



Bird Monitoring at Tallgrass Prairie National Preserve, Kansas

2001-2008 Status Report

Natural Resource Technical Report NPS/HTLN/NRTR—2010/318



ON THE COVER

Bird habitat at Tallgrass Prairie National Preserve
Photo from Heartland I&M Network Files

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2001-2008 Status Report

Natural Resource Technical Report NPS/HTLN/NRTR—2010/318

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Executive Summary

In 2001, the Heartland I&M Network (HTLN) initiated breeding bird surveys on Tallgrass Prairie National Preserve, Kansas (TAPR) to address two objectives. The first is to monitor changes in bird community composition and abundance. The second is to monitor the responses of bird communities to changes in habitat structure and other habitat variables related to management activities. This report provides plot specific and habitat-wide data on populations and breeding habitat of birds at TAPR between 2001 and 2008, excluding 2003. Ninety-one species of birds were recorded during 913 plot visits. Seventy-nine of the 91 bird species are permanent or summer residents on the Preserve. The Grasshopper sparrow (*Ammodramus savannarum*) has the highest density of all species on the Preserve. Partners in Flight, a coalition of agencies and individuals whose mission it is to conserve North America's declining bird populations, classify fifteen species found at TAPR as species of continental importance. Twelve species are classified as grassland obligate species.

Key characteristics of a tallgrass prairie, such as vertical structure and grass litter, have increased on TAPR since 2006, the year patch-burn-grazing management was implemented on part of the Preserve and other parts were rested from fire. Corresponding with the increase in vertical structure and grass litter has been an increase in two grassland obligate species of interest, Eastern meadowlark (*Sturnella magna*) and Henslow's sparrow (*Ammodramus henslowii*). A third species, Western meadowlark (*Sturnella neglecta*), subsequently declined because it favors shorter sparser grasses.

Uniformity in habitat parameters across the grassland has prohibited us from developing concrete bird species richness-habitat relationships. However, as management designed to increase the diversity of habitat in the grassland continues, greater variability in habitat parameters can be expected. This increased variation in habitat parameters will increase our ability to model meaningful bird species-habitat relationships. Habitat parameters across the riparian areas of the Preserve may not change as readily as the grassland habitat. Thus, these narrow ribbons of large trees on the Preserve in all likelihood will provide similar habitat to birds year after year.

Acknowledgements

We would like to thank the staff of Tallgrass Prairie National Preserve, Kansas for allowing us access to the Preserve during our site visits. We would especially like to thank Kristen Hase for her assistance in the field and support for our program.

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 aimed at preserving 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.

Topography of the Flint Hills subregion of the Osage Plains physiographic area is a rocky, rolling terrain (Fitzgerald et al. 2000). This terrain is more suited for livestock grazing than rowcrops. Thus, the grassland landscape, with its remnant tallgrass prairie has remained largely un-fragmented. However, annual spring burns and intense grazing have created a homogenous landscape that cannot meet the needs of all bird species. Approximately 134 bird species nest in the Osage Plains physiographic area, and Partners in Flight (PIF) have designated 39 of these species as species of conservation priority because of declining numbers and habitat loss (Fitzgerald et al. 2000). Data collected during the U.S. Geological Survey's annual North American Breeding Bird Surveys (BBS) between 1966 and 2007 also indicate that a number of bird species in the Osage Plains physiographic area show evidence of population declines (Sauer et al. 2008). Species such as the Black-billed cuckoo (*Coccyzus erythrophthalmus*), Black-crowned night heron (*Nycticorax nycticorax*), Greater prairie chicken (*Tympanuchus cupido*), Loggerhead shrike (*Lanius ludovicianus*), Northern Flicker (*Colaptes auratus*), Northern harrier (*Circus cyaneus*), Prairie warbler (*Dendroica discolor*), and Yellow warbler (*Dendroica petechia*) have declined at alarming rates.

We use trends in the composition and abundance of bird populations as long-term indicators of ecosystem integrity in the grassland and riparian habitats of Tallgrass Prairie National Preserve, Kansas (TAPR). Ecosystem integrity is defined as the system's capability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region (Karr and Dudley 1981). 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 in the grassland and riparian areas may reflect the effectiveness of management in restoring and maintaining these communities at TAPR. Long-term trends in community composition and abundance of breeding bird populations provide one measure for assessing the ecological integrity and sustainability of this system.

Objectives

There are two primary objectives for monitoring breeding birds at TAPR:

- Identify significant temporal changes in the species composition and abundance of bird communities that occur at TAPR during the breeding season.

- Improve our understanding of breeding bird species-habitat relationships and the effects of management actions such as grazing or prescribed fire on bird populations, by correlating changes in bird community composition and abundance with changes in specific habitat variables (e.g., vegetation structure, ground cover).

This report summarizes survey results for the first seven years of monitoring.

Methods

Site Selection

Permanent monitoring locations or 'plots' were created by overlaying a systematic grid of 400 x 400 meter cells (originating from a random start point) across the grassland habitat on the Preserve. The orientation of the systematic grid was rotated 34 degrees from north to prevent sampling sites from being influenced by man-made features oriented along cardinal directions. Riparian corridors were identified as a separate stratum, with sampling extending 125 m on either side of the stream channel (Palmer and Fox Creeks). The riparian stratum makes up 5.3% of the total area (4398 ha) at TAPR. Within the riparian stratum, plots were located at 250 m intervals along the extent of a stream. Any plots from the overall park grid that fell within the riparian stratum were discarded. We established 242 grassland (including brome plots) and 18 riparian plots (Figure 1).

This systematic approach to selecting sampling sites allows flexibility to choose the appropriate reference frame to answer different monitoring questions. When making park-wide inferences, results from each stratum at TAPR are weighted by area and combined to give an overall park mean and variance. At the same time, more intensive sampling in the riparian corridor ensures an adequate sample to describe habitat relationships specific to this less common, but important stratum. The systematic grid also allows us to limit the reference frame appropriately when asking more specific monitoring questions (e.g. only those sampling points within particular management units would be used to compare the avian response to different fire or grazing regimes, etc.).

During bird surveys, monitoring plots were located using navigation waypoints (Appendix 1) in a GPS unit and temporarily marked with 36-inch pin flags to aid in re-locating 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. Monitoring plots were re-located each year a bird survey was conducted.

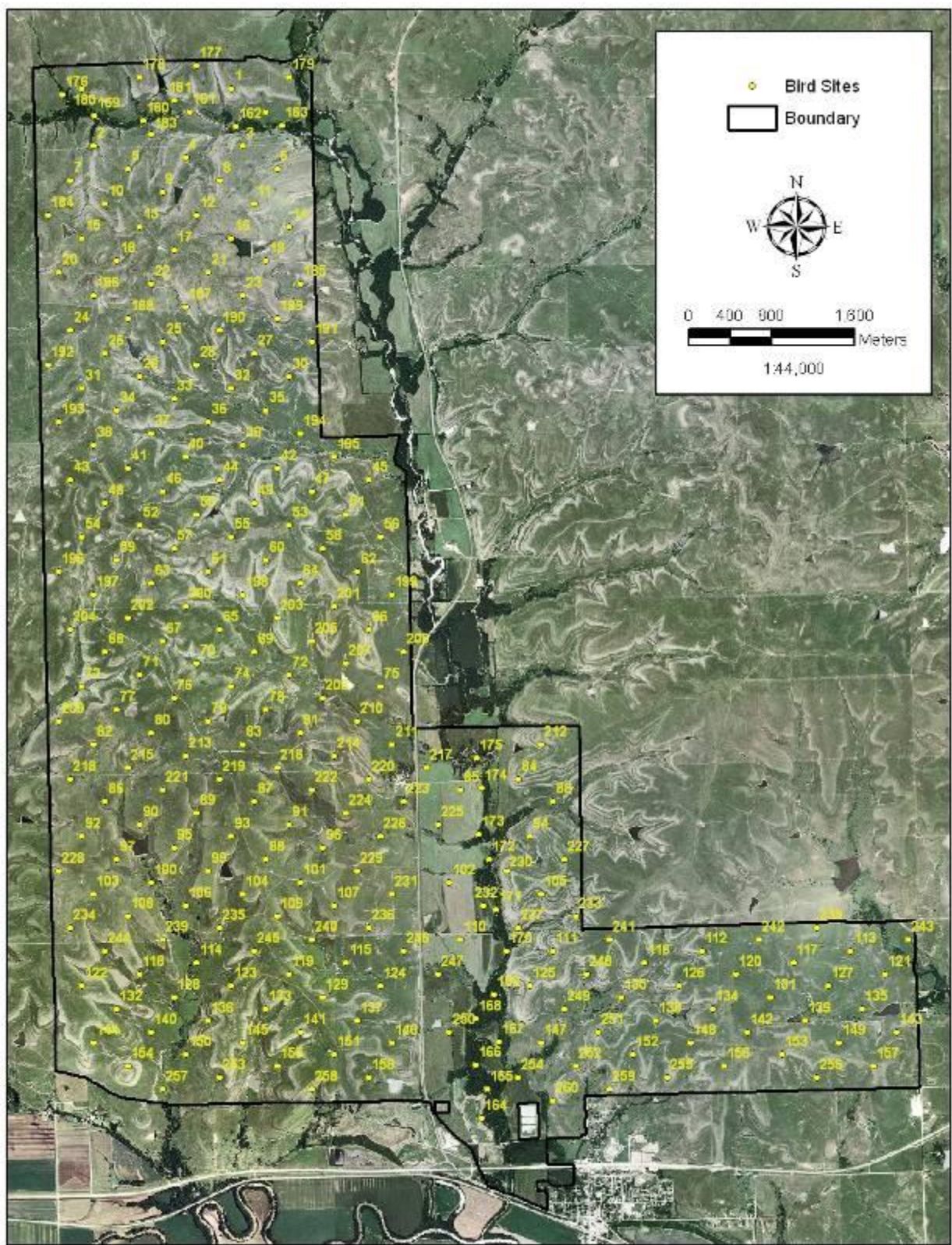


Figure 1. Bird plot locations on Tallgrass Prairie National Preserve, Kansas.

Bird Surveys

Bird surveys followed methods outlined in the bird monitoring protocol by Peitz et al. (2008) and summarized below. 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 counted along with their corresponding distance from observer. Bird observations were separated into two time segments: those detected during the first three minutes of the count (to allow future comparisons with the national Breeding Bird Survey data), and any new birds detected during the final two minutes of the count. 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 were treated as a separate observation. After completing a count 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. We sampled birds during a period when it was light enough to observe birds to four hours after sunrise. A total of 913 plots were sampled; 176 in 2001, 260 in 2002, 97 in 2004, 97 in 2005, 99 in 2006, 89 in 2007, and 95 in 2008.

Variations in the number of plots sampled annually are the result of several factors. In 2001 all interior plots, those greater than 50-m from an interior or boundary fence were sampled. In 2002 all established points on the Preserve were sampled. Between 2004 and 2008 variations in the number of plots sampled are the result of grassland plots being assigned membership into one of six panels in a five year rotating panel design, and being sampled accordingly. Panel membership was assigned to all points in a systematic manner by numbering points sequentially along transects aligned northwest to southeast, starting with the most northeast point. Then assignment to panels (A through F) was done in a repeated fashion using the sequenced numbers (i.e. number 1 = A, 2 = B, 3 = C, 4 = D, 5 = E, 6 = F, 7 = A, 8 = B and so on). Plots in panel A were sampled in all years ($n = 41$); panel B sampled in year one of the revisit cycle ($n = 41$); panel C in year two ($n = 40$); panel D in year three ($n = 40$); panel E in year four ($n = 40$); and panel F sampled in year five ($n = 40$) as weather permitted. Some plots were dropped from sampling when prolonged (several days) inclement weather precluded their sampling. All 18 riparian plots were sampled annually, exception being year 2004 when two plots were lost to severe stream erosion and not re-established until the following year.

Variable circular plot counts were conducted in an attempt to get an “instantaneous count” of all birds present. The observer vigilantly approached each plot, recording birds flushed and their distance from plot center. Counts were started as soon as the observer reached plot center. Doing this, our method took into account the fact that birds close to the observer have a higher probability of being detected (if they were not flushed) than birds far from the observer and that different species have different detection functions (i.e., the probability of detecting a bird at different distances from the observer). An important assumption of the method is that birds exactly at the center of the plot have a 100% probability of being detected, and that there is a high probability of detecting birds within the first 5-10 meters of the plot center. The most important birds to detect are those very close to the observer (within the first 5-10 meters), and it is highly desirable that estimated distances, or those taken with a rangefinder, be within 1-2

meters of actual distances for any bird within 20 meters of the observer. We measured distances to each individual bird or flock with a rangefinder. We also recorded all birds seen or heard along with distance from the observer when possible, not just the individuals within 20 meters. For this report, all birds seen or heard during the full 5-min are included.

Bird Habitat

The collection of habitat data followed methods outlined in the bird monitoring protocol by Peitz et al. (2008). A summary of the sampling method's follows: Habitat data collection started after the first variable circular plot count was completed. Observers visited plots for habitat measures in the same order they were surveyed (for birds) to avoid disturbing birds on a plot prior to the survey. Once the habitat crew arrived at a plot, they set up the center subplot and completed all habitat measures for this subplot and the 50-m radius plot. The center subplot is used to characterize habitat structure, ground cover, and foliar vegetation available to birds on a plot. The larger 50-m radius plot provides large-scale plot attribute information that helps place a plot in a landscape context.

We characterized habitat available for each bird species on a number of different scales as follows. Slope, slope variability, aspect, aspect variability, and topographic position of each 50-m radius plot were determined and recorded first. Measurements were recorded during the first year of monitoring, and were not re-measured in subsequent years. The amount of various vegetation types and the amount of road and water cover on each plot sampled were recorded annually. As plots were sampled, horizontal vegetation cover was estimated in 0.50-m (2001-2007, excluding 2003) or 0.25-m (2008) intervals from 0.0 to 2.0 meters above ground surface using a 0.15-m wide cover board. Area of the cover board obscured by vegetation was estimated at 15-m distances from plot center. Using a graduated measuring rod, vertical vegetation structure was measured in 1-m increments up to 7.5 meters in height at four locations around the perimeter of the subplot. Locations were in the four cardinal directions. Vertical structure was recorded for deciduous, coniferous, and herbaceous vegetation. Trees were tallied by species and size class (<1.0 cm, 1.1 – 2.5 cm, 2.6 – 8.0 cm, 8.1 – 15.0 cm, 15.1 – 23.0 cm, 23.1 – 38.0 or >38.0 cm) on the subplot. Lastly, at the subplot, ground and foliar cover were recorded in a 1.78-m radius nested sample plot. Ground cover included deciduous and grass litter, bare soil, rock, woody debris (>2.5 cm diameter), and unvegetated. Foliar cover was estimated for six plant guilds, including warm- and cool-season grasses, forbs, moss and lichens, shrubs and vines, tree seedlings, and total foliar cover (<1.5 m tall). Average parameter values were reported for grassland (including brome habitat) and riparian habitats, annually.







Data Analysis

Prior to summary analysis, the residency status (permanent resident, summer resident, migrant, and out of normal residency range) of each bird species recorded was determined. Identifying the residency of each species helps to exclude migrants and those out of their normal range from analysis of breeding birds within TAPR. Hereafter, permanent and summer resident birds are referred to as breeding species. The frequency and abundance of breeding bird species were determined in four ways annually. 1) For each breeding species, the number of individuals encountered per plot visit (individuals / plot visit) was averaged over all plots. 2) The proportion of plots occupied by each breeding species was determined (total number of plots occupied by a species/total number of plots visited). 3) Restricting the area of inference to a 100-m radius (3.14

ha) around each plot center, we determined each breeding species density (individuals / 3.14 ha) and averaged these values across all plots (average density \pm std dev). 4) To examine local density, density was calculated as in (3) above, but only from plots where a breeding species was encountered. Do to their size and to accommodate the flow of this report, frequency and abundance tables are included in the Appendix section (Appendix 2 – 5). Distance software was used to determine species density estimates, adjusted for undetected individuals, on seven upland species that have enough observations (>60) to do so accurately: Brown-headed cowbird (*Molothrus ater*), Dickcissel (*Spiza americana*), Eastern meadowlark (*Sturnella magna*), Grasshopper sparrow (*Ammodramus savannarum*), Red-winged blackbird (*Agelaius phoeniceus*), Upland sandpiper (*Bartramia longicauda*), and Western meadowlark (*Sturnella neglecta*), and one riparian species Eastern wood-peewee (*Contopus virens*) (Buckland et al. 1993, Buckland et al. 2001). Distance software will be used in the future for other species density estimates once there are enough observations to do so accurately.

Annual distribution of breeding bird richness among plots was analyzed using Hot Spot Analysis as implemented in ArcGIS 9.3 (2009). Hot Spot Analysis uses a spatial statistic for identifying plots with richness values lower or higher in magnitude than expected by random chance. For each year the spatial distribution of richness values were compared against a hypothetical spatially random distribution of richness. Analysis was preformed for a given year on both total species richness and the richness of grassland obligate species on grassland plots, and total species richness on riparian plots. Euclidean distance and inverse distance weighting criteria were used to group plots. These results were then reported as a measure of standard deviation (z-score) for each plot in a given year.

The calculated z-scores were grouped and color coded (blue, lower than expected and red, higher than expected) by confidence intervals:

Z- score values		Confidence Interval
	< -1.96	 > 1.96 95 %
	-1.959 - -1.65	 1.65 - 1.959 90%
	-1.649 - -1.28	 1.28 - 1.649 80%

The greater the confidence interval indicates the larger the departure from random the richness value is at that plot. The output is a series of maps depicting high or low total breeding species richness for the grassland and riparian habitats, and richness of breeding grassland obligates in the grassland habitat of the Preserve. For a more thorough methodology description see: <http://resources.esri.com/Geoprocessing/>.

Trends in breeding species richness and the richness of breeding grassland obligate species were assessed using box and whisker plots on richness values. Lines within a box represent that year's median richness value. Boxes below and above the median values represent the largest values in the first and third quartiles of richness values, respectively. The lower and upper whiskers represent the extent of data, unless values fall at or beyond ranges of 1.5 inter-quartiles below or above the median values. Circles on a figure denote outliers, values that fall outside of the 1.5 inter-quartile ranges in the data. A chart was created for the comparison of annual total breeding bird species richness and the richness of breeding grassland obligate bird species in the grassland

habitat. More formal trends analysis will be performed on the bird data once enough years (>14; Sauer and Droege, 1990) of data have been collected to warrant doing so.

Location and permanent abiotic measures on each plot and habitat subplot were reported (Appendix 6). Annual averages (\pm std dev) for semi-permanent plot data, including road and water cover were calculated from plot estimates for both grassland and riparian habitats. In 2001 and 2002, using plot values, averages (\pm std dev) for horizontal vegetation cover between 0 – 0.50, 0.5 – 1.0, 1.0 – 1.50, and 1.5 – 2.00 meters were calculated by habitat type. Between 2004 and 2007, using plot values, averages (\pm std dev) for horizontal vegetation cover between 0 – 0.50, 0.25-0.75, 0.5 – 1.0, 0.75-1.25, 1.0 – 1.50, 1.25-1.75, and 1.5 – 2.00 meters were calculated by habitat type. In 2008, using plot values, averages (\pm std dev) for horizontal vegetation cover between 0 – 0.25, 0.25-0.5, 0.5 – 0.75, 0.75-1.0, 1.0 – 1.25, 1.25-1.5, 1.5 – 1.75, and 1.75 – 2.0 meters were calculated by habitat type. Average (\pm std dev) annual vertical structure diversity was estimated and reported by habitat type as well.

$$\text{Structural Diversity Index} = \frac{((\sum p_i / 8) + a) * 100}{2}$$

Where p_i – is the observed frequency for vegetation in the i th interval touching a measuring rod out of twelve measuring events, and a – is the percent of intervals with recorded vegetation in eight height increments. Vertical structure diversity values are weighted equally to represent both the vertical height of vegetation and how dense the vegetation is within each height increment.

Within each plot, ground cover, including deciduous and grass litter, bare soil, rock, woody debris (>2.5 cm DBH), and unvegetated were averaged (\pm std dev) across plots within each habitat type. Foliar cover, by guild of warm- and cool-season grasses, forbs, mosses and lichens, shrubs and vines, tree seedlings and total foliar cover (<1.5 m tall) were averaged (\pm std dev) across plots within habitat types as well. Again, to accommodate the flow of this report, average habitat values are reported in Appendix 7 (grassland habitat) and Appendix 8 (riparian habitat). Species composition and size classes of trees in the riparian habitat are report in Appendix 9.

We utilized a multiple linear regression analysis to assess bird species richness and habitat relationships (Steel and Torrie 1980). Multiple linear regression is a technique aimed at finding a linear relationship between the dependent variable and multiple independent variables. Multiple regression finds the set of parameters B_0, B_1, \dots, B_{mi} that provides the best fit between the model and the given data (which are a set of N vectors - $\{(Y_i, X_{1i}, \dots, X_{mi}), i=1, \dots, N\}$). An iterative process was used to identify parameters with high variance inflation factors (a measure of redundancy among explanatory variables) and those that contribute to the model (OLS, ArcGIS 9.3 2009).

Results

Bird Surveys

Ninety-one bird species were recorded during the breeding bird surveys at TAPR between 2001 and 2008, excluding 2003 (Table 1). Forty of the 91 species recorded are classified as permanent residents (Stokes and Stokes 1996). Of the remaining species, 39 are classified as summer residents, two as winter residents, nine as migrants, and one species as out of its normal range. Three species, Great egret (*Casmerodius albus*), Ring-necked pheasant (*Phasianus colchicus*), and Semipalmated sandpiper (*Calidris pusilla*), were only observed outside the 5-min survey periods. Fifteen species--Acadian flycatcher (*Empidonax virescens*), Brown thrasher (*Toxostoma rufum*), Carolina wren (*Thryothorus ludovicianus*), Dickcissel (*Spiza americana*), Eastern towhee (*Pipilo erythrophthalmus*), Golden-winged warbler (*Vermivora chrysoptera*), Grasshopper sparrow (*Ammodramus savannarum*), Greater prairie-chicken (*Tympanuchus cupido*), Henslow's sparrow (*Ammodramus henslowii*), Indigo bunting (*Passerina cyanea*), Prothonotary warbler (*Protonotaria citrea*), Red-bellied woodpecker (*Melanerpes carolinus*), Red-headed woodpecker (*Melanerpes erythrocephalus*), White-eyed vireo (*Vireo griseus*), and Yellow-throated vireo (*Vireo flavifrons*)--are considered species of continental importance (Rich et al. 2004). Twelve species--Bobolink (*Dolichonyx oryzivorus*), Dickcissel, Eastern meadowlark (*Sturnella magna*), Grasshopper sparrow, Greater prairie-chicken, Henslow's sparrow, Horned lark (*Eremophila alpestris*), Northern harrier (*Circus cyaneus*), Sedge wren (*Cistothorus platensis*), Upland sandpiper (*Bartramia longicauda*), Vesper sparrow (*Pooecetes gramineus*), and Western meadowlark (*Sturnella neglecta*)--are grassland obligate species. Appendix 2 listed by breeding species, the annual number of individual birds recorded per plots visited for both the grassland and riparian habitats. Appendix 3 list the proportion of plots occupied annually by each breeding bird species for both habitat types.

Density estimates, adjusted for un-detected individuals, for the most observed breeding bird species on the Preserve--Brown-headed cowbird, Dickcissel, Eastern meadowlark, Grasshopper sparrow, Red-winged blackbird, Upland sandpiper, Western meadowlark, and Eastern woodpeewee--are listed in Table 2. The Grasshopper sparrow has the highest average annual density ($3.77 \text{ SE} \pm 0.23$ individuals/ha) of any species found in the grassland habitat. The Eastern woodpeewee, the only species found in the riparian area with enough observations to calculate density adjusted for un-detected individuals, has an average annual density estimate of $0.93 (\text{SE} \pm 0.16)$ individuals/ha. Annual breeding bird density estimates, not adjusted for un-detected individuals, are listed by habitat types in Appendix 4, and by plots occupied in each habitat type in Appendix 5.

Annual hot spot analysis identified areas in the grassland where both total breeding bird species richness (Figure 2a), and the richness of breeding grassland obligate species (Figure 3a), were higher and lower in magnitude than expected by random chance. However, these areas of high and low species richness were not consistent across years. The annual median total breeding bird richness values for plots, along with the range of values, are given in Figure 2b. Across years, the median total breeding species richness ranged from three to five bird species per plot. Across years, the richness of breeding grassland obligates range from two to three species per plot (Figure 3b). The riparian areas had similar sections of high and low total breeding bird species richness as the grassland (Figure 4a); with no clear pattern on areas across years. Across years,

the median total breeding species richness values for the riparian areas ranged from three to five bird species per plot. After an initial increase in the number of different breeding bird species recorded in the grassland at TAPR, between 2001 and 2002, there has been a gradual decline from 48 to 29 species (40%, Figure 5). During this decline in breeding species richness, the richness of breeding grassland obligate birds remained constant at six to eight species annually.

Table 1. Species recorded at Tallgrass Prairie National Preserve, Kansas during breeding bird surveys, years 2001-2008, excluding 2003.

Common name	Species name	AOU code	Residency Status ¹
Acadian flycatcher	<i>Empidonax virescens</i>	ACFL	SR
American crow	<i>Corvus brachyrhynchos</i>	AMCR	R
American goldfinch	<i>Carduelis tristis</i>	AMGO	R
American robin	<i>Turdus migratorius</i>	AMRO	R
Bank swallow	<i>Riparia riparia</i>	BANS	SR
Barn swallow	<i>Hirundo rustica</i>	BARS	SR
Barred owl	<i>Strix varia</i>	BDOW	R
Belted kingfisher	<i>Megasceryle alcyon</i>	BEKI	R
Bewick's wren	<i>Thryomanes bewickii</i>	BEWR	R
Black-billed cuckoo	<i>Coccyzus erythrophthalmus</i>	BBCU	SR
Black-capped chickadee	<i>Poecile atricapillus</i>	BCCH	R
Blue-gray gnatcatcher	<i>Poliophtila caerulea</i>	BGGN	SR
Blue grosbeak	<i>Guiraca caerulea</i>	BLGR	SR
Blue jay	<i>Cyanocitta cristata</i>	BLJA	R
Bobolink*	<i>Dolichonyx oryzivorus</i>	BOBO	M
Brown creeper	<i>Certhia americana</i>	BRCR	WR
Brown-headed cowbird	<i>Molothrus ater</i>	BHCO	R
Brown thrasher	<i>Toxostoma rufum</i>	BRTH	R
Canada goose	<i>Branta canadensis</i>	CAGO	R
Carolina Chickadee	<i>Parus carolinensis</i>	CACH	R
Carolina wren	<i>Thryothorus ludovicianus</i>	CARW	R
Cattle egret	<i>Bubulcus ibis</i>	CAEG	SR
Cliff swallow	<i>Petrochelidon pyrrhonota</i>	CLSW	SR
Common grackle	<i>Quiscalus quiscula</i>	COGR	R
Common nighthawk	<i>Chordeiles minor</i>	CONI	SR
Common yellowthroat	<i>Geothlypis trichas</i>	COYE	SR
Dickcissel*	<i>Spiza americana</i>	DICK	SR
Downy woodpecker	<i>Picoides pubescens</i>	DOWO	R
Eastern bluebird	<i>Sialia sialis</i>	EABL	R
Eastern kingbird	<i>Tyrannus tyrannus</i>	EAKI	SR
Eastern meadowlark*	<i>Sturnella magna</i>	EAME	R
Eastern phoebe	<i>Sayornis phoebe</i>	EAPH	SR
Eastern (Rufous-side) towhee	<i>Pipilo erythrophthalmus</i>	EATO	WR
Eastern wood-pewee	<i>Contopus virens</i>	EAWP	SR
Field sparrow	<i>Spizella pusilla</i>	FISP	R
Golden-winged warbler	<i>Vermivora chrysoptera</i>	GWWA	O
Grasshopper sparrow*	<i>Ammodramus savannarum</i>	GRSP	SR
Gray catbird	<i>Dumetella carolinensis</i>	GRCA	SR
Great blue heron	<i>Ardea herodias</i>	GBHE	R
Great crested flycatcher	<i>Myiarchus crinitus</i>	GCFL	SR
Great horned owl	<i>Bubo virginianus</i>	GHOW	R
Great egret**	<i>Casmerodius albus</i>	GREG	SR

Table 1. Species recorded at Tallgrass Prairie National Preserve, Kansas during breeding bird surveys, years 2001-2008, excluding 2003 (continued).

Common name	Species name	AOU code	Residency Status ¹
Great-tailed grackle	<i>Quiscalus mexicanus</i>	GTGR	SR
Greater prairie-chicken*	<i>Tympanuchus cupido</i>	GPCH	R
Hairy woodpecker	<i>Picoides villosus</i>	HAWO	R
Henslow's sparrow*	<i>Ammodramus henslowii</i>	HESP	SR
Horned lark*	<i>Eremophila alpestris</i>	HOLA	R
House wren	<i>Troglodytes aedon</i>	HOWR	SR
Indigo bunting	<i>Passerina cyanea</i>	INBU	SR
Killdeer	<i>Charadrius vociferous</i>	KILL	R
Lark sparrow	<i>Chondestes grammacus</i>	LASP	SR
Loggerhead shrike	<i>Lanius ludovicianus</i>	LOSH	R
Mourning dove	<i>Zenaidura macroura</i>	MODO	R
Northern bobwhite	<i>Colinus virginianus</i>	NOBO	R
Northern cardinal	<i>Cardinalis cardinalis</i>	NOCA	R
Northern (Yellow-shafted) flicker	<i>Colaptes auratus</i>	YSFL	R
Northern harrier*	<i>Circus cyaneus</i>	NOHA	R
Northern mockingbird	<i>Mimus polyglottos</i>	NOMO	R
Northern (Baltimore) oriole	<i>Icterus galbula</i>	BAOR	SR
Northern parula	<i>Parula americana</i>	NOPA	M
Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>	NRWS	SR
Orchard oriole	<i>Icterus spurius</i>	OROR	SR
Pied-billed grebe	<i>Podilymbus podiceps</i>	PBGR	SR
Prothonotary warbler	<i>Protonotaria citrea</i>	PROW	SR
Red-bellied woodpecker	<i>Melanerpes carolinus</i>	RBWO	R
Red-eyed vireo	<i>Vireo olivaceus</i>	REVI	SR
Red-headed woodpecker	<i>Melanerpes erythrocephalus</i>	RHWO	R
Red-tailed hawk	<i>Buteo jamaicensis</i>	RTHA	R
Red-winged blackbird	<i>Agelaius phoeniceus</i>	RWBL	R
Ring-necked pheasant**	<i>Phasianus colchicus</i>	RPHE	R
Ruby-throated hummingbird	<i>Archilochus colubris</i>	RTHU	SR
Scarlet tanager	<i>Piranga olivacea</i>	SCTA	M
Scissor-tailed flycatcher	<i>Tyrannus forficatus</i>	STFL	SR
Sedge wren*	<i>Cistothorus platensis</i>	SEWR	M
Semipalmated sandpiper**	<i>Calidris pusilla</i>	SESA	M
Summer tanager	<i>Piranga rubra</i>	SUTA	M
(Eastern) Tufted titmouse	<i>Baeolophus bicolor</i>	ETTI	R
Turkey vulture	<i>Cathartes aura</i>	TUVU	SR
Upland sandpiper*	<i>Bartramia longicauda</i>	UPSA	SR
Veery	<i>Catharus fuscescens</i>	VEER	M
Vesper sparrow*	<i>Poocetes gramineus</i>	VESP	M
Western kingbird	<i>Tyrannus verticalis</i>	WEKI	SR
Western meadowlark*	<i>Sturnella neglecta</i>	WEME	R
White-breasted nuthatch	<i>Sitta carolinensis</i>	WBNU	R

Table 1. Species recorded at Tallgrass Prairie National Preserve, Kansas during breeding bird surveys, years 2001-2008, excluding 2003 (continued).

Common name	Species name	AOU code	Residency Status ¹
White-eyed vireo	<i>Vireo griseus</i>	WEVI	SR
Wild turkey	<i>Meleagris gallopavo</i>	WITU	R
Wood duck	<i>Aix sponsa</i>	WODU	M
Yellow-billed cuckoo	<i>Coccyzus americanus</i>	YBCU	SR
Yellow-breasted chat	<i>Icteria virens</i>	YBCH	SR
Yellow-throated vireo	<i>Vireo flavifrons</i>	YTVI	SR
Yellow warbler	<i>Dendroica petechia</i>	YWAR	SR

¹ Obligate grassland species. These species require relatively treeless grasslands for all or most of their breeding cycle (Northern Prairie Wildlife Research Center. Accessed in 2009, <http://www.npwrc.usgs.gov/>).

** Species recorded only while traveling between point transects or at other times outside of 5-min survey periods.

¹ Residency status: SR = summer resident; R = year around resident; M = late season migrant; WR = winter resident; O = outside of normal range. According to Stokes and Stokes (1996).

Species names are valid and verified names obtained from ITIS in 2009 (Integrated Taxonomic Information System <http://www.itis.gov/>).

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Table 2. Average breeding bird species density (\pm std. dev.) calculated using Distance software, for birds at Tallgrass Prairie National Preserve, Kansas, by habitat type and survey year. Distance software accounts for un-detected individuals. Species were recorded during a 5-min survey, excluding flyovers.

Common name	Individuals / ha						
	Grassland						
	2001 n=158	2002 n=242	2004 n=81	2005 n=79	2006 n=81	2007 n=71	2008 n=77
Brown-headed cowbird	0.63 (0.14)	0.54 (0.10)	0.60 (0.14)	0.55 (0.17)	0.41 (0.08)	0.52 (0.11)	0.47 (0.09)
Dickcissel	0.83 (0.08)	0.89 (0.10)	0.75 (0.11)	0.58 (0.10)	0.86 (0.11)	0.71 (0.09)	0.80 (0.09)
Eastern meadowlark	0.55 (0.10)	0.00	0.42 (0.06)	0.00	0.00	0.84 (0.12)	0.47 (0.09)
Grasshopper sparrow	3.94 (0.32)	3.69 (0.26)	3.58 (0.31)	3.60 (0.28)	3.48 (0.30)	3.95 (0.45)	4.15 (0.32)
Red-winged blackbird	0.76 (0.32)	0.56 (0.14)	0.39 (0.07)	0.38 (0.18)	0.30 (0.07)	0.56 (0.13)	0.23 (0.08)
Upland sandpiper	0.48 (0.09)	0.26 (0.05)	0.50 (0.18)	0.33 (0.05)	0.33 (0.05)	0.33 (0.05)	0.33 (0.12)
Western meadowlark	0.24 (0.02)	0.26 (0.02)	0.28 (0.03)	0.39 (0.04)	0.32 (0.03)	0.24 (0.03)	0.37 (0.05)
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Eastern wood-pewee	0.88 (0.15)	1.06 (0.25)	0.75 (0.18)	0.97 (0.18)	0.88 (0.19)	0.88 (0.18)	1.32 (0.34)

Bolded species names are those species considered of continental importance (Rich et al. 2004).

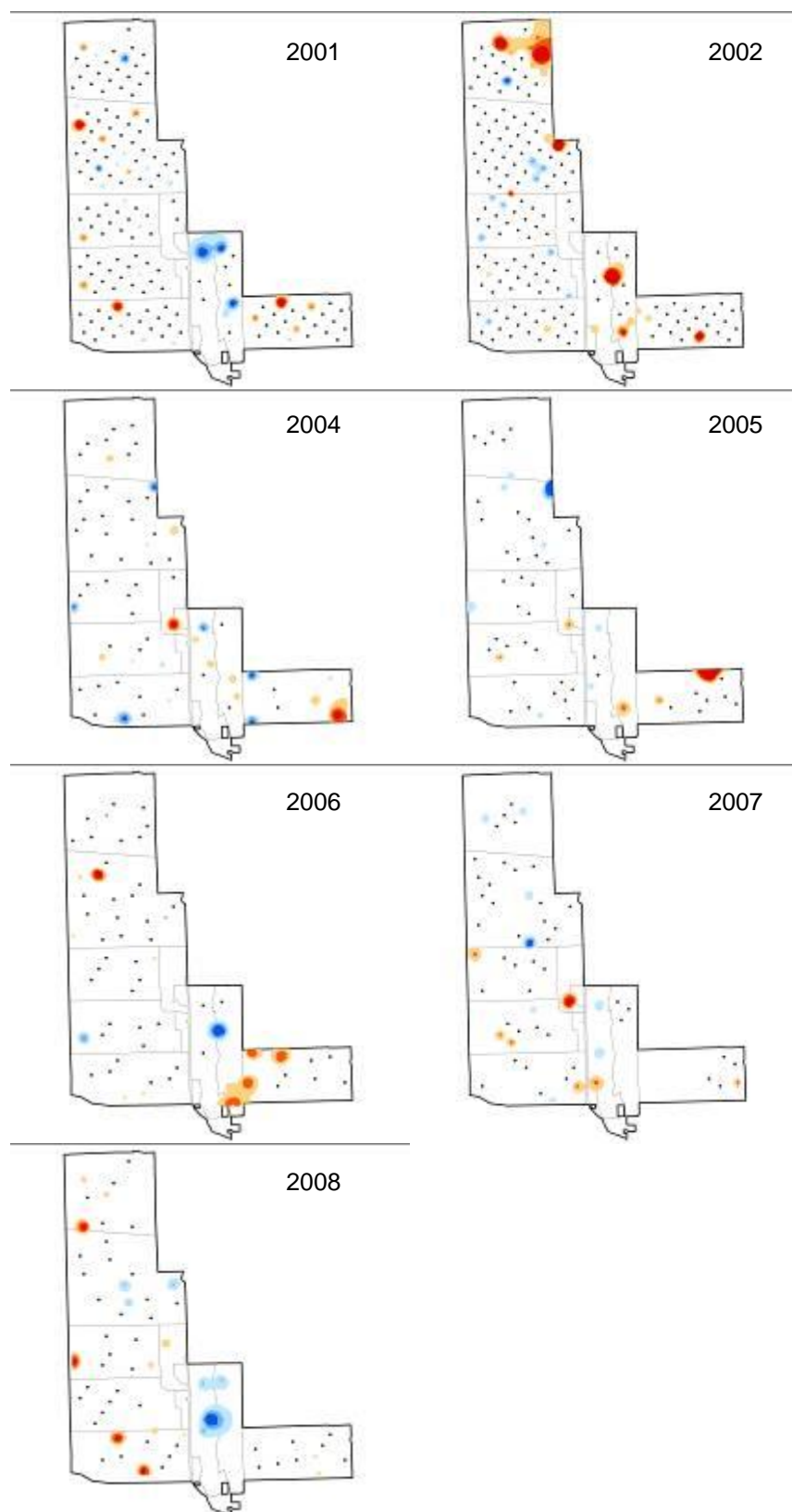


Figure 2a. Areas of higher (red) and lower (blue) than expected breeding bird species richness for grassland plots on Tallgrass Prairie National Preserve, Kansas, years 2001–2008, excluding 2003.

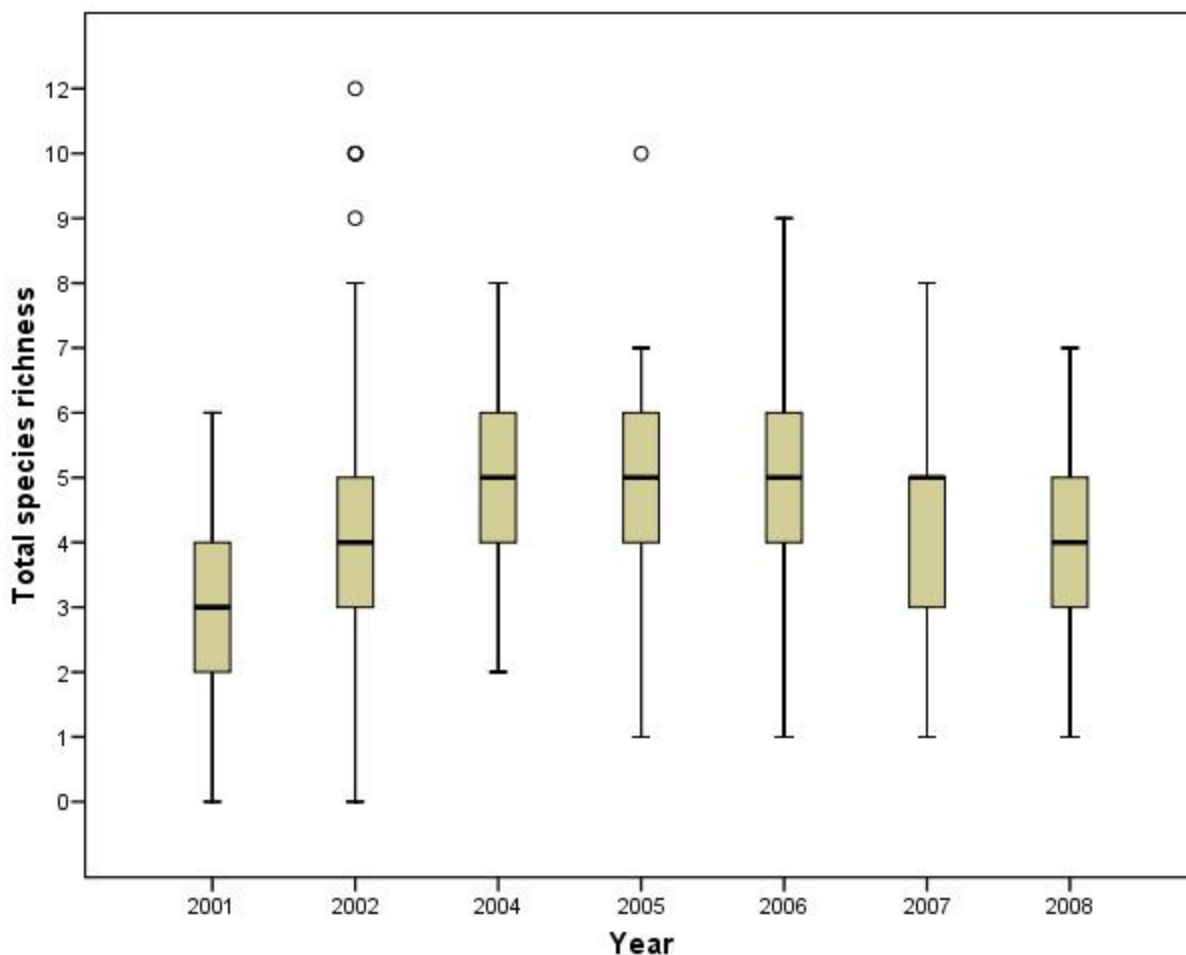


Figure 2b. Box and whisker plots on the frequency of breeding bird species richness across grassland plots at Tallgrass Prairie National Preserve, Kansas, years 2001–2008, excluding 2003. Horizontal lines within each box represent that year's median richness value. Boxes below and above the median values represent the largest values in the first and third quartiles of richness values, respectively. The lower and upper whiskers represent the extent of data, unless values fall at or beyond ranges of 1.5 inter-quartiles below or above the median values. Circles denote outliers, values that fall outside of the 1.5 inter-quartile ranges in the data.

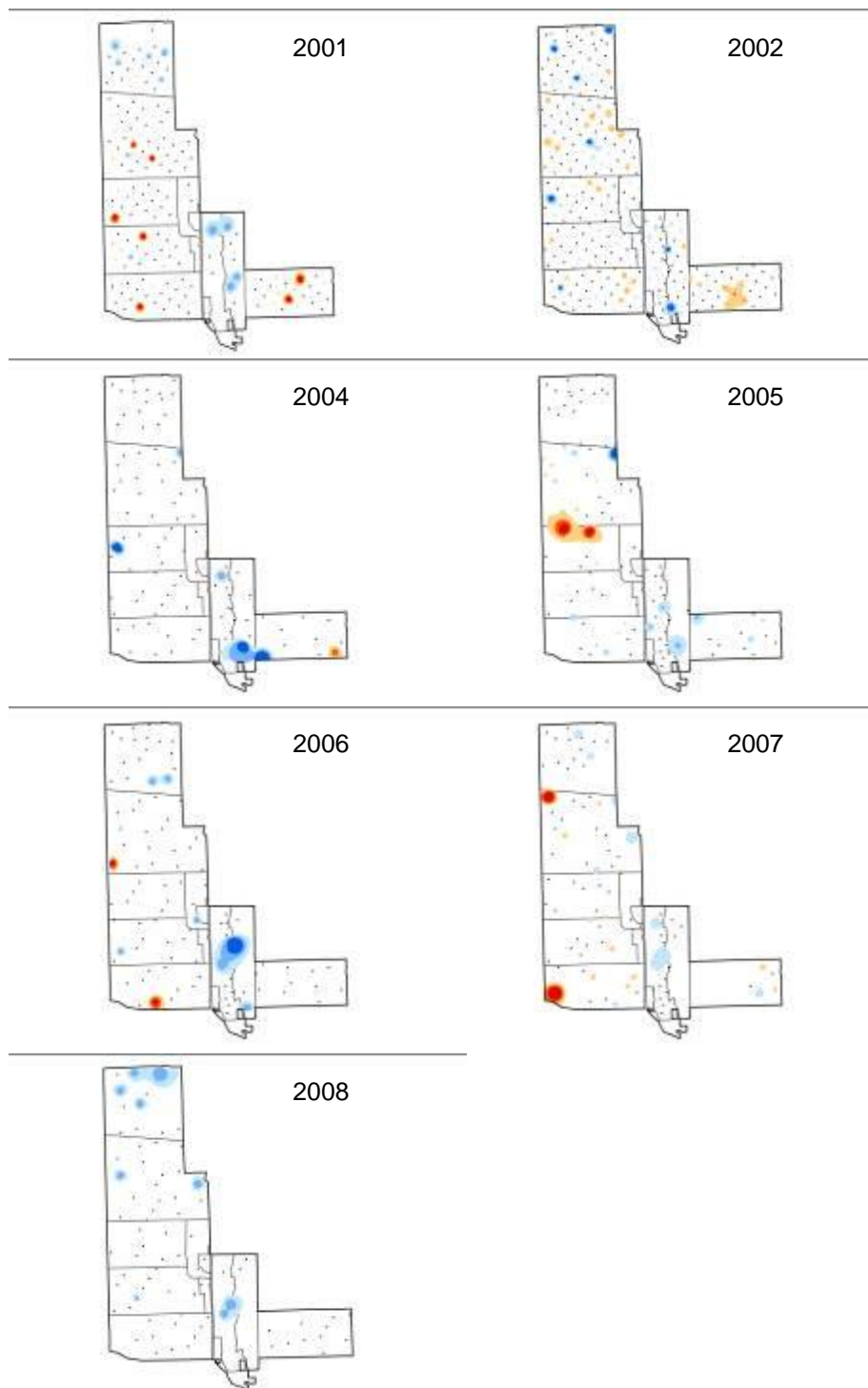


Figure 3a. Areas of higher (red) and lower (blue) than expected breeding grassland obligate bird species richness for grassland plots on Tallgrass Prairie National Preserve, Kansas, years 2001–2008, excluding 2003.

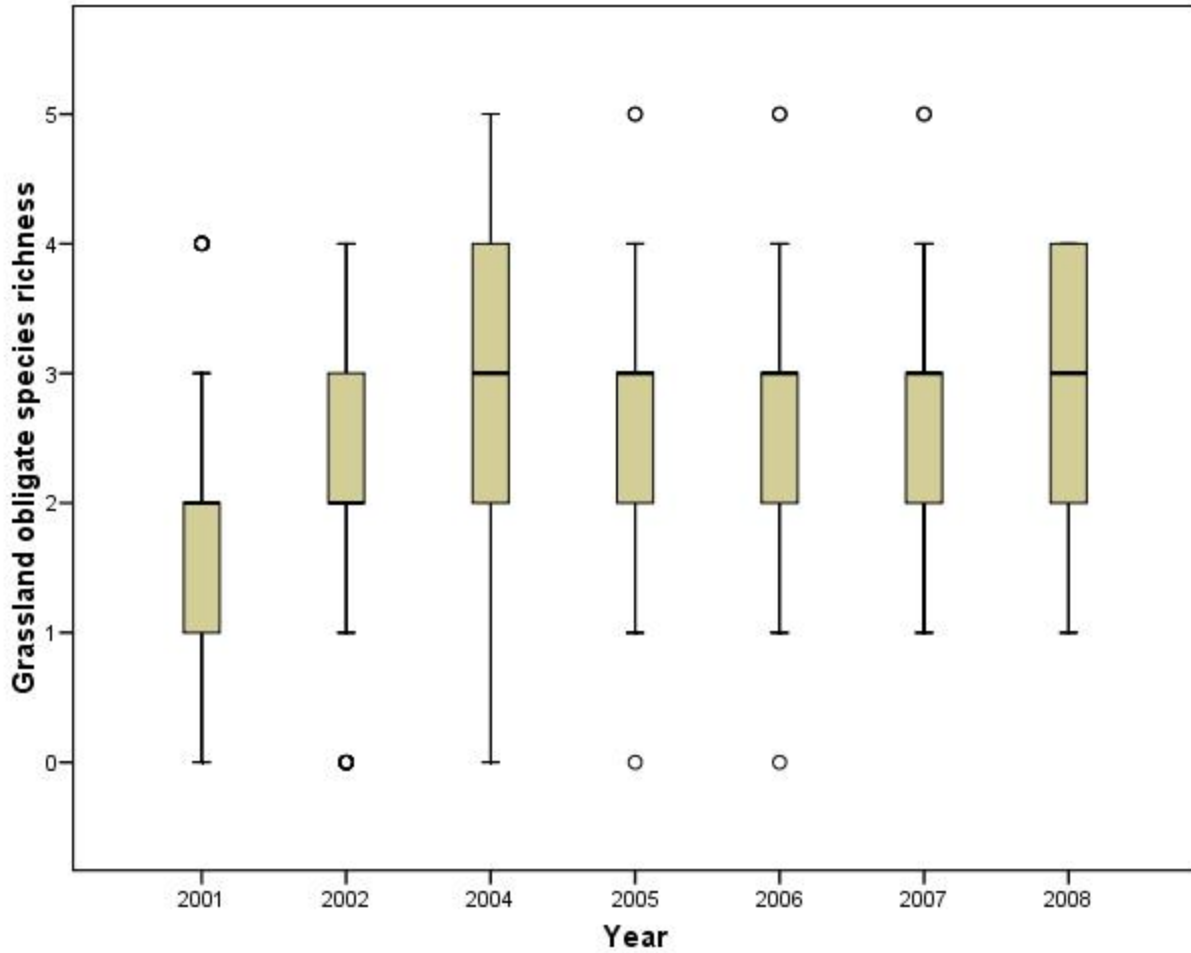


Figure 3b. Box and whisker plots on the frequency of breeding grassland obligate bird species richness across grassland plots at Tallgrass Prairie National Preserve, Kansas, years 2001–2008, excluding 2003. Horizontal lines within each box represent that year's median richness value. Boxes below and above the median values represent the largest values in the first and third quartiles of richness values, respectively. The lower and upper whiskers represent the extent of data, unless values fall at or beyond ranges of 1.5 inter-quartiles below or above the median values. Circles denote outliers, values that fall outside of the 1.5 inter-quartile ranges in the data.

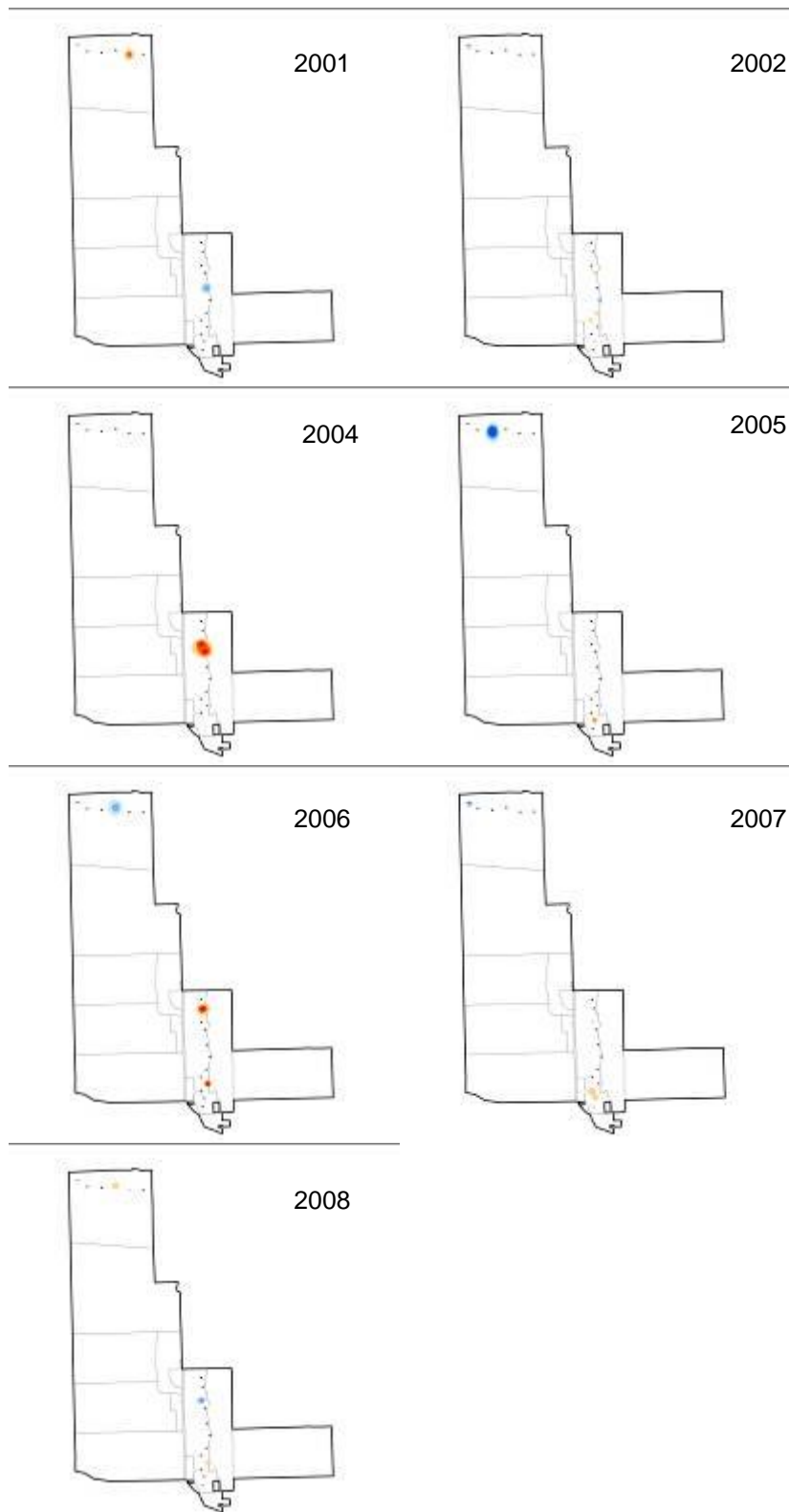


Figure 4a. Areas of higher (red) and lower (blue) than expected breeding bird species richness for riparian plots on Tallgrass Prairie National Preserve, Kansas, years 2001–2008, excluding 2003.

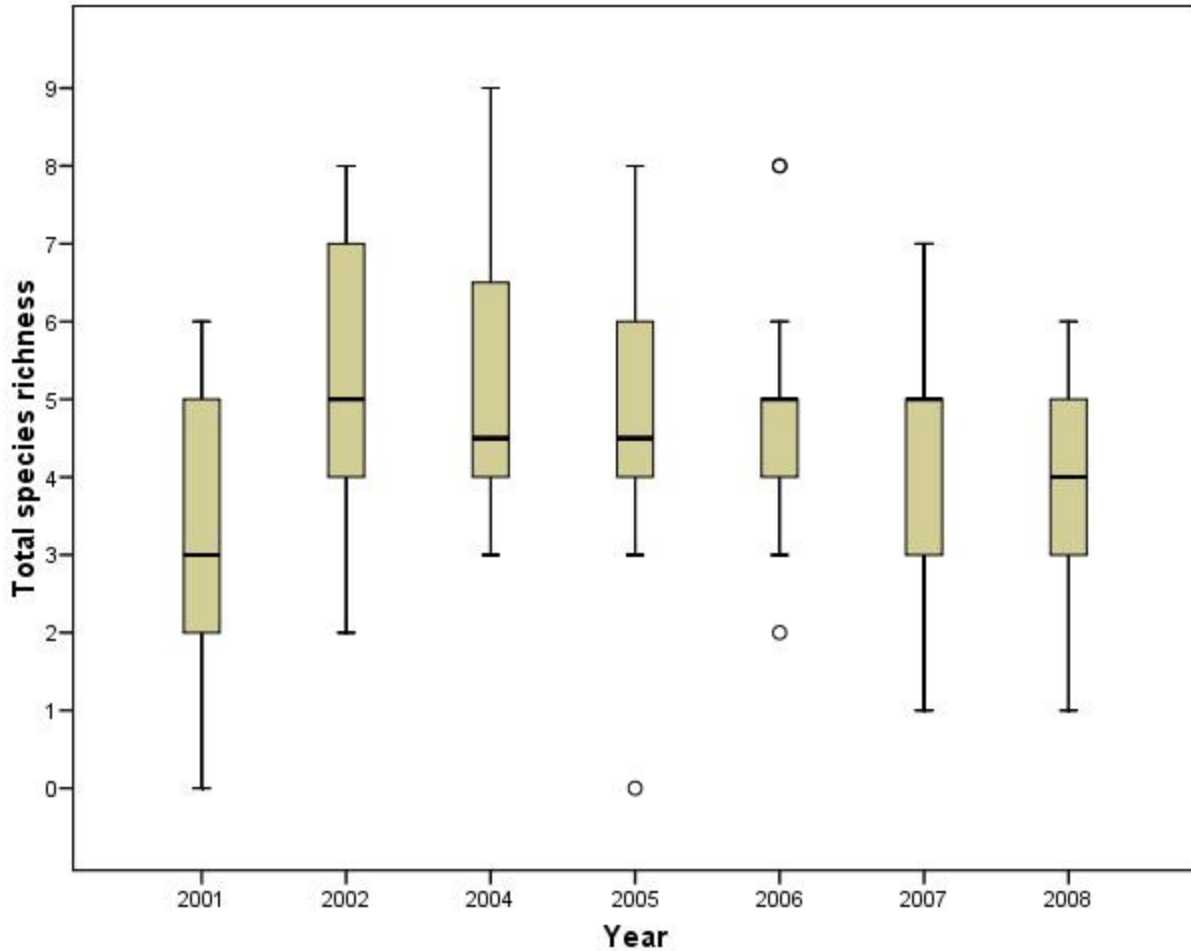


Figure 4b. Box and whisker plots on the frequency of breeding bird species richness across riparian plots at Tallgrass Prairie National Preserve, Kansas, years 2001–2008, excluding 2003. Horizontal lines within each box represent that year’s median richness value. Boxes below and above the median values represent the largest values in the first and third quartiles of richness values, respectively. The lower and upper whiskers represent the extent of data, unless values fall at or beyond ranges of 1.5 inter-quartiles below or above the median values. Circles denote outliers, values that fall outside of the 1.5 inter-quartile ranges in the data.

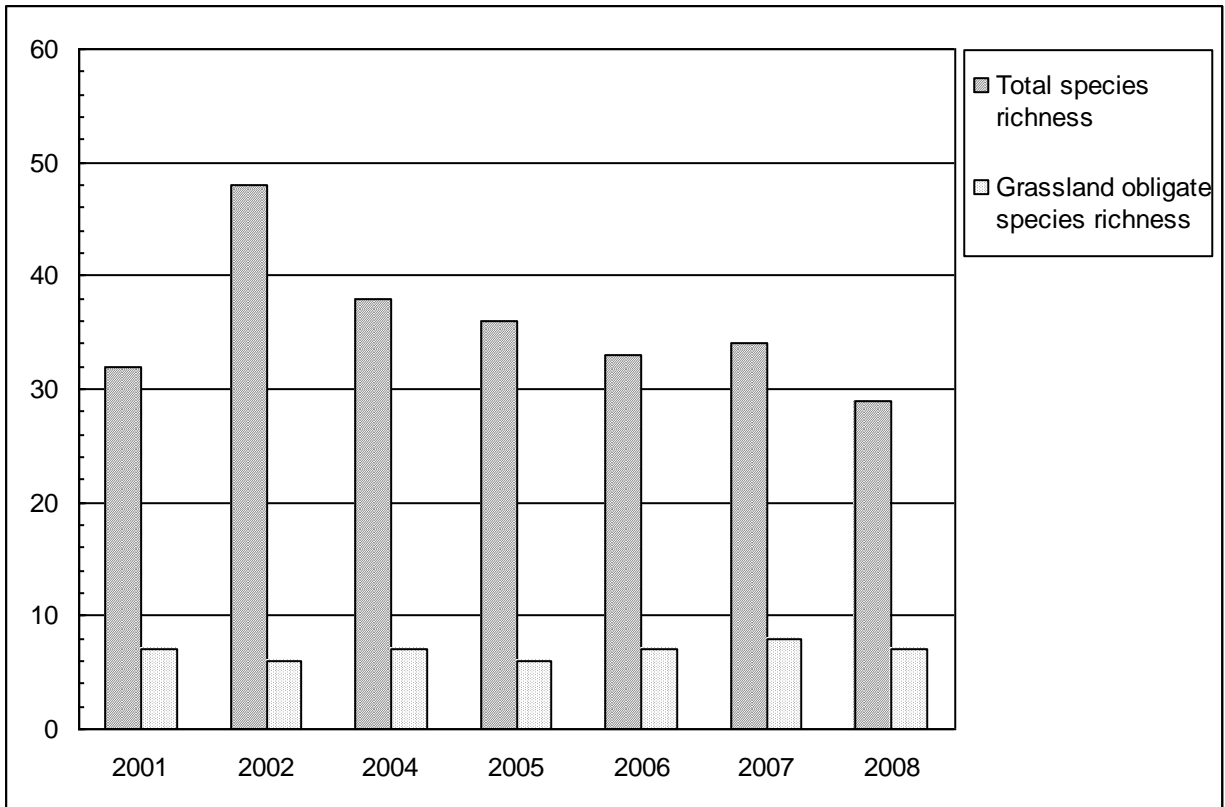


Figure 5. Total richness of breeding bird species recorded in the grassland habitat on Tallgrass Prairie National Preserve, Kansas, years 2001–2008, excluding 2003, compared to total richness of breeding grassland obligate bird species.

Bird Habitat

The abiotic features of plots sampled for breeding birds and their habitat are given in Appendix 6. Annual averages (\pm std dev) for semi-permanent features, woodland features (including canopy cover, canopy height, and basal area), horizontal vegetation cover, vertical structure diversity, ground cover, and foliar cover are listed separately by grassland and riparian habitats in Appendix 7 and 8, respectively. The woody components of the riparian areas consist of variously sized trees and shrubs from 17 different families (Appendix 9). Using a reiterative ordinary least squared regression analysis to link breeding bird species richness with habitat features, we failed to identify any consistent species richness-habitat relationships, both within and across years. Uniformity in habitat parameters across plots within both the grassland and riparian habitats prohibited us from developing meaningful species richness-habitat relationships.

Discussion

Bird surveys and habitat assessments were initiated at TAPR in 2001 to assist the park in assessing the integrity of their grassland and riparian areas through time. Seventy-nine of the 91 bird species recorded during the breeding bird surveys are permanent or summer residents to the area (Stokes and Stokes 1996). However, two of these 79 species--Great egret and Ring-necked pheasant--were only observed outside the standard 5-min sampling periods. Therefore, analyses focus on the 77 species that have some value in characterizing the breeding bird community of TAPR. Seventy-one of these species have similar breeding season occurrence patterns as those reported for them on the Konza Prairie Biological Station, a 3568-ha long-term ecological research, education, and prairie conservation site in operation since 1971 (Konza Prairie Biological Station 2009). Konza Prairie Biological Station is located in similar Flint Hills' tallgrass prairie as TAPR, and is located only 113 kilometers north of the Preserve. With the long history of bird monitoring on the Konza Prairie (nearly 40 years), and similarity in bird species composition to TAPR, the Preserve is well situated to develop and implement obtainable habitat management objectives based on findings from the Biological Station. In the near-term, impacts of proposed management on bird habitats and bird communities can be assessed using findings from the Konza Prairie before any management action is implemented. As data is gathered long-term through the current monitoring, localized variations in bird communities, and their response to the impacts of on-site habitat management can be better assessed, than using data collected off-site.

Of the fifteen bird species of continental importance recorded, thirteen are breeding species, and of these only six--Brown thrasher, Carolina wren, Dickcissel, Grasshopper sparrow, Greater prairie-chicken, Red-bellied woodpecker, and Yellow-throated vireo--occurred in five or more years of our monitoring. Therefore, these six breeding bird species serve as better measures for assessing changing habitat conditions for species of continental importance than the rest of the species. Likewise, nine of the 12 grassland obligate species breed on the Preserve. Seven of the nine breeding grassland obligate species--Dickcissel, Eastern meadowlark, Grasshopper sparrow, Greater prairie-chicken, Horned lark, Upland sandpiper, and Western meadowlark--occurred in five or more years of our monitoring, making them better measures for assessing changing grassland conditions. Four of these grassland obligates--Dickcissel, Grasshopper sparrow, Upland sandpiper and Western meadowlark--have occurred in each year of our monitoring in sufficient numbers to establish densities adjusted for undetected individuals. Trends in these breeding species densities will be readily established once enough years (>14 yr; Sauer and Droege, 1990) of data have been collected to do so.

Annual hot spot analysis identified areas in the grassland with both total breeding bird species richness, and the richness of breeding grassland obligate species, higher and lower in magnitude than expected by random chance. However, these areas of high and low species richness were not consistent across years, suggesting that sporadic annual variations in habitats across the Preserve are readily identified by birds. Three breeding grassland obligate species in the upland areas of the Preserve--Eastern meadowlark, Henslow's sparrow, and Western meadowlark--appear to be sensitive to subtle changes in grassland conditions. Henslow's sparrow, for example, was not recorded on the Preserve until 2006, the year after a reduction in the stocking rate of cattle was implemented, and the first year of patch-burn-grazing on ~1543 ha of the

Preserve (unpublished data). An additional 530 ha were not burned in 2006 as well, with isolated pockets of habitat left unburned in pastures that received prescribed fire (Brian Obermeyer, personal communication). Similar to findings by Herkert (1994), our data also shows that Henslow's sparrow only utilized plots with two or more years of post-fire vegetation structure on them. Western meadowlark, a species that favors the more sparse shortgrass prairie of the western Great Plains were generally more common on the Preserve when grazing and fire pressures were higher (2001-2005). Between 2001 and 2005, intense early stocking of cattle (double stocking of cattle followed by early destocking), and annual spring burns were the management practices utilized across the Preserve. This management practice produced habitat with less structure and grass litter that is more characteristic of shortgrass than tallgrass prairie. With the articulated goal of increasing heterogeneous habitat structure across the Preserve, management personnel implemented a patch-burn-grazing strategy on part of it, and reduced the stocking rate of cattle across all of it (Leis et.al. 2009). The Eastern meadowlarks showed a marked increase in abundance and distribution during our 2008 bird surveys, two years after the new management strategy.

Comparing annual breeding species richness values for grassland obligates, suggests that as a whole, the Preserve has provided for the habitat needs of most obligate species across years, as demonstrated by their relatively stable richness (Figure 5). The gradual decline in total breeding species richness in the grassland also suggest that as the Preserve moves from being intensely burned and grazed, to being less so, some non-tallgrass adapted bird species are dropping out of the bird community. Our differences in high and low total species richness could be an artifact of differences in sample sizes between 2002 and 2008, as nine species--Acadian flycatcher, American goldfinch, Common yellowthroat, Downy woodpecker, Field sparrow, Great horned owl, Indigo bunting, Loggerhead shrike, and Yellow-breasted chat--were only recorded in 2002, possibly do to the larger number of plots being sampled. However, 14 other species--American crow, Black-capped chickadee, Blue jay, Cliff swallow, Common grackle, Eastern phoebe, Northern cardinal, Northern (Yellow-shafted) flicker, Red-bellied woodpecker, Scissor-tailed flycatcher, White-breasted nuthatch, Wild turkey, Yellow-billed cuckoo, and Yellow-throated vireo-- present in 2002, occurred in two or more years on the Preserve prior to being absent from the grassland bird community in 2008. One species--Carolina wren--occurred in 2008, but not in other years.

Accounting for the species recorded in only one year, breeding grassland obligates averaged 18% of the bird community between 2001 and 2005. Since 2005 they have averaged 23% of the grassland bird community. Based on bird community composition changes, one goal of patch-burn-grazing management, returning vertical structure and litter to the plant community with the intent of enhancing the tallgrass prairie ecosystem for wildlife, is working. Resting other areas of the Preserve from annual burning has helped as well. More non-tallgrass adapted species can be expected to drop out of the grassland breeding bird community as key characteristic of a tallgrass prairie develop. However, one needs to remember that it is more important to implement processes that allow for the full expression of the tallgrass prairie ecosystem, as measured through grassland obligate species numbers, than it is to focus on increasing the number of all breeding species present. Many of these non-grassland obligate bird species are generalist that can live in many of the other habitats found across the landscape.

Of the 48 bird species recorded in the riparian areas of TAPR, only 22% occurred in five or more years of surveys. These 12 species--Bewick's wren, Blue-gray gnatcatcher, Carolina wren, Eastern wood-peewee, Great-crested flycatcher, Northern cardinal, Red-bellied woodpecker, Red-eyed vireo, Tufted titmouse, White-breasted nuthatch, Yellow-throated vireo, and Yellow warbler--will serve as better measures for assessing changing riparian conditions. The Carolina wren, Red-bellied woodpecker, and Yellow-throated vireo are species of continental importance. The only species that occurred in the riparian area with sufficient numbers to establish densities adjusted for undetected individuals is the Eastern wood-peewee. Like the grassland species, trends in this species density will be readily established once enough years (>14 yr; Sauer and Droege, 1990) of data have been collected to do so.

Key characteristic of tallgrass prairie are vertical structure and grass litter, mainly resulting from warm season grasses. The lack of vertical structure in the plant community early on in our study not only affects the function of the plant community, but also decreases the variability in wildlife habitat (James and DeBacker, 2007). Since implementing patch-burn-grazing on part of the Preserve, the annual vertical structure index, a combined measure of vegetation height and density, has risen slightly, from 9.45% to 9.91% in the grassland habitat. Although a small increase in the vertical structure on the Preserve, it is a positive increase none-the-less. Grass litter has risen from 14.22% (2001-2005) to 20.84% (2006-2008) on grassland plots across the Preserve.

Uniformity in habitat parameters across the grassland has prohibited us from developing meaningful bird species richness-habitat relationships with our measured parameters. However, as management designed to increase the diversity of habitat in the grassland continues, greater variability in habitat parameters can be expected. This increased variation in habitat parameter will increase our ability to model meaningful bird species-habitat relationships. Habitat parameters across the riparian areas of the Preserve may not change as readily as the grassland habitat. Therefore, modeling breeding bird species-habitat relationship for the riparian areas may not be accomplished. However, these narrow ribbons of large trees on the Preserve in all likelihood will provide similar habitat for riparian bird species year after year. Geographically weighted regression, one of several spatial regression techniques, should be used on our data in the future to establish bird species richness-habitat relationships. Geographically weighted regression is the natural next step after ordinary least square regression analysis in analyzing spatial data, and is increasingly used in geography and other disciplines. Geographically weighted regression provides a local model of the variable or process you are trying to understand/predict by fitting a regression equation to every feature in the dataset. Geographically weighted regression constructs these separate equations by incorporating the dependent and explanatory variables of features falling within the bandwidth of each target feature. The shape and size of the bandwidth is dependent on user input.

Similarities in the breeding bird communities between the Konza Prairie Biological Station and TAPR, position the Preserve well in assessing trends in the bird community and the effects of management actions on bird habitat. At this point in monitoring, time is needed for trends to develop that are not influenced by innate annual variability in the data. Annual hot spot analysis suggests that subtle (those not captured by parameters that are currently measured), sporadic annual variations in areas across the grassland habitat on the Preserve are identified by birds.

However, these variations in habitat are rarely consistent from one year to the next. Since implementing patch-burn-grazing on part of the Preserve, the annual vertical structure index has risen as well as the amount of grass litter. This increased variation in habitat parameters will increase our ability to model meaningful bird species-habitat relationships in the future. Habitat parameters in the riparian areas of the Preserve may not change as readily as the grassland habitat, as management for improving the grassland has little effect there.

Literature Cited

- ArcGIS 9.3. 2009. Geoprocessing-computing with data. Online. (<http://resources.esri.com/geoprocessing/>). Accessed 6 July 2009.
- Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. Chapman and Hall, New York. 446pp.
- Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press. 432pp.
- Cairns Jr., J., P. V. McCormick, and B. R. Niederlehner. 2004. A proposed framework for developing indicators of ecosystem health. *Hydrobiologia* 263:1-44.
- Fancy, S. G. 1997. A new approach for analyzing bird densities from variable circular-plot counts. *Pacific Science* 51:107-114.
- Fitzgerald, J. A., B. Busby, M. Howery, R. Klalaske, D. Reinking, and D. N. Pashley. 2000. Partners in Flight bird conservation plan for the Osage Plains (Physiographic Area 33). Cornell Lab of Ornithology, Ithaca, New York. 51pp.
- Herkert, J. R. 1994. Status and habitat selection of the Henslow's Sparrow in Illinois. *The Wilson Bulletin* 106:35-45.
- ITIS (Integrated Taxonomic Information System). 2009. Online. (<http://www.itis.gov/>). Accessed 12 May 2009.
- James, K., and M. DeBacker. 2007. Plant Community Monitoring Trend Report, Tallgrass Prairie National Preserve. Natural Resource Technical Report NPS/HTLN/NRTR—2007/030. National Park Service, Fort Collins, Colorado. 41pp.
- Karr, J. R. 1991. Biological integrity: a long-neglected aspect of water resource management. *Ecological Applications* 1:66-84.
- Karr, J. R., and D. R. Dudley. 1981. Ecological perspective on water quality goals. *Environmental Management* 5:55-68.
- Konza Prairie Biological Station. 2009. Phenological checklist of the birds of Konza Prairie. Online. (http://www.konza.ksu.edu/data_catalog/flora_fauna/bird.html). Accessed 10 September 2009.
- Leis, S. A., D. G. Peitz, K. M. James, and L. Morrison. 2009. Trajectory of avian habitat structure in a grassland with recent reduction in fire and grazing disturbance. Unpublished report, Heartland Inventory and Monitoring Network.

- Mallory, M. L., H. G. Gilchrist, B. M. Braune, and A. J. Gaston. 2006. Marine birds as indicators of arctic marine ecosystem health: linking the northern ecosystem initiative to long-term studies. *Environmental Monitoring and Assessment* 113:31-48.
- Maurer, B. A. 1993. Biological diversity, ecological integrity, and neotropical migrants: New perspectives for wildlife managers. Pages 24-31 *in* D.M. Finch and P.W. Stangel, editors. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report RM-229.
- Northern Prairie Wildlife Research Center. 2009. Northern Prairie Wildlife Research Center-online. Online. (<http://www.npwrc.usgs.gov/>). Accessed 10 September 2009.
- Peitz, D. G., G. A. Rowell, J. L. Haack, K. M. James, L. W. Morrison, and M. D. Debacker. 2008. Breeding bird monitoring protocol for the Heartland Network Inventory and Monitoring Program. Natural Resource Report NPS/HTLN/NRR-2008/044. National Park Service, Fort Collins, Colorado. 152pp.
- Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Inigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, and T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology, Ithaca, New York. 84pp.
- Sauer, J. R., and S. Droege, editors. 1990. Survey Designs and Statistical Methods for the Estimation of Avian Population Trends. U.S. Fish and Wildlife Service, Biological Report 90(1). 166pp.
- Sauer, J. R., J. E. Hines, and J. Fallon. 2008. The North American Breeding Bird Survey, Results and Analysis 1966 - 2007. Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, MD available from (<http://www.mbr-pwrc.usgs.gov/bbs/bbs.html>). Accessed 10 September 2009.
- Steel, R. G. D., and J. H. Torrie. 1980. Principles and procedures of statistics: a biometrical approach. McGraw-Hill Book Company, New York, New York. 633pp.
- Stokes, D. W., and L. Q. Stokes. 1996. Stokes Field Guide to Birds: Eastern Region. Little, Brown and Company, New York, New York. 471pp.
- Wood, J. K., N. Nur, C. A. Howell, and G. R. Geupel. 2006. Overview of Cosumnes riparian bird study and recommendations for monitoring and management. A Report to the California Bay-Delta Authority Ecosystem Restoration Program. Petaluma, California. 18pp.

Appendices

Appendix 1. Plot I.D. and habitat type for each breeding bird survey plot at Tallgrass Prairie National Preserve, Kansas. Also given are x and y UTM coordinates for each plot. UTM Zone 14 North, Datum 1983 (Conus).

Plot I.D.	Habitat Type	X Coordinate (Easting)	Y Coordinate (Northing)
TAPRTweety1	Grassland	711444.688	4263461.000
TAPRTweety2	Grassland	710113.438	4262906.000
TAPRTweety3	Grassland	711555.625	4262906.000
TAPRTweety4	Grassland	711000.938	4262795.500
TAPRTweety5	Grassland	710446.250	4262684.500
TAPRTweety6	Grassland	711888.438	4262684.500
TAPRTweety7	Grassland	709891.563	4262573.500
TAPRTweety8	Grassland	711333.750	4262573.500
TAPRTweety9	Grassland	710779.063	4262462.500
TAPRTweety10	Grassland	710224.375	4262351.500
TAPRTweety11	Grassland	711666.563	4262351.500
TAPRTweety12	Grassland	711111.875	4262240.500
TAPRTweety13	Grassland	710557.188	4262129.500
TAPRTweety14	Grassland	711999.375	4262129.500
TAPRTweety15	Grassland	710002.500	4262018.500
TAPRTweety16	Grassland	711444.688	4262018.500
TAPRTweety17	Grassland	710890.000	4261907.500
TAPRTweety18	Grassland	710335.313	4261797.000
TAPRTweety19	Grassland	711777.500	4261797.000
TAPRTweety20	Grassland	709780.563	4261686.000
TAPRTweety21	Grassland	711222.813	4261686.000
TAPRTweety22	Grassland	710668.125	4261575.000
TAPRTweety23	Grassland	711555.625	4261464.000
TAPRTweety24	Grassland	709891.563	4261131.000
TAPRTweety25	Grassland	710779.063	4261020.000
TAPRTweety26	Grassland	710224.375	4260909.500
TAPRTweety27	Grassland	711666.563	4260909.500
TAPRTweety28	Grassland	711111.875	4260798.500
TAPRTweety29	Grassland	710557.188	4260687.500
TAPRTweety30	Grassland	711999.375	4260687.500
TAPRTweety31	Grassland	710002.500	4260576.500
TAPRTweety32	Grassland	711444.688	4260576.500
TAPRTweety33	Grassland	710890.000	4260465.500
TAPRTweety34	Grassland	710335.313	4260354.500
TAPRTweety35	Grassland	711777.500	4260354.500
TAPRTweety36	Grassland	711222.813	4260243.500
TAPRTweety37	Grassland	710668.125	4260132.500
TAPRTweety38	Grassland	710113.438	4260022.000
TAPRTweety39	Grassland	711555.625	4260022.000
TAPRTweety40	Grassland	711000.938	4259911.000
TAPRTweety41	Grassland	710446.250	4259800.000
TAPRTweety42	Grassland	711888.438	4259800.000
TAPRTweety43	Grassland	709891.563	4259689.000
TAPRTweety44	Grassland	711333.750	4259689.000
TAPRTweety45	Grassland	712776.000	4259689.000
TAPRTweety46	Grassland	710779.063	4259578.000
TAPRTweety47	Grassland	712221.250	4259578.000
TAPRTweety48	Grassland	710224.375	4259467.000
TAPRTweety49	Grassland	711666.563	4259467.000

Appendix 1. Plot I.D. and habitat type for each breeding bird survey plot at Tallgrass Prairie National Preserve, Kansas. Also given are x and y UTM coordinates for each plot. UTM Zone 14 North, Datum 1983 (Conus) (continued).

Plot I.D.	Habitat Type	X Coordinate (Easting)	Y Coordinate (Northing)
TAPRTweety50	Grassland	711111.875	4259356.000
TAPRTweety51	Grassland	712554.063	4259356.000
TAPRTweety52	Grassland	710557.188	4259245.000
TAPRTweety53	Grassland	711999.375	4259245.000
TAPRTweety54	Grassland	710002.500	4259134.000
TAPRTweety55	Grassland	711444.688	4259134.000
TAPRTweety56	Grassland	712886.938	4259134.000
TAPRTweety57	Grassland	710890.000	4259023.500
TAPRTweety58	Grassland	712332.188	4259023.500
TAPRTweety59	Grassland	710335.313	4258912.500
TAPRTweety60	Grassland	711777.500	4258912.500
TAPRTweety61	Grassland	711222.813	4258801.500
TAPRTweety62	Grassland	712665.063	4258801.500
TAPRTweety63	Grassland	710668.125	4258690.500
TAPRTweety64	Grassland	712110.313	4258690.500
TAPRTweety65	Grassland	711333.750	4258246.500
TAPRTweety66	Grassland	712776.000	4258246.500
TAPRTweety67	Grassland	710779.063	4258136.000
TAPRTweety68	Grassland	710224.375	4258025.000
TAPRTweety69	Grassland	711666.563	4258025.000
TAPRTweety70	Grassland	711111.875	4257914.000
TAPRTweety71	Grassland	710557.188	4257803.000
TAPRTweety72	Grassland	711999.375	4257803.000
TAPRTweety73	Grassland	710002.500	4257692.000
TAPRTweety74	Grassland	711444.688	4257692.000
TAPRTweety75	Grassland	712886.938	4257692.000
TAPRTweety76	Grassland	710890.000	4257581.000
TAPRTweety77	Grassland	710335.313	4257470.000
TAPRTweety78	Grassland	711777.500	4257470.000
TAPRTweety79	Grassland	711222.813	4257359.000
TAPRTweety80	Grassland	710668.125	4257248.500
TAPRTweety81	Grassland	712110.313	4257248.500
TAPRTweety82	Grassland	710113.438	4257137.500
TAPRTweety83	Grassland	711555.625	4257137.500
TAPRTweety84	Grassland	714218.188	4256804.500
TAPRTweety85	Brome	713663.500	4256693.500
TAPRTweety86	Grassland	710224.375	4256582.500
TAPRTweety87	Grassland	711666.563	4256582.500
TAPRTweety88	Grassland	714551.000	4256582.500
TAPRTweety89	Grassland	711111.875	4256471.500
TAPRTweety90	Grassland	710557.188	4256360.500
TAPRTweety91	Grassland	711999.375	4256360.500
TAPRTweety92	Grassland	710002.500	4256250.000
TAPRTweety93	Grassland	711444.688	4256250.000
TAPRTweety94	Grassland	714329.125	4256250.000
TAPRTweety95	Grassland	710890.000	4256139.000
TAPRTweety96	Grassland	712332.188	4256139.000
TAPRTweety97	Grassland	710335.313	4256028.000
TAPRTweety98	Grassland	711777.500	4256028.000
TAPRTweety99	Grassland	711222.813	4255917.000
TAPRTweety100	Grassland	710668.125	4255806.000
TAPRTweety101	Grassland	712110.313	4255806.000

Appendix 1. Plot I.D. and habitat type for each breeding bird survey plot at Tallgrass Prairie National Preserve, Kansas. Also given are x and y UTM coordinates for each plot. UTM Zone 14 North, Datum 1983 (Conus) (continued).

Plot I.D.	Habitat Type	X Coordinate (Easting)	Y Coordinate (Northing)
TAPRTweety102	Brome	713552.563	4255806.000
TAPRTweety103	Grassland	710113.438	4255695.000
TAPRTweety104	Grassland	711555.625	4255695.000
TAPRTweety105	Grassland	714440.063	4255695.000
TAPRTweety106	Grassland	711000.938	4255584.000
TAPRTweety107	Grassland	712443.125	4255584.000
TAPRTweety108	Grassland	710446.250	4255473.000
TAPRTweety109	Grassland	711888.438	4255473.000
TAPRTweety110	Brome	713663.500	4255251.500
TAPRTweety111	Grassland	714551.000	4255140.500
TAPRTweety112	Grassland	715993.250	4255140.500
TAPRTweety113	Grassland	717435.438	4255140.500
TAPRTweety114	Grassland	711111.875	4255029.500
TAPRTweety115	Grassland	712554.063	4255029.500
TAPRTweety116	Grassland	715438.563	4255029.500
TAPRTweety117	Grassland	716880.750	4255029.500
TAPRTweety118	Grassland	710557.188	4254918.500
TAPRTweety119	Grassland	711999.375	4254918.500
TAPRTweety120	Grassland	716326.063	4254918.500
TAPRTweety121	Grassland	717768.250	4254918.500
TAPRTweety122	Grassland	710002.500	4254807.500
TAPRTweety123	Grassland	711444.688	4254807.500
TAPRTweety124	Grassland	712886.938	4254807.500
TAPRTweety125	Grassland	714329.125	4254807.500
TAPRTweety126	Grassland	715771.375	4254807.500
TAPRTweety127	Grassland	717213.563	4254807.500
TAPRTweety128	Grassland	710890.000	4254696.500
TAPRTweety129	Grassland	712332.188	4254696.500
TAPRTweety130	Grassland	715216.625	4254696.500
TAPRTweety131	Grassland	716658.875	4254696.500
TAPRTweety132	Grassland	710335.313	4254585.500
TAPRTweety133	Grassland	711777.500	4254585.500
TAPRTweety134	Grassland	716104.188	4254585.500
TAPRTweety135	Grassland	717546.375	4254585.500
TAPRTweety136	Grassland	711222.813	4254475.000
TAPRTweety137	Grassland	712665.063	4254475.000
TAPRTweety138	Grassland	715549.500	4254475.000
TAPRTweety139	Grassland	716991.688	4254475.000
TAPRTweety140	Grassland	710668.125	4254364.000
TAPRTweety141	Grassland	712110.313	4254364.000
TAPRTweety142	Grassland	716437.000	4254364.000
TAPRTweety143	Grassland	717879.188	4254364.000
TAPRTweety144	Grassland	710113.438	4254253.000
TAPRTweety145	Grassland	711555.625	4254253.000
TAPRTweety146	Grassland	712997.875	4254253.000
TAPRTweety147	Grassland	714440.063	4254253.000
TAPRTweety148	Grassland	715882.313	4254253.000
TAPRTweety149	Grassland	717324.500	4254253.000
TAPRTweety150	Grassland	711000.938	4254142.000
TAPRTweety151	Grassland	712443.125	4254142.000
TAPRTweety152	Grassland	715327.625	4254142.000
TAPRTweety153	Grassland	716769.813	4254142.000

Appendix 1. Plot I.D. and habitat type for each breeding bird survey plot at Tallgrass Prairie National Preserve, Kansas. Also given are x and y UTM coordinates for each plot. UTM Zone 14 North, Datum 1983 (Conus) (continued).

Plot I.D.	Habitat Type	X Coordinate (Easting)	Y Coordinate (Northing)
TAPRTweety154	Grassland	710446.250	4254031.000
TAPRTweety155	Grassland	711888.438	4254031.000
TAPRTweety156	Grassland	716215.125	4254031.000
TAPRTweety157	Grassland	717657.313	4254031.000
TAPRTweety158	Grassland	712776.000	4253920.000
TAPRTweety159	Riparian	710124.563	4263197.500
TAPRTweety160	Riparian	710595.688	4263155.500
TAPRTweety161	Riparian	711047.063	4263231.000
TAPRTweety162	Riparian	711485.500	4263098.000
TAPRTweety163	Riparian	711937.875	4263106.500
TAPRTweety164	Riparian	713868.747	4253532.017
TAPRTweety165	Riparian	713917.305	4253809.841
TAPRTweety166	Riparian	713812.750	4254043.000
TAPRTweety167	Riparian	714030.250	4254271.500
TAPRTweety168	Riparian	713809.000	4254492.500
TAPRTweety169	Riparian	713985.612	4254725.183
TAPRTweety170	Riparian	714108.110	4255143.297
TAPRTweety171	Riparian	714000.500	4255541.500
TAPRTweety172	Riparian	713937.750	4256031.000
TAPRTweety173	Riparian	713834.688	4256265.000
TAPRTweety174	Riparian	713867.938	4256715.000
TAPRTweety175	Riparian	713817.500	4257008.000
TAPRTweety176	Riparian	709815.813	4263404.000
TAPRTweety177	Grassland	711111.875	4263683.000
TAPRTweety178	Grassland	710557.188	4263572.000
TAPRTweety179	Grassland	711999.375	4263572.000
TAPRTweety180	Grassland	710002.500	4263461.000
TAPRTweety181	Grassland	710890.000	4263350.000
TAPRTweety182	Grassland	711777.500	4263239.000
TAPRTweety183	Grassland	710668.125	4263017.000
TAPRTweety184	Grassland	709669.625	4262240.500
TAPRTweety185	Grassland	712110.313	4261575.000
TAPRTweety186	Grassland	710113.438	4261464.000
TAPRTweety187	Grassland	711000.938	4261353.000
TAPRTweety188	Grassland	710446.250	4261242.000
TAPRTweety189	Grassland	711888.438	4261242.000
TAPRTweety190	Grassland	711333.750	4261131.000
TAPRTweety191	Grassland	712221.250	4261020.000
TAPRTweety192	Grassland	709669.625	4260798.500
TAPRTweety193	Grassland	709780.563	4260243.500
TAPRTweety194	Grassland	712110.313	4260132.500
TAPRTweety195	Grassland	712443.125	4259911.000
TAPRTweety196	Grassland	709780.563	4258801.500
TAPRTweety197	Grassland	710113.438	4258579.500
TAPRTweety198	Grassland	711555.625	4258579.500
TAPRTweety199	Grassland	712997.875	4258579.500
TAPRTweety200	Grassland	711000.938	4258468.500
TAPRTweety201	Grassland	712443.125	4258468.500
TAPRTweety202	Grassland	710446.250	4258357.500
TAPRTweety203	Grassland	711888.438	4258357.500
TAPRTweety204	Grassland	709891.563	4258246.500
TAPRTweety205	Grassland	712221.250	4258136.000

Appendix 1. Plot I.D. and habitat type for each breeding bird survey plot at Tallgrass Prairie National Preserve, Kansas. Also given are x and y UTM coordinates for each plot. UTM Zone 14 North, Datum 1983 (Conus) (continued).

Plot I.D.	Habitat Type	X Coordinate (Easting)	Y Coordinate (Northing)
TAPRTweety206	Grassland	713108.813	4258025.000
TAPRTweety207	Grassland	712554.063	4257914.000
TAPRTweety208	Grassland	712332.188	4257581.000
TAPRTweety209	Grassland	709780.563	4257359.000
TAPRTweety210	Grassland	712665.063	4257359.000
TAPRTweety211	Grassland	712997.875	4257137.500
TAPRTweety212	Grassland	714440.063	4257137.500
TAPRTweety213	Grassland	711000.938	4257026.500
TAPRTweety214	Grassland	712443.125	4257026.500
TAPRTweety215	Grassland	710446.250	4256915.500
TAPRTweety216	Grassland	711888.438	4256915.500
TAPRTweety217	Brome	713330.688	4256915.500
TAPRTweety218	Grassland	709891.563	4256804.500
TAPRTweety219	Grassland	711333.750	4256804.500
TAPRTweety220	Grassland	712776.000	4256804.500
TAPRTweety221	Grassland	710779.063	4256693.500
TAPRTweety222	Grassland	712221.250	4256693.500
TAPRTweety223	Grassland	713108.813	4256582.500
TAPRTweety224	Grassland	712554.063	4256471.500
TAPRTweety225	Brome	713441.625	4256360.500
TAPRTweety226	Grassland	712886.938	4256250.000
TAPRTweety227	Grassland	714661.938	4256028.000
TAPRTweety228	Grassland	709780.563	4255917.000
TAPRTweety229	Grassland	712665.063	4255917.000
TAPRTweety230	Grassland	714107.250	4255917.000
TAPRTweety231	Grassland	712997.875	4255695.000
TAPRTweety232	Brome	713885.375	4255584.000
TAPRTweety233	Grassland	714772.875	4255473.000
TAPRTweety234	Grassland	709891.563	4255362.500
TAPRTweety235	Grassland	711333.750	4255362.500
TAPRTweety236	Grassland	712776.000	4255362.500
TAPRTweety237	Grassland	714218.188	4255362.500
TAPRTweety238	Grassland	717102.625	4255362.500
TAPRTweety239	Grassland	710779.063	4255251.500
TAPRTweety240	Grassland	712221.250	4255251.500
TAPRTweety241	Grassland	715105.688	4255251.500
TAPRTweety242	Grassland	716547.938	4255251.500
TAPRTweety243	Grassland	717990.125	4255251.500
TAPRTweety244	Grassland	710224.375	4255140.500
TAPRTweety245	Grassland	711666.563	4255140.500
TAPRTweety246	Grassland	713108.813	4255140.500
TAPRTweety247	Brome	713441.625	4254918.500
TAPRTweety248	Grassland	714883.813	4254918.500
TAPRTweety249	Grassland	714661.938	4254585.500
TAPRTweety250	Grassland	713552.563	4254364.000
TAPRTweety251	Grassland	714994.750	4254364.000
TAPRTweety252	Grassland	714772.875	4254031.000
TAPRTweety253	Grassland	711333.750	4253920.000
TAPRTweety254	Brome	714218.188	4253920.000
TAPRTweety255	Grassland	715660.438	4253920.000
TAPRTweety256	Grassland	717102.625	4253920.000
TAPRTweety257	Grassland	710779.063	4253809.000

Appendix 1. Plot I.D. and habitat type for each breeding bird survey plot at Tallgrass Prairie National Preserve, Kansas. Also given are x and y UTM coordinates for each plot. UTM Zone 14 North, Datum 1983 (Conus) (continued).

Plot I.D.	Habitat Type	X Coordinate (Easting)	Y Coordinate (Northing)
TAPRTweety258	Grassland	712221.250	4253809.000
TAPRTweety259	Grassland	715105.688	4253809.000
TAPRTweety260	Grassland	714551.000	4253698.000

Appendix 2. Number of individuals encountered per plot visit, over all plots sampled each year, for breeding bird species recorded at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys, by habitat type. Number of individuals per plot includes all individuals recorded on plots during a 5-min survey, including flyovers.

Common name	Individual / plot visit						
	Grassland						
	2001 n=158	2002 n=242	2004 n=81	2005 n=79	2006 n=81	2007 n=71	2008 n=77
Acadian flycatcher	0.00	0.01	0.00	0.00	0.00	0.00	0.00
American crow	0.00	0.08	0.07	0.06	0.10	0.04	0.00
American goldfinch	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Bank swallow	<0.01	0.06	0.09	0.08	0.02	0.00	0.09
Barn swallow	0.05	0.03	0.25	0.11	0.23	0.01	0.01
Bewick's wren	0.00	0.01	0.01	0.01	0.00	0.01	0.01
Black-billed cuckoo	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Black-capped chickadee	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Blue-gray gnatcatcher	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Blue jay	0.03	0.06	0.02	0.05	0.09	0.07	0.00
Brown-headed cowbird	0.65	1.14	0.90	0.97	0.89	0.83	0.74
Brown thrasher	0.02	0.06	0.10	0.03	0.07	0.03	0.03
Canada goose	0.00	0.07	0.21	0.01	0.10	0.03	0.03
Carolina wren	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Cattle egret	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Cliff swallow	0.14	0.01	0.00	0.00	0.00	0.01	0.00
Common grackle	0.01	<0.01	0.01	0.01	0.02	0.00	0.00
Common nighthawk	0.16	0.25	0.05	0.47	0.15	0.23	0.09
Common yellowthroat	0.00	<0.01	0.00	0.00	0.00	0.00	0.00
Dickcissel	0.71	0.82	0.69	0.86	1.48	1.01	1.61
Downy woodpecker	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Eastern bluebird	0.01	0.00	0.00	0.04	0.00	0.01	0.05
Eastern kingbird	0.02	0.05	0.07	0.09	0.15	0.14	0.01
Eastern meadowlark	0.26	0.02	0.01	0.00	0.00	0.03	0.64
Eastern phoebe	0.00	<0.01	0.02	0.00	0.00	0.00	0.00
Eastern wood-pewee	0.00	0.01	0.00	0.01	0.00	0.00	0.01
Field sparrow	0.00	<0.01	0.00	0.00	0.00	0.00	0.00
Grasshopper sparrow	1.04	0.86	1.05	1.03	0.95	1.15	1.23
Great blue heron	0.01	0.01	0.04	0.04	0.04	0.03	0.03
Great crested flycatcher	0.00	0.03	0.15	0.06	0.04	0.07	0.04
Great horned owl	0.00	<0.01	0.00	0.00	0.00	0.00	0.00
Great-tailed grackle	0.01	0.00	0.02	0.01	0.00	0.00	0.00
Greater prairie-chicken	0.03	0.04	0.01	0.00	0.01	0.00	0.01
Hairy woodpecker	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Henslow's sparrow	0.00	0.00	0.00	0.00	0.02	0.01	0.18
Horned lark	0.02	0.00	0.38	0.11	0.12	0.06	0.00
Indigo bunting	0.00	<0.01	0.00	0.00	0.00	0.00	0.00
Killdeer	0.08	0.13	0.20	0.33	0.25	0.17	0.10

Appendix 2. Number of individuals encountered per plot visit, over all plots sampled each year, for breeding bird species recorded at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys, by habitat type. Number of individuals per plot includes all individuals recorded on plots during a 5-min survey, including flyovers (continued).

Common name	Individuals / plot visit						
	Grassland						
	2001 n=158	2002 n=242	2004 n=81	2005 n=79	2006 n=81	2007 n=71	2008 n=77
Lark sparrow	0.02	0.10	0.11	0.09	0.02	0.14	0.09
Loggerhead shrike	0.00	<0.01	0.00	0.00	0.00	0.00	0.00
Mourning dove	0.10	0.07	0.01	0.01	0.02	0.08	0.10
Northern bobwhite	0.00	0.04	0.05	0.10	0.20	0.08	0.08
Northern cardinal	0.00	0.05	0.01	0.03	0.01	0.03	0.00
Northern (Yellow-shafted) flicker	0.00	<0.01	0.01	0.00	0.00	0.00	0.00
Northern harrier	0.00	0.00	0.00	0.01	0.00	0.01	0.00
Northern mockingbird	0.00	0.00	0.00	0.03	0.01	0.01	0.00
Northern (Baltimore) oriole	0.00	0.00	0.00	0.04	0.02	0.08	0.06
Northern rough-winged swallow	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Orchard oriole	0.01	0.01	0.00	0.00	0.07	0.00	0.03
Pied-billed grebe	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Red-bellied woodpecker	0.01	0.4	0.02	0.03	0.00	0.01	0.00
Red-headed woodpecker	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Red-tailed hawk	0.00	0.00	0.01	0.01	0.00	0.01	0.00
Red-winged blackbird	0.17	0.35	0.48	0.41	0.33	0.48	0.14
Scissor-tailed flycatcher	0.00	0.01	0.05	0.03	0.06	0.07	0.00
(Eastern) Tufted titmouse	0.00	0.07	0.02	0.00	0.02	0.03	0.01
Turkey vulture	0.01	0.02	0.01	0.03	0.05	0.01	0.03
Upland sandpiper	0.41	1.10	1.10	0.76	0.73	0.54	0.56
Western kingbird	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Western meadowlark	0.26	1.06	1.58	1.97	1.60	1.18	0.78
White-breasted nuthatch	0.00	0.02	0.00	0.01	0.00	0.00	0.00
Wild turkey	0.00	<0.01	0.01	0.00	0.00	0.00	0.00
Yellow-billed cuckoo	0.00	0.04	0.02	0.00	0.00	0.00	0.00
Yellow-breasted chat	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Yellow-throated vireo	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Yellow warbler	0.13	0.00	0.00	0.00	0.00	0.00	0.00
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Acadian flycatcher	0.00	0.28	0.00	0.00	0.00	0.00	0.00
American crow	0.06	0.28	0.00	0.06	0.06	0.06	0.06
American goldfinch	0.22	0.00	0.00	0.00	0.00	0.00	0.00
American robin	0.00	0.00	0.06	0.00	0.00	0.00	0.00
Bank swallow	0.00	0.00	0.25	0.00	0.00	0.00	0.17
Barn swallow	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Barred owl	0.11	0.00	0.00	0.39	0.00	0.00	0.00

Appendix 2. Number of individuals encountered per plot visit, over all plots sampled each year, for breeding bird species recorded at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys, by habitat type. Number of individuals per plot includes all individuals recorded on plots during a 5-min survey, including flyovers (continued).

Common name	Individuals / plot visit						
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Belted kingfisher	0.06	0.00	0.06	0.06	0.00	0.06	0.06
Bewick's wren	0.11	0.11	0.06	0.06	0.00	0.11	0.17
Black-billed cuckoo	0.06	0.06	0.00	0.44	0.00	0.00	0.00
Black-capped chickadee	0.11	0.67	0.25	0.11	0.00	0.00	0.00
Blue-gray gnatcatcher	0.06	0.00	0.13	0.28	0.28	0.17	0.28
Blue grosbeak	0.00	0.00	0.19	0.00	0.00	0.00	0.06
Blue jay	0.17	0.17	0.19	0.33	0.17	0.17	0.11
Brown-headed cowbird	0.06	0.00	0.00	0.00	0.00	0.06	0.06
Brown thrasher	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Canada goose	0.00	0.00	0.00	0.00	0.00	0.11	0.00
Carolina Chickadee	0.00	0.00	0.00	0.00	0.00	0.00	0.17
Carolina wren	0.17	0.00	0.00	0.11	0.11	0.11	0.06
Cliff swallow	0.00	0.11	0.00	0.00	0.00	0.00	0.00
Common nighthawk	0.00	0.06	0.00	0.00	0.00	0.00	0.00
Common yellowthroat	0.00	0.28	0.00	0.00	0.00	0.00	0.06
Dickcissel	0.00	0.28	0.00	0.17	0.11	0.17	0.06
Downy woodpecker	0.11	0.22	0.00	0.00	0.00	0.00	0.06
Eastern bluebird	0.00	0.00	0.00	0.06	0.22	0.11	0.00
Eastern kingbird	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Eastern phoebe	0.00	0.11	0.19	0.06	0.06	0.06	0.06
Eastern wood-pewee	0.33	0.72	0.50	0.78	0.83	0.83	0.33
Gray catbird	0.06	0.00	0.00	0.06	0.00	0.00	0.00
Great blue heron	0.00	0.00	0.00	0.00	0.00	0.06	0.00
Great crested flycatcher	0.33	0.33	0.88	0.56	0.72	0.56	0.17
Great horned owl	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Hairy woodpecker	0.00	0.00	0.19	0.06	0.00	0.00	0.00
House wren	0.00	0.00	0.00	0.00	0.06	0.00	0.00
Indigo bunting	0.06	0.17	0.00	0.00	0.00	0.11	0.33
Lark sparrow	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Mourning dove	0.00	0.00	0.00	0.06	0.00	0.06	0.22
Northern cardinal	0.17	0.44	0.25	0.28	0.22	0.33	0.28
Northern (Yellow-shafted) flicker	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Northern mockingbird	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Northern (Baltimore) oriole	0.00	0.00	0.00	0.39	0.39	0.00	0.06
Orchard oriole	0.06	0.11	0.06	0.00	0.06	0.00	0.00
Prothonotary warbler	0.11	0.00	0.00	0.00	0.00	0.00	0.00
Red-bellied woodpecker	0.17	0.39	0.25	0.22	0.39	0.17	0.28
Red-eyed vireo	0.00	0.28	0.19	0.17	0.33	0.22	0.11

Appendix 2. Number of individuals encountered per plot visit, over all plots sampled each year, for breeding bird species recorded at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys, by habitat type. Number of individuals per plot includes all individuals recorded on plots during a 5-min survey, including flyovers (continued).

Common name	Individuals / plot visit						
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Red-headed woodpecker	0.00	0.06	0.19	0.00	0.00	0.00	0.00
Red-tailed hawk	0.00	0.00	0.06	0.00	0.06	0.00	0.00
Red-winged blackbird	0.00	0.17	0.06	0.00	0.00	0.06	0.00
Ruby-throated hummingbird	0.00	0.00	0.00	0.06	0.00	0.00	0.00
(Eastern) Tufted titmouse	0.11	0.56	0.50	0.17	0.39	0.39	0.11
Turkey vulture	0.00	0.00	0.06	0.00	0.00	0.00	0.00
Western meadowlark	0.00	0.11	0.31	0.00	0.11	0.00	0.00
White-breasted nuthatch	0.00	0.44	0.13	0.17	0.28	0.22	0.11
White-eyed vireo	0.17	0.00	0.00	0.00	0.00	0.00	0.00
Wild turkey	0.00	0.00	0.06	0.06	0.00	0.11	0.00
Yellow-billed cuckoo	0.11	0.33	0.81	0.00	0.00	0.06	0.22
Yellow-breasted chat	0.00	0.00	0.00	0.00	0.00	0.06	0.00
Yellow-throated vireo	0.06	0.06	0.13	0.17	0.00	0.06	0.17
Yellow warbler	0.22	0.00	0.25	0.11	0.33	0.0	0.06

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Appendix 3. Proportion of plots occupied annually by breeding bird species (including flyovers) at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys, by habitat type.

Common name	Proportion of plots occupied						
	Grassland						
	2001 n=158	2002 n=242	2004 n=81	2005 n=79	2006 n=81	2007 n=71	2008 n=77
Acadian flycatcher	0.00	0.01	0.00	0.00	0.00	0.00	0.00
American crow	0.00	0.06	0.06	0.01	0.05	0.04	0.00
American goldfinch	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Bank swallow	0.01	0.05	0.05	0.04	0.02	0.00	0.05
Barn swallow	0.04	0.02	0.10	0.10	0.12	0.01	0.01
Bewick's wren	0.00	0.01	0.01	0.01	0.00	0.01	0.01
Black-billed cuckoo	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Black-capped chickadee	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Blue-gray gnatcatcher	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Blue jay	0.01	0.04	0.02	0.05	0.06	0.06	0.00
Brown-headed cowbird	0.37	0.64	0.42	0.49	0.44	0.51	0.42
Brown thrasher	0.02	0.06	0.09	0.03	0.06	0.03	0.01
Canada goose	0.00	0.01	0.06	0.01	0.06	0.01	0.01
Carolina wren	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Cattle egret	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Cliff swallow	0.08	<0.01	0.00	0.00	0.00	0.01	0.00
Common grackle	0.01	<0.01	0.01	0.01	0.01	0.00	0.00
Common nighthawk	0.11	0.20	0.04	0.32	0.14	0.17	0.09
Common yellowthroat	0.00	<0.01	0.00	0.00	0.00	0.00	0.00
Dickcissel	0.38	0.61	0.35	0.46	0.58	0.54	0.83
Downy woodpecker	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Eastern bluebird	0.01	0.00	0.00	0.03	0.00	0.01	0.01
Eastern kingbird	0.02	0.05	0.06	0.05	0.09	0.10	0.01
Eastern meadowlark	0.18	0.02	0.01	0.00	0.00	0.01	0.43
Eastern phoebe	0.00	<0.01	0.02	0.00	0.00	0.00	0.00
Eastern wood-pewee	0.00	0.01	0.00	0.01	0.00	0.00	0.01
Field sparrow	0.00	<0.01	0.00	0.00	0.00	0.00	0.00
Grasshopper sparrow	0.66	0.73	0.73	0.70	0.64	0.68	0.77
Great blue heron	0.01	<0.01	0.01	0.04	0.04	0.01	0.03
Great crested flycatcher	0.00	0.03	0.14	0.06	0.04	0.07	0.04
Great horned owl	0.00	<0.01	0.00	0.00	0.00	0.00	0.00
Great-tailed grackle	0.01	0.00	0.01	0.01	0.00	0.00	0.00
Greater prairie-chicken	0.01	0.02	0.01	0.00	0.01	0.00	0.01
Hairy woodpecker	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Henslow's sparrow	0.00	0.00	0.00	0.00	0.01	0.01	0.09
Horned lark	0.02	0.00	0.28	0.11	0.12	0.06	0.00
Indigo bunting	0.00	<0.01	0.00	0.00	0.00	0.00	0.00
Killdeer	0.06	0.11	0.17	0.25	0.23	0.11	0.09

Appendix 3. Proportion of plots occupied annually by breeding bird species (including flyovers) at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys, by habitat type (continued).

Common name	Proportion of plots occupied						
	Grassland						
	2001 n=158	2002 n=242	2004 n=81	2005 n=79	2006 n=81	2007 n=71	2008 n=77
Lark sparrow	0.01	0.07	0.04	0.08	0.02	0.11	0.08
Loggerhead shrike	0.00	<0.01	0.00	0.00	0.00	0.00	0.00
Mourning dove	0.07	0.06	0.01	0.01	0.02	0.04	0.08
Northern bobwhite	0.00	0.04	0.05	0.10	0.14	0.08	0.05
Northern cardinal	0.00	0.05	0.01	0.03	0.01	0.03	0.00
Northern (Yellow-shafted) flicker	0.00	<0.01	0.01	0.00	0.00	0.00	0.00
Northern harrier	0.00	0.00	0.00	0.01	0.00	0.01	0.00
Northern mockingbird	0.00	0.00	0.00	0.03	0.01	0.01	0.00
Northern (Baltimore) oriole	0.00	0.00	0.00	0.04	0.02	0.06	0.06
Northern rough-winged swallow	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Orchard oriole	0.01	0.01	0.00	0.00	0.06	0.00	0.01
Pied-billed grebe	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Red-bellied woodpecker	0.01	0.04	0.02	0.03	0.00	0.01	0.13
Red-headed woodpecker	0.00	0.00	0.00	0.03	0.04	0.00	0.00
Red-tailed hawk	0.00	0.00	0.01	0.01	0.00	0.01	0.00
Red-winged blackbird	0.06	0.22	0.26	0.20	0.25	0.20	0.00
Scissor-tailed flycatcher	0.00	0.01	0.04	0.03	0.05	0.04	0.00
(Eastern) Tufted titmouse	0.00	0.06	0.02	0.00	0.02	0.03	0.01
Turkey vulture	0.01	0.01	0.01	0.01	0.04	0.01	0.03
Upland sandpiper	0.27	0.72	0.75	0.57	0.60	0.46	0.40
Western kingbird	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Western meadowlark	0.23	0.90	0.88	0.85	0.89	0.83	0.42
White-breasted nuthatch	0.00	0.02	0.00	0.01	0.00	0.00	0.00
Wild turkey	0.00	<0.01	0.01	0.00	0.00	0.00	0.00
Yellow-billed cuckoo	0.00	0.04	0.02	0.00	0.00	0.00	0.00
Yellow-breasted chat	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Yellow-throated vireo	0.00	<0.01	0.01	0.00	0.00	0.00	0.00
Yellow warbler	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Acadian flycatcher	0.00	0.28	0.00	0.00	0.00	0.00	0.00
American crow	0.06	0.22	0.00	0.06	0.06	0.06	0.06
American goldfinch	0.06	0.00	0.00	0.00	0.00	0.00	0.00
American robin	0.00	0.00	0.06	0.00	0.00	0.00	0.00
Bank swallow	0.00	0.00	0.06	0.00	0.00	0.00	0.06
Barn swallow	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Barred owl	0.06	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 3. Proportion of plots occupied annually by breeding bird species (including flyovers) at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys, by habitat type (continued).

Common name	Proportion of plots occupied						
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Belted kingfisher	0.06	0.00	0.06	0.06	0.00	0.06	0.06
Bewick's wren	0.11	0.11	0.06	0.06	0.00	0.11	0.06
Black-billed cuckoo	0.06	0.06	0.00	0.33	0.00	0.00	0.00
Black-capped chickadee	0.06	0.33	0.25	0.11	0.00	0.00	0.00
Blue-gray gnatcatcher	0.06	0.00	0.13	0.28	0.22	0.17	0.28
Blue grosbeak	0.00	0.00	0.13	0.00	0.00	0.00	0.06
Blue jay	0.11	0.11	0.13	0.33	0.17	0.11	0.11
Brown-headed cowbird	0.06	0.00	0.00	0.00	0.00	0.06	0.06
Brown thrasher	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Canada goose	0.00	0.00	0.00	0.00	0.00	0.06	0.00
Carolina Chickadee	0.00	0.00	0.00	0.00	0.00	0.00	0.11
Carolina wren	0.17	0.00	0.00	0.11	0.11	0.11	0.06
Cliff swallow	0.00	0.06	0.00	0.00	0.00	0.00	0.00
Common nighthawk	0.00	0.06	0.00	0.00	0.00	0.00	0.00
Common yellowthroat	0.00	0.17	0.00	0.00	0.00	0.00	0.06
Dickcissel	0.00	0.17	0.00	0.11	0.11	0.17	0.06
Downy woodpecker	0.11	0.22	0.00	0.00	0.00	0.00	0.06
Eastern bluebird	0.00	0.00	0.00	0.06	0.11	0.06	0.00
Eastern kingbird	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Eastern phoebe	0.00	0.11	0.19	0.06	0.06	0.06	0.06
Eastern wood-pewee	0.33	0.56	0.44	0.72	0.78	0.72	0.22
Gray catbird	0.06	0.00	0.00	0.06	0.00	0.00	0.00
Great blue heron	0.00	0.00	0.00	0.00	0.00	0.06	0.00
Great crested flycatcher	0.22	0.22	0.75	0.56	0.61	0.44	0.17
Great horned owl	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Hairy woodpecker	0.00	0.00	0.19	0.06	0.06	0.00	0.00
House wren	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Indigo bunting	0.06	0.11	0.00	0.00	0.00	0.11	0.39
Lark sparrow	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Mourning dove	0.00	0.00	0.00	0.06	0.00	0.06	0.17
Northern cardinal	0.17	0.28	0.13	0.28	0.17	0.28	0.17
Northern (Yellow-shafted) flicker	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Northern mockingbird	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Northern (Baltimore) oriole	0.00	0.00	0.00	0.17	0.28	0.00	0.06
Orchard oriole	0.06	0.06	0.06	0.00	0.06	0.00	0.00
Prothonotary warbler	0.11	0.00	0.00	0.00	0.00	0.00	0.00
Red-bellied woodpecker	0.17	0.39	0.19	0.22	0.33	0.17	0.28
Red-eyed vireo	0.00	0.22	0.19	0.17	0.28	0.22	0.11

Appendix 3. Proportion of plots occupied annually by breeding bird species (including flyovers) at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys, by habitat type (continued).

Common name	Individuals / plot visit						
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Red-headed woodpecker	0.00	0.06	0.13	0.00	0.00	0.00	0.00
Red-tailed hawk	0.00	0.00	0.06	0.00	0.06	0.00	0.00
Red-winged blackbird	0.00	0.06	0.06	0.00	0.00	0.06	0.00
Ruby-throated hummingbird	0.00	0.00	0.00	0.06	0.00	0.00	0.00
(Eastern) Tufted titmouse	0.06	0.44	0.44	0.17	0.39	0.39	0.11
Turkey vulture	0.00	0.00	0.06	0.00	0.00	0.00	0.00
Western meadowlark	0.00	0.11	0.19	0.00	0.06	0.00	0.00
White-breasted nuthatch	0.00	0.39	0.06	0.17	0.28	0.17	0.11
White-eyed vireo	0.17	0.00	0.00	0.00	0.00	0.00	0.00
Wild turkey	0.00	0.00	0.06	0.06	0.00	0.11	0.00
Yellow-billed cuckoo	0.11	0.28	0.50	0.00	0.00	0.00	0.22
Yellow-breasted chat	0.00	0.00	0.00	0.00	0.00	0.06	0.00
Yellow-throated vireo	0.06	0.06	0.13	0.17	0.00	0.06	0.17
Yellow warbler	0.17	0.00	0.25	0.11	0.22	0.00	0.06

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Appendix 4. Average density (\pm std. dev.) by habitat of breeding bird species at Tallgrass Prairie National Preserve, Kansas, during the 2001–2008 (excluding 2003) breeding bird surveys. Species densities are only for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers. Some species were excluded from this the tables as they did not have individuals recorded within 100-m of plot center.

Common name	Individuals / ha						
	Grassland						
	2001 n=158	2002 n=242	2004 n=81	2005 n=79	2006 n=81	2007 n=71	2008 n=77
American goldfinch	0.00	<0.01 (0.04)	0.00	0.00	0.00	0.00	0.00
Bewick's wren	0.00	<0.01 (0.04)	<0.01 (0.04)	<0.01 (0.04)	0.00	0.00	<0.01 (0.04)
Black-capped chickadee	0.00	<0.01 (0.04)	0.01 (0.04)	0.00	0.00	0.00	0.00
Blue-gray gnatcatcher	<0.01 (0.03)	0.00	0.00	0.00	0.00	0.00	0.00
Blue jay	0.00	0.00	<0.01 (0.04)	0.00	0.00	0.00	0.00
Brown-headed cowbird*	0.07 (0.25)	0.09 (0.25)	0.04 (0.16)	0.02 (0.08)	0.06 (0.15)	0.09 (0.24)	0.09 (0.23)
Brown thrasher	0.01 (0.04)	0.01 (0.05)	0.01 (0.05)	<0.01 (0.04)	0.02 (0.09)	0.00	0.01 (0.07)
Common grackle	0.00	0.00	<0.01 (0.04)	0.00	0.00	0.00	0.00
Common nighthawk	0.01 (0.04)	<0.01 (0.03)	0.00	0.00	0.00	0.00	<0.01 (0.04)
Dickcissel*	0.20 (0.31)	0.16 (0.33)	0.13 (0.25)	0.11 (0.22)	0.25 (0.38)	0.17 (0.29)	0.37 (0.38)
Eastern bluebird	<0.01 (0.03)	0.00	0.00	0.00	0.00	0.00	0.02 (0.14)
Eastern kingbird	<0.01 (0.03)	0.01 (0.08)	0.01 (0.06)	0.02 (0.11)	0.02 (0.11)	0.03 (0.12)	<0.01 (0.04)
Eastern meadowlark	0.07 (0.12)	0.00	<0.01 (0.04)	0.00	0.00	0.00	0.11 (0.20)
Eastern phoebe	0.00	<0.01 (0.03)	0.00	0.00	0.00	0.00	0.00
Eastern wood-pewee	0.00	0.00	0.00	0.00	0.00	0.00	<0.01 (0.04)
Field sparrow	0.00	<0.01 (0.02)	0.00	0.00	0.00	0.00	0.00
Grasshopper sparrow	0.32 (0.31)	0.27 (0.28)	0.33 (0.26)	0.33 (0.25)	0.29 (0.27)	0.37 (0.35)	0.38 (0.30)
Great crested flycatcher	0.00	<0.01 (0.03)	0.02 (0.09)	<0.01 (0.04)	<0.01 (0.04)	0.00	<0.01 (0.04)
Greater prairie-chicken	0.01 (0.06)	0.01 (0.07)	0.00	0.00	0.00	0.00	<0.01 (0.04)
Hairy woodpecker	<0.01 (0.03)	0.00	0.00	0.00	0.00	0.00	0.00
Henslow's sparrow	0.00	0.00	0.00	0.00	0.01 (0.07)	<0.01 (0.04)	0.05 (0.19)
Horned lark	0.01 (0.04)	0.00	0.08 (0.19)	0.04 (0.10)	0.04 (0.10)	0.01 (0.05)	0.00
Killdeer	<0.01 (0.04)	0.01 (0.07)	0.02 (0.10)	0.04 (0.12)	0.02 (0.10)	0.02 (0.09)	<0.01 (0.04)
Lark sparrow	<0.01 (0.03)	0.03 (0.11)	0.03 (0.14)	0.02 (0.07)	<0.01 (0.04)	0.03 (0.12)	0.02 (0.07)
Mourning dove	<0.01 (0.03)	0.01 (0.05)	0.00	0.00	0.00	0.01 (0.08)	0.01 (0.07)
Northern cardinal	0.00	<0.01 (0.04)	0.00	0.00	<0.01 (0.04)	<0.01 (0.04)	0.00

Appendix 4. Average density (\pm std. dev.) by habitat of breeding bird species at Tallgrass Prairie National Preserve, Kansas, during the 2001–2008 (excluding 2003) breeding bird surveys. Species densities are only for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers. Some species were excluded from this the tables as they did not have individuals recorded within 100-m of plot center (continued).

Common name	Individuals / ha						
	Grassland						
	2001 n=158	2002 n=242	2004 n=81	2005 n=79	2006 n=81	2007 n=71	2008 n=77
Northern mockingbird	0.00	0.00	0.00	0.00	0.00	<0.01 (0.04)	0.00
Northern (Baltimore) oriole	0.00	0.00	0.00	<0.01 (0.04)	0.00	0.02 (0.12)	0.02 (0.07)
Orchard oriole	<0.01 (0.03)	<0.01 (0.02)	0.00	0.00	0.02 (0.07)	0.00	0.00
Red-bellied woodpecker	<0.01 (0.03)	<0.01 (0.03)	0.00	0.00	0.00	0.00	0.00
Red-headed woodpecker	0.00	0.00	0.00	0.01 (0.07)	<0.01 (0.04)	0.00	0.00
Red-winged blackbird	0.04 (0.26)	0.05 (0.28)	0.04 (0.11)	0.03 (0.11)	0.04 (0.15)	0.05 (0.18)	0.01 (0.08)
Scissor-tailed flycatcher	0.00	0.00	0.02 (0.09)	<0.01 (0.04)	<0.01 (0.04)	0.02 (0.11)	0.00
(Eastern) Tufted titmouse	0.00	0.00	<0.01 (0.04)	0.00	0.00	0.00	0.00
Upland sandpiper	0.05 (0.16)	0.03 (0.10)	<0.01 (0.04)	0.00	<0.01 (0.04)	0.02 (0.07)	0.02 (0.09)
Western kingbird	<0.01 (0.03)	0.00	0.00	0.00	0.00	0.00	0.00
Western meadowlark	0.08 (0.15)	0.13 (0.21)	0.18 (0.23)	0.23 (0.31)	0.20 (0.24)	0.15 (0.22)	0.13 (0.25)
White-breasted nuthatch	0.00	<0.01 (0.02)	0.00	0.00	0.00	0.00	0.00
Yellow-billed cuckoo	0.00	<0.01 (0.02)	0.00	0.00	0.00	0.00	0.00
Yellow-breasted chat	0.00	<0.01 (0.05)	0.00	0.00	0.00	0.00	0.00
Yellow-throated vireo	0.00	<0.01 (0.02)	0.00	0.00	0.00	0.00	0.00
Yellow warbler	<0.01 (0.04)	0.00	0.00	0.00	0.00	0.00	0.00
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Acadian flycatcher	0.00	0.02 (0.08)	0.00	0.00	0.00	0.00	0.00
American goldfinch	0.02 (0.08)	0.00	0.00	0.00	0.00	0.00	0.00
Bank swallow	0.00	0.00	0.00	0.00	0.00	0.00	0.05 (0.23)
Barred owl	0.04 (0.15)	0.00	0.00	0.00	0.00	0.00	0.00
Belted kingfisher	0.00	0.00	0.02 (0.08)	0.00	0.00	0.00	0.02 (0.08)
Bewick's wren	0.04 (0.10)	0.02 (0.08)	0.02 (0.08)	0.02 (0.08)	0.00	0.04 (0.10)	0.05 (0.23)

Appendix 4. Average density (\pm std. dev.) by habitat of breeding bird species at Tallgrass Prairie National Preserve, Kansas, during the 2001–2008 (excluding 2003) breeding bird surveys. Species densities are for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers (continued).

Common name	Individuals / ha						
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Black-billed cuckoo	0.00	0.02 (0.08)	0.00	0.04 (0.10)	0.00	0.00	0.00
Black-capped chickadee	0.04 (0.15)	0.14 (0.33)	0.08 (0.14)	0.04 (0.10)	0.00	0.00	0.00
Blue-gray gnatcatcher	0.02 (0.08)	0.00	0.04 (0.11)	0.09 (0.15)	0.07 (0.14)	0.05 (0.12)	0.09 (0.15)
Blue grosbeak	0.00	0.00	0.06 (0.17)	0.00	0.00	0.00	0.02 (0.08)
Blue jay	0.02 (0.08)	0.00	0.06 (0.17)	0.05 (0.12)	0.02 (0.08)	0.02 (0.08)	0.00
Brown-headed cowbird	0.02 (0.08)	0.00	0.00	0.00	0.00	0.00	0.02 (0.08)
Brown thrasher	0.02 (0.08)	0.00	0.00	0.00	0.00	0.00	0.00
Carolina Chickadee	0.00	0.00	0.00	0.00	0.00	0.00	0.05 (0.16)
Carolina wren	0.05 (0.12)	0.00	0.00	0.04 (0.10)	0.04 (0.10)	0.04 (0.10)	0.02 (0.08)
Common yellowthroat	0.00	0.07 (0.17)	0.00	0.00	0.00	0.00	0.02 (0.08)
Dickcissel	0.00	0.07 (0.17)	0.00	0.04 (0.15)	0.00	0.02 (0.08)	0.02 (0.08)
Downy woodpecker	0.04 (0.10)	0.02 (0.08)	0.00	0.00	0.00	0.00	0.02 (0.08)
Eastern bluebird	0.00	0.00	0.00	0.02 (0.08)	0.07 (0.23)	0.04 (0.15)	0.00
Eastern kingbird	0.00	0.00	0.00	0.00	0.00	0.00	0.02 (0.08)
Eastern phoebe	0.00	0.02 (0.08)	0.04 (0.11)	0.00	0.00	0.02 (0.08)	0.02 (0.08)
Eastern wood-pewee	0.09 (0.15)	0.11 (0.19)	0.12 (0.16)	0.19 (0.19)	0.19 (0.19)	0.21 (0.19)	0.11 (0.22)
Gray catbird	0.02 (0.08)	0.00	0.00	0.02 (0.08)	0.00	0.00	0.00
Great crested flycatcher	0.11 (0.22)	0.05 (0.23)	0.26 (0.21)	0.14 (0.16)	0.14 (0.20)	0.14 (0.22)	0.05 (0.12)
Hairy woodpecker	0.00	0.00	0.06 (0.13)	0.02 (0.08)	0.00	0.00	0.00
House wren	0.00	0.00	0.00	0.00	0.02 (0.08)	0.00	0.00
Indigo bunting	0.02 (0.08)	0.05 (0.16)	0.00	0.00	0.00	0.04 (0.10)	0.14 (0.22)
Lark sparrow	0.00	0.00	0.00	0.00	0.00	0.00	0.02 (0.08)
Mourning dove	0.00	0.00	0.00	0.00	0.00	0.00	0.07 (0.18)
Northern cardinal	0.04 (0.10)	0.07 (0.23)	0.08 (0.25)	0.05 (0.12)	0.04 (0.10)	0.09 (0.18)	0.05 (0.16)
Northern (Yellow-shafted) flicker	0.00	0.00	0.00	0.02 (0.08)	0.00	0.00	0.00
Northern mockingbird	0.02 (0.08)	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 4. Average density (\pm std. dev.) by habitat of breeding bird species at Tallgrass Prairie National Preserve, Kansas, during the 2001–2008 (excluding 2003) breeding bird surveys. Species densities are only for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers. Some species were excluded from this the tables as they did not have individuals recorded within 100-m of plot center (continued).

Common name	Individuals / ha						
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Northern (Baltimore) oriole	0.00	0.00	0.00	0.09 (0.31)	0.09 (0.18)	0.00	0.02 (0.08)
Orchard oriole	0.02 (0.08)	0.04 (0.15)	0.02 (0.08)	0.00	0.02 (0.08)	0.00	0.00
Prothonotary warbler	0.04 (0.10)	0.00	0.00	0.00	0.00	0.00	0.00
Red-bellied woodpecker	0.04 (0.10)	0.04 (0.10)	0.08 (0.18)	0.05 (0.12)	0.11 (0.19)	0.04 (0.10)	0.04 (0.10)
Red-eyed vireo	0.00	0.09 (0.18)	0.06 (0.13)	0.05 (0.12)	0.11 (0.19)	0.07 (0.14)	0.04 (0.10)
Red-headed woodpecker	0.00	0.00	0.06 (0.17)	0.00	0.00	0.00	0.00
Red-tailed hawk	0.00	0.00	0.00	0.00	0.02 (0.08)	0.00	0.00
Red-winged blackbird	0.00	0.04 (0.15)	0.00	0.00	0.00	0.00	0.00
(Eastern) Tufted titmouse	0.04 (0.15)	0.05 (0.16)	0.10 (0.19)	0.04 (0.10)	0.12 (0.16)	0.12 (0.16)	0.02 (0.08)
Western meadowlark	0.00	0.00	0.04 (0.16)	0.00	0.02 (0.08)	0.00	0.00
White-breasted nuthatch	0.00	0.07 (0.14)	0.04 (0.16)	0.04 (0.10)	0.09 (0.15)	0.07 (0.17)	0.04 (0.10)
White-eyed vireo	0.05 (0.12)	0.00	0.00	0.00	0.00	0.00	0.00
Wild turkey	0.00	0.00	0.00	0.00	0.00	0.02 (0.08)	0.00
Yellow-billed cuckoo	0.02 (0.08)	0.00	0.14 (0.26)	0.00	0.00	0.00	0.07 (0.14)
Yellow-throated vireo	0.02 (0.08)	0.00	0.02 (0.08)	0.05 (0.12)	0.00	0.02 (0.08)	0.05 (0.12)
Yellow warbler	0.08 (0.17)	0.00	0.06 (0.12)	0.04 (0.10)	0.11 (0.22)	0.00	0.02 (0.08)

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Appendix 5. Average bird density (\pm std. dev.) by habitat type for plots occupied by breeding species at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys. Species densities are only for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers. Some species were excluded from this the tables as they did not have individuals recorded within 100-m of plot center. A standard deviation of 0.00, indicate the species occurred on two or more plots with equal density. When a species occurs on only one plot, standard deviation could not be calculated.

Common name	Individuals / ha						
	Grassland						
	2001 n=158	2002 n=242	2004 n=81	2005 n=79	2006 n=81	2007 n=71	2008 n=77
American goldfinch	0.00	0.32 (0.00)	0.00	0.00	0.00	0.00	0.00
Bewick's wren	0.00	0.32 (0.00)	0.32	0.32	0.00	0.00	0.32
Black-capped chickadee	0.00	0.32 (0.00)	0.32	0.00	0.00	0.00	0.00
Blue-gray gnatcatcher	0.32	0.00	0.00	0.00	0.00	0.00	0.00
Blue jay	0.00	0.00	0.32	0.00	0.00	0.00	0.00
Brown-headed cowbird	0.45 (0.35)	0.45 (0.30)	0.41 (0.16)	0.32 (0.00)	0.32 (0.00)	0.45 (0.34)	0.42 (0.25)
Brown thrasher	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32	0.32 (0.00)	0.00	0.32 (0.00)
Common grackle	0.00	0.00	0.32	0.00	0.00	0.00	0.00
Common nighthawk	0.32 (0.00)	0.32 (0.00)	0.00	0.00	0.00	0.00	0.32
Dickcissel	0.33 (0.07)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)
Eastern bluebird	0.32	0.00	0.00	0.00	0.00	0.00	0.32 (0.00)
Eastern kingbird	0.32	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32
Eastern meadowlark	0.35 (0.16)	0.00	0.32	0.00	0.00	0.00	0.32 (0.00)
Eastern phoebe	0.00	0.32	0.00	0.00	0.00	0.00	0.00
Eastern wood-pewee	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Field sparrow	0.00	0.31	0.00	0.00	0.00	0.00	0.00
Grasshopper sparrow	0.32 (0.04)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.33 (0.10)	0.32 (0.00)
Great crested flycatcher	0.00	0.32 (0.00)	0.32 (0.00)	0.32	0.32	0.00	0.32
Greater prairie-chicken	0.45 (0.23)	0.80 (0.23)	0.00	0.00	0.00	0.00	0.32
Hairy woodpecker	0.32	0.00	0.00	0.00	0.00	0.00	0.00
Henslow's sparrow	0.00	0.00	0.00	0.00	0.32 (0.00)	0.32	0.32 (0.00)
Horned lark	0.32 (0.00)	0.00	0.34 (0.07)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.00
Killdeer	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32
Lark sparrow	0.32	0.37 (0.16)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)

Appendix 5. Average bird density (\pm std. dev.) by habitat type for plots occupied by breeding species at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys. Species densities are only for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers. Some species were excluded from this the tables as they did not have individuals recorded within 100-m of plot center. A standard deviation of 0.00, indicate the species occurred on two or more plots with equal density. When a species occurs on only one plot, standard deviation could not be calculated (continued).

Common name	Individuals / ha						
	Grassland						
	2001 n=158	2002 n=242	2004 n=81	2005 n=79	2006 n=81	2007 n=71	2008 n=77
Mourning dove	0.32	0.42 (0.18)	0.00	0.00	0.00	0.32 (0.00)	0.32 (0.00)
Northern cardinal	0.00	0.32 (0.00)	0.00	0.00	0.32	0.32	0.00
Northern mockingbird	0.00	0.00	0.00	0.00	0.00	0.32	0.00
Northern (Baltimore) oriole	0.00	0.00	0.00	0.32	0.00	0.32 (0.00)	0.32 (0.00)
Orchard oriole	0.32	0.32	0.00	0.00	0.32 (0.00)	0.00	0.00
Red-bellied woodpecker	0.32	0.32 (0.00)	0.00	0.00	0.00	0.00	0.00
Red-headed woodpecker	0.00	0.00	0.00	0.32 (0.00)	0.32	0.00	0.00
Red-winged blackbird	0.35 (0.07)	0.40 (0.35)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)
Scissor-tailed flycatcher	0.00	0.00	0.32 (0.00)	0.32	0.32	0.32 (0.00)	0.00
(Eastern) Tufted titmouse	0.00	0.00	0.32	0.00	0.00	0.00	0.00
Upland sandpiper	0.32 (0.00)	0.33 (0.07)	0.32	0.00	0.32	0.32 (0.00)	0.32 (0.00)
Western kingbird	0.32	0.00	0.00	0.00	0.00	0.00	0.00
Western meadowlark	0.33 (0.05)	0.33 (0.07)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)
White-breasted nuthatch	0.00	0.32	0.00	0.00	0.00	0.00	0.00
Yellow-billed cuckoo	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yellow-breasted chat	0.00	0.32 (0.00)	0.00	0.00	0.00	0.00	0.00
Yellow-throated vireo	0.00	0.32	0.00	0.00	0.00	0.00	0.00
Yellow warbler	0.32 (0.00)	0.00	0.00	0.00	0.00	0.00	0.00
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Acadian flycatcher	0.00	0.32	0.00	0.00	0.00	0.00	0.00
American goldfinch	0.32	0.00	0.00	0.00	0.00	0.00	0.00
Bank swallow	0.00	0.00	0.00	0.00	0.00	0.00	0.96

Appendix 5. Average bird density (\pm std. dev.) by habitat type for plots occupied by breeding species at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys. Species densities are only for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers. Some species were excluded from this the tables as they did not have individuals recorded within 100-m of plot center. A standard deviation of 0.00, indicate the species occurred on two or more plots with equal density. When a species occurs on only one plot, standard deviation could not be calculated (continued).

Common name	Individuals / ha						
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Barred owl	0.64	0.00	0.00	0.00	0.00	0.00	0.00
Belted kingfisher	0.00	0.00	0.32	0.00	0.00	0.00	0.32
Bewick's wren	0.32 (0.00)	0.32 (0.32)	0.32	0.32	0.00	0.32 (0.00)	0.96
Black-billed cuckoo	0.00	0.32	0.00	0.32 (0.00)	0.00	0.00	0.00
Black-capped chickadee	0.64	0.85 (0.18)	0.32 (0.00)	0.32 (0.00)	0.00	0.00	0.00
Blue-gray gnatcatcher	0.32	0.00	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)
Blue grosbeak	0.00	0.00	0.48 (0.23)	0.00	0.00	0.00	0.32
Blue jay	0.32	0.00	0.48 (0.23)	0.32 (0.00)	0.32	0.32	0.00
Brown-headed cowbird	0.32	0.00	0.00	0.00	0.00	0.00	0.32
Brown thrasher	0.32	0.00	0.00	0.00	0.00	0.00	0.00
Carolina Chickadee	0.00	0.00	0.00	0.00	0.00	0.00	0.48 (0.23)
Carolina wren	0.32 (0.00)	0.00	0.00	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32
Common yellowthroat	0.00	0.42 (0.18)	0.00	0.00	0.00	0.00	0.32
Dickcissel	0.00	0.42 (0.18)	0.00	0.64	0.00	0.32	0.32
Downy woodpecker	0.32 (0.00)	0.32	0.00	0.00	0.00	0.00	0.32
Eastern bluebird	0.00	0.00	0.00	0.32	0.64 (0.45)	0.64	0.00
Eastern kingbird	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Eastern phoebe	0.00	0.32	0.32 (0.00)	0.00	0.00	0.32	0.32
Eastern wood-pewee	0.32 (0.00)	0.38 (0.14)	0.32 (0.00)	0.35 (0.10)	0.35 (0.10)	0.35 (0.10)	0.48 (0.18)
Gray catbird	0.32	0.00	0.00	0.32	0.00	0.00	0.00
Great crested flycatcher	0.48 (0.19)	0.96	0.38 (0.13)	0.32 (0.00)	0.36 (0.12)	0.42 (0.16)	0.32 (0.00)
Hairy woodpecker	0.00	0.00	0.32 (0.00)	0.32	0.32	0.00	0.00
House wren	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Indigo bunting	0.32	0.48 (0.23)	0.00	0.00	0.00	0.32 (0.00)	0.42 (0.16)

Appendix 5. Average bird density (\pm std. dev.) by habitat type for plots occupied by breeding species at Tallgrass Prairie National Preserve, Kansas during the 2001-2008 (excluding 2003) breeding bird surveys. Species densities are only for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers. Some species were excluded from this the tables as they did not have individuals recorded within 100-m of plot center. A standard deviation of 0.00, indicate the species occurred on two or more plots with equal density. When a species occurs on only one plot, standard deviation could not be calculated (continued).

Common name	Individuals / ha						
	Riparian						
	2001 n=18	2002 n=18	2004 n=16	2005 n=18	2006 n=18	2007 n=18	2008 n=18
Northern cardinal	0.32 (0.00)	0.64 (0.45)	0.64 (0.45)	0.32 (0.00)	0.32 (0.00)	0.40 (0.16)	0.48
Lark sparrow	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Mourning dove	0.00	0.00	0.00	0.00	0.00	0.00	0.42 (0.18)
Northern (Yellow-shafted) flicker	0.00	0.00	0.00	0.32	0.00	0.00	0.00
Northern mockingbird	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Northern (Baltimore) oriole	0.00	0.00	0.00	0.80 (0.68)	0.40 (0.16)	0.00	0.32
Orchard oriole	0.32	0.64	0.32	0.00	0.32	0.00	0.00
Prothonotary warbler	0.32 (0.00)	0.00	0.00	0.00	0.00	0.00	0.00
Red-bellied woodpecker	0.32 (0.00)	0.32 (0.00)	0.42 (0.18)	0.32 (0.00)	0.38 (0.14)	0.32 (0.00)	0.32 (0.00)
Red-eyed vireo	0.00	0.40 (0.16)	0.32 (0.00)	0.32 (0.00)	0.38 (0.14)	0.32 (0.00)	0.32 (0.00)
Red-headed woodpecker	0.00	0.00	0.48 (0.23)	0.00	0.00	0.00	0.00
Red-tailed hawk	0.00	0.00	0.00	0.00	0.32	0.00	0.00
Red-winged blackbird	0.00	0.64	0.00	0.00	0.00	0.00	0.00
(Eastern) Tufted titmouse	0.64	0.48 (0.23)	0.40 (0.16)	0.32 (0.00)	0.32 (0.00)	0.32 (0.00)	0.32
Western meadowlark	0.00	0.00	0.64	0.00	0.32	0.00	0.00
White-breasted nuthatch	0.00	0.32 (0.00)	0.64	0.32 (0.00)	0.32 (0.00)	0.42 (0.18)	0.32 (0.00)
White-eyed vireo	0.32 (0.00)	0.00	0.00	0.00	0.00	0.00	0.00
Wild turkey	0.00	0.00	0.00	0.00	0.00	0.32	0.00
Yellow-billed cuckoo	0.32	0.00	0.56 (0.16)	0.00	0.00	0.00	0.32 (0.00)
Yellow-throated vireo	0.32	0.00	0.32	0.32 (0.00)	0.00	0.32	0.32 (0.00)
Yellow warbler	0.42 (0.18)	0.00	0.32 (0.00)	0.32 (0.00)	0.48 (0.18)	0.00	0.32

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Appendix 6. Abiotic features of 50-m radius plots sampled for breeding birds at Tallgrass Prairie National Preserve, Kansas.

Plot number	Slope (°)	Slope variability	Aspect (°)	Aspect variability	Topographic position	Habitat type
TAPRTweety1	2	medium	226	medium	upper-slope	Grassland
TAPRTweety2	8	medium	318	medium	lower-slope	Grassland
TAPRTweety3	4	medium	33	low	upper-slope	Grassland
TAPRTweety4	9	low	105	low	upper-slope	Grassland
TAPRTweety5	6	high	100	high	draw	Grassland
TAPRTweety6	6	medium	351	low	upper-slope	Grassland
TAPRTweety7	3	medium	96	medium	mid-slope	Grassland
TAPRTweety8	4	low	279	low	upper-slope	Grassland
TAPRTweety9	4	low	95	low	upper-slope	Grassland
TAPRTweety10	3	low	245	low	upper-slope	Grassland
TAPRTweety11	5	low	150	low	upper-slope	Grassland
TAPRTweety12	4		50	--	crest	Grassland
TAPRTweety13	1	low	354	low	upper-slope	Grassland
TAPRTweety14	8	low	343	low	mid-slope	Grassland
TAPRTweety15	5	high	42	high	mid-slope	Grassland
TAPRTweety16	7	medium	171	medium	upper-slope	Grassland
TAPRTweety17	0	low	251	medium	upper-slope	Grassland
TAPRTweety18	9	high	8	high	upper-slope	Grassland
TAPRTweety19	6	medium	360	low	--	Grassland
TAPRTweety20	5	medium	322	high	draw	Grassland
TAPRTweety21	1	low	98	low	upper-slope	Grassland
TAPRTweety22	2	low	90	low	upper-slope	Grassland
TAPRTweety23	2	high	127	high	draw	Grassland
TAPRTweety24	11	low	334	low	upper-slope	Grassland
TAPRTweety25	6	high	178	high	draw	Grassland
TAPRTweety26	3	medium	135	high	draw	Grassland
TAPRTweety27	8	low	213	low	upper-slope	Grassland
TAPRTweety28	5	low	69	low	upper-slope	Grassland
TAPRTweety29	2	high	93	high	draw	Grassland
TAPRTweety30	5	low	136	low	upper-slope	Grassland
TAPRTweety31	4	medium	236	medium	upper-slope	Grassland
TAPRTweety32	4	low	183	low	upper-slope	Grassland
TAPRTweety33	8	low	50	medium	upper-slope	Grassland
TAPRTweety34	2	low	200	low	upper-slope	Grassland
TAPRTweety35	3	low	227	low	draw	Grassland
TAPRTweety36	0	high	295	high	crest	Grassland
TAPRTweety37	4	high	22	high	draw	Grassland
TAPRTweety38	8	medium	322	medium	upper-slope	Grassland
TAPRTweety39	3	low	156	low	mid-slope	Grassland
TAPRTweety40	4	high	19	high	draw	Grassland
TAPRTweety41	3	low	6	medium	draw	Grassland
TAPRTweety42	7	medium	52	low	upper-slope	Grassland
TAPRTweety43	6	low	25	medium	upper-slope	Grassland
TAPRTweety44	6	medium	167	low	upper-slope	Grassland
TAPRTweety45	4	medium	144	high	draw	Grassland
TAPRTweety46	2	low	182	low	upper-slope	Grassland
TAPRTweety47	4	medium	37	high	draw	Grassland
TAPRTweety48	5	high	200	high	draw	Grassland
TAPRTweety49	2	high	333	high	draw	Grassland
TAPRTweety50	4	low	123	low	upper-slope	Grassland
TAPRTweety51	8	high	141	low	upper-slope	Grassland
TAPRTweety52	8	medium	25	medium	upper-slope	Grassland

Appendix 6. Abiotic features of 50-m radius plots sampled for breeding birds at Tallgrass Prairie National Preserve, Kansas (continued).

Plot number	Slope (°)	Slope variability	Aspect (°)	Aspect variability	Topographic position	Habitat type
TAPRTweety53	2	low	67	low	crest	Grassland
TAPRTweety54	2	medium	200	medium	draw	Grassland
TAPRTweety55	2	low	22	low	upper-slope	Grassland
TAPRTweety56	3	low	125	low	mid-slope	Grassland
TAPRTweety57	2	low	154	medium	upper-slope	Grassland
TAPRTweety58	12	low	35	low	upper-slope	Grassland
TAPRTweety59	6	medium	190	high	--	Grassland
TAPRTweety60	1	low	193	low	--	Grassland
TAPRTweety61	2	low	243	low	upper-slope	Grassland
TAPRTweety62	3	low	56	low	mid-slope	Grassland
TAPRTweety63	8	low	71	low	upper-slope	Grassland
TAPRTweety64	3	high	209	high	draw	Grassland
TAPRTweety65	2	low	60	low	upper-slope	Grassland
TAPRTweety66	9	medium	128	medium	upper-slope	Grassland
TAPRTweety67	2	low	150	low	crest	Grassland
TAPRTweety68	1	low	192	low	crest	Grassland
TAPRTweety69	5	low	129	low	mid-slope	Grassland
TAPRTweety70	3	medium	101	high	mid-slope	Grassland
TAPRTweety71	2	low	253	low	mid-slope	Grassland
TAPRTweety72	7	high	49	low	mid-slope	Grassland
TAPRTweety73	10	high	260	high	mid-slope	Grassland
TAPRTweety74	12	medium	100	low	upper-slope	Grassland
TAPRTweety75	2	low	195	low	mid-slope	Grassland
TAPRTweety76	4	low	29	low	mid-slope	Grassland
TAPRTweety77	4	low	295	low	mid-slope	Grassland
TAPRTweety78	11	high	329	high	upper-slope	Grassland
TAPRTweety79	7	high	63	high	mid-slope	Grassland
TAPRTweety80	4	low	215	low	mid-slope	Grassland
TAPRTweety81	2	low	31	low	crest	Grassland
TAPRTweety82	5	low	255	medium	upper-slope	Grassland
TAPRTweety83	1	low	57	low	crest	Grassland
TAPRTweety84	9	high	230	high	mid-slope	Grassland
TAPRTweety85	1	low	73	low	lower-slope	Brome
TAPRTweety86	4	medium	175	medium	mid-slope	Grassland
TAPRTweety87	3	low	52	low	upper-slope	Grassland
TAPRTweety88	7	high	190	medium	lower-slope	Grassland
TAPRTweety89	2	high	204	high	--	Grassland
TAPRTweety90	3	medium	159	high	upper-slope	Grassland
TAPRTweety91	2	high	122	medium	crest	Grassland
TAPRTweety92	1	low	326	medium	upper-slope	Grassland
TAPRTweety93	2	medium	155	low	upper-slope	Grassland
TAPRTweety94	8	high	218	high	mid-slope	Grassland
TAPRTweety95	3	medium	138	medium	upper-slope	Grassland
TAPRTweety96	4	high	43	high	mid-slope	Grassland
TAPRTweety97	2	high	169	high	mid-slope	Grassland
TAPRTweety98	2	low	35	medium	upper-slope	Grassland
TAPRTweety99	0	high	211	high	crest	Grassland
TAPRTweety100	2	high	107	high	lower-slope	Grassland
TAPRTweety101	1	low	126	low	upper-slope	Grassland
TAPRTweety102	1	low	57	low	lower-slope	Brome
TAPRTweety103	1	low	61	low	crest	Grassland
TAPRTweety104	5	medium	257	high	mid-slope	Grassland

Appendix 6. Abiotic features of 50-m radius plots sampled for breeding birds at Tallgrass Prairie National Preserve, Kansas (continued).

Plot number	Slope (°)	Slope variability	Aspect (°)	Aspect variability	Topographic position	Habitat type
TAPRTweety105	11	high	195	medium	upper-slope	Grassland
TAPRTweety106	3	low	216	low	mid-slope	Grassland
TAPRTweety107	3	medium	35	medium	upper-slope	Grassland
TAPRTweety108	4	high	164	high	draw	Grassland
TAPRTweety109	4	high	122	high	mid-slope	Grassland
TAPRTweety110	3	low	59	low	lower-slope	Brome
TAPRTweety111	10	high	285	high	upper-slope	Grassland
TAPRTweety112	8	high	220	high	draw	Grassland
TAPRTweety113	3	low	41	low	upper-slope	Grassland
TAPRTweety114	0	low	0	low	level	Grassland
TAPRTweety115	2	high	104	high	mid-slope	Grassland
TAPRTweety116	5	medium	114	low	draw	Grassland
TAPRTweety117	4	low	227	low	--	Grassland
TAPRTweety118	5	low	115	low	upper-slope	Grassland
TAPRTweety119	1	low	25	low	crest	Grassland
TAPRTweety120	2	low	60	low	upper-slope	Grassland
TAPRTweety121	3	low	22	low	mid-slope	Grassland
TAPRTweety122	2	low	69	low	crest	Grassland
TAPRTweety123	8	medium	320	medium	--	Grassland
TAPRTweety124	8	low	1	low	mid-slope	Grassland
TAPRTweety125	13	high	259	high	upper-slope	Grassland
TAPRTweety126	3	high	241	high	draw	Grassland
TAPRTweety127	5	low	101	low	upper-slope	Grassland
TAPRTweety128	2	low	130	low	lower-slope	Grassland
TAPRTweety129	6	high	40	low	upper-slope	Grassland
TAPRTweety130	0	medium	225	high	draw	Grassland
TAPRTweety131	1	low	135	high	--	Grassland
TAPRTweety132	7	low	205	low	--	Grassland
TAPRTweety133	2	low	201	low	crest	Grassland
TAPRTweety134	4	low	326	low	upper-slope	Grassland
TAPRTweety135	4	medium	124	low	mid-slope	Grassland
TAPRTweety136	5	high	275	high	upper-slope	Grassland
TAPRTweety137	7	low	140	medium	mid-slope	Grassland
TAPRTweety138	9	high	75	high	draw	Grassland
TAPRTweety139	5	high	358	high	mid-slope	Grassland
TAPRTweety140	3	low	171	low	mid-slope	Grassland
TAPRTweety141	3	high	197	high	mid-slope	Grassland
TAPRTweety142	2	low	109	medium	upper-slope	Grassland
TAPRTweety143	3	low	355	low	upper-slope	Grassland
TAPRTweety144	4	low	125	low	upper-slope	Grassland
TAPRTweety145	7	medium	120	high	upper-slope	Grassland
TAPRTweety146	4	medium	58	low	mid-slope	Grassland
TAPRTweety147	3	low	149	low	lower-slope	Grassland
TAPRTweety148	0	medium	94	medium	crest	Grassland
TAPRTweety149	5	high	355	high	draw	Grassland
TAPRTweety150	3	high	253	medium	mid-slope	Grassland
TAPRTweety151	1	low	41	low	crest	Grassland
TAPRTweety152	8	high	232	high	--	Grassland
TAPRTweety153	3	medium	133	high	draw	Grassland
TAPRTweety154	5	medium	13	low	--	Grassland
TAPRTweety155	1	medium	193	medium	lower-slope	Grassland
TAPRTweety156	1	low	316	low	crest	Grassland

Appendix 6. Abiotic features of 50-m radius plots sampled for breeding birds at Tallgrass Prairie National Preserve, Kansas (continued).

Plot number	Slope (°)	Slope variability	Aspect (°)	Aspect variability	Topographic position	Habitat type
TAPRTweety157	1	high	311	high	crest	Grassland
TAPRTweety158	4	low	64	low	mid-slope	Grassland
TAPRTweety159	1		131	--	--	Riparian
TAPRTweety160	24	high	345	high	mid-slope	Riparian
TAPRTweety161	2	medium	354	medium	lower-slope	Riparian
TAPRTweety162	2	low	18	low	lower-slope	Riparian
TAPRTweety163	0	low	115	low	level	Riparian
TAPRTweety164	0	low	64	low	level	Riparian
TAPRTweety165	3	low	82	low	level	Riparian
TAPRTweety166	1	medium	247	low	level	Riparian
TAPRTweety167	2	medium	127	low	lower-slope	Riparian
TAPRTweety168	1	medium	164	low	level	Riparian
TAPRTweety169	3	medium	84	low	level	Riparian
TAPRTweety170	2	medium	116	low	level	Riparian
TAPRTweety171	1	medium	31	low	level	Riparian
TAPRTweety172	2	low	112	low	level	Riparian
TAPRTweety173	5	low	33	low	level	Riparian
TAPRTweety174	1	low	75	low	lower-slope	Riparian
TAPRTweety175	10	low	70	low	lower-slope	Riparian
TAPRTweety176	2	low	149	low	lower-slope	Riparian
TAPRTweety177	1	medium	205	medium	crest	Grassland
TAPRTweety178	2	low	241	low	upper-slope	Grassland
TAPRTweety179	8	medium	52	medium	mid-slope	Grassland
TAPRTweety180	1	low	212	low	mid-slope	Grassland
TAPRTweety181	9	low	192	low	lower-slope	Grassland
TAPRTweety182	2	low	155	low	lower-slope	Grassland
TAPRTweety183	4	medium	115	medium	upper-slope	Grassland
TAPRTweety184	5	low	35	low	upper-slope	Grassland
TAPRTweety185	5	high	30	high	draw	Grassland
TAPRTweety186	2	low	234	low	upper-slope	Grassland
TAPRTweety187	8	high	205	high	draw	Grassland
TAPRTweety188	2	low	170	low	upper-slope	Grassland
TAPRTweety189	5	low	241	low	upper-slope	Grassland
TAPRTweety190	2	low	233	medium	upper-slope	Grassland
TAPRTweety191	4	medium	140	medium	draw	Grassland
TAPRTweety192	6	low	156	low	upper-slope	Grassland
TAPRTweety193	8	high	292	high	upper-slope	Grassland
TAPRTweety194	2	low	199	low	lower-slope	Grassland
TAPRTweety195	2	medium	349	medium	lower-slope	Grassland
TAPRTweety196	3	low	83	medium	upper-slope	Grassland
TAPRTweety197	2	low	290	low	upper-slope	Grassland
TAPRTweety198	11	medium	250	low	upper-slope	Grassland
TAPRTweety199	2	low	62	low	mid-slope	Grassland
TAPRTweety200	7	high	355	high	draw	Grassland
TAPRTweety201	2	high	282	medium	crest	Grassland
TAPRTweety202	3	low	274	low	mid-slope	Grassland
TAPRTweety203	13	high	283	low	upper-slope	Grassland
TAPRTweety204	4	medium	101	medium	mid-slope	Grassland
TAPRTweety205	2	high	185	high	draw	Grassland
TAPRTweety206	2	low	105	low	lower-slope	Grassland
TAPRTweety207	4	low	225	medium	mid-slope	Grassland
TAPRTweety208	5	medium	80	medium	lower-slope	Grassland

Appendix 6. Abiotic features of 50-m radius plots sampled for breeding birds at Tallgrass Prairie National Preserve, Kansas (continued).

Plot number	Slope (°)	Slope variability	Aspect (°)	Aspect variability	Topographic position	Habitat type
TAPRTweety209	5	medium	330	medium	upper-slope	Grassland
TAPRTweety210	5	low	45	low	mid-slope	Grassland
TAPRTweety211	4	medium	80	low	lower-slope	Grassland
TAPRTweety212	9	high	222	medium	mid-slope	Grassland
TAPRTweety213	3	low	245	low	mid-slope	Grassland
TAPRTweety214	7	low	132	low	upper-slope	Grassland
TAPRTweety215	7	high	240	high	mid-slope	Grassland
TAPRTweety216	4	high	178	high	mid-slope	Grassland
TAPRTweety217	4	low	69	low	lower-slope	Brome
TAPRTweety218	3	high	295	high	mid-slope	Grassland
TAPRTweety219	1	low	218	low	upper-slope	Grassland
TAPRTweety220	6	medium	210	low	lower-slope	Grassland
TAPRTweety221	1	low	209	low	mid-slope	Grassland
TAPRTweety222	5	medium	132	medium	mid-slope	Grassland
TAPRTweety223	2	low	169	low	level	Grassland
TAPRTweety224	8	medium	55	low	upper-slope	Grassland
TAPRTweety225	1	low	55	low	lower-slope	Brome
TAPRTweety226	2	high	40	high	draw	Grassland
TAPRTweety227	5	medium	256	medium	upper-slope	Grassland
TAPRTweety228	10	high	240	high	draw	Grassland
TAPRTweety229	4	low	132	low	mid-slope	Grassland
TAPRTweety230	13	high	290	high	upper-slope	Grassland
TAPRTweety231	2	low	113	low	lower-slope	Grassland
TAPRTweety232	0	medium	55	medium	lower-slope	Brome
TAPRTweety233	7	high	298	high	draw	Grassland
TAPRTweety234	1	low	43	low	crest	Grassland
TAPRTweety235	5	high	115	medium	mid-slope	Grassland
TAPRTweety236	8	medium	218	high	--	Grassland
TAPRTweety237	8	high	140	low	mid-slope	Grassland
TAPRTweety238	6	low	40	low	upper-slope	Grassland
TAPRTweety239	8	medium	106	medium	upper-slope	Grassland
TAPRTweety240	5	medium	136	medium	mid-slope	Grassland
TAPRTweety241	3	high	140	high	draw	Grassland
TAPRTweety242	1	low	150	medium	crest	Grassland
TAPRTweety243	3	low	222	low	mid-slope	Grassland
TAPRTweety244	2	medium	144	medium	upper-slope	Grassland
TAPRTweety245	3	medium	185	medium	upper-slope	Grassland
TAPRTweety246	1	medium	196	low	lower-slope	Grassland
TAPRTweety247	2	low	21	low	lower-slope	Brome
TAPRTweety248	4	medium	202	medium	draw	Grassland
TAPRTweety249	3	low	180	low	mid-slope	Grassland
TAPRTweety250	3	high	135	high	lower-slope	Grassland
TAPRTweety251	12	medium	358	medium	upper-slope	Grassland
TAPRTweety252	4	medium	301	medium	draw	Grassland
TAPRTweety253	6	medium	221	low	mid-slope	Grassland
TAPRTweety254	0	low	248	low	level	Brome
TAPRTweety255	12	high	238	high	mid-slope	Grassland
TAPRTweety256	5	low	142	low	upper-slope	Grassland
TAPRTweety257	1	low	136	low	lower-slope	Grassland
TAPRTweety258	7	high	116	high	upper-slope	Grassland
TAPRTweety259	4	high	193	medium	lower-slope	Grassland
TAPRTweety260	4	medium	231	low	mid-slope	Grassland

Appendix 7. Averages (\pm std dev) for habitat parameters in the grasslands at Tallgrass Prairie National Preserve, Kansas during the bird breeding seasons, 2001–2008 (excluding 2003). Within the scale in which habitat parameters are collected, 50-m plot, 5-m subplot, and 1.78-m sample plot, percentages of coverage may not necessarily sum to 100% as values are averaged over mid-point values of cover classes (i.e. class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%).

Habitat Parameter	2001	2002	2004	2005	2006	2007	2008
50 meter plot coverage							
Brome Field (%)	1.85 (13.35)	3.24 (17.47)	6.02 (23.61)	7.41 (25.99)	3.61 (18.53)	4.12 (19.75)	3.80 (18.99)
Disturbed Floodplain (%)	--	--	--	0.19 (1.69)	--	0.65 (4.48)	1.58 (5.58)
Intermittent Water Cover (%)	0.27 (2.99)	>0.01 (0.03)	--	--	--	--	--
Upland Prairie (%)	93.88 (17.36)	92.61 (19.69)	85.12 (27.44)	86.90 (27.41)	92.81 (18.65)	87.96 (21.93)	88.57 (22.05)
Pasture Road (%)	0.55 (2.43)	0.32 (1.53)	0.70 (2.90)	0.32 (1.77)	0.31 (1.75)	0.30 (1.84)	0.66 (2.49)
Pond (%)	0.59 (4.37)	0.43 (3.65)	1.39 (7.13)	0.23 (1.72)	0.39 (2.34)	0.22 (1.78)	0.49 (4.27)
Riparian Prairie (%)	--	--	--	1.34 (8.16)	--	--	0.76 (4.60)
Riparian Woodland (%)	0.12 (1.22)	0.18 (1.41)	0.25 (1.70)	0.01 (0.06)	0.12 (0.57)	0.01 (0.06)	0.19 (1.71)
Seep	--	--	--	0.04 (0.34)	--	--	0.05 (0.35)
Shrub (%)	0.03 (0.25)	0.08 (0.98)	--	0.95 (5.93)	--	--	--
Stream (%)	0.41 (2.10)	0.80 (4.65)	0.67 (2.88)	1.04 (3.35)	0.41 (1.80)	0.60 (2.57)	0.72 (2.95)
5 meter subplot							
Canopy cover							
Hardwood (%)	0.00	0.44 (6.12)	0.00	0.05 (0.47)	0.77 (6.96)	0.00	0.36 (3.20)
Total cover (%)	0.00	0.44 (6.12)	0.00	0.05 (0.47)	0.77 (6.96)	0.00	0.36 (3.20)
Canopy Height							
Hardwood (m)	0.10 (1.24)	0.13 (1.16)	0.10 (0.89)	0.10 (0.90)	0.16 (1.44)	0.00	0.16 (1.41)
Basal Area							
Hardwood (m ² /ha)	0.02 (0.24)	0.04 (0.32)	0.00	0.03 (0.16)	0.07 (0.57)	0.00	0.03 (0.23)
Total (m ² /ha)	0.02 (0.24)	0.04 (0.32)	0.00	0.03 (0.16)	0.07 (0.57)	0.00	0.03 (0.23)
Horizontal vegetation profile at 15-m							
0.00 – 0.25 m (%)	--	--	--	--	--	--	91.27 (12.23)
0.00 – 0.50 m (%)	82.29 (24.41)	65.47 (30.12)	61.99 (31.72)	53.73 (28.90)	67.60 (30.61)	71.90 (24.30)	--
0.25 – 0.50 m (%)	--	--	--	--	--	--	46.27 (39.51)
0.25 – 0.75 m (%)	--	--	18.02 (29.01)	10.46 (25.63)	12.34 (23.43)	16.97 (30.52)	--
0.50 – 0.75 m (%)	--	--	--	--	--	--	5.66 (21.72)
0.50 – 1.00 m (%)	4.10 (14.30)	4.52 (18.50)	2.97 (13.50)	1.38 (6.33)	2.51 (12.40)	5.63 (20.50)	--
0.75 – 1.00 m (%)	--	--	--	--	--	--	4.68 (20.10)
0.75 – 1.25 m (%)	--	--	0.66 (4.47)	0.00	0.66 (4.47)	0.43 (2.50)	--
1.00 – 1.25 m (%)	--	--	--	--	--	--	3.64 (18.22)
1.00 – 1.50 m (%)	0.01 (0.06)	0.09 (1.00)	0.00	0.19 (1.69)	0.00	0.00	--
1.25 – 1.50 m (%)	--	--	--	--	--	--	0.04 (0.34)
1.25 – 1.75 m (%)	--	--	0.00	0.19 (1.69)	0.00	0.00	--
1.50 – 1.75 m (%)	--	--	--	--	--	--	0.00
1.50 – 2.00 m (%)	0.62 (7.82)	0.16 (2.44)	0.00	0.00	0.00	0.00	--
1.75 – 2.00 m (%)	--	--	--	--	--	--	0.00

Appendix 7. Averages (\pm std dev) for habitat parameters in the grasslands at Tallgrass Prairie National Preserve, Kansas during the bird breeding seasons, 2001–2008 (excluding 2003). Within the scale in which habitat parameters are collected, 50-m plot, 5-m subplot, and 1.78-m sample plot, percentages of coverage may not necessarily sum to 100% as values are averaged over mid-point values of cover classes (i.e. class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%) (continued).

Habitat Parameter	2001	2002	2004	2005	2006	2007	2008
Vertical structure diversity (%)	9.37 (1.16)	9.57 (1.60)	9.36 (0.56)	9.49 (0.65)	9.57 (1.56)	9.40 (0.44)	10.77 (5.46)
1.78 meter sample plot coverage							
Deciduous litter (%)	0.12 (1.22)	0.43 (0.98)	0.17 (0.58)	0.30 (0.25)	0.36 (0.38)	0.30 (0.52)	0.40 (0.37)
Grass litter (%)	9.59 (17.43)	28.53 (20.89)	11.45 (14.60)	7.30 (14.56)	9.57 (15.28)	29.58 (19.23)	23.36 (28.17)
Bare soil (%)	49.74 (21.22)	50.29 (23.47)	67.54 (16.92)	74.15 (16.70)	70.38 (22.22)	59.75 (15.66)	61.51 (26.94)
Rock (%)	7.11 (13.24)	7.50 (11.99)	10.79 (16.40)	8.34 (13.24)	7.91 (13.56)	9.05 (16.77)	3.11 (7.88)
Woody debris (%)	0.02 (0.24)	0.01 (0.06)	1.14 (9.44)	0.01 (0.06)	0.06 (0.34)	1.25 (10.09)	0.05 (0.35)
Unvegetated (%)	81.61 (9.06)	83.84 (9.95)	84.69 (15.26)	84.78 (8.83)	86.79 (12.24)	85.21 (3.73)	86.23 (6.72)
Warm-season grass (%)	20.03 (15.48)	38.94 (18.31)	25.21 (14.50)	25.40 (14.21)	17.67 (16.00)	31.89 (17.10)	20.04 (14.20)
Cool-season grass (%)	3.82 (11.46)	6.65 (16.87)	9.96 (14.77)	7.16 (16.55)	3.48 (10.87)	4.17 (15.92)	5.12 (12.30)
Forb (%)	20.68 (12.33)	9.56 (9.85)	17.35 (10.13)	15.34 (9.58)	8.20 (9.18)	10.50 (12.07)	8.60 (10.28)
Moss and lichen (%)	<0.01 (0.04)	0.48 (1.54)	1.53 (2.94)	0.99 (2.03)	0.33 (0.72)	0.31 (1.81)	0.26 (0.26)
Woody shrub and vine (%)	1.37 (7.85)	4.67 (7.07)	1.28 (5.01)	3.07 (4.26)	2.71 (4.03)	1.68 (3.11)	2.45 (3.25)
Tree seedling (%)	<0.01 (0.04)	0.01 (0.19)	0.00	0.00	0.04 (0.33)	0.04 (0.36)	0.00
Total foliar (%)	53.48 (19.45)	44.64 (17.34)	52.04 (16.21)	41.23 (14.75)	33.31 (20.18)	58.06 (14.65)	41.11 (13.25)

Appendix 8. Averages (\pm std dev) for habitat parameters in the riparian areas at Tallgrass Prairie National Preserve, Kansas during the bird breeding seasons, 2001–2008 (excluding 2003). Within the scale in which habitat parameters are collected, 50-m plot, 5-m subplot, and 1.78-m sample plot, percentages of coverage may not necessarily sum to 100% as values are averaged over mid-point values of cover classes (i.e. class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%).

Habitat Parameter	2001	2002	2004	2005	2006	2007	2008
50 meter plot coverage							
Brome Field (%)	3.14 (9.28)	3.14 (9.28)	9.72 (19.05)	11.44 (24.76)	5.83 (12.49)	0.17 (0.71)	4.53 (12.03)
Corn Field (%)	--	--	--	--	2.08 (8.84)	1.00 (3.56)	--
Upland Prairie (%)	2.08 (8.84)	2.08 (8.84)	5.41 (15.69)	8.81 (21.29)	1.83 (4.84)	0.17 (0.71)	8.83 (21.28)
Old Field (%)	--	--	--	--	--	--	0.86 (3.53)
Pasture Road (%)	--	--	--	--	0.17 (0.71)	0.03 (0.11)	0.03 (0.12)
Pond (%)	--	--	0.19 (0.75)	--	--	--	--
Restored Prairie (%)	--	--	--	2.08 (8.84)	2.08 (8.84)	2.08 (8.84)	2.08 (8.84)
Riparian Prairie (%)	--	--	--	--	--	--	8.36 (24.11)
Riparian Woodland (%)	88.19 (17.08)	88.19 (17.08)	72.03 (26.60)	67.81 (30.78)	58.75 (27.74)	60.56 (25.92)	42.64 (27.81)
Shrub (%)	--	--	--	0.03 (0.12)	--	--	0.17 (0.71)
Stream (%)	20.14 (15.19)	24.17 (12.75)	17.73 (10.91)	30.00 (10.91)	27.92 (12.81)	23.58 (22.35)	31.25 (10.37)
5 meter subplot							
Canopy cover							
Hardwood (%)	80.66 (21.47)	66.37 (18.45)	85.04 (14.00)	88.00 (18.22)	85.67 (16.17)	85.10 (16.92)	87.65 (21.19)
Total cover (%)	80.66 (21.47)	66.37 (18.45)	85.04 (14.00)	88.00 (18.22)	85.67 (16.17)	85.10 (16.92)	87.65 (21.19)
Canopy Height							
Hardwood (m)	17.69 (10.11)	20.85 (7.07)	24.27 (9.40)	16.81 (7.07)	20.96 (7.62)	16.61 (7.44)	21.61 (7.83)
Basal Area							
Hardwood (m ² /ha)	7.83 (4.22)	7.28 (3.37)	6.38 (4.13)	8.50 (4.50)	8.78 (4.37)	7.94 (4.26)	8.17 (3.91)
Total (m ² /ha)	7.83 (4.22)	7.28 (3.37)	6.38 (4.13)	8.50 (4.50)	8.78 (4.37)	7.94 (4.26)	8.17 (3.91)
Horizontal vegetation profile at 15-m							
0.00 – 0.25 m (%)	--	--	--	--	--	--	97.50 (0.00)
0.00 – 0.50 m (%)	90.28 (17.34)	92.25 (22.27)	93.75 (9.35)	80.42 (33.22)	97.7 (0.00)	94.17 (14.14)	--
0.25 – 0.50 m (%)	--	--	--	--	--	--	96.81 (2.95)
0.25 – 0.75 m (%)	--	--	75.81 (35.97)	70.22 (40.25)	90.14 (15.94)	78.22 (32.64)	--
0.50 – 0.75 m (%)	--	--	--	--	--	--	48.31 (41.88)
0.50 – 1.00 m (%)	48.20 (35.30)	43.30 (39.30)	36.30 (36.40)	32.00 (36.60)	53.30 (44.10)	51.80 (43.80)	--
0.75 – 1.00 m (%)	--	--	--	--	--	--	25.30 (37.60)
0.75 – 1.25 m (%)	--	--	17.22 (29.32)	17.25 (33.60)	24.50 (33.88)	30.28 (39.42)	--
1.00 – 1.25 m (%)	--	--	--	--	--	--	17.56 (33.45)
1.00 – 1.50 m (%)	9.81 (26.50)	10.10 (26.40)	8.63 (25.50)	21.40 (35.40)	12.20 (27.00)	21.40 (32.40)	--
1.25 – 1.50 m (%)	--	--	--	--	--	--	10.40 (25.00)
1.25 – 1.75 m (%)	--	--	8.63 (25.47)	18.36 (31.30)	15.19 (33.42)	23.14 (36.29)	--
1.50 – 1.75 m (%)	--	--	--	--	--	--	11.31 (23.21)
1.50 – 2.00 m (%)	14.90 (25.00)	15.20 (29.30)	2.38 (9.50)	19.50 (33.70)	19.80 (34.60)	28.20 (42.30)	--
1.75 – 2.00 m (%)	--	--	--	--	--	--	16.80 (28.60)

Appendix 8. Averages (\pm std dev) for habitat parameters in the riparian areas at Tallgrass Prairie National Preserve, Kansas during the bird breeding seasons, 2001-2008 (excluding 2003). Within the scale in which habitat parameters are collected, 50-m plot, 5-m subplot, and 1.78-m sample plot, percentages of coverage may not necessarily sum to 100% as values are averaged over mid-point values of cover classes (i.e. class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%) (continued).

Habitat Parameter	2001	2002	2004	2005	2006	2007	2008
Vertical structure diversity (%)	27.65 (9.42)	24.35 (5.64)	24.22 (6.52)	21.49 (4.59)	22.19 (7.33)	27.91 (12.56)	27.60 (12.32)
1.78 meter sample plot coverage							
Deciduous litter (%)	36.36 (28.68)	43.00 (24.81)	14.72 (15.69)	17.25 (18.67)	42.00 (26.77)	20.69 (20.97)	62.22 (26.67)
Grass litter (%)	4.67 (9.40)	7.72 (14.89)	6.91 (10.24)	7.75 (14.53)	3.58 (9.14)	10.92 (19.54)	4.64 (14.49)
Bare soil (%)	35.11 (27.76)	22.92 (29.50)	67.50 (20.25)	66.42 (25.09)	52.94 (26.74)	54.75 (18.42)	17.78 (22.01)
Rock (%)	1.22 (3.57)	3.50 (6.36)	2.31 (5.00)	4.92 (9.87)	3.58 (9.17)	2.50 (8.79)	1.94 (4.80)
Woody debris (%)	4.11 (9.02)	5.89 (6.70)	9.59 (6.36)	5.19 (5.50)	4.11 (5.16)	5.94 (14.87)	2.67 (3.33)
Unvegetated (%)	82.67 (24.22)	82.64 (14.94)	79.69 (14.63)	70.00 (15.51)	83.61 (14.53)	88.47 (5.76)	89.86 (6.27)
Warm-season grass (%)	0.94 (3.51)	1.69 (4.84)	2.16 (5.07)	3.86 (9.67)	1.89 (4.82)	5.31 (9.71)	0.22 (0.71)
Cool-season grass (%)	13.17 (14.67)	21.89 (26.08)	13.72 (17.65)	26.81 (21.90)	17.31 (14.25)	17.86 (22.69)	14.03 (15.75)
Forb (%)	10.50 (9.37)	15.44 (13.61)	20.63 (10.06)	14.89 (14.61)	14.97 (17.61)	6.36 (6.39)	6.72 (6.07)
Moss and lichen (%)	0.00	0.61 (0.90)	3.44 (5.85)	1.19 (3.58)	1.22 (3.57)	0.03 (0.12)	0.47 (0.67)
Woody shrub and vine (%)	9.31 (24.02)	6.83 (12.48)	10.63 (14.43)	9.33 (11.94)	7.28 (11.84)	2.67 (5.72)	6.44 (9.72)
Tree seedling (%)	0.22 (0.26)	0.97 (1.31)	1.13 (3.77)	0.00	0.64 (1.11)	1.78 (3.55)	2.69 (5.67)
Total foliar (%)	36.86 (25.77)	33.36 (21.15)	42.81 (23.22)	43.61 (19.33)	43.47 (17.58)	38.06 (16.30)	34.89 (22.01)

Appendix 9. Stems per hectare of trees found in the riparian area on Tallgrass Prairie National Preserve, Kansas by size class, during the 2001-2008(excluding 2003) bird-breeding seasons. Stems per hectare of trees are reported by family.

Family	<1.0 cm	1.1 – 2.5 cm	2.6 – 8.0 cm	8.1 – 15.0 cm	15.1 – 23.0 cm	23.1 – 38.0 cm	>38.0 cm
Aceraceae	0	0	0	7	0	7	0
Anacardiaceae	0	7	0	0	0	0	0
Cornaceae	74	36	19	0	7	0	0
Fabaceae	0	7	21	13	7	7	8
Fagaceae	7	7	11	11	7	7	7
Hippocastanaceae	0	0	24	11	7	0	0
Juglandaceae	0	14	14	15	14	8	8
Magnoliaceae	0	0	0	0	7	0	0
Oleacea	0	7	10	17	16	12	9
Platanaceae	0	0	0	7	7	7	14
Rosaceae	0	7	0	0	0	0	0
Rutaceae	7	0	0	0	0	0	0
Salicaceae	78	50	35	32	25	50	35
Sapindaceae	0	0	14	0	0	0	0
Tiliaceae	0	0	0	0	0	7	0
Unknown shrub	28	106	21	0	0	0	0
Ulmaceae	28	13	82	81	63	71	34
Total stems	222	254	251	194	160	176	115
Snags	0	14	11	16	13	7	0

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