Effects of the Conservation Reserve Program on Priority Shortgrass Prairie Birds

A Conservation Effects Assessment Project

Submitted to:
Charlie Rewa, USDA Natural Resources Conservation Service
Skip Hyberg, USDA Farm Service Agency
Sally Benjamin, USDA Farm Service Agency

Submitted by:
Megan McLachlan, Mike Carter
Playa Lakes Joint Venture

430 Life Sciences West
Oklahoma State University
Stillwater, OK 74078
megan.mclachlan@pljv.org

June 30, 2009

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

In 2003, a multi-agency effort initiated the Conservation Effects Assessment Project (CEAP) to quantify environmental benefits of U.S. Department of Agriculture (USDA) conservation programs such as the Conservation Reserve Program (CRP), Wetland Reserve Program (WRP), and Environmental Quality Improvement Program (EQIP). This project is part of the Wildlife Component of CEAP which was created to quantify effects of conservation programs on wildlife in agricultural landscapes.

The Playa Lakes Joint Venture (PLJV), Natural Resources Conservation Service (NRCS), and Farm Service Agency (FSA) designed this CEAP project to evaluate the effects of the CRP on priority birds in the shortgrass prairie Bird Conservation Region (BCR 18). This assessment follows a previous assessment of the CRP on priority birds in the mixed-grass prairie BCR (BCR19).

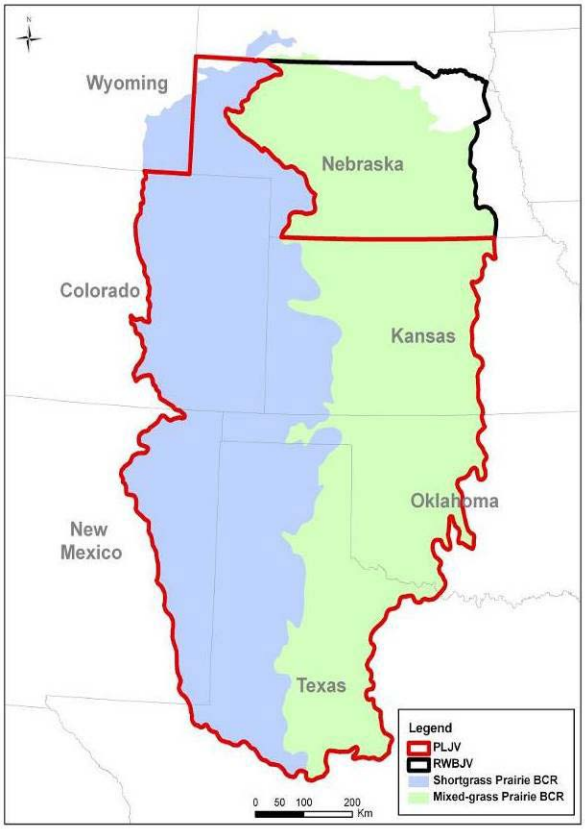


Figure 1. The shortgrass prairie and mixed-grass prairie Bird Conservation Regions (BCRs 18 and 19) and the boundaries of the Playa Lakes Joint Venture (PLJV) and Rainwater Basin Joint Venture (RWBJV).

Background

The PLJV is a non-profit partnership of federal and state wildlife agencies, conservation groups, private industry, and landowners dedicated to conserving bird habitat in the Southern Great Plains. We provide science-based guidance and decision-support tools for all-bird conservation throughout the region, as well as outreach, coordination and financial support to our partners and local groups to conduct on-the-ground habitat work. The PLJV works in the Southern Great Plains which includes eastern Colorado and New Mexico, western Nebraska, Kansas, and Oklahoma, and the Texas Panhandle (Figure 1). The region largely encompasses the shortgrass and mixed-grass Bird Conservation Regions (BCR18 and 19, respectively; Figure 1). The PLJV also works cooperatively with Rainwater Basin Joint Venture (RWBJV) which spans the northern portion of BCR19.

The PLJV is uniquely qualified and equipped to conduct regional bird analyses such as evaluating the effects of habitat change or conversion on bird population goals, developing spatially explicit models that locate suitable/critical bird habitat, and spatially targeting on-the-ground conservation efforts to maximize benefits to birds. The PLJV

has compiled resources, developed tools, and established working partnerships that serve to further all-bird conservation in and around the JV. Chief examples are:

- Species for Management Action (SMA) database – This tool compiles and stores conservation status information from multiple sources (including federal, regional, and state-based sources such as U.S. Fish and Wildlife Service (USFWS) and Partners in Flight (PIF)) for all species breeding, wintering, or migrating in BCRs 18 and 19. This tool allows user to identify/classify species according to conservation information.
- *A Review of Distribution, Habitat Use, and Population Density Data for the Hierarchical All Bird (HABS) Database* (Dobbs 2007) – This document is an exhaustive literature review (updated frequently) that serves as a one-stop resource guide for demographic and ecological information on bird species occurring in BCRs18 and 19. This document provides data for the Hierarchical All Bird System (HABS) database, including bird density and use-day data specific to geographic location, season of the year, habitat, and its condition.
- Hierarchical All Bird System (HABS) database – HABS is a tool developed to calculate a landscape's capacity to achieve population objectives for priority species, both currently (i.e., based on current habitat availability), and in the future (i.e., based on alternative scenarios of future habitat availability based on conservation and management work). HABS allows its user to determine how much conservation work needs to be done for individual species as well as predict the potential impacts of habitat change or conversion on bird population goals.
- Great Plains GIS Partnership (G^2P^2) - The PLJV is part of the Great Plains GIS Partnership (G^2P^2). G^2P^2 is a collaborative group of GIS professionals from the U.S. Fish and Wildlife Service (USFWS), Rainwater Basin Joint Venture (RWBJV), Playa Lakes Joint Venture (PLJV), Nebraska Game and Parks Commission (NGPC), and Central Platte Natural Resources District (CPNRD). The Partnership is dedicated to the development, evaluation, and integration of GIS data into biological and landscape level planning models for the Central Great Plains region.

Justification

The CRP is a USDA program, established in 1985, under which private landowners voluntarily remove highly erodible and environmentally sensitive land from crop production and establish vegetative cover on it. Landowners are paid for enrolling their land through an annual, per-acre rental rate and enrollment contracts which span 10 to 15 years. The main goals of the CRP are to reduce soil erosion, improve water and air quality, and provide wildlife habitat. Over 35 million acres of marginal cropland are currently enrolled in CRP nation-wide. Of those, more than 25 million acres are planted to vegetation dominated by grasses (U.S. Department of Agriculture 2004a), including nearly 6.1 million acres in the shortgrass prairie BCR (BCR18; Figure 1).

Considering its programmatic size and geographic extent, the CRP has great potential to affect prairie wildlife, including grassland birds. Grassland birds are declining faster than

any other guild of North American birds (Samson and Knopf 1994) as a cumulative effect of habitat loss, fragmentation, and degradation of remnant grasslands (World Wildlife Fund Canada 1998, Brennan and Kuvlesky 2005). More than 80% of native grasslands in North America have been lost since the mid-1800's (Samson and Knopf 1994). Consequently, grassland wildlife habitat has become a priority conservation concern. Some even predict the decline of grassland species "to become a prominent wildlife conservation crisis of the 21st century (Brennan and Kuvlesky 2005)." These predictions seem even more plausible with increasing demand being put on grasslands from biofuels, wind-based, and petroleum-based energy needs.

Some consider the CRP a vehicle for reserving declining population trends of grassland birds (Johnson and Igl 1995). Many studies have investigated the effects of CRP on grassland birds, typically by comparing abundance measures, diversity indices, or nest success on CRP fields with other habitat types. The magnitude and direction (i.e., positive or negative) of effect varies by species, ecological region, characteristics of CRP land and the landscape in question. In Nebraska, King and Savidge (1995) found bird abundance was 4 times greater in CRP fields than crop fields (1995). In Kansas, avian abundance was lower in CRP than pasture (Klute and Robel 1997). In six mid-western states, Best et al. (1997) found that CRP supported 13.5 times as many nests as rowcrop fields (1997). In the Prairie Pothole Region, Reynolds et al. (2001) found that nest success of five duck species was higher in CRP than any other habitat used by ducks (2001). In Kansas, Ring-necked Pheasants used wheat stubble more than CRP fields (Rodgers 1999).

Yet no studies, to our knowledge, have quantified the effects of CRP on regional bird populations, explicitly asking the question 'How many birds does CRP support?' PLJV, NRCS, and FSA developed this CEAP project to address that question. For 8 priority species we estimate: 1) how many birds CRP currently supports, 2) how many birds would be supported if CRP acres were replaced with cropland, and 3) how do those numbers compare to the regional population goals.

Acronyms
This report uses acronyms listed and defined in the following table.

Table 1. List of acronyms used in this report and their definitions.

Acronym	Definition
ABC	American Bird Conservancy
BBS	Breeding Bird Survey
BCR	Bird Conservation Region
BCR18	Shortgrass Prairie Bird Conservation Region
BCR19	Mixed-grass Prairie Bird Conservation Region
FSA	Farm Service Agency
NRCS	Nature Resources Conservation Service
PIF	Partners in Flight
PLJV	Playa Lakes Joint Venture
RWBJV	Rainwater Basin Joint Venture
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service

METHODS

Project Area: Shortgrass Prairie Bird Conservation Region (BCR18)
BCR18 is located in the western Great Plains of North America, encompassing portions of seven states including Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas (Figure 1). BCR18 spans over 95 million acres of gently sloping terrain comprised of a variety of habitats, both naturally occurring (e.g., prairie, wetlands, streams) and man-made (e.g., cropland, urban areas, reservoirs). The shortgrass prairie is dominated by blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*) interspersed with small amounts of tallgrass species in the east (e.g., little bluestem (*Schizachyrium scoparium),* Indian grass (*Sorghastrum nutans*)). Common shrub species occurring in BCR18 are sand sagebrush (*Artemisia filifolia*) and sand shinnery oak (Q*uercus havardii rydb*.). Woodland habitat ranges from scattered cottonwood trees (*Populus* spp.), small clustered plantings of Siberian elm (*Ulmus pumila*) and Russian olive (*Elaeagnus angustifolia*), to large expanses of honey mesquite (*Prosopis glandulosa)* and eastern red-cedar (*Juniperus virginiana*). Historically dominated by grassland and shrubland habitat, BCR18 now has as much cropland (comprising about 43% of its total landcover) as it does native grassland and shrubland combined. Major crop types are wheat, sorghum, corn (primarily in the north), soybeans, sunflowers, and alfalfa. Over 6 million acres of cropland in BCR18 (about 15%) are currently enrolled in the CRP.

Priority Species
Priority bird species included in this analysis are those which use CRP and/or cropland habitat within BCR18 during the breeding season (Table 2) and for which adequate density data are available. The PLJV Landbird Team identified priority species in BCR18 by consolidating several regional and continental lists of species of concern including: 1) the Partners in Flight North (PIF) American Landbird Conservation Plan

(Rich et al. 2004), 2) high priority birds from the U.S. Shorebird Conservation Plan (Brown et al. 2001) and Waterbird Conservation for the Americas Plan (Kushlan et al. 2002), 3) species from the U.S. Fish and Wildlife Service (USFWS) Birds of Conservation Concern (BCC) lists, and 4) species for which habitat work is targeted within BCR18 (e.g. upland game birds such as Ring-necked Pheasants). The Team also classified a species as a priority when 10% of a species population occurs in BCR18 and BCR19 combined and it has a declining population trend, according to the U.S. Geological Service (USGS) Breeding Bird Survey (BBS; Sauer et al. 2006). The Landbird Team identified a total of 18 priority species for BCR18 of which 10 occur in CRP and/or cropland habitat. Density data were available for 7 of the 10 species so this analysis includes a total of 7 priority bird species (Table 2). These 7 species include 3 landbirds, 2 game-birds, 1 raptor, and 1 shorebird (Table 2).

Table 2. List of priority bird species analyzed in this project including common name, scientific name, and description.

Common Name	Scientific Name	Description
Cassin's Sparrow	*Aimophila cassinii*	migratory landbird
Grasshopper Sparrow	*Ammodramus savannarum*	migratory landbird
Lark Bunting	*Calamospiza melanocorys*	migratory landbird
Lesser Prairie-Chicken	*Tympanuchus pallidicinctus*	resident upland game-bird
Mountain Plover	*Charadrius montanus*	migratory shorebird
Ring-necked Pheasant	*Phasianus colchicus*	resident upland game-bird
Swainson's Hawk	*Buteo swainsoni*	migratory raptor

Data Analysis

To quantify the effects of the CRP on priority birds in the shortgrass prairie, we calculated and compared the carrying capacities of two landcover scenarios for the shortgrass prairie BCR for individual species. One landcover scenario depicts current CRP fields (in context of other landcover types) and the other scenario depicts those same CRP fields as cropland. The amount of each crop type apportioned to these cropland acres was based on 2004 National Agricultural Statistics Service county-level data. The underlying assumption of this method is that all CRP fields were once cropland.

To create and compare the scenarios we used four integrated components: (1) a seamless spatial landcover layer, (2) bird densities, (3) bird population goals, and (4) the Hierarchical All Bird System (HABS). These components are analogous to the four steps of our analysis: (1) calculate the number of acres of each habitat within each state of BCR18 and the availability and suitability of each habitat to each bird species, (2) link bird species to those habitats via bird densities, (3) step-down the national population goals of each species to each state of the BCR, and (4) determine how much of the population goal is being lost/gained by comparing the carrying capacities of the two landscape scenarios. We analyzed each state within the BCR separately because bird population goals and bird-to-habitat links (i.e., densities) are most appropriately related at this spatial scale. Each of the four steps is described below in detail.

Step 1: Calculate Habitat Acres

The first step to quantifying the effects of CRP on priority bird species was to determine how many acres of each habitat, including CRP, occurred in each state of the BCR. Using a Geographic Information System (GIS), PLJV developed a seamless landcover layer for the shortgrass prairie BCR (Figure 2) with the exception of the Wyoming portion of the BCR (which is not considered in the analysis). The seamless landcover is classified into a system of habitat Associations and Conditions that are used to determine the amount and types of habitat available to birds. Associations are landcover classes generally considered to be mappable at the landscape scale (e.g., shortgrass prairie). Conditions are recognized as having distinctive characteristics important to birds but are not necessarily mappable with current GIS data (e.g., few shrubs/high grass).

Previous to this CEAP project, spatial CRP data were unavailable so we updated the landcover layer with the CRP field polygons, taken from the Common Land Unit Layer (CLU) provided by FSA. We partitioned the CRP Association into six Conditions according to Conservation Practice (CP): grass, trees in upland, trees in riparian, wetland, playas/non-floodplain wetland, and other CRP practice. Although there are CPs distinguishing between native grass plantings (CP2) and a CP designating non-native grass plantings (CP1), these were not used in the Condition classes because there is uncertainty regarding the definition of a native planting. Through interviewing CRP professionals and researchers, we determined that native plantings (CP2) did not necessarily indicate species native to the area but rather to North America. For example, shortgrass or tallgrass species planted in the shortgrass prairie may be considered a CP2 but they are not truly native to the area. In addition, there is also a practice designating existing/established grass (CP10) which does not indicate native or non-native planting, creating more uncertainty. So we applied assumed proportions of native to non-native plantings specific to each state in BCR18 based on opinions of CRP professionals and researchers. In Kansas, we assumed all CRP grass plantings were native. In Nebraska, Oklahoma, and Texas we assumed 10% were native and 90% non-native. We also updated the landcover layer with the crop field boundaries delineated in the CLU layer as it was the most current data available. Detailed information on the landcover layer including its development and list of Associations and Conditions are documented in "Habitat Assessment Procedures Technical Companion Document to the PLJV Implementation Planning Guide" (Playa Lakes Joint Venture 2007).

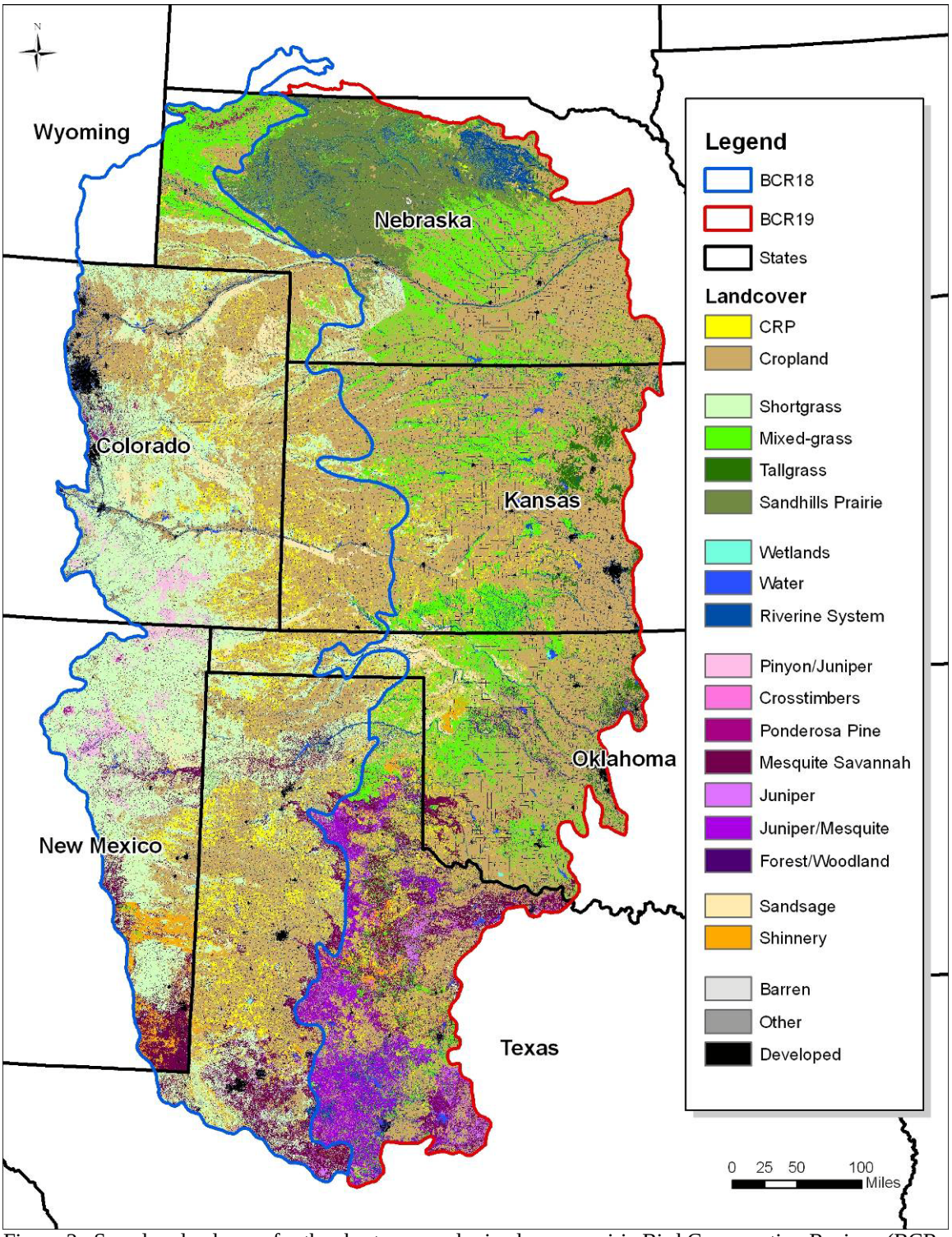


Figure 2. Seamless landcover for the shortgrass and mixed-grass prairie Bird Conservation Regions (BCRs 18 & 19, respectively).

Once the landcover was updated with the CLU data, we calculated the total number of acres of each Association and Condition within each state area. These acres were then used in HABS to determine carrying capacities (discussed in *Step 4*) for the priority bird species. However, for some species, habitat acres were further refined using a *Range*, *Suitability*, and/or *Large Block Factor*. We applied *Factors* when the overall BCR habitat acreage did not adequately reflect the amount of habitat actually available and/or suitable to the species because of its restricted range (i.e., the species/habitat occurs within a limited portion of the BCR) or because of special habitat requirements (i.e., the species may require large blocks). Refer to *Step 4*, Table 4 for an example of each *Factor*.

Determining a *Large Block Factor* requires developing and running a spatial model, specific to the species' habitat needs, on the landcover. We determined *Large Block Factors* for two species, Lesser Prairie-Chicken and Long-billed Curlew, and because of their limited range in BCR18, we also applied a *Range Factor*. For example, the range of the Lesser Prairie-Chicken extends only into a limited portion of BCR18 (Figure 3) so we determine a *Range Factor* by calculating the number of habitat acres with a 10-mile buffer of the known range and compared it to the overall acres. For instance, if there were 500,000 acres of suitable habitat for Lesser Prairie-Chickens in BCR18 but only 20,000 acres were within its range, then we would apply a *Range Factor* of 0.04 when estimating carrying capacity in HABS. These species also require large, unfragmented blocks of habitat, so including acres of small, fragmented parcels of habitat in the acres calculations would over-inflate the carrying capacity for the species. So we developed spatial models within a GIS to identify large blocks of habitat within known species range (Figure 3). Then we compared the number of large block acres to the overall habitat acres within its range to determine a *Large Block Factor*. For instance, if there were 20,000 acres of habitat within the Lesser Prairie-Chicken range but only 5,000 acres were in large block configuration, we applied a *Large Block Factor* of 0.25 when estimating carrying capacity in HABS. Altogether, carrying capacity for Lesser Prairie-Chicken would be calculated as follows: carrying capacity = 500,000ac * 0.04 * 0.25 *density. We ran this model on both landscape scenarios (with and without CRP) because the number of large block acres, and thus the *Large Block Factor*, would be different (Figure 4).

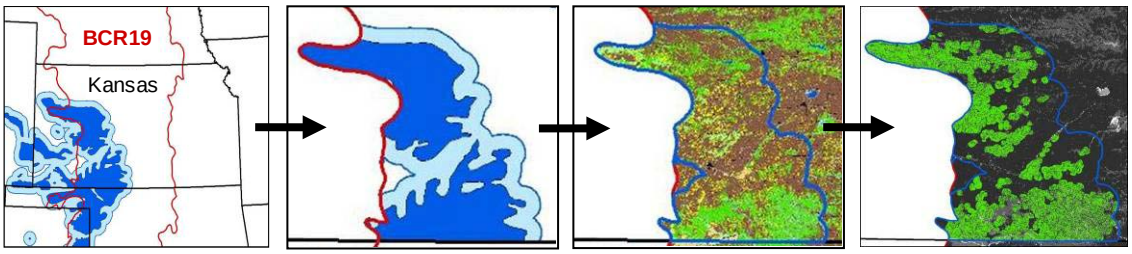


Figure 3. Illustration of the process used to identify large-blocks of suitable Lesser Prairie-Chicken habitat, BCR19 portion of Kansas: a) Lesser Prairie-Chicken range (dark blue) and 10-mile buffer (light blue) and BCR19 boundary (red), b) buffered range within BCR19 portion of Kansas only, c) landcover layer with 10-mile buffer on which large-block model is applied, and d) large-block acres as identified by model.

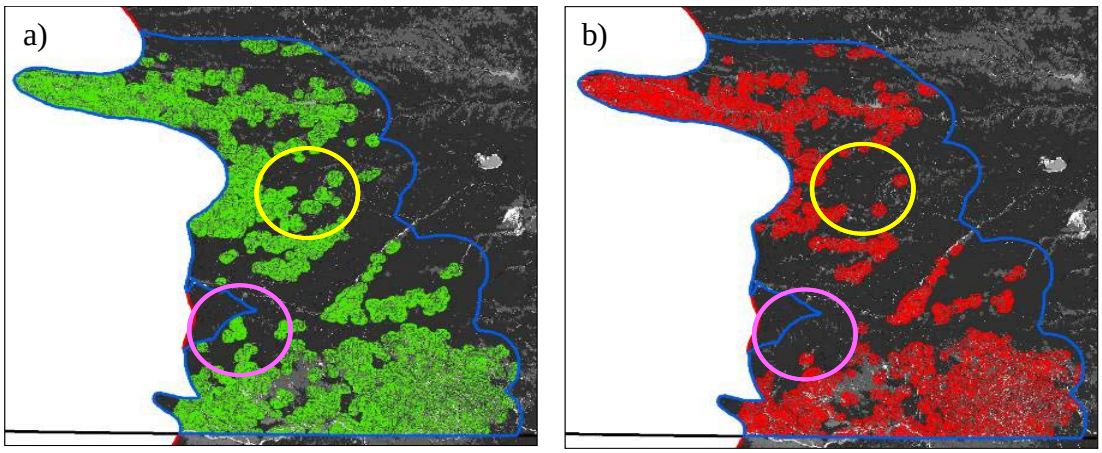


Figure 4. An example of the amount of large blocks of suitable Lesser Prairie-Chicken habitat (within its range in BCR19-KS) when: a) CRP is included in the landcover (large block acres are green), and (b) CRP is reclassified to cropland (large block acres are red). Notice the change in large block acres inside the yellow and pink circles.

Step 2: Link Birds to Habitats with Densities

To calculate the carrying capacities of the two landscape scenarios, we needed to link bird species to habitat acres with species densities. The PLJV Landbird Team and Waterbird Team assigned priority species to habitats Associations and Conditions. Then we conducted an exhaustive literature review to determine at which densities species occurred in their assigned habitat Associations and Conditions (Dobbs 2007). Data sources included peer-reviewed journals, theses and dissertations, government publications, unpublished reports, species accounts in the Birds of North America (BNA) series, state bird books and breeding bird atlases, published and unpublished (courtesy of Cornell Lab of Ornithology) Breeding Bird Census (BBC) data (1982-1996), and world wide web-publications. Where density data were not available for a species, those densities that were most similar in location and habitat Condition were assigned and adjusted using Breeding Bird Survey (BBS) relative abundance maps when necessary (BBS is a U.S. Geological Survey (USGS) long-term (>30 years) monitoring program under which volunteers conduct annual, fixed, road-based point count surveys nation-wide). Densities are stored in HABS and related to the habitat acres to calculate carry capacities (discussed further in *Step 3*). All densities used in this project are documented in "A Review of Distribution, Habitat Use, and Population Density Data in the Hierarchical All Bird System (HABS) Database" (Dobbs 2007).

Step 3: Bird Population Goals

The PLJV Landbird Team developed population goals for all priority species in BCR18. They followed the recommendation of Partners in Flight (PIF) which aims to return bird population numbers back to the same levels as 30 years ago. They determined population goals using two factors, estimated current carrying capacity and BBS population trend (specific to each BCR). The current carrying capacity of each species was determined by multiplying their habitat-specific densities (Step 2) by the number of acres of habitat in the landcover (Step 1). We calculated population goals as follows. If the species' population trend is > 0 (a growing population), the population goal equaled the estimated

current carrying capacity (a goal of maintaining the population). If the species' trend is < 0 (a declining population), we applied the following formula to determine a population goal:

$$\frac{\textit{Current Estimated Carrying Capacity}}{\textit{(1-Absolute Value [Trend])}^{29}}.$$

To ensure robust data were used, BBS trend data were limited to those trends where the P-value was < 0.1 and the number of routes within the BCR on which the bird was detected was ≥ 14. If these criteria were not met, then a survey-wide (national) trend was used instead of the BCR-based trend. For some species, there were no appropriate trend, in which case population goals were developed through expert opinion. For example, Lesser Prairie-Chicken population goals were determined by members of the Lesser Prairie-Chicken Interstate Working Group. Trends used for each priority species are stored in HABS.

Step 4: Hierarchical All Bird Systems (HABS)

The Hierarchical All Bird System (HABS) database is a tool developed by PLJV to store parameters and calculate a landscape's capacity to achieve population objectives for priority species. The carrying capacity can be based on current conditions (i.e., current habitat availability) and/or potential future conditions (i.e., alternative scenarios of future habitat availability resulting from conservation and management work). In HABS, data are stored in a hierarchical manor such that each bird density is specific to not only a species but also to a geographic area, a habitat within that area, a condition of that habitat, and a season of the year. For example, Lesser Prairie-Chickens occur at a density of 0.0125 birds/ac in the BCR18 region of Kansas in CRP with native plant species during the breeding season. The hierarchical levels on which HABS functions are described in the following table.

Table 3. Each of the five hierarchical levels of the Hierarchical All Bird System (HABS), a description, and an example (listed from highest to lowest level of order).

Hierarchical Level	**Description**	**Example**
Area	where a Bird Conservation Region (BCR) intersects a state	BCR18 portion of Kansas
Association	a mappable habitat	CRP
Condition	management condition or a more specific, potentially un-mappable, habitat	Native grasses
Season/Period	breeding, wintering, migratory	Breeding
Species	priority bird species	Lesser Prairie-Chicken

To better reflect a species' full range of spatial-temporal distribution and habitat use within the PLJV region, HABS also stores data on the availability and suitability of habitat acres. HABS incorporates three factors regarding spatial-temporal variation among species: *Range Factor, Suitability Factor, and Large Block Factor*. These are described in the following table and, in *Step 1*, additional examples of *Range Factor* and *Large Block Factor* are provided.

Table 4. List of spatial and temporal factors considered in the Hierarchical All Brid System (HABS) database, including a description, and an example.

Factor Type	**Description**	**Example**
Range Factor	Proportion of total acres of an Association or Condition (see Table 3) that are within a species range.	In BCR18-NM, there are 9.4 million acres of shortgrass prairie but only 5.6 million acres are within Mountain Plover range. *Range Factor* = 0.60.
Suitability Factor	Proportion of total acres of an Association or Condition that are suitable for species use during the specified Season/Period (see Table 3).	In BCR18-TX, there are 2.9 million acres of wheat; however, because of early Spring harvest, this habitat Condition is no longer suitable to Grasshopper Sparrows during their breeding season. *Suitability Factor* = 0.
Large Block Factor	Proportion of acres of an Association or Condition that are in large block configuration. Criteria for large blocks are determined in a spatial model developed for each Species and Area (see Table 3).	In BCR18-CO there are 1.9 million acres of sand sage but only about 273,000 acres are in large block configuration. *Large Block Factor* = 0.15.

RESULTS

We present statistics describing BCR18 landcover, including CRP, to first familiarize the reader with the landscape. Then we present results for each priority species describing the effects of CRP on the population goals.

Landscape Statistics

The shortgrass prairie BCR spans approximately 93.1 million acres across the six states included in this analysis (Nebraska, Colorado, Kansas, Oklahoma, New Mexico, and Texas; Figure 1), hereafter referred to BCR18. Colorado and Texas represent the largest portions of BCR18, comprising 28.1 and 25.9 million acres, respectively. New Mexico also represents a large portion of the BCR, with 16.9 million acres, while both Nebraska and Kansas each represent about half that area, about 9 million acres each. Oklahoma contains the smallest portion, about 4.3 million acres.

Landcover composition of each state is highly variable (Figures 5 and 6) but across BCR18 landcover varies most noticeably along a latitudinal gradient that becomes evident when comparing dominant landcover types (namely grassland and cropland) across the six states (Figure 2). Generally speaking, grassland is most abundant in the west and cropland is most abundant in the east.

All states are dominated by cropland except Colorado and New Mexico which are dominated by a combination of 'natural' habitats including grassland, shrubland, woodland, and wetlands. Over 70% of all grassland acres in BCR18 (31.5 million acres) occur in Nebraska, Colorado, and New Mexico (Figure 2). Kansas, Oklahoma, and Texas contain much smaller portions of BCR18 grassland, < 25% combined. Kansas and Oklahoma contain the fewest grassland acres, <3% each.

Shrubland is most abundant in the south and grows sparser moving north. Texas, New Mexico, and Colorado contain 80% of the 5 million acres of shrubland in BCR18. Woodlands are also most abundant in the southern regions of BCR18 with Texas and New Mexico containing over 85% of the 7.6 million woodland acres.

Cropland, including land in the CRP, comprises about half of the total area of BCR18 (39.6 million acres; Figure 2). All BCR18 states are comprised of at least 45% cropland, except New Mexico which is only 10% cropland. Conversely, Kansas is dominated by cropland in BCR18, comprising over 80% of its area. The dominant crop types in BCR18 are dryland wheat, sorghum, corn (grow mostly in the north), and cotton (grow mostly in the south). Other crops include alfalfa, soybeans, sunflowers, peanuts, millet, and hay.

About 16% of all cropland (about 6.1 million acres) in BCR18 is enrolled in the CRP. Most states in BCR18 have around 15% of their cropland enrolled in the CRP with the exceptions of Nebraska, which has relatively few CRP acres (7%) enrolled, and Oklahoma, which has 26% of its cropland enrolled. Of the 6.1 million acres of CRP in BCR18, nearly all (99%) are planted to grass (Table 5). About 29,000 acres are planted to trees (e.g., shelter belts, riparian buffers), about 8,000 acres are planted to wetland

habitat (e.g., wetland restoration, playa buffers), and about 4,000 acres are in other practices not considered bird habitat (e.g., diversion and erosion control structures). The amount of CRP fields planted to native and non-native grasses in each state is not clear because of the ambiguity of the Conservation Practice called 'Existing grasses' (i.e., CRP Conservation Practice 10), which constitutes many CRP acres in each state. Therefore, the percent of acres of native and non-native CRP grass (a Condition in HABS) is based on opinion of CRP experts within each state (see *Step 1* for more details).

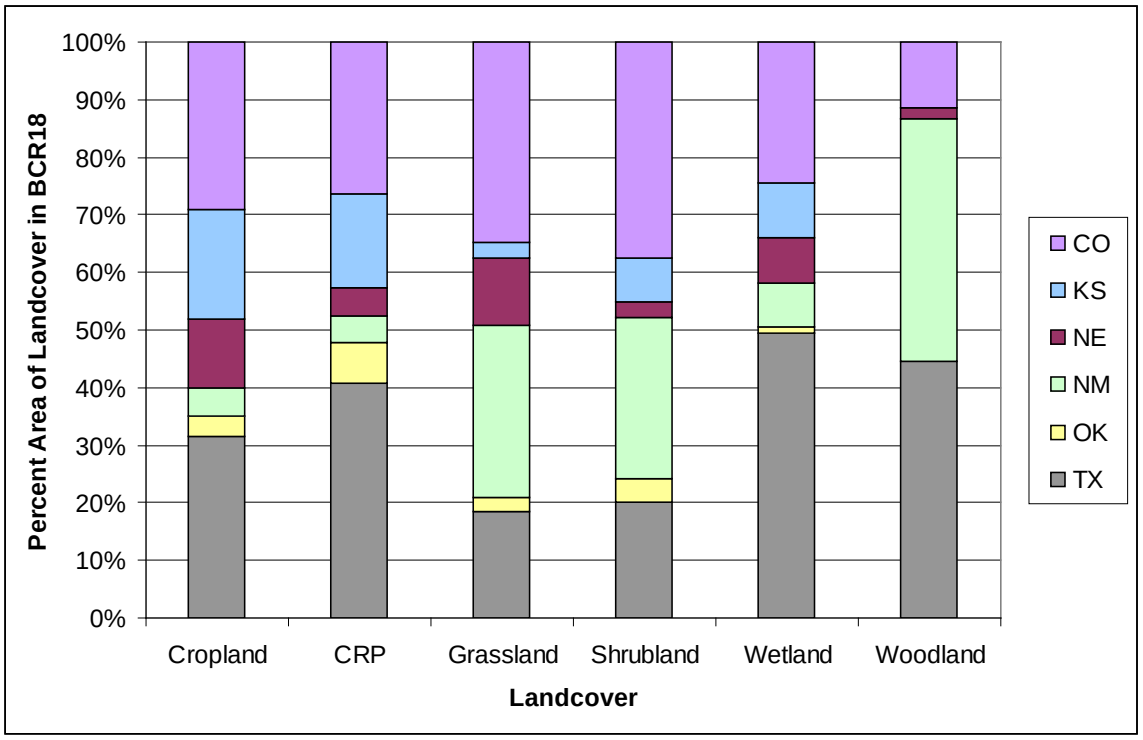


Figure 5. For each of several general landcover types, the percent of total landcover area of the shortgrass prairie Bird Conservation Region (BCR18) occurring in each state.

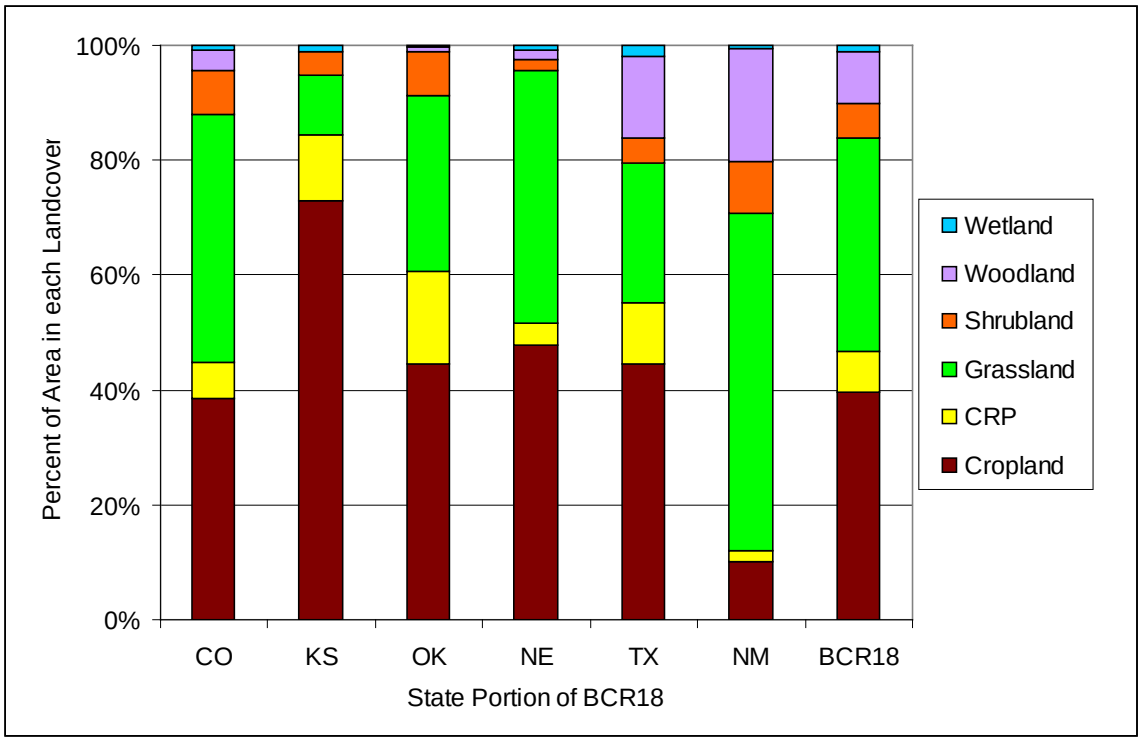


Figure 6. General landcover composition in each state portion of the shortgrass prairie BCR and the entire BCR (excluding Wyoming).

Table 5. Estimated acres of CRP in each state within the shortgrass prairie Bird Conservation Region (BCR18) by general planting type and summed to include all CRP acres. CRP acres were estimated using the Common Land Unit Layer (CLU), a spatial dataset.

Area	Native Grass	Non-native Grass	Trees (upland)	Trees (riparian)	Wetland	Wetland (non-floodplain)	Other Practices	All CRP
NE	29,099	261,888	17,729	99	1,529	0	560	**310,904**
CO	160,692	1,446,231	4,953	366	652	0	1,709	**1,614,603**
KS	1,001,576	0	1,098	37	224	337	1,021	**1,004,293**
OK	42,453	382,073	3	7	0	0	0	**424,536**
NM	28,766	258,890	311	1,819	383	0	88	**290,526**
TX	250,366	2,253,296	1,943	928	4,870	45	431	**2,511,879**
BCR18	**1,512,952**	**4,602,378**	**26,037**	**3,256**	**7,658**	**382**	**3,809**	**6,156,472**

Effects of CRP on priority shortgrass prairie birds

Summary

The effects of CRP on the 7 priority species varied widely with some species showing substantial benefit (in terms of population goals) while others show no benefit. The contribution of CRP to the population goals of the species ranged from 0% to 28%. The species showing the greatest benefit from CRP was Grasshopper Sparrow, with CRP contributing 27.5% of its population goal in BCR18. Lesser Prairie-Chicken also benefited considerably from CRP which contributed over 10% of its population goal. CRP also contributed 8% - 9% of the population goals for Cassin's Sparrow, Lark Bunting, and Ring-necked Pheasant. Swainson's Hawks showed a smaller benefit from CRP (5%) – this species uses grassland and cropland habitat types at similar rates. One species, Mountain Plover, showed no benefit from CRP (the species does not use CRP habitat) but instead showed an increase in population goal (3%) when CRP was converted to cropland (the species uses fallow cropland).

Species-by-species Results

Results for the 7 species are presented individually. For each species, we first give a brief description of its conservation status, distribution, and habitat use. Conservation status includes classification from several sources including the Partners in Flight North American Landbird Conservation Plan (Rich et al. 2004), the U.S. Shorebird Conservation Plan (Brown et al. 2001), Waterbird Conservation for the Americas plan (Kushlan et al. 2002), and species from state (NE, CO, KS, OK, NM, TX) and federal (USFWS) threatened, endangered, and species of concern lists. PIF classifications include Watch List Species (species having multiple reasons for conservation concern across their range) and Stewardship Species (species that warrant concern due to their restricted range; Rich et al. 2004). All other classifications are self-explanatory. Distribution is described in the text and illustrated with maps produced using BBS relative abundance data (Sauer et al. 2006).

We then describe the general effect of CRP on the species population goal within each state area. Results are presented in a subsequent table(s) and table headings are described below in Table 6.

Table 6. List and description of the column headings presented in the results tables. Carrying capacity is the number of birds supported by a habitat(s) in a given area.

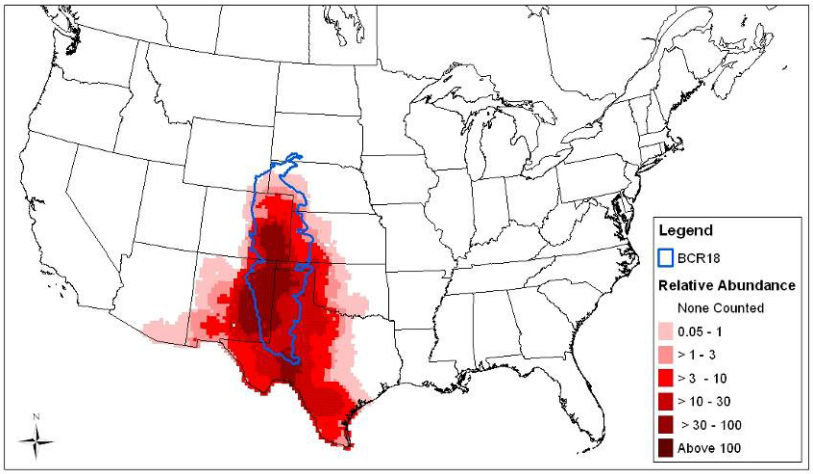
Column Headings in the Results Tables and their Definitions
State Area
Population Goal - species total population goal for that state area
Carrying Capacity - estimated carrying capacity based on all habitats
% Pop. Goal - percent of total population goal achieved through all habitats
CRP
Carrying Capacity - estimated carrying capacity of CRP
% Pop. Goal - percent of total population goal achieved through CRP
CRP to Cropland
Carrying Capacity Lost/Gained - estimated carrying capacity lost or gained when CRP acres were reclassified to cropland
% Pop. Goal Lost/Gained - percent of total population goal lost or gained when CRP acres were reclassified to cropland
CRP in Large Blocks
Carrying Capacity Lost/Gained - estimated carrying capacity of CRP acres in large block configuration (based on spatial model parameters)
% Pop. Goal Lost/Gained - percent of total population goal achieved through CRP acres in large block configuration
Non-CRP Habitat in Large Blocks
Carrying Capacity Lost/Gained - estimated carrying capacity of suitable habitat that is not CRP and is in large block configuration
% Pop. Goal Lost/Gained - percent of total population goal achieved through suitable habitat that is not CRP and is in large block configuration

Cassin's Sparrow *(Aimophila cassinii)*

Cassin's Sparrow, a PIF Stewardship Species, breeds throughout BCR18 with exception of the northern reaches of Nebraska. Cassin's Sparrows use a wide range of grassland habitats from short to moderate grass with sparse to moderate shrub cover or small trees (e.g., mesquite, oak) (Dunning et al. 1999). They also use cropland including wheat (Thompson and Ely 1992) but at much lower densities (Hanni and McLachlan 2004, Sparks et al. 2005, Sparks and Hanni 2006).

Analysis was conducted for all BCR18 states except Nebraska. In Nebraska, Cassin's Sparrows occur only along the southern edge of BCR18. With few acres of CRP in this area, effects of CRP would be insubstantial and so no analysis was conducted.

The estimated carrying capacity of the 5 states combined is about 5.1 million Cassin's Sparrows and CRP contributes about 9% of that carrying capacity. Nearly all that carrying capacity (8%) is lost when CRP is converted to cropland. Cassin's Sparrows populations are most concentrated in Colorado and New Mexico, where native grasslands are most abundant in BCR18; thus, in these two states, loss of CRP has a small effect (-7% and -1%, respectively) relative to the other states. Effects of CRP on Cassin's Sparrow are greatest in Kansas (-24%) where there is very little native grassland and the species is more likely to depend on CRP grassland for survival. Oklahoma and Texas showed similar effects of CRP, each losing 12% of the population goal for the species.

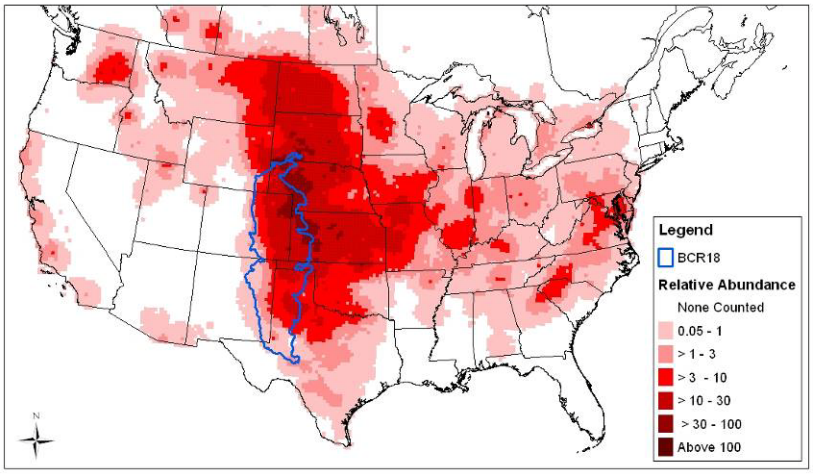


	State Area			CRP		CRP to Cropland	
State Area	Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity Lost/Gained	% Pop. Goal Lost/Gained
CO	1,060,175	815,668	77%	76,490	7.2%	-74,978	**-7.1%**
KS	558,622	429,788	77%	143,025	25.6%	-136,827	**-24.5%**
OK	337,800	259,894	77%	50,773	15.0%	-40,557	**-12.0%**
NM	2,483,760	1,910,934	77%	34,404	1.4%	-33,945	**-1.37%**
TX	2,200,597	1,693,076	77%	299,438	13.6%	-265,557	**-12.0%**
Total	*6,640,954*	*5,109,360*	*77%*	*604,130*	*9.1%*	*-551,864*	***-8.3%***

Grasshopper Sparrow (*Ammodramus savannarum*)

Grasshopper Sparrow is a PIF Stewardship Species that breeds throughout BCR18, showing increasing abundance from south to north. Grasshopper Sparrows occur in native prairie, cropland, and CRP and prefer grass of intermediate height, moderately deep litter, and sparse woody vegetation (Dechant et al. 2002b). They also use hayfields and pasture, and occasionally cultivated cropland (e.g., corn, oats), but at much lower densities (Dechant et al. 2002a).

The estimated carrying capacity of BCR18 is about 5.9 million Grasshopper Sparrows and CRP habitat contributes about 27% of that capacity. Nearly all that carrying capacity (25%) is lost when CRP is converted to cropland, amounting to 1.1 million birds lost. Greatest concentrations of Grasshopper Sparrows occur in the northern states of Colorado, Kansas, and Nebraska which is where CRP habitat contributes most to the population goals (21% in Colorado, 28% in Kansas, and 7% in Nebraska).

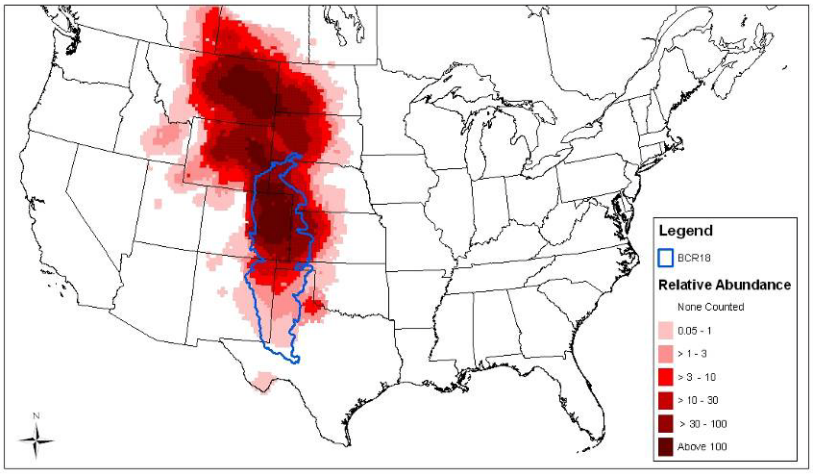


	State Area			CRP		CRP to Cropland	
State Area	Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity Lost/Gained	% Pop. Goal Lost/Gained
NE	2,722,529	1,386,484	50%	192,925	7.1%	-187,819	**-6.9%**
CO	1,493,825	760,750	50%	314,636	21.0%	-302,949	**-20.3%**
KS	2,358,110	1,200,899	50%	670,154	28.4%	-618,789	**-26.2%**
OK	1,188,207	605,110	50%	146,886	12.3%	-118,068	**-9.9%**
NM	1,109,674	565,116	50%	9,953	0.9%	-8,609	**-0.8%**
TX	2,711,342	1,380,787	50%	289,672	10.6%	-258,790	**-9.5%**
Total	*11,583,687*	*5,899,146*	*50%*	*1,624,226*	*27.5%*	*-1,495,024*	***-25.3%***

Lark Bunting (*Calamospiza melanocorys*)

Lark Buntings is a PIF Stewardship Species that breeds throughout BCR18, with dense concentrations in the northern half of the BCR. This species uses grasslands of low to moderate height, often with some shrubs, weedy fallow fields, CRP, hay, pasture, and alfalfa (Dechant et al. 2002b, Sparks et al. 2005). Breeding is associated primarily with shortgrass, sand sage, and mixed grass prairie in Kansas and Nebraska (Kingery 1998, Busby and Zimmerman 2001, Dinan and Johnsgard 2004), plus sand hills prairie in Nebraska (Dinan and Johnsgard 2004). It is also known to use fallow cropland and stubble, cultivated crops (e.g., wheat), and alfalfa in Oklahoma and Kansas (Busby and Zimmerman 2001, Reinking 2004).

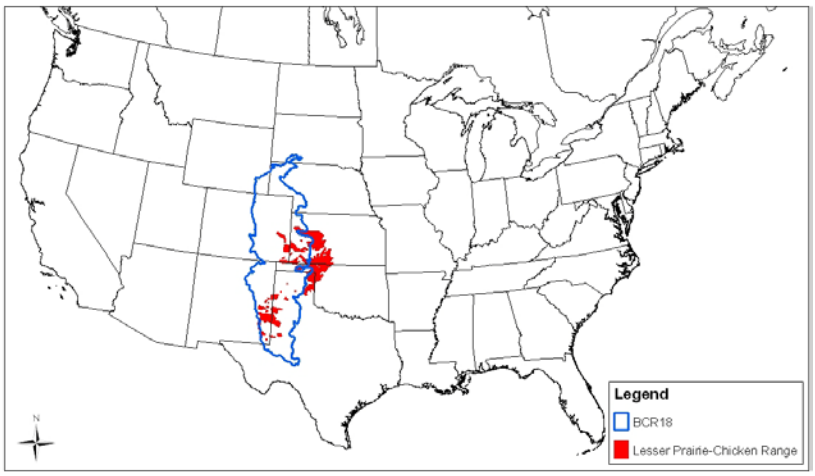
The estimated carrying capacity of BCR18 is about 5.6 million Lark Buntings and CRP habitat contributes about 8% of that capacity. Most of that capacity (6%) is lost when CRP is converted to cropland. The most notable effects of CRP conversion to cropland are seen in Texas (-8.6%) and Oklahoma (-10.4%), where although populations are less dense, there is little native grassland available making CRP grassland more important habitat as compared to other states such as Colorado where native grasslands are more abundant. In Colorado and Nebraska, the effects of CRP on Lark Bunting are more likely a reflection of the high density of birds in that area.



	State Area			CRP		CRP to Cropland	
State Area	Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity Lost/Gained	% Pop. Goal Lost/Gained
NE	1,443,717	735,232	50%	100,187	6.9%	-85,449	**-5.9%**
CO	6,643,713	3,383,399	50%	553,264	8.3%	-506,286	**-7.6%**
KS	1,316,512	670,451	50%	107,870	8.2%	-37,539	**-2.9%**
OK	644,855	328,401	50%	86,773	13.5%	-67,256	**-10.4%**
NM	479,483	244,183	50%	5,868	1.22	-4,412	**-0.9%**
TX	469,303	238,999	50%	51,074	10.9%	-40,343	**-8.6%**
Total	*10,997,583*	*5,600,665*	*50%*	*905,036*	*8.2%*	*-741,285*	***-6.7%***

Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*)
This resident game bird is a PIF Watch List species, a species of Highest Continental Concern according to the American Bird Conservancy, a State Threatened species in Colorado, and is currently listed as a candidate under the federal Endangered Species Act. Lesser Prairie-Chickens are patchily distributed in southern portions of BCR 18 in Colorado, Kansas, Oklahoma, New Mexico, and Texas. They are most abundant in southwestern portion of Kansas (Price et al. 1995). Habitat use varies across their range, but generally consists of dwarf shrub-mixed grass vegetation types associated with sandy soils, which may be interspersed with short grass or mixed grass prairie (Taylor and Guthery 1980; see Hagan 2005). Habitat is comprised primarily of sand sage prairie in Kansas (Andrews and Righter 1992, Giesen 1994, Busby and Zimmerman 2001), and primarily shinnery oak prairie in Oklahoma and Texas (Riley et al. 1992, Jackson and DeArment 1963; see Hagan 2005). This species also uses CRP in some areas, including Kansas, (Fields 2004), as well as cropland (Crawford and Bolen 1976).

The estimated carrying capacity of BCR18 is about 15,000 Lesser Prairie-Chickens and CRP directly contributes to 10% of that capacity. Indirectly, CRP contributes another 1% of carrying capacity by creating Large Blocks of habitat comprised of both CRP and native grassland and shrubland. If CRP were converted to cropland, some of those Large Blocks would be lost or reduced, causing a combined 11% loss in carrying capacity (about 5,464 birds). Direct effects of CRP on Lesser Prairie-Chickens are most substantial in Kansas (providing 16.4% of its carrying capacity). This is because CRP is planted to native grass species in Kansas which provides more suitable habitat to the species. In all other BCR18 states, CRP was planted predominantly with non-native species that provides far less suitable; thus, in these states, the indirect contribution of CRP to creating Large Blocks of habitat is actually greater than is direct contribution via providing suitable habitat.



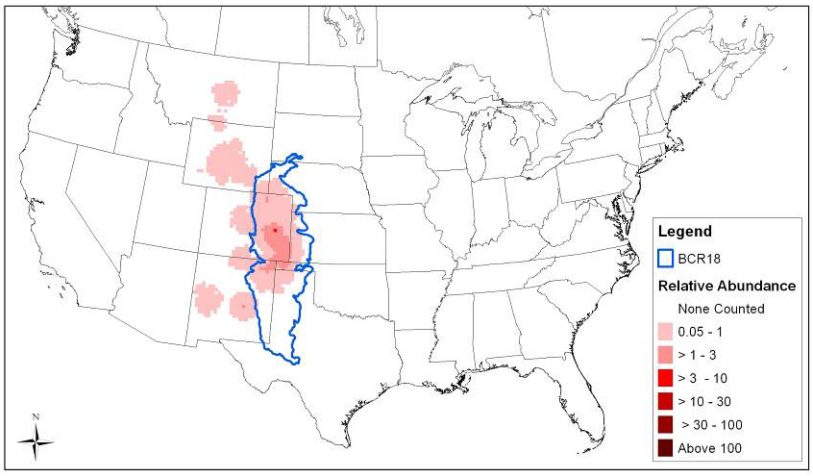
	State Area			CRP in Large Blocks		CRP to Cropland	
State Area	Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity Lost/Gained	% Pop. Goal Lost/Gained
CO	12,579	4,090	33%	27	0.2%	-27	**-0.2%**
KS	30,045	9,769	33%	4,934	16.4%	-4,934	**-16.4%**
OK	1,922	625	33%	14	0.7%	-14	**-0.7%**
NM	3,300	1,073	33%	3	0.1%	-3	**-0.1%**
TX	818	266	33%	16	2.0%	-16	**-2.0%**
Total	*48,664*	*15,823*	*33%*	*4,994*	*10.3%*	*-4,994*	***-10.3%***

	State Area			Non-CRP Habitat in Large Blocks		CRP to Cropland	
State Area	Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity Lost/Gained	% Pop. Goal Lost/Gained
CO	12,579	4,090	33%	4,063	32.3%	-122	**-1.0%**
KS	30,045	9,769	33%	4,835	16.1%	-270	**-0.9%**
OK	1,922	625	33%	611	31.8%	-40	**-2.1%**
NM	3,300	1,073	33%	1,070	32.4%	-6	**-0.9%**
TX	818	266	33%	250	30.6%	-32	**-3.9%**
Total	*48,664*	*15,823*	*33%*	*10,829*	*22.3%*	*-470*	***-1.0%***

Mountain Plover (*Charadrius montanus*)

Mountain Plover is a migratory shorebird that is considered a regional priority species with imperiled continental status under the U.S. Shorebird Conservation Plan and was recently petitioned for listing under the Endangered Species Act (found warranted but precluded). This species breeds throughout the northern two-thirds of BCR18 with highest concentrations occurring in Colorado. It uses shortgrass prairie with very short and sparse grass, especially prairie dog towns, but also will nest and forage in fallow crop fields (Kingery 1998, Bubsy and Zimmerman 2001).

The estimated carrying capacity of BCR18 is about 6,021 Mountain Plovers and CRP habitat does not contribute to that capacity because CRP grass habitat is unsuitable for the species (again, requiring very short grass with interspersed bare ground). If CRP were converted to cropland, fallow fields would provide suitable habitat to the species; therefore, our analysis shows slight gains in the population goals for the species, amounting to a 2.9% overall gain for the BCR (350 birds). However, it should be noted that although Mountain Plovers forage and nest in fallow crop fields, research indicates that nest success is lower in crop fields that native grasslands (Dreitz 2009) so crop fields should not be considered surrogate for native habitats.



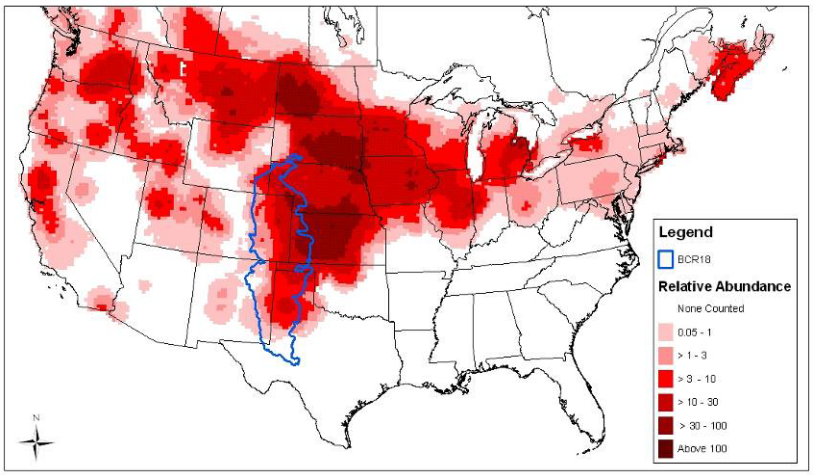
	State Area			CRP		CRP to Cropland	
State Area	Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity Lost/Gained	% Pop. Goal Lost/Gained
NE	617	314	50%	0	0%	25	**+4.0%**
CO	7,303	3,719	50%	0	0%	209	**+2.9%**
KS	1,697	864	50%	0	0%	79	**+4.7%**
OK	461	235	50%	0	0%	29	**+6.1%**
NM	1,294	659	50%	0	0%	1	**+0.0%**
TX	452	230	50%	0	0%	7	**+1.5%**
Total	*11,824*	*6,021*	*50%*	*0*	*0%*	*350*	***+2.9%***

Ring-necked Pheasant (*Phasianus colchicus*)

This resident exotic game bird occurs predominately in the eastern portions of BCR18 with highest concentrations in Nebraska, Colorado, and Kansas. Ring-necked Pheasants use a wide variety of habitats but are most common in areas having a mix of cultivated cropland, grassland and/or CRP, with areas of heavy cover (e.g., roadside ditches, fence rows) (Giudice and Ratti 2001). They use small-grain fields, fallow fields, and alfalfa (Mollhoff 2001), as well as hayfields and pasture (Thompson and Ely 1989). Wetlands with emergent vegetation and wet meadows provide important habitat during winter (Giudice and Ratti 2001, Dinan and Johnsgard 2004).

The carrying capacities, and hence, population goals for Ring-necked Pheasants are underestimated by as much as half in this analysis, judging by harvest data published for each state. We believe this error is because the density data used in this calculation are low due to inadequate survey methods (regarding Ring-necked Pheasant detection only). Density data were derived from point counts and walking-line transects which are not effective detection methods for this species; however, they were the only density data available. Regardless of the underestimated carrying capacity, the *percent* of population goal provided through CRP habitat and the *percent* of population goal lost or gained are credible, as they are percents.

The estimated carrying capacity of BCR18 is about 731,000 Ring-necked Pheasants and CRP contributes about 8% of that carrying capacity. If CRP were converted to cropland, there would be little effect on the carrying capacity for Ring-necked Pheasants in BCR18 as this species uses CRP and cropland at similar rates. However, it should be noted that Ring-necked Pheasants are known to use CRP for winter cover, when many crop fields are of unsuitable vegetative stature, so CRP's full benefit to this species is not reflected here (this analysis is based on density data collected during breeding season only).

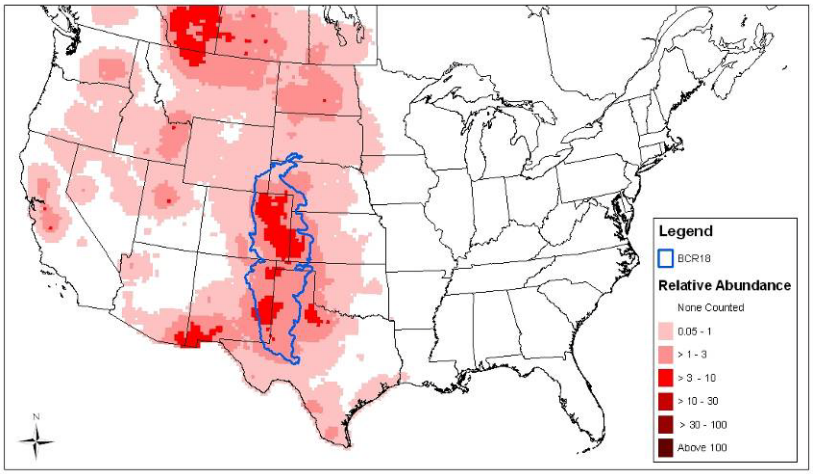


	State Area			CRP		CRP to Cropland	
State Area	Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity Lost/Gained	% Pop. Goal Lost/Gained
NE	103,186	60,933	60%	2,235	2.2%	1,402	**+1.4%**
CO	208,566	123,162	60%	16,737	8.0%	-1,382	**-0.7%**
KS	188,135	111,097	60%	11,945	6.4%	2,681	**+1.5%**
OK	13,703	8,108	60%	1,666	12.1%	203	**+1.5%**
NM	15,554	9,185	60%	1,013	6.6%	-233	**-1.5%**
TX	202,278	119,449	60%	26,220	13.0%	-5,961	**-2.9%**
Total	*731,422*	*431,934*	*60%*	*59,816*	*8.2%*	*-3,290*	***-0.4%***

Swainson's Hawk (*Buteo swainsoni*)

This migratory raptor is a PIF Watch List Species, a Tier II At-risk Species in Nebraska, a Category II Species of Special Concern in Oklahoma, and a species experiencing Declines or High Threats according to the ABC. Swainson's Hawks breed throughout BCR18 and use a wide variety of habitats including native grassland and shrubland, hay fields, pasture, cultivated land with scattered trees, riparian woodland, and shelterbelts (Thompson and Ely 1989, England et al. 1997, Busby and Zimmerman 2001, Johnson et al. 2004). Research suggests that they prefer some cultivated cropland and tolerates extensive areas of cultivated cropland in territories (Dechant et al. 2001) but requires sparsely available or aggregations (e.g., associated with riparian areas, homesteads) of trees for nest sites (Olendorff 1973).

The estimated carrying capacity of BCR18 is about 90,000 Swainson's Hawks and CRP contributes about 3% of that carrying capacity. If CRP were converted to cropland, it seems there would be little effect on the carrying capacity of BCR18 as this species is documented using cropland and grasslands at very similar rates in BCR18 (Hanni and McLachlan 2004, Sparks et al. 2005, Sparks and Hanni 2006). Swainson's Hawks are documented as using CRP in BCR18; however, there were no density data available for CRP so we assumed that native grass CRP has a density equivalent to shortgrass prairie and non-native CRP has a density equivalent to mixed-grass prairie. Accordingly, CRP does not contribute to much the population goal of Swainson's Hawks in the BCR.



	State Area			CRP		CRP to Cropland	
State Area	Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity	% Pop. Goal	Carrying Capacity Lost/Gained	% Pop. Goal Lost/Gained
NE	1,904	1,904	100%	38	2.0%	37	**+2.0%**
CO	34,716	34,716	100%	1,334	3.8%	375	**+1.1%**
KS	13,701	13,701	100%	2,003	14.6%	-463	**-3.3%**
OK	1,525	1,525	100%	149	9.6%	81	**+5.3%**
NM	28,611	28,611	100%	273	1.0%	-25	**-0.1%**
TX	9,674	9,674	100%	876	9.1%	-315	**-3.3%**
Total	*90,131*	*90,131*	*100%*	*4,673*	*5.2%*	*-310*	***-0.3%***

DISCUSSION

CRP and Wildlife Conservation

When CRP was developed in 1985, its primary objectives were to reduce soil erosion and surplus commodities. Little consideration was given to CRP as potential wildlife habitat. Many CRP fields in the Great Plains were planted to monocultures or mixtures of introduced grass species and, as mandated by law; most CRP fields remained virtually undisturbed for the life of their contracts (10 – 15 years or longer for re-enrolled fields). As a result, CRP fields planted to grass may have dissimilar vegetation composition and structure relative to surrounding native prairie (McIntyre and Thompson 2003, Kamler et al. 2003, Samson et al. 2004, Kamler et al. 2005). A difference in habitat characteristics indicates a potential difference in benefits to wildlife. For instance, some biologists suggest that CRP in the shortgrass prairie BCR provides poor quality habitat to shortgrass dependent wildlife (Milchunas et al. 1998, McIntyre and Thompson 2003, Kamler et al. 2003, Samson et al. 2004, Kamler et al. 2005) because of the disproportionately taller vegetation in undisturbed and/or non-native CRP fields (McIntyre and Thompson 2003, Kamler et al. 2003, Samson et al. 2004, Kamler et al. 2005).

In recent years, however, the focus of the CRP has expanded to include wildlife habitat as an additional program objective (Allen 1994). Beginning in 1996, eligible CRP offers were ranked according to an Environmental Benefits Index (EBI). The EBI is a rating system aimed at maximizing the value of erosion reduction and wildlife habitat. Since then, the EBI has been refined to improve the quality of wildlife habitat by encouraging establishment of diverse native vegetation over monocultures of introduced species, and to promote restoration of rare and declining wildlife habitat. Additionally, in recognition of the need for periodic disturbance and management of CRP land, the USDA authorized managed haying and grazing in 2002 (which is to occur no more frequently than one out of every three years) to improve the quality of CRP land for wildlife (U.S. Department of Agriculture 2004b). Managed haying and grazing are particularly important additions to the program as they allow the opportunity to alter the vegetation structure of existing CRP habitat to suit the requirements of target wildlife. These changes to CRP are promising for wildlife conservation, especially for grassland birds, considering the impressive number of CRP acres enrolled in the Great Plains.

Still there are other factors that continue to affect, and likely limit, the benefits of CRP to grassland wildlife. Two chief factors are the spatial (e.g., size, shape) and landscape (e.g., juxtaposition, neighboring habitats) characteristics of CRP fields. CRP fields are often located in highly fragmented landscapes dominated by cropland and can take any number of shapes and sizes from long, narrow strips, to triangular corner plots, to 690-acre blocks. These are important habitat features when considering conservation of grassland birds because many are thought to be sensitive to habitat fragmentation (O'Connor et al.1999, Brennan and Kuvlesky 2005), size and shape of habitat patches (Johnson and Temple 1986, Herkert 1994, Vickery 1994, Johnson and Igl 2001, Brennan and Kuvlesky 2005, Cunningham 2005), and landscape composition (Rotenberry and Wiens 1980, Knick and Rotenberry 1995, Cunningham and Johnson 2006).

In this CEAP project, we went to great lengths to incorporate as many habitat parameters as possible when evaluating the effect of CRP of priority shortgrass prairie birds, including spatial and landscape characteristics. The biggest hindrance was the availability of reliable and current data. Data on the vegetation composition or management activities (i.e., vegetation structure) for individual CRP fields are not available in regional data sets but are stored at county-level field offices. Considering the large spatial scale of this project, acquiring these data for the nearly 100,000 CRP fields in the study area was infeasible. So we applied assumptions based on expert opinions about the proportion of CRP fields that are planted to native or non-native species (discussed in Methods). Furthermore, for many grassland bird species, the relative importance of these factors in defining an individual species' habitat requirements is not well understood nor well documented. When data were available for species, they were incorporated into calculations of carrying capacity and noted in the individual species results.

Benefits of CRP to Shortgrass Prairie Birds

The 7 priority bird species included in this analysis are species which are documented as using CRP and/or cropland in BCR18 (and had sufficient density data). These criteria limited the number of species available for analysis because of the inherent dissimilarity in the vegetative composition and structure between native shortgrass prairie (including shrubland such as sand sage) and CRP fields planted to grass. Many shortgrass prairie bird species, especially those endemic to the area, require vegetation structure and composition that CRP does not currently provide in most areas because of non-native plantings and/or lack of disturbance (i.e., grazing, haying). Thus, the findings in this report do not apply to the broad suite of shortgrass prairie-associated birds, but rather, a subset that generally represents species that use a variety of grassland habitats, in particular, those that use habitat with moderate grass height, relatively dense vegetation, and little to no shrub cover.

Our analysis indicates that for two priority bird species, CRP is making substantial impacts on their populations in BCR18, Grasshopper Sparrow and Lesser Prairie-Chicken. The large benefit of CRP to Grasshopper Sparrow is related to its use of grassland with moderate grass heights, a limited habitat type in the shortgrass prairie. This makes CRP, as currently administered and managed, an important source of habitat for the species. The positive effect of CRP on the Lesser Prairie-Chicken is primarily attributed to the large amounts of native grass plantings that occur in Kansas. This 'native' CRP not only provides suitable habitat for this species of high concern (a candidate species under the Endangered Species Act) but the CRP fields also serve to expand and connect otherwise fragmented blocks of native habitat which are critical to the species' survival.

For other species, including Cassin's Sparrow, Lark Bunting, and Ring-necked Pheasant, the benefit of CRP is moderate by comparison but still significant in terms of conservation of the species. Both Cassin's Sparrow and Lark Bunting benefit from CRP grassland because they will use a variety of grassland habitats which includes grassland with moderate grass height and low shrub cover. However, these species will also use the shorter stature grasses interspersed with shrubs which are typical of native shortgrass

prairie. Thus, CRP habitat can provide an alternative habitat type for these species. Ring-necked Pheasants use an even wider variety of habitats from native shortgrass prairie, to riparian woodland, to corn fields. So the benefit of CRP to this exotic game species is not as evident as with species with more specialized habitat needs. In fact, our analysis showed that conversion of CRP to cropland would have little to no effect on this generalist species because of its ability to utilize cropland habitat at nearly equal rates. One consideration that may add credit to the positive effect of CRP on Ring-necked Pheasant is the ability of CRP to provide wintering habitat for this resident bird, unlike most cropland cover.

For Swainson's Hawk and Mountain Plover, both of which occur and nest in cropland-dominated areas, there appeared to be little to no benefit of CRP over cropland. Swainson's Hawks nest in areas with extensive cropland and use cropland at similar rates as grassland so it is difficult to discern any clear benefit of CRP to the species. However, CRP fields may provide better habitat for its prey species than cropland, so it is possible that CRP fields provide more benefit than this analysis can determine. The effect of CRP on Mountain Plovers is more evident. CRP fields, even those that are native, cannot provide the required habitat structure unless they experience heavy disturbance which results in very short vegetation with plenty of bare ground. Although it is possible to achieve these characteristics, doing so would conflict with the other goals of the CRP, in particular, reducing soil erosion. Therefore, our analysis indicates that conversion of CRP to cropland (in this case fallow cropland) can show positive effects for Mountain Plover. However, this is not to encourage conversion of CRP, but rather, to point out that in some cases the CRP in not an appropriate tool for conservation of a species, especially considering the multiple goals of the CRP.

Many factors can influence whether CRP has an effect (either positive or negative) on a bird species as well as the magnitude of effect. Below we discuss some of the factors that influenced the effects of CRP on the species in this analysis.

Native Plantings

Comparing the overall effect of CRP among the states, CRP in Kansas often produced the most benefit for priority birds. This benefit is largely attributable to that fact that nearly all CRP grass in Kansas is planted with native species, as opposed to the mostly non-native CRP grasses in the other states. Native grasses generally provide more suitable habitat for grassland birds, and, thus, they occur at greater densities on this habitat. This is particularly true in the shortgrass prairie where native grasslands are short in stature, unlike many of the non-native CRP grasses which were established the region (such as smooth brome, weeping love grass, and old world blue stem). In our analysis, CRP in Kansas showed greater benefit to three species that are either documented as or thought by experts as using native CRP plantings at higher densities than non-native (including Cassin's Sparrow, Lark Bunting, and Lesser Prairie-Chicken).

Area Requirements

CRP proved beneficial to Lesser Prairie-Chicken, an area-sensitive species, in two ways. First it provides suitable habitat through native CRP plantings and, second, it creates

large blocks of suitable habitat by connecting otherwise fragmented small blocks of native habitat. Our spatial models showed that CRP contributed to and connected large blocks of suitable habitat for Lesser Prairie-Chicken, and, consequently, when CRP was reclassified to cropland, it resulted in fragmentation of that previously suitable habitat. In addition to the prairie-chickens, other priority birds in this analysis are area- and/or disturbance-sensitive, including Grasshopper Sparrow. However, the area requirements (i.e., size of habitat block) are much smaller for Grasshopper Sparrow (20-30 ac in Nebraska; Helzer 1996, Helzer and Jelinski 1999) relative to the average size of a CRP field in BCR18 which is about 125 ac (for grass and wildlife habitat plantings). So we did not develop spatial models nor apply *Large Block Factors* for Grasshopper Sparrow to evaluate CRP.

Overall, CRP is positively affecting a variety of priority bird species in the shortgrass prairie. Although some species benefit more than others, in general, CRP is providing an alternative suitable habitat typically preferred over otherwise present cropland. CRP is particularly important in connecting and enlarging existing blocks of fragmented prairie habitat. This is a critical landscape component (i.e., habitat corridors and buffers) for both area-sensitive and ground birds such as the Lesser Prairie-Chicken. Below we suggest ways to further increase these benefits of CRP to grassland birds.

Recommendations

To maximize benefits of CRP to grassland birds, we recommend that CRP be delivered in a strategic approach that focuses on three central factors: 1) species of greatest conservation need, 2) spatial targeting of acres, and 3) managed native plantings.

CRP delivery should be aimed at benefiting species that are of highest conservation concern as well as species for which action will benefit the most number of species (i.e., umbrella species or groups instead of single species). Priority species can be identified, as they were in this CEAP project, by consolidating federal, regional, and state species conservation lists and determining which species occur in the planning area. (PLJV developed the Species for Management Action (SMA) database to identify species in BCRs 18 and 19 and this tool can be expanded to include any region in North America). It is also important to determine if CRP is an appropriate tool for conserving each priority species, as it will not always be the case. Wildlife habitat is only one of several goals of the CRP, and the management required to benefit a particular species may conflict other goals such as reducing soil erosion. For example, Mountain Plovers are a high priority species of the shortgrass prairie that requires bare ground and short stature grassland vegetation. Managing CRP for such conditions may increase erosion. Therefore, it is necessary to determine and consider the habitat requirements of identified priority species.

CRP should be spatially targeted according to its context within the landscape (i.e., Is a field surrounded by cropland, urban development, or native habitat?) and according to spatial habitat requirements of priority species (i.e., Does the species require large blocks of habitat or does it tolerate habitat fragmentation?). Spatial targeting can locate and rank existing CRP fields and qualified crop fields based on their potential benefit to priority species. This process answers the question, 'Where is CRP needed to benefit a species'? We suggest development of a Decision Support Tool (DST) that evaluates CRP fields, crop fields, and the habitat requirements of bird species (including spatial parameters) against the landscape through a Geographic Information System (GIS). PLJV developed and used such a DST for this CEAP project to identify suitable habitat for Lesser Prairie-Chickens. The DST evaluated CRP location, acres, and conservation practice within the context of surrounding habitat. The illustration in Figure 7 shows how a DST can rank crop fields into tiers of potential benefit to Lesser Prairie-Chicken considering adjacency to large blocks of native habitat, existing CRP fields, and major roads (no tolerance). When CRP and crop fields are ranked according to potential benefit to birds, it allows strategic enrollment and re-enrollment of fields, creating more and higher quality habitat. To maximize the number of high ranking fields enrolled in CRP, we suggest targeted solicitation of landowners for enrollment and increased financial incentives to landowners of high ranking fields. Landowners of high ranking fields may receive a signing incentive payment, practice incentive payment, or higher rental rates.

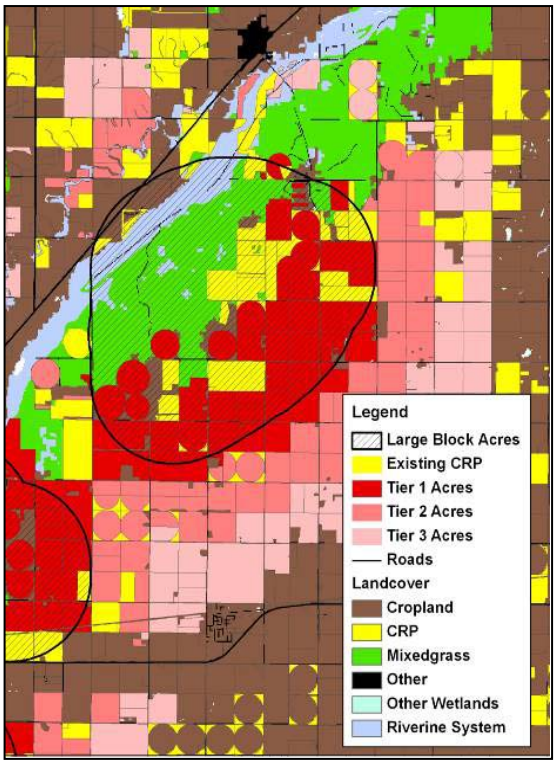


Figure 7. Map produced by a Decision Support Tool showing the rank (Tier 1 = highest priority (red), Tier 2 = medium priority (dark pink), Tier 3 = low priority (light pink)) of crop fields near existing large blocks of suitable Lesser Prairie-Chicken habitat.

Habitat condition of CRP is just as important as its location. If the vegetation composition or structure of CRP is unsuitable, its location is moot. CRP plantings should resemble the native plant communities in which they are imbedded and managed according to the habitat needs of the priority species. This means planting diverse mixtures of native plants, including grasses, forbs, and shrubs that are adapted to particular soil types within the region. Proper stand development may require application of specific maintenance activities such as weed control or re-seeding to encourage full emergence of the planting. It may also require prescribing management activities to achieve more specific desired vegetation structure and composition such as prescribed grazing, haying, or burning.

Strategic CRP delivery will increase conservation benefits to the species that need them the most and will save substantial conservation dollars by using them more effectively. The current opportunistic approach of CRP delivery has certainly provided considerable benefit to many wildlife species, including grassland birds; however, the potential impact of a more targeted approach to CRP and wildlife conservation is tremendous. This CEAP project has shown clear benefit of CRP to several priority shortgrass prairie bird species. We believe these benefits could be even greater if CRP were delivered in a more strategic approach.

Assumptions and Limitations

Population Goals and Carrying Capacity Estimates

Population goals and carrying capacities presented in this report are estimates and do not reflect a true census of any bird species, and thus, should be viewed with caution. These estimates reflect the potential capacity of the landscape to support bird populations based on the best available spatial landcover and species-to-habitat densities. Furthermore, the species-to-habitat densities used in this analysis are based on bird count data rather than nesting success/density; therefore, carrying capacity represents species occurrence not recruitment. Data on species recruitment is generally very sparse relative to occurrence data and, thus, were not incorporated into our analysis. While the carrying capacities presented in this project must be viewed with caution, the *percent* of the current carrying capacity which CRP holds for each species listed can be viewed with greater confidence because density information has been tied to each specific habitat type found within the region.

Density Data

Density data were gathered through an exhaustive literature search; however, because this analysis considers several habitats simultaneously (and so required several habitat-specific density estimates for a single species) it was sometimes necessary to apply density estimates from multiple sources to a single species. This lack of consistency among density estimates, resulting from various methods authors used in calculating density, can cause discrepancy when comparing habitats. A strong effort was made to identify outliers in the density data to reduce such problems. Furthermore, density data are almost exclusively available for the breeding season so this analysis is limited to those species occurring in BCR18 during the breeding season and its results (i.e., carrying capacity) applied only to the breeding season.

Trend Data

Population goals were derived, in part, from species trend data from the U.S. Geological Survey (USGS) Breeding Bird Survey (BBS). The BBS is a long-term (30+ years) national bird survey from which trend data are calculated for individual species (Sauer et al. 2006). See <http://www.mbr-pwrc.usgs.gov/bbs/trend/tf06.html> for an explanation of the methods used to calculate trends and limitations of BBS data. Using BBS trends to determine population goals may results in goals that are greater than the ability of the current landscape to deliver. This could happen for several reasons: 1) habitat acreages have changed over the last thirty years because of habitat change or conversion, 2) current GIS landcover data do not accurately reflect the true landscape, or 3) factors

outside of the breeding range may be affecting trend. For those species where a trend-based population goal required more than doubling the estimated current carrying capacity, the population goal was capped at doubling.

Landcover Data

Carrying capacities presented in this report are based on habitat acres as depicted in a regional (BCR18) landcover developed by PLJV. The landcover is a combination of multiple state-based and regional coverages (see *Step 1* in Methods) reclassified to single classification system to create a continuous landcover across state boundaries. All spatial landcover layers have inherent error so the habitat acres we used in estimating carrying capacity can only be considered estimates themselves. Currently, there is no accuracy assessment for the landcover layer; however, accuracy levels of the source data used in creating it are available in "Habitat Assessment Procedures Technical Companion Document to the PLJV Implementation Planning Guide" (Playa Lakes Joint Venture 2007).

Not all habitat Conditions are spatially explicit (i.e., not mapped) so acres for these Conditions were derived from statistics (e.g., the National Agricultural Statistics Service provided statistics of crop type acres) or assumed based on expert opinion (e.g., 25% of the mixed grass prairie has 'many shrubs' and 'high grass'). The *Range Factors* applied to acres of habitat Associations and Conditions are based on estimated species' range boundaries which have some inherent error as ranges can be dynamic (i.e., change over time, with weather). The *Suitability Factor* is based out of literature or expert opinion. The *Large Block Factors* are based on calculations from spatial models that were developed with criteria based from scientific literature and expert opinion (e.g., Interstate Lesser Prairie-Chicken Working Group).

LITERATURE CITED

Allen, A. W. 1994. Regional and state perspectives on Conservation Reserve Program contributions to wildlife habitat, report prepared for the Habitat Protection Committee of the International Association of Fish and Wildlife Agencies. Fort Collins, Mid-continent Ecological Science Center, National Biological Survey, Federal Aid in Wildlife Restoration Report.

Andrews, R., and R. Righter. 1992. Colorado birds: a reference to their distribution and habitat. Denver Museum of Natural History, Denver, Colorado, USA.

Best, L.B., H. Campa III, K.E. Kemp, R.J. Robel, M.R. Ryan, J.A. Savidge, H.P. Weeks Jr., and S.R. Winterstein. 1997. Bird abundance and nesting in CRP fields and cropland in the Midwest: a regional approach. Wildlife Society Bulletin 25:864-877.

Brennan, L. A. and W. P. Kuvlesky Jr. 2005. North American grassland birds: An unfolding conservation crisis? Journal of Wildlife Management 69:1-13.

Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. The U.S. Shorebird Conservation Plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, Massachusetts, USA.

Busby. W. H., and J. L. Zimmerman. 2001. Kansas Breeding Bird Atlas. University Press of Kansas, Lawrence, Kansas, USA.

Crawford, J. A., and E. G. Bolen. 1976. Effects of land use on Lesser Prairie Chickens in Texas. Journal of Wildlife Management 40: 96–104.

Cunningham, M. A. 2005. A Comparison of public lands and farmlands for grassland bird conservation. The Professional Geographer 57:51-65.

Cunningham, M. A. and D. H. Johnson. 2006. Proximate and landscape factors influence grassland bird distributions. Ecological Applications 16:1062-1075.

Dechant, J. A., M. F. Dinkins, D. H. Johnson, L. D. Igl, C. M. Goldade, and B. R. Euliss. 2001 (revised). Effects of management practices on grassland birds: Swainson's Hawk. Northern Prairie Wildlife Research Center, Jamestown, ND.

Dechant, J.A., M.L. Sondreal, D.H. Johnson, L.D. Igl, C.M. Goldade, M.P. Nenneman, and B.R. Euliss. 2002a. Effects of management practices on grassland birds: Grasshopper Sparrow. Northern Prairie Wildlife Research Center, Jamestown, North Dakota, USA.

Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, C. M. Goldade, A. L. Zimmerman, and B. R. Euliss. 2002b (revised). Effects of management practices on

grassland birds: Lark Bunting. Northern Prairie Wildlife Research Center, Jamestown, North Dakota, USA.

Dinan, J., and P. A. Johnsgard. 2004. Habitat associations for Nebraska bird species. Unpublished spreadsheet.

Dobbs, R.C. 2007. A review of distribution, habitat use, and population density data in the Hierarchical All Bird Strategy (HABS) Database. Playa Lakes Joint Venture, Lafayette, Colorado, USA.

Dreitz, V. J. 2009. Parental behaviour of a precocial species: implications for juvenile survival. Journal of Applied Ecology, In Press.

Dunning, J.B., Jr., R.K. Bowers, Jr., S.J. Suter, and C.E. Bock. 1999. Cassin's Sparrow (*Aimophila cassinii*). No. 471 *in* The Birds of North America (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, Pennsylvania, USA.

England, A. S., M. J. Bechard, and C. S. Houston. 1997. Swainson's Hawk (*Buteo swainsoni*). No. 265 *in* The Birds of North America (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C., USA.

Fields, T. L. 2004. Breeding season habitat use of Conservation Reserve Program (CRP) land by Lesser Prairie-Chickens in west central Kansas. M.Sc., Colorado State University, Fort Collins, Colorado, USA.

Giesen, K. M. 1994. Movements and nesting habitat of Lesser Prairie-Chicken hens in Colorado. Southwest Naturalist 39: 96-98.

Giudice, J. H., and J. T. Ratti. 2001. Ring-necked Pheasant (*Phasianus colchicus*). No. 572 *in* The Birds of North America (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, Pennsylvania, USA.

Hagan, C. A. 2005. Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*). *In* The Birds of North America Online (A. Poole, Ed.). Cornell Laboratory of Ornithology, Ithaca, NY; Retrieved from The Birds of North American Online database.

Hanni, D. J., and M. M. McLachlan. 2004. Section-based monitoring of breeding birds within the shortgrass prairie Bird Conservation Region (BCR18). Rocky Mountain Bird Observatory, Brighton, CO, USA.

Helzer, C. J. 1996. The effects of wet meadow fragmentation on grassland birds. M.S. thesis. University of Nebraska, Lincoln, Nebraska, USA.

Helzer, C. J., and D. E. Jelinski. 1999. The relative importance of patch area and perimeter-area ratio to grassland breeding birds. Ecological Applications 9:1448-1458.

Herkert, J. R. 1994. The effects of habitat fragmentation of Midwestern grassland bird communities. Ecological Applications 4:461-471.

Jackson, A. S., and R. DeArment. 1963. The Lesser Prairie Chicken in the Texas Panhandle. Journal of Wildlife Management 27: 733–737.

Johnson, D.H., and L.D. Igl. 1995. Contributions of the Conservation Reserve Program to populations of breeding birds in North Dakota: Wilson Bulletin 107:.709-718.

Johnson, D. H. and L. D. Igl. 2001. Area requirements of grassland birds: A regional perspective. Auk 118:24–34.

Johnson, D. H., L. D. Igl, and J. A. Dechant Shaffer. 2004. Effects of management practices on grassland birds. Northern Prairie Wildlife Research Center, Jamestown, North Dakota, USA.
perspective. Auk 118:24–34.

Johnson, D.H. and S. A. Temple. 1986. Assessing habitat quality for nesting birds in fragmented tallgrass prairies *in* Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. University of Wisconsin, Madison, Wisconsin, USA.

Kamler, J. F., W. B. Ballard, E. B. Fish, P.R. Lemons, K. Mote, and C.C. Perchellet. 2003. Habitat use, home ranges, and survival of swift foxes in fragmented landscape: conservation implication. Journal of Mammalogy 84:989-995.

Kamler, J. F., W. B. Ballard, P. R. Lemons, R. L. Gillard, and K. Mote. 2005. Home range and habitat use of coyotes in an area of native prairie, farmland, and CRP fields. American Midland Naturalist 153:394-404.

King, J.W. and J.A. Savidge. 1995. Effects of the Conservation Reserve Program on wildlife in southeast Nebraska. Wildlife Society Bulletin 23:377-385.

Kingery, H. E. (ed.) 1998. Colorado breeding bird atlas. Colorado Bird Atlas Partnership, Denver, Colorado, USA.

Klute, D.S., and R.J. Robel. 1997. Will conversion of Conservation Reserve Program (CRP) lands to pasture be detrimental for grassland birds in Kansas? American Midland naturalist 137: 206-212.

Knick, S. T, and J. T. Rotenberry. 1995. Landscape characteristics of fragmented shrubsteppe habitats and breeding passerine birds. Conservation Biology 9:1059-1071.

Kushlan, J.A., M.J. Steinkamp, K.C. Parsons, J. Capp, M. Acosta Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R.M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul ,R. Phillips, J.E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1. Waterbird Conservation for the Americas, Washington, DC, USA.

McIntyre, N. E. and T. R. Thompson. 2003. A comparison of Conservation Reserve Program habitat plantings with respect to arthropod prey for grassland birds. American Midland Naturalist 150:291-301.

Milchunas, D. G., Lauenroth, W. K., and Burke, I.C. 1998. Livestock grazing: animal and plant biodiversity of shortgrass prairie steppe and the relationship to ecosystem function. Oikos 83:65-74.

Mollhoff, W. J. 2001. The Nebraska breeding bird atlas, 1984-1989. Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

O'Connor, R. J. M. T. Jones, R. B. Boone, and T. B. Lauber. 1999. Linking continental climate and land use patterns with grassland bird distribution across the conterminous United States. Studies in Avian Biology 19:35-59.

Olendorff, R. R. 1973. The ecology of the nesting birds of prey of northeastern Colorado. U.S. International Biological Program Technical Report 211.

Playa Lakes Joint Venture. 2007. Habitat assessment procedures technical companion document to the PLJV Implementation Planning Guide. Playa Lakes Joint Venture, Lafayette, Colorado, USA.

Price, J., S. Droege, and A. Price. 1995. The summer atlas of North American birds. Academic Press, San Diego, California, USA.

Reinking, D. L. (ed.) 2004. Oklahoma breeding bird atlas. University of Oklahoma Press, Norman, Oklahoma, USA.

Reynolds, R.E., T.L. Shaffer, R.W. Renner, W.E. Newton, and B.D.J. Batt. 2001. Impact of the Conservation Reserve Program on duck recruitment in the U.S. Prairie Pothole Region. Journal of Wildlife Management 65:765-780.

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. Iñigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology, Ithaca, New York, USA.

Riley, T. Z., C. A. Davis, M. Ortiz, and M. J. Wisdom. 1992. Vegetative characteristics of successful and unsuccessful nests of Lesser Prairie Chickens. Journal of Wildlife Management 56: 383–387.

Rodgers, R.D. 1999. Why haven't pheasant populations in western Kansas increased with CRP? Wildlife Society Bulletin 27:654-665.

Rotenberry, J.T., and J.A. Wiens. 1980. Habitat structure, patchiness, and avian communities in North American steppe vegetation: a multivariate analysis. Ecology 61:1228-1250.

Samson, F. and F. Knopf. 1994. Prairie Conservation in North America. BioScience 44: 418-421.

Samson, F. B., Knopf, F.L., and Ostlie, W.R. 2004. Great Plains ecosystems: Past, present, and future. Wildlife Society Bulletin 32:6-15.

Sauer, J. R., J. E. Hines, and J. Fallon. 2006. The North American Breeding Bird Survey, Results and Analysis 1966 - 2006. Version 6.2.2006. USGS Patuxent Wildlife Research Center, Laurel, MD, USA.

Sparks, R. A., D. J. Hanni, and M. McLachlan. 2005. Section-based monitoring of breeding birds within the Shortgrass Prairie Bird Conservation Region (BCR 18). Rocky Mountain Bird Observatory, Brighton, Colorado, USA.

Sparks, R. A., and D. J. Hanni. 2006. Section-based monitoring of breeding birds within the Shortgrass Prairie Bird Conservation Region (BCR 18). Rocky Mountain Bird Observatory, Brighton, Colorado, USA.

Taylor, M. A., and F. S. Guthery. 1980. Status, ecology, and management of the Lesser Prairie Chicken. U.S. Dep. Agric. Forest Service Gen. Tech. Rep. RM-77, Rocky Mountain Forest and Range Experimental Station, Fort Collins, Colorado, USA.

Thompson, M. C., and C. Ely. 1989. Birds in Kansas, Vol. 1. Museum of Natural History, University of Kansas. Lawrence, Kansas, USA.

Thompson, M. C., and C. Ely. 1992. Birds in Kansas, Vol. 2. Museum of Natural History, University of Kansas, Lawrence, Kansas, USA.

U.S. Department of Agriculture Farm Service Agency. 2004a. Conservation Reserve Program Fiscal year Summary 2003. U. S. Department of Agriculture Farm Service Agency.

U.S. Department of Agriculture Farm Service Agency. 2004b. Fact Sheet: Conservation Reserve Program Haying and Grazing of Acreage. Farm Service Agency Online, www.fsa.usda.gov/pas/publications/facts/haygraze04.htm.

Vickery, P. D. 1994. Effects of habitat area of the distribution of grassland birds in Maine. Conservation Biology 8:1087-1097.

World Wildlife Fund Canada. 1988. Prairie Conservation Action Plan. World Wildlife Fund Canada, Toronto, Ontario, Canada.