

**AVIAN INVENTORY OF TALLGRASS PRAIRIE
NATIONAL PRESERVE, KANSAS, 1998-1999**



by

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EXECUTIVE SUMMARY

Introduction

More than 95% of native tallgrass prairie has been destroyed and most remaining prairie lands are fragmented (Knopf and Sampson 1997). Loss and fragmentation of prairie habitats has resulted in a widespread decline of grassland bird species (Herkert et al. 1993). Unfortunately, the status of grassland birds on many National Park Service (NPS) areas is unknown. In 1997, the NPS identified grassland birds as a high-priority research need within the Midwest Region. Baseline inventories and long-term ecological monitoring programs are needed in NPS areas to monitor grassland bird population trends. This report includes the results of an initial baseline inventory of grassland and other species of birds at Tallgrass Prairie National Preserve (TAPR), located in the Flint Hills of Chase County, Kansas.

Methods

We conducted avian censuses from May 1998 through August 1999, using a combination of point count and transect methods to determine species distributions, relative abundance, and densities. We used survey data and incidental bird sightings to develop a bird checklist for the preserve. Breeding birds were surveyed using fixed-distance (50-m and 100-m radius) circular point counts and resident, migratory, and breeding birds were surveyed using strip transects 500-m long and 100-m wide. Points and transects were unequally distributed among all habitats at TAPR. To understand bird and habitat associations, we quantified habitat characteristics for grassland areas where breeding bird counts were conducted using standardized methods.

Results and Discussion

We identified 132 bird species within the preserve boundaries. Fifteen were considered to be grassland-associated species. The number of grassland-associated species we found at

TAPR was typical of prairie ecosystems (Cody 1966, Wiens 1973, Zimmerman 1997). For the two main watersheds at TAPR, species diversity was significantly higher at Fox Creek than Palmer Creek during the breeding season as well as year-round.

Eastern meadowlark (*Sturnella magna*) and dickcissel (*Spiza americana*) comprised a large percentage of the total number of birds for all of the habitats. Both species are characteristic of tallgrass prairie and are capable of utilizing a variety of grassland habitat types. Bird species that had the highest relative abundance for a given habitat also had the highest densities as determined by strip-transects. Overall bird density was higher year-round for the Fox Creek gallery forest than the Palmer Creek forest. Bird densities within TAPR peaked in November 1998 when large mixed-species flocks of sparrows and longspurs were found on the preserve.

Unburned and ungrazed prairie had a higher percentage of litter and grass cover, deeper litter depth, higher plant density, and lower percent bare ground than burned and grazed prairie. The riparian/prairie habitat had the highest percent bare ground, forb cover, and forb density, and the lowest percent litter and grass cover, perhaps due to shading from trees and heavy cattle use in the riparian areas. The tallest grass height, highest plant density, and lowest percent forb cover were found in the brome (*Bromus inermis*) fields where this exotic dominated the landscape. Most of TAPR, however, consisted of burned and grazed prairie, where litter depth and grass height were lowest, because annual prescribed-burns removed the litter layer and grazing reduced vegetation height.

Eastern meadowlark and dickcissel were found in all of the grassland habitat types, but grasshopper sparrows (*Ammodramus savannarum*) were never observed within brome fields. Upland sandpipers (*Bartramia longicauda*) were most likely to be found in areas with short,

sparse vegetation in the burned and grazed prairie. In contrast, the presence of red-winged blackbirds (*Agelaius phoeniceus*) was positively correlated with grass height within brome fields.

Management Recommendations

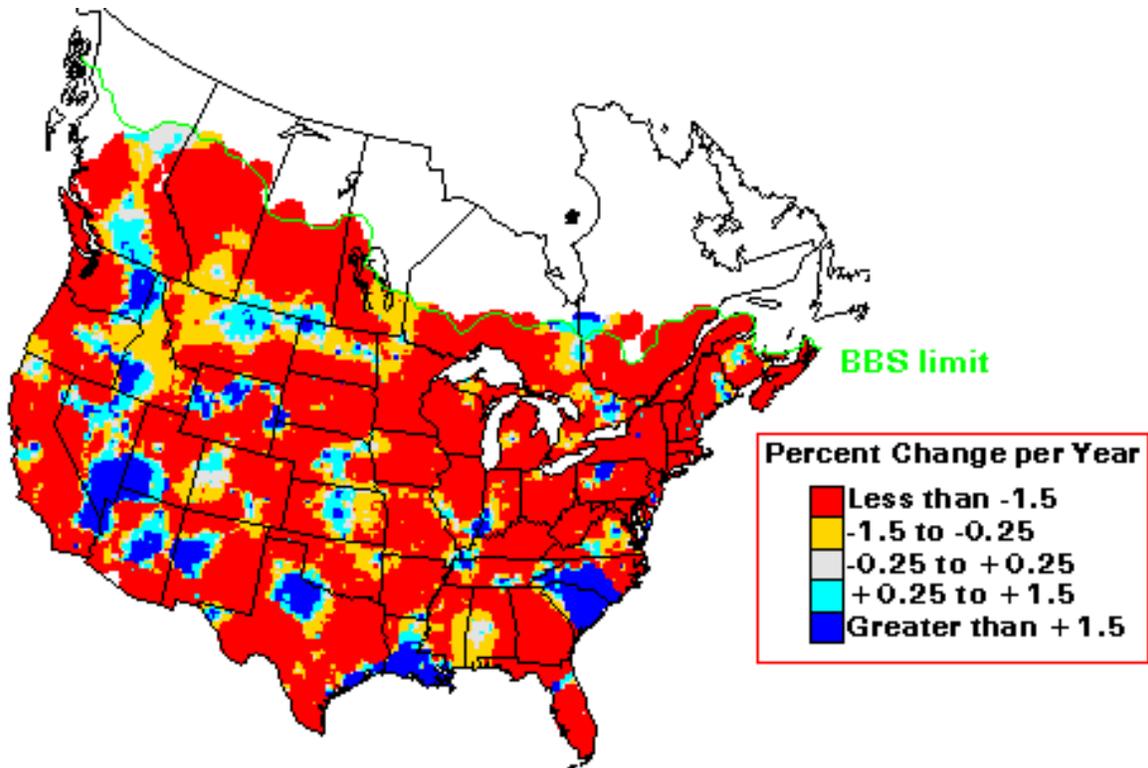
Many grassland species rely on a mosaic of habitat types for different aspects of their life histories (Johnson and Igl 1999). Fire and light- to moderate grazing can be important tools for maintaining landscape heterogeneity and promoting plant diversity (Sample and Mossman 1997). To best benefit birds, burns should be scheduled before the breeding season or in the fall and burned on rotation every 2 to 5 years with variable frequency and seasonality (Sample and Mossman 1997, Heiburt 1998). Most bird species respond best to light grazing intensities with a rotation grazing regime in which some sections are grazed while others are left ungrazed (Herkert et al. 1993). If possible, areas should be left ungrazed until late in the nesting season and grazing should be discontinued soon enough in the fall to allow vegetation regrowth before dormancy (Sample and Mossman 1997).

INTRODUCTION

Two centuries ago, tallgrass prairie covered the midcontinent of North America from Mexico to Canada. At that time, prairie ecosystems were maintained by periodic fires, grazing by large mammals, and frequent droughts (Knopf and Sampson 1997). As European settlers moved west, natural fires were suppressed, livestock replaced native grazers, and much of the prairie habitat was converted to agricultural use. It is estimated that only 1 to 4% of presettlement native tallgrass prairie remains today (Heibert 1998). Most of the surviving tallgrass prairie is found within the Flint Hills of Kansas. Loss and fragmentation of prairie habitats have resulted in widespread declines of grassland bird species (Herkert et al. 1993, Knopf 1994). Grassland birds are declining more rapidly and consistently than any other guild of North American birds (Fig. 1; Sauer et al. 1999). Seventy percent of grassland bird species monitored by the National Breeding Bird Survey (BBS) have declined significantly over the past 30 years, and many other grassland bird species have shown negative population trends that are cause for concern (Peterjohn 1994). In addition, the status of grassland birds on many National Park Service (NPS) areas is unknown.

Baseline inventories and long-term ecological monitoring programs are needed to monitor grassland bird population trends in NPS areas. In 1997, the NPS identified grassland birds as a high-priority research need within the Midwest Region of the NPS system. This report includes the results of a baseline inventory of birds, including those species associated with

Figure 1. Population trends for the grassland-bird guild within North America, 1966-1996 (Sauer et al. 1999).



grassland habitats, at Tallgrass Prairie National Preserve (TAPR), Kansas. We describe which bird species utilize TAPR and provide baseline data for comparison with future surveys at the preserve. In addition, we describe the grassland habitats of breeding birds at TAPR.

STUDY AREA

The inventory was conducted throughout TAPR, located in the Flint Hills of Chase County, Kansas. TAPR consists of the former ZBar Ranch, purchased by the National Park Trust (NPT) in 1994. The land was officially designated as a unit of the National Park system in 1996, although most of the preserve remains under the ownership of the NPT. However, the NPS will cooperatively manage the preserve and eventually own up to 70 ha.

TAPR protects approximately 3,800 ha of native tallgrass prairie. In addition, areas surrounding the creeks, springs, and former Zbar/Spring Hill Ranch Headquarters Area are forested. In 1998 and 1999, approximately 15 ha located adjacent to the schoolhouse (Southwind Nature Trail Area) remained unburned and ungrazed, 440 ha adjacent to Fox Creek remained planted with smooth brome (*Bromus inermis*), and 3,640 ha was burned and grazed annually. To date, the prairie is burned each year between mid-March and mid-April. Cattle are placed on the prairie between mid-April and 1 August. Actual cattle-stocking dates and densities vary from year to year (Barbara Zurhellen, personal communication).

METHODS

We conducted surveys of breeding, migrant, and resident bird populations to determine species presence, distributions, relative abundance, and densities from May 1998 to August 1999. Raptors, greater prairie chickens (*Tympanuchus cupido*), swallows, and nightjars were noted but not included in quantitative data because our methods were not appropriate for these species. We considered direct evidence of breeding to be observations of copulation, nests, food carrying, or fledglings. In addition to bird censuses, we also quantified habitat characteristics for grassland areas where breeding bird counts were conducted in order to understand habitat associations and to provide baseline data on habitat structure. We used survey data and incidental bird sightings to develop a bird checklist for TAPR.

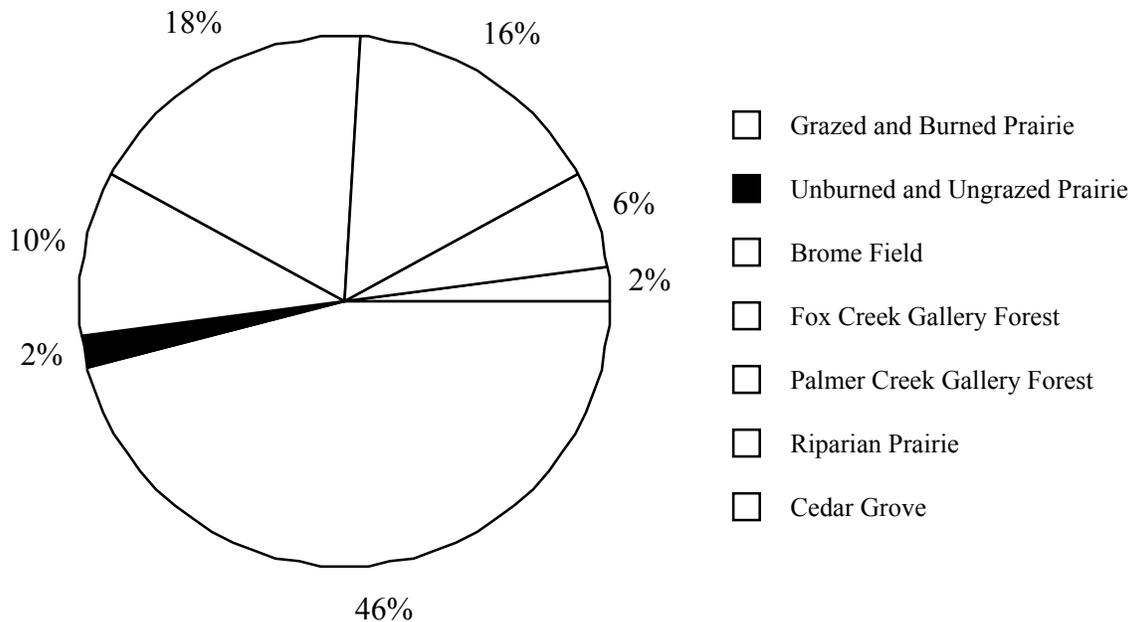
Point Counts

We surveyed breeding birds using standardized procedures for fixed-distance circular point counts; 5-minute counts within a 100 m radius, wherein all birds were identified by sight and/or sound and counted (Ralph et al. 1993, 1995). We recorded whether birds occurred within 0-50 m, 51-100 m, over 100 m from the point, and flying overhead. In addition, we indicated

whether birds were identified in 0-3 or 3-5 minutes from initiation of the count. Only trained observers proficient at identification of birds by sight and sound performed counts. We started counts within one-half hour of local sunrise and ended no later than 0930. Counts were not conducted in rain, high winds, or other inclement weather that could affect our detection of birds. We calculated relative abundance for each species by dividing the number of individuals of a species within 100-m radius points by the total number of all birds of all species observed within the points.

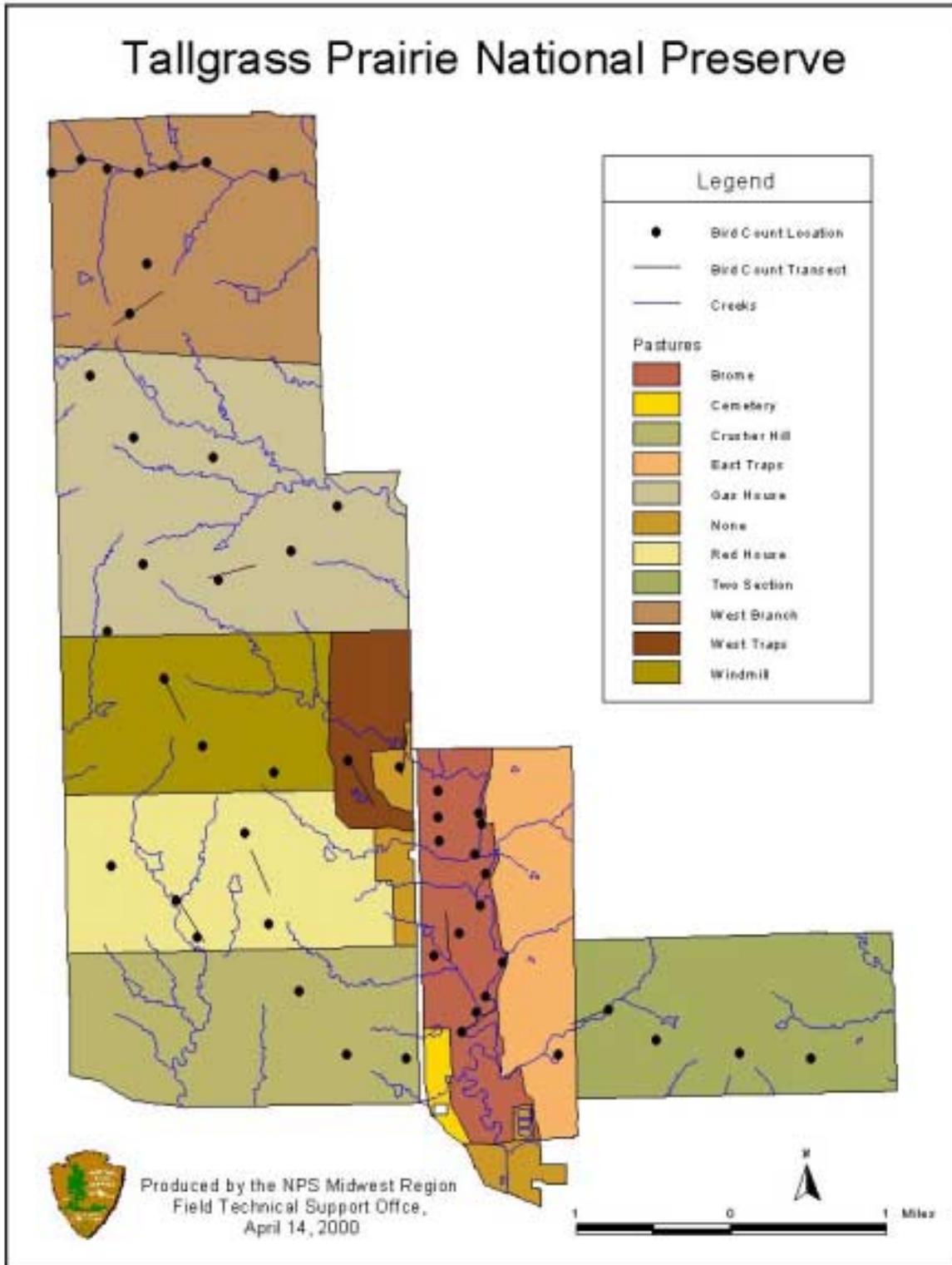
We distributed point locations throughout all habitat types at TAPR (Fig. 2). To facilitate future location of points for NPS personnel, we placed points at least 500 m apart on roads and Trails (Fig. 3). Most of the roads on TAPR were small 4-wheel trails (2-tracks) and the one gravel road was used only by tour buses during a few designated times. Fifty points were

Figure 2. Distribution of bird points within habitat types at Tallgrass Prairie National Preserve, Kansas, 1998-1999.



distributed in proportion to habitat type present at TAPR: 23 in burned and grazed prairie, one in unburned and ungrazed prairie (Schoolhouse Prairie), five in brome field, nine along Fox Creek gallery forest, eight along Palmer Creek gallery forest, one in the cedar grove, and three in mixed riparian/prairie areas (areas near a creek, spring, or pond). We recorded each point location using Global Positioning Systems (GPS) ([Appendix A](#)). Point counts were conducted 23-26 May, 11-13 June, and 23-27 June 1998, and 8-9 June 1999. We compared number of species at Fox and Palmer Creeks with t-tests using the maximum number of species within each point over all point-count dates.

Figure 3. Point-count and transect locations at Tallgrass Prairie National Preserve, 1998-1999.



Transects

We also surveyed breeding, migratory, and resident birds using fixed-distance (100 x 500 m) strip transects. Transects were located throughout all habitats in the preserve and placed approximately 2414 m apart (Fig. 3). Of the 11 transects, six were located within burned and grazed native prairie, one in unburned and ungrazed prairie (including the Ranch Headquarters cedar grove), one in brome field, one in gallery forest along Fox Creek, one in gallery forest along Palmer Creek, and one at Red House Spring. We recorded the start and end locations of each transect using GPS (Appendix A). We walked slowly within each strip, trying to cover as much ground as possible by walking in a zig-zag pattern. We recorded all birds seen or heard within each strip. Counts were conducted bimonthly: 9-11 September 1998, 13 November 1998, 24 January 1999, 11 March 1999, 23-25 May 1999, and 15-16 August 1999. We calculated densities (birds per hectare) for each species by dividing the number of individual birds for each species by the area of the strip (100 x 500 m = 5 hectares). We compared densities and species diversity at Fox and Palmer Creeks using paired t-tests with sampling dates ($n = 6$) as pairs.

Habitat

We quantified basic habitat characteristics of the 23 burned and grazed, one unburned and ungrazed, five brome field, and three riparian/prairie points. We did not quantify habitat along Fox or Palmer Creeks or the Cedar Grove because the primary focus of this study was on grassland birds. We measured slope using a clinometer and aspect using a compass at each point. We then centered two 90-m transects on each bird point after randomly selecting their compass bearings. We then sampled vegetation every 15 m along each transect, resulting in 12 vegetation samples per point.

We used an ocular tube made by taping threads of monofilament line across a small, open ended steel can to determine percent canopy and ground cover (James and Shugart 1970). We determined canopy cover by looking directly overhead through the tube and recorded presence or absence of canopy cover where the threads crossed. We determined ground cover hits by looking through the tube at the ground, and recorded whether bare ground, rock, litter, grass, forb, or woody plant occurred where the threads crossed.

We measured litter depth and heights of the nearest grass, forb, and woody plant at each sampling point using a 1.2-m tall dowel marked at 1- and 10-cm intervals. We estimated the height of plants greater than 3.6 m. We used the same dowel to measure distribution of vegetation by recording contacts or “hits” in each 10-cm interval (Rotenberry and Weins 1980). Average hits in the first 10-cm interval were used as indices of spatial variation. We also created an index of spatial variation using a checkerboard with nine 3-cm² squares (Bibby et al. 1993). We placed the board vertically into the vegetation then walked away from the board until 50% of it was blocked by vegetation. We also calculated the coefficient of variation for grass, forb, and maximum vegetation height, and both of the indices of spatial variation to determine variation among sampling points within each bird point.

We estimated grass and forb density by the point-quarter sampling procedure (Weins 1973). At each point, we measured the distance to the nearest grass and forb. Both grass and forb density indices were calculated for each bird point by the equation:

$$\text{density index} = 1 \div (\sum d \div N)^2$$

where d = distance in cm to the nearest forb or grass, and N = number of samples per bird point (twelve).

RESULTS

We identified 132 bird species within the preserve boundaries combining point and transect surveys and incidental observations (Table 1). Fifteen species were considered grassland-associated species. We found direct evidence of nesting for 38 species including six of the grassland-associated species. Thirty-four additional species are believed to nest in the preserve, given the observations of singing males or general knowledge of the distribution of species within the Flint Hills (Table 1). Two species breeding at TAPR, European starling (*Sturnus vulgaris*) and house sparrow (*Melamprosops domesticus*), are exotic species.

Point Counts

A total of 52 species was recorded during breeding bird point counts including eleven grassland-associated species. Twenty species were found in burned and grazed prairie, eight in unburned and ungrazed prairie, 21 in brome fields, 31 at Fox Creek, 29 at Palmer Creek, and 28 in the riparian/prairie habitats (Tables 2 and 3). The five most abundant (relative to total birds

Table 1. Species list of birds found at Tallgrass Prairie National Preserve, Kansas, 1998-1999. Species shown in bold are grassland-associated species, ** indicates species known to nest at the preserve, * indicates species believed to nest at the preserve, # indicates exotic/introduced species.

Common Name	Scientific Name	May	June	September	November	January	March	May	June	August
Pied-billed Grebe	<i>Podilymbus podiceps</i>				X					
American White Pelican	<i>Pelecanus erythrorhynchos</i>						X			
* Great Blue Heron	<i>Ardea herodias</i>	X	X	X	X		X	X	X	X
Green Heron	<i>Butorides virescens</i>								X	
Turkey Vulture	<i>Cathartes aura</i>	X	X	X		X	X	X	X	X
Greater White-fronted Goose	<i>Anser albifrons</i>						X			
Snow Goose	<i>Chen caerulescens</i>				X		X			
Canada Goose	<i>Branta canadensis</i>	X				X	X			
** Wood Duck	<i>Aix sponsa</i>	X	X				X	X	X	X
Gadwall	<i>Anas strepera</i>				X		X			
American Wigeon	<i>Anas americana</i>						X			
Mallard	<i>Anas platyrhynchos</i>		X		X	X	X			
Blue-winged Teal	<i>Anas discors</i>				X		X			
Northern Pintail	<i>Anas acuta</i>						X			
Green-winged Teal	<i>Anas crecca</i>						X			
Unidentified Teal	<i>Anas spp.</i>		X		X	X				
Canvasback	<i>Aythya valisineria</i>						X			
Redhead	<i>Aythya americana</i>						X			
Ring-necked Duck	<i>Aythya collaris</i>				X		X			
Lesser Scaup	<i>Aythya affinis</i>						X			
Bufflehead	<i>Bucephala albeola</i>						X			
Common Goldeneye	<i>Bucephala clangula</i>					X	X			
Bald Eagle	<i>Haliaeetus leucocephalus</i>				X	X				
Northern Harrier	<i>Circus cyaneus</i>			X	X	X	X			
Swainson's Hawk	<i>Bueo swainsni</i>	X								
** Red-tailed Hawk	<i>Buteo jamaicensis</i>		X	X	X	X	X	X	X	X
Rough-legged Hawk	<i>Buteo lagopus</i>					X				
* American Kestrel	<i>Falco sparverius</i>	X		X	X	X				
Merlin	<i>Falco columbarius</i>						X			
** Greater Prairie-chicken	<i>Tympanuchus cupido</i>	X	X	X	X	X	X	X	X	X
* Wild Turkey	<i>Meleagris gallopavo</i>	X			X					
** Northern Bobwhite	<i>Colinus virginianus</i>	X	X	X	X				X	X
Sandhill Crane	<i>Grus canadensis</i>				X					
** Killdeer	<i>Charadrius virginianus</i>	X	X	X			X	X	X	X
** Upland Sandpiper	<i>Bartramia longicauda</i>	X	X					X	X	X
Common Snipe	<i>Gallinago gallinago</i>				X	X				
Unidentified Gull	<i>Larus spp.</i>				X		X			
Rock Dove	<i>Columba livia</i>						X		X	X
** Mourning Dove	<i>Zenaida macroura</i>	X	X	X		X	X	X	X	X
* Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>		X							
** Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	X	X	X					X	X
** Great Horned Owl	<i>Bubo virginianus</i>	X	X		X	X				X
Barred Owl	<i>Strix varia</i>			X						

Common Name	Scientific Name	May	June	September	November	January	March	May	June	August
** Common Nighthawk	<i>Chordeiles minor</i>	X	X	X				X	X	X
* Chimney Swift	<i>Chaetura pelagica</i>	X							X	
Ruby-throated Hummingbird	<i>Archilochus colubris</i>							X		
* Belted Kingfisher	<i>Cerle alcyon</i>	X		X	X			X	X	
* Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	X	X							
** Red-bellied Woodpecker	<i>Melanerpes carolinus</i>	X	X	X		X	X	X	X	
** Downy Woodpecker	<i>Picoides pubescens</i>	X	X	X	X	X	X			X
* Hairy Woodpecker	<i>Picoides villosus</i>			X	X	X	X		X	
** Northern Flicker	<i>Colaptes auratus</i>	X	X	X	X	X	X	X	X	
** Pileated Woodpecker	<i>Dryocopus pileatus</i>		X							
** Eastern Wood-pewee	<i>Contopus virens</i>	X	X	X					X	X
Yellow-bellied Flycatcher	<i>Empidonax flaviventris</i>	X	X							
* Acadian Flycatcher	<i>Empidonax virens</i>	X	X	X				X		
Least Flycatcher	<i>Empidonax minimus</i>			X						
** Eastern Phoebe	<i>Sayornis phoebe</i>	X	X	X				X	X	
** Great Crested Flycatcher	<i>Myiarchus crinitus</i>	X	X	X				X	X	
Western Kingbird	<i>Tyrannus verticalis</i>								X	
** Eastern Kingbird	<i>Tyrannus tyrannus</i>	X	X	X				X	X	X
** Scissor-tailed Flycatcher	<i>Tyrannus forficatus</i>	X	X	X				X	X	
* Loggerhead Shrike	<i>Lanius ludovicianus</i>		X		X					
White-eyed Vireo	<i>Vireo griseus</i>		X							
Yellow-throated Vireo	<i>Vireo flavifrons</i>		X							
Warbling Vireo	<i>Vireo gilvus</i>	X								
** Red-eyed Vireo	<i>Vireo olivaceus</i>	X	X						X	
** Blue Jay	<i>Cyanocitta cristata</i>	X	X	X	X			X	X	X
* American Crow	<i>Corvus brachyrhynchos</i>	X	X	X	X	X	X	X	X	X
* Horned Lark	<i>Eremophila alpestris</i>				X	X	X	X	X	X
** Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	X	X					X	X	X
** Bank Swallow	<i>Riparia riparia</i>	X		X					X	
** Barn Swallow	<i>Hirundo rustica</i>	X	X	X				X	X	X
** Black-capped Chickadee	<i>Poecile atricapillus</i>	X	X	X	X	X	X	X	X	X

Common Name	Scientific Name	May	June	September	November	January	March	May	June	August
** Tufted Titmouse	<i>Baeolophus bicolor</i>	X	X	X	X	X	X	X	X	X
* White-breasted Nuthatch	<i>Sitta carolinensis</i>	X	X	X	X	X	X	X	X	X
Brown Creeper	<i>Certhia americana</i>						X			
* Carolina Wren	<i>Thryothorus ludovicianus</i>	X	X	X		X	X	X	X	
** Bewick's Wren	<i>Thryothorus bewickii</i>		X		X					
* House Wren	<i>Troglodytes aedon</i>	X	X	X	X				X	
Winter Wren	<i>Troglodytes troglodytes</i>					X	X			
Blue-gray Gnatcatcher	<i>Po;ioptila caerulea</i>		X	X			X	X		
** Eastern Bluebird	<i>Sialia sialis</i>	X	X	X	X	X	X	X	X	X
Townsend's Solitaire	<i>Myadestes townsendi</i>					X	X			
Swainson's Thrush	<i>Catharus ustulatus</i>							X		
** American Robin	<i>Turdus migratorius</i>	X	X	X		X	X	X	X	X

Common Name	Scientific Name	May	June	September	November	January	March	May	June	August
* Gray Catbird	<i>Dumetella carolinensis</i>	X		X					X	
* Northern Mockingbird	<i>Mimus polyglottos</i>	X	X	X				X	X	
* Brown Thrasher	<i>Toxostoma rufum</i>	X	X	X				X	X	
** # European Starling	<i>Sturnus vulgaris</i>	X	X	X	X	X	X	X	X	
Cedar Waxwing	<i>Bombycilla cedrorum</i>									
Tennessee Warbler	<i>Vermivora peregrina</i>								X	
* Northern Parula	<i>Parula americana</i>	X	X	X						
Yellow Warbler	<i>Dendroica petechia</i>	X								
Palm Warbler	<i>Dendroica palmarum</i>				X					
American Redstart	<i>Mniotilta ruticilla</i>				X					
Mourning Warbler	<i>Oporornis philadelphia</i>				X					
* Common Yellowthroat	<i>Oporornis formosus</i>	X							X	
* Yellow-breasted Chat	<i>Geothlypis trichas</i>		X							
* Summer Tanager	<i>Piranga rubra</i>			X					X	
** Eastern Towhee	<i>Pipilo erythrophthalmus</i>	X	X		X			X		
American Tree Sparrow	<i>Torreornis arborea</i>				X	X	X			
* Chipping Sparrow	<i>Spizella passerina</i>	X			X			X	X	
* Field Sparrow	<i>Spizella pusilla</i>		X	X				X		
Vesper Sparrow	<i>Spizella gramineus</i>							X		
* Lark Sparrow	<i>Chondestes grammacus</i>	X	X	X					X	X
Savannah Sparrow	<i>Passerculus sandwichensis</i>				X	X	X			
** Grasshopper Sparrow	<i>Ammodramus savannarum</i>	X	X	X	X			X	X	X
Fox Sparrow	<i>Xenospiza iliaca</i>				X	X	X			
Song Sparrow	<i>Passerella melodia</i>				X	X	X			
White-throated Sparrow	<i>Zonotrichia albicollis</i>				X	X				
Harris' Sparrow	<i>Zonotrichia querula</i>				X	X	X			
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>				X					
Dark-eyed Junco	<i>Junco hyemalis</i>				X	X	X			
Lapland Longspur	<i>Calcarius lapponicus</i>				X	X	X			
Smith's Longspur	<i>Calcarius pictus</i>				X	X	X			
** Northern Cardinal	<i>Cardinalis cardinalis</i>	X	X	X	X	X	X	X	X	X
* Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>	X						X		
* Blue Grosbeak	<i>Cyanocompsa caerulea</i>								X	
* Indigo Bunting	<i>Passerina cyanea</i>	X	X	X				X	X	X
** Dickcissel	<i>Spiza amercana</i>	X	X	X				X	X	X
** Red-winged Blackbird	<i>Agelaius phoeniceus</i>	X	X		X	X	X	X	X	
** Eastern Meadowlark	<i>Sturnella magna</i>	X	X	X			X	X	X	X
Western Meadowlark	<i>Sturnella neglecta</i>	X			X	X				
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>				X					
* Common Grackle	<i>Quiscalus quiscula</i>	X	X	X				X	X	
* Great-tailed Grackle	<i>Quiscalus mexicanus</i>		X	X			X			X
** Brown-headed Cowbird	<i>Molothrus ater</i>	X	X					X	X	X
** Orchard Oriole	<i>Icterus parisorum</i>	X	X						X	X
* Baltimore Oriole	<i>Icterus galbula</i>	X	X						X	
* Oriole Integrate	<i>Icterus spp.</i>							X	X	X
Purple Finch	<i>Carpodacus purpureus</i>				X		X			
* American Goldfinch	<i>Carduelis tristis</i>	X	X	X	X	X			X	
* # House Sparrow	<i>Melampus domesticus</i>	X	X	X	X				X	

seen within 100-m radius points) breeding species at TAPR were all grassland-associated: eastern meadowlark (19.0%), grasshopper sparrow (14.8%), dickcissel (11.7%), brown-headed cowbird (11.1%), and upland sandpiper (6.0%). Eastern meadowlark (EAME), grasshopper sparrow (GRSP), brown-headed cowbird (BHCO), and upland sandpiper (UPSA) were the four most abundant species in burned and grazed prairie, while dickcissel (DICK), eastern meadowlark, grasshopper sparrow, and northern bobwhite (NOBO) were the most abundant in unburned and ungrazed prairie (Fig. 3). Dickcissel, eastern meadowlark, and red-winged blackbird (RWBL) were most abundant in brome fields. In forested habitats black-capped chickadee (BCCH), eastern tufted titmouse (ETTI), indigo bunting (INBU) and dickcissel were most abundant at Fox Creek, while black-capped chickadee, brown-headed cowbird, blue jay (BLJA), and dickcissel were most abundant at Palmer Creek (Fig 3). Species diversity (number of species) in the gallery forest was higher at Fox Creek (mean = 10.2, SE = 0.8) than Palmer Creek (mean = 7.4, SE = 0.8) during the point-counts period ($t = 2.55$, $df = 15$, $P = 0.02$).

Transects

We recorded 72 species on transect counts including 11 grassland-associated species. We found 17 species in burned and grazed prairie, 35 in unburned and ungrazed prairie (including the Ranch Headquarters cedar grove), 13 in brome fields, 39 at Fox Creek, 24 at Palmer Creek, and 47 in riparian/prairie habitats (Tables 4 and 5). Bird density (average number of birds per

Table 2. Breeding birds found in grassland habitats at Tallgrass Prairie National Preserve, Kansas, 1998-1999, as determined by point counts (excluding swallows and raptors). Species shown in bold are grassland-associated.

Common Name	Burned and Grazed Prairie (23 points)		Unburned and Ungrazed Prairie (1 point)		Brome Field (5 points)	
	Total	Relative Abundance	Total	Relative Abundance	Total	Relative Abundance
Northern Bobwhite	12	0.8	3	8.3	1	0.6
Killdeer	18	1.3	—	—	11	6.6
Upland Sandpiper	162	11.2	—	—	—	—
Mourning Dove	18	1.3	1	2.8	—	—
Downy Woodpecker	—	—	—	—	3	1.8
Common Nighthawk	57	3.9	—	—	1	2.8
Eastern Wood-pewee	—	—	—	—	3	1.8
Great Crested Flycatcher	—	—	—	—	3	1.8
Eastern Kingbird	4	0.3	—	—	—	—
Red-eyed Vireo	—	—	—	—	1	0.6
Blue Jay	—	—	—	—	6	3.6
American Crow	2	0.1	—	—	1	0.6
Horned Lark	1	0.1	—	—	—	—
Eastern Titmouse	—	—	—	—	3	1.8
Black-capped Chickadee	—	—	—	—	8	4.8
White-breasted Nuthatch	—	—	—	—	1	0.6
House Wren	—	—	—	—	5	3.0
Eastern Bluebird	1	0.1	—	—	—	—
Northern Mockingbird	2	0.1	—	—	—	—
Yellow-breasted Chat	—	—	—	—	1	0.6
Grasshopper Sparrow	394	27.3	3	8.3	—	—
Northern Cardinal	—	—	—	—	6	3.6
Indigo Bunting	—	—	1	2.8	4	2.4
Dickcissel	158	10.9	13	36.1	43	25.6
Red-winged Blackbird	6	0.4	2	5.6	19	11.3
Eastern Meadowlark	408	28.3	25	14.9	46	27.8
Western Meadowlark	1	0.1	—	—	—	—
Common Grackle	4	0.3	—	—	—	—
Great-tailed Grackle	—	—	—	—	3	1.8
Brown-headed Cowbird	193	13.4	1	2.8	14	8.3
Orchard Oriole	1	0.1	—	—	—	—
Baltimore Oriole	1	0.1	—	—	—	—

Table 3. Breeding birds found in riparian habitats at Tallgrass Prairie National Preserve, Kansas, 1998-1999, as determined by point counts (excluding swallows and raptors). Species shown in bold are grassland-associated.

Common Name	Fox Creek Gallery Forest (9 points)		Palmer Creek Gallery Forest (8 points)		Prairie/Riparian (3 points)	
	Total	Relative Abundance	Total	Relative Abundance	Total	Relative Abundance
Great Blue Heron	—	—	2	0.6	—	—
Wood Duck	13	2.7	—	—	—	—
Northern Bobwhite	—	—	—	—	7	3.0
Killdeer	1	0.2	2	0.6	—	—
Upland Sandpiper	—	—	—	—	3	1.3
Mourning Dove	—	—	8	2.4	6	2.6
Yellow-billed Cuckoo	21	4.3	10	3.0	5	2.2
Common Nighthawk	—	—	4	1.2	2	0.9
Belted Kingfisher	—	—	5	1.5	—	—
Red-headed Woodpecker	2	0.4	—	—	—	—
Red-bellied Woodpecker	22	4.5	9	2.7	4	1.7
Hairy Woodpecker	1	0.2	—	—	—	—
Downy Woodpecker	18	3.7	6	1.8	—	—
Northern Flicker	—	—	1	0.3	1	0.4
Pileated Woodpecker	2	0.4	—	—	—	—
Eastern Wood-pewee	23	4.7	14	4.2	—	—
Acadian Flycatcher	1	0.2	3	0.9	—	—
Eastern Phoebe	2	0.4	4	1.2	4	1.7
Great Crested Flycatcher	20	4.1	11	3.3	6	2.6
Eastern Kingbird	2	0.4	4	1.2	8	3.5
Scissor-tailed Flycatcher	—	—	1	0.3	3	1.3
Yellow-throated Vireo	1	0.2	—	—	—	—
Warbling Vireo	—	—	1	0.3	—	—
Red-eyed Vireo	7	1.4	1	0.3	—	—
Blue Jay	23	4.7	27	8.0	5	2.2
American Crow	26	5.3	8	2.4	—	—
Black-capped Chickadee	55	11.3	48	14.2	5	2.2
Eastern Titmouse	44	10.9	15	4.5	2	0.9
White-breasted Nuthatch	8	1.6	5	1.5	—	—
Blue-gray Gnatcatcher	11	2.3	5	1.5	—	—
Bewick's Wren	—	—	1	0.3	—	—
Carolina Wren	10	1.8	—	—	—	—
House Wren	7	1.4	5	1.5	—	—
Eastern Bluebird	5	1.0	8	2.4	6	2.6
American Robin	3	0.6	5	1.5	3	1.3
Northern Mockingbird	—	—	5	1.5	3	1.3
Brown Thrasher	1	0.2	1	0.3	2	0.9
European Starling	2	0.4	—	—	10	4.3
Northern Parula	11	2.3	3	0.9	—	—

Common Name	Fox Creek Gallery Forest (9 points)		Palmer Creek Gallery Forest (8 points)		Prairie/Riparian (3 points)	
	Total	Relative Abundance	Total	Relative Abundance	Total	Relative Abundance
Yellow Warbler	1	0.2	—	—	—	—
Summer Tanager	1	0.2	—	—	—	—
Eastern Towhee	—	—	2	0.6	1	0.4
Field Sparrow	1	0.2	2	0.6	—	—
Grasshopper Sparrow	2	0.4	1	0.3	9	3.9
Lark Sparrow	4	0.8	—	—	—	—
Song Sparrow	—	—	—	—	2	0.9
Northern Cardinal	16	3.3	7	2.1	—	—
Rose-breasted Grosbeak	—	—	1	0.3	1	0.4
Blue Grosbeak	1	0.2	—	—	1	0.4
Indigo Bunting	33	6.6	9	2.7	2	0.9
Dickcissel	31	6.3	17	5.0	57	24.6
Red-winged Blackbird	6	1.2	2	0.6	2	0.9
Eastern Meadowlark	29	5.9	15	4.5	36	15.5
Common Grackle	1	0.2	—	—	—	—
Brown-headed Cowbird	20	4.1	48	4.2	26	11.2
Baltimore Oriole	—	—	5	1.5	1	0.4
House Sparrow	2	3.6	—	—	—	—
American Goldfinch	—	—	4	1.2	3	1.3

Figure 4. Relative abundance (% of total) of the four most common breeding bird species found in the major habitats at Tallgrass Prairie National Preserve, Kansas, 1998-1999 (see text on page 13 for definition of species codes).

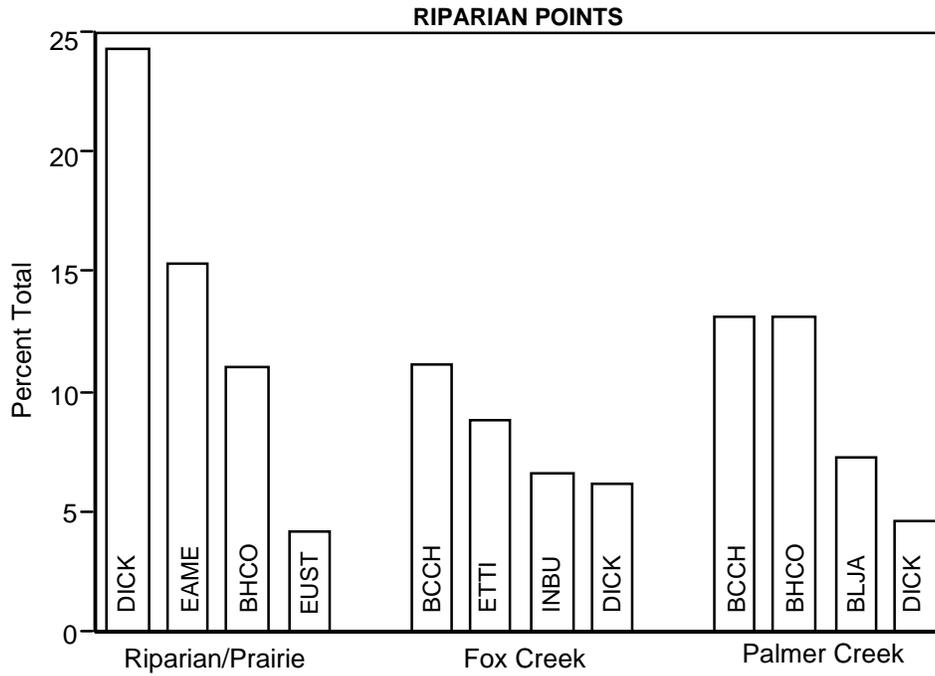
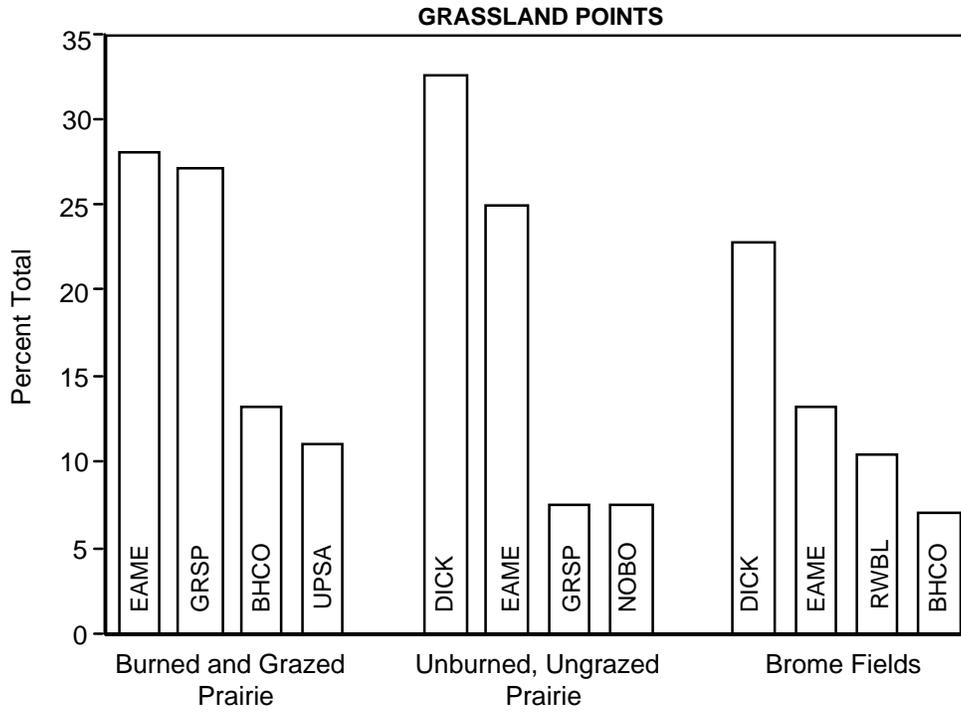


Table 4. Densities of birds found in grassland habitats at Tallgrass Prairie National Preserve, Kansas, 1998-1999, as determined by strip-transects. Species shown in bold are grassland-associated.

Common Name	Burned and Grazed Prairie (6 transects)		Unburned and Ungrazed Prairie (1 transect)		Brome Field (1 transect)	
	Total	Birds/ha	Total	Birds/ha	Total	Birds/ha
Killdeer	9	1.8	1	0.2	1	0.2
Upland Sandpiper	6	1.2	0	0	0	0
Mourning Dove	8	1.6	6	1.2	0	0
Belted Kingfisher	1	0.2	0	0	0	0
Red-bellied Woodpecker	0	0	3	0.6	0	0
Downy Woodpecker	0	0	0	0	3	0.6
Northern Flicker	0	0	2	0.4	0	0
Eastern Wood-pewee	0	0	1	0.2	0	0
Least Flycatcher	0	0	1	0.2	0	0
Eastern Phoebe	0	0	3	0.6	0	0
Great Crested Flycatcher	0	0	1	0.2	0	0
Eastern Kingbird	2	0.4	0	0	0	0
Scissor-tailed Flycatcher	0	0	6	1.2	0	0
American Crow	0	0	4	0.8	0	0
Horned Lark	30	6	0	0	0	0
Black-capped Chickadee	0	0	30	6	0	0
Eastern Titmouse	0	0	1	0.2	0	0
Carolina Wren	0	0	5	1	0	0
Blue-gray Gnatcatcher	0	0	1	0.2	0	0
Eastern Bluebird	0	0	1	0.2	1	0.2
Townsend's Solitaire	0	0	1	0.2	0	0
American Robin	0	0	1	0.2	16	3.2
Brown Thrasher	0	0	8	1.6	0	0
European Starling	0	0	16	3.2	0	0
Palm Warbler	0	0	1	0.2	0	0
Summer Tanager	0	0	1	0.2	0	0
Eastern Towhee	0	0	2	0.4	0	0
American Tree Sparrow	0	0	3	0.6	0	0
Savannah Sparrow	2	0.4	1	0.2	4	0.8
Grasshopper Sparrow	65	13	1	0.2	3	0.6
Fox Sparrow	0	0	6	1.2	0	0
Harris' Sparrow	0	0	14	2.8	0	0
Dark-eyed Junco	1	0.2	2	0.4	0	0
Lapland Longspur	77	15.4	0	0	1	0.2
Smith's Longspur	136	27.2	0	0	0	0
Northern Cardinal	0	0	8	1.6	0	0
Dickcissel	3	0.6	5	1	39	7.8
Red-winged Blackbird	50	10	1	0.2	4	0.8
Eastern Meadowlark	83	16.6	14	2.8	14	2.8
Western Meadowlark	11	2.2	0	0	1	0.2

Common Name	Burned and Grazed Prairie (6 transects)		Unburned and Ungrazed Prairie (1 transect)		Brome Field (1 transect)	
	Total	Birds/ha	Total	Birds/ha	Total	Birds/ha
Brewer's Blackbird	0	0	3	0.6	0	0
Common Grackle	0	0	0	0	34	6.8
Brown-headed Cowbird	5	1	3	0.6	6	1.2
American Goldfinch	4	0.8	1	0.2	0	0

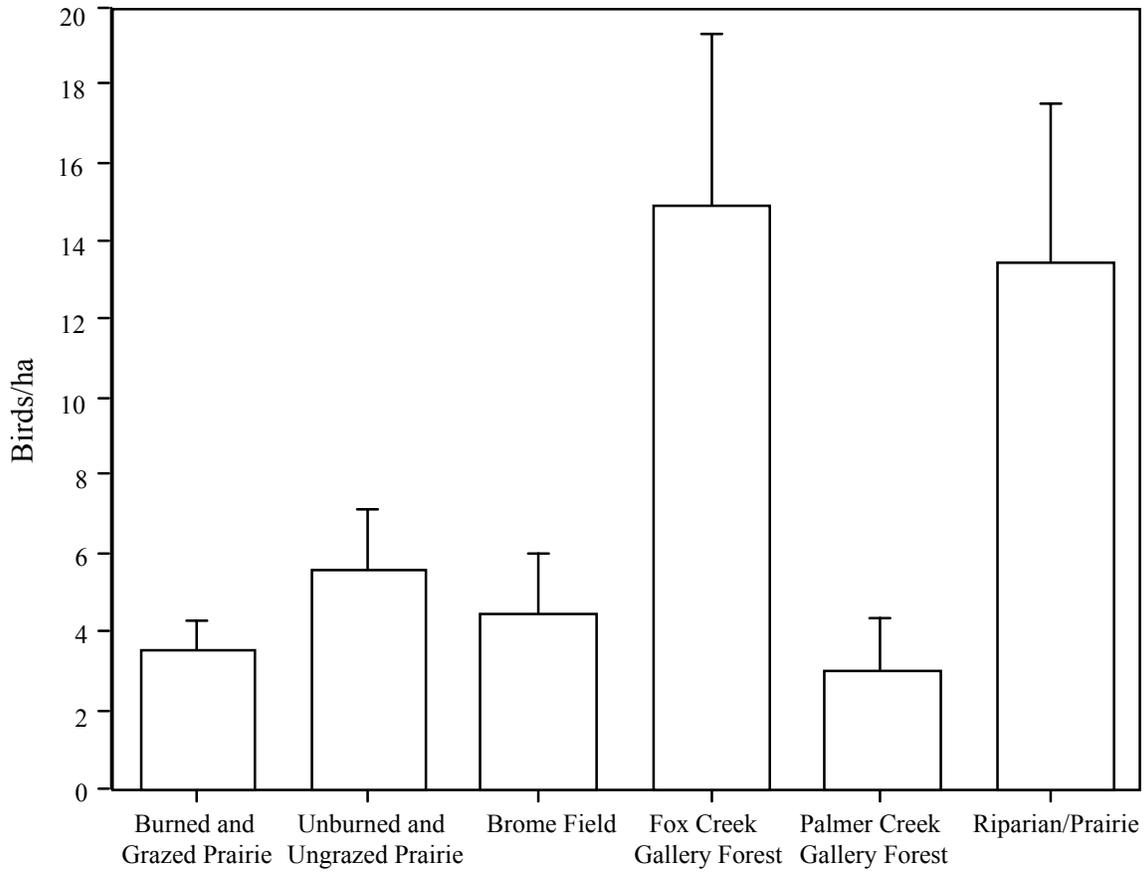
Table 5. Densities of birds found in riparian habitats at Tallgrass Prairie National Preserve, Kansas, 1998-1999, as determined by strip-transects. Species shown in bold are grassland-associated.

Common Name	Fox Creek Gallery Forest (1 transect)		Palmer Creek Gallery Forest (1 transect)		Riparian/Prairie (1 transect)	
	Total	Birds/ha	Total	Birds/ha	Total	Birds/ha
Killdeer	0	0	0	0	3	0.6
Mourning Dove	0	0	2	0.4	41	8.2
Yellow-billed Cuckoo	3	0.6	1	0.2	2	0.4
Ruby-throated Hummingbird	1	0.2	0	0	0	0
Belted Kingfisher	0	0	2	0.4	3	0.6
Red-bellied Woodpecker	9	1.8	1	0.2	4	0.8
Downy Woodpecker	15	3	3	0.6	3	0.6
Hairy Woodpecker	3	0.6	0	0	8	1.6
Northern Flicker	15	3	3	0.6	13	2.6
Eastern Wood-pewee	4	0.8	3	0.6	0	0
Acadian Flycatcher	2	0.4	0	0	0	0
Least Flycatcher	1	0.2	0	0	3	0.6
Eastern Phoebe	0	0	1	0.2	0	0

Common Name	Fox Creek Gallery Forest (1 transect)		Palmer Creek Gallery Forest (1 transect)		Riparian/Prairie (1 transect)	
	Total	Birds/ha	Total	Birds/ha	Total	Birds/ha
Great Crested Flycatcher	2	0.4	2	0.4	5	1
Eastern Kingbird	0	0	0	0	16	3.2
Scissor-tailed Flycatcher	0	0	0	0	2	0.4
Loggerhead Shrike	0	0	0	0	1	0.2
Blue Jay	3	0.6	8	1.6	0	0
American Crow	16	3.2	0	0	1	0.2
Horned Lark	0	0	0	0	10	2
Black-capped Chickadee	51	10.2	21	4.2	20	4
Tufted Titmouse	18	3.6	17	3.4	9	1.8
White-breasted Nuthatch	12	2.4	1	0.2	0	0
Brown Creeper	1	0.2	0	0	0	0
Carolina Wren	9	1.8	5	1	2	0.4
Bewick's Wren	1	0.2	0	0	0	0
House Wren	4	0.8	0	0	2	0.4
Winter Wren	2	0.4	0	0	0	0
Blue-gray Gnatcatcher	2	0.4	0	0	0	0
Eastern Bluebird	2	0.4	2	0.4	21	4.2
Swainson's Thrush	0	0	1	0.2	0	0
American Robin	57	11.4	1	0.2	9	1.8
Brown Thrasher	0	0	0	0	7	1.4
European Starling	30	6	0	0	6	1.2
Cedar Waxwing	6	1.2	0	0	0	0
Northern Parula	4	0.8	0	0	0	0
Summer Tanager	2	0.4	0	0	0	0
Eastern Towhee	0	0	1	0.2	0	0
American Tree Sparrow	93	18.6	1	0.2	75	15
Chipping Sparrow	2	0.4	0	0	38	7.6
Field Sparrow	0	0	0	0	45	9
Vesper's Sparrow	0	0	0	0	1	0.2
Lark Sparrow	0	0	0	0	2	0.4
Savannah Sparrow	3	0.6	0	0	0	0
Grasshopper Sparrow	0	0	0	0	5	1
Fox Sparrow	7	1.4	0	0	26	5.2
Song Sparrow	7	1.4	2	0.4	38	7.6
White-throated Sparrow	0	0	0	0	18	3.6
Harris' Sparrow	20	4	0	0	62	12.4
White-crowned Sparrow	0	0	0	0	3	0.6
Dark-eyed Junco	76	15.2	2	0.4	51	10.2
Lapland Longspur	0	0	0	0	10	2
Smith's Longspur	0	0	0	0	15	3
Northern Cardinal	6	1.2	0	0	2	0.4
Indigo Bunting	7	1.4	1	0.2	0	0
Dickcissel	0	0	0	0	22	4.4

Common Name	Fox Creek Gallery Forest (1 transect)		Palmer Creek Gallery Forest (1 transect)		Riparian/Prairie (1 transect)	
	Total	Birds/ha	Total	Birds/ha	Total	Birds/ha
Red-winged Blackbird	1	0.2	0	0	3	0.6
Eastern Meadowlark	0	0	0	0	25	5
Brown-headed Cowbird	0	0	1	0.2	24	4.8
Orchard Oriole	0	0	0	0	5	1
Oriole Integrade	0	0	0	0	4	0.8
Purple Finch	2	0.4	0	0	7	1.4
American Goldfinch	10	2	0	0	0	0

Figure 5. Density (mean birds per hectare \pm SE) of birds per habitat type found on strip-transects at Tallgrass Prairie National Preserve, Kansas, 1998-1999.



hectare) was higher at Fox Creek gallery forest (14.9 ± 4.4 birds/ha) than Palmer Creek gallery forest (2.9 ± 3.1 birds/ha) over the course of one year ($t = 2.41$, $df = 5$, $P = 0.06$) (Fig. 4). Also, species diversity was significantly higher at Fox Creek (15.6 ± 1.6) than Palmer Creek (5.0 ± 1.2) gallery forest ($t = 4.46$, $df = 5$, $P = 0.007$). Average bird density at TAPR varied seasonally and peaked in November (Fig. 5).

Habitat

Unburned and ungrazed prairie had the highest percentage of litter and grass cover and riparian/prairie habitat had the highest percentage of canopy cover, bare ground, forb cover, and woody plant cover of the bird points (Table 6). No canopy cover or woody plant cover was recorded for burned and grazed prairie, unburned and ungrazed prairie, or brome field bird points. Percent bare ground was lowest in unburned and ungrazed prairie, percent litter and grass cover were lowest in riparian/prairie, the lowest percent forb cover was observed in brome field. Litter depth was deepest in unburned an ungrazed prairie and lowest in burned and grazed prairie. Grass height was tallest in the brome field and shortest in burned and grazed prairie. Forb height was tallest in unburned and ungrazed prairie and shortest in riparian/prairie habitat. Vertical and horizontal plant density was greatest in unburned and ungrazed prairie and brome field, grass density was greatest in burned and grazed prairie, and forb density was greatest in riparian/prairie habitat. Spatial variation in grass height was relatively similar among the habitat types but variation in forb height and maximum plant height was greatest in the riparian/prairie

Figure 6. Density (mean birds per hectare \pm SE) of birds found on strip-transects during one year at Tallgrass Prairie National Preserve, Kansas, during two months in 1998 and four months in 1999.

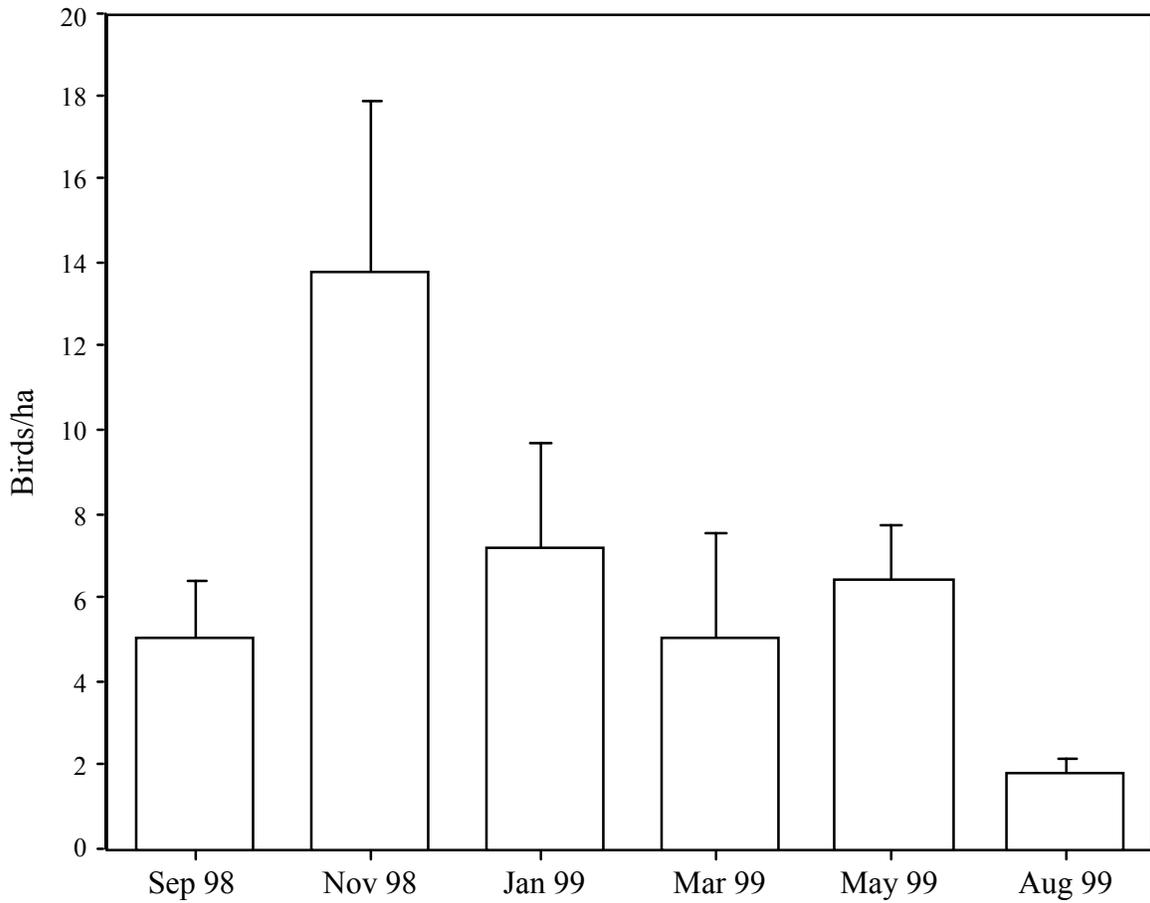


Table 6. Habitat variables (means ± SD) of grassland bird points at Tallgrass Prairie National Preserve, Kansas, 1999.

Habitat Variable	Burned and Grazed (23 pts)	Unburned and Ungrazed (1 pt)	Brome Field (5 pts)	Riparian/Prairie (3 pts)	All (32 pts)
Slope	2.4 ± 2.6	5.5	0.6 ± 0.8	1.7 ± 1.7	N/A
Aspect	62.1 ± 80.8	35	29.2 ± 34.6	100.7 ± 130.6	N/A
% Woody Cover	0.0	0.0	0.0	2.8	0.7
% Bare Ground	8.0	0.0	1.7	13.9	7.3
% Litter Cover	1.4	16.7	5.0	0.0	6.0
% Grass Cover	60.2	66.7	90.0	30.6	62.4
% Forb Cover	29.2	16.7	3.3	47.2	26.3
Average Litter Depth (cm)	0.0 ± 0.2	9.0 ± 4.7	1.3 ± 1.1	0.2 ± 0.5	0.6 ± 1.9
Average Grass Height (cm)	13.9 ± 9.5	23.7 ± 9.4	50.2 ± 32.2	16.1 ± 11.1	20.3 ± 20.6
Average Forb Height (cm)	15.9 ± 10.8	33.2 ± 7.4	33.9 ± 22.1	19.4 ± 13.1	19.7 ± 15.1
Average Vertical Hits	6.0 ± 3.9	5.9 ± 3.1	11.0 ± 8.6	5.9 ± 5.0	6.8 ± 5.4
Cover Index	10.9 ± 8.8	2.6 ± 2.2	11.4 ± 15.7	15.5 ± 15.3	11.1 ± 11.0
Grass-Density Index*	2.0 ± 4.5	3.6 ± 2.0	7.1 ± 16.9	4.4 ± 8.9	3.1 ± 8.5
Forb-Density Index*	8.3 ± 9.3	10.3 ± 7.0	79.4 ± 177.3	10.0 ± 24.2	19.8 ± 76.1

* Indices have inverse relationships with density (larger numbers indicate less density of grass and forbs).

and least in the unburned and ungrazed prairie. Spatial variation in vertical plant density was greatest in the brome field and lowest in the burned and grazed prairie. Spatial variation in horizontal plant density was greatest in the riparian/prairie and lowest in the burned and grazed prairie.

DISCUSSION

Based on published species distributions and Breeding Bird Survey data for eastern Kansas, we observed most of the species we expected to find at TAPR and future monitoring will likely expand the species list by increasing observations of rare birds and migrants. The most abundant breeding grassland species, eastern meadowlark, grasshopper sparrow, and upland sandpiper, are all species that have shown significant population declines across the United States. TAPR falls within the Rolling Red Prairie physiographic region of the Breeding Bird Survey, where field sparrow, grasshopper sparrow, eastern meadowlark, and brown-headed cowbird populations have declined significantly over the past 32 years ([Table 7](#)). Eastern meadowlark has shown significant declines within the Rolling Red Prairie physiographic region and Kansas, but was the most abundant breeding species in the burned and grazed prairie at TAPR as determined by both point count and strip-transect methods.

Nearly all of the breeding bird species characteristic of tallgrass prairie habitat within the Flint Hills were recorded at TAPR. Exceptions were common yellowthroat, Henslow's sparrow

Table 7. Population trends for breeding grassland birds found at Tallgrass Prairie National Preserve, Kansas, 1998 and 1999. Trends for the physiographic region, state, and nation were derived from North American Breeding Bird Survey data. * denotes $P \leq 0.05$, ** denotes $P \leq 0.01$, trend is significantly different than zero (Sauer et al. 1999).

Species	Rolling Red Prairie Region			Kansas			United States		
	1966-98	1966-79	1980-98	1966-98	1966-79	1980-98	1966-98	1966-79	1980-98
Greater Prairie-Chicken	n/a	n/a	n/a	-5.7	n/a	-8.2	6.2	18.2**	-3.8
Northern Bobwhite	0.1	0.8	-0.6	-0.8	-0.8	0	-2.7**	-0.6	-3.5**
Upland Sandpiper	2.2*	12.5*	-1.3	2.3*	6.8*	-1.6	1.0*	3.3**	-1.3*
Field Sparrow	-3.5*	-4.1	0.4	-0.1	-3.0	3.2*	-3.1**	-5.1**	-2.2**
Grasshopper Sparrow	-3.5*	5.4	-2.0	-2.2**	2.9*	-2.3	-3.4**	-4**	-2.1**
Dickcissel	0.2	-0.9	0.1	0.4	-1.0	1.4**	-1.5**	-4.7**	0.20
Red-winged Blackbird	1.6	4.8*	0.4	-0.1	1.7	-0.5	-1.0**	0.6*	-0.9**
Eastern Meadowlark	-1.9**	-0.3	-1.9*	-2.3**	-3.1*	-2.2**	-2.7**	-1.1**	-3.0**
Common Grackle	-0.7	7.2*	-3.4	-0.4	1.6	-1.7	-1.6**	0	-2.0**
Brown-headed Cowbird	-1.8**	-0.5	0.4	-0.6	1.1	0.8*	-0.8**	1.1**	-0.5*

(*Ammodramus henslowii*) and sedge wren (*Cistothorus platensis*). TAPR is at the western periphery of breeding ranges for Henslow's sparrow and sedge wren. In addition, all three species are unlikely to occur on moderately to heavily grazed lands or recently or frequently burned areas (Zimmerman 1993, Herkert 1994, Sample and Mossman 1997, Johnson and Igl 1999). Henslow's sparrows are associated with habitats that include a well-developed litter layer, high cover of dead residual vegetation, and tall, dense vegetation (Johnson and Igl 1999). The combination of frequent burning and heavy grazing reduces litter, standing dead vegetation, and vegetation height and density. The small unburned, ungrazed Southwind Nature Trail prairie area was probably not large enough to support Henslow's sparrow because the species is also area sensitive (Herkert et al. 1993). Sedge wrens are moderately area sensitive, and nest in the tallgrass prairie of Kansas late in the season (July through October) except during drought years (Zimmerman 1993). Sedge wrens may not occur at TAPR or may have been absent during the duration of this study. It is also possible that we did not observe sedge wrens at TAPR due to their late seasonal occurrence or the small proportion of moist meadow habitat at TAPR. Zimmerman (1992) found higher densities of upland sandpiper in burned, ungrazed prairie but densities of mourning dove, common yellowthroat, dickcissel, grasshopper sparrow, and eastern meadowlark were higher in unburned, ungrazed prairie on Konza Prairie Natural Area, Kansas. He did not find Henslow's sparrows on burned prairie there, but they were present on unburned areas (Zimmerman 1992).

Avian species diversity is low in grassland habitats compared to forests (Cody 1966). Variation in species diversity among grassland habitats at TAPR most likely reflected differences in habitat-area and number of points per habitat rather than avian preferences for a given habitat type. For example, only a small proportion of the prairie was unburned and ungrazed

(Southwind Nature Trail prairie area) and thus it had only one point location. Eastern meadowlark and dickcissel, however, both comprised a large proportion of the total number of birds for all of the grassland habitats. Both species are associated with tallgrass prairie habitats and are relatively tolerant of moderately grazed and frequently burned areas. However, eastern meadowlarks prefer areas with some litter cover and dickcissels prefer areas with moderately deep litter for breeding (Zimmerman 1993, Johnson and Igl 1999). These two species also made up a large proportion of number of birds in the riparian forest habitats because the narrow riparian zones were surrounded by prairie. Within burned and grazed prairie, upland sandpipers and grasshopper sparrows had high relative abundance. Grasshopper sparrows and upland sandpipers prefer to forage in short, sparse vegetation, which was provided in the burned and grazed prairie (Johnson and Igl 1999). Grasshopper sparrows were never observed in the brome fields, dominated by rhizominous smooth brome, probably because they prefer areas with moderately tall, clumped vegetation interspersed with bare patches of ground (Johnson and Igl 1999). In contrast, red-winged blackbirds were commonly seen within brome field, the habitat with the tallest grasses and no bare ground. Red-winged blackbirds were likely attracted to the brome fields since the ground was fairly moist in the spring and tall, and the dense grasses could be used for territorial perches and for nesting.

The majority of bird species at TAPR occurred in forested riparian areas. Species diversity was higher at Fox Creek than Palmer Creek during the breeding season as well as year-round, possibly due to the wider riparian zone and seemingly more dense and mature gallery forest. Several forest-bird species were very abundant at both creeks including eastern titmouse, black-capped chickadee, and blue jay.

MANAGEMENT RECOMMENDATIONS

Most grassland bird species evolved with a mosaic of habitat patches that changed over time. These mosaics were the result of interactions among fire, grazing, and climate (Heibert 1998). Many grassland species still rely on a mosaic of habitat types for different aspects of their life histories (Johnson and Igl 1999). For example, some grassland bird species need short, sparse vegetation for foraging and tall, dense vegetation for nesting.

Fire is an important tool for creating landscape heterogeneity, controlling woody vegetation, reducing litter build-up, and increasing grass and forb production and diversity. To best benefit birds, burns should be scheduled before the breeding season and in the fall (Sample and Mossman 1997). Burning for livestock forage management in the Flint Hills usually occurs in April, when early nests of greater prairie-chickens and mourning doves will be destroyed (Zimmerman 1997). Rotational burning, every 2 to 5 years with variable frequency and seasonality is considered best for promoting diverse grasslands, and best mimics historic burn cycles (Heibert 1998). Yearly, same season burning decreases landscape and plant species diversity and discourages bird species that require residual vegetation (Sample and Mossman 1997, Heibert 1998). However, individual bird species differ in their tolerance for burned areas with some birds responding positively to newly burned sites while other species can not tolerate areas after burning (Herkert 1993, Sample and Mossman 1997, Johnson and Igl 1999). For example, management practices that favor Henslow's sparrows may not be optimal for grasshopper sparrows and dickcissels, but Henslow's sparrows are much more rare (Swengel 1996).

Grazing can also be used to create landscape heterogeneity, control woody plant species, reduce litter build-up, and reduce vegetation height and density, and often results in greater

vegetation diversity than burning (Sample and Mossman 1997). Areas should not be heavily grazed, however, because heavily grazed areas rarely provide adequate nesting habitat for bird species of management concern (Sample and Mossman 1997). Grazing depresses the numbers of grassland-dependent birds, however, when combined with burning regimes (Zimmerman 1997). Most bird species respond best to light grazing intensities with a rotation grazing regime in which some sections are grazed while others are left ungrazed (Herkert 1993). Leaving some areas unburned and ungrazed for several years will also promote grazing and burning intolerant prairie species such as Henslow's sparrows and sedge wrens (Johnson and Igl 1999). If possible, areas should be left ungrazed until late in the nesting season and grazing should be discontinued soon enough in the fall to allow vegetation regrowth before dormancy (Sample and Mossman 1997).

Finally, many grassland-dependent bird species are area sensitive. Management practices that affect patches of continuous prairie habitat, including grazing and burning, should be planned in such a way that large enough areas are created to support breeding birds. For example, dickcissels and Henslow's sparrows are more abundant in larger prairies (Herkert 1994, Swengel 1996). TAPR is already divided into large pastures, separated by fencing. This partitioning is ideal for applying different management regimes to large areas to create a mosaic of habitats within TAPR. For example, each pasture could be burned on a different rotational scheme in different years.

We believe that it is important for the TAPR to continue a long-term bird monitoring because it will allow managers to assess the response of bird populations to changes in land-management. Future monitoring needs to include additional methods to inventory and monitor greater prairie chickens, raptors, swallows, and nightjars at TAPR. Finally, future research

should also assess the impacts of grazing and burning on reproductive success of selected avian species at TAPR.

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APPENDIX A: GPS Locations of Point Counts and Strip Transects at TAPR, 1998-1999.

Point Locations						
Point	Location	Habitat	Easting	Northing	Elevation (m)	Error (m)
GP1	Gas House	Burned & Grazed Prairie	0711220	4260045	420	8
GP2	Gas House	Burned & Grazed Prairie	0710418	4260244	428	7.8
GP3	Gas House	Burned & Grazed Prairie	0709976	4260864	461	7.6
GP4	West Traps	Burned & Grazed Prairie	0710376	4261504	463	10
GP5	West Traps	Burned & Grazed Prairie	0710556	4262009	442	11
GP6	Palmer Creek	Riparian	0710818	4262997	402	6.2
GP7	Palmer Creek	Riparian	0710471	4262929	411	5.9
GP8	Palmer Creek	Riparian	0710148	4262975	415	15
GP9	Palmer Creek	Riparian	0709885	4263067	410	8.5
GP10	Palmer Creek	Riparian	0709591	4262930	415	7.3
GP11	Palmer Creek	Riparian	0711158	4263033	396	6.9
GP12	Palmer Creek	Riparian	0711836	4262929	393	6.7
GP13	Palmer Creek	Riparian	0711836	4262892	394	8
BF1	Fox Creek	Riparian	0713728	4254205	354	6.5
BF2	Fox Creek	Riparian	0713876	4254405	375	9.3
BF3	Fox Creek	Riparian	0713973	4254570	358	11
BF4	Fox Creek	Riparian	0714150	4254913	380	11
BF5	Brome	Brome	0713457	4254989	362	10
BF6	Brome	Brome	0713702	4255214	362	7.6
BF7	Brome	Brome	0713489	4256660	365	6.8
BF8	Brome	Brome	0713499	4256396	365	8.6
BF9	Brome	Brome	0713506	4256146	366	8.6
BF10	Fox Creek	Riparian	0713939	4256325	357	8.3
BF11	Fox Creek	Riparian	0713910	4256430	361	7.4
BF12	Fox Creek	Riparian	0713872	4256018	368	16
BF13	Fox Creek	Riparian	0713980	4255821	364	16
BF14	Fox Creek	Riparian	0713924	4255492	358	13
ST1	Nature Trail	Cedar Grove	0713170	4253944	405	11
ST2	Schoolhouse Prairie	Unburned & Ungrazed Prairie	0713110	4256901	378	9.9
ST3	West Traps	Burned & Grazed Prairie	0712577	4256960	424	16
ST4	West Traps	Burned & Grazed Prairie	0711829	4256842	432	11
ST5	West Traps	Burned & Grazed Prairie	0711108	4257110	440	11
ST6	West Traps	Burned & Grazed Prairie	0710719	4257799	440	11
ST7	Gas House	Burned & Grazed Prairie	0710144	4258275	440	12
ST8	Gas House	Burned & Grazed Prairie	0710507	4258963	442	9.9
ST9	Gas House	Burned & Grazed Prairie	0711276	4258801	427	8.8
ST10	Gas House	Burned & Grazed Prairie	0712003	4259091	430	8.5
ST11	Gas House	Burned & Grazed Prairie	0712470	4259543	430	13
CR1	Two Sections	Burned & Grazed Prairie	0717266	4253944	405	11
CR2	Two Sections	Burned & Grazed Prairie	0716541	4253997	414	9.3
CR3	Two Sections	Burned & Grazed Prairie	0715695	4254132	415	9.1
CR4	Two Sections	Prairie/Riparian	0715216	4254440	414	10
CR5	Two Sections	Prairie/Riparian	0714716	4253982	414	11
CR6	Crusher Hill	Burned & Grazed Prairie	0712575	4253983	405	11
CR7	Crusher Hill	Burned & Grazed Prairie	0712089	4254630	405	9.5
CR8	Red House	Burned & Grazed Prairie	0711783	4255302	412	9.5
CR9	Red House	Prairie/Riparian	0711064	4255174	380	8.6

Point Locations						
Point	Location	Habitat	Easting	Northing	Elevation (m)	Error (m)
CR10	Red House	Burned & Grazed Prairie	0710848	4255545	406	7.2
CR11	Red House	Burned & Grazed Prairie	0710188	4255898	423	16
CR12	Red House	Burned & Grazed Prairie	0711546	4256231	419	8.1

Transect Locations						
Transect	Location	Habitat	Easting	Northing	Elevation (m)	Error (m)
BF (start)	Brome	Brome	0713609	4254942	393	none
BF (finish)			0713564	4255439	365	none
FC (start)	Fox Creek	Riparian	0713749	4254226	297	none
FC (finish)			0714087	4254478	334	none
TR1 (start)	Tour Loop	Burned & Grazed Prairie	0712836	4256505	361	none
TR1 (finish)			0712579	4256999	389	none
TR2 (start)	Tour Loop	Burned & Grazed Prairie	0710918	4257393	370	none
TR2 (finish)			0710690	4257857	464	none
TR3 (start)	Tour Loop	Burned & Grazed Prairie	0711175	4258828	375	none
TR3 (finish)			0711649	4258954	424	12
WB (start)	West Branch	Burned & Grazed Prairie	0710211	4261396	509	11.4
WB (finish)			0710710	4261747	448	11.7
PC (start)	Palmer Creek	Riparian	0711051	4263010	484	11.1
PC (finish)			0710629	4262976	445	14.5
RH1 (start)	Red House	Burned & Grazed Prairie	0711594	4256062	473	16.9
RH1 (finish)			0711789	4255610	414	8.8
RH2 (start)	Red House	Riparian (spring)	0710839	4255594	394	10
RH2 (finish)			0711125	4255117	408	10.1
TS (start)	Two Sections	Burned & Grazed Prairie/ Riparian	0715242	4254461	418	12.7
TS (finish)			0714816	4254284	378	14.5
SH (start)	Schoolhouse	Unburned & Ungrazed Prairie/Cedar Grove	0713174	4257296	399	10.7
SH (finish)			0713128	4250836	376	11.9