura pelagica*	CHSW	SR
Chipping Sparrow	*Spizella passerina*	CHSP	SR
Cliff Swallow	*Petrochelidon pyrrhonota*	CLSW	SR
Common Grackle	*Quiscalus quiscula*	COGR	SR
Common Yellowthroat	*Geothlypis trichas*	COYE	SR
Cooper's Hawk	*Accipiter cooperii*	COHA	SR
Dark-eyed Junco[2]	*Junco hyemalis*	DEJU	M
Dickcissel[3]	***Spiza americana***	**DICK**	**SR**
Downy Woodpecker	*Picoides pubescens*	DOWO	R
Eastern Bluebird	*Sialia sialis*	EABL	SR
Eastern Kingbird	*Tyrannus tyrannus*	EAKI	SR
Eastern Meadowlark	*Sturnella magna*	EAME	SR
Eastern Phoebe	*Sayornis phoebe*	EAPH	SR
Eastern Towhee	*Pipilo erythrophthalmus*	EATO	SR
Eastern Wood-pewee	*Contopus virens*	EAWP	SR
European Starling	*Sturnus vulgaris*	EUST	R
Field Sparrow	*Spizella pusilla*	FISP	SR
Grasshopper Sparrow	*Ammodramus savannarum*	GRSP	SR
Gray Catbird	*Dumetella carolinensis*	GRCA	SR
Great Blue Heron	*Ardea herodias*	GBHE	SR
Great Crested Flycatcher	*Myiarchus crinitus*	GCFL	SR
Hairy Woodpecker	*Picoides villosus*	HAWO	R
Hermit Thrush	*Catharus guttatus*	HETH	M
Hooded Merganser	*Lophodytes cucullatus*	HOME	SR
Hooded Warbler	*Setophaga citrina*	HOWA	SR
House Finch	*Carpodacus mexicanus*	HOFI	R
House Wren	*Troglodytes aedon*	HOWR	SR
Indigo Bunting	*Passerina cyanea*	INBU	SR

[1] M = migrant through the area; R = year around resident; SR = summer resident; T = transient; According to Jackson et al. (1996).

[2] Species recorded only while traveling between survey plots or at other times outside of 5-min survey periods.

[3] Species of regional concern for the Prairie Hardwood Transition Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

Table 2 (continued). Bird species recorded during breeding bird surveys at Effigy Mounds NM, Iowa, from 2009 through 2017. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Species names are valid and verified names taken from the Integrated Taxonomic Information System web site (ITIS 2017).

Common name	Species name	AOU code	Residency[1]
Kentucky Warbler	*Geothlypis formosa*	KEWA	SR
Killdeer	*Charadrius vociferus*	KILL	SR
Least Flycatcher	*Empidonax minimus*	LEFL	SR
Mallard	*Anas platyrhynchos*	MALL	SR
Mourning Dove	*Zenaida macroura*	MODO	SR
Northern Cardinal	*Cardinalis cardinalis*	NOCA	R
Northern Flicker	*Colaptes auratus*	YSFL	R
Northern Parula	*Setophaga americana*	NOPA	SR
Northern Rough-winged Swallow[2]	*Stelgidopteryx serripennis*	NRWS	SR
Olive-sided Flycatcher[2]	*Contopus cooperi*	OSFL	M
Ovenbird	*Seiurus aurocapilla*	OVEN	SR
Pileated Woodpecker	*Dryocopus pileatus*	PIWO	R
Prothonotary Warbler	*Protonotaria citrea*	PROW	SR
Red-bellied Woodpecker	*Melanerpes carolinus*	RBWO	R
Red-eyed Vireo	*Vireo olivaceus*	REVI	SR
Red-headed Woodpecker[3]	***Melanerpes erythrocephalus***	**RHWO**	**R**
Red-shouldered Hawk	*Buteo lineatus*	RSHA	R
Red-tailed Hawk	*Buteo jamaicensis*	RTHA	R
Red-winged Blackbird	*Agelaius phoeniceus*	RWBL	R
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	RBGR	SR
Ruby-throated Hummingbird	*Archilochus colubris*	RTHU	SR
Scarlet Tanager	*Piranga olivacea*	SCTA	SR
Sedge Wren	*Cistothorus platensis*	SEWR	SR
Song Sparrow	*Melospiza melodia*	SOSP	R
Spotted Sandpiper	*Actitis macularius*	SPSA	SR
Swainson's Thrush	*Catharus ustulatus*	SWTH	M
Swamp Sparrow	*Melospiza georgiana*	SWSP	SR
Tennessee Warbler	*Leiothlypis peregrina*	TEWA	M
Tree Swallow	*Tachycineta bicolor*	TRES	SR
Tufted Titmouse	*Baeolophus bicolor*	ETTI	R
Turkey Vulture	*Cathartes aura*	TUVU	SR
Veery	*Catharus fuscescens*	VEER	SR
Warbling Vireo	*Vireo gilvus*	WAVI	SR
White-breasted Nuthatch	*Sitta carolinensis*	WBNU	R
White-eyed Vireo	*Vireo griseus*	WEVI	SR

[1] M = migrant through the area; R = year around resident; SR = summer resident; T = transient; According to Jackson et al. (1996).

[2] Species recorded only while traveling between survey plots or at other times outside of 5-min survey periods.

[3] Species of regional concern for the Prairie Hardwood Transition Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

Table 2 (continued). Bird species recorded during breeding bird surveys at Effigy Mounds NM, Iowa, from 2009 through 2017. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Species names are valid and verified names taken from the Integrated Taxonomic Information System web site (ITIS 2017).

Common name	Species name	AOU code	Residency[1]
Willow Flycatcher[3]	***Empidonax traillii***	**WIFL**	**SR**
Wilson's Warbler	*Cardellina pusilla*	WIWA	M
Wild Turkey	*Meleagris gallopavo*	WITU	R
Wood Duck	*Aix sponsa*	WODU	SR
Wood Thrush	*Hylocichla mustelina*	WOTH	SR
Worm-eating Warbler	*Helmitheros vermivorum*	WEWA	SR
Yellow Warbler	*Setophaga petechia*	YWAR	SR
Yellow-bellied Sapsucker	*Sphyrapicus varius*	YBSA	SR
Yellow-breasted Chat	*Icteria virens*	YBCH	SR
Yellow-billed Cuckoo	*Coccyzus americanus*	YBCU	SR
Yellow-throated Vireo	*Vireo flavifrons*	YTVI	SR

[1] M = migrant through the area; R = year around resident; SR = summer resident; T = transient; According to Jackson et al. (1996).

[2] Species recorded only while traveling between survey plots or at other times outside of 5-min survey periods.

[3] Species of regional concern for the Prairie Hardwood Transition Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

Twenty-three breeding species were observed during the survey period in sufficient numbers to calculate annual abundances with some degree of statistical confidence (Appendix B) using Distance software. Park-wide abundances for species with less than 60 observations are reported in Appendix C. Of the twenty-three species observed in sufficient numbers to calculate annual abundances, American Redstart (*Setophaga ruticilla*), American Robin (*Turdus migratorius*), Baltimore Oriole (*Icterus galbula*), and Blue-gray Gnatcatcher (*Polioptila caerulea*) were the most abundant and widespread species on Effigy Mounds NM. However, American Redstart was the only species that had a strong increase in population size over the nine years of monitoring (Figure 3; Appendix D). Four other species, Brown-headed Cowbird (*Molothrus ater*), Common Yellowthroat (*Geothlypis trichas*), Red-winged Blackbird (*Agelaius phoeniceus*), and Rose-breasted Grosbeak (*Pheucticus ludovicianus*), had moderate increases in population size. One species, Eastern Wood-pewee (*Contopus virens*), had a stable population.

For 14 species, we were unable to detect positive or negative population trends with certainty, and three other species had unreliable trend estimates. Regional trends (2005-2015) reported by Sauer et al. (2017; Figure 3; Appendix E) for the Prairie Hardwood Transition Bird Conservation Region were uncertain for 11 of the 23 species, including the Rose-breasted Grosbeak. Seven species including the American Redstart had populations that were increasing within the region. Five species, including three with positive trends on the park (Brown-headed Cowbird, Common Yellowthroat, and Red-winged Blackbird), had populations that were declining within the region.

Diversity, richness, and evenness in distribution of individuals across species in the breeding bird community on Effigy Mounds NM were unchanged over the nine monitoring years since 2009 (Figure 4). Bird community richness averaged 55 (58 with 2013 data excluded) species annually on the park. Average estimated species richness was 64 by the ACE estimator and 70 by the ICE estimator. These results should be interpreted with caution, however, as inter-annual variability in the number of plots sampled may have influenced these metrics. For example, the dip in diversity and richness and spike in evenness in 2013 are almost certainly artifacts of missing wetland species due to wetland sites not being sampled because of flooding.

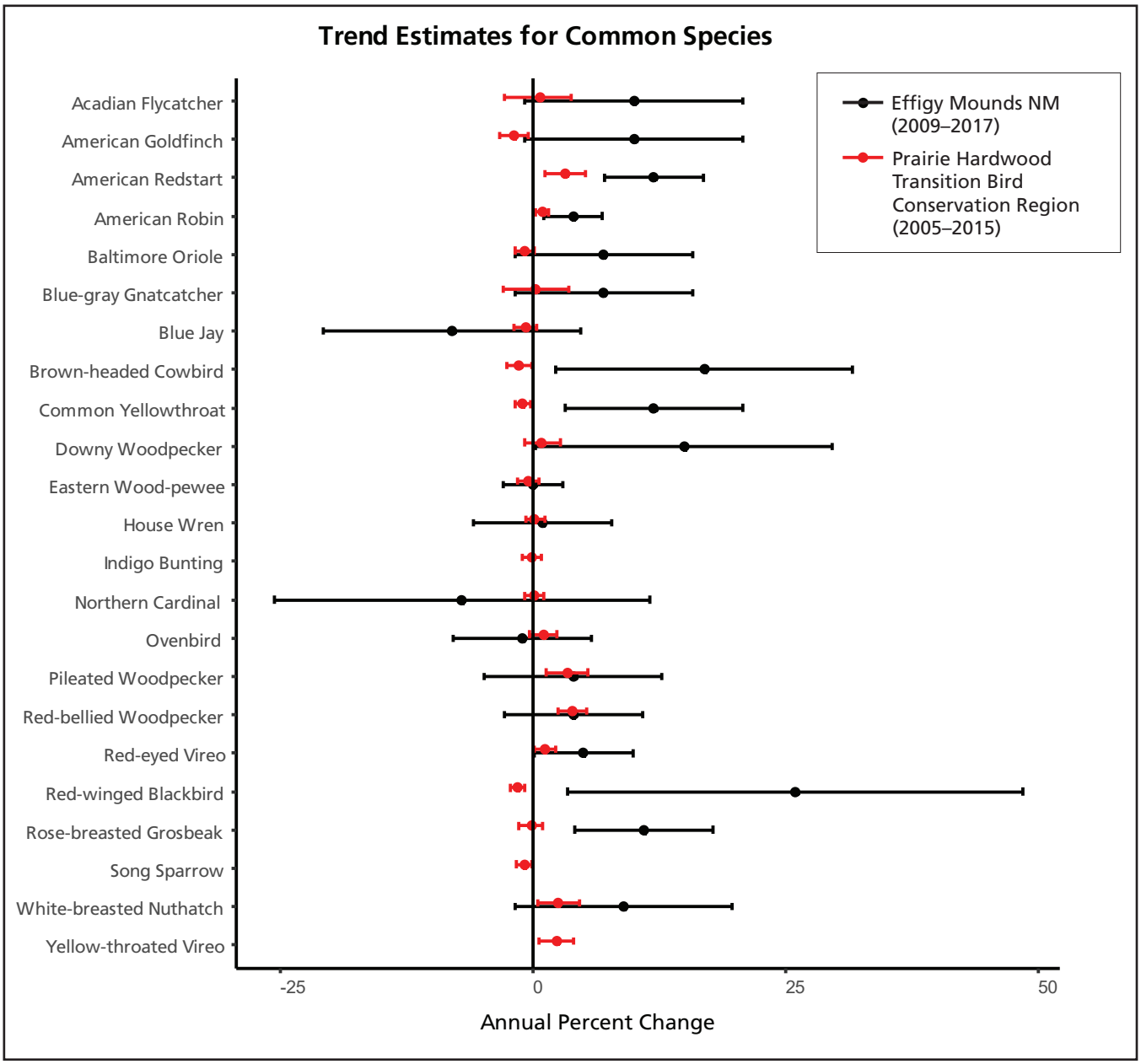

Figure 3. Comparison of bird population trends from Effigy Mounds NM, Iowa, (2009 through 2017) with those of the larger Prairie Hardwood Transition Bird Conservation Region (2005 through 2015). Error bars represent 95% confidence intervals.

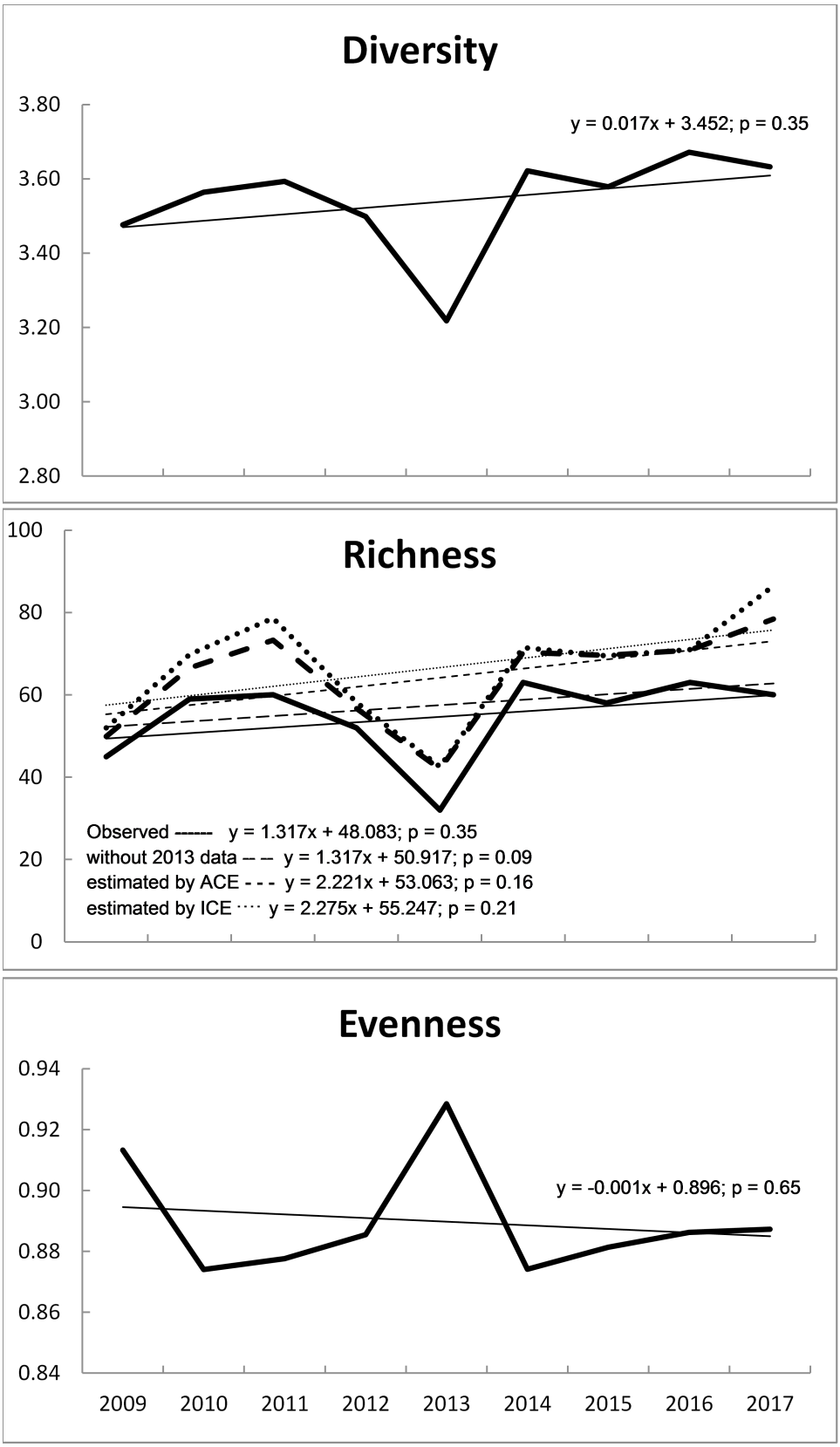

Figure 4. Trends in bird community diversity, richness, and species distribution evenness on Effigy Mounds NM, Iowa, from 2009 through 2017.

Discussion

Breeding bird surveys were initiated at Effigy Mounds NM in 2009 to assist the park in assessing the integrity of their wetlands, grasslands, and woodlands through time. During the nine years of monitoring, 327 plots have been surveyed and 102 bird species have been recorded. Ninety are permanent or summer residents to the area (Jackson et al. 1996). Therefore, these 90 species have some value in characterizing the park's breeding bird community and their habitat. Eight breeding species of concern for the Prairie Hardwood Transition Bird Conservation Region should be given additional consideration in the management of natural resources on the park: Bald Eagle (*Haliaeetus leucocephalus*), Black-billed Cuckoo (*Coccyzus erythropthalmus*), Blue-winged Warbler (*Vermivora pinus*), Brown Thrasher (*Toxostoma rufum*), Cerulean Warbler (*Setophaga cerulean*), Dickcissel (*Spiza americana*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), and Willow Flycatcher (*Empidonax traillii*). However, all eight species were recorded on Effigy Mounds NM in low numbers making it difficult to assess the influences of managing for their needs (Table 2, Appendix C). If it is not feasible to manage habitat for these species directly, then at least habitat should be managed in a way that does not conflict with their needs. For example, complete removal of riparian habitat would be detrimental to the Bald Eagle and Cerulean Warbler, and conversion of prairie to woodland would be detrimental to the Dickcissel.

The Tufted Titmouse (*Baeolophus bicolor*) is a year-round resident at Effigy Mounds NM. NPS

Twenty-three of the 90 breeding species were observed during the survey period in sufficient numbers to calculate annual abundances and trends with some degree of statistical confidence. The American Redstart (*Setophaga ruticilla*), American Robin (*Turdus migratorius*), Baltimore Oriole (*Icterus galbula*), and Blue-gray Gnatcatcher (*Polioptila caerulea*) were the most abundant and widespread species on Effigy Mounds NM, thus these species provide for the best characterization of the habitat currently present. The American Redstart utilizes mixed woodland and thickets, American Robins are habitat generalists that use a wide range of habitats, Baltimore Orioles are found in deciduous trees near open areas, and Blue-gray Gnatcatchers prefer woods, swamps, and shrubby areas (Stokes and Stokes 1996). Habitat on the park is a mix of deciduous tree, shrubs, permanent and seasonally flooded areas, and brushy openings (Hop et.al. 2005). The diverse mix of habitat (structural composition) on Effigy Mounds NM is important for the species of regional concern, as their microhabitat requirements vary (Pashley and Barrow 1993). For example, Bald Eagles and Cerulean Warblers prefer mature deciduous trees along streams and swampy or coastal areas; Red-headed Woodpeckers prefer farmlands, open woodlands, orchards, and urban/suburban forest; Dickcissels prefer prairies and weedy fields, and most other species of regional concern require thick shrubby or old field habitat (Stokes and Stokes 1996).

Comparing population trends on the park with regional trends for the Prairie Hardwood Transition Bird Conservation Region (Figure 3) suggest that the bird community at Effigy Mounds NM is faring better than in the region as a whole. Population trends were significantly better for most species present, especially for American Redstart, Brown-headed Cowbird (*Molothrus ater*), Common Yellowthroat (*Geothlypis trichas*), Red-winged Blackbird (*Agelatus phoeniceus*), and Rose-breasted Grosbeak (*Pheucticus ludovicianus*). All five species had significant positive population trends on the park (Figure 3; Appendix D) but only one (American Redstart) had a significant positive trend within the larger region (Figure 3; Appendix E). Another species, Eastern Wood-pewee (*Contopus virens*), had a stable population on the park although its region-wide population trend was uncertain. Several bird species on the park had

The Great Blue Heron (*Ardea herodias*) is a summer resident at Effigy Mounds NM. NPS

uncertain or statistically unreliable population trends but none were reported as having negative trends supporting our suggestion that the bird community at the park is faring better than in the region as a whole. Region-wide, five of the twenty-three species on the park; American Goldfinch (*Spinus tristis*), Brown-headed Cowbird, Common Yellowthroat, Red-winged Blackbird, and Song Sparrow (*Melospiza melodia*) had negative trends.

Over the nine years of bird monitoring on Effigy Mounds NM, the unchanging diversity, richness, and evenness in distribution of individuals across species values suggest habitat on the park has remained similar across years (Figure 4), and provides for a rich array of breeding species (average of 55 species annually, 58 with 2013 data excluded). However, this species rich stable community structure could be altered if significant portions of the parks woodland were cut or lost to fire, or if the remaining prairie was converted to woodlands.

A word of caution is needed here; since we have a limited number of survey years within the park, trends and indices may change as more years of data are collected. However, our reported data are a baseline for placing bird populations at the park into the context of those seen in the larger Prairie Hardwood Transition Bird Conservation Region and should help the park make more informed natural resource management decisions. Our reported data also contribute information to efforts of other agencies (Partners in Flight, US Geological Survey, US Fish and Wildlife Service, Cornell Lab, Bird Conservancy of the Rockies, etc.) researching the full life cycle of migratory birds.

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Appendix A. Plots Sampled

Table A1. Plots sampled on Effigy Mounds NM, Iowa, between 2009 and 2017 and gross habitat type. "Yes" indicates plot was sampled; "No" indicates it was not.

	Year sampled									
Plot	2009	2010	2011	2012	2013	2014	2015	2016	2017	Plot type
EFMO1[1]	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Upland**
EFMO2[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO3[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Upland**
EFMO4[1]	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO5[1]	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO6[1]	**No**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO7	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Wetland
EFMO8[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Upland**
EFMO9[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO10	No	Yes	Yes	No	No	No	Yes	Yes	No	Upland
EFMO11	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Wetland
EFMO12	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Upland
EFMO13[1]	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**No**	**Yes**	**Wetland**
EFMO14[1]	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Wetland**
EFMO15[1]	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO16[1]	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO17[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO18[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Upland**
EFMO19	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Wetland
EFMO20	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Wetland
EFMO21	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Wetland
EFMO22	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Wetland
EFMO23	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Wetland
EFMO24[1]	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Upland**
EFMO25[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO26[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO27[1]	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Wetland**
EFMO28	No	Yes	Yes	No	No	Yes	Yes	Yes	No	Upland
EFMO29	No	No	Yes	No	No	No	No	No	No	Upland
EFMO30	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Wetland
EFMO31	No	No	Yes	No	No	Yes	No	Yes	No	Wetland
EFMO32	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Wetland
EFMO33[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Upland**

[1] Plot was included in analysis of individual bird species trends (also in bold).

Table A1 (continued). Plots sampled on Effigy Mounds NM, Iowa, between 2009 and 2017 and gross habitat type. "Yes" indicates plot was sampled; "No" indicates it was not.

	Year sampled									
Plot	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Plot type**
EFMO34	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Upland
EFMO35	No	No	No	No	No	Yes	No	No	No	Wetland
EFMO36	No	Yes	Yes	Yes	No	Yes	Yes	No	No	Wetland
EFMO37[1]	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Wetland**
EFMO38[1]	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO39	Yes	No	No	No	No	No	No	No	Yes	Upland
EFMO40	Yes	No	No	No	No	No	No	No	Yes	Upland
EFMO41	Yes	Yes	No	No	No	No	No	No	Yes	Upland
EFMO42[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO43[1]	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Upland**
EFMO44	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Upland
EFMO45[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO46	Yes	No	No	No	Yes	No	Yes	No	Yes	Upland
EFMO47[1]	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Upland**
EFMO48	No	Yes	No	Yes	No	Yes	Yes	No	No	Upland
EFMO49	No	No	No	No	No	No	Yes	Yes	No	Upland
EFMO50[1]	**No**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Wetland**
EFMO51	No	Yes	No	Yes	No	Yes	Yes	Yes	No	Wetland
EFMO52[1]	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Wetland**

[1] Plot was included in analysis of individual bird species trends (also in bold).

Appendix B. Proportion of Plots Occupied (Corrected for Undetected Individuals) and Abundance

Table B1. Annual proportion of plots occupied (includes flyovers) by each breeding bird species and estimated abundance (corrected for undetected individuals using Distance software) of each species at Effigy Mounds NM, Iowa, during the 2009 to 2017 spring bird surveys (n = number of plots sample).

	Proportion of plots occupied by year (Abundance)								
Common name	**2009 n = 34**	**2010 n = 45**	**2011 n = 39**	**2012 n = 35**	**2013 n = 21**	**2014 n = 38**	**2015 n = 40**	**2016 n = 39**	**2017 n = 36**
Acadian Flycatcher	0.06 (40)	0.13 (90)	0.26 (229)	0.20 (137)	0.14 (98)	0.05 (36)	0.28 (223)	0.18 (141)	0.11 (115)
American Goldfinch	0.03 (19)	0.33 (85)	0.41 (142)	0.34 (121)	0 (0)	0.50 (163)	0.48 (179)	0.62 (200)	0.14 (18)
American Redstart	0.15 (155)	0.58 (764)	0.69 (1127)	0.83 (1180)	0.19 (293)	0.87 (1018)	0.73 (967)	0.90 (1127)	0.64 (854)
American Robin	0.29 (344)	0.87 (1055)	0.69 (852)	0.63 (744)	0.10 (86)	0.66 (733)	0.73 (854)	0.77 (806)	0.56 (699)
Baltimore Oriole	0.12 (108)	0.42 (414)	0.62 (714)	0.63 (775)	0.38 (244)	0.79 (906)	0.63 (751)	0.82 (939)	0.22 (183)
Blue-gray Gnatcatcher	0.18 (267)	0.24 (362)	0.46 (854)	0.51 (995)	0.14 (216)	0.45 (717)	0.25 (416)	0.59 (893)	0.28 (421)
Blue Jay	0.12 (21)	0.31 (234)	0.33 (240)	0.31 (226)	0.14 (34)	0.21 (170)	0.23 (162)	0.38 (277)	0.06 (20)
Brown-headed Cowbird	0.09 (27)	0.11 (99)	0.28 (257)	0.17 (156)	0 (0)	0.13 (120)	0.18 (136)	0.21 (187)	0.25 (329)
Common Yellowthroat	0.09 (24)	0.40 (170)	0.41 (187)	0.49 (208)	0.10 (26)	0.47 (170)	0.33 (135)	0.44 (138)	0.28 (105)
Downy Woodpecker	0.09 (83)	0.27 (199)	0.36 (271)	0.23 (161)	0 (0)	0.42 (297)	0.38 (265)	0.49 (344)	0.17 (137)
Eastern Wood-pewee	0.62 (248)	0.62 (279)	0.67 (310)	0.74 (388)	0.24 (105)	0.58 (261)	0.78 (339)	0.72 (320)	0.47 (204)
House Wren	0.15 (71)	0.71 (460)	0.38 (271)	0.26 (165)	0.14 (69)	0.29 (152)	0.33 (204)	0.46 (222)	0.36 (214)
Indigo Bunting	0.18 (98)	0.24 (156)	0.18 (113)	0.26 (142)	0.14 (53)	0.18 (102)	0.15 (97)	0.18 (99)	0.17 (92)
Northern Cardinal	0.06 (20)	0.20 (66)	0.26 (95)	0.23 (77)	0.05 (16)	0.26 (88)	0.25 (92)	0.28 (95)	0.08 (28)
Ovenbird	0.24 (85)	0.24 (90)	0.21 (82)	0.17 (64)	0.14 (46)	0.13 (42)	0.18 (64)	0.21 (66)	0.22 (124)
Pileated Woodpecker	0.09 (5)	0.27 (21)	0.23 (19)	0.17 (16)	0 (0)	0.18 (15)	0.25 (20)	0.33 (27)	0.11 (9)
Red-bellied Woodpecker	0.12 (67)	0.47 (365)	0.33 (254)	0.63 (501)	0.19 (73)	0.39 (321)	0.43 (362)	0.51 (430)	0.28 (212)
Red-eyed Vireo	0.21 (172)	0.47 (430)	0.62 (582)	0.63 (523)	0.38 (349)	0.50 (366)	0.70 (568)	0.64 (470)	0.47 (468)
Red-winged Blackbird	0.03 (0)	0.07 (48)	0.15 (112)	0.26 (152)	0.05 (15)	0.45 (189)	0.23 (125)	0.44 (184)	0.06 (43)

Table B1 (continued). Annual proportion of plots occupied (includes flyovers) by each breeding bird species and estimated abundance (corrected for undetected individuals using Distance software) of each species at Effigy Mounds NM, Iowa, during the 2009 to 2017 spring bird surveys (n = number of plots sample).

	Proportion of plots occupied by year (Abundance)								
Common name	**2009 n = 34**	**2010 n = 45**	**2011 n = 39**	**2012 n = 35**	**2013 n = 21**	**2014 n = 38**	**2015 n = 40**	**2016 n = 39**	**2017 n = 36**
Rose-breasted Grosbeak	0.15 (136)	0.51 (387)	0.46 (338)	0.54 (433)	0 (0)	0.71 (538)	0.43 (379)	0.69 (490)	0.39 (311)
Song Sparrow	0.12 (84)	0.36 (309)	0.33 (306)	0.23 (179)	0.05 (27)	0.37 (285)	0.23 (213)	0.36 (277)	0.03 (32)
White-breasted Nuthatch	0.09 (84)	0.20 (208)	0.13 (98)	0.37 (382)	0.05 (45)	0.16 (201)	0.15 (143)	0.26 (269)	0.28 (265)
Yellow-throated Vireo	0 (0)	0.11 (38)	0.59 (217)	0.29 (111)	0 (0)	0.42 (157)	0.18 (62)	0.49 (172)	0.19 (78)

Appendix C. Proportion of Plots Occupied (Not Corrected for Undetected Individuals) and Abundance

Table C1. Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using birds within 200-m of plot center and not corrected for undetected individuals) of breeding bird species at Effigy Mounds NM, Iowa, during the 2009 to 2017 spring bird surveys (n = number of plots sample). "–" denotes when a species was present on a plot but outside 200-m of plot center therefore their annual abundance value could not be calculated.

	Proportion of plots occupied by year (Abundance)								
Common name	**2009 n = 34**	**2010 n = 45**	**2011 n = 39**	**2012 n = 35**	**2013 n = 21**	**2014 n = 38**	**2015 n = 40**	**2016 n = 39**	**2017 n = 36**
American Crow	0.09 (12)	0.11 (11)	0.10 (8)	0.23 (21)	0 (0)	0.08 (9)	0.15 (12)	0.23 (15)	0.11 (–)
Bald Eagle[1]	**0 (0)**	**0 (0)**	**0.08 (11)**	**0.06 (2)**	**0 (0)**	**0.11 (9)**	**0.08 (4)**	**0.13 (4)**	**0 (0)**
Barn Swallow	0 (0)	0 (0)	0.03 (2)	0 (0)	0 (0)	0.03 (–)	0.03 (2)	0.03 (–)	0 (0)
Belted Kingfisher	0 (0)	0.02 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (2)	0.03 (–)	0 (0)
Black-and-white Warbler	0.03 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.08 (7)
Black-billed Cuckoo[1]	**0.06 (2)**	**0.02 (2)**	**0.05 (4)**	**0 (0)**	**0 (0)**	**0.05 (4)**	**0 (0)**	**0 (0)**	**0 (0)**
Black-capped Chickadee	0.03 (2)	0.09 (9)	0.08 (6)	0.06 (5)	0.14 (12)	0.18 (15)	0.18 (16)	0.21 (17)	0.06 (5)
Blue-winged Warbler[1]	**0 (0)**	**0.07 (7)**	**0.08 (10)**	**0.03 (2)**	**0 (0)**	**0.08 (6)**	**0.03 (2)**	**0.08 (6)**	**0.08 (9)**
Brown Creeper	0.03 (2)	0.04 (4)	0 (0)	0 (0)	0 (0)	0.03 (2)	0.05 (4)	0.03 (2)	0 (0)
Brown Thrasher[1]	**0.03 (2)**	**0 (0)**	**0 (0)**	**0 (0)**	**0.05 (4)**	**0.03 (2)**	**0 (0)**	**0.03 (2)**	**0 (0)**
Canada Goose	0 (0)	0.02 (2)	0 (0)	0 (0)	0 (0)	0.05 (4)	0 (0)	0 (0)	0.06 (–)
Carolina Wren	0 (0)	0 (0)	0 (0)	0 (0)	0.05 (4)	0 (0)	0 (0)	0 (0)	0 (0)
Cedar Waxwing	0 (0)	0.02 (2)	0.03 (2)	0 (0)	0 (0)	0.03 (2)	0.03 (2)	0 (0)	0 (0)
Cerulean Warbler[1]	**0.18 (19)**	**0.29 (27)**	**0.23 (25)**	**0.03 (2)**	**0 (0)**	**0.05 (4)**	**0.03 (2)**	**0.18 (15)**	**0.08 (11)**
Chipping Sparrow	0 (0)	0 (0)	0.03 (2)	0 (0)	0.05 (8)	0 (0)	0 (0)	0 (0)	0.03 (2)
Cliff Swallow	0 (0)	0 (0)	0.08 (13)	0.03 (12)	0 (0)	0 (0)	0.03 (2)	0 (0)	0 (0)
Common Grackle	0 (0)	0.07 (5)	0.08 (6)	0.09 (7)	0 (0)	0.18 (15)	0.23 (16)	0.41 (33)	0.03 (2)

[1] Species of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

Table C1 (continued). Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using birds within 200-m of plot center and not corrected for undetected individuals) of breeding bird species at Effigy Mounds NM, Iowa, during the 2009 to 2017 spring bird surveys (n = number of plots sample). "–" denotes when a species was present on a plot but outside 200-m of plot center therefore their annual abundance value could not be calculated.

	Proportion of plots occupied by year (Abundance)								
Common name	**2009 n = 34**	**2010 n = 45**	**2011 n = 39**	**2012 n = 35**	**2013 n = 21**	**2014 n = 38**	**2015 n = 40**	**2016 n = 39**	**2017 n = 36**
Cooper's Hawk	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (2)	0 (0)	0 (0)	0 (0)
Dickcissel[1]	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0.03 (2)**
Eastern Bluebird	0 (0)	0 (0)	0 (0)	0.03 (2)	0 (0)	0.03 (2)	0.10 (8)	0.05 (4)	0.03 (2)
Eastern Kingbird	0.03 (5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Eastern Meadowlark	0 (0)	0 (0)	0.03 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Eastern Phoebe	0 (0)	0 (0)	0.03 (2)	0 (0)	0 (0)	0.03 (2)	0.08 (6)	0.03 (2)	0.06 (5)
Eastern Towhee	0.03 (2)	0.04 (4)	0 (0)	0.09 (7)	0.05 (4)	0.05 (4)	0.23 (20)	0.23 (19)	0.08 (11)
European Starling	0 (0)	0.02 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Field Sparrow	0.03 (2)	0.02 (4)	0.03 (2)	0.06 (5)	0 (0)	0.03 (4)	0.08 (8)	0.05 (6)	0.03 (2)
Grasshopper Sparrow	0 (0)	0.02 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Gray Catbird	0.03 (2)	0.13 (11)	0.03 (2)	0.11 (9)	0.05 (4)	0.18 (15)	0.05 (4)	0.21 (17)	0.08 (9)
Great Blue Heron	0 (0)	0 (0)	0.03 (–)	0 (0)	0.05 (–)	0.05 (4)	0.03 (–)	0.03 (2)	0.03 (2)
Great Crested Flycatcher	0.21 (17)	0.11 (11)	0.10 (8)	0.06 (5)	0.14 (12)	0.05 (4)	0.03 (2)	0.05 (4)	0.22 (16)
Hairy Woodpecker	0 (0)	0.20 (16)	0.13 (10)	0.06 (5)	0 (0)	0 (0)	0.15 (14)	0.08 (6)	0 (0)
Hooded Merganser	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (2)	0 (0)	0 (0)
Hooded Warbler	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.08 (7)
House Finch	0 (0)	0 (0)	0.03 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Kentucky Warbler	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (2)	0 (0)
Killdeer	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.05 (–)	0 (0)
Least Flycatcher	0 (0)	0.02 (2)	0.13 (10)	0.11 (9)	0 (0)	0.05 (4)	0 (0)	0.03 (2)	0 (0)

[1] Species of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

Table C1 (continued). Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using birds within 200-m of plot center and not corrected for undetected individuals) of breeding bird species at Effigy Mounds NM, Iowa, during the 2009 to 2017 spring bird surveys (n = number of plots sample). "–" denotes when a species was present on a plot but outside 200-m of plot center therefore their annual abundance value could not be calculated.

	Proportion of plots occupied by year (Abundance)								
Common name	**2009 n=34**	**2010 n=45**	**2011 n=39**	**2012 n=35**	**2013 n=21**	**2014 n=38**	**2015 n=40**	**2016 n=39**	**2017 n=36**
Mallard	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (5)
Mourning Dove	0 (0)	0.04 (4)	0 (0)	0.03 (2)	0 (0)	0.05 (4)	0 (0)	0.10 (8)	0 (0)
Northern Flicker	0 (0)	0.02 (2)	0.08 (6)	0 (0)	0 (0)	0.08 (4)	0 (0)	0.10 (8)	0.03 (2)
Northern Parula	0.06 (5)	0 (0)	0.03 (2)	0 (0)	0 (0)	0 (0)	0.03 (2)	0 (0)	0.08 (7)
Prothonotary Warbler	0.03 (2)	0.11 (9)	0.18 (21)	0.17 (21)	0 (0)	0.21 (24)	0.15 (18)	0.23 (23)	0.03 (2)
Red-headed Woodpecker[1]	**0 (0)**	**0.11 (11)**	**0.03 (2)**	**0 (0)**	**0 (0)**	**0.11 (9)**	**0.05 (4)**	**0.08 (8)**	**0.03 (2)**
Red-shouldered Hawk	0 (0)	0.02 (2)	0.03 (6)	0 (0)	0 (0)	0.08 (6)	0 (0)	0.05 (2)	0 (0)
Red-tailed Hawk	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (2)
Ruby-throated Hummingbird	0.06 (2)	0.04 (4)	0.05 (4)	0 (0)	0 (0)	0.05 (4)	0.03 (2)	0.08 (6)	0.03 (–)
Scarlet Tanager	0.24 (22)	0.18 (14)	0.15 (13)	0.14 (12)	0 (0)	0.13 (11)	0.20 (16)	0.23 (19)	0.19 (18)
Sedge Wren	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (2)
Spotted Sandpiper	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (2)	0 (0)
Swamp Sparrow	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (2)
Tree Swallow	0 (0)	0 (0)	0.05 (17)	0.06 (9)	0 (0)	0.08 (6)	0.03 (4)	0.05 (–)	0 (0)
Tufted Titmouse	0.06 (5)	0.29 (27)	0.03 (2)	0.03 (2)	0.05 (4)	0.08 (6)	0.15 (12)	0.08 (6)	0.28 (25)
Turkey Vulture	0 (0)	0.02 (–)	0.03 (–)	0 (0)	0 (0)	0.05 (–)	0.03 (–)	0.08 (–)	0.03 (–)
Veery	0.06 (2)	0 (0)	0 (0)	0.03 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (2)
Warbling Vireo	0 (0)	0.11 (11)	0.08 (13)	0.20 (21)	0.14 (12)	0.24 (24)	0.20 (18)	0.15 (17)	0.08 (7)
White-eyed Vireo	0 (0)	0.02 (2)	0 (0)	0.03 (2)	0 (0)	0 (0)	0 (0)	0.03 (2)	0 (0)
Willow Flycatcher[1]	**0.06 (5)**	**0.02 (2)**	**0.03 (2)**	**0.06 (5)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**

[1] Species of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

Table C1 (continued). Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using birds within 200-m of plot center and not corrected for undetected individuals) of breeding bird species at Effigy Mounds NM, Iowa, during the 2009 to 2017 spring bird surveys (n = number of plots sample). "–" denotes when a species was present on a plot but outside 200-m of plot center therefore their annual abundance value could not be calculated.

	Proportion of plots occupied by year (Abundance)								
Common name	**2009 n=34**	**2010 n=45**	**2011 n=39**	**2012 n=35**	**2013 n=21**	**2014 n=38**	**2015 n=40**	**2016 n=39**	**2017 n=36**
Wild Turkey	0.06 (36)	0.07 (5)	0.03 (2)	0 (0)	0.10 (4)	0.05 (2)	0 (0)	0.03 (2)	0.14 (7)
Wood Duck	0 (0)	0.11 (5)	0 (0)	0.03 (5)	0 (0)	0.05 (6)	0.05 (2)	0.03 (2)	0.14 (9)
Wood Thrush	0.12 (7)	0.13 (14)	0.10 (10)	0.29 (28)	0.10 (8)	0.16 (15)	0.23 (20)	0.15 (13)	0.14 (14)
Worm-eating Warbler	0 (0)	0 (0)	0 (0)	0.03 (2)	0 (0)	0.03 (2)	0 (0)	0 (0)	0.03 (2)
Yellow Warbler	0 (0)	0.02 (2)	0.03 (2)	0.26 (23)	0.10 (8)	0.16 (13)	0.05 (4)	0.15 (13)	0.06 (7)
Yellow-bellied Sapsucker	0.09 (12)	0.07 (5)	0.15 (13)	0.20 (19)	0.05 (4)	0.24 (21)	0.15 (14)	0.18 (15)	0.06 (5)
Yellow-breasted Chat	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (2)	0.03 (2)	0 (0)	0 (0)
Yellow-billed Cuckoo	0.12 (7)	0.18 (15)	0.23 (21)	0.23 (19)	0.19 (8)	0.05 (4)	0.23 (20)	0.18 (15)	0 (0)

Appendix D. Effigy Mounds NM Trends

Table D1. Trends, annual change in abundance (individuals) of breeding birds recorded on Effigy Mounds NM, Iowa, from 2009 through 2017.

Common name	Trend[1]	SE of slope	Trend Classification[2]
Acadian Flycatcher	1.10	0.06	Uncertain
American Goldfinch	1.10	0.06	Uncertain
American Redstart	1.12	0.03	Strong Increase
American Robin	1.04	0.02	Uncertain
Baltimore Oriole	1.07	0.05	Uncertain
Blue-gray Gnatcatcher	1.07	0.05	Uncertain
Blue Jay	0.92	0.07	Uncertain
Brown-headed Cowbird	1.17	0.08	Moderate Increase
Common Yellowthroat	1.12	0.05	Moderate Increase
Downy Woodpecker	1.15	0.08	Uncertain
Eastern Wood-pewee	1.00	0.02	Stable
House Wren	1.01	0.04	Uncertain
Indigo Bunting	–[3]	–	–
Northern Cardinal	0.93	0.10	Uncertain
Ovenbird	0.99	0.04	Uncertain
Pileated Woodpecker	1.04	0.05	Uncertain
Red-bellied Woodpecker	1.04	0.04	Uncertain
Red-eyed Vireo	1.05	0.03	Uncertain
Red-winged Blackbird	1.26	0.12	Moderate Increase
Rose-breasted Grosbeak	1.11	0.04	Moderate Increase
Song Sparrow	–[3]	–	–
White-breasted Nuthatch	1.09	0.06	Uncertain
Yellow-throated Vireo	–[3]	–	–

[1] Trends were determined using the statistical software TRIM Version 3.54 (2006).

[2] Trend classification types depending on statistical significance and magnitude (Pannekoek and van Strien 2005; van Strien et al. 2001), and following Gregory et. al. (2007). The multiplicative overall slope estimate in TRIM was converted into one of the following categories depending on the overall slope as well as its 95% confidence interval (= slope ± 1.96 times the standard error of the slope): Strong increase – increase significantly more than 5% per year. Criterion: lower limit of confidence interval > 1.05. Moderate increase – significant increase, but not significantly more than 5% per year. Criterion: 1.00 < lower limit of confidence interval < 1.05. Stable – no significant increase or decline, and it is certain that trends are less than 5% per year. Criterion: confidence interval encloses 1.00 but lower limit > 0.95 and upper limit < 1.05. Uncertain – no significant increase or decline, but not certain if trends are less than 5% per year. Criterion: confidence interval encloses 1.00 but lower limit < 0.95 or upper limit > 1.05. Moderate decline – significant decline, but not significantly more than 5% per year. Criterion: 0.95 < upper limit of confidence interval < 1.00. Steep decline – decline significantly more than 5% per year. Criterion: upper limit of confidence interval < 0.95.

[3] Denotes species with "poorly known" trend estimates," which implies that the statistical power of the scheme for that particular species is too limited to detect a change of less than 20% in 20 years.

Appendix E. Regional Trends

Regional trend data from BBS surveys (Sauer et al. 2017). While this BBS data provides a huge amount of information about regional population change for many species, there are a variety of possible problems with estimates of change. Small sample sizes, low relative abundances on survey routes, imprecise trends, and missing data all can compromise BBS results. Therefore the results in this Appendix should be viewed as general trend directions unless the reader has a thorough knowledge of the BBS data under analysis.

Table E1. Regional (Prairie Hardwood Transition Bird Conservation Region) trends for breeding birds recorded on Effigy Mounds NM, Iowa, for years 2005 through 2015.

		95% Confidence Interval	
Common Name	**Trend**	**Lower**	**Upper**
Acadian Flycatcher	0.72	-2.75	3.81
American Crow	0.60	-0.20	1.37
American Goldfinch	-1.87	-3.28	-0.49
American Redstart	3.17	1.20	5.17
American Robin	0.94	0.31	1.53
Bald Eagle[1]	**15.15**	**10.07**	**20.33**
Baltimore Oriole	-0.77	-1.73	0.19
Barn Swallow	-1.27	-2.39	-0.20
Belted Kingfisher	-1.53	-3.63	0.53
Black-and-white Warbler	-0.20	-2.52	2.20
Black-billed Cuckoo[1]	**-2.36**	**-5.17**	**0.45**
Black-capped Chickadee	2.75	1.26	4.43
Blue Jay	-0.73	-1.83	0.38
Blue-gray Gnatcatcher	0.28	-2.96	3.54
Blue-winged Warbler[1]	**0.39**	**-2.77**	**2.62**
Brown Creeper	2.03	-7.69	16.48
Brown Thrasher[1]	**-1.52**	**-3.11**	**0.03**
Brown-headed Cowbird	-1.36	-2.61	-0.10
Canada Goose	15.13	3.26	22.85
Carolina Wren	5.59	-4.12	14.59
Cedar Waxwing	0.81	-1.29	2.94
Cerulean Warbler[1]	**-1.38**	**-5.61**	**4.01**
Chimney Swift	-1.74	-3.46	-0.20
Chipping Sparrow	-0.12	-0.96	0.68
Cliff Swallow	3.48	-0.79	7.15
Common Grackle	-1.85	-3.00	-0.66
Common Yellowthroat	-0.98	-1.72	-0.25
Cooper's Hawk	2.92	-0.90	5.55
Dickcissel[1]	**-0.51**	**-4.44**	**3.55**

[1] Species of regional concern for the Prairie Hardwood Transition Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

Table E1 (continued). Regional (Prairie Hardwood Transition Bird Conservation Region) trends for breeding birds recorded on Effigy Mounds NM, Iowa, for years 2005 through 2015.

		95% Confidence Interval	
Common Name	**Trend**	**Lower**	**Upper**
Downy Woodpecker	0.89	-0.80	2.70
Eastern Bluebird	-0.95	-3.05	1.22
Eastern Kingbird	-1.32	-2.82	0.37
Eastern Meadowlark	-2.24	-3.45	-0.97
Eastern Phoebe	-0.93	-2.70	0.97
Eastern Towhee	2.57	0.90	4.38
Eastern Wood-pewee	-0.44	-1.55	0.61
European Starling	-1.77	-2.82	-0.88
Field Sparrow	-2.89	-4.03	-1.72
Grasshopper Sparrow	-7.12	-10.48	-3.90
Gray Catbird	0.31	-0.59	1.21
Great Blue Heron	-0.69	-2.91	1.45
Great Crested Flycatcher	-0.02	-1.19	1.23
Hairy Woodpecker	0.89	-1.18	3.23
Hooded Merganser	8.58	2.94	16.52
Hooded Warbler	9.24	-0.20	25.87
House Finch	-4.36	-7.46	-1.16
House Wren	0.20	-0.72	1.15
Indigo Bunting	-0.06	-1.02	0.91
Kentucky Warbler	NA	NA	NA
Killdeer	-1.47	-2.77	-0.27
Least Flycatcher	-2.03	-3.91	-0.11
Mallard	1.19	-1.13	3.47
Mourning Dove	-0.34	-1.22	0.52
Northern Cardinal	0.11	-0.85	1.03
Northern Flicker	-2.31	-3.87	-0.63
Northern Parula	7.15	-5.41	26.46
Northern Rough-winged Swallow*	-0.31	-2.54	2.31
Ovenbird	1.08	-0.35	2.44
Pileated Woodpecker	3.46	1.35	5.49
Prothonotary Warbler	1.02	-3.72	6.78
Red-bellied Woodpecker	3.96	2.55	5.34
Red-eyed Vireo	1.17	0.16	2.22
Red-headed Woodpecker[1]	**-3.59**	**-6.08**	**-1.11**
Red-shouldered Hawk	3.61	-3.82	11.97
Red-tailed Hawk	1.33	-0.64	3.10
Red-winged Blackbird	-1.53	-2.23	-0.85

[1] Species of regional concern for the Prairie Hardwood Transition Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

Table E1 (continued). Regional (Prairie Hardwood Transition Bird Conservation Region) trends for breeding birds recorded on Effigy Mounds NM, Iowa, for years 2005 through 2015.

		95% Confidence Interval	
Common Name	**Trend**	**Lower**	**Upper**
Rose-breasted Grosbeak	-0.15	-1.34	1.00
Ruby-throated Hummingbird	2.87	0.08	5.52
Scarlet Tanager	1.59	-0.37	3.61
Sedge Wren	-10.46	-14.74	-6.01
Song Sparrow	-0.83	-1.59	-0.06
Spotted Sandpiper	-0.34	-4.74	4.97
Swamp Sparrow	1.51	-0.14	3.45
Tree Swallow	1.22	-0.78	3.21
Tufted Titmouse	3.83	1.19	6.54
Turkey Vulture	6.73	3.76	9.75
Veery	0.87	-1.02	3.10
Warbling Vireo	-0.75	-1.99	0.48
White-breasted Nuthatch	2.54	0.55	4.66
White-eyed Vireo	4.34	-3.48	12.56
Willow Flycatcher[1]	**-0.70**	**-2.28**	**0.99**
Wild Turkey	8.42	3.41	13.33
Wood Duck	1.55	-1.16	4.43
Wood Thrush	0.54	-1.40	2.52
Worm-eating Warbler	NA	NA	NA
Yellow Warbler	0.35	-0.98	1.51
Yellow-bellied Sapsucker	4.71	2.48	7.74
Yellow-breasted Chat	-2.52	-9.67	9.72
Yellow-billed Cuckoo	-4.70	-8.53	-0.82
Yellow-throated Vireo	2.39	0.60	4.04

[1] Species of regional concern for the Prairie Hardwood Transition Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

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