RAINWATER BASIN JOINT VENTURE LANDBIRD PLAN

A REGIONAL CONTRIBUTION TO THE

NORTH AMERICAN LANDBIRD CONSERVATION PLAN

AND THE

RAINWATER BASIN JOINT VENTURE IMPLEMENTATION PLAN

BY THE RAINWATER BASIN JOINT VENTURE

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Executive Summary

More than one in four birds has disappeared from the North American landscape over the last 50 years; a total loss of 3 billion individuals (Rosenberg et al. 2019). Species that breed in grassland habitats have suffered the most, declining by 53% (Rosenberg et al. 2019). The area of Nebraska administered by the Rainwater Basin Joint Venture contains habitats that support a large number of breeding landbirds, particularly grassland-dependent species. In this plan, 23 priority landbird species are identified, eight of which are used to develop grassland habitat objectives intended to reverse or stabilize population declines. This plan supports and supplements the continental Partners in Flight Landbird Conservation Plan by deriving our population objectives directly from their 2016 revision.

Two prominent threats impacting landbirds in the RWBJV Region are conversion of grasslands to agriculture and woody encroachment. Annual rates of grassland conversion exceed 1% in some areas. Over one million acres are impacted by woody encroachment each year. Conservation strategies will focus on keeping existing grassland on the landscape by providing education and incentives that are expected to slow the rate of conversion to other land uses and halting the encroachment of woody species. Restoration of grasslands will be needed to bring back landbird populations that have already been lost. Increasing the quantity and quality of breeding habitat available in this geography will offset the impact of broad-scale threats (e.g., climate change and habitat loss in wintering grounds).

This plan also describes methods to help improve the efficiency of conservation actions by targeting geographic areas that support the highest numbers and diversity of birds. These methods can be adapted to fit the preferred landscapes, species, and conservation practices of partner organizations. Funding up to $40 million each year will be needed to maintain current grassland habitats and restore additional acres needed to support population goals. Achieving this level of funding will be challenging; therefore, it will be important to focus on conservation design efforts that can maximize return-on-investments. The Rainwater Basin Joint Venture hopes this plan provides the information and inspiration our partnership needs to implement both long-term planning and immediate actions that will ultimately help recover vulnerable species and halt continued declines of more common species as well.

Introduction

The Rainwater Basin Joint Venture (RWBJV) partnership was established in 1992. It initially focused on waterfowl conservation within the Rainwater Basin wetland complex (RWB). In 2001, a national call was made for joint ventures to expand their conservation focus to all species of birds. In response, the RWBJV expanded its administrative area and mission to include portions of Bird Conservation Regions (BCRs) 11 (Prairie Pothole Region), 19 (Central Mixed-grass Prairie Region), and 17 (Badlands and Prairies) within Nebraska, which includes wetland, grassland, and woodland birds. This administrative area is referred to in this document as the RWBJV Region.

A recent report has documented the loss of nearly 3 billion birds over the last 50 years (Rosenberg et al. 2019). Landbird species have been particularly hard hit, with 59% of species experiencing significant population declines. Many factors have contributed to the decline. Human-driven land use practices (e.g., conversion of grasslands, shrublands, and forests to agricultural, residential, commercial, and industrial uses) are the main cause of habitat degradation and loss, and reduced landbird populations across the continent (Murphy 2003, Peterjohn 2003, Smith and Lomolino 2004, Askins et al. 2007). Invasive woody plants, agricultural pesticides, domestic cat predation, and incompatible land management practices have also been linked to declines (Frost and Powell 2011, Li et al. 2020, Loss et al. 2015, Stanton et al. 2018). In addition, the impacts of climate change are expected to negatively impact many bird species and the resources they depend on by reducing available moisture and increasing extreme weather events (Bateman et al. 2020, Bathke et al. 2014, Conrey et al. 2016).

Building on Past Conservation Actions

In 2000, the first Partners in Flight (PIF) North American Landbird Conservation Plan (LCP, Pashley et al. 2000) was written to guide landbird conservation. The most recent revision was published in 2016 and provides an updated framework for species prioritization and development of population trend objectives to guide habitat conservation (Rosenberg et al. 2016). The PIF Landbird Conservation Plan was developed by various conservation constituents, including state and federal agencies, non-government conservation organizations, and individual researchers from across North America.

The PIF Landbird Conservation Plan complements the existing landscape-scale conservation efforts of the North American Waterfowl Management Plan (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1986), the Canadian Shorebird Plan (Donaldson et al. 2000), the U.S. Shorebird Conservation Plan (Brown et al. 2001), and the Waterbird Conservation for the Americas Plan (Kushlan et al. 2002). Given the complexity in managing the several hundred landbird species found throughout North America, the PIF Landbird Conservation Plan focused on a continental scale to serve as a “blueprint” to help guide conservation plans at regional, state, provincial, territorial, and local levels (Rich et al. 2004).

The 2021 RWBJV Landbird Plan is a revision of the 2013 RWBJV Landbird Plan. The revised plan is designed to complement actions taken by others to prioritize, conserve, and protect landbird populations at regional, national, and international levels. It incorporates a significant amount of new information including updated Breeding Bird Survey (BBS) trend data, eBird relative abundance models, eastern red cedar (*Juniperus virginiana*) encroachment rates, and contemporary grassland conversion rates. This new information significantly improves the biological foundation that is now guiding landbird conservation and management actions across the RWBJV Region.

Strategic Habitat Conservation

Strategic Habitat Conservation (SHC) is a spatially explicit Adaptive Resource Management planning framework (National Ecological Assessment Team 2006). The RWBJV uses the SHC framework to guide our approach to conservation because it provides a transparent repeatable methodology to integrate geospatial datasets and relevant research to design sustainable landscapes capable of supporting species at desired populations. It answers the key conservation questions of how much habitat is needed to sustain populations and where can different conservation approaches be strategically delivered to maximize the return on investments. The framework consists of four primary elements: Biological Planning, Conservation Design, Conservation Delivery, and Research and Monitoring (Figure 1). This document will primarily address the Biological Planning and Conservation Design elements.

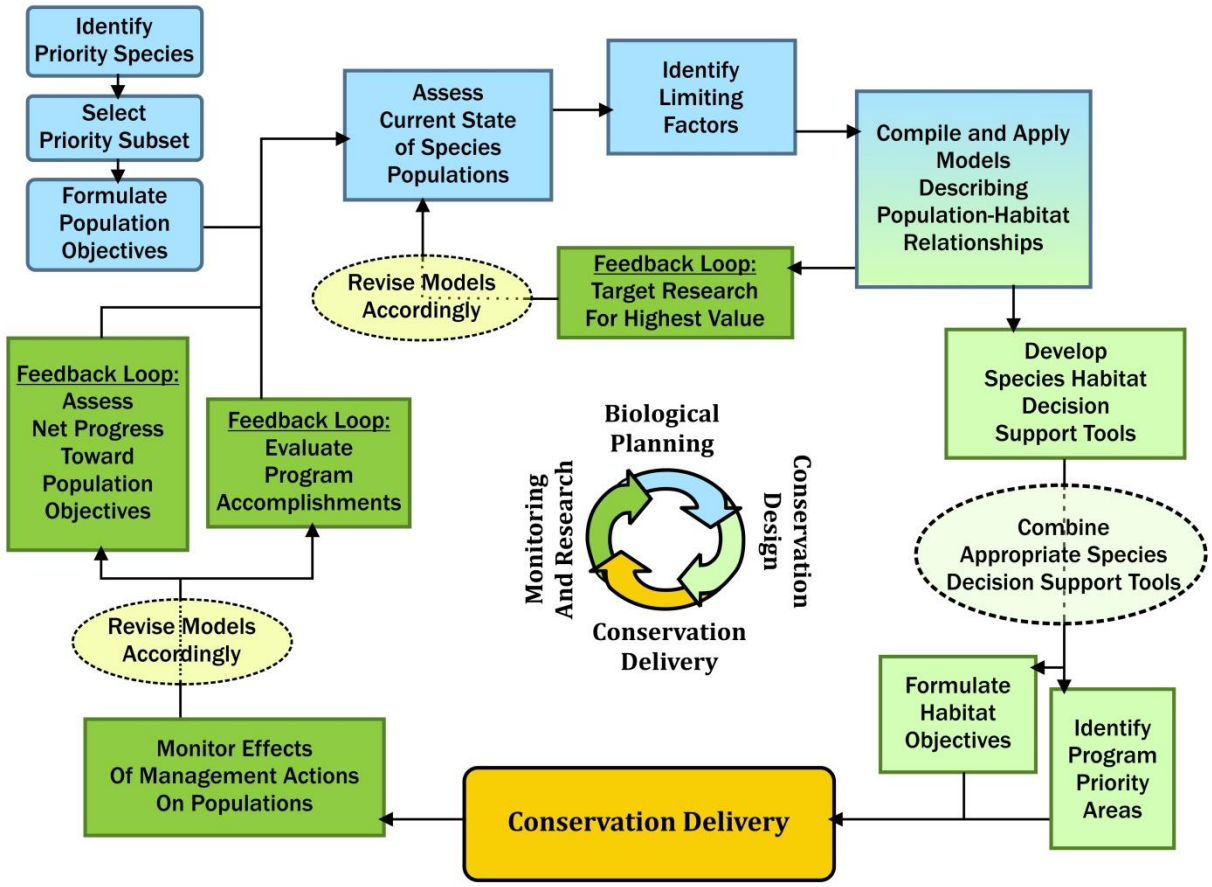


Figure 1. Strategic Habitat Conservation framework (USFWS 2008)

RWBJV Region

The RWBJV Region spans three Bird Conservation Regions (BCR) including BCR 19 (Central Mixed-grass Prairies: 87%), BCR 11 (Prairie Potholes: 11%), and BCR 17 (Badlands and Prairies: <2%; North American Bird Conservation Initiative 1999). The portions of BCR 11 and 17 administered by the RWBJV are at the southern edge of their respective range. The areas have no true prairie pothole wetlands or badlands, and the landscape is dominated by land uses and habitats characteristic of BCR 19. In Nebraska, BCR 11 is dominated by row-crop agriculture, while the wetlands and grasslands generally are confined to the

drainages of the Missouri and Niobrara rivers (Bishop et al. 2020). To define the RWBJV Region, all of BCR 11, 17, and 19 in Nebraska were therefore combined into a single unit (Figure 2).

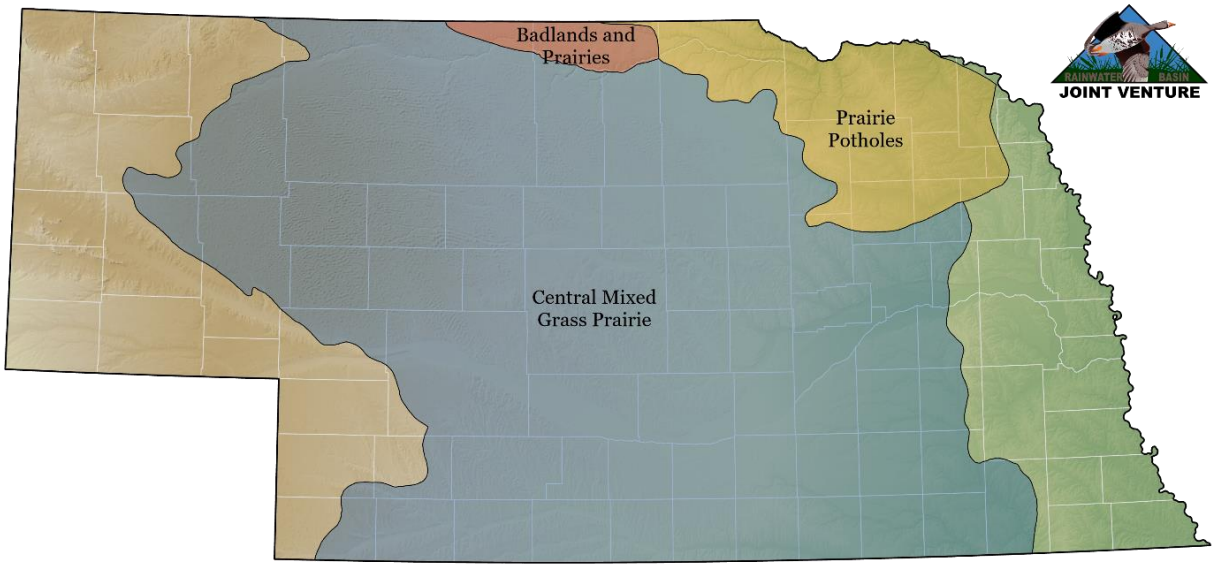


Figure 2. Map of the three Bird Conservation Regions that make up the Rainwater Basin Joint Venture Region.

The RWBJV Region encompasses approximately 34.7 million acres and contains 400,000 acres of wetland habitats, 1.2 million acres of woodlands, and 20 million acres of grasslands. Wetlands comprise nearly 3.5% of the RWBJV Region, while grasslands and woodlands cover approximately 56% and 3.4% of the landscape, respectively. The RWBJV Region is part of the Great Plains, characterized by its wide variations in temperature and precipitation. West of the 100th meridian, evaporation and transpiration exceed precipitation, commonly drying wetlands even in wetter years. Precipitation occurs sporadically, which results in variable amounts of water in wetland systems (LaGrange 2005). In some years, precipitation and snow melt may come early and be abundant enough to fill most palustrine wetlands and sustain flows in riverine wetlands. In other years, the greatest precipitation occurs as a result of summer thunderstorms (Gersib et al. 1989, Bishop and Vrtiska 2008). This temporal variation of precipitation alters the phenology, species composition, and structure of the wetland, woodland, and grassland vegetation communities.

Over 63 million birds of 132 species have detectable breeding populations in the RWBJV Region (Partners in Flight 2020). Three million of these are non-native or introduced birds, such as European Starlings or Rock Pigeons. Of the 60 million native birds, 39% are habitat generalists, 34% nest in grasslands, and 26% use forest or woodland habitats. Only 1% use niche or specialty habitats such as freshwater marsh, scrub-shrub, or cliffs. The most abundant species are Western Meadowlark, Brown-headed Cowbird, and Mourning Dove, with over 5 million each in the RWBJV Region. The RWBJV Region is particularly important for four species that have more than 10% of their global population spending the breeding season here: Dickcissel, Grasshopper Sparrow, Greater Prairie-Chicken, and Red-headed Woodpecker.

Wetlands are impacted by a wide variety of human alterations. Modifications include wetland drainage (e.g., ditches, concentration pits), stream alterations (e.g., channelization, stream degradation, dams, diversions, water withdrawals), watershed modifications (e.g., land leveling, culturally-accelerated

sedimentation), and invasive species. These modifications directly impact wetland numbers, size, and function (LaGrange 2005; LaGrange et al. 2011).

Grasslands dominated by mixed-grass, tall grass, and sandhill prairie communities once occupied a majority of the RWBJV Region. Outside of the Sandhills, much of the grasslands have been converted to row-crop agriculture. Remnant grasslands are generally associated with the Region's riverine systems or lands not suitable for row-crop agriculture. Grasslands that remain are often integrated into agricultural operations for grazing or haying, which can significantly impact the habitat values these lands provide to wildlife. Similar trends in grassland conversion exist throughout the Great Plains.

The RWBJV performed two analyses to estimate grassland conversion rates for the RWBJV Region (Grosse et al. 2020). Across the Region, row crop production replaced grasslands at annual rates up to 3%, while eastern red cedar encroachment is transitioning grasslands to woodlands at a rate of 1-3% annually. These transition rates could result in significant losses over the next 30 years if left unchecked.

Cottonwood (*Populus deltoids*) gallery forest woodlands are generally confined to the drainages of the major river systems. Along the Loup, Missouri, Platte, and Republican rivers, the woodlands are generally composed of deciduous species with Russian olive (*Elaegnus angustifolia*) and eastern red cedar as the primary invasive species impacting these woodlands. More shade-tolerant green ash (*Fraxinus pennsylvanica*) and common hackberry (*Celtis occidentalis*) are naturally successional species that can provide suitable habitat for a number of species. These two species can compete with less desirable Russian olive and eastern red cedar that often invade and degrade habitat quality. Along the Niobrara River there is a greater diversity of species, including both deciduous and coniferous woodlands, where invasion by eastern red cedar is also a major threat to these communities.

Geographic Focus Areas in the RWBJV Region

For planning purposes, the RWBJV Region is divided, based on landscape characteristics, into eight Geographic Focus Areas (GFAs; Figure 3): 1) Central Loess Hills, 2) Central and North Platte River, 3) Missouri River, 4) Northeast Prairies/Elkhorn River, 5) Rainwater Basin 6) Republican River/Blue River Drainages and Loess Canyons, 7) Sandhills, and 8) Verdigris – Bazile Creek Drainages.

Each GFA contains a variety of wetland, grassland, and woodland habitats (Table 1). Over half of the non-riverine wetlands found within the RWBJV Region are located in the Sandhills, with a majority of these acres classified as sub-irrigated wet meadows (palustrine wetlands). The Rainwater Basin GFA contains the highest density of playa wetlands (palustrine wetlands). Outside of the Sandhills, grasslands are generally confined to the floodplains of the major river systems or on environmentally sensitive lands.

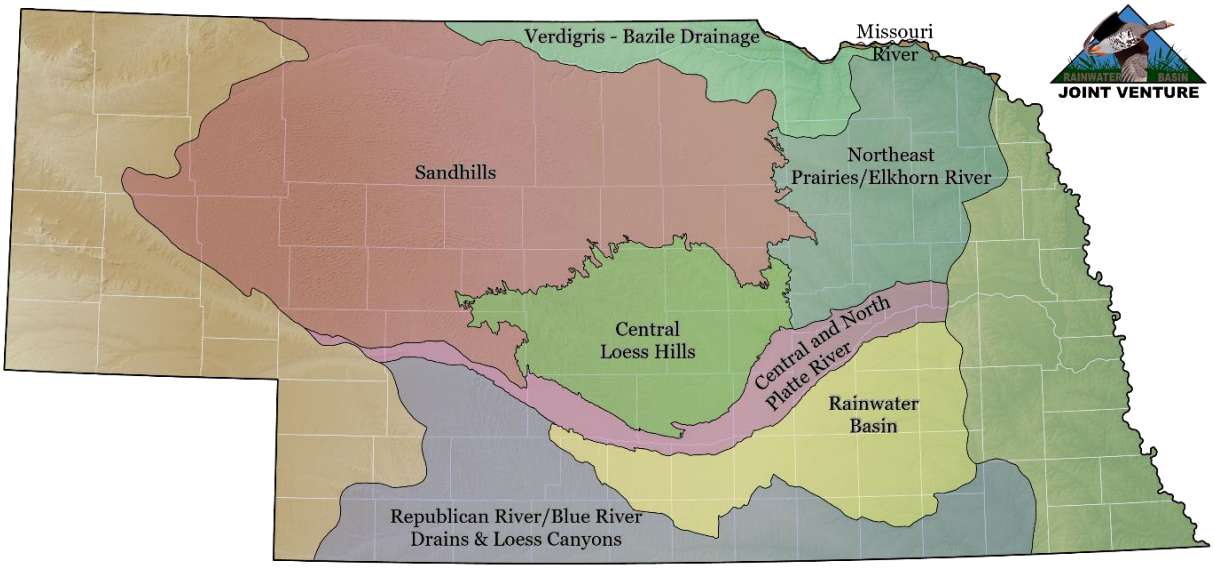


Figure 3. Geographic focus areas in the RWBJV Region.

Table 1. Percent area of five landcover types within eight Geographic Focus Areas in the Rainwater Basin Joint Venture Region (Bishop et al. 2020).

Geographic Focus Area	Total Area (ac)	Wetland (%)	Grassland (%)	Woodland (%)	Cropland (%)	Developed (%)
Central Loess Hills	3,598,455	0.5	54.5	4.3	32.2	5.3
Central and North Platte River	1,985,857	1.3	20.0	5.4	57.5	11.1
Missouri River	74,099	12.7	6.7	10.3	30.6	5.2
Northeast Prairies/ Elkhorn River	3,953,665	0.5	17.5	3.7	70.9	7.3
Rainwater Basin	3,830,158	0.9	9.8	2.0	78.4	7.8
Republican River/Blue River Drainages and Loess Canyons	5,797,034	0.1	44.0	4.7	44.6	5.3
Sandhills	13,517,095	1.8	89.8	1.2	4.7	1.6
Verdigris – Bazile Creek Drainages	1,986,776	1.8	62.0	12.2	17.8	3.9

Although the majority of the RWBJV Region is privately-owned, there is an existing conservation estate made up of protected lands (Table 2). The Nebraska Game and Parks Commission (NGPC) owns over 60,000 acres of land managed as state parks, historical parks, recreation areas, and wildlife management areas. Several federal government agencies also maintain lands that support habitats, including the U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service, United States Department of Agriculture (USDA), National Park Service, and the U.S. Army Corps of Engineers. Smaller public entities, such as cities, counties, and Natural Resource Districts (NRDs) also own acres that support breeding landbirds. Additionally, non-government conservation organizations such as Audubon Nebraska, Ducks Unlimited, Northern Prairies Land Trust, the Crane Trust, and The Nature Conservancy manage and protect lands

through fee-title or permanent easements. This footprint encompasses thousands of acres throughout the state, where most are managed to benefit breeding birds.

Table 2. Amount of land in long-term or permanent conservation in the eight Geographic Focus Areas of the Rainwater Basin Joint Venture Region.

Geographic Focus Area	% under Conservation	Conservation Easement (ac)	Non-Government Organization (ac)	Public: Local (ac)	Public: State (ac)	Public: Federal (ac)
Central Loess Hills	0.5	2,571	0	536	8,148	7,583
Central and North Platte River	2.6	15,621	20,195	972	14,096	1,206
Missouri River	12.8	3,987	0	0	6,421	194
Northeast Prairies/ Elkhorn River	0.3	2,390	0	553	8,052	0
Rainwater Basin	2.2	9,126	3,285	1,700	11,507	58,882
Republican River/Blue River Drainages and Loess Canyons	1.2	3,248	1,027	858	10,331	54,701
Sandhills	3.5	36,054	47,391	0	29,409	354,226
Verdigris – Bazile Creek Drainages	2.1	17,099	8,949	0	8,800	6,752
Total	2.4	87,526	80,847	4,083	88,616	475,960

The Farm Service Agency's (FSA) Conservation Reserve Program (CRP) is an important grassland restoration tool in landscapes with marginally productive and erosion-susceptible cropland. CRP is the primary conservation tool used in GFAs where these marginal lands occur in proximity to more productive croplands, i.e., the Central Loess Hills, Northeast Prairies/Elkhorn River, Republican River/Blue River Drainages and Loess Canyons, and along the eastern boundary of the Sandhills.

Conservation easements are largely composed of Natural Resource Conservation Service (NRCS) and local NRD easements. Many NRCS easement programs have been phased out, but the previously enrolled areas (e.g., easements from the Wetland Reserve Program and Grassland Reserve Program) maintain conservation protections through the agreed easement term. Currently the NRCS has the Agricultural Conservation Easement Program (ACEP) which has several subtypes. These include Agricultural Land Easements (ALE), which conserves grassland, rangeland, pasture, and shrubland for maintaining compatible use with livestock grazing; Wetland Reserve Easements (WRE), which restores, protects, and enhances wetlands; and Wetland Reserve Enhancement Partnerships (WREP), which has more options for wetland compatibility with irrigation systems.

NRD easements typically target grasslands or wetlands that affect surface or groundwater quality. These easements are established and administered by each NRD individually. Unlike western states that have an abundance of public lands, the small footprint of the conservation estate in the RWBJV Region will require a commitment to private lands conservation programs. Conservation programs will have to find unique win-win solutions that maximize habitat for landbirds on private working farm and ranch operations. Acceptable short-term and long-term conservation practices will be needed to offset

economic drivers which promote conversion; to offset maximized profitable grazing; and to incentivize opportunities to reduce the encroachment of woody invasive species, primarily eastern red cedar.

Central and North Platte River

The Central and North Platte GFA encompasses 270-mile (435 km) segment of the Platte River. It includes the lower portion of the Loup River system and its confluences with the Platte River at the eastern boundary and extends to Lake McConaughy Reservoir on the North Platte River at its western boundary.

Central Platte River

The Central Platte River comprises the eastern portion of the CFA. It is a 90-mile segment of the Platte River, extending from Lexington to Chapman, Nebraska. Historically, the Central Platte River portion was a wide, shallow river with multiple channels that meandered across an expansive floodplain. Large, scouring floods maintained an expanse of wetlands throughout the river valley and limited growth in the active channel bed to early successional species. Following European settlement, the entire Platte River is extensively regulated. By the 1930s, flood pulses and river flows that once shaped the ecosystem were greatly reduced. As a result, the areas of active floodplain and associated wet meadows were reduced, the river channels narrowed and deepened, and extensive riparian forests became established along islands and river banks.

For example, a comparison of average annual discharge levels at the city of North Platte, Nebraska, before and after 1930, shows a 70% reduction in river flows (U.S. Fish and Wildlife Service 1981). At the same monitoring location, the channel width narrowed from nearly 2,950 ft. to less than 330 ft. between 1870 and 1970. Similarly, the average channel width near Overton, Nebraska, declined from 4,800 ft. in 1865 to 740 ft. in 1998 (Murphy et al. 2004). Sidle et al. (1989) reported that a large percentage of the open riverine/sandbar (60 to 80%) and wet meadow (55%) habitat was lost in this reach of the Platte River because of agricultural conversion, development, and hydrologic changes.

Despite the highly altered nature of this system, the combination of broad, braided river channels, adjacent wet meadows, and abundant food resources continue to attract millions of wetland-dependent migratory birds each year. Palustrine and riverine wetlands (totaling 63,000 acres) and 130,000 acres of grassland (Bishop et al. 2020) continue to provide necessary roosting, loafing, and foraging habitat. Most notable bird use is by endangered Whooping Cranes (USFWS 1978), over 80% of the midcontinent population of Sandhill Cranes (Kinzel et al. 2006, Krapu et al. 2014), and millions of migrating and wintering waterfowl (Bishop and Vrtiska 2008). The Central Platte River also provides stopover habitat for a myriad of waterbirds and non-breeding habitat for numerous shorebirds. The Central Platte River also provides breeding habitat for the threatened Piping Plover, recently delisted Interior Least Tern, and an estimated 468,000 priority grassland nesting birds.

Today, the Central Platte River portion is intensely cultivated. Based on the 2020 USDA National Agriculture Statistics Service's (NASS) Cropland Data Layer (CDL), over 58% of the historic floodplain is planted to corn, soybeans, or alfalfa (NASS 2021). In 2004, Nebraska Department of Natural Resources (DNR) declared much of the Platte River was over-appropriated due mostly to water diversion for irrigation. The designation required new groundwater and surface water depletions to be offset, with the intent of managing the entire system in a sustainable manner. Although cropland conversion has slowed, gravel mining, as well as residential and commercial development, continues to result in the loss of riverine and wet-meadow habitats (Pauley et al. 2018). Research from this portion of the CFA indicates that riparian grassland landcover has expanded since restoration efforts began in the 1980s,

but these gains have been concentrated near lands owned and managed by non-government organizations (Krapu et al. 2014, Caven et al. 2019).

Invasive plant species continue to degrade in-channel habitats and adjacent wet meadows. The primary invasive threats include eastern red cedar, Kentucky bluegrass (*Poa pratensis*), phragmites (*Phragmites australis australis*), purple loosestrife (*Lythrum salicaria*), reed canary grass (*Phalaris arundinacea*), and smooth brome (*Bromus inermis*).

North Platte River

The North Platte River is one of the two main tributaries that form the Platte River. The North Platte River originates in Colorado and flows through Wyoming before entering Nebraska. The stretch of the North Platte River within the Central and North Platte River GFA is located approximately 60 miles upstream from the river stretch designated as the Central Platte River. This stretch of river has a high density of palustrine and riverine wetland habitats, including 42,400 acres of wet meadows and 277,000 acres of additional grasslands dominated by sandhills prairie species (Bishop et al. 2020).

The wetland and grassland habitats in this 80-mile stretch of river from Lewellen to North Platte, Nebraska, have been negatively impacted by the extensive regulation of North Platte River flows since European settlement. It is estimated that 25% of the historic wet meadows have been converted to row-crop agriculture (LaGrange 2005). The altered flow regimes have resulted in an increase of scrub-shrub and forested wetlands at the expense of riverine and emergent wetlands (LaGrange 2005). Despite the negative impacts of land-use conversion and altered flow regimes, this stretch of river contains a diverse mix of riverine and marsh-like wetlands within the historic floodplain and river channel. Approximately 80% of the wetlands are either temporary or seasonal in nature (LaGrange 2005). This area is extremely important to a portion of the mid-continent population of Sandhill Cranes (approximately 200,000 individuals) (Caven et al. 2020, Krapu et al. 2011).

Although grassland and wet meadow conversion for row-crop agriculture has slowed as a result of the moratorium on new irrigated acres, these habitats continue to be converted for gravel mining operations and urban/suburban/commercial development (Pauley et al. 2018).

Wet meadows and grasslands in the North Platte River valley are also being invaded by eastern red cedar, Kentucky bluegrass, phragmites, purple loosestrife, reed canary grass, Russian olive, and smooth brome.

Central Loess Hills

The Central Loess Hills GFA, located in the center of the RWBJV Region, contains rolling to steep loess hills dissected by the valleys of the North, Middle, and South Loup rivers. Ridge tops (tables) are nearly level to gently sloping and covered with loess soils. Scattered across these table lands are numerous playa wetlands referred to as the Central Table Playas (LaGrange 2005). Hydric soil mapping units (polygons) and depressional wetland points defined in the Soil Survey Geographic Database (SSURGO), as well as the palustrine wetlands delineated in the National Wetlands Inventory (NWI; Cowardin et al. 1979), estimate there were once over 6,300 playas covering more than 18,000 acres. An assessment of aerial photography completed in 2010, found just over half of these playas (3,470 individual wetland footprints) continue to demonstrate some level of function, such as ponding water or growing hydric vegetation (Bishop et al. 2020). Playa wetlands in this CFA are generally smaller than those found in the Rainwater Basin and are characterized by seasonal and temporary water regimes.

The Central Loess Hills contain the lower reaches of the Middle Loup, North Loup, and South Loup Rivers, all of which are spring-fed and originate in the Sandhills. Sandbars and shallow side channels are typical features within and adjacent to the active river channels, which receives a relatively constant year-round flow. Over 176,000 acres of riverine habitat and 100,000 acres of wet meadow occur within the floodplains.

Approximately 30,100 acres of palustrine wetlands, 58,500 acres of riverine habitat and approximately 1.9 million acres of grasslands (Bishop et al. 2020) exists within the GFA. The playa wetlands provide important migration stopover habitat for the endangered Whooping Crane (Austin and Richert 2001), as well as numerous other species of wetland-dependent migratory birds (e.g., waterfowl, shorebirds, wading birds). The riverine wetlands provide breeding habitat for the threatened population of Piping Plover and Interior Least Tern. The wet meadows and associated grasslands support an estimated 1,346,000 priority grassland nesting birds.

Row-crop agriculture and ranching are dominant land uses. Row-crop agriculture is generally confined to the river valleys and areas of limited topographic relief. Most of the steep, more erodible slopes remain as native grasslands dominated by mixed-grass prairie communities. Farm commodity prices and the guaranteed income provided by the Federal Crop Insurance Program contribute to grassland and wetland conversion.

The encroachment of undesirable plant species (e.g., eastern red cedar, Russian olive) has occurred on thousands of acres of native habitats. Fire suppression is thought to be a major factor causing their expansion.

Missouri River

The Missouri River GFA forms the northeast boundary of the RWBJV Region. This 125-mile stretch of river, between Ponca and Spencer, Nebraska, contains the southernmost unchannelized portion of the Missouri River. Because this portion of the river remains unchannelized, the active channel and associated floodplain contain a myriad of riverine and palustrine wetlands.

Prior to the 1930s, the Missouri River was an unmanaged, natural river that supported a tremendous number and diversity of fish and wildlife. The river was characterized as a braided river containing sheltered backwaters, sloughs, chutes, oxbows, gravel bars, sandbars, mudflats, snags, alluvial islands, deep pools, marshland, and shallow-water areas (U.S. Fish and Wildlife Service 1980). The width of the river varied from 1,500 feet to over one mile.

Between 1930 and 1970 channelization and main-stem dams narrowed and deepened the river channel resulting in the loss of associated floodplain wetlands. Main-stem dams located in the Dakotas, Montana, and Nebraska changed water quality, quantity, and timing of flooding throughout the Missouri River system (LaGrange 2005). Controlled water releases have reduced the flood pulse that was a key factor in maintaining the in-channel habitat and adjacent floodplain wetlands. Although this portion of the Missouri River is not channelized, it is still negatively impacted by the upstream dams and their altered flow regimes. Reduced sediment loads negatively influence channel morphology while controlled releases from upstream dams reduce scouring and in-channel habitat maintenance (LaGrange 2005). Many of the historic off-channel wetlands have been altered to increase row-crop agriculture. Today 22,700 acres (31% of the landscape) are under row-crop agriculture production (Bishop et al. 2020).

Approximately 28,000 acres of palustrine and riverine wetlands, and 5,000 acres of grasslands (Bishop et al. 2020) presently exist. Despite the numerous alterations to this system, these wetlands still provide

vital stopover habitat for migratory waterfowl and shorebirds, as well as breeding habitat for Interior Least Tern and the threatened population of Piping Plover. Existing grasslands support almost 10,000 grassland breeding priority birds.

The greatest threat is riverbed degradation (LaGrange 2005). Other key threats include residential/agricultural/commercial development, roads, water pollution, water development projects, stream bank stabilization, drainage, and filling (LaGrange 2005). Projects associated with each of these threats have both direct and indirect impacts that cumulatively impair river functions by isolating the floodplain from the river and reducing the natural river dynamics.

Purple loosestrife and phragmites have become established throughout this stretch of the Missouri River, including the confluence of the Niobrara River. Expansion of these species into the backwaters of Lewis and Clark Lake and the Niobrara and Missouri rivers is a threat to native plants and habitat.

Northeast Prairies/Elkhorn River

The Northeast Prairies/Elkhorn River GFA is located in the north-central portion of the RWBJV Region. As with most of eastern Nebraska, this GFA is intensely farmed (71%; Bishop et al. 2020) and fragmented amid a dense human population. Historically, the uplands were an assemblage of tallgrass and mixed grass prairie species (Schneider et al. 2011). Some portions contained a high density of playa wetlands. Approximately 78,000 acres of palustrine and riverine wetlands and nearly 4 million acres of grassland (Bishop et al. 2020) remain.

Nearly 10% of the current grassland cover has been reestablished through CRP. Although many of these acres were not planted exclusively to native species, the acres complement the native tallgrass remnants scattered throughout the GFA. A majority of the CRP contracts are expiring in the 2020s, and current high commodity prices and the safety net provided by the Federal Crop Insurance Program are accelerating conversion of these acres back to row-crop agriculture.

Today, the mesic floodplains and steeper drainages associated with the Elkhorn River contain savannahs, woodlands, and densely forested habitats. Remnant tallgrass prairies are scattered across the drainage. The playa wetlands contain a diverse mix of early successional wetland vegetation communities. These habitats provide a place for numerous grassland and wetland-dependent birds and breeding grounds for Piping Plover and Interior Least Tern.

Invasive plant species, such as eastern red cedar, Kentucky bluegrass, phragmites, purple loosestrife, reed canary grass, and smooth brome, continue to degrade wet meadows and adjacent mesic floodplains. Cottonwoods in floodplain-woodlands are being displanted by invasive buckthorn, honeysuckle, and eastern red cedar. Limited grasslands have resulted in more intense livestock grazing. Intense grazing and fire suppression are believed to be major factors contributing to the encroachment of undesirable plant species (i.e., Kentucky bluegrass, eastern red cedar, and smooth brome).

Rainwater Basin

The Rainwater Basin is recognized by the RWBJV as the highest priority GFA because of the extensive loss of grassland and wetland habitats The GFA encompasses 6,150 mi^2 in the south-central portion of the RWBJV Region. High densities of clay-pan playa wetlands are scattered through an expansive rolling loess plain formed by deep deposits of wind-blown silt. Runoff from intense summer storms and melting snowfall fill these shallow depressions.

Row-crop agriculture, predominately corn and soybean, constitutes 78% of the current land use acreage. Grassland habitats make up 9.7% (375,000 acres; Bishop, 2020), while 1.3% is savanna and

woodland communities. The non-farmed areas are confined to the steeper drainages associated with the Republican and Blue river systems. A small portion (1.3%; 16,000 acres; Bishop, 2020) of the riverine systems' acreage is riverine wetlands.

Analyses of historic soil data (1910–1917), NWI (1980–1982), and SSURGO data (1961–2004) indicate that playa wetlands were once a prominent feature of this landscape. The surveys identify the historical wetland density to have been consisting of approximately 11,000 individual playa wetlands (204,000 acres). That number included over 1,000 semi-permanent and seasonal wetlands (over 70,000 acres) and about 10,000 temporary wetlands (134,000 acres).

A breeding waterfowl habitat survey used the historic soil data to evaluate the distribution of remaining wetlands (McMurtrey et al. 1972). It reported that 82% of the major wetlands were converted to agriculture, accounting for the loss of approximately 63% of the total wetland acres. The fast-paced degradation continued and by 1985 only 10% of the surveyed wetlands remained. Today roughly 40,000 acres (17%) of the historical wetlands remain. They make up less than 1% of the landscape (Bishop and Vrtiska, 2008). The remaining wetlands represented only 22% of the original surveyed acres, and virtually all were hydrologically impaired (Schildman and Hurt 1984). The Nebraska Wetlands Priority Plan (Gersib 1991) has given these wetlands a Priority 1 (most imperiled) rank due to the extensive wetland loss and continued degradation.

Despite the extensive wetland loss, this region still hosts a spectacular wildlife migration. During spring migration, the GFA provides roosting, loafing, and foraging habitat for millions of migratory waterfowl and other wetland-dependent species. It provides essential staging habitat for an estimated 8.6 million waterfowl (RWBJV 2013*c*) and nearly 600,000 shorebirds (RWBJV 2013*a*), as well as vital stopover habitat for the endangered Whooping Crane. Grasslands in the region support more than 972,000 priority breeding landbirds.

Current wetland rules and laws have helped to significantly to reduce active wetland drainage. However, wetland functions continue to decline, caused by drainage, water concentration pits, land leveling, and accelerated sedimentation (LaGrange et al. 2011). The combination of sedimentation and altered watershed hydrology encourages the spread of invasive species; primarily reed canary grass, hybrid cattail (Grace and Harrison 1986) and river bulrush (Kaul et al. 2006, Rolfsmeier and Steinauer 2010).

Republican River/Blue River Drainages and Loess Canyons

The Republican River/Blue River Drainages and Loess Canyons GFA lies along the southern boundary of the RWBJV Region. The topography and soils of this GFA vary from steep hills and canyons with highly erodible soils in the west, to relatively flat productive plains, rolling hills, and breaks in the east. Stream flows vary and are dependent on precipitation. Grasslands are dominated by mixed-grass prairie communities, with tallgrass prairies occurring along the eastern boundary. The 2.5 million acres of grassland (Bishop et al. 2020) support approximately 2.5 million nesting grassland birds of priority status.

Limited surface and groundwater supplies differentiate this GFA from other GFAs. A substantial proportion of the cropland is dry-land farming. Significant irrigation development has caused groundwater depletion within the Republican River drainage, causing the 2004 over-appropriation designation by the Nebraska DNR. Restrictions were placed on developing additional irrigated acres and water allocations.

The basin area of the Blue River basin is defined by the drainage area of the Big and Little Blue Rivers. This basin area currently has no irrigation limitations using groundwater development, but mechanisms are in place if further groundwater depletions occur.

Approximately 32,000 acres of palustrine wetlands, 125,000 acres of riverine wetlands, 28,000 acres of lakes and reservoirs exist (Bishop et al. 2020). With the exception of Harlan County Reservoir (16,000-acre flood-control reservoir), water bodies are typically associated with small watershed impoundments created for flood control, grade stabilization, and livestock water. These man-made wetland features (reservoirs and stock ponds) provide migration and, at times, wintering habitat for waterfowl, as well as stopover habitat for numerous species of shorebirds.

In the western portion, there are numerous playa wetlands that are part of the Southwest Playa complex (LaGrange 2005). These freshwater wetlands receive water from runoff and are small (most are < 5 acres), with temporary or seasonal hydroperiods. Most have no natural outlet for water. The wetlands commonly dry early in the growing season and are farmed.

Invasive species continue to threaten habitat quality of both grassland and wetlands. Fire suppression and year-long grazing regimes are major factors contributing to their establishment in grasslands. Phragmites, purple loosestrife, and reed canary grass have played a role in reducing habitat, constricting river channel widths, and depleting surface water flows. Woody encroachment has been particularly problematic in the Loess Canyons, prompting aggressive control measures.

Sandhills

The Sandhills GFA is a 19,300 mi^2 grass-stabilized, sand dune formation located in the western portion of the RWBJV Region. The climate is semi-arid but contains an abundance of lakes, wetlands, wet meadows, and spring-fed streams

The Sandhills is the largest contiguous grassland-stabilized dune system in North America (Schneider et al. 2011). Over 12 million acres of grasslands exists (Bishop et al. 2020). Conversion from grassland to cropland is limited by the sandy soil. Many of the lands originally developed for row-crop production have been returned to grasslands through CRP. However, CRP does not assure permanent conservation. Many CRP contracts are scheduled to expire in the near future. Current commodity prices, land values, and cash rent are at all-time highs; and the Federal Crop Insurance Program provides a source of guaranteed income for cultivation of these environmentally sensitive lands.

Groundwater recharge is the prominent characteristic of the sands, creating a vast aquifer that stores 700-800 million acre-feet of groundwater (Keech and Bentall 1971). Streams, lakes, and wet meadows are found in long, gently sloping valleys lying between the dune formations Approximately 400,000 acres of palustrine and riverine, and 93,000 acres of lacustrine wetlands exist (Bishop et al. 2020).

Most of the area's lakes, wetlands, and streams are sustained by groundwater discharge from adjoining dunes. About 90% of the stream flow (2.4 million acre-feet) comes from groundwater discharge (Bentall 1990). The Niobrara River flows along the Sandhills' northern border, and the Platte River flows along its southern border.

The mosaic of wetlands and grasslands were identified by Bellrose (1980) as the most significant waterfowl nesting habitat outside of the Prairie Pothole Region. Vrtiska and Powell (2011) estimated that 275,000 waterfowl nest in the Sandhills annually. The larger Sandhills lakes provide nesting habitat for a majority of the High Plains flock of Trumpeter Swans (Grosse et al. 2012). The wet meadows and grasslands provide vital nesting habitat for an estimated 7 million priority grassland birds. A significant

portion of the estimated 400,000 breeding shorebirds found in the RWBJV Region occur in the Sandhills (RWBJV 2013*a*). Nearly all of the nesting waterbirds in the RWBJV Region occur in the Sandhills (RWBJV 2013*b*).

Wetland loss in the Sandhills has occurred primarily through drainage by surface ditches, beginning as early as 1900 (U.S. Fish and Wildlife Service 1960; McMurtrey et al. 1972; LaGrange 2005). With the introduction of center-pivot irrigation systems to the Sandhills in the early 1970s, land leveling/shaping and local water-table declines resulted in extensive wetland losses in some areas. While quantifiable data are not available, estimates of wetland acres drained range from 15% (McMurtrey et al. 1972) to 46% (U.S. Fish and Wildlife Service 1986). Sandhills wetlands were given a Priority 1 ranking, the most imperiled status in the Nebraska Wetlands Priority Plan, because of very extensive past losses (Gersib 1991).

Wetland drainage has created an increase in hayed grasslands. This drainage directly impacts the targeted lake or wetland but also leads to cumulative wetland losses, both downstream and upstream. Ditching causes the channel to become entrenched, lowering the groundwater table and increasing lateral drainages which impact adjacent wetlands. Smaller wetlands are threatened by conversion from ranching to irrigated row-crop agriculture. Concentrated, large-scale irrigation development can result in long-term effects on wetland communities by lowering the groundwater table.

The pace and extent of woody encroachment, mainly eastern red cedar, has been steadily increasing from east to west in recent years.

Verdigris-Bazile Creek Drainages

This landscape is located in the northern portion of the RWBJV Region and is defined by the watersheds of Verdigris and Bazile Creeks, which empties into the Niobrara and Missouri Rivers. Keya Paha River and Ponca Creek also provide important riverine habitats. Topography is variable, resulting in a mosaic of cropland, grasslands, and woodlands.

The GFA contains 1.2 million acres of grassland (Bishop et al. 2020). There is a transition from tallgrass prairie along the eastern boundary to mixed-grass prairie along the western edge. This transition provides a diverse assemblage of grasslands. Grassland conversion to cropland continues to be influenced by Farm Bill programs. CRP has been utilized to reestablish grasslands on former row-crop acres with steeper topography and water erosion problems. Although many of these acres were not planted exclusively to native species, the reestablished grassland acres complement the native tall-grass and mixed-grass remnants. Unfortunately, CRP lands have no assurance to last past the expiration of the contract. It is estimated that this landscape provides nesting habitat for 780,000 priority grassland breeding birds (RWBJV 2013*a*).

Approximately 36,800 acres of palustrine wetlands, 56,000 acres of riverine wetlands exist (Bishop et al. 2020). The Niobrara River provides breeding habitat for the threatened population of Piping Plover and recently delisted Interior Least Tern.

Woodlands are generally confined to the drainages and bluffs associated with the major riverine systems (Verdigris Creek, Bazile Creek, Missouri River bluffs, and breaks; Schneider et al. 2011). These woodlands were historically dominated by deciduous species.

Fire suppression and season-long grazing regimes encourage favorable conditions for the expansion of invasive eastern red cedar, honey locust, Siberian elm, Kentucky bluegrass, and smooth brome.

Priority Species

The first two steps of the Biological Planning process outlined in the SHC framework are to identify and select a subset of priority species. Focusing on a small yet diverse suite of species allows the establishment of realistic and measurable objectives. If these objectives are reached, it is assumed achieved conservation actions will benefit a larger number of species using similar habitats. Species prioritizing helps direct limited resources towards those with the most urgent conservation need. For planning purposes, the focus is on the breeding phase of the annual life cycle. The number of species that breed in the RWBJV Region is much greater than the numbers that reside here during the non-breeding season (Figure 4).

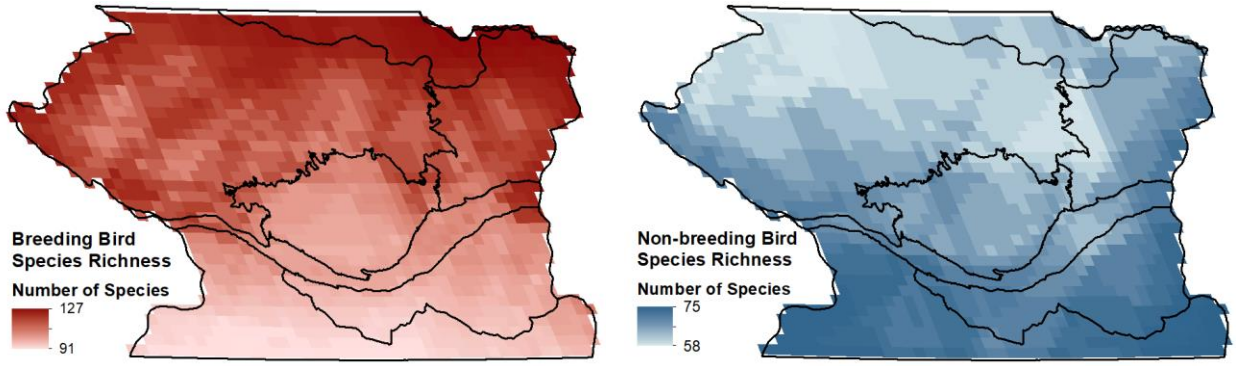


Figure 4. Number of birds species during breeding (left) and non-breeding (right) seasons in the Rainwater Basin Joint Venture Region (Jenkins et al. 2013, BirdLife International 2018).

Several factors were examined to select 23 landbird species from a total of 132 breeding species within the RWBJV Region (Table 3). Six species were selected because of their status as "Yellow-D watchlist species" in the PIF LCP and having over 1,000 individuals in our geography. The PIF LCP defines Yellow-D species as those experiencing population declines and moderate to high threats. Another six species were selected because of their status as a "Common Bird in Steep Decline" in the PIF LCP and having a PIF Regional Combined Score of 13 or above for BCR 19. The Chimney Swift, a Common Bird in Steep Decline with a score above 13, was excluded because conservation actions needed to support that species do not fall within the Joint Venture's purview. Nine species were selected based on the Regional Importance Species Status, (PIF LCP) and large numbers or declining trends. The Short-eared Owl was included because of precipitously steep negative population trends with the RWBJV Region. Finally, the Ring-necked Pheasant was included because of their priority status with RWBJV partner organizations.

These 23 priority species were placed into two categories: planning and stewardship. Eight species placed in the planning category are considered high priority and were used to set population and habitat objectives. The remaining 15 species, designated stewardship species, do not have set population objectives but their habitat needs should be considered in future conservation planning and delivery efforts. The assumption is that if habitat needs for planning Species are met, there will be sufficient habitat to support stewardship species. Species accounts for all 23 species are provided in Appendix 1.

Table 3. Variables used to select planning (orange) and stewardship (blue) priority landbird species for the Rainwater Basin Joint Venture Region.

Species	Breeding Habitat	PIF LCP Species Status[1]	Population Estimate in JV [2]	Estimated % of USA/Canada Population in JV[2]	BCR 19 Regional Combined Score (breeding)[3]	Regional Importance Status in BCR 19[3]	Survey-wide BBS Trend 1966-2019[4]	Survey-wide BBS Trend 2010-2019[4]	BCR19 BBS Trend 1966-2019[4]	BCR19 BBS Trend 2010-2019[4]	NE BBS Trend 1966-2019[4]	NE BBS Trend 2010-2019[4]
Dickcissel	Grassland	-	3,034,000	0.1071	14	Stewardship	-0.6	1.7	0.8	0.9	-0.6	-1.6
Eastern Meadowlark	Grassland	CBSD	160,620	0.0065	14	Concern	-2.6	-2.0	-0.1	-1.8	-0.9	3.4
Grasshopper Sparrow	Grassland	CBSD	4,640,000	0.1380	16	Concern	-2.5	-3.7	-0.9	-3.7	-1.7	-1.8
Greater Prairie-Chicken	Grassland	Yellow	227,200	0.6396	17	Stewardship/Concern	2.7	9.5	7.3	6.9	7.1	8.5
Northern Bobwhite	Grassland	CBSD	187,130	0.0425	15	Concern	-3.1	-1.8	-0.9	-2.1	-0.9	-0.9
Ring-necked Pheasant	Grassland	-	1,124,000	0.0705	12	-	-0.6	-1.8	-0.8	-3.9	-1.3	0.1
Red-headed Woodpecker	Forest	Yellow	235,300	0.1301	16	Concern	-1.4	2.1	-0.1	1.6	-0.5	1.7
Western Meadowlark	Grassland	-	6,770,000	0.0712	14	Concern	-0.9	0.1	-1.2	-2.6	-1.0	-1.6
Baltimore Oriole	Forest	-	1,062,400	0.0902	15	Concern	-0.8	-0.9	-0.3	-0.7	0.4	-0.7
Black-billed Cuckoo	Forest	Yellow	1,130	0.0013	14	Concern	-2.0	-1.3	-3.5	-3.3	-4.4	-3.3
Bobolink	Grassland	Yellow	359,500	0.0350	13	-	-1.5	-2.4	0.0	-1.4	0.8	-0.7
Brown Thrasher	Forest	-	421,100	0.0685	15	Concern	-0.9	-0.2	-0.7	-0.4	-1.0	0.3
Burrowing Owl	Grassland	-	13,890	0.0137	14	Concern	-0.7	0.8	-2.3	-0.4	1.1	-4.2
Chestnut-collared Longspur	Grassland	Yellow	5,600	0.0018	-	-	-2.5	-1.8			-3.3	-1.8
Eastern Kingbird	Grassland	-	2,141,000	0.0813	15	Concern	-1.0	-0.8	-0.8	-2.1	-0.5	-1.3
Eastern Whip-poor-will	Forest	Yellow	18,000	0.0098	-	-	-1.8	0.1				
Ferruginous Hawk	Grassland	-	274	0.0025	15	Concern	0.9	0.6	-0.4	-1.0	0.9	2.9
Lark Bunting	Grassland	CBSD	168,000	0.0136	15	Concern	-3.7	-1.9	-4.8	0.6	-0.9	1.9
Lark Sparrow	Grassland	-	569,300	0.0535	15	Concern	-1.2	-1.6	-0.8	-1.8	0.8	-2.7
Loggerhead Shrike	Grassland	CBSD	77,100	0.0170	15	Concern	-2.6	-0.2	-4.6	-5.3	-3.2	-5.9
Northern Harrier	Grassland	-	3,360	0.0041	15	Concern	-0.8	-0.6	-3.2	-3.2	-0.6	-1.4
Short-eared Owl	Grassland	CBSD	290	0.0005	-	-	-1.7	4.3	-0.7	-0.2	-0.4	-0.3
Yellow-billed Cuckoo	Forest	CBSD	59,760	0.0072	15	Concern	-0.8	1.6	-0.7	1.1	-0.3	2.2

[1] Rosenberg et al. 2016; [2] Partners in Flight 2020; [3] Partners in Flight 2021; [4] Sauer et al. 2020

Population Objectives

Setting population objectives for the eight planning species is a key step in the Strategic Habitat Conservation process. The eight species were separated into two groups—requiring separate conservation strategies. Qualifications for the first group were occurring on the PIF Yellow-D watchlist and those who population numbers are low in all or part of their range. The strategy (Reverse Decline) for this group is to reverse current population declines. Species included in this group are Greater Prairie- Chicken, Red-headed Woodpecker, Dickcissel, and Ring-necked Pheasant.

Qualifications for the second group are species recognized by the PIF Common Birds in Steep Decline and those who have larger overall populations but showing strongly negative population trends. The strategy (Stabilize) for this group is to stabilize current populations. Species included in the Stabilize group are Eastern Meadowlark, Western Meadowlark, Grasshopper Sparrow, and Northern Bobwhite.

Population objectives were broken into two time periods: to be accomplished in the first 10 years of implementation, and to be reached at the end of 30 years (Table 4). Resource needs, implementation strategies, and tracking progress were taken into consideration in formulating measurable outcomes.

Dickcissel, Ring-necked Pheasant, and Western Meadowlark are not included in the PIF Landbird Plan Watchlist. Strategies for these three species are based on: recent and long-term BBS trends shown in Table 3, and survey-wide, state of Nebraska, and BCR 19 scales. BBS will be used to continually evaluate progress via trends for each GFA.

Table 4. Ten- and thirty-year objectives for eight planning species based on two conservation strategies.

Strategy	10-year Objective	30-year Objective	Planning Species
Reverse Decline	Slow rate of decline by 75%	Increase current population by 15% AND achieve or maintain > 0% trends in each GFA	Greater Prairie-Chicken, Red-headed Woodpecker, Dickcissel, Ring-necked Pheasant
Stabilize	Slow rate of decline by 60%	Lose no more than 33% of current population AND achieve or maintain ≥ 0% trends in each GFA	Eastern Meadowlark, Western Meadowlark, Grasshopper Sparrow, Northern Bobwhite

Setting trend and population objectives for each GFA allows for efforts to be focused on areas with the greatest needs. Mean population trend for each GFA was derived from BBS shapefiles created using data from 1966-2015 (Sauer et al. 2017). Population estimates for the RWBJV Region were obtained from the PIF Population Estimates Database Version 3.0 for the portions of BCRs 19, 17, and 11 within Nebraska (pif.birdconservancy.org). Most PIF estimates are derived from BBS data from 2006-15 and calculated using this general model (Stanton et al. 2019, Will et al. 2019):

Population Estimate = (Species Count / Area Sampled) x Region Area x Detection Adjustments

The PIF estimate for Northern Bobwhite, however, was adapted from Dimmick et al. (2002) and updated by the PIF Science Committee with consideration to recent eBird trend data. Relative abundance rasters produced using eBird data from 2014-2018 were used to calculate the percentage of each species' population within each GFA (Fink et al. 2020). This process involved summing the value of all relative abundance pixels in each GFA and dividing that number by the total sum of all pixels in the JV Region. This provided an estimate of each GFA's planning species' population (Fink et al. 2020).

For species targeted for a Reverse Decline strategy and negative trend, our 30-year objective was to increase the population size by 15%. The annual percent growth needed to be obtained over 30 years to meet that population objective was calculated. For species targeted for a Stabilize strategy and current negative trend, the population objective was calculated as the population size that would result if a 30-year objective of a 0% population change was attained (Figure 5).

Changes in trend were calculated to increase at equal intervals each year with an increase of 60% by year 10 and a zero increase in year 30. The population objective for each year was calculated based on the trend goal for that respective year. The formula used was:

$$\text{population}_{year+1} = \text{population}_{year} + (\text{population}_{year} * (\text{trend}_{year}/100))$$

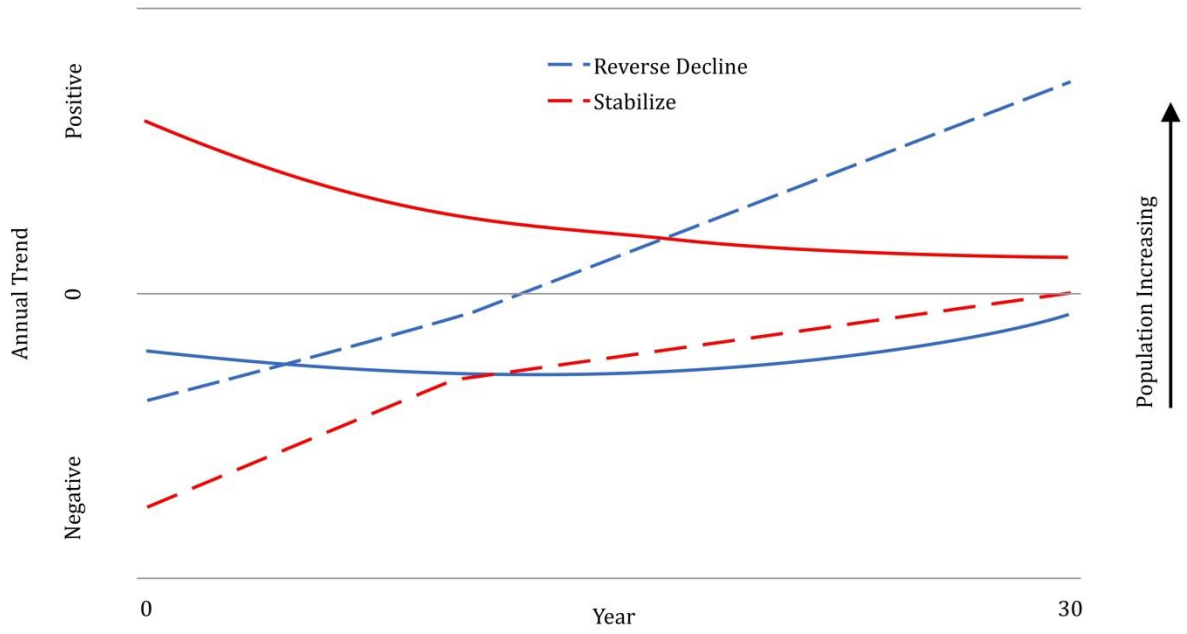
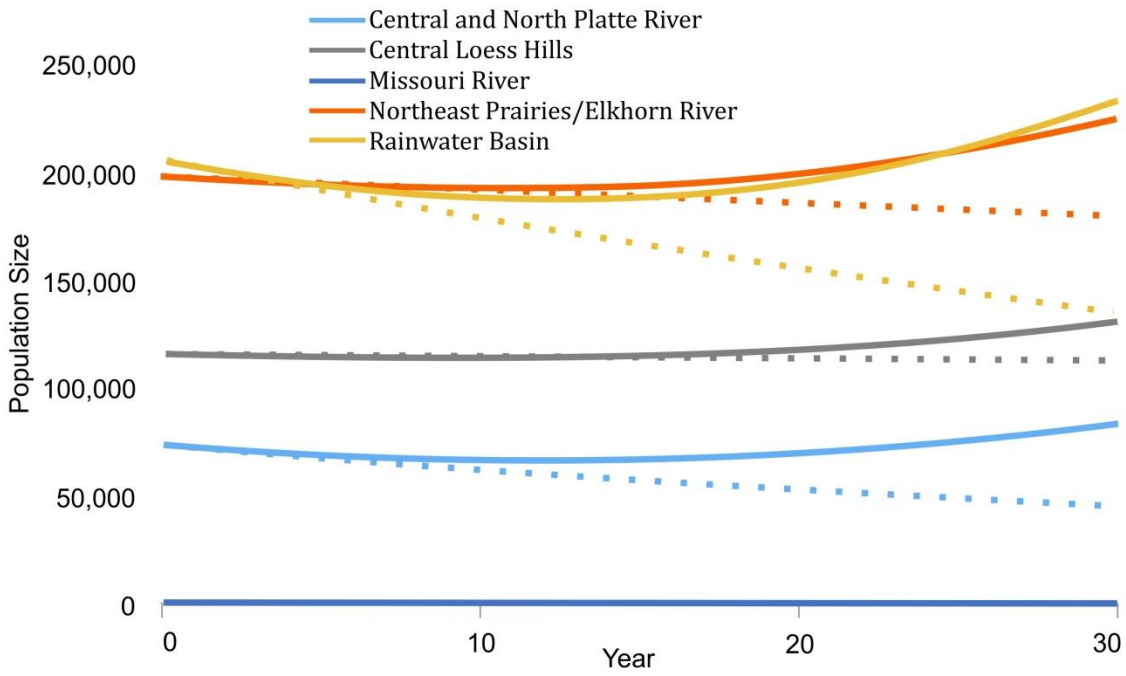


Figure 5. Examples of projected changes in annual trend (dashed lines) and population (solid lines) over a 30-year time period based on two different conservation strategies: Reverse Decline and Stabilize. The Reverse Decline strategy will result in a 15% increase in total population size over 30 years. The Stabilize strategy aims to achieve a zero trend after 30 years while allowing a drop in total population size of no more than 33%.

Dickcissel

Strategy: Reverse Decline

Dickcissels appear to be experiencing range expansion within the RWBJV Region. The steepest positive trends occur in the Sandhills and Verdigris-Bazile Drainage where relative abundance is low (see Species Account, Appendix 1). Conversely, trends are more negative in the eastern and south-eastern portions where relative abundance is highest. This pattern may indicate that losses in the Rainwater Basin and Central Platte River areas can be offset by gains elsewhere if positive trends can be maintained. Dickcissels would likely benefit from grassland conservation in all GFAs.



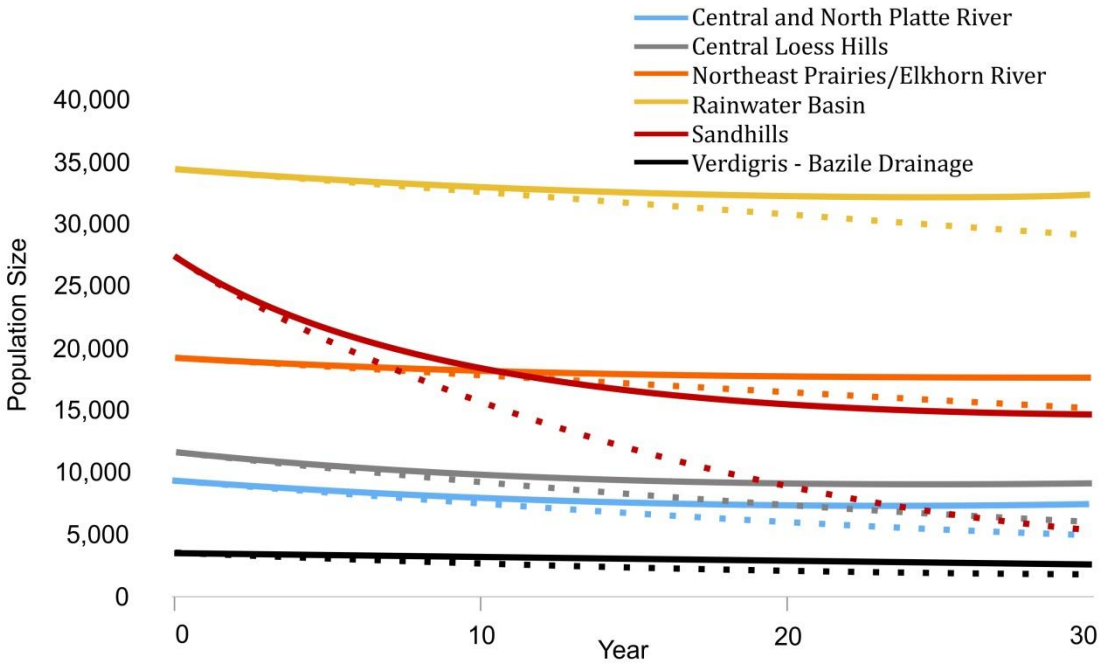
Population objectives (solid) and projected populations assuming no action (dashed)

Geographic Focus Area	Current trend (%)	10-year trend objective (%)	30-year trend objective (%)	Current population	30-year population objective	Population in 30 years if no action taken
Central and North Platte River	-1.64	-0.41	3.10	75,615	86,957	46,025
Central Loess Hills	-0.06	-0.01	1.53	116,141	133,562	114,146
Missouri River	-0.16	-0.04	1.62	1,824	2,098	1,738
Northeast Prairies/Elkhorn River	-0.32	-0.08	1.80	199,166	229,041	180,664
Rainwater Basin	-1.47	-0.37	2.93	209,411	240,823	134,290
Republican River/Blue River Drainages & Loess Canyons	0.06	> 0	> 0	221,713	254,970	
Sandhills	3.30	> 0	> 0	246,501	283,476	
Verdigris - Bazile Drainage	3.18	> 0	> 0	53,628	61,672	

Eastern Meadowlark

Strategy: Stabilize

Eastern Meadowlarks are experiencing steep declines throughout much of their entire range. Likewise, trends are negative in most GFAs. In particular, precipitous declines are occurring in the Sandhills, which lies on the northwestern edge of their breeding range. This GFA is experiencing significant woody encroachment. Range shifts may also be related to climate change. Improving habitat quality should maintain positive trends and reverse negative trends.



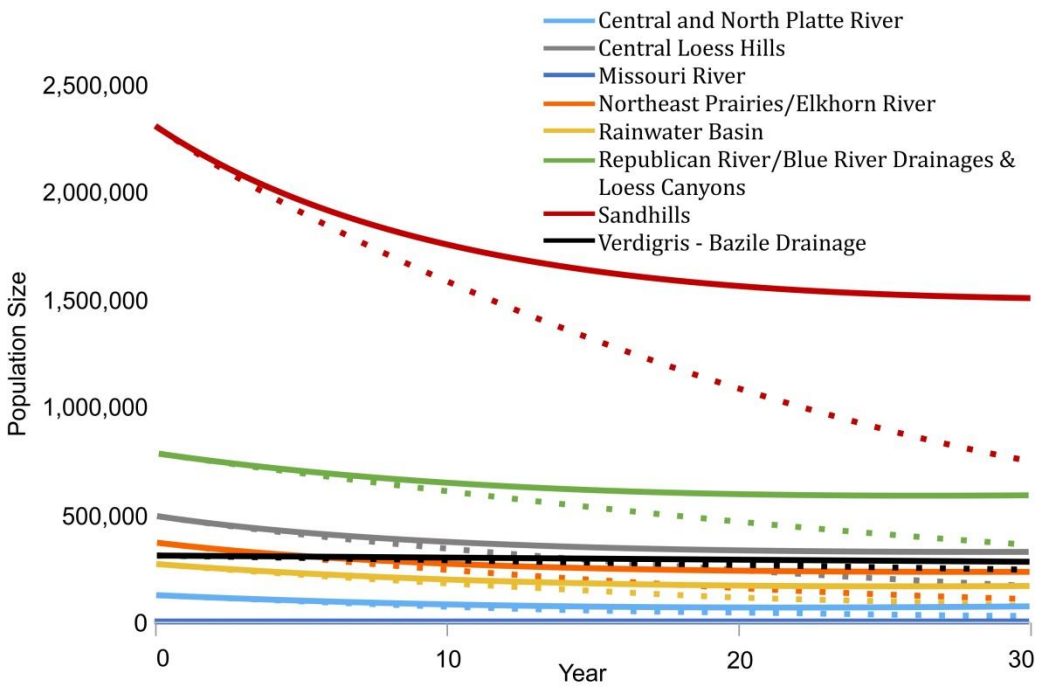
Population objectives (solid) and projected populations assuming no action (dashed)

Geographic Focus Area	Current trend (%)	10-year trend objective (%)	30-year trend objective (%)	Current population	30-year population objective	Population in 30 years if no action taken
Central and North Platte River	-1.97	-0.79	0	9,281	7,388	5,107
Central Loess Hills	-2.16	-0.86	0	11,632	9,058	6,039
Missouri River	3.11	> 0	> 0	135	188	
Northeast Prairies/Elkhorn River	-0.77	-0.31	0	19,275	17,636	15,282
Rainwater Basin	-0.55	-0.22	0	34,346	32,225	29,080
Republican River/Blue River Drainages & Loess Canyons	3.99	> 0	> 0	55,344	76,869	
Sandhills	-5.34	-2.14	0	27,261	14,598	5,247
Verdigris - Bazile Drainage	-1.99	-0.80	0	3,347	2,657	1,829

Grasshopper Sparrow

Strategy: Stabilize

Although Grasshopper Sparrows are experiencing steep declines in most of the RWBJV Region, they remain common within their entire range. Abundance of this species is closely correlated with large areas of intact grasslands (see distribution map in Species Account, Appendix 1). Considering the low levels of grassland conversion in the Sandhills, woody encroachment is likely driving the steeply negative trend in that region. Conservation efforts that improve existing grasslands are likely to benefit this species, particularly in the Sandhills.



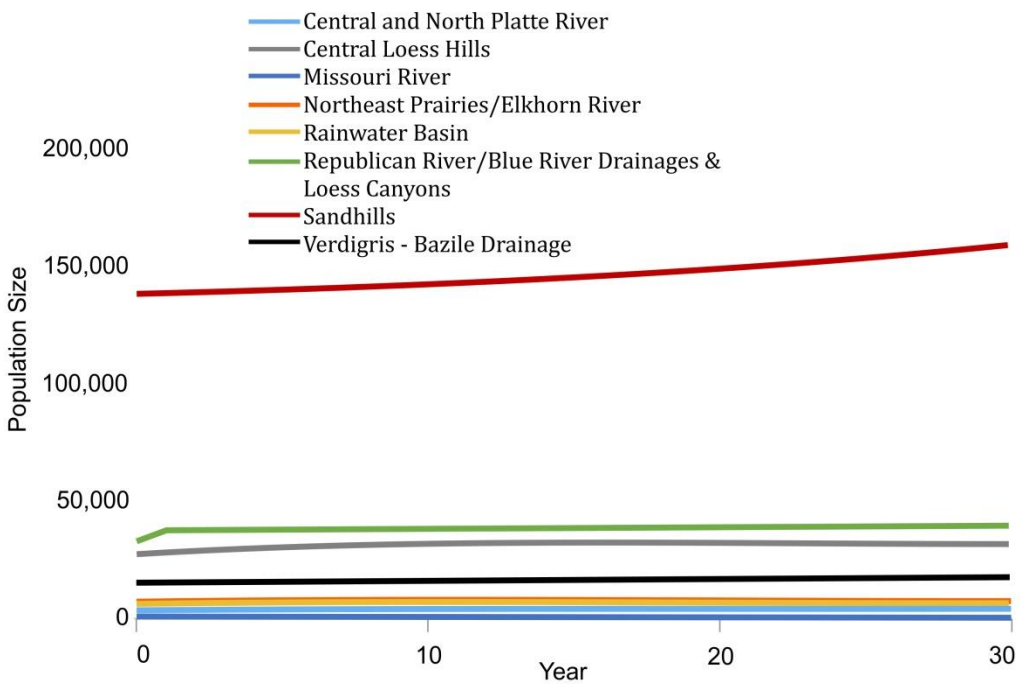
Population objectives (solid) and projected populations assuming no action (dashed)

Geographic Focus Area	Current trend (%)	10-year trend objective (%)	30-year trend objective (%)	Current population	30-year population objective	Population in 30 years if no action taken
Central and North Platte River	-4.43	-1.77	0	118,013	70,417	30,300
Central Loess Hills	-3.36	-1.34	0	483,360	327,208	173,427
Missouri River	-2.93	-1.17	0	2,722	1,937	1,115
Northeast Prairies/Elkhorn River	-4.00	-1.60	0	372,053	233,673	109,451
Rainwater Basin	-4.18	-1.67	0	272,166	167,353	75,686
Republican River/Blue River Drainages & Loess Canyons	-2.54	-1.01	0	783,414	583,880	362,393
Sandhills	-3.67	-1.47	0	2,301,688	1,501,400	748,617
Verdigris - Bazile Drainage	-0.73	-0.29	0	306,584	281,949	246,323

Greater Prairie-Chicken

Strategy: Reverse Decline

Although population trends are positive for Greater Prairie-Chickens in every GFA, more than half of the total range-wide population has been lost since 1970; declines being steeper outside the RWBJV Region. BCR 19, which includes most of the RWBJV Region, is the area of highest importance for this Yellow-D watchlist species. Nearly two-thirds of all breeding Greater Prairie-Chickens occur in the RWBJV Region. Conservation actions that help support this species will help offset losses in other portions of its range, as well as maintain a grassland habitat stronghold to support their long-term persistence within the RWBJV Region.



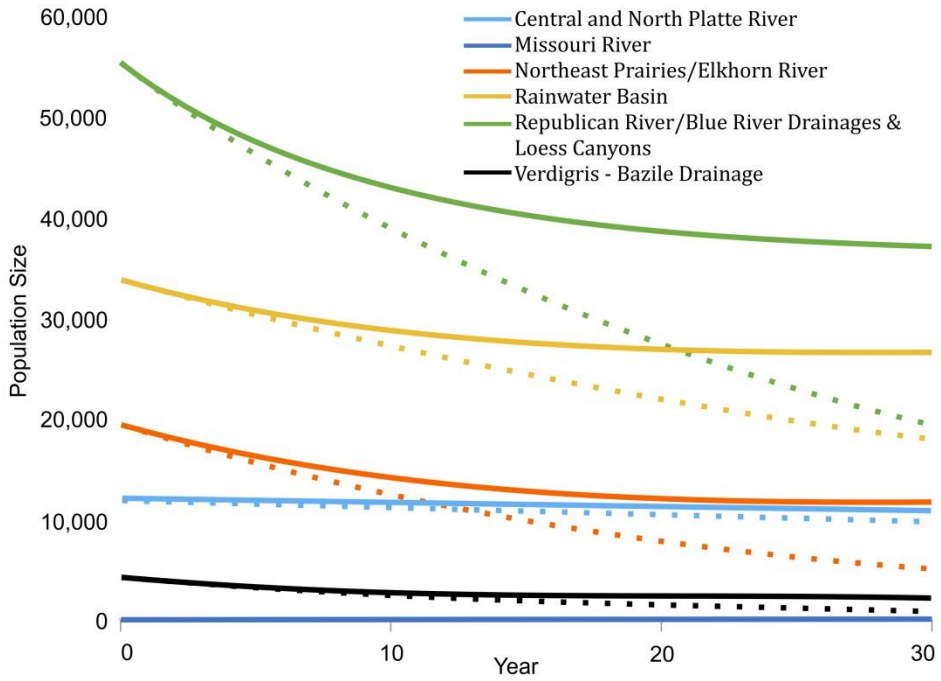
Population objectives (solid) and projected populations assuming no action (dashed)

Geographic Focus Area	Current trend (%)	10-year trend objective (%)	30-year trend objective (%)	Current population	30-year population objective	Population in 30 years if no action taken
Central and North Platte River	5.75	> 0	> 0	3,090	3,554	
Central Loess Hills	3.70	> 0	> 0	27,254	31,342	
Missouri River	5.42	> 0	> 0	6	7	
Northeast Prairies/Elkhorn River	5.72	> 0	> 0	5,810	6,682	
Rainwater Basin	9.40	> 0	> 0	5,496	6,320	
Republican River/Blue River Drainages & Loess Canyons	11.56	> 0	> 0	33,402	38,412	
Sandhills	0.21	0.39	0.74	137,726	158,385	
Verdigris - Bazile Drainage	0.91	> 0	> 0	14,416	16,578	

Northern Bobwhite

Strategy: Stabilize

Northern Bobwhite is currently wide-ranging and abundant. It has, however, been identified as a Common Bird in Steep Decline and is expected to lose half of its population in the next 10 years (Rosenberg et al. 2016). The species is considered a shrubland or forest bird through parts of its range, but primarily uses grasslands and habitats that interface with grasslands in the RWBJV Region. Conservation and restoration of grass habitats in the eastern and southern portions will help halt declines.



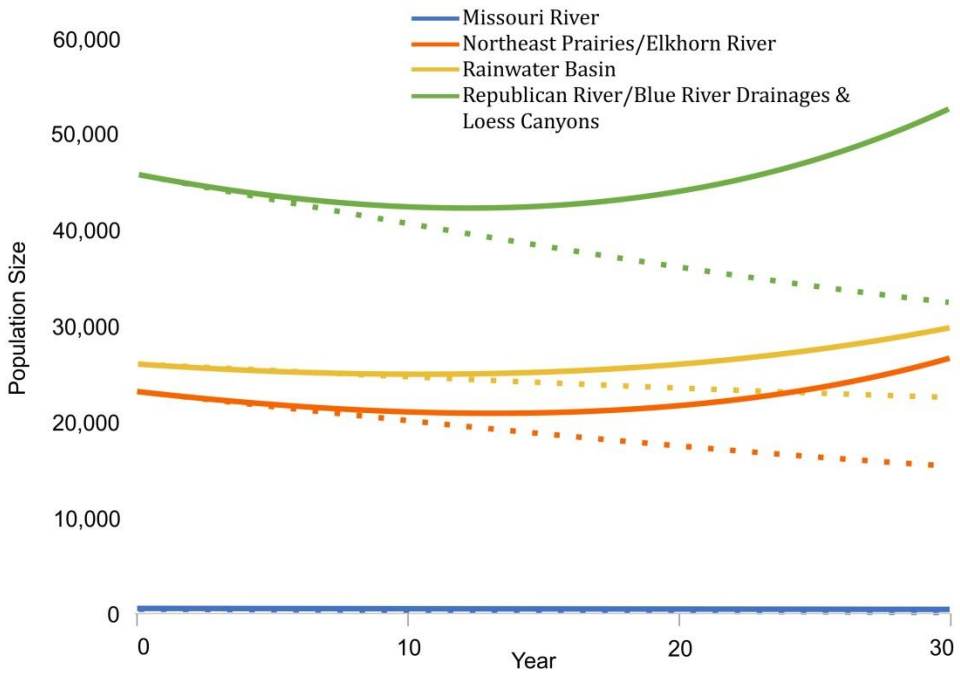
Population objectives (solid) and projected populations assuming no action (dashed)

Geographic Focus Area	Current trend (%)	10-year trend objective (%)	30-year trend objective (%)	Current population	30-year population objective	Population in 30 years if no action taken
Central and North Platte River	-0.68	-0.27	0	12,028	11,120	9,798
Central Loess Hills	1.57	> 0	> 0	31,673	50,553	
Missouri River	-5.74	-2.30	0	38	19	6
Northeast Prairies/Elkhorn River	-4.38	-1.75	0	19,448	11,671	5,069
Rainwater Basin	-2.11	-0.84	0	33,662	26,381	17,775
Republican River/Blue River Drainages & Loess Canyons	-3.45	-1.38	0	55,247	37,022	19,298
Sandhills	0.28	> 0	> 0	30,877	33,543	
Verdigris - Bazile Drainage	-4.96	-1.98	0	4,159	2,332	905

Red-Headed Woodpecker

Strategy: Reverse Decline

Red-headed woodpeckers have experienced steep population declines in their range--seeing a 68% decline since 1970. In the Great Plains, the species' range seems to be shifting toward the west, a pattern that is also apparent in the RWBJV Region. These changes have been attributed to climate change and are expected to continue. Improving forest habitat quality, particularly in savanna habitats, is likely to benefit this species without negatively impacting grassland species.



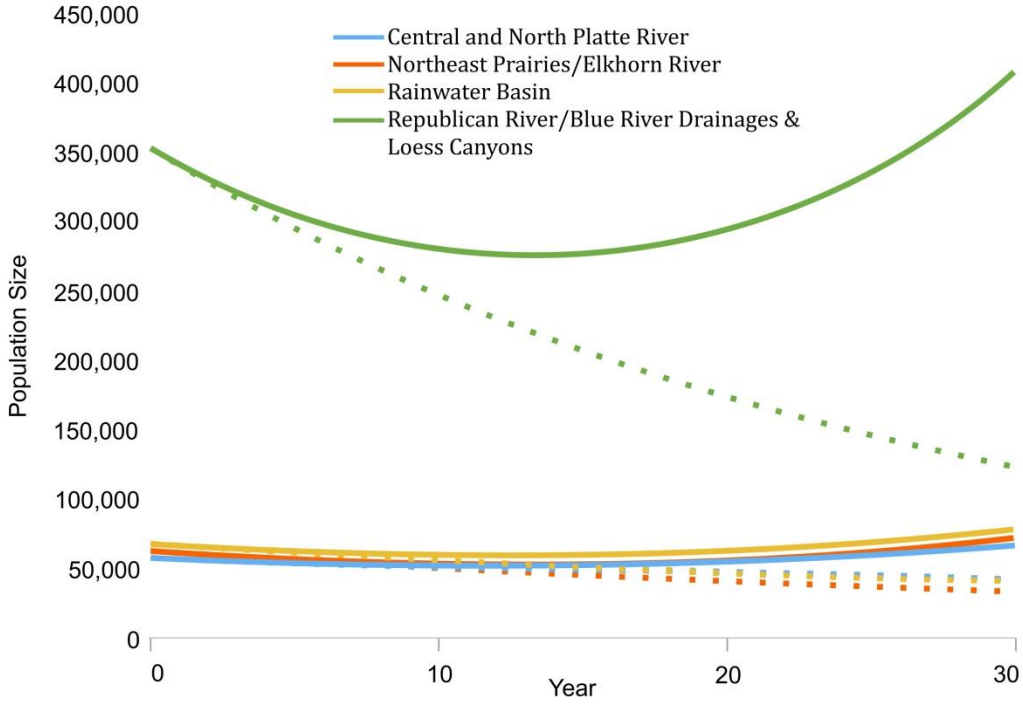
Population objectives (solid) and projected populations assuming no action (dashed)

Geographic Focus Area	Current trend (%)	10-year trend objective (%)	30-year trend objective (%)	Current population	30-year population objective	Population in 30 years if no action taken
Central and North Platte River	0.06	> 0	> 0	14,260	16,399	
Central Loess Hills	0.11	> 0	> 0	25,964	29,859	
Missouri River	-0.74	-0.18	2.20	439	505	352
Northeast Prairies/Elkhorn River	-1.38	-0.35	2.85	23,123	26,592	15,224
Rainwater Basin	-0.46	-0.12	1.93	25,894	29,778	22,533
Republican River/Blue River Drainages & Loess Canyons	-1.13	-0.28	2.60	45,691	52,544	32,461
Sandhills	3.13	> 0	> 0	89,208	102,590	
Verdigris - Bazile Drainage	1.2	> 0	> 0	10,720	12,328	

Ring-Necked Pheasant

Strategy: Reverse Decline

NGPC has targeted parts of the Republican River/Blue River Drainages & Loess Canyons GFA as conservation priorities for Ring-necked Pheasants (Berggren Plan). Pheasants are likely to benefit greatly from NGPC's strategy because abundances are high and trends steeply negative in the south-west portion of our geography. Trends also tend to be negative in eastern GFAs. Conservation efforts in those areas would benefit not only Ring-necked Pheasants, but also our partners that prioritize recreational opportunities since human population centers occur in or near that part of our geography.



Population objectives (solid) and projected populations assuming no action (dashed)

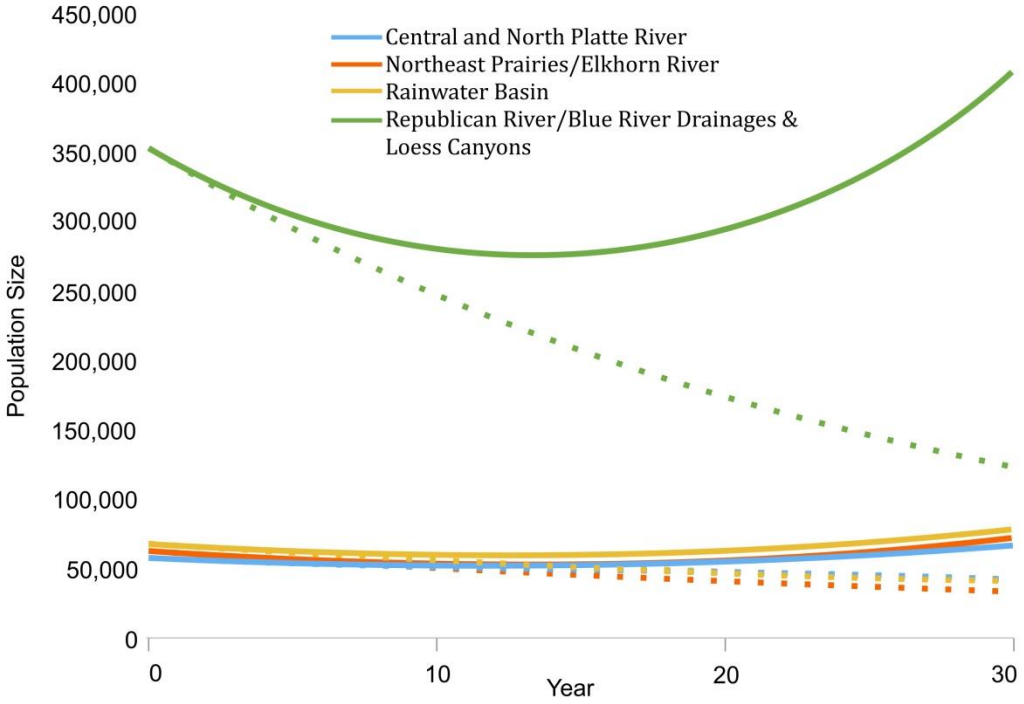
Geographic Focus Area	Current trend (%)	10-year trend objective (%)	30-year trend objective (%)	Current population	30-year population objective	Population in 30 years if no action taken
Central and North Platte River	-0.96	-0.24	2.43	58,200	66,930	43,526
Central Loess Hills	0.61	> 0	> 0	88,542	101,823	
Missouri River	1.43	> 0	> 0	2,213	2,545	
Northeast Prairies/Elkhorn River	-2.02	-0.51	3.48	63,295	72,789	34,285
Rainwater Basin	-1.68	-0.42	3.14	68,082	78,295	40,926
Republican River/Blue River Drainages & Loess Canyons	-3.44	-0.86	4.91	353,475	406,497	123,822
Sandhills	2.21	> 0	> 0	436,955	502,498	
Verdigris - Bazile Drainage	0.99	> 0	> 0	53,237	61,223	

Western Meadowlark

Strategy: Stabilize

Western Meadowlarks are experiencing gradual declines in every GFA. The steepest declines are occurring in the easternmost portion of the RWBJV Region, which is near the edge of their overall breeding range (see Species Account, Appendix 1). This may indicate a shrinking or shifting range for this species.

Grassland conservation in the western half of the RWBJV Region, closer to the heart of their range, would likely have a greater positive impact for this species. Removal of existing woody invasion and prevention of additional cedar encroachment in the eastern Sandhills and Central Loess Hills will also be important to support desired populations.



Population objectives (solid) and projected populations assuming no action (dashed)

Geographic Focus Area	Current trend (%)	10-year trend objective (%)	30-year trend objective (%)	Current population	30-year population objective	Population in 30 years if no action taken
Central and North Platte River	-0.44	-0.18	0.00	191,667	182,132	167,758
Central Loess Hills	-0.43	-0.17	0.00	587,523	558,978	515,879
Missouri River	-0.86	-0.34	0.00	2,213	2,004	1,707
Northeast Prairies/Elkhorn River	-1.03	-0.41	0.00	359,296	318,957	263,172
Rainwater Basin	-1.07	-0.43	0.00	349,005	308,466	252,717
Republican River/Blue River Drainages & Loess Canyons	-0.27	-0.11	0.00	990,161	959,965	913,269
Sandhills	-0.32	-0.13	0.00	3,947,042	3,805,984	3,589,344
Verdigris - Bazile Drainage	-0.33	-0.13	0.00	343,094	330,405	310,950

Limiting Factors

In order to meet species and habitat goals, threats causing population declines or preventing growth were recognized. The Unified Classifications of Threats and Actions (Salafsky et al. 2008) was used to rank threats impacting priority species and their habitats. Five general habitat types associated with the priority species were considered. Also considered were twenty threats identified and rated based on their impact on birds throughout the RWBJV Region. Table 5 is a matrix which summarizes the level of impact each threat has on the habitat types and as an overall threat. Appendix 2 details the methodology used to develop the matrix. Impacts identified as high or very high are described in further detail below.

Table 5. Level of impact for each identified threat to priority bird species based on five habitat associates as ranked by a team of experts. Threat levels were determined based on the expected scope, irreversibility, and severity of each within the RWBJV Region.

Threats	Species Associated with Sparsely Vegetated Grassland	Species Associated with Low to Intermediately Vegetated Grassland	Species Associated with Densely Vegetated/Mesic Grassland	Species Associated with Wooded Grassland or Savannah	Species Associated with Forest/ Woodland	Overall Threat Level
Past or ongoing conversion to agriculture (i.e., row crops)	very high	very high	very high	very high	very high	very high
Woody encroachment (e.g., eastern red cedar, deciduous species)	moderate	very high	very high	low	low	high
Climate change (e.g., warmer and wetter climate, extreme weather events, etc.)	moderate	moderate	moderate	moderate	high	high
Sensitivity to grazing regime (i.e., too much or too little)	high	moderate	high	low	none	high
Fire suppression (e.g., frequency, intensity, timing)	low	moderate	moderate	high	moderate	high
Changing agricultural practices (e.g., clean practices that remove perches/trees/ fencerows/shelterbelts and reduce waste grain)	low	low	low	high	moderate	high
Invasive/non-native grasses and forbs and associated low plant community diversity	low	low	low	low	low	moderate

Threats	Species Associated with Sparsely Vegetated Grassland	Species Associated with Low to Intermediately Vegetated Grassland	Species Associated with Densely Vegetated/Mesic Grassland	Species Associated with Wooded Grassland or Savannah	Species Associated with Forest/ Woodland	Overall Threat Level
Agricultural pesticides – direct mortality via bioaccumulation or acute toxicity	low	low	low	moderate	moderate	moderate
Altered mammal predator communities (i.e., cats or overabundant native meso-predators)	low	low	low	low	low	moderate
Disease – indirect effects (e.g., plague effects on prairie dog colonies)	high	low	low	low	none	moderate
Avian brood parasites (i.e., Brown-headed Cowbirds)	none	low	low	low	moderate	moderate
Human take – poaching, over-harvest, or pest control	high	low	none	low	none	moderate
Urban/suburban sprawl	low	low	low	low	moderate	low
Energy infrastructure (e.g., gas/oil wells, wind turbines)	low	low	low	low	low	low
Agricultural pesticides – indirect mortality via reductions in prey populations or reduced nest success	low	low	low	low	low	low
Early haying or burning (i.e., during the nesting season)	none	low	low	low	none	low
Collisions with structures or vehicles	low	low	low	low	low	low
Alteration of hydrological processes (e.g., damming rivers, surface and groundwater diversion)	none	none	low	none	moderate	low
Disease – direct mortality (e.g., West Nile Virus)	low	low	none	low	low	low
Tourism/Recreation	low	none	none	none	none	low

Past and Ongoing Conversion to Agriculture

Row-crop agriculture is the dominant land use in most of the RWBJV region. Currently, nearly one-third of the RWBJV region is planted to corn or soybeans (NASS 2021). Conversion has slowed since the turn of the century due to limits on development of new irrigation; but some level of conversion still occurs in all GFAs (Table 6; Appendix 3, Lark et al. 2020). Federal farm programs, past and present, contribute to the conversion. Grassland conversion remains low in the Sandhills due to unsuitable soils and topography. Economics is causing some past conversions in this GFA to be converted back to grassland (Figure 6).

Table 6. Annual rates (%) of conversion of grassland to row-crop agriculture in each GFA based on USDA Common Land Unit (CLU) data from 2008-2018 and NASS Cropland Data Layer (CDL) from 2008-2016.

Geographic Focus Area	Annual rate based on CLU (%)	Annual rate based on CDL (%)
Central and North Platte River	-0.5836	-0.1415
Central Loess Hills	-0.3682	-0.1801
Missouri River	-3.0038	-0.2176
Northeast Prairies/Elkhorn River	-1.9197	-1.4739
Rainwater Basin	-3.1478	-0.6094
Republican River/Blue River Drainages & Loess Canyons	-0.4346	-0.2408
Sandhills	-0.0289	-0.0383
Verdigris - Bazile Drainage	-0.3774	-0.2947

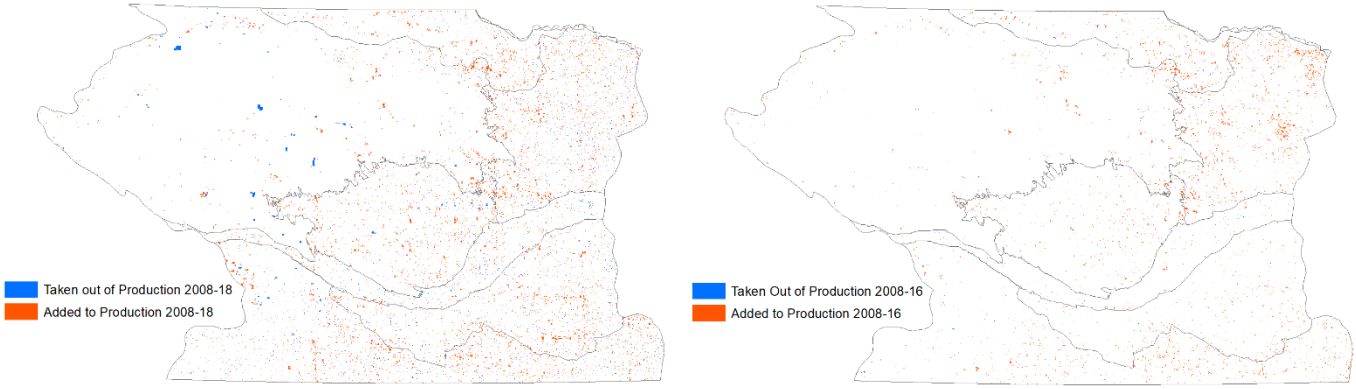


Figure 6. Maps indicating areas of land taken out of or added to agricultural production in each GFA based on USDA FSA CLU data from 2008-2018 (left) and NASS CDL from 2008-2016 (right).

Impacted Geographic Focus Areas: Central and North Platte River, Central Loess Hills, Missouri River, Northeast Prairies/Elkhorn River, Rainwater Basin, Republican River/Blue River Drainages & Loess Canyons, Verdigris-Bazile Drainage

Impacted Habitats: Sparsely Vegetated Grassland, Low to Intermediately Vegetated Grassland, Densely Vegetated/Mesic Grassland, Wooded Grassland or Savannah, Forest/Woodland

Impacted Priority Species: Baltimore Oriole, Black-billed Cuckoo, Bobolink, Brown Thrasher, Burrowing Owl, Chestnut-collared Longspur, Dickcissel, Eastern Kingbird, Eastern Meadowlark, Eastern Whippoorwill, Ferruginous Hawk, Grasshopper Sparrow, Greater Prairie-Chicken, Lark Bunting, Lark Sparrow, Loggerhead Shrike, Northern Bobwhite, Northern Harrier, Red-headed Woodpecker, Ring-necked Pheasant, Short-eared Owl, Western Meadowlark, Yellow-billed Cuckoo.

Woody Encroachment

Many grassland-obligate bird species are not able to use encroached areas, even at low levels of invasion. A number of factors have contributed to woody plant invasions of Great Plains grasslands. Eastern red cedar, in particular, has rapidly spread in parts of the RWBJV Region, displacing and fragmenting prairie habitats (Figure 7; Appendix 3). Fire suppression is considered the greatest cause of woody encroachment. Drought, absentee landowners, and active planting for windbreaks also are contributing factors.

Woody encroachment is documented to cost Nebraska more than 530,000 tons of herbaceous productivity in 2019 (D. Fogarty, unpubl. data). Culture and social norms perceive red cedar as good wildlife habitat. The presence of game species, such as deer and turkey, affirms this perception; creating a socio-political challenge to removing existing trees. Tree removal is both laborious and time-intensive; requiring follow-up mechanical treatments or prescribed fire to address seed germination.

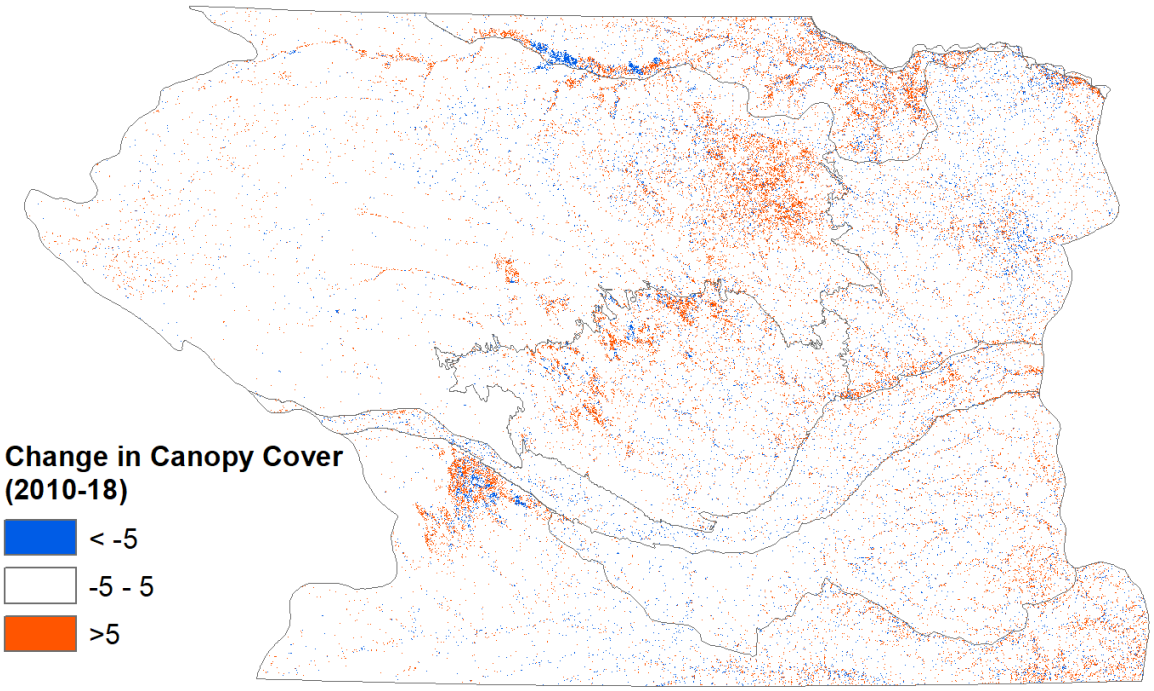


Figure 7. Change in percent tree cover between 2009/11 and 2017/19, derived from Rangeland Analysis Platform data (University of Montana; Appendix 3).

Impacted Geographic Focus Areas: Central Loess Hills, Northeast Prairies/Elkhorn River, Republican River/Blue River Drainages & Loess Canyons, Sandhills, Verdigris-Bazile Drainage

Impacted Habitats: Sparsely Vegetated Grassland, Low to Intermediately Vegetated Grassland, Densely Vegetated/Mesic Grassland

Impacted Priority Species: Bobolink, Burrowing Owl, Chestnut-collared Longspur, Dickcissel, Eastern Meadowlark, Ferruginous Hawk, Grasshopper Sparrow, Greater Prairie-Chicken, Lark Bunting, Northern Bobwhite, Northern Harrier, Ring-necked Pheasant, Short-eared Owl, Western Meadowlark

Climate Change

Temperatures in the RWBJV Region are expected to increase, particularly in winter and spring. The number of temperature stress days (>100°F) is expected to increase. Annual precipitation is expected to remain the same, but the number of heavy rainfall events is expected to increase (Bathke et al. 2014). These changes are likely to affect the plant and insect communities that are critical sources of food for breeding birds. Higher spring temperatures can cause direct mortality of nestlings. Some bird species may experience range shifts in response to climate changes, leading to local extirpations. The most vulnerable priority species include Red-headed Woodpecker, Bobolink, and Brown Thrasher (Table 7).

Table 7. Vulnerability status and projected trends in Nebraska under a 3°C warming scenario. Trend values represent the percent of Nebraska in which each trend will occur (climate.audubon.org).

RWBJV Region Priority Species	Range-wide Vulnerability	Nebraska Trend (% of total area)				
		Potential Extirpation	Worsening	Stable	Improving	Potential Colonization
Planning Species						
Dickcissel	STABLE				92	8
Eastern Meadowlark	MODERATE			16		10
Grasshopper Sparrow	LOW			52	40	
Greater Prairie-Chicken	STABLE			35	64	
Northern Bobwhite	STABLE			54	35	
Red-headed Woodpecker	HIGH	89				
Western Meadowlark	LOW			88		3
Stewardship Species						
Baltimore Oriole	LOW	31		38		
Black-billed Cuckoo	LOW	3				
Bobolink	HIGH	41				
Brown Thrasher	HIGH	89				
Burrowing Owl	STABLE			25		38
Chestnut-collared Longspur	HIGH	4				
Eastern Kingbird	MODERATE	86		9		
Eastern Whip-poor-will	HIGH	12				
Ferruginous Hawk	MODERATE	8		12		
Lark Bunting	HIGH	25	26			
Lark Sparrow	STABLE			46	48	
Loggerhead Shrike	STABLE	25		58		
Northern Harrier	LOW	34				
Short-eared Owl	MODERATE	7		21		
Yellow-billed Cuckoo	STABLE				75	22

Impacted Geographic Focus Areas: Central and North Platte River, Central Loess Hills, Missouri River, Northeast Prairies/Elkhorn River, Rainwater Basin, Republican River/Blue River Drainages & Loess Canyons, Verdigris-Bazile Drainage

Impacted Habitats: Low to Intermediately Vegetated Grassland, Densely Vegetated/Mesic Grassland, Wooded Grassland or Savannah, Forest/Woodland

Impacted Priority Species: Baltimore Oriole, Black-billed Cuckoo, Bobolink, Brown Thrasher, Chestnut-collared Longspur, Eastern Kingbird, Eastern Whippoorwill, Ferruginous Hawk, Lark Bunting, Loggerhead Shrike, Northern Harrier, Red-headed Woodpecker, Ring-necked Pheasant, Short-eared Owl

Sensitivity to Grazing Regime

Historically, a combination of bison grazing, wildland fires, and fires intentionally set by native indigenous peoples maintained highly diverse grassland plant communities. Now, twenty-three million acres of public and private lands in Nebraska are used for cattle grazing and fires no longer occur in natural cycles. Decisions about timing, duration, and intensity of grazing are not made with consideration to birds or their habitats.

A variety of grazing regimes are used in the RWBJV Region (e.g., deferred rotations, high-intensity short-duration, patch-burn, twice-over rest-rotation, and season-long). Too much or too little grazing, or grazing at the wrong times, can promote invasive grasses and forbs, resulting in lower biodiversity and grassland conditions. Grazing regimes influence vegetation structure (i.e., plant height and density), impacting the availability of food, cover, and nesting locations. Loss of nesting substrate or cover and direct loss of nests to trampling (Fromberger et al 2020) may affect breeding success. The level of sensitivity to grazing varies widely by bird species (Table 8). These disparate habitat needs make it difficult to prescribe a one-size-fits-all solution.

Table 8. Grazing tolerances for grassland priority species (adapted from Table 1 of Ryan et al. 2006).

Species	Grazing Tolerance
Bobolink	Moderate to Light
Burrowing Owl	Heavy
Chestnut-collared Longspur	Heavy to Light
Dickcissel	Light to Intolerant
Eastern Meadowlark	Moderate to Light
Ferruginous Hawk	Heavy to Moderate
Grasshopper Sparrow	Moderate
Greater Prairie-Chicken	Moderate to Intolerant
Lark Bunting	Heavy to Moderate
Northern Bobwhite	Light
Northern Harrier	Light to Intolerant
Short-eared Owl	Light to Intolerant
Western Meadowlark	Moderate to Light

Impacted Geographic Focus Areas: Central and North Platte River, Central Loess Hills, Missouri River, Northeast Prairies/Elkhorn River, Rainwater Basin, Republican River/Blue River Drainages & Loess Canyons, Verdigris-Bazile Drainage

Impacted Habitats: Sparsely Vegetated Grassland, Low to Intermediately Vegetated Grassland, Densely Vegetated/Mesic Grassland

Impacted Priority Species: Bobolink, Burrowing Owl, Chestnut-collared Longspur, Dickcissel, Eastern Meadowlark, Ferruginous Hawk, Grasshopper Sparrow, Greater Prairie-Chicken, Lark Bunting, Northern Bobwhite, Northern Harrier, Ring-necked Pheasant, Short-eared Owl, Western Meadowlark

Fire Suppression

Intermittent wildland fires are an essential component of most native plant communities in the RWBJV Region. Prior to European settlement, grasslands burned at regular intervals; ignited either by lightning or by indigenous peoples. The suppression of natural fire disturbance cycles exacerbates other threats to landbirds by leading to increases in non-native plants, woody encroachment, and reductions in biodiversity.

Fire suppression has primarily socio-economic origins. Social acceptance of wildland fire was low for most of the 20th century due to safety, legal, and health concerns. Presently, attitudes towards fire have improved, but the need to reduce or eliminate risks has increased the costs of prescribed burns significantly. Educational outreach and communication efforts are needed to: educate the public about the benefits of fire as a land management practice, train landowners and other partners on safe burning methods, and raise funds for equipment and skilled support staff.

Impacted Geographic Focus Areas: Central Loess Hills, Northeast Prairies/Elkhorn River, Republican River/Blue River Drainages & Loess Canyons, Verdigris-Bazile Drainage

Impacted Habitats: Sparsely Vegetated Grassland, Low to Intermediately Vegetated Grassland, Densely Vegetated/Mesic Grassland

Impacted Priority Species: Bobolink, Burrowing Owl, Chestnut-collared Longspur, Dickcissel, Eastern Meadowlark, Ferruginous Hawk, Grasshopper Sparrow, Greater Prairie-Chicken, Lark Bunting, Northern Bobwhite, Northern Harrier, Ring-necked Pheasant, Short-eared Owl, Western Meadowlark

Changing Agricultural Practices

Global population growth and associated increases in demand for agricultural products have led to changes in farmland practices in recent decades. Producers have increased the amount of cropland area by removing fencerows, wind breaks, and other small patches of native habitat. Increased use of pesticides, fertilizers, and mechanized equipment also impact breeding birds, both directly and indirectly.

Direct pesticide exposure can be problematic in higher concentrations. Indirect effects include a reduction in plant and insect-based forages, as well as habitat structure. Herbicide-resistant crop hybrids, such as Roundup Ready®, allow for the elimination of other plant species in fields (Burger et al. 2015). Restoration of field margins and corners to grassland and establishment of prairie strips within crop fields can support breeding birds. New methods to reduce agrichemical inputs (e.g., precision agriculture) are also being developed and include variable rate irrigation technology and integrated pest management. These conservation actions can also improve water and soil quality, although education and incentives may be needed to encourage implementation by agricultural producers.

Impacted Geographic Focus Areas: Central and North Platte River, Central Loess Hills, Missouri River, Northeast Prairies/Elkhorn River, Rainwater Basin, Republican River/Blue River Drainages & Loess Canyons, Verdigris-Bazile Drainage

Impacted Habitats: Sparsely Vegetated Grassland, Low to Intermediately Vegetated Grassland, Densely Vegetated/Mesic Grassland, Wooded Grassland or Savannah, Forest/Woodland

Impacted Priority Species: Baltimore Oriole, Black-billed Cuckoo, Bobolink, Brown Thrasher, Burrowing Owl, Chestnut-collared Longspur, Dickcissel, Eastern Kingbird, Eastern Meadowlark, Eastern Whippoorwill, Ferruginous Hawk, Grasshopper Sparrow, Greater Prairie-Chicken, Lark Bunting, Lark Sparrow, Loggerhead Shrike, Northern Bobwhite, Northern Harrier, Red-headed Woodpecker, Ring-necked Pheasant, Short-eared Owl, Western Meadowlark, Yellow-billed Cuckoo

Indirect Effects of Disease and Human Take

These threats primarily impact Burrowing Owls in the RWBJV Region. Burrowing Owls have a symbiotic relationship with prairie dogs, which are considered by many to be a nuisance species. Landowners often remove existing colonies and discourage establishment of new colonies. Prairie dog colonies can be decimated by sylvatic plague. The loss of colonies reduces the availability of nesting sites. Burrowing Owls may also be poached or unintentionally killed during prairie dog control efforts.

Impacted Geographic Focus Areas: Central Loess Hills, Rainwater Basin, Republican River/Blue River Drainages & Loess Canyons, Sandhills, Verdigris-Bazile Drainage

Impacted Habitats: Sparsely Vegetated Grassland

Impacted Priority Species: Burrowing Owl

Other Threats

Several other threats impacting landbirds in the RWBJV Region were identified and rated low or moderate for all bird-habitat associations. Threats related to human development such as urban/suburban sprawl, collisions with structures or vehicles, and tourism/recreation were not considered severe because the RWBJV Region is mostly rural with declining human population numbers.

Many important habitats in our region are not suitable for the installation of energy infrastructure, such as wind turbines, due to unfavorable soils and topography; thus it is not expected to be a limiting factor. More information is needed to accurately assess the impacts of some threats, such as indirect mortality via reductions in prey populations or reduced nest success related to agricultural insecticides and early haying or burning. Alteration of hydrological processes and direct mortality caused by disease are threats that disproportionally affect certain species, while having little to no impact on most of our priority species.

Habitat Objectives

Habitat objectives were developed by translating population targets to estimates of habitat required to support priority species at desired levels. These habitat estimates, in turn help direct resource allocations in a more effective and efficient manner. Quantifying a total estimate of habitat by GFA demonstrates to partners the level of conservation actions needed to recover and secure landbird populations. Progress made on habitat objectives is easier to measure than population targets. Habitat objectives were set relevant to our two highest ranked limiting factors, conversion to agriculture and woody encroachment.

To calculate the amount of grassland conservation needed to offset the impacts of agricultural conversion, an estimate of the amount of grassland acres expected to remain after 30 years is needed. This is assuming the recent mean rate of conversion does not change (Table 9). Two different conversion estimates were used: one derived from Common Land Unit (CLU) classifications and the other adapted

from Lark et al. (2020) using the CDL. This allowed grassland habitat objectives to be formulated based on two different methods and data sources.

The CLU is a vector dataset that contains a map unit for all agriculture lands and is used by FSA to track and manage enrollment in different USDA Farm Bill programs. A majority of producers are enrolled in the USDA Farm Program. Map units managed by producers not enrolled do not have any data despite being cultivated. As a result, when these tracts become newly enrolled in Farm Bill programs, the analysis assumes a conversion from grassland to cropland, even though the land was already cultivated. This does not happen often, but does cause the CLU classification to overestimate conversion.

Lark et al. (2020) post-processed the CDL to evaluate conversion rates. The CDL is a satellite derived raster dataset that has annual error that can become confounded. In addition, satellite derived products do not have the thematic accuracy of vector-based datasets. Cropland is generally correctly identified, but the CDL does not perform well at accurately mapping grasslands; particularly in Nebraska (Lark et al. 2021). Based on evaluation of the CDL, the Lark et al. (2020) approach provides a more conservative estimate that probably underestimates conversion. The methodology used for both analyses is presented in Appendix 3.

Table 9. Amount of grassland habitat in each Geographic Focus Area in the RWBJV Region in 2018; and the amount predicted to remain in 2048, assuming continuing annual rate of loss. (Appendix 2, Lark et al. 2020).

Geographic Focus Area	Grassland area in 2018 (ac)	Mean annual rate of loss (%) *	Grassland area in 2048 if trends continue (ac)
Central and North Platte River	396,786	-0.3626	355,822
Central Loess Hills	1,955,050	-0.2742	1,800,477
Missouri River	4,811	-1.6107	2,956
Northeast Prairies/Elkhorn River	690,869	-1.6968	413,451
Rainwater Basin	370,102	-1.8786	209,525
Republican River/Blue River Drainages & Loess Canyons	2,542,698	-0.3377	2,297,320
Sandhills	12,128,079	-0.0336	12,006,378
Verdigris - Bazile Drainage	1,229,429	-0.3361	1,111,337

*Based on USDA CLU data from 2008-18 and NASS CDL data from 2010-16.

In some GFAs, the amount of grassland predicted to be converted over the next 30 years exceeds the amount of farmable land. Some acres are already in long-term or permanent conservation status and not able to be converted to agriculture. There are also acres that are very unlikely to be converted to agriculture due to soil or topography conditions.

Non-irrigated Land Capability Class as defined in the Soil Survey Geographic Database (SSURGO) was used as the soil characteristic that best represents areas unsuitable for crop production. Land Capability Class groups soils according to their suitability for field crops; reflecting their limitations, risk of damage, and response to management (NRCS Soil Survey 2019). Those lands identified as possessing a Non-irrigated Land Capability Class of four or greater were considered unlikely for long-term conversion.

Generally, class four and greater consist of soils that will support only a limited number of plants that can be successfully cultivated and require careful management. To determine the number of grassland acres expected to remain in 2048, either the prediction based on continuing rates of loss or the number of grassland acres that cannot be converted were used, whichever was higher (Table 10).

Table 10. Area of grassland expected to remain in 2048; based on recent conversion trends and limits on conversion due to soil and topography conditions.

Geographic Focus Area	Grassland area in 2048 if trends continue (ac)	Grassland area that cannot be converted (ac)	Grassland area expected to remain in 2048 (ac)
Central and North Platte River	355,822	312,489	355,822
Central Loess Hills	1,800,477	1,265400	1,800,477
Missouri River	2,956	3,687	3,687
Northeast Prairies/Elkhorn River	413,451	378,052	413,451
Rainwater Basin	209,525	244,833	244,833
Republican River/Blue River Drainages & Loess Canyons	2,297,320	1,981,653	2,297,320
Sandhills	12,006,378	11,873,202	12,006,378
Verdigris - Bazile Drainage	1,111,337	1,011,847	1,111,337

An estimate was made of the amount of grassland acres needed to support goal populations of six declining priority grassland species in 30 years; assuming that current breeding densities remain the same in each GFA (Table 11). The difference between the 30-year grassland habitat objective for the species with the greatest need and the amount of grassland area expected to remain in 2048 became the estimate for grassland conservation need (Table 12).

In GFAs where species currently have a positive trend, it was assumed the carrying capacity for the current habitat amount had not been met. It appears population densities can increase and no habitat shortage exists at this time. For example, Greater Prairie-Chickens are experiencing positive trends in each GFA, so it is assumed this species currently has no habitat shortage. In some situations (e.g., Sandhills), the rate of grassland loss was low enough that the amount of habitat expected to remain in 30 years exceeds the amount needed to support goal populations.

Table 11. Total grassland area (ac) needed to support 30-year population objectives assuming no change in breeding density.

Geographic Focus Area	Dickcissel	Eastern Meadowlark	Grasshopper Sparrow	Northern Bobwhite	Ring-necked Pheasant	Western Meadowlark
Central and North Platte River	456,304	315,870	236,758	366,826	456,304	377,048
Central Loess Hills	2,248,308	1,522,374	1,323,461			1,860,063
Missouri River	5,533		3,424	2,457		4,356
Northeast Prairies/Elkhorn River	794,499	632,136	433,910	414,588	794,499	613,302
Rainwater Basin	425,617	347,252	227,572	290,052	425,617	327,113
Republican River/Blue River Drainages & Loess Canyons			1,895,077	1,703,910	2,924,103	2,465,157
Sandhills		6,494,641	7,911,192			11,694,650
Verdigris - Bazile Drainage		976,136	1,130,639	689,334		1,183,961

Table 12. Amount of grassland conservation (ac) needed to offset projected losses to agricultural conversion in order to meet 30-year population objectives for the species with the greatest habitat need, assuming no change in breeding density.

Geographic Focus Area	Grassland habitat objective for the species with the greatest need (ac)	Species with the greatest need	Grassland expected to remain in 2048 (ac)	Difference between amount of grassland needed and amount expected to remain (ac)
Central and North Platte River	456,304	Ring-necked Pheasant and Dickcissel	355,822	100,482
Central Loess Hills	2,248,308	Dickcissel	1,800,477	447,831
Missouri River	5,533	Dickcissel	3,687	1,846
Northeast Prairies/Elkhorn River	794,499	Ring-necked Pheasant and Dickcissel	413,451	381,048
Rainwater Basin	425,617	Ring-necked Pheasant and Dickcissel	244,833	180,784
Republican River/Blue River Drainages & Loess Canyons	2,924,103	Ring-necked Pheasant	2,297,320	626,783
Sandhills	11,694,650	Western Meadowlark	12,006,378	-
Verdigris - Bazile Drainage	1,183,961	Western Meadowlark	1,111,337	72,624

Grassland losses to woody (primarily eastern red cedar) encroachment are widespread and ongoing in the RWBJV Region. In order to meet long-term habitat objectives, a two-pronged approach is needed to address red cedar invasion. They are restoration of encroached areas to high-quality grassland habitat and prevention of further encroachment into existing grassland.

Estimating the number of acres that become encroached each year will help determine the amount of ongoing cedar management via prescribed fire and mechanical removal that is needed. To estimate this, percent tree canopy data available in the Rangeland Analysis Platform (University of Montana 2018) was used. Grassland areas that reached three canopy cover thresholds (1%, 3%, and 5%) were measured for each year (Table 13). For example, about a half a million acres in the Sandhills is expected to attain 1% or greater canopy cover every year. This estimate does not include areas that were already above 1% canopy cover. This information can be used to target areas for treatment and help estimate the potential costs of preventing further encroachment. Methodologies for this analysis are outlined in Appendix 4.

Table 13. Number of acres that are predicted to reach three levels of woody encroachment each year (Appendix 4).

Geographic Focus Area	**Grassland Acres**	**Annual Treatment Acres**		
		1% Threshold	3% Threshold	5% Threshold
Central and North Platte River	397,171	27,546	8,996	5,287
Central Loess Hills	1,961,158	188,612	61,601	36,198
Missouri River	4,965	640	209	123
Northeast Prairies/Elkhorn River	691,891	90,785	29,650	17,423
Rainwater Basin	375,356	67,420	22,019	12,939
Republican River/Blue River Drainages & Loess Canyons	2,550,695	123,276	40,262	23,659
Sandhills	12,138,351	501,375	163,749	96,224
Verdigris-Bazile Drainage	1,231,801	155,129	50,665	29,772
Total	19,351,388	1,154,783	377,151	221,625

Red-headed Woodpecker is the only planning species which prefers habitat other than grassland. It is associated with open-forest, savanna, and woodland edge areas (King et al. 2007). Considering the historically prairie-dominated landscape in the RWBJV Region, improving forest quality is more reasonable than increasing forest acreage. The quality of upland and riparian forests and savannas with open understories can be maintained with prescribed fire along with control of invasive plants and shade-tolerant woody species. Dead snags should be created or maintained in and around known Red-headed Woodpecker territories. Encouraging growth of mature trees through selective harvest would also benefit this species.

Conservation Strategies

Conservation strategies focus on the two most severe threats to grassland birds: conversion of habitat to agriculture and woody encroachment.

The RWBJV recognizes that grassland conversion will continue into the future. Nevertheless, a set of strategies have been developed to limit agricultural conversion and maintain a significant grassland

base. One strategy is to build a grassroots coalition to educate the public of the value of grasslands beyond that of beef production. Another strategy is to develop a combination of incentives and program offerings that will help ranching to be profitable and sustainable. Some of these incentives could include financial assistance for cross fencing, livestock water improvements, and other works to facilitate cattle grazing. Conservation programs to support these activities include the USDA Environmental Quality Incentives Program (EQIP), Landowner Agreements by the NGPC and the Nebraska Natural Legacy Project, and programs administered by the USFWS Partners for Fish and Wildlife Program (PFW). It is the RWBJV's aim to prevent 50% of the grassland conversion.

A diversity of programmatic options is available through RWBJV partners to support grassland restoration. The majority are administered by USDA through EQIP, Conservation Stewardship Program (CSP), CRP, and ACEP. Livestock producers are generally more receptive to short-term programs; therefore, a priority was set to achieve approximately 40% grassland restoration through EQIP or other three-year type agreements. EQIP contracts generally cover approximately 75% of the cost of grassland establishment and provide payment to compensate lost income during the initial years. NGPC and PFW provide 10-year landowner agreements to support grassland restoration. Programs by other partners do not have rental payment or compensation for lost income while grassland is being established.

The RWBJV is focused on increasing CRP enrollment in the RWBJV Region to achieve 10% of the grassland restoration objectives. CRP contracts are generally ten to fifteen years in duration and provide cost-share for restoration and grassland establishment. Annual payments are based on the aggregated rental rates of the three most prominent soils under contract. Qualifications for CRP are tied to soil erosion indexes with financial compensation based on non-irrigated rental rates. This causes some GFAs to have more eligible acres and more favorable rental rates than other GFAs. To help ensure that CRP can achieve the desired 10% population response, the RWBJV partners will work to deliver continuous practices and develop incentives to ensure viable CRP practices are available in GFAs where CRP is not as economically viable.

Table 14. Projected amount of grassland conservation needed within five strategies to support population targets for priority species with the greatest need and acreage objectives.

Geographic Focus Area	Grass Conservation Deficit (ac)	Conservation Strategies				
		Prevent from conversion (ac)	ERC removal (ac)	Short-term grassland restoration (e.g., EQIP; ac)	CRP (ac)	Other long-term easement programs (ac)
Central and North Platte River	100,482	50,241	20,096	20,096	5,024	5,024
Central Loess Hills	447,831	223,916	89,566	89,566	22,392	22,392
Missouri River	1,846	923	369	369	92	92
Northeast Prairies / Elkhorn River	381,048	190,524	76,210	76,210	19,052	19,052
Rainwater Basin	180,784	90,392	36,157	36,157	9,039	9,039
Republican River/Blue River Drainages & Loess Canyons	626,783	313,392	125,357	125,357	31,339	31,339
Sandhills	0	-	-	-	-	-
Verdigris - Bazile Drainage	72,624	36,312	14,525	14,525	3,631	3,631

ACEP is a successful wetland conservation program which offers thirty-year and perpetual easements. The program restores and protects a grassland buffer around wetlands, generally at a 1:1 grassland to wetland acreage ratio. Long-term conservation programs are slated to provide 10% of the desired levels of restored grasslands to offset conversion in the RWBJV Region. Compensation to the landowner is based on appraised value. Seventy-five percent of the upland restoration costs is paid by NRCS. Partners often cover the remaining 25%. For perpetual easements, NRCS covers the entire restoration cost.

Tree removal within grasslands is another strategy that is being implemented to increase quality grassland acres and support desired populations of landbirds. Forty percent of the grassland acreage objectives will be achieved by the removal of encroaching woody species (Table 13). Tree removal is supported through a variety of partnerships: USDA and non-Farm Bill Programs, PFW, Nebraska Forest Service, non-governmental organizations, and local landowner cooperatives. Landowners frequently remove trees in less impacted areas; but large areas, tree densities, and site-specific limitations (i.e., terrain), may become cost or technically prohibitive. RWBJV partners can provide financial and technical assistance.

Outlining specific strategies for achieving habitat objectives allows an estimate of the total cost to recover landbirds in the RWBJV Region. Cost estimates convey the scope and severity of the threats facing grassland birds and helps partners plan for allocation of resources. Cost of grassland conservation is estimated to be $19.1 million each year to reach our habitat objectives on a thirty-year timetable (Table 15).

Table 15. Total grassland objectives and estimated cost for five conservation strategies.

	Conservation Strategies				
	Prevent from conversion	ERC removal	Short-term Grassland Restoration	CRP	Other long-term easement programs
Grassland Objective (ac)	905,699	362,280	362,280	90,570	90,570
Predicted cost per acre ($)	30	60	200	1,500	3,500
Total cost ($)	27,170,970	21,736,776	72,455,920	135,854,850	316,994,650

Woody encroachment is considered a severe threat because of the current extent and continued expansion of cedar and other woody invasive species. In addition to removing existing woody invasive species, action needs to be taken to prevent additional encroachment. An estimate of the annual cost to treat grasslands within three encroachment thresholds was made (Table 16). It is estimated to cost $18 per acre to apply prescribed fire. While the total number of grassland acres that need management is high, per-acre cost is relatively low. Additionally, removal and management of woody encroachment is receiving more socio-political support due to its negative economic impact on the livestock industry.

The conservation strategies outlined in this plan are intended to address the two most severe threats impacting landbirds in the RWBJV Region, grassland conversion and woody encroachment. Although there are several other high-level threats to landbirds, the RWBJV lacks the influence, resources, or knowledge to address those issues alone. It can, in collaboration with other Migratory Bird Joint Ventures and through the Association of Joint Venture Management Boards, collectively advance legislation that could impact climate change.

Table 16. Cost estimate to apply prescribed fire to all acres that reach each of three woody encroachment thresholds every year.

	Estimated Treatment Cost ($)		
	1% Threshold	3% Threshold	5% Threshold
Central and North Platte River	495,001	161,667	95,000
Central Loess Hills	3,389,355	1,106,961	650,482
Missouri River	11,499	3,756	2,207
Northeast Prairies/Elkhorn River	1,631,408	532,817	313,099
Rainwater Basin	1,211,529	395,685	232,516
Republican River/Blue River Drainages & Loess Canyons	2,215,275	723,507	425,154
Sandhills	9,009,715	2,942,567	1,729,137
Verdigris-Bazile Drainage	2,787,673	910,452	535,008
Total	20,751,456	6,777,411	3,982,603

Fire suppression is often driven by cultural attitudes that are slow and difficult to change. The RWBJV will have to work with other state partners to support legislation that addresses the liability issues associated with prescribed fire and highlight the benefits of prescribed fire for grassland management. Addressing these issues will promote cultural acceptance of prescribed burning.

The RWBJV recognizes that different grassland species respond differently to grazing regimes. The partnership will support grazing research which identifies how different practices can benefit both livestock operations and landbirds.

The RWBJV will remain committed to developing and implementing a comprehensive approach to conservation with each partner playing a unique role. The RWBJV role is primarily to help protect and restore grasslands; but, also to support other outside actions that will make successful landbird conservation a reality in the Region.

Conservation Design

Species Distribution Models (SDMs) are the foundation of providing the greatest results from conservation actions. They were developed from stop-level data collected annually as part of the Breeding Bird Survey (BBS). Five priority species had sufficient observations to generate statistically valid SDMs. SDMs for Dickcissel, Eastern Meadowlark, Grasshopper Sparrow, and Western Meadowlark were based on BBS data. SDM for Greater Prairie-Chicken was developed from state-wide, section level survey data collected by NGPC.

Based on Greater Prairie-Chicken response curves to grasslands (Figure 8), thresholds for grassland core areas were established; they consisted of 70% grassland composition within 810-meters (Figure 9). The 810-meter distance was chosen to match the smallest scale at which conservation projects typically occur.

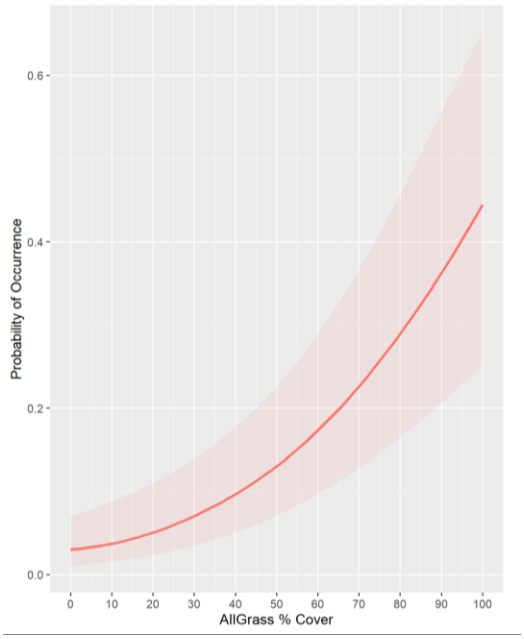


Figure 8. Greater Prairie-Chicken response curves to grassland generated in the SDM process.

The population estimates outlined in this plan were integrated into the SDMs to create pseudo-abundance models. The abundance models were further refined to delineate core landscapes that support 50% of the population of each of the five species. As an example, Figure 10 displays the core landscape for the Grasshopper Sparrow. The core landscapes for all five species were overlaid to identify Grassland Bird Conservation Areas (GBCAs; Figure 11). The GBCAs were defined at the state, RWBJV Region, and GFA scales. The GBCAs are considered coarse filters; but they can be refined at different scales to enable partners to apply these tools relative to their geopolitical boundaries (i.e., NRD Boundary, NGPC Districts, etc.).

The species habitat relationships described in the SDM equations are used to develop program-specific geospatial targeting tools. Targeting tools can be customized to support partner work in explicit areas for a specific set of conservation programs. As a result, a suite of geospatial targeting tools was developed to address each of the grassland protection, restoration, and management strategies outlined in this plan. Contact the RWBJV for more information about how custom design tools can be developed for specific conservation programs and strategies.

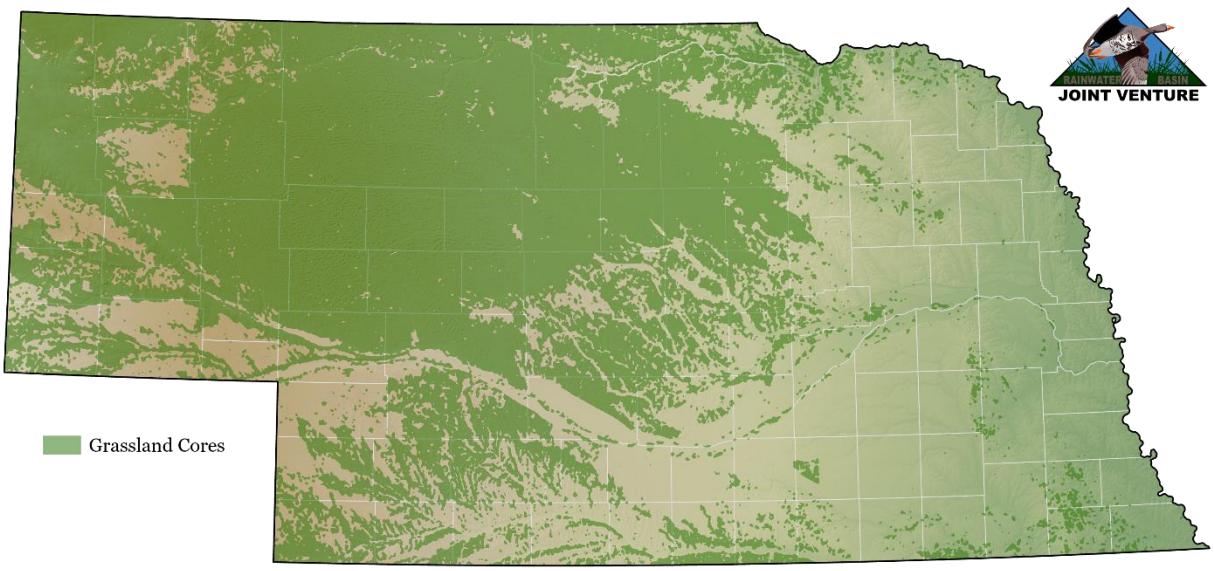


Figure 9. Grassland cores with composition of 70% or more grass within 810-meters.

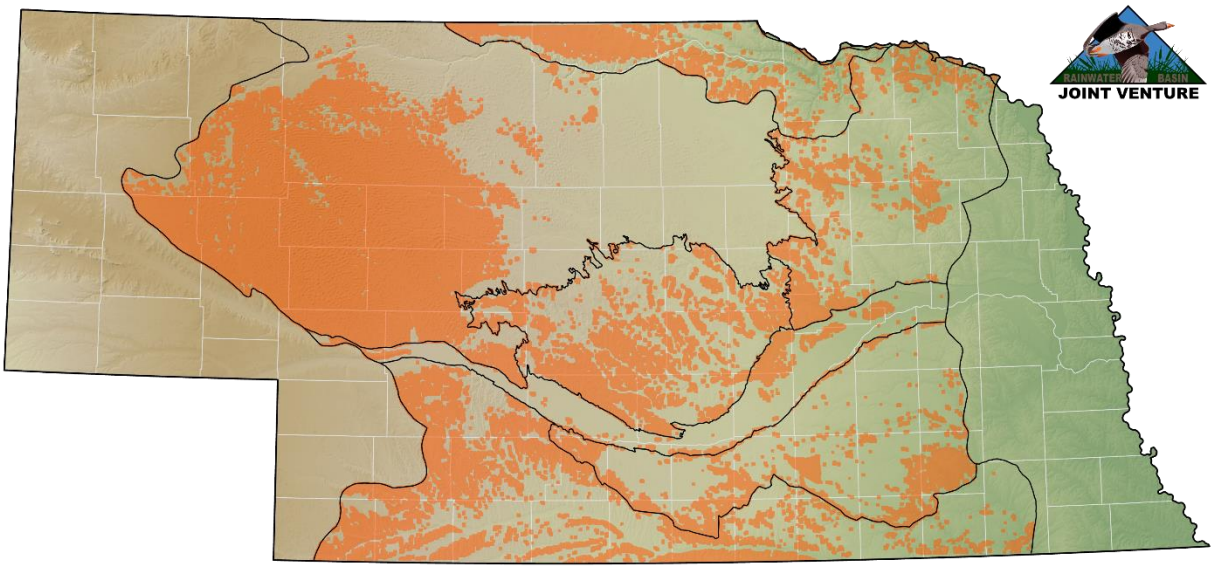


Figure 10. High density target areas (orange) within each Geographic Focus Area that support 50% of breeding Grasshopper Sparrows.

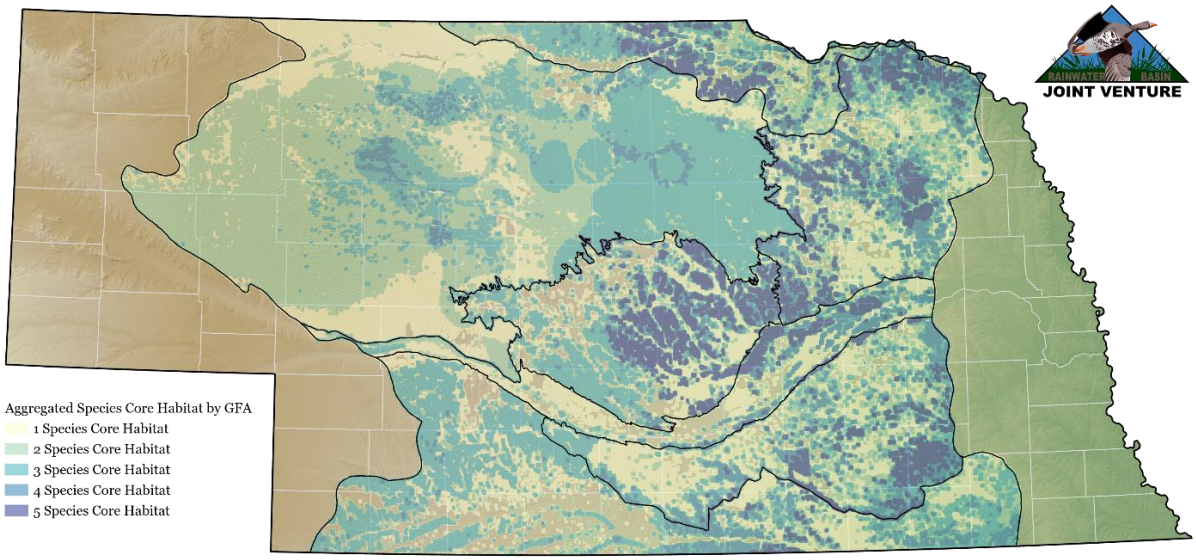


Figure 11. Aggregated core habitat for all modeled species; supporting 50% of the population within each GFA.

A grassland enhancement tool was developed to help target areas for tree removal and prescribed fire. A spatial application of woody encroachment into grassland was produced and used in conjunction with the management approach described in "Reducing Woody Encroachment in Grasslands: A Guide for Understanding Risk and Vulnerability" by Twidwell et al. (2021). In the guide, Twidwell et al. (2021) describe four stages of the woody encroachment process: Woodland Transition, Encroachment, Dispersal & Recruitment, and Intact Grasslands (Figure 12).

The Woodland Transition stage is composed of woodlands or shelterbelts which provide the initial seed source for further encroachment. The adjacent Encroachment stage also contains mature seed-bearing trees, but at a lower density than the Woodland Transition stage. The Dispersal & Recruitment stage consists of areas with incoming seed and/or areas experiencing encroachment by juvenile woody plants. The Intact Grassland stage represents treeless grassland without the threat of woody encroachment.

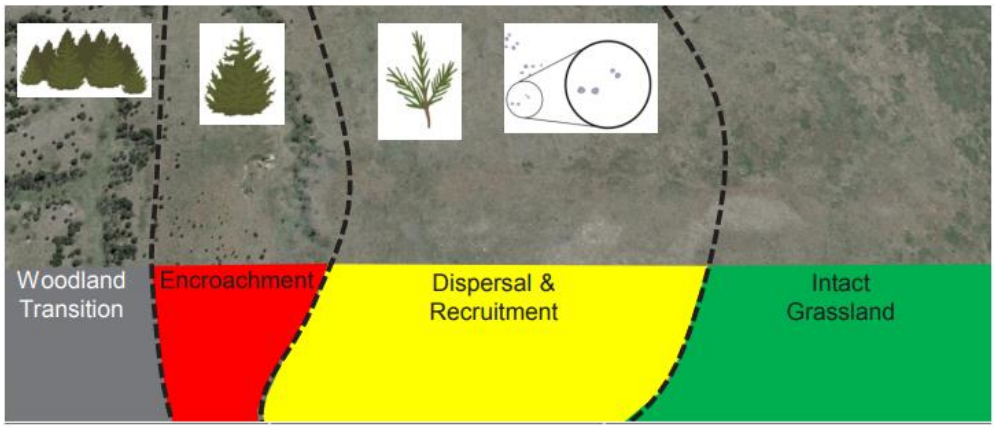


Figure 12. Stages of woody encroachment (Twidwell et al. 2020).

To effectively protect Intact Grassland, strategic management needs to target the Dispersal & Recruitment stages to prevent future seed contamination of Intact Grasslands (Twidwell and Fogarty

2020). A prioritization toolbox was produced to approximate each of these stages using geospatial data layers. The Woodland Transition stage can typically be picked up using remote sensing products. Combined tree classes from Ecological Mapping Systems of Nebraska (Diamond et al. 2021) and Trees Outside of Forests Image-based Inventory (TOFii, Kellerman et al. 2019) were used to delineate this stage.

Rangeland Analysis Platform's (Allred et al. 2021) percent tree canopy data for 2019 was used to delineate the Encroachment stage. It included areas where tree canopy was greater than or equal to the NRCS ultra-low density woodland designation of 3% for NRCS Practice 314 -Brush Management, Scenario #276 (NRCS 2021). The immature trees and seed-contaminated soil components of the Dispersal & Recruitment stage cannot be captured using imagery based remote sensing products. However, 90% of dispersal and recruitment occurs within 100-yards of seed sources (Twidwell et al. 2021). A 300-foot (100-yard) buffer was placed around Woodland Transitional and Encroachment areas to represent the Dispersal & Recruitment stage. Grassland outside of these areas was considered Intact Grasslands with respect to woody encroachment (Figure 13). Areas designated in the Encroachment and Dispersal & Recruitment stages were added to the prioritization toolbox for brush management (tree removal or prescribed fire).

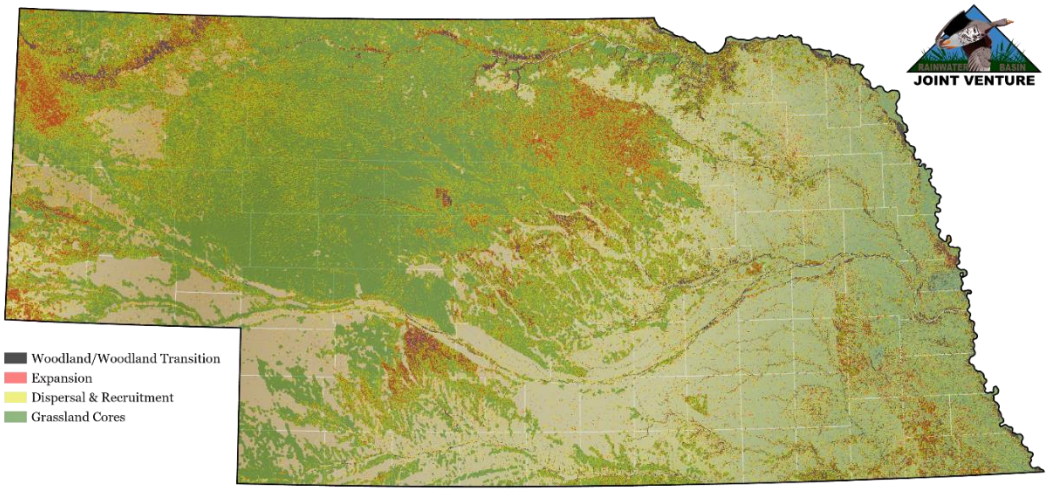


Figure 13. Stages of woody encroachment and grassland cores in Nebraska in based on 2019 data.

The first step in developing a conservation design tool is to define the objective by strategy. To illustrate this, two examples are provided below. In the first example, a tool will be developed to identify specific tracts of land in the Central Loess Hills for CRP grassland restoration. The CRP tool highlights tracts that are eligible for CRP enrollment and would benefit grassland species through grassland restoration.

Example: *Expanding Grassland Cores Through Grassland Restoration Using CRP*

Based on the species response curves to grassland (Figure 9), the CRP tool was developed to identify grasslands within GFAs where the greatest species response would occur. These are areas currently having moderate value for species (40-70% grassland composition) and changing them to high value grassland cores (>70% grassland composition). The criteria for identifying eligible tracts for CRP enrollment were tracts with at least 40 acres of cropland containing at least 25% highly erodible soils (Figure 14). Eligible CRP tracts were prioritized by subsetting tracts with between 40% and 70% grassland within 810-meters (Figure 15). This spatial query allows the RWBJV partners to develop marketing and outreach materials to engage landowners owning priority tracts. Marketing and

outreach materials can be customized to highlight the wildlife benefits of CRP enrollment to landowners and decision makers.

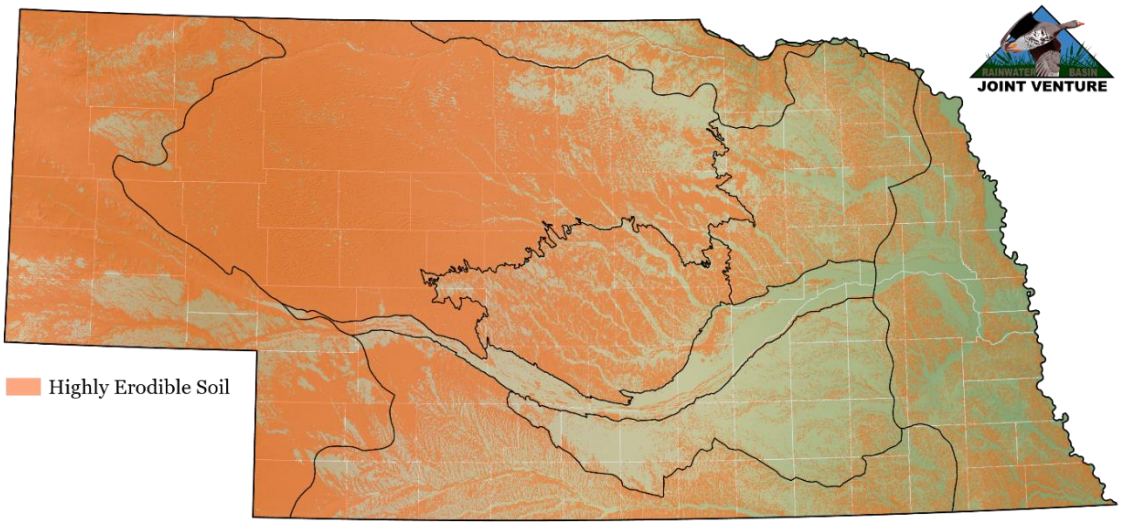


Figure 14. Highly erodible soils index using the Revised Universal Soil Loss Equation (RUSLE2).

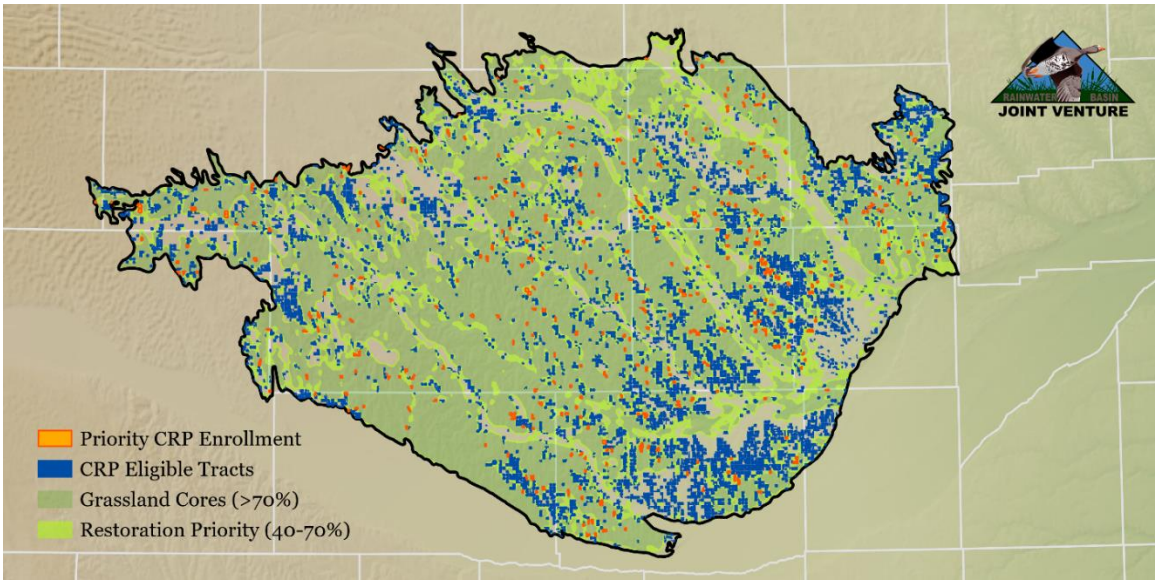


Figure 15. CRP eligible tracts containing 40 or more acres of cropland with 25% or more highly erodible soils (blue) and prioritized CRP enrollments (orange) that have the greatest grassland bird benefits within the Central Loess Hills GFA.

This simple prioritization, based on grassland core expansion, can provide better habitat for grassland birds. To demonstrate this, a comparison was made between current distribution of grassland CRP and a roughly equivalent random selection of prioritized enrollments—using the estimated individuals of Greater Prairie-Chickens (GRPC) and Grasshopper Sparrows (GRSP) impacted by each as a measure (Table 17).

There are significantly more acres in the prioritized tracts than the number of acres currently enrolled in CRP in the Central Loess Hills. Therefore, a subset of the prioritization tracts was selected. This selection had slightly fewer acres of CRP enrolled than the current distribution, 7,183 and 7,475 respectively. The

resulting number of GRPC impacted by prioritization increased from 985 to 1,110 individuals. Likewise, the current distribution of grassland CRP supports 1 GRSP per 6.22 acres. The restoration prioritization tool would increase the density of birds to 1 GRSP per 4.43 acres; a 40% increase.

Table 17. Comparison of impacted grassland birds using the current distribution of CRP and a random subset of prioritized CRP enrollment.

	Current Distribution of Grassland CRP	Subset of Prioritized CRP
Total Acres	7,475	7,183
Estimated # of GRPC	985	1,110
Estimated # of GRSP	1,202	1,621

Example: Reducing Grassland Vulnerability to Woody Encroachment with Integrated Management

This second example demonstrates reductions in management effort and cost using new scientific guidelines for implementing EQIP and other woody management programs (Twidwell et al. 2021, NRCS 2020). This strategy focuses on large-scale woody species management to reduce overall encroachment risk to a project area. This is accomplished by repeated treatments which reduce grassland exposure to sources of seed contamination.

The demonstration area (Calamus Block) consists of 42,000 acres of grassland habitat in the Sandhills GFA with 23 landowner/operators. Tree removal and prescribed fires were performed on several tracts from 2017-2020. Seventy-three percent of the area is encroached or at immediate risk of encroachment. Acreages are: Woodland/Woodland Transition, 622; Expansion, 5,937; and Dispersal & Recruitment, 24,039 (Figure 16).

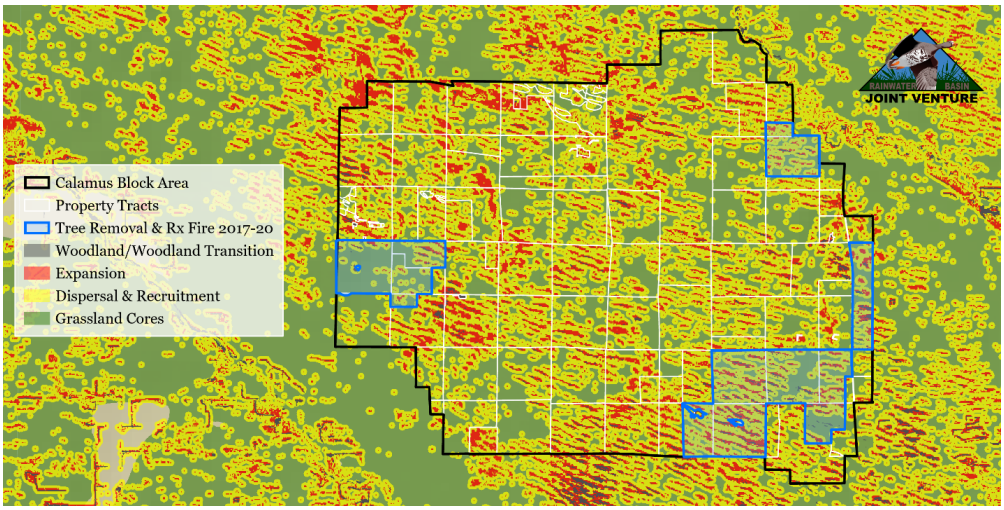


Figure 16. Calamus Block demonstration area.

Tree removal and fire were used on 5,231 acres during the four-year period. Figure 17A shows the distribution of woody invasion prior to treatments. After initial treatments (Figure 17B), mature trees have been removed; but seedlings and seeds left behind create a high risk of re-encroachment unless follow-up treatments are implemented to deplete the seed bank that exists within the Dispersal & Recruitment stage. Once the seed bank is depleted only areas adjacent (within 100-200 m) to seed sources located on untreated tracts are at further risk of encroachment (Figure 17C). Achieving this final stage dramatically lowers long-term management costs compared to reactive management that only targets mature trees. Figure 17C shows the contrast between landscapes fully treated and landscapes left untreated over a period of time.

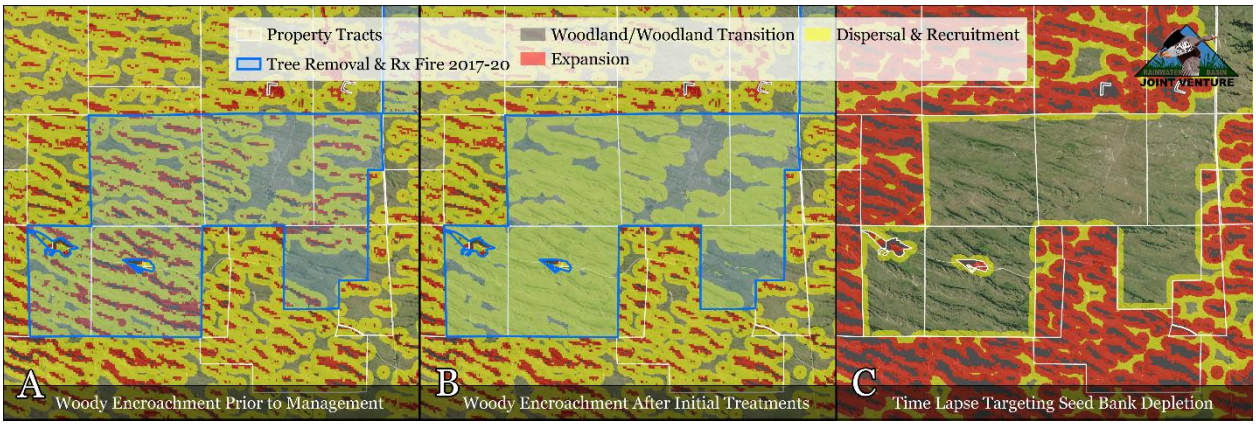


Figure 17. Woody encroachment prior to (A) and after initial treatment (B), with the objective of restoring Intact Grassland (C) through follow-up treatments. Tree expansion (outside the treated area) is expected to expand without management (C).

Table 18. Local-scale woody encroachment risk after treatment 2017-20 associated with Figure 18.

Encroachment stage	Acres Pre-treatment (A)	Acres Post-treatment (B)	Acres After Restoration (C)
Woodland/Woodland Transition	145	8	16
Expansion	461	7	16
Dispersal & Recruitment	1,716	2,306	384
Intact Grassland	597	597	2,503

Approximately 7.5 million acres of Nebraska grasslands are in the intact grassland stage and are at risk to encroachment; posing near-term threats to rangeland producers' profitability (D. Fogarty, unpubl. data). Therefore, Intact Grasslands can be more efficiently maintained by focusing restoration on large, compact areas to reduce the amount of land area in the Dispersal & Recruitment stage in relation to the Intact Grassland stage (Figure 18). This will require coordination and cooperation among adjacent landowners to deliver meaningful, long-lasting eastern red cedar management.

There is a gain in management efficiency by working with multiple landowners within a project area. Figure 18 shows the effect of focusing restoration on larger areas involving multiple landowners. If the entire Calamus Block was treated rather than just one owner, the risk of encroachment is reduced by 11%. If every landowner in the Calamus Block had participated in tree control, each acre treated in the

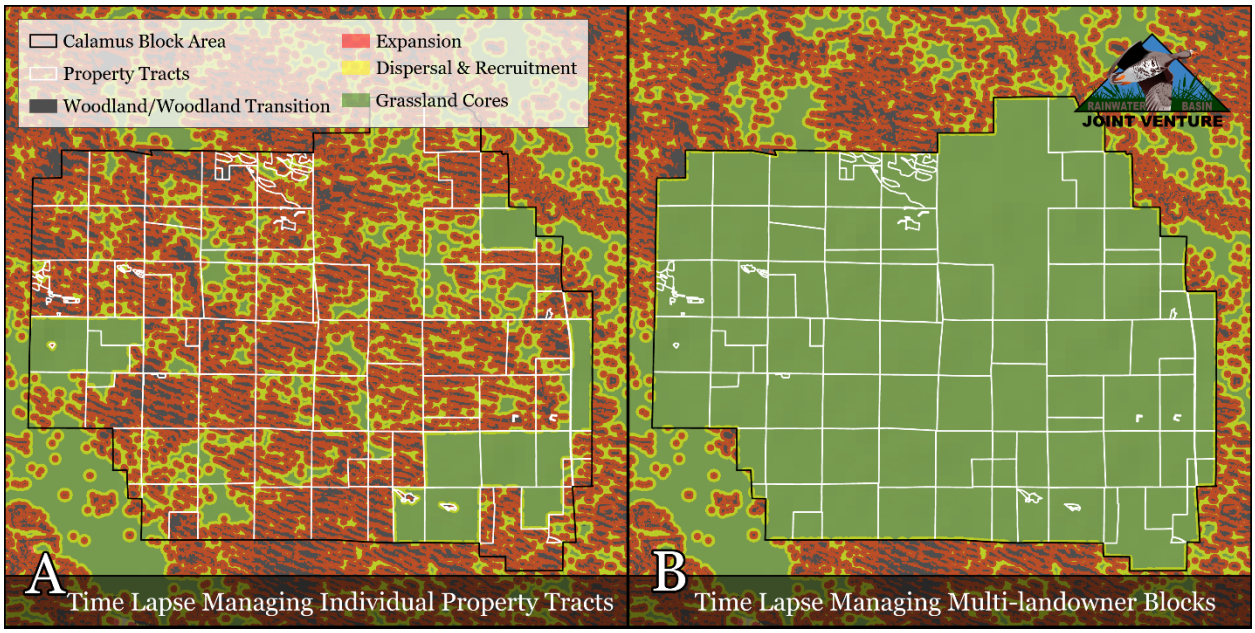


Figure 18. Restoration of Intact Grassland on individual properties (A) and restoration of large multi-property blocks (B).

Dispersal & Recruitment zones would defend 39 acres of grassland. In contrast, only 6 acres are defended when treatment occurs on small tracts. Table 19 shows the numerical differences.

Table 19. Difference in acreage and proportion of woody encroachment risk when delivered by landowner or multiple landowners within large compact areas.

	Single Ownership		Multiple Ownerships	
Encroachment stage	**Post-treatment Within Treated Area Acres**	**Proportion of Treatment Area**	**Block Post-treatment Acres**	**Proportion of Block Treatment Area**
Dispersal & Recruitment	720	13.77%	1,043	2.48%
Intact Grasslands	4,511	86.23%	40,984	97.52%

Management Prioritization Maximizing Wildlife Benefit

The benefit of species-driven conservation prioritization is given below using the Central Loess Hills GFA. The approach was to compare the number of GRPC on EQIP prescribed burn and mechanical tree removal from 2017-2019 with the GRPC population if treatment was targeted for optimum GRPC numbers (Figure 19).

CLU or ownership boundaries with a mean canopy of at least 1% were used as management units. This was mapped using Rangeland Analysis Platform developed by the University of Montana (2018, Figure 20). An approximate number of treatment acres were randomly selected from CLUs located in the upper 50% GRPC prioritization area (Figure 21).

The actual acres treated through EQIP were 21,728 acres of mechanical removal and 11,265 acres of prescribed fire. Under this hypothetical delivery, slightly fewer acres were treated (18,785 and 10,834 acres, respectively); but the number of GRPC impacted increased from 107 to 172 with tree removal, and from 54 to 95 individuals with prescribed fire. The mean percent canopy for the management units decreased from 6.5% to 3.2% under the GRPC prioritized management scenario. This supports the idea

that it may be more impactful to protect and manage intact grasslands rather than areas already experiencing encroachment. Targeting areas based on current wildlife use is more likely to sustain wildlife benefits long-term.

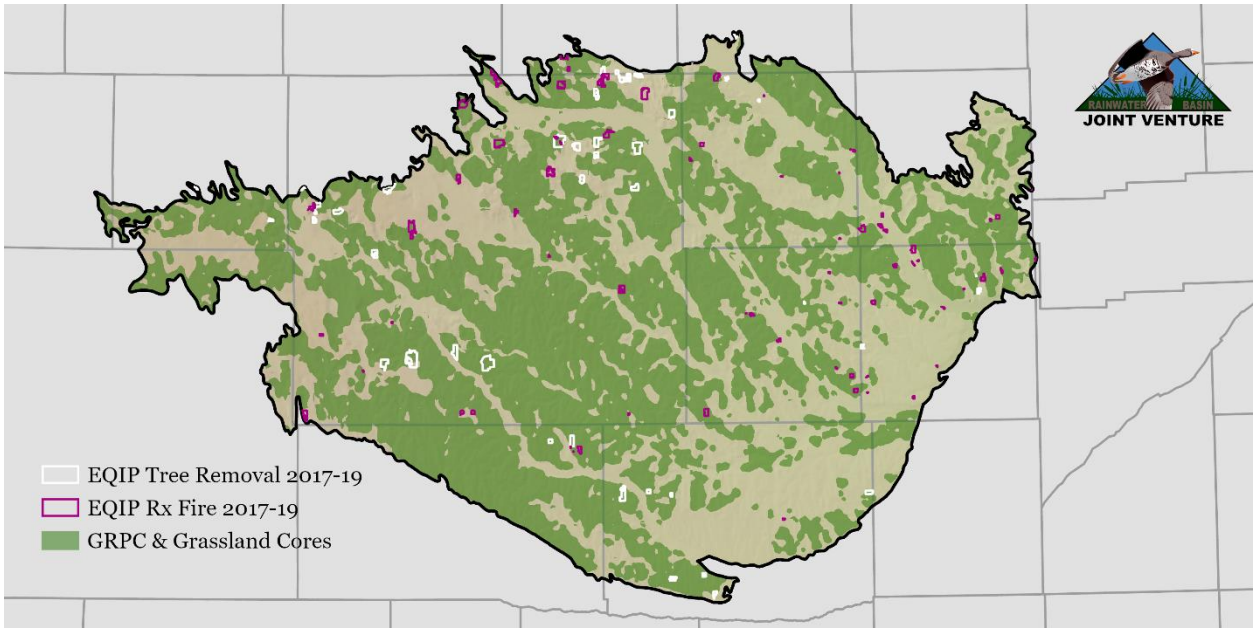


Figure 19. EQIP prescribed fire and tree removals applied 2017-19 for the Central Loess Hills GFA.

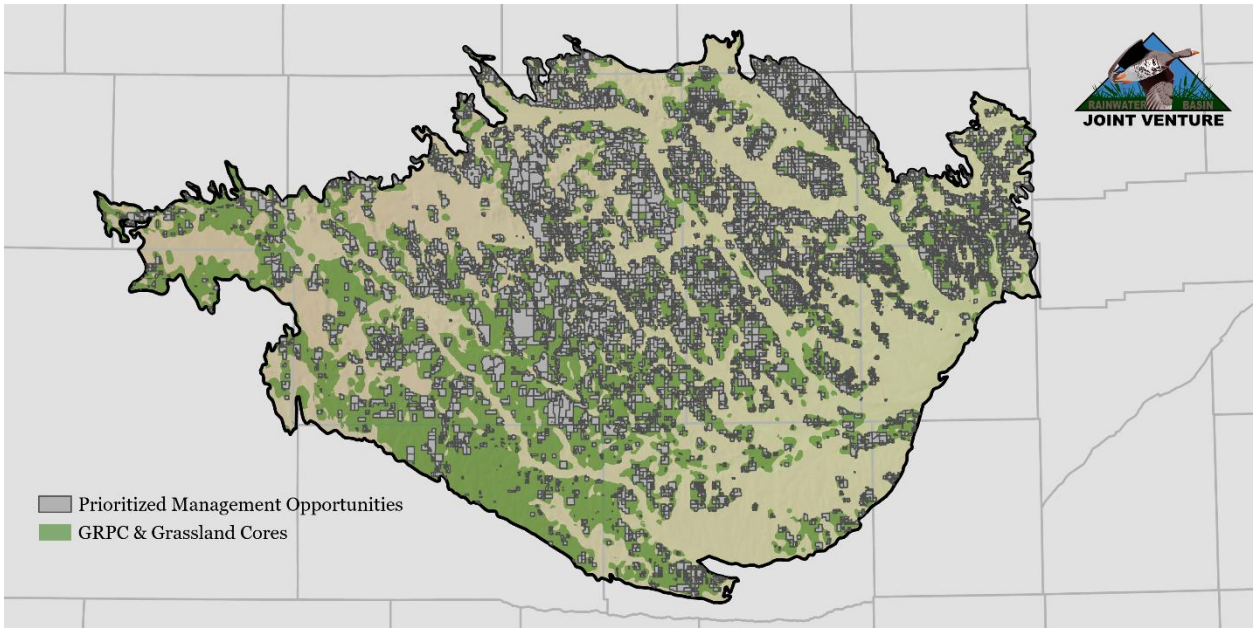


Figure 20. Central Loess Hills GFA brush management and prescribed fire opportunities prioritized by GRPC habitat cores.

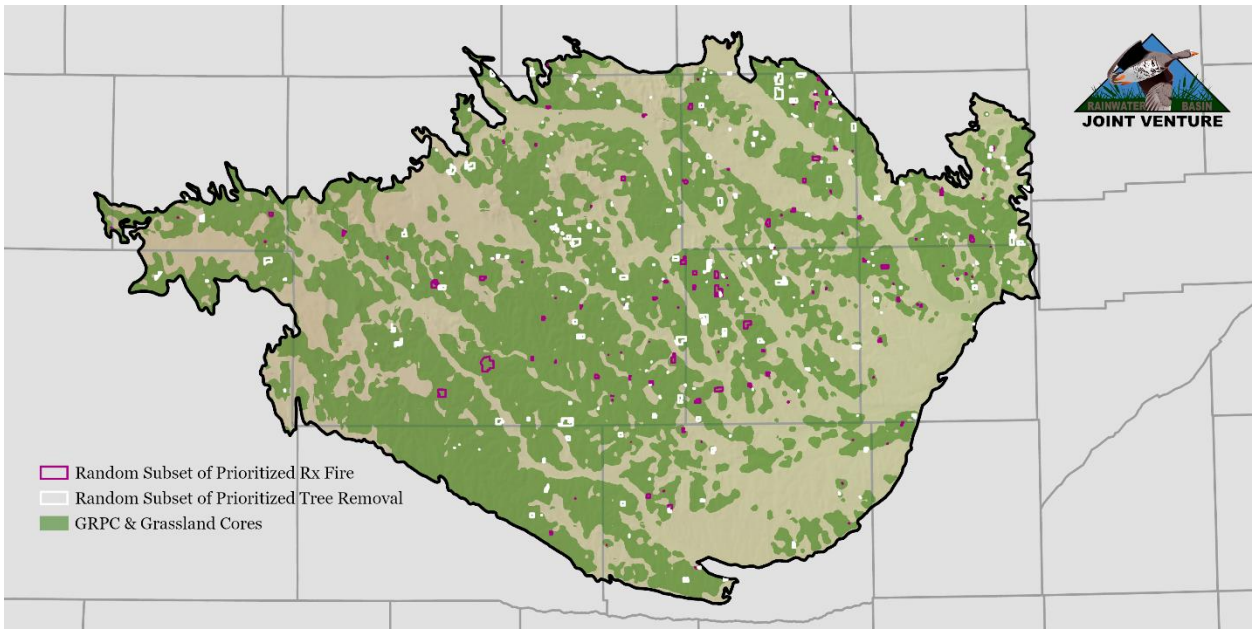


Figure 21. Random subsets of priority areas equivalent to area managed from 2017-19.

Research and Monitoring

The success of the SHC process requires outcome-based monitoring which allows for the constant refinement of conservation delivery actions. The RWBJV intends to monitor progress towards established population objectives using updates from PIF Population Estimates Database, eBird relative abundance data and BBS trends. By taking advantage of these existing bird monitoring programs, the expense of developing a new program from the ground up can be avoided. Ongoing research can also be used to confirm the validity of assumptions made during the planning and design steps. Most of these evaluation needs have already been outlined in our RWBJV Research, Inventory, and Monitoring Plan that was completed in 2015. The status of each research issue for landbirds in the 2015 plan can be found in Appendix 5, along with new issues that have since been identified.

Conclusions

- The RWBJV Region contains critical habitat that supports over 60 million native breeding landbird individuals of 132 species.
- The highest priority species in the RWBJV Region are Dickcissel, Eastern Meadowlark, Grasshopper Sparrow, Greater Prairie-Chicken, Northern Bobwhite, Ring-necked Pheasant, Red-headed Woodpecker, Western Meadowlark.
- The most impactful actionable threats to priority species in the RWBJV Region are conversion of grasslands to agriculture and invasive woody encroachment.
- Grassland acres will need to be maintained, protected, and restored to meet the habitat needs of breeding landbirds at objective populations.
- The cost to achieve population and habitat objectives on a 30-year timeline is estimated to be as high as $40 million per year.
- Decision support tools can and should be developed to increase the impact of conservation efforts.

Citations

Allred, B. W., Bestelmeyer, B. T., Boyd, C. S., Brown, C., Davies, K. W., Duniway, M. C., ... & Uden, D. R. 2021. Improving Landsat predictions of rangeland fractional cover with multitask learning and uncertainty. Methods in Ecology and Evolution 12:841-849.

Askins, R.A., F. Chavez-Ramirez, B.C. Dale, C.A. Haas, J.R. Herkert, F.L. Knopf, and P.D. Vickery. 2007. Conservation of grassland birds in North America: understanding ecological processes in different regions. Ornithological Monographs No. 64.

Austin, J.E., and A.L. Richert. 2001. A comprehensive review of the observational and site evaluation data of migrant Whooping Cranes in the United States, 1943–99. U.S. Geological Survey, Northern Prairie Wildlife Research Center, Jamestown, North Dakota, and State Museum, University of Nebraska-Lincoln, Lincoln, Nebraska, USA.

Bateman, B.L., L. Taylor, C. Wilsey, J. Wu, G.S. LeBaron, and G. Langham. 2020. Risk to North American birds from climate change-related threats. Conservation Science and Practice, 2(8), p.e243.

Bathke D.J., R.J. Oglesby, C.M. Rowe, and D.A. Whilhite. 2014. Understanding and assessing climate change: implications for Nebraska. A synthesis report to support decision making and natural resource management in a changing climate. School of Natural Resources, Institute of Agriculture and Natural Resources. University of Nebraska – Lincoln, Lincoln, p 73.

Bishop, A., R. Grosse, A. Barenberg, N. Volpe, and J. Reins. 2020. Nebraska Land Cover (2016 edition). Rainwater Basin Joint Venture. Grand Island, Nebraska, USA.

Brown, S.B., C. Hickey, B. Harrington, and R. Gill (Eds.). 2001. United States shorebird conservation plan. Manomet Center for Conservation Sciences, Manomet, Massachusetts, USA.

Bellrose, F.C. 1980. Ducks, geese, and swans of North America. Stackpole, Harrisburg, Pennsylvania, USA.

Bentall, R. 1990. Streams. Pages 93–114 in A. Bleed and C. Flowerday, Eds. Atlas of the Sand Hills. Resource Atlas No. 5a. Conservation and Survey Division, University Nebraska, Lincoln, Nebraska, USA.

Birdlife International. 2018. http://www.birdlife.org

Bishop, A.A. and M. Vrtiska. 2008. Effects of the Wetlands Reserve Program on waterfowl carrying capacity in the Rainwater Basin region of south-central Nebraska. U.S. Fish and Wildlife Service, Grand Island, Nebraska, USA.

Caven A.J., E.M. Brinley Buckley, K.C. King, J.D. Wiese, D.M. Baasch, G.D. Wright, M.J. Harner, A.T. Pearse, M. Rabbe, D.M. Varner, B. Krohn, N. Arcilla, K.D. Schroeder, and K.F. Dinan. 2019. Temporospatial shifts in Sandhill Crane staging in the Central Platte River Valley in response to climatic variation and habitat change. Monogr. West N. Am. Nat., 11 (2019), p. 32

Caven, A.J., D.M. Varner, and J. Drahota. 2020. Sandhill Crane abundance in Nebraska during spring migration: making sense of multiple data points. Transactions of the Nebraska Academy of Sciences, 40 (2020), pp. 6-18

Condra, G.E. 1939. An outline of the principal natural resources of Nebraska and their conservation. University of Nebraska Conservation and Survey Division Bulletin No. 20.

Conrey, R.Y., S.K. Skagen, A.A. Yackel Adams, and A.O. Panjabi. 2016. Extremes of heat, drought and precipitation depress reproductive performance in shortgrass prairie passerines. Ibis 158:614-629.

Conservation Measures Partnership. 2016. CMP Direct Threats Classification v 2.0.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, FWS/OBS/-79/31, Washington, D.C., USA.

Diamond, D., L.F. Elliot, G. Steinauer, K. Kindscher, P. Hanberry, C.D. True, and M. Sunde. 2021. Ecological Mapping Systems of Nebraska.

Dimmick, R. W., M. J. Gudlin, and D. F. McKenzie. 2002. The northern bobwhite conservation initiative. Miscellaneous publication of the Southeastern Association of Fish and Wildlife Agencies, South Carolina, USA.

Donaldson, G.M., C. Hyslop, R.I.G. Morrison, H.L. Dickson, and I. Davidson. 2000. Canadian shorebird conservation plan. Canadian Wildlife Service, Environment Canada, Ottawa, Ontario, Canada.

Fields, S. and K. Barnes. 2019. Grassland Assessment of North American Great Plains Migratory Bird Joint Ventures. Prairie Pothole Joint Venture. Great Falls, Montana.

Fink, D., T. Auer, A. Johnston, M. Strimas-Mackey, O. Robinson, S. Ligocki, B. Petersen, C. Wood, I. Davies, B. Sullivan, M. Iliff, and S. Kelling. 2020. eBird Status and Trends, Data Version: 2018; Released: 2020. Cornell Lab of Ornithology, Ithaca, New York. https://doi.org/10.2173/ebirdst.2018

Fromberger, M., A, Campomizzi, Z. Lebrun-Southcott, A. Pintaric, N. MacDonald, and E. Nol. 2020. Factors affecting Bobolink nest survival across grassland types. Avian Conservation and Ecology 15:13.

Frost, J.S. and L.A. Powell. 2011. Cedar infestation impacts avian communities along the Niobrara River Valley, Nebraska. Restoration Ecology 19:529-536.

Gersib, R.A., B. Elder, K.F. Dinan, and T.H. Hupf. 1989. Waterfowl values by wetland type within Rainwater Basin wetlands with special emphasis on activity time budget and census data. Nebraska Game and Parks Commission and U.S. Fish and Wildlife Service, Lincoln, Nebraska, USA.

Gersib, R.A. 1991. Nebraska wetlands priority plan. Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

Grace, J.B. and J.S. Harrison. 1986. The Biology of Canadian Weeds: Typha latifolia L., T. angustifolia L. and T. x glauca Gord. Canadian Journal of Plant Science 66:361–379.

Grosse, R.C., N.D. Niemuth, T.L. Shaffer, and A.A. Bishop. 2012. Landscape-level habitat use by trumpeter swans in the Sandhills of Nebraska and South Dakota. Twenty second Trumpeter Swan Society Conference. Polson, Montana, USA.

gSSURGO: Gridded Soil Survey Geographic Database for Nebraska. United States Department of Agriculture, Natural Resources Conservation Service. Available online at http://datagateway.nrcs.usda.gov/. March 3, 2020 (201912 official release).

Hasson F., S. Keeney, and H. P. Mckenna. 2000. Research guidelines for the Delphi Survey Technique. Journal of Advanced Nursing 32(4):1008-1015.

Jenkins, C.N., S.L. Pimm, and L.N. Joppa. 2013. Global Patterns of Terrestrial Vertebrate Diversity and Conservation. PNAS 110(28): E2602-E2610.

Kaul, R.B., D. Sutherland, and S. Rolfsmeier. 2006. The flora of Nebraska. School of Natural Resources, University of Nebraska-Lincoln, Lincoln, Nebraska, USA.

Keech, C.F. and R. Bentall. 1971. Dunes of the plains. Conservation and Survey Division Resource Report No. 4, University of Nebraska-Lincoln, Lincoln, Nebraska, USA.

Kushlan, J.A., M.J. Steinkamp, K. Parsons, J. Capp, M.A. Cruz, M. Coulter, I. Davison, L. Dickson, N. Edelson, R. Elliott, R.M. Ervin, 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, Version 1. North America Waterbird Conservation Initiative, Washington, D.C., USA.

LaGrange, T.G. 2005. A guide to Nebraska's wetlands and their conservation needs. Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

LaGrange, T.G., R. Stutheit, M. Gilbert, D. Shurtliff, and P.M. Whited. 2011. Sedimentation of Nebraska's playa wetlands: a review of current knowledge and issues. Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

Lark, T.J., I.H. Schelly, and H.K. Gibbs. 2021. Accuracy, Bias, and Improvements in Mapping Crops and Cropland across the United States Using the USDA Cropland Data Layer. Remote Sensing, 13(5), p.968.

Lark, T.J., S.A. Spawn, M. Bougie, and H.K. Gibbs. 2020. Cropland expansion in the United States produces marginal yields at high costs to wildlife. Nature communications 11:1-11.

Li, Y., R. Miao, and M. Khanna. 2020. Neonicotinoids and decline in bird biodiversity in the United States. Nature Sustainability 3:1027-1035.

McMurtrey, M.D., R. Craig, and G. Schildman. 1972. Nebraska wetland survey. Habitat Work Plan K71, Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

Murphy, M.T. 2003. Avian population trends within the evolving agriculture landscape of eastern and central United States. Auk 120:20–34.

Murphy, P.J., T.J. Randle, L.M. Fotherby, and J.A. Daraio. 2004. The Platte River channel: history and restoration. Bureau of Reclamation Technical Service Center. Denver, Colorado, USA.

National Agricultural Statistics Service. 2019. Cropland Data Layer. United States Department of Agriculture. Available online at https://nassgeodata.gmu.edu/CropScape/ Accessed March 13, 2020.

National Agricultural Statistics Service. Cropland Data Layer of Nebraska 2020. United States Department of Agriculture. 20210201 release. Available online at https://nassgeodata.gmu.edu/CropScape/

National Ecological Assessment Team. 2006. Strategic Habitat Conservation handbook: a report from the National Ecological Assessment Team—29 June 2006. U.S. Fish and Wildlife Service, Arlington, Virginia, USA, and U.S. Geological Survey Reston, Virginia, USA.

Natural Resource Conservation Service Soil Survey Staff. Gridded Soil Survey Geographic Database for Nebraska. United States Department of Agriculture, Natural Resources Conservation Service. Available online at http://datagateway.nrcs.usda.gov/. March 3, 2020 (201912 official release).

Natural Resources Conservation Service. 2020. Gridded Soil Survey Geographic (gSSURGO) Database for Nebraska. United States Department of Agriculture. Available online at https://gdg.sc.egov.usda.gov/ Accessed March 11, 2020.

North American Bird Conservation Initiative. 1999. Bird Conservation Regions. www.nabcius.org/bcrs.htm

Owensby, C. E., Blan, K. R., Eaton, B. J., & Russ, O. G. (1973). Evaluation of eastern redcedar infestations in the northern Kansas Flint Hills. Rangeland Ecology & Management/Journal of Range Management Archives, 26(4), 256-260.

Partners in Flight. 2020. Population Estimates Database, version 3.1. Available at http://pif.birdconservancy.org/PopEstimates. Accessed on September 27, 2021.

Pashley, D.N., C.J. Beardmore, J.A. Fitzgerald, R.P. Ford, W.C. Hunter, M.S. Morrison, and K.V. Rosenberg. 2000. Partners in Flight: conservation of the land birds of the United States. American Bird Conservancy. 92 pp.

Pauley, N.M., M.J. Harner, E.M. Brinley Buckley, P.R. Burger, and K. Geluso. 2018. Spatial analysis of borrow pits along the Platte River in south-central Nebraska, USA, in 1957 and 2016. Transactions of the Nebraska Academy of Sciences 38:36-46.

Peterjohn, B.G. 2003. Agricultural landscapes: can they support healthy bird populations as well as farm products? Auk 120:14–19.

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, and T.C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Laboratory of Ornithology, Ithaca, New York, USA.

Rolfsmeier, S.B. and G. Steinauer. 2010. Terrestrial ecological systems and natural communities of Nebraska, version IV. Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

Rosenberg, K.V., Dokter, A.M., Blancher, P.J., Sauer, J.R., Smith, A.C., Smith, P.A., Stanton, J.C., Panjabi, A., Helft, L., Parr, M. and Marra, P.P., 2019. Decline of the North American avifauna. Science, 366(6461), pp.120-124.

Rosenberg K.V., J. A. Kennedy, R. Dettmers, R. P. Ford, D. Reynolds, J.D. Alexander, C. J. Beardmore, P. J. Blancher, R. E.Bogart, G. S. Butcher, A. F. Camfield, A. Couturier, D. W. Demarest, W. E. Easton, J.J. Giocomo, R.H. Keller, A. E. Mini, A. O. Panjabi, D. N. Pashley, T. D. Rich, J. M. Ruth, H. Stabins, J. Stanton, T. Will. 2016. Partners in Flight Landbird Conservation Plan: 2016 Revision for Canada and Continental United States. Partners in Flight Science Committee. 119 pp.

Ryan, M.R., R.A. Pierce, K.M. Suedkamp-Wells, and C.K. Kerns. 2006. Assessing bird population responses to grazing. Pages 8-24 in W. Hohman (editor). Migratory bird responses to grazing. United States Department of Agriculture, Washington, DC. Natural Resources Conservation Service, Technical Report 190-54

Salafsky, N., D. Salzer, A. J. Stattersfield, C. Hilton-taylor, S. H. M. Butchart, B. Collen, N. Cox, L. L. Master, O. Connor, D. Wilkie, R. Neugarten, S. H. M. Butchart, B. E. N. Collen, and N. Cox. 2008. A standard lexicon for biodiversity conservation: Unified classifications of threats and actions. Conservation Biology 22:897–911.

Schildman, G. and J. Hurt. 1984. Update of Rainwater Basin wetland survey. Survey of habitat work plan K-83, W-15-R-40. Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

Ryan, M.R., R A. Pierce, K.M. Suedkamp-Wells, and C.K. Kerns. 2006. Assessing bird population responses to grazing. Pages 8-24 in W. Hohman (editor). Migratory bird responses to grazing. United

States Department of Agriculture, Washington, DC. Natural Resources Conservation Service, Technical Report 190-54

Sauer, J. R., D. K. Niven, J. E. Hines, D. J. Ziolkowski, Jr, K. L. Pardieck, J. E. Fallon, and W. A. Link. 2017. The North American Breeding Bird Survey, Results and Analysis 1966 - 2015. Version 2.07.2017 USGS Patuxent Wildlife Research Center, Laurel, MD

Sidle, J. G., E. D. Miller, and P. J. Currier. 1989. Changing habitats in the Platte River valley of Nebraska. Prairie Naturalist 21:91–104.

Smith, G.A. and M.V. Lomolino. 2004. Black-tailed prairie dogs and the structure of avian communities on the shortgrass plains. Oecologia 138:592–602.

Stanton, J. C., P. Blancher, K. V. Rosenberg, A. O. Panjabi, and W. E. Thogmartin (2019). Estimating uncertainty of North American landbird population sizes. Avian Conservation and Ecology 14(1):4.

Stanton, R.L., Morrissey, C.A. and Clark, R.G., 2018. Analysis of trends and agricultural drivers of farmland bird declines in North America: A review. Agriculture, Ecosystems & Environment, 254, pp.244-254.

Twidwell, D., D.T. Fogarty, and J.R. Weir. 2021. Reducing woody plant encroachment in grasslands: A guide for understanding risk and vulnerability. Oklahoma State University Cooperative Extension Service, E-1054.

U. S. Fish and Wildlife Service. 2008. Strategic habitat conservation handbook: a guide to implementing the technical elements of strategic habitat conservation, version 1.0. U.S. Fish and Wildlife Service, Arlington, Virginia, USA.

U. S. Fish and Wildlife Service. 2020. National Wetlands Inventory. U.S. Department of the Interior, Fish and Wildlife Service. http://www.fws.gov/wetlands/ Accessed March 24, 2020.

United States Fish and Wildlife Service and Canadian Wildlife Service - North American Waterfowl Management Plan Committee. 1986. North American Waterfowl Management Plan. U.S. Fish and Wildlife Service, Washington, D.C., USA and Ottawa, Canada.

University of Montana. 2018. Rangeland Analysis Platform. Available online at https://rangelands.app/ Accessed March 13, 2020.

Will, T., Stanton, J.C., Rosenberg, K.V., Panjabi, A.O., Camfield, A., Shaw, A., Thogmartin, W.E., Blancher, P.J., Will, T., Stanton, J.C. and Rosenberg, K.V. 2019. Handbook to the Partners in Flight Population Estimates Database, Version 3.0.

Appendixes

Appendix 1. Species Account

The information in this appendix can be used to plan and design conservation activities for 23 priority species.

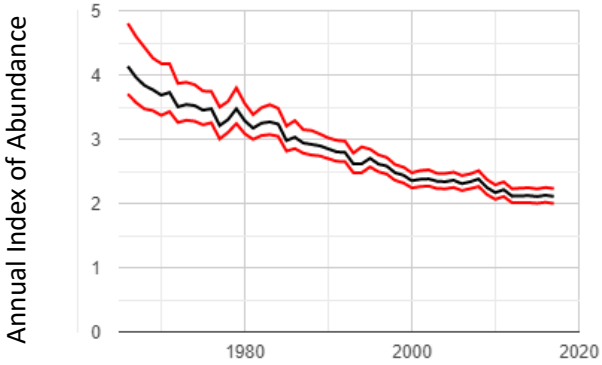
- The **Rationale** section lists factors that influenced the decision in selecting each priority species. For most species, this includes graphs that depict survey-wide, BCR-level, or state-level declines in the Breeding Bird Survey Annual Index of Abundance from 1966-2017. Positive or flat trends are not included.
- The **Distribution** map shows the relative abundance of each species within the RWBJV Region based on eBird data collected between 2014 and 2018 (Fink et al. 2020). Except for non-migrating species and short-eared owls, distribution during the breeding season is shown.
- **Breeding Habitat** includes a brief description of the habitat characteristics associated with higher recruitment rates.
- The **Population Status** map shows estimates for annual percent change in population based on Breeding Bird Survey data collected from 1966-2015 (Sauer et al. 2017).
- The **Threats** section lists the primary factors limiting population recovery or growth within the RWBJV Region.
- Specific **Management Actions** that would be expected to positively impact each species are listed.
- **Information Needs** describes research questions that, if answered, would help improve the effectiveness and/or efficiency of conservation efforts targeted towards each species.

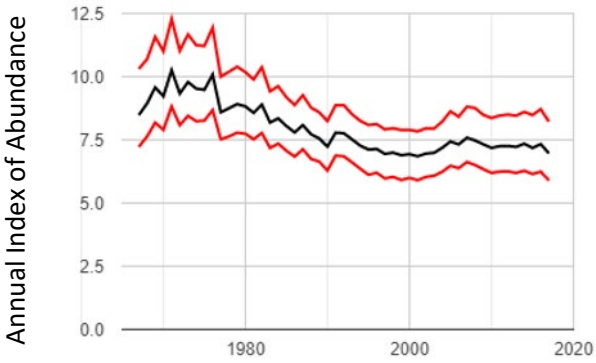
BALTIMORE ORIOLE

(*Icterus galbula*); Stewardship Species

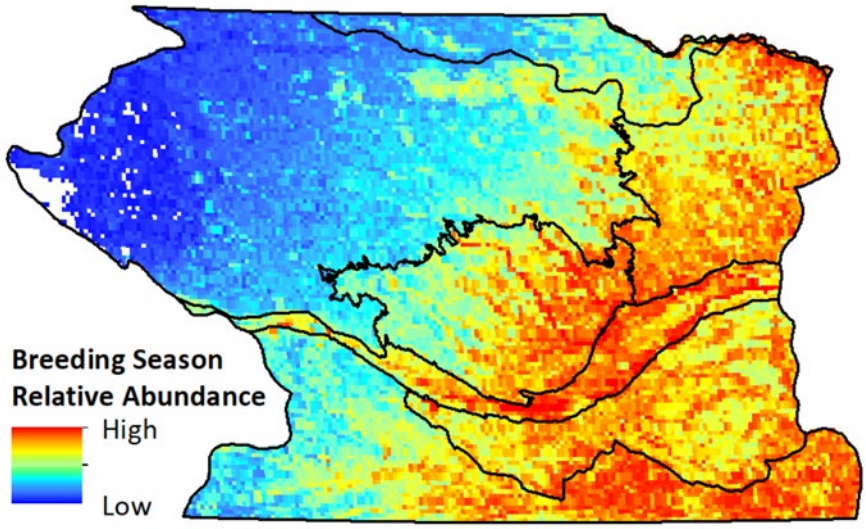
Rationale:

- Population change of -42% from 1970-2014,
- Partners in Flight Species of Regional Concern in BCR 19, and
- Negative BBS trends both survey-wide (left) and in BCR 19 (right)





Distribution

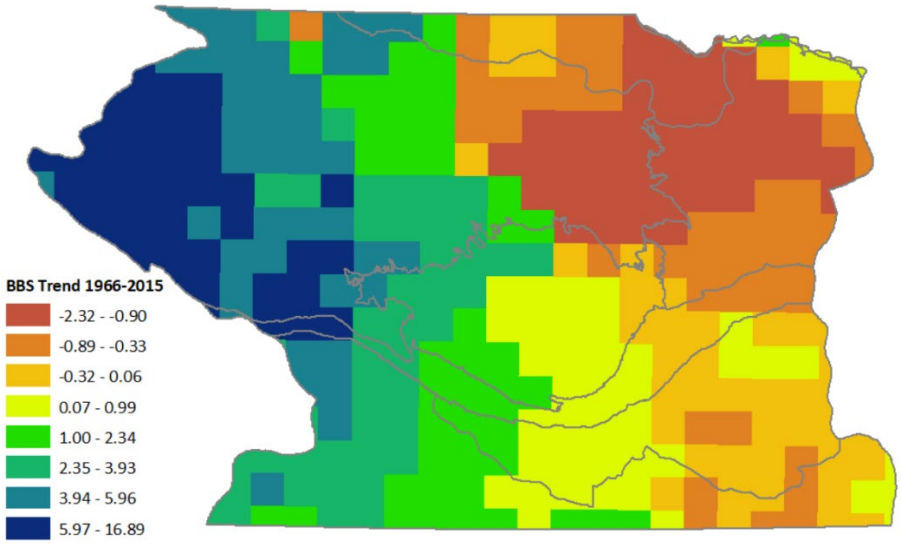


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding Habitat:

- Typically favors woodland edge (especially riparian) and open areas with scattered trees,
- Strong preference for deciduous woodlands. In eastern Great Plains: in open deciduous woodlands, parklands, and wooded urban areas. In western Great Plains: generally found in cottonwoods along streams, in shelterbelts, and in towns.

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Habitat loss/Degradation loss and removal of mature trees in woodlots and along riparian corridors,
- Grazing generally decreases understory vegetation, may increase Brown-headed Cowbird parasitism, and can alter or eliminate riparian habitats by changing channels or lowering water table, and
- Brown-headed Cowbird brood parasitism may affect local populations.

Management actions:

- Maintenance of treed parks or preservation of other small groves of shade trees in urban and suburban areas helps ensure a broad breeding distribution.

Information needs:

- The effects of pesticide use and unseasonably cold or wet summer weather on nesting populations need quantification,
- Potential impacts of cowbird parasitism, and
- Develop regional habitat model considering tree basal area within woodland restorations to savanna habitats.

Links to more info

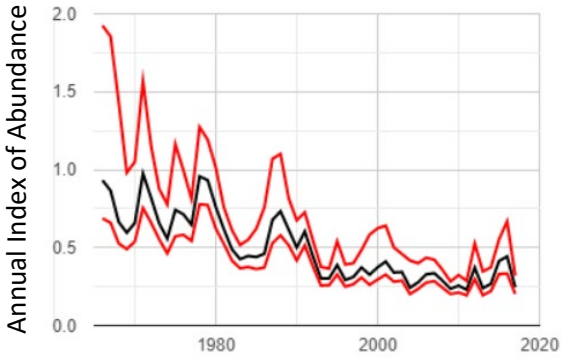
Rising, J. D. and N. J. Flood (2020). Baltimore Oriole (Icterus galbula), version 1.0. In Birds of the World (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.balori.01

BLACK-BILLED CUCKOO

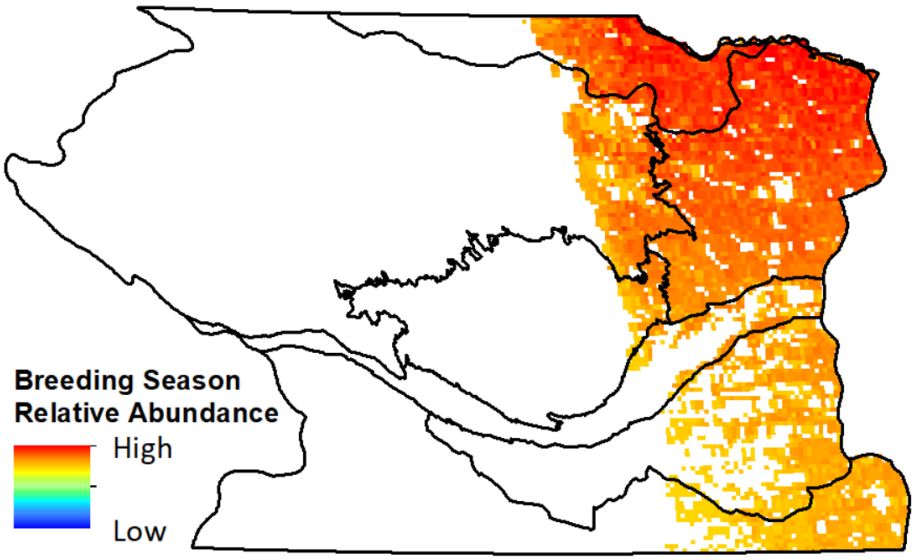
(*Coccyzus erythropthalmus*); Stewardship Species

Rationale:

- Population change of -68% from 1970-2014,
- Expected to lose 50% of current population within 37 years,
- Partners in Flight Yellow Watchlist Species,
- Partners in Flight Species of Regional Concern in BCR 19,
- Tier I species of greatest conservation need in Nebraska State Wildlife Action Plan, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)



Distribution



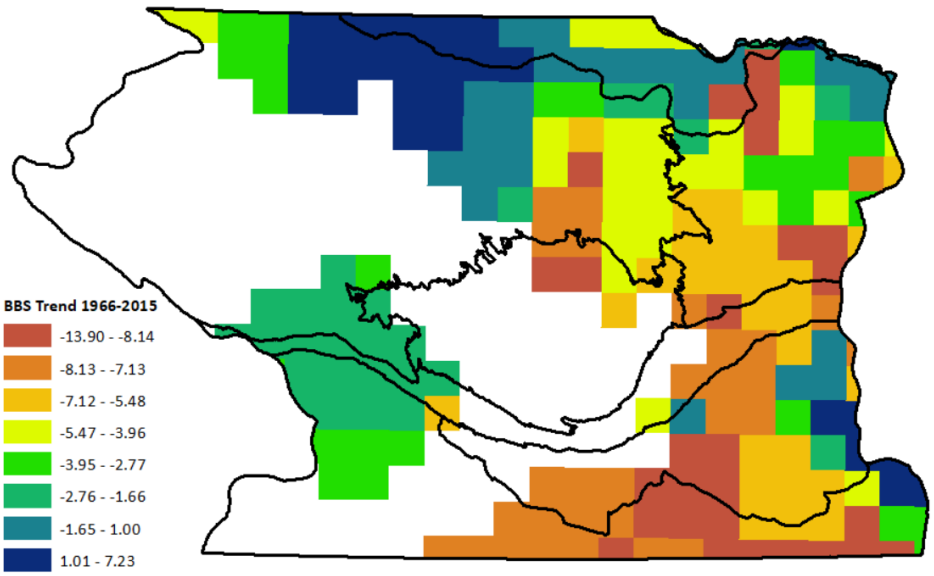
Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Groves of trees, forest edges, thickets and other dense wooded habitats.

- Frequently associated with water/mesic environments, such as young deciduous and mixed deciduous-coniferous woods, the edges of bogs and marshes, rivers and lakeshores, abandoned farmlands or brushy hillsides and pastures.

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Habitat Loss/Degradation: reduced understory cover and density,
- Destruction or modification of preferred habitat due to agricultural and grazing activities
- Conversion of habitat to cropland, and
- Conversion of woody cover to invasive nonnative vegetation, such as salt cedar

Management actions:

- Preservation of existing riparian forest fragments via acquisition, conservation easements or incentives, and
- Restoration of riparian forest to improve connectivity of fragments and/or increase fragment size

Information needs:

- Identification of high-quality habitats and landscapes for breeding and migration in the RWBJV Region, and
- Identification of the scale of breeding and natal dispersal and describing linkages between wintering and breeding populations

Links to more info

Environmental Conservation Online System (ECOS) 2020. Species Account for Black-billed Cuckoo (*Coccyzus erythropthalmus*). https://ecos.fws.gov/ecp/species/9399

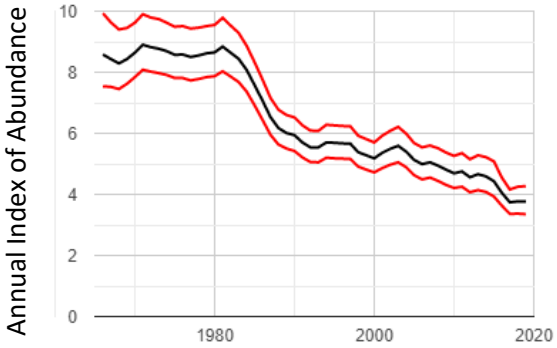
Hughes, J.M. (2020). Black-billed Cuckoo (*Coccyzus erythropthalmus*), version 1.0. In Birds of the World (P.G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.bkbcuc.01

BOBOLINK

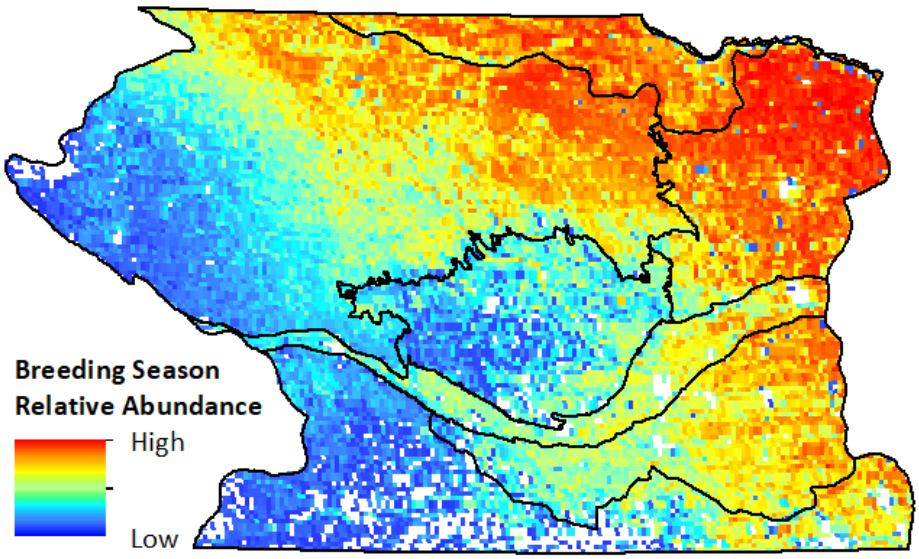
(*Dolichonyx oryzivorus*); Stewardship Species

Rationale:

- Population change of -60% from 1970-2014,
- Expected to lose 50% of current population within 48 years,
- Partners in Flight Yellow Watchlist Species, and
- Negative BBS trend survey-wide



Distribution

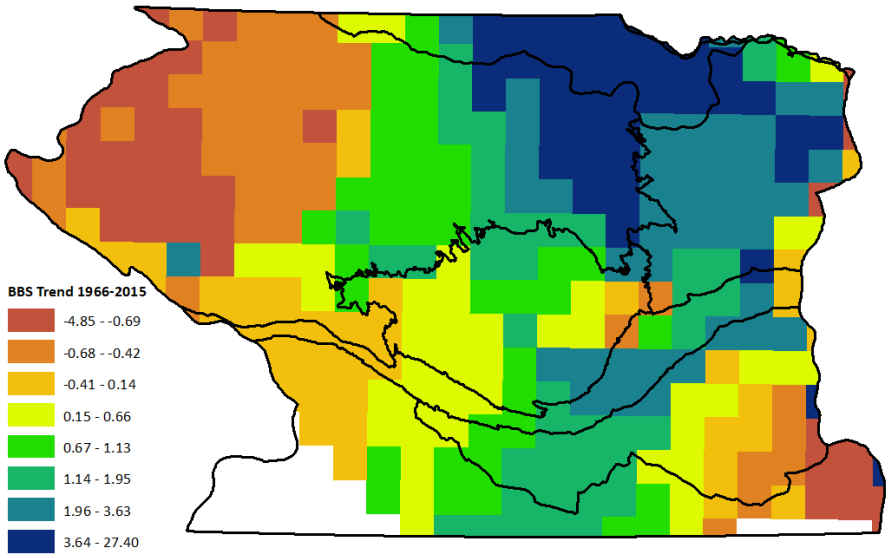


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Found in tall to moderate height vegetation, in moderate to dense stands with a moderate amount of litter,
- Grassland generalist found in native grasslands and tame grasslands, hay fields, lightly to moderately grazed pastures, no-till cropland, small-grain fields, old fields, wet-meadows, and fields enrolled in the Conservation Reserve Program (CRP), and
- Nests on the ground in tallgrass prairies, meadows, and weedy areas, with good grass and litter cover

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Woody encroachment,
- Loss and fragmentation of grassland habitats due to agricultural conversion, and
- Destruction of habitat during breeding season: overgrazing, haying, and frequent burning

Management actions:

- Haying should be completed outside the breeding season (mid-May to late July),
- When possible alternate haying years to allow for accumulation of detrital litter,
- Prescribed fire should be implemented in a 3-5 year rotation,
- Focus on larger tracts at least >40 ha,
- Manage against woody encroachment,
- Moderate to light intensity grazing to maintain taller vegetation structure,
- Preservation of existing native grasslands via acquisition, conservation easements or incentives, and
- Restoration and reclamation of pasture, hay fields and grassland in core areas

Information needs

- Determine which management practices can be economically replicated in working ranch operations to produce optimal breeding habitat in wet meadows found in the Central Platte River and Sandhills, and
- Identify factors limiting population growth

Links to more info

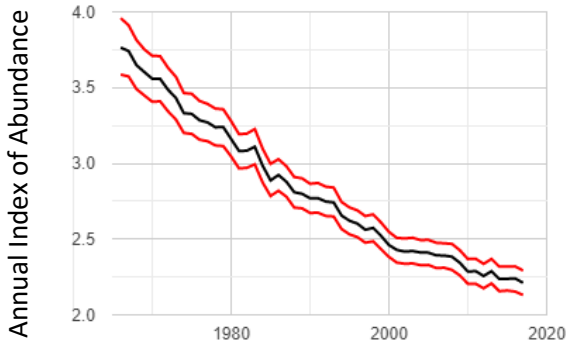
Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, C. M. Goldade, A. L. Zimmerman, and B. R. Euliss. 1999 (revised 2001). Effects of management practices on grassland birds: Bobolink. Northern Prairie Wildlife Research Center, Jamestown, ND. 24 pages. https://pubs.usgs.gov/unnumbered/93888/report.pdf

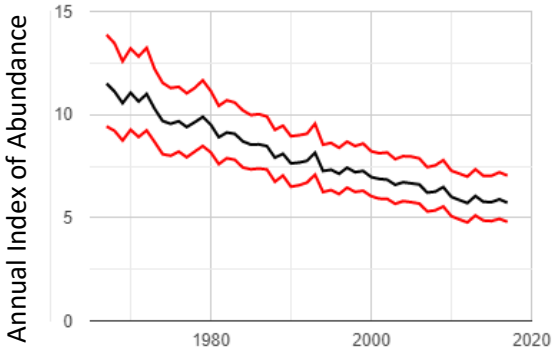
BROWN THRASHER

(*Toxostoma rufum*): Stewardship Species

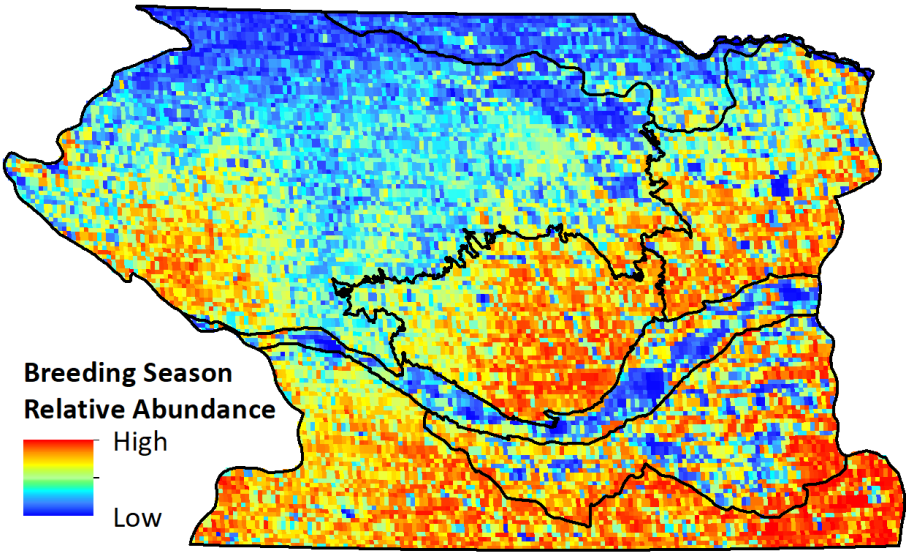
Rationale:

- Population change of -35% from 1970-2014,
- Partners in Flight Species of Regional Concern in BCR 19, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)





Distribution

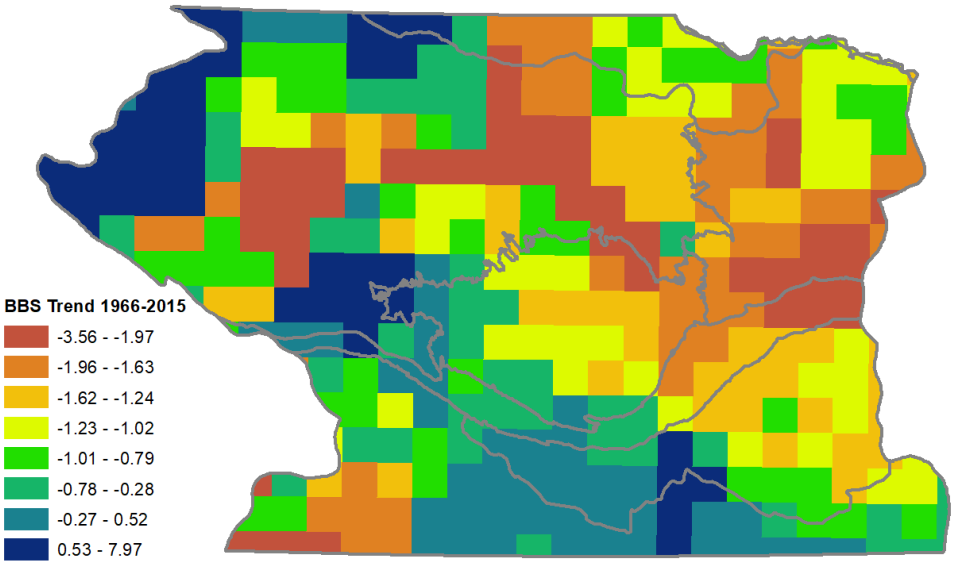


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Commonly breeds in fencerows, shelterbelts, and woody draws,
- Reaches highest densities in shrub or mid-successional stages of forests, and
- Can be found in unburned tallgrass prairie, breeding in woody draws

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Habitat loss, degradation, and fragmentation of shrubby, edge habitat, and
- Risk of mortality from insecticides in agricultural areas (i.e. orchards)

Management actions:

- No known management actions are being taken to increase or maintain populations, and
- Oak savannah restoration (via fire) may benefit this species by promoting open woodlands

Information needs:

- Assess and monitor the distribution and abundance in Nebraska, particularly in shrubby habitats,
- Assess the species' role as an agricultural pest and its susceptibility to agricultural chemicals, and
- Determine the effects of land management practices and nest site selection on nest predation rates

Links to more info

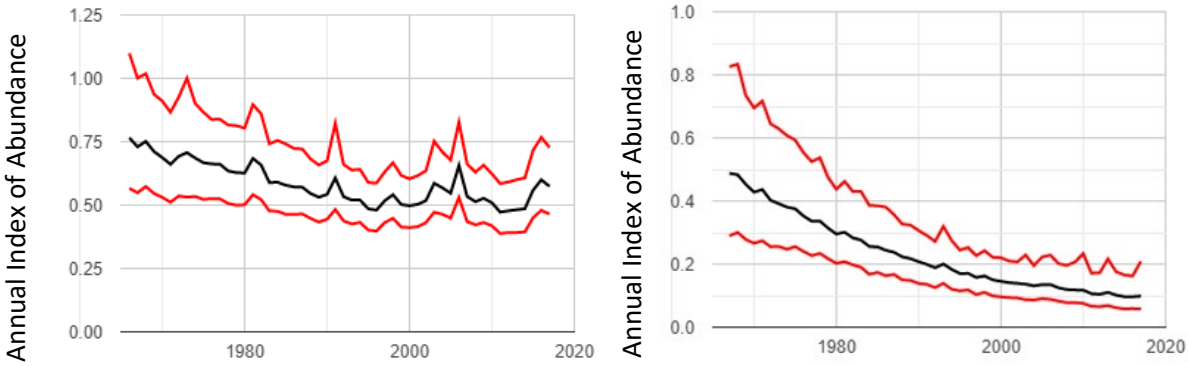
Cavitt, J. F. and C. A. Haas (2020). Brown Thrasher (*Toxostoma rufum*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.
https://birdsoftheworld.org/bow/species/brnthr/cur/introduction

BURROWING OWL

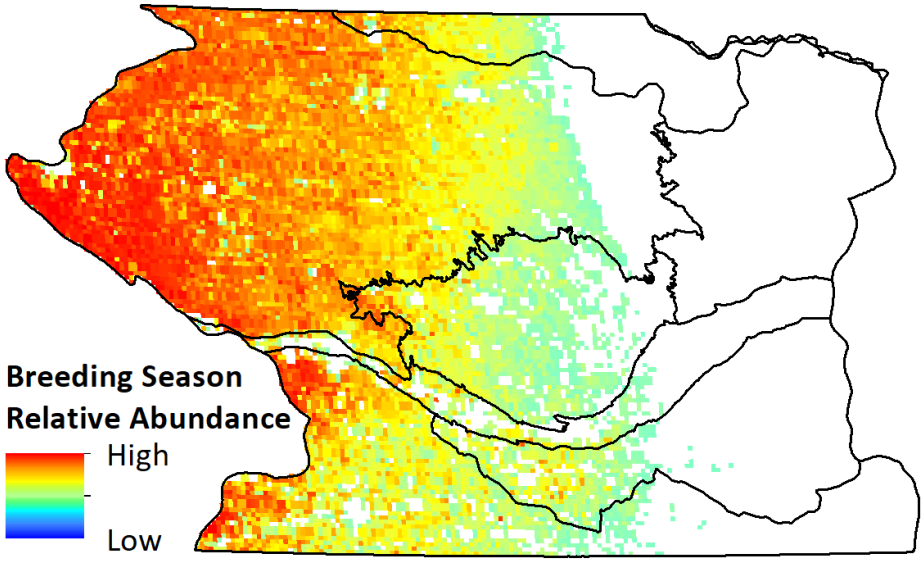
(*Athene cunicularia*); Stewardship Species

Rationale:

- Population change of -35% from 1970-2014,
- Partners in Flight Species of Regional Concern in BCR 19,
- Tier I Species of Greatest Conservation Need in Nebraska State Wildlife Action Plan, and
- Negative BBS trends both survey-wide (left) and in BCR 19 (right)



Distribution

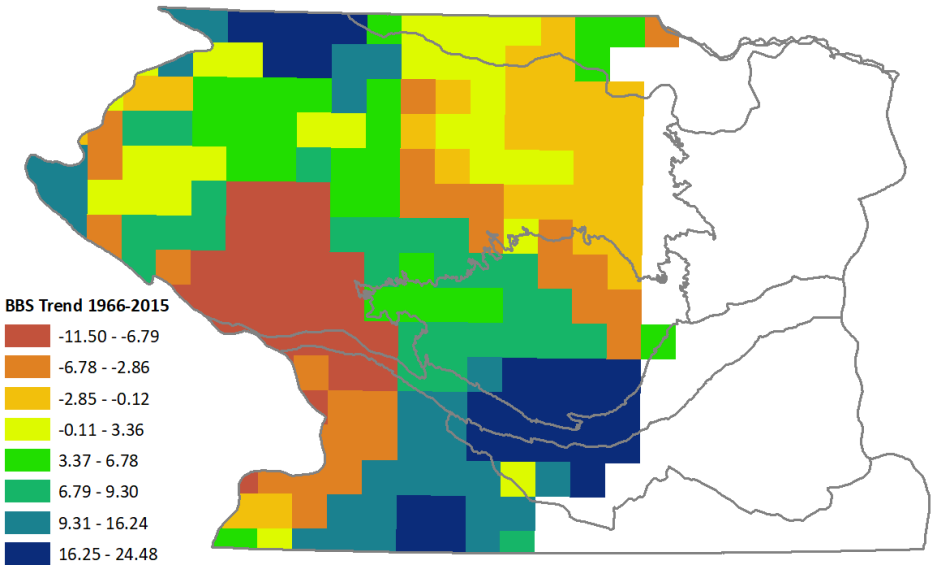


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Open landscapes with short vegetation and little shrub cover,
- Shortgrass prairie and grazed pastures, and
- Closely associated with prairie dog towns; nesting in burrows built by black-tailed prairie dogs (Cynomys ludovicianus) and other fossorial mammals

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Loss, degradation, and fragmentation of grassland habitat, including conversion to agriculture,
- Industry, utility, and wind energy development; particularly entanglement in fences, and collisions with vehicles, power lines and wind turbines,
- Eradication of fossorial mammals; (e.g., black-tailed prairie dogs, Cynomys ludovicianus) by anthropogenic means (e.g., poisoning, shooting) and plague (Yersinia pestis), and
- Environmental contaminants and insecticides can reduce food source.

Management actions:

- Maintain contiguous areas of native grassland,
- Manage for short grass vegetation (e.g., prescribed burning, mowing, grazing in mid-March before birds are nesting),
- Conserve prairie dog towns by minimizing disturbance from humans and managing for disease,
- Evaluate presence before and after industrial related activities like wind turbine and associated infrastructure development,
- Minimize use of pesticides (e.g. insecticides, rodenticides), and
- Use lowest pesticide toxicity levels when possible to minimize effect to birds and prey.

Information needs:

- Increase understanding of distribution, trends, and reproduction, and
- Determine best management actions and timing of management actions.

Links to more info

https://birdsoftheworld.org/bow/species/burowl/cur/introduction

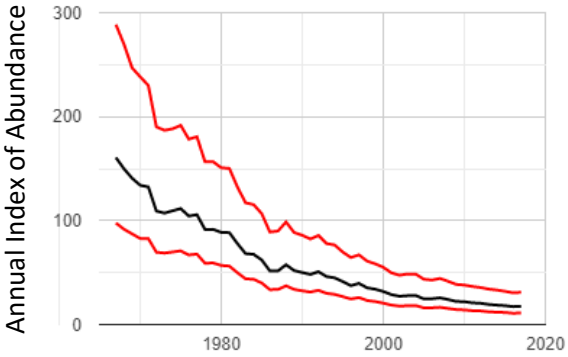
Klute, D.S., L.W. Ayers, M.T. Green, W.H. Howe, S.L. Jones, J.A. Shaffer, S.R. Sheffield, and T.S. Zimmerman. 2003. Status Assessment and Conservation Plan for the Western Burrowing Owl in the United States. U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication FWS/BTP-R6001-2003, Washington, D.C.
Panella, M.J. 2013. Western Burrowing Owl (*Athene cunicularia hypugagea*): A Species Conservation Assessment for the Nebraska Natural Legacy Project. Nebraska Game and Parks Commission, Lincoln, NE.

CHESTNUT-COLLARED LONGSPUR

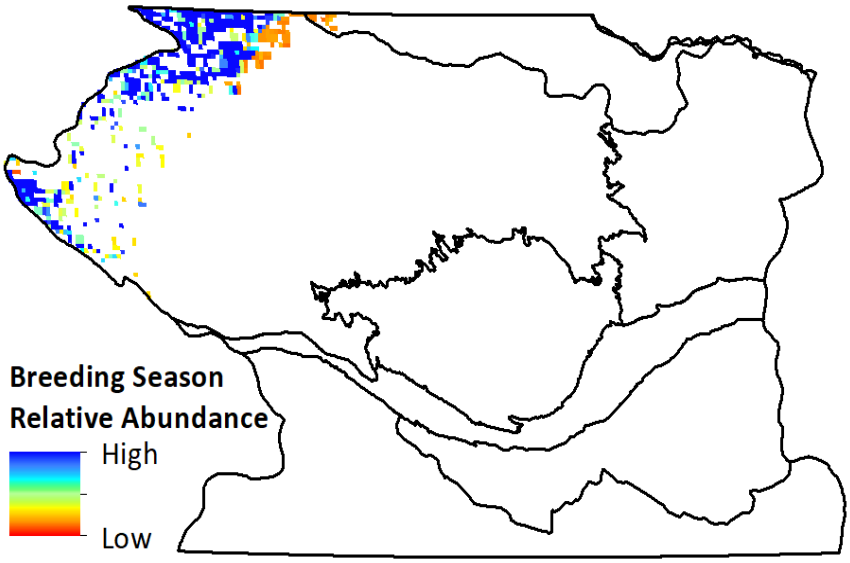
(*Calcarius ornatus*); Stewardship Species

Rationale:

- Population change of -85% from 1970-2014,
- Expected to lose 50% of current population within 21 years,
- Partners in Flight Yellow Watchlist Species,
- Tier I Species of Greatest Conservation Need in Nebraska
- State Wildlife Action Plan. and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)



Distribution

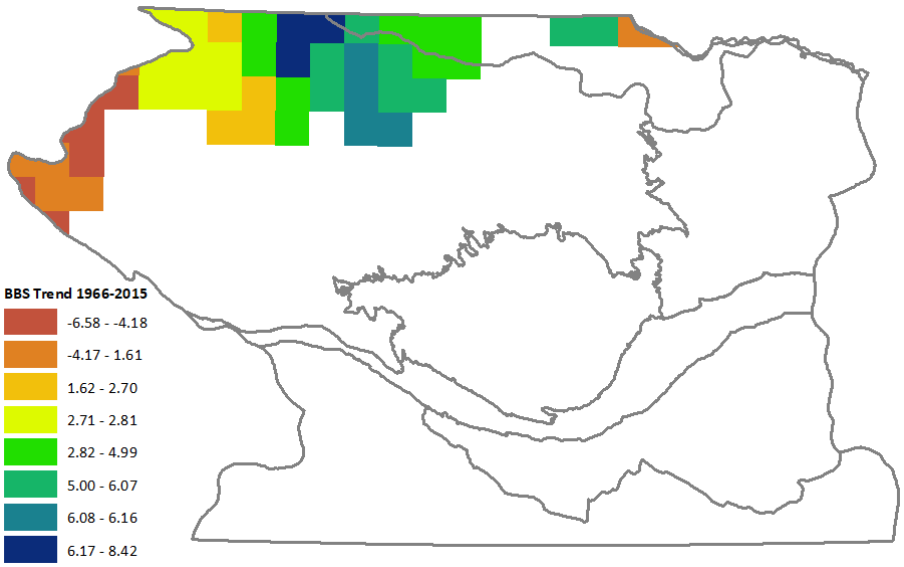


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Breeds in short- and mixed-grass prairie in flat to low rolling topography, and
- Nests on the ground in areas of generally low grass height and limited litter cover, avoiding woody cover

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Loss and fragmentation of grassland habitats due to agricultural conversion,
- Degradation of grasslands due to invasive and non-native plants, and
- Grazing levels that result in conditions not preferred by the species

Management actions:

- Moderate-intensity, rotational grazing regimes, less frequent grazing in dry, less-productive areas,
- Infrequent, patch-burn prescribed fire, and
- Preservation of existing native grasslands via acquisition, conservation easements or incentives, and
- Restoration and reclamation of pastureland

Information needs:

- Determine which management practices and grassland conditions supports both high densities of breeding birds but also high nest densities and high rates of productivity,
- Identify factors limiting population growth, and
- Explore the effects of parasitism by Brown-headed Cowbirds

Links to more info

https://birdsoftheworld.org/bow/species/chclon/cur/introduction

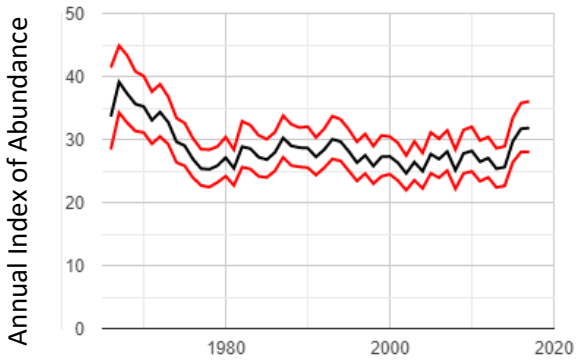
K.V. Rosenberg, J.A. Kennedy, R. Dettmers, R.P. Ford, D. Reynolds, J.D. Alexander, C.J. Beardmore, P.J. Blancher, R.E. Bogart, G.S. Butcher, A.F. Camfield, A. Couturier, D.W. Demarest, W.E. Easton, J.J. Giocomo, R.H. Keller, A.E. Mini, A.O. Panjabi, D.N. Pashley, T.D. Rich, J.M. Ruth, H. Stabins, J. Stanton, T. Will. 2016. Partners in Flight Landbird Conservation Plan: 2016 Revision for Canada and Continental United States. Partners in Flight Science Committee. 119 pp.

DICKCISSEL

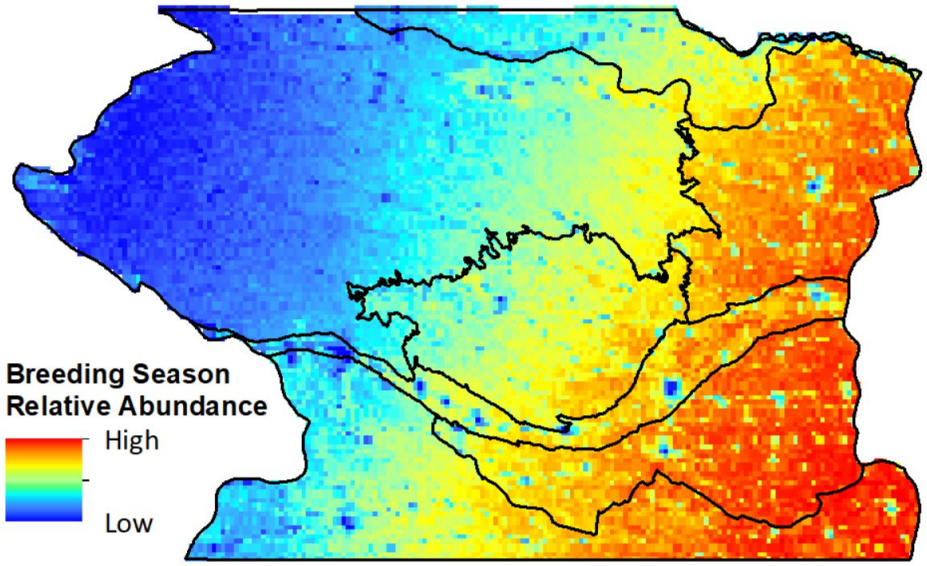
(*Spiza americana*); Planning Species

Rationale:

- Population change of -14% from 1970-2014,
- Partners in Flight Species of Regional Stewardship in BCR 19, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)



Distribution

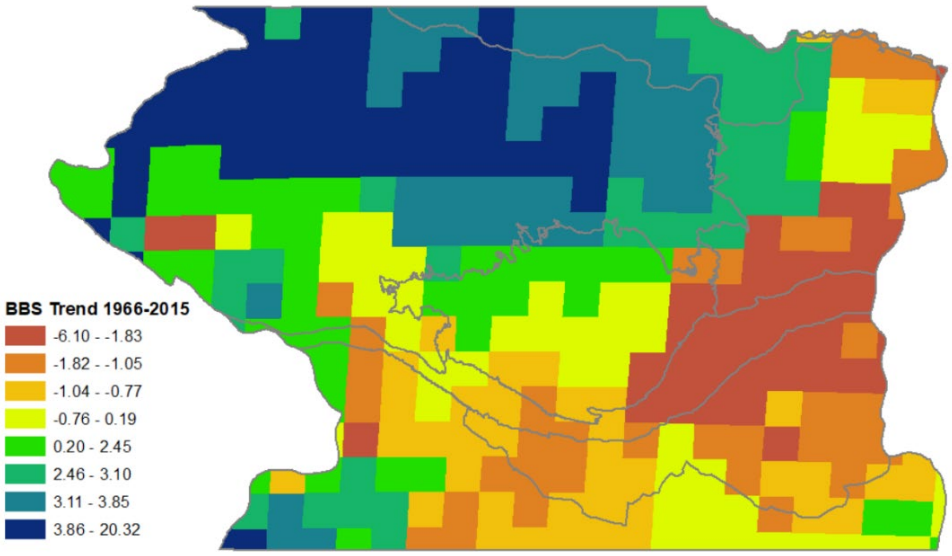


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- An obligate grassland specialist; nests in a variety of open grassland habitats with dense cover, and
- Includes moderate to tall vegetation, moderately deep litter, and many elevated song perches, native and restored grasslands, hayfields, old fields undergoing early stages of succession, lightly grazed pastures, moderately grazed and idle prairie, fallow areas in agricultural landscapes, no-till crop fields, and linear strips of grassy habitat, such as fencerows, stream sides, and roadsides.

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Mowing of hay can be a major source of nest failure in hayfields where nest densities can be high, and
- Brown-headed Cowbird parasitism

Management actions:

- Preservation of existing native grasslands via acquisition, conservation easements or incentives,
- Restoration and reclamation of pastureland,
- Conduct haying outside the breeding season (late May to late July),
- Continue implementation of CRP in large patches (>40 acres),
- Use burning, mowing, or grazing to control succession and maintain open grasslands

Information needs:

- Quantify double brooding attempts,
- Quantify annual and lifetime reproductive success,
- Assess nest success in a variety of habitat conditions and types (hayland, CRP, native grasslands, other habitats), and
- Identify opportunities to reduce impacts of identified threats.

Links to more info

Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, C. M. Goldade, A. L. Zimmerman, and B. R. Euliss. 1999 (revised 2002). Effects of management practices on grassland birds: Dickcissel. Northern Prairie Wildlife Research Center, Jamestown, ND. 32 pages.

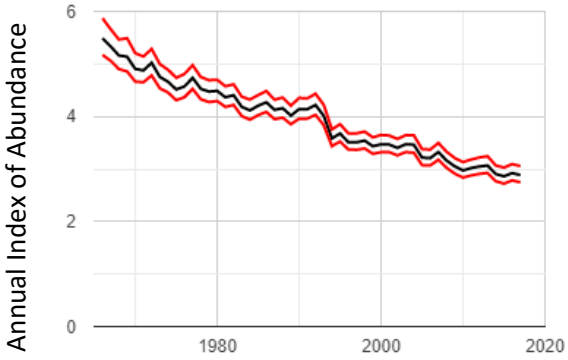
Temple, S. A. (2020). Dickcissel (Spiza americana), version 1.0. In Birds of the World (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.dickci.01

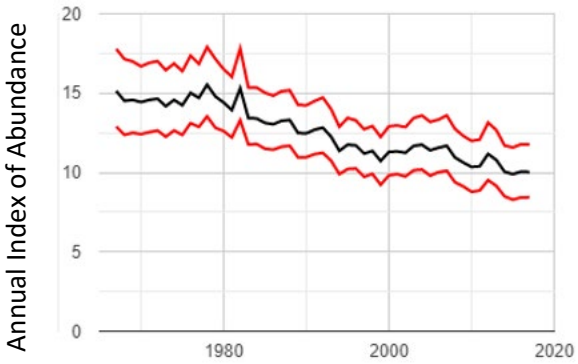
EASTERN KINGBIRD

(*Tyrannus tyrannus*); Stewardship Species

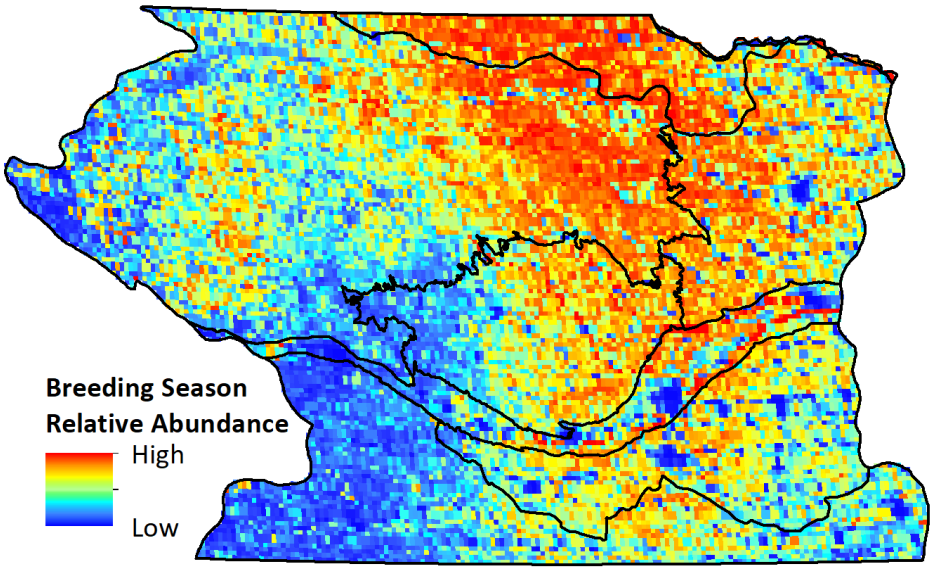
Rationale:

- Population change of -38% from 1970-2014,
- Partners in Flight Species of Regional Concern in BCR 19, and
- Negative BBS trend both survey-wide (left) and in BCR 19 (right)





Distribution

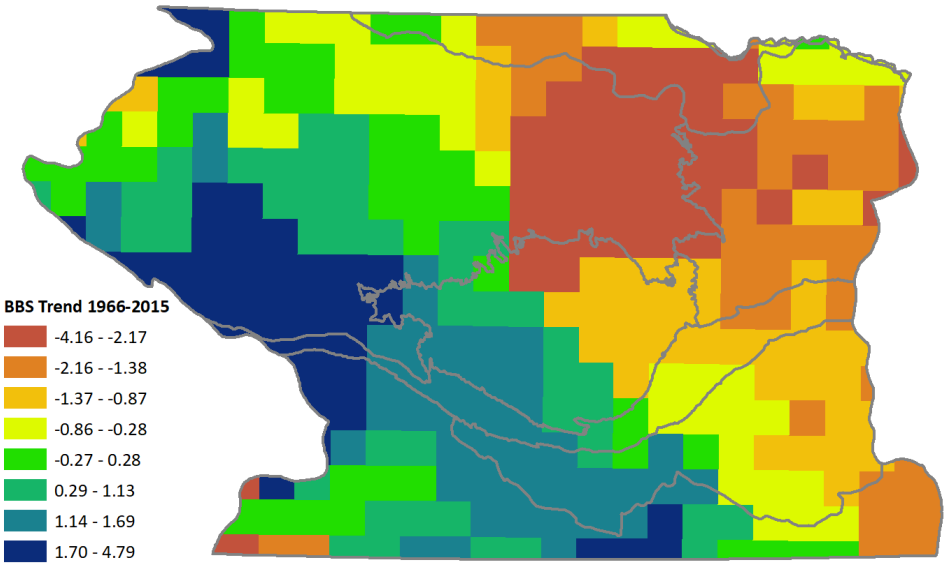


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Open environments; usually fields with scattered shrubs and trees, orchards, along shelterbelts, and especially along woodland edges in forested regions.

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Loss of habitat caused by human development, forest succession and change within agricultural landscapes (removal of hedgerows and shelterbelts),
- Removal of perches and trees used for foraging and nesting, respectively, make agricultural habitat unsuitable, and
- Nest predation by American Crow and nest parasitism by Brown-headed Cowbirds.

Management actions:

- Protection of shelterbelts and lightly forested riparian corridors.

Information needs:

- Assess nesting success, effects of Brown-headed Cowbird parasitism, and population demographics with respect to habitat type to identify potential causes of broad scale population declines.

Links to more info

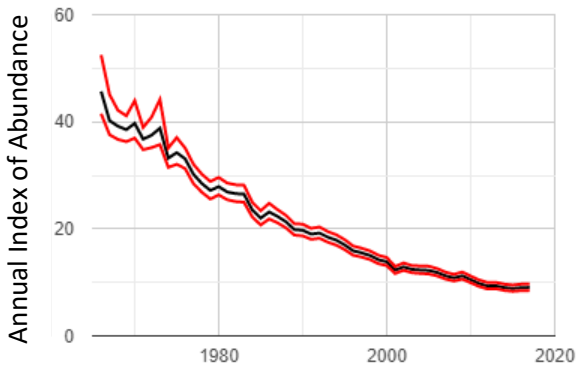
Murphy, M. T. and P. Pyle (2020). Eastern Kingbird (*Tyrannus tyrannus*), version 1.0. In Birds of the World (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.easkin.01

EASTERN MEADOWLARK

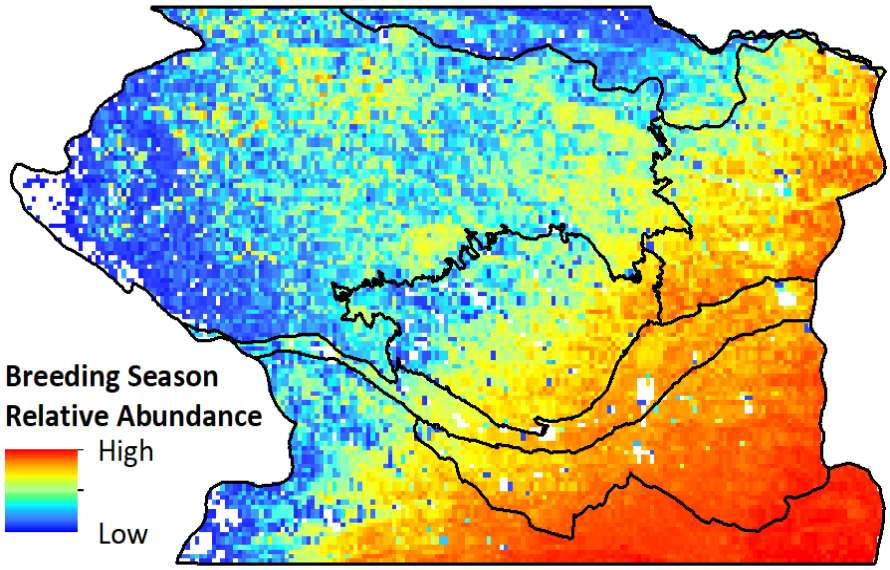
(Sturnella magna); Planning Species

Rationale:

- Population change of -77% from 1970-2014,
- Expected to lose 50% of current population within 23 years,
- Partners in Flight Common Birds in Steep Decline Species,
- Partners in Flight Species of Regional Concern in BCR 19,
- Tier II Species of Greatest Conservation Need in Nebraska State Wildlife Action Plan, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)



Distribution

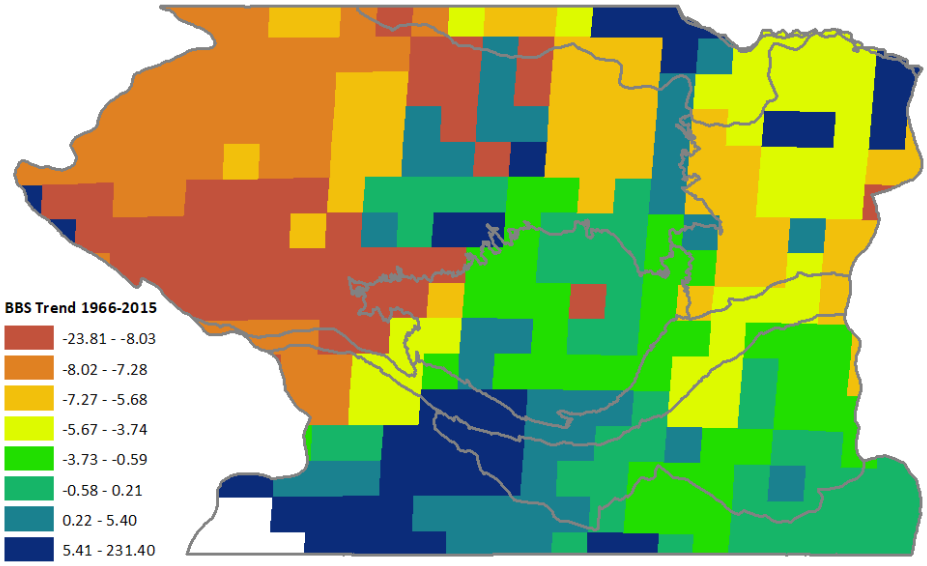


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Found in low, moist areas and poorly drained grasslands,
- Nests on the ground in tallgrass prairies, meadows, and weedy areas, with good grass and litter cover

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Loss and fragmentation of grassland habitats due to agricultural conversion,
- Overgrazing, early season haying, and frequent burning, and
- Direct human disturbance within the breeding territory

Management actions:

- Moderate-intensity, rotational grazing regimes,
- Delayed and infrequent haying,
- Infrequent, patch-burn prescribed fire,
- Preservation of existing native grasslands via acquisition, conservation easements or incentives, and
- Restoration and reclamation of pastureland, hay fields and grassland

Information needs:

- Determine which management practices produce optimal breeding habitat,
- Explore the effects of parasitism by Brown-headed Cowbirds, and
- Identify factors limiting population growth

Links to more info

https://birdsoftheworld.org/bow/species/easmea/cur/introduction

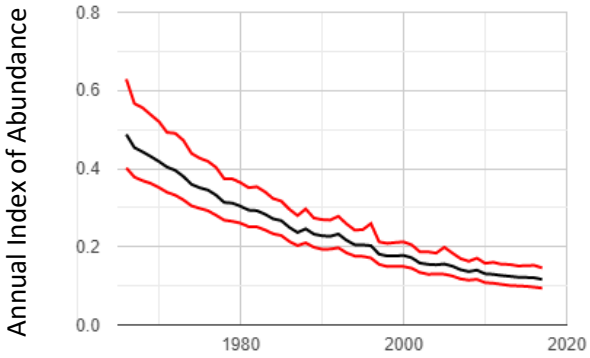
EASTERN WHIP-POOR-WILL

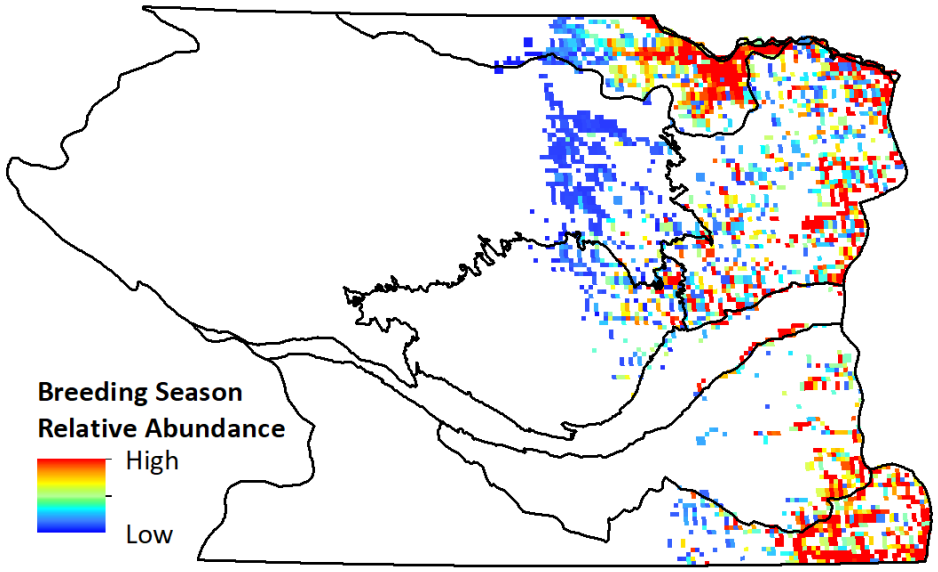
(*Antrostomus vociferus*); Stewardship Species


Phil Swanson

Rationale:

- Population change of -69% from 1970-2014,
- Partners in Flight Yellow Watchlist Species,
- Tier II Species of Greatest Conservation Need in Nebraska State Wildlife Action Plan, and
- Negative BBS trend survey-wide





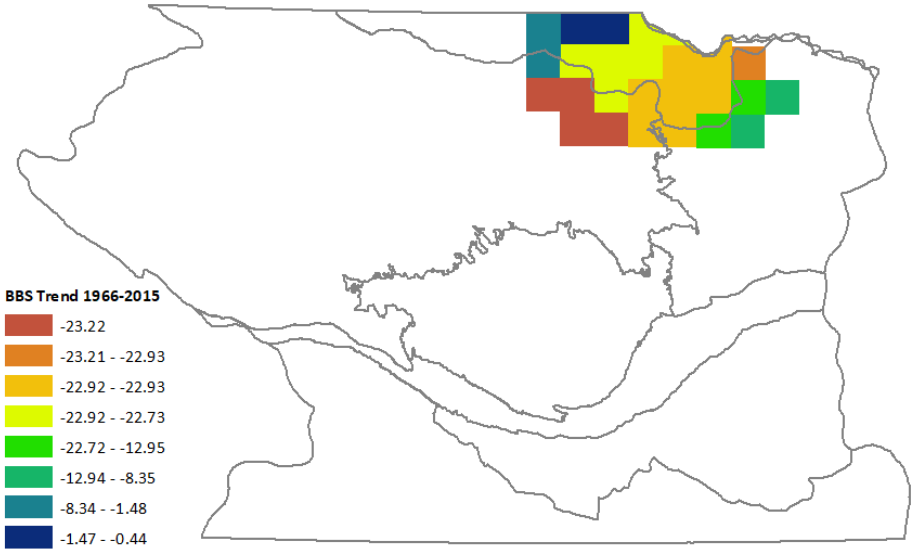
Map created using eBird data from 2014-2018 (Fink et al. 2020)

Distribution

Breeding habitat:

- Nests on the ground in deciduous and mixed woodlands with limited underbrush and scattered open areas.

Population status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Increased density of understory vegetation, especially eastern red cedar infestation,
- Loss and fragmentation of woodland habitats due to agricultural conversion, and
- Overgrazing in woodland areas

Management actions:

- Prescribed fire reintroduction of oak woodlands to manage understory, and
- Preservation of existing large tracts of oak woodlands with intersperse open areas, preferably native prairie habitats.

Information needs:

- Additional information on population status and habitat needs in Nebraska, and
- Determine which management practices produce optimal breeding habitat

Links to more info

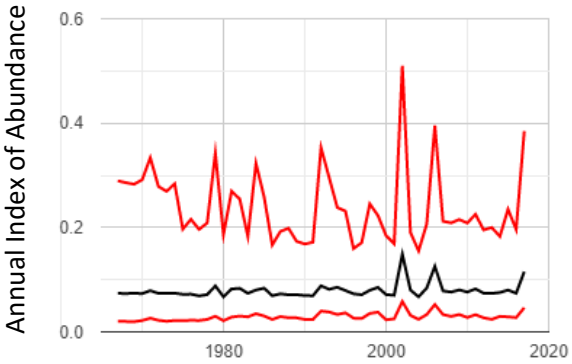
https://birdsoftheworld.org/bow/species/whip-p1/cur/introduction

FERRUGINOUS HAWK

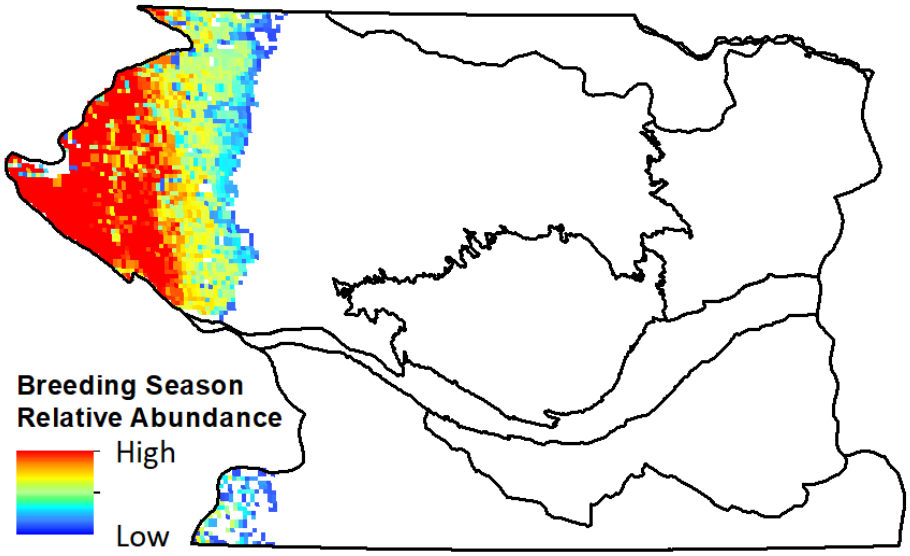
(*Buteo regalis*); Stewardship Species

Rationale:

- Partners in Flight Species of Regional Concern in BCR 19,
- Tier I species of greatest conservation need in Nebraska State Wildlife Action Plan, and
- Ambiguous BBS trends in both BCR 19 (left) and in Nebraska (right)



Distribution

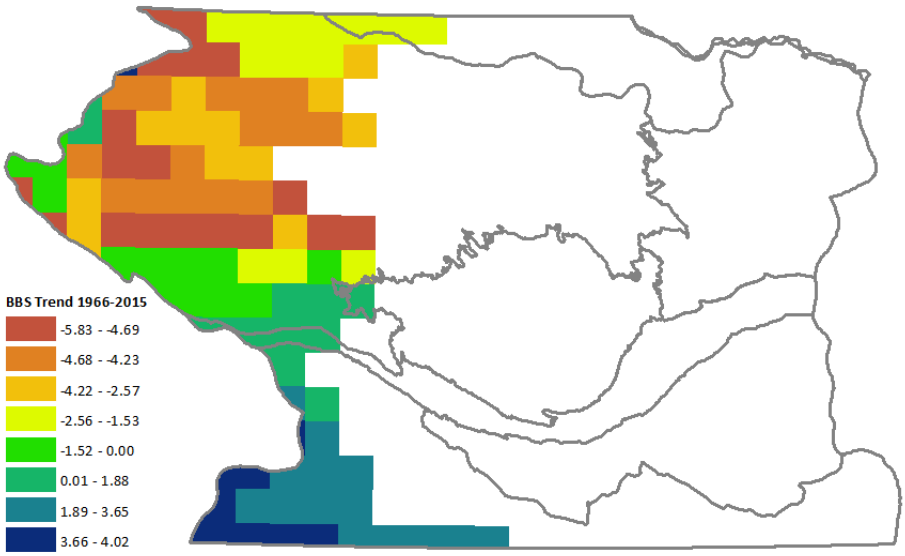


Map created using eBird data from 2014-2018 (Fink et al. 2020

Breeding habitat:

- Open landscapes with short vegetation; shortgrass prairie and Sandhill dune prairie,
- Nest on rocky outcrops, in isolated trees, or anthropogenic features like power lines, and
- Associated with black-tailed prairie dog towns

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Habitat loss, degradation, and fragmentation of grasslands including conversion to agriculture,
- Encroaching woody invasive plants,
- Eradication of black-tailed prairie dog towns from anthropogenic means (e.g., poisoning, shooting, etc.) and plague and other means of prey reduction,
- Wind energy and other industrial development, and
- Disturbances during breeding season causing nest abandonment

Management actions:

- Manage contiguous areas of native grassland and shortgrass prairie via light or rotational grazing,
- Prevent cattle from rubbing on and weakening potential nest trees,
- Prevent reduction of habitat from encroaching shrub and tree cover of invasive woody plants, and
- Conserve prairie dog towns and increase habitat for other small mammal prey

Information needs:

- Evaluate presence before and after industrial related activities like wind turbine and associated infrastructure development,
- Increase understanding of distribution, trends, and reproduction via surveys, especially in southwest Nebraska and the Sandhills, and
- Determine best management actions and timing of management actions, particularly the potential effects of prescribed burning

Links to more info

https://www.allaboutbirds.org/guide/Ferruginous_Hawk

Collins, C.P. and T.D. Reynolds. 2005. Ferruginous Hawk (*Buteo regalis*): A Technical Conservation Assessment. USDA Forest Service, Rocky Mountain Region, Rigby, ID.

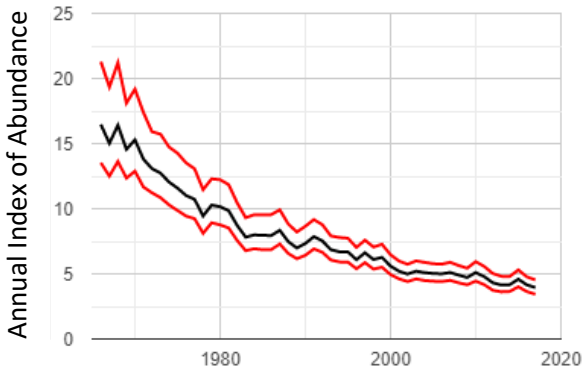
Shaffer, J.A., Igl, L.D., Johnson, D.H., Sondreal, M.L., Goldade, C.M., Zimmerman, A.L., Thiele, J.P., and Euliss, B.R., 2019, The effects of management practices on grassland birds—Ferruginous Hawk (*Buteo regalis*), chap. N *of* Johnson, D.H., Igl, L.D., Shaffer, J.A., and DeLong, J.P., eds., The effects of management practices on grassland birds: U.S. Geological Survey Professional Paper 1842, 13 p., https://doi.org/10.3133/pp1842N.

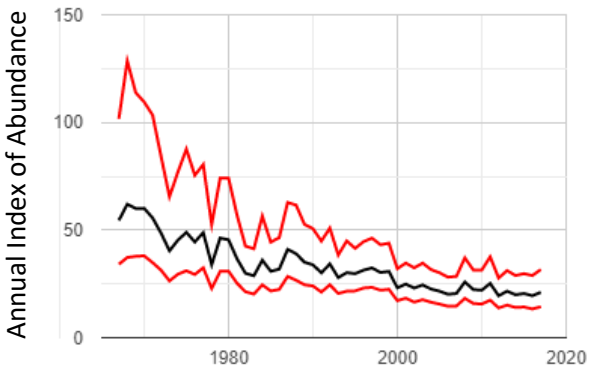
GRASSHOPPER SPARROW

(*Ammodramus savannarum*); Planning Species

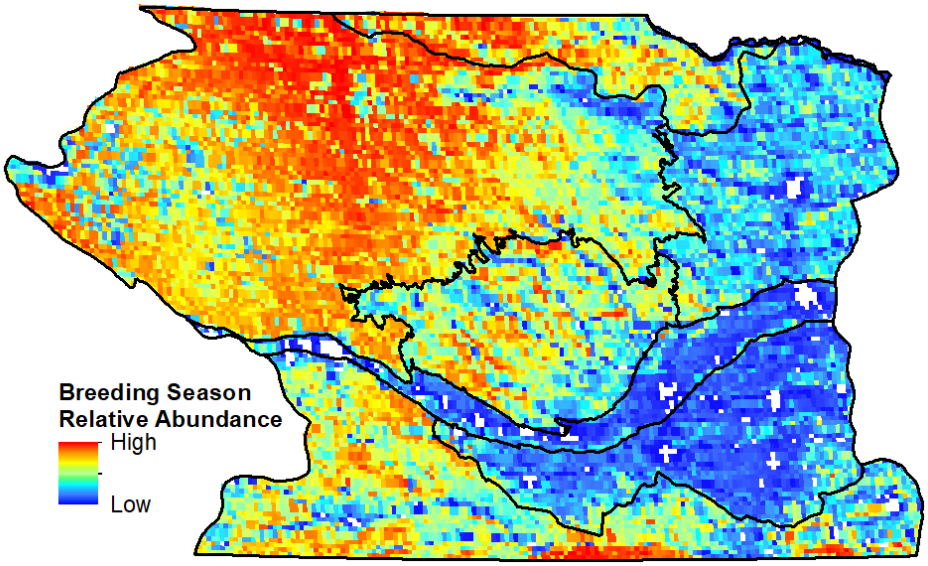
Rationale:

- Population change of -68% from 1970-2014,
- Partners in Flight Common Birds in Steep Decline Species,
- Partners in Flight Species of Regional Concern in BCR 19, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)





Distribution

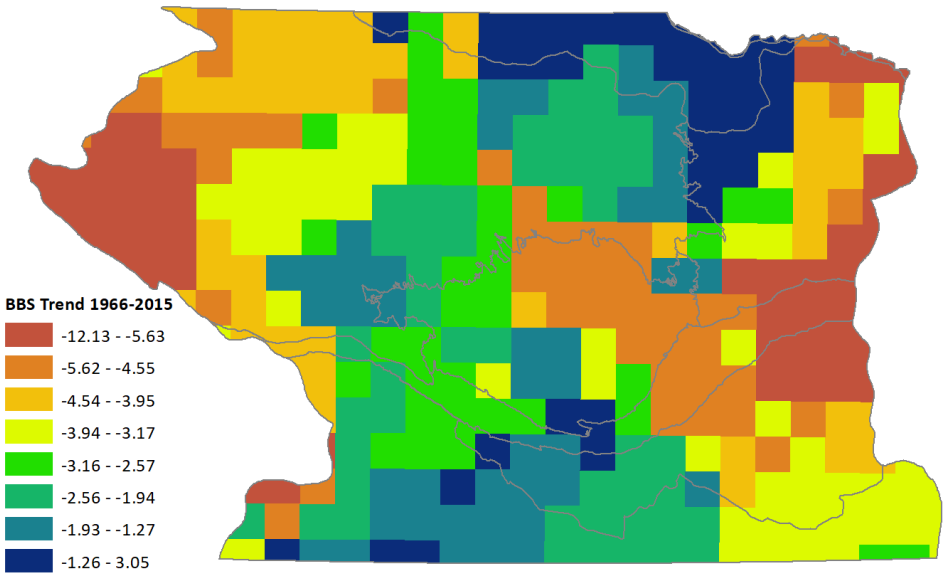


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Nests on the ground in large tracts of open grassland habitats, and
- Prefers short- or mixed-grass areas and avoids shrubby or forested habitats

Population status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Woody encroachment into grassland habitats, especially eastern red cedar,
- Loss and fragmentation of grassland habitats due to agricultural conversion, and
- Overgrazing and early season haying

Management actions:

- Light to moderate grazing, prescribed fire, and deferred haying, and
- Preservation of existing native grasslands via acquisition, conservation easements or incentives

Information needs

- Identify factors limiting population growth, and
- Determine which management practices produce optimal breeding habitat

Links to more info

https://birdsoftheworld.org/bow/species/graspa/cur/introduction
https://www.fws.gov/migratorybirds/pdf/management/focal-species/GrasshopperSparrow.pdf

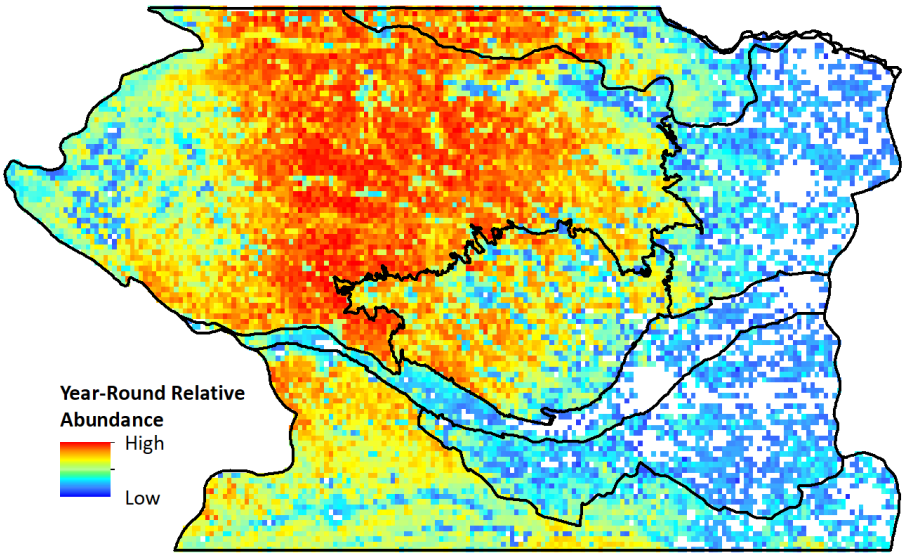
GREATER PRAIRIE CHICKEN

(*Tympanuchus cupido*); Planning Species

Rationale:

- Partners in Flight Yellow Watchlist Species,
- Partners in Flight Species of Regional Concern and Regional Stewardship in BCR 19, and
- Tier II species of greatest conservation need in Nebraska State Wildlife Action Plan

Distribution

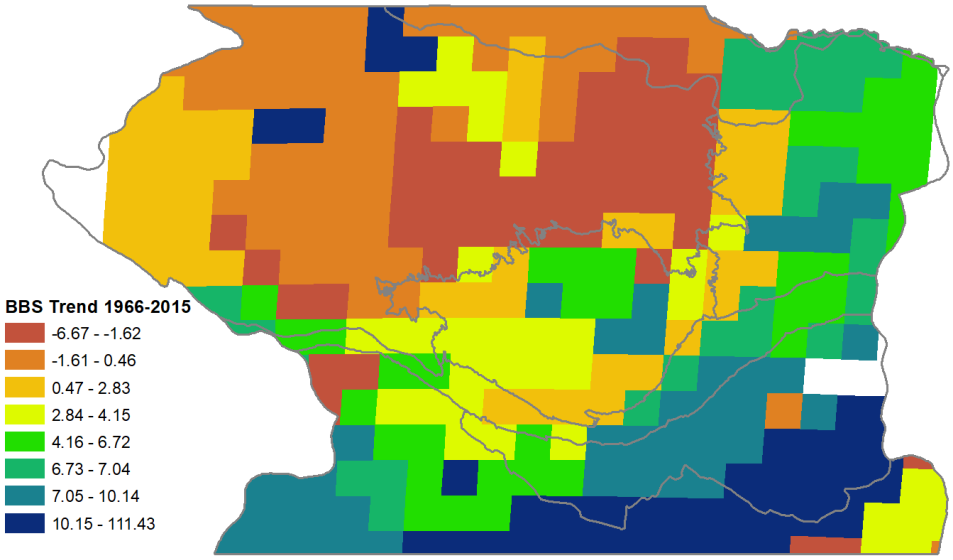


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Nests in undisturbed mixed-grass prairie, preferring thick vegetation 10-18 inches high,
- Avoids human disturbance, such as roads and powerlines, and
- Often nests in CRP grasslands in agricultural landscapes

Population status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Woody encroachment into grassland habitats, particularly eastern red cedar,
- Loss and fragmentation of grassland habitats due to agricultural conversion,
- Reduction in insect foods caused by pesticides,
- Overgrazing and early season haying,
- Non-native grasses, and
- Wind and energy development

Management actions:

- Establish well-managed CRP grasslands near existing populations,
- Maintain connectivity among subpopulations with conservation of grassland corridors, and
- Removal of trees and other woody encroachment

Information needs:

- Long-term population monitoring to assess changes in abundance over time and space,
- Habitat needs of chicks during the first year, particularly the first two weeks post-hatch, and
- Extent and intensity of hybridization with sympatric species

Links to more info

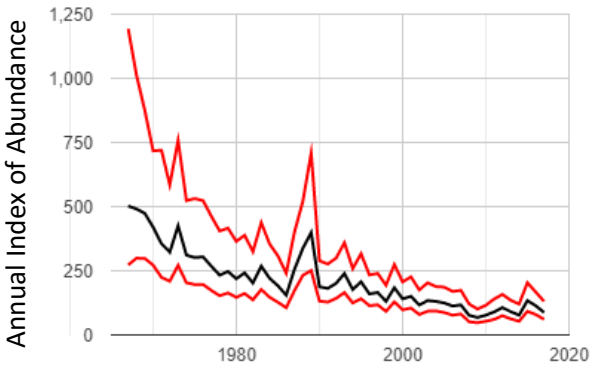
https://birdsoftheworld.org/bow/species/grpchi/cur/introduction

LARK BUNTING

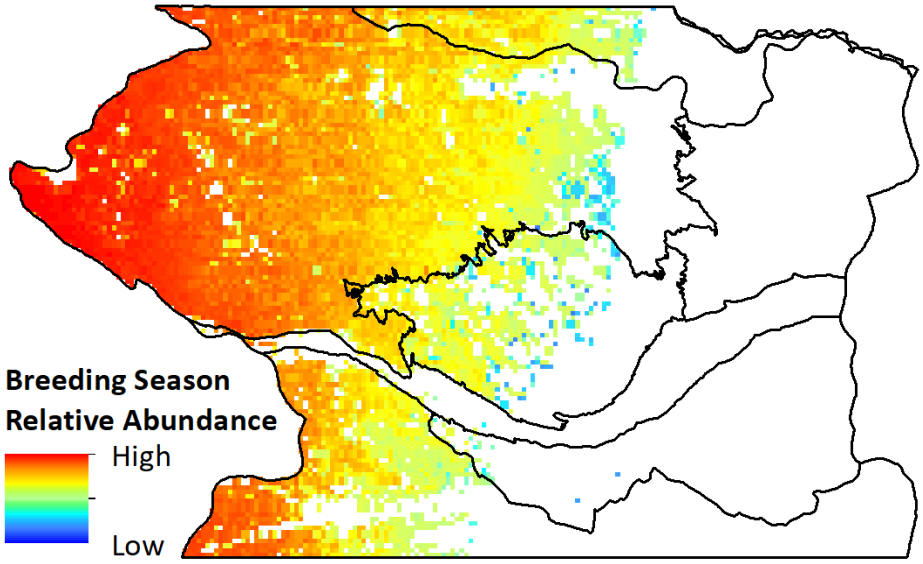
(*Calamospiza melanocorys*); Stewardship Species

Rationale:

- Population change of -86% from 1970-2014,
- Expected to lose 50% of current population within 16 years,
- Partners in Flight Common Birds in Steep Decline Species,
- Partners in Flight Species of Regional Concern in BCR 19, and
- Negative BBS trends both survey-wide (left) and in BCR 19 (right)



Distribution

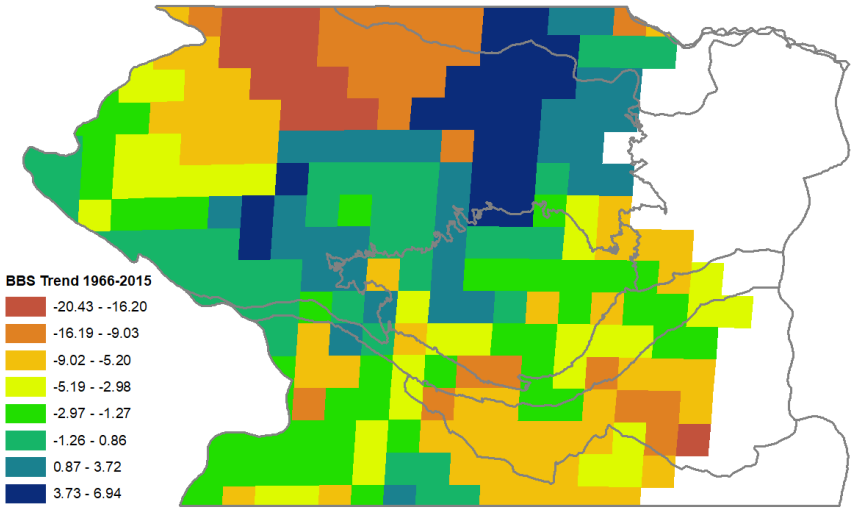


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Breeds in short- and mixed grass prairie and shrub steppe habitats, also readily uses CRP grasslands, and
- Nests on ground, often next to shrubs, glass clumps, and concentrations of forbs

Population status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Loss and fragmentation of grassland and shrub steppe habitats due to agricultural conversion,
- Degradation of grasslands and shrub steppe due to invasive and non-native plants,
- Loss of CRP grasslands,
- Loss of shrub cover, including loss as a result of fire, and
- Inappropriate levels of grazing that affect preferred conditions by the species, i.e., heavy summer grazing in short-grass prairie reduces habitat quality

Management actions:

- Moderate-intensity, rotational grazing regimes, less frequent grazing in dry, less-productive areas,
- Heavy grazing in tall grass and productive grasslands to maintain habitat quality,
- Delay mowing of hayfields until nesting is complete,
- Preservation of existing native grasslands and shrub steppe via acquisition, conservation easements or incentives, and
- Restoration and reclamation of pastureland

Information needs

- Determine which management practices within grassland and sage steppe support high densities of breeding birds, high nest densities, and high rates of productivity,
- Identify factors limiting population growth, and
- Explore the effects of parasitism by Brown-headed Cowbirds

Links to more info

https://birdsoftheworld.org/bow/species/larbun/cur/introduction

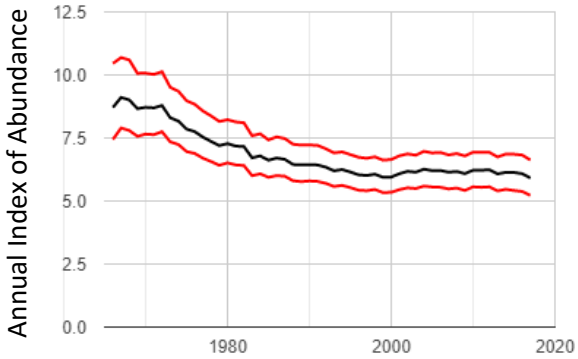
K. V. Rosenberg, J. A. Kennedy, R. Dettmers, R. P. Ford, D. Reynolds, J.D. Alexander, C. J. Beardmore, P. J. Blancher, R. E. Bogart, G. S. Butcher, A. F. Camfield, A. Couturier, D. W. Demarest, W. E. Easton, J.J. Giocomo, R.H. Keller, A. E. Mini, A. O. Panjabi, D. N. Pashley, T. D. Rich, J. M. Ruth, H. Stabins, J. Stanton, T. Will. 2016. Partners in Flight Landbird Conservation Plan: 2016 Revision for Canada and Continental United States. Partners in Flight Science Committee. 119 pp.

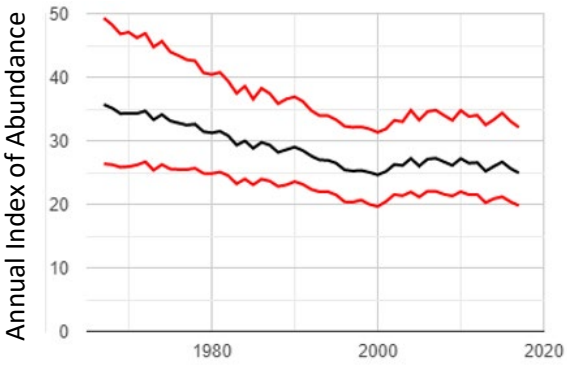
LARK SPARROW

(*Chondestes grammacus*); Stewardship Species

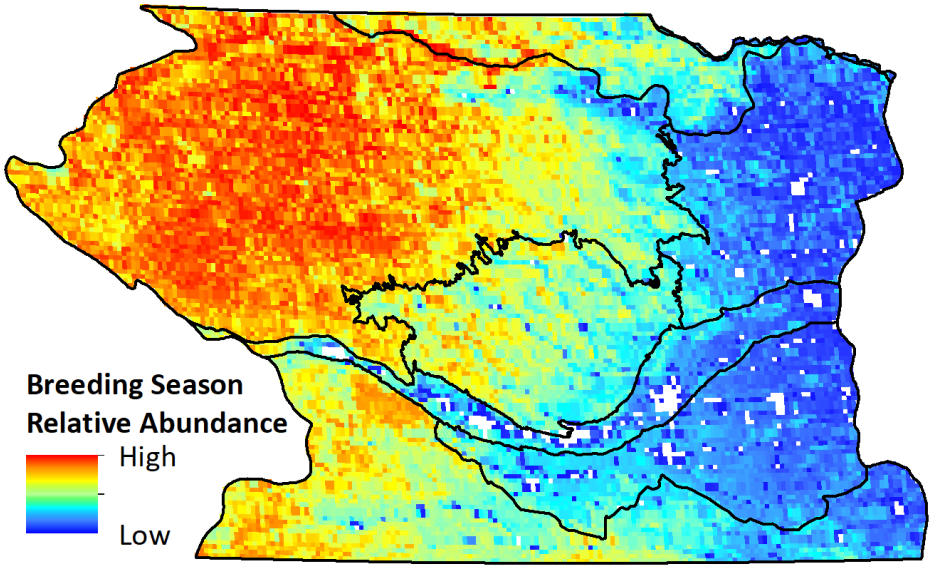
Rationale:

- Population change of -32% from 1970-2014,
- Partners in Flight Species of Regional Concern in BCR 19, and
- Negative BBS trends both survey-wide (left) and in BCR 19 (right)





Distribution

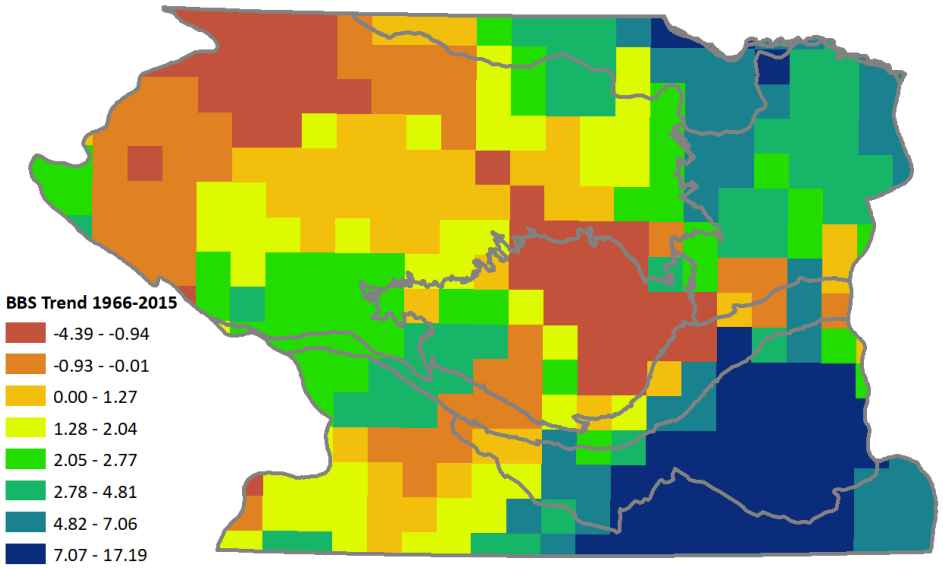


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Structurally open habitats or ecotones, i.e., cultivated habitats, orchards, open parklike woodlands, woodland edges, riparian areas, and grasslands (shortgrass, mixed-grass, and tallgrass prairie) with a shrub component and sparse litter.

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Long-term fire suppression often allows vegetative communities to grow to dense stands, thereby reducing edge habitat and bare soils
- Complete removal of woody vegetation negatively impacts nesting,
- Brown-headed Cowbird parasitism,
- Eastern Red Cedar Encroachment/Expansion into grasslands systems, and
- Conversion of grassland/shrubland to agriculture, although agriculture can be benefit edge or ecotone habitats are created in crop margins

Management actions

- Promote proper grazing of grasslands (not left idle indefinitely),
- Promote inclusion of desirable shrub cover in CRP projects,
- Promote prescribed burning of grasslands and shrublands,
- Conduct burns before arrival to breeding grounds,
- Conduct burns at intervals of 5 to 8 years to increase amount of open foraging area,
- Patch burning should be conducted to leave unburned patches for nesting and perching,
- Prevent high levels of cedar encroachment/reforestation of grasslands and shrublands. During brush removal, leave about 10% brush cover, and
- Minimize habitat loss, land conversion, and tree encroachment

Information needs

- The Lark Sparrow is poorly studied. Studies with marked individuals are needed to quantify nesting demographics; adult and juvenile survival; and migration routes and wintering areas And
- Study of habitat preference, and
- Determine if agricultural lands serve as population sources or sinks?

Links to more info

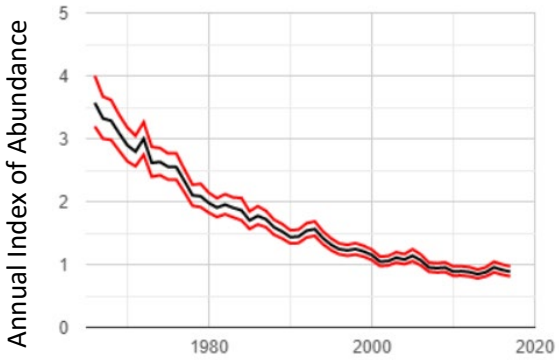
Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, C. M. Goldade, B. D. Parkin, and B. R. Euliss. 1999 (revised 2002). Effects of management practices on grassland birds: Lark Sparrow. Northern Prairie Wildlife Research Center, Jamestown, ND. 18 pages. https://pubs.usgs.gov/unnumbered/93875/report.pdf
Martin, J. W. and J. R. Parrish (2020). Lark Sparrow (*Chondestes grammacus*), version 1.0. In Birds of the World (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.larspa.01

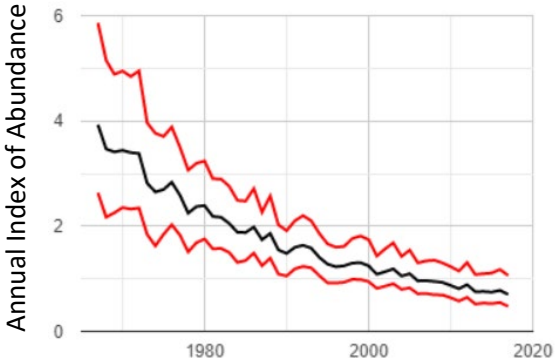
LOGGERHEAD SHRIKE

(*Lanius ludovicianus*); Stewardship Species

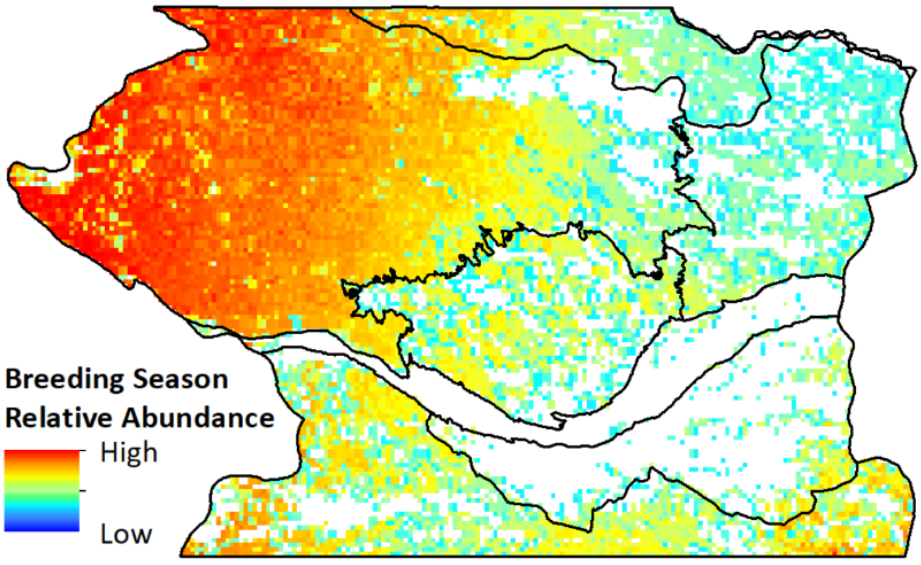
Rationale:

- Population change of -74% from 1970-2014,
- Expected to lose 50% of current population within 24 Years,
- Partners in Flight Common Birds in Steep Decline Species,
- Partners in Flight Species of Regional Concern in BCR 19,
- Tier I species of greatest conservation need in Nebraska State Wildlife Action Plan, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)





Distribution

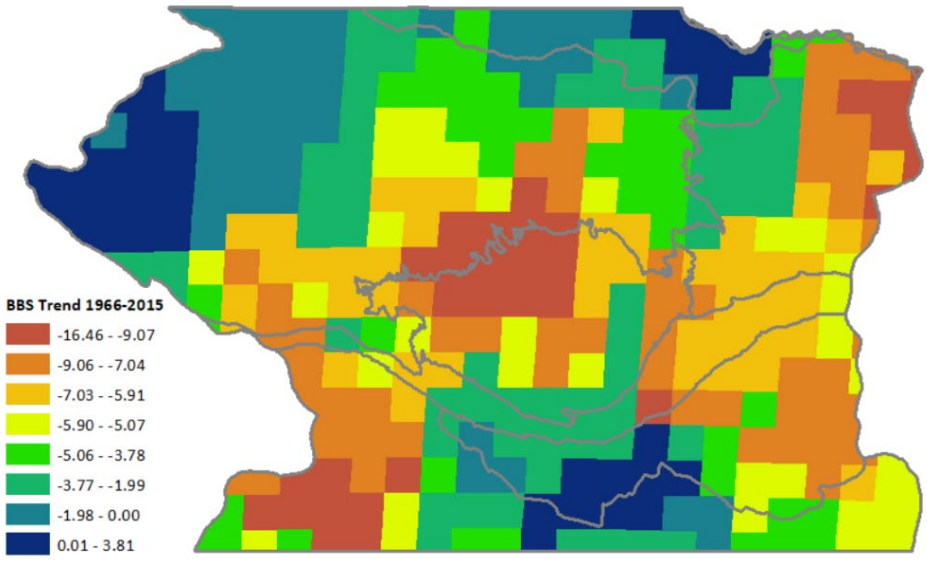


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Nests in isolated tree or shrub thickets in grasslands or pastures; prefers to nest in trees or shrubs possessing thorns

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Loss and fragmentation of grassland habitats due to agricultural conversion, and
- Reduction of prey availability caused by pesticide use

Management actions:

- Moderate-intensity, rotational grazing regimes,
- Retention of shelter-belts and small thickets,
- Delayed and infrequent haying,
- Infrequent, patch-burn prescribed fire,
- Preservation of existing native grasslands via acquisition, conservation easements or incentives, and
- Restoration and reclamation of pasture, hay fields and grassland establishment

Information needs:

- Determine which management practices produce optimal breeding habitat,
- Identify life stages that are the source of declines, and
- Identify factors limiting population growth

Links to more info

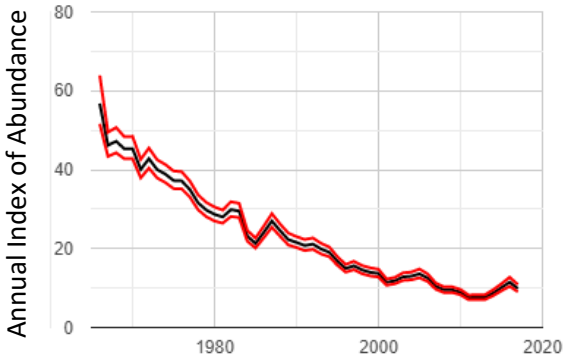
https://birdsoftheworld.org/bow/species/logshr/cur/introduction

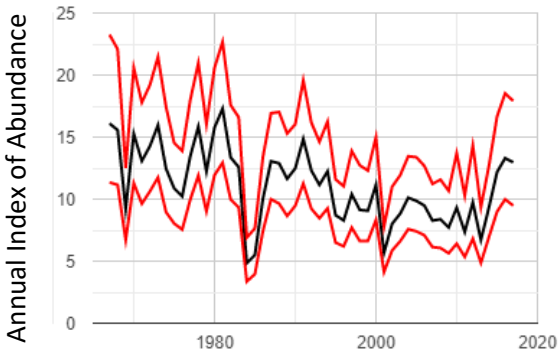
NORTHERN BOBWHITE

(*Colinus virginianus taylori*); Planning Species

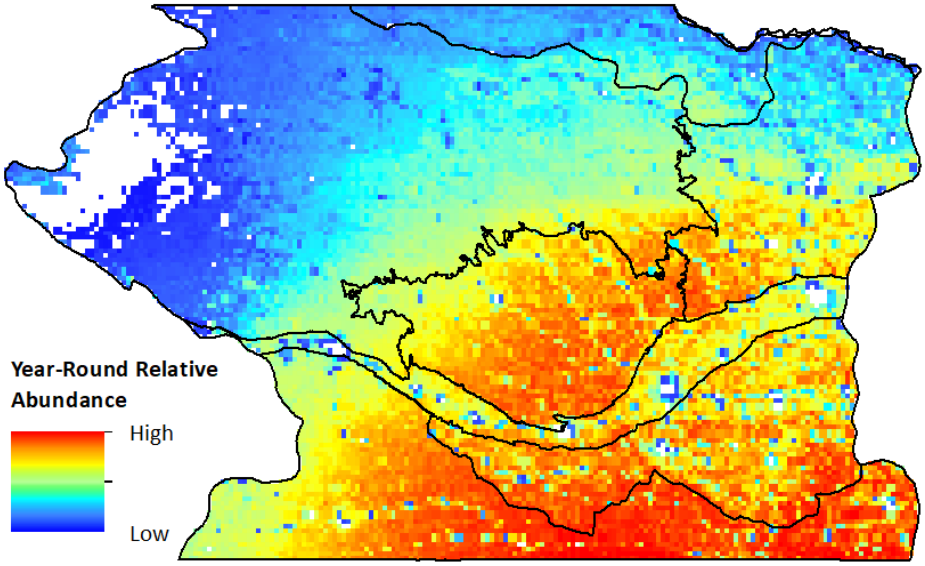
Rationale:

- Population change of -83% from 1970-2014,
- Expected to lose 50% of current population within 10 years,
- Partners in Flight Common Birds in Steep Decline Species,
- Partners in Flight Species of Regional Concern in BCR 19, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)





Distribution

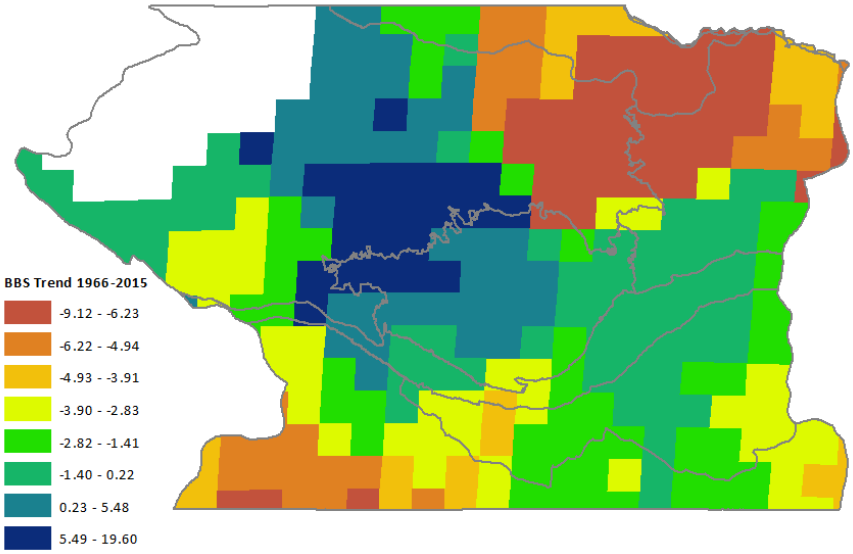


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Nests sites often include a diverse assemblage of grasses, forbs, and shrubs, and
- Preferred nest and brood rearing sites are a mixed mosaic of habitat types in a small area, ranging from bare ground to thick cover

Population status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Changing agricultural practices that result in the loss of fencerows, wind breaks, and field corners, and
- Excessive woody encroachment commonly caused by fire suppression and overgrazing

Management actions:

- Removal and management of woody invasives, particularly eastern red cedar, and
- Develop outreach efforts and incentives to encourage landowners to incorporate native forbs and shrubs into CRP grasslands

Information needs

- Measure direct or indirect impacts of pesticides, and
- Identify disturbance regimes that could increase survival of broods

Links to more info

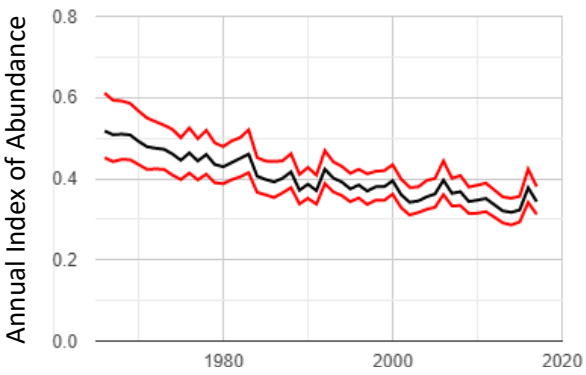
https://birdsoftheworld.org/bow/species/norbob/cur/introduction
https://bringbackbobwhites.org/

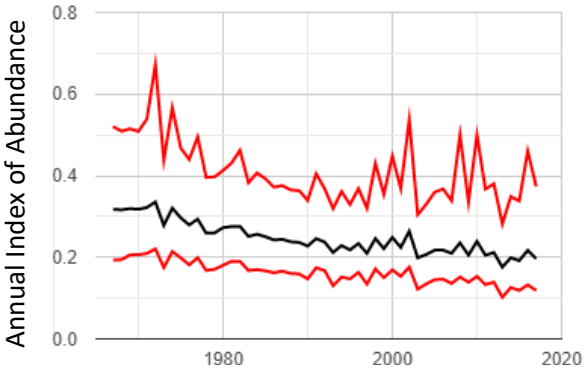
NORTHERN HARRIER

(*Circus cyaneus*); Stewardship Species

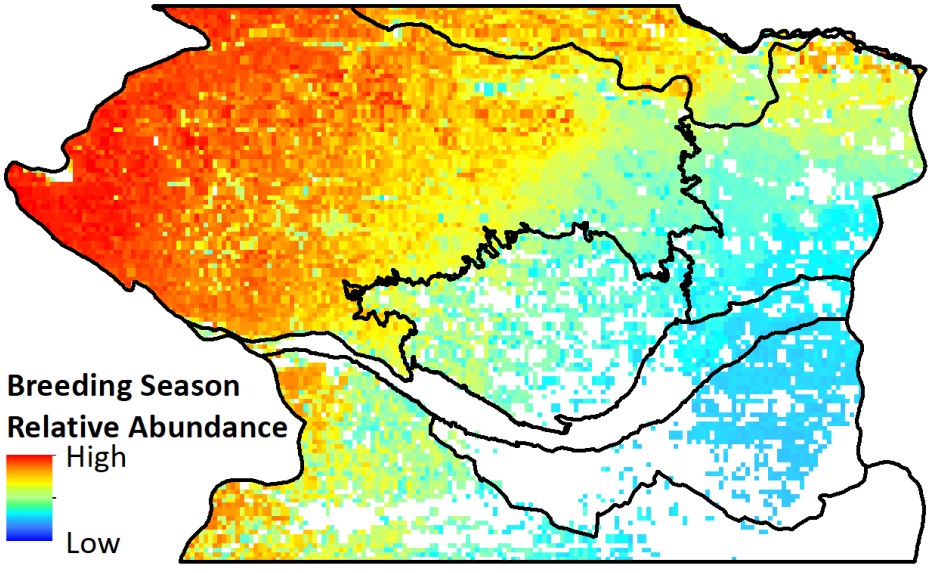
Rationale:

- Population change of -37% from 1970-2014,
  Partners in Flight Species of Regional Concern in BCR 19, and
  Negative BBS trends both survey-wide (left) and in Nebraska (right)





Distribution

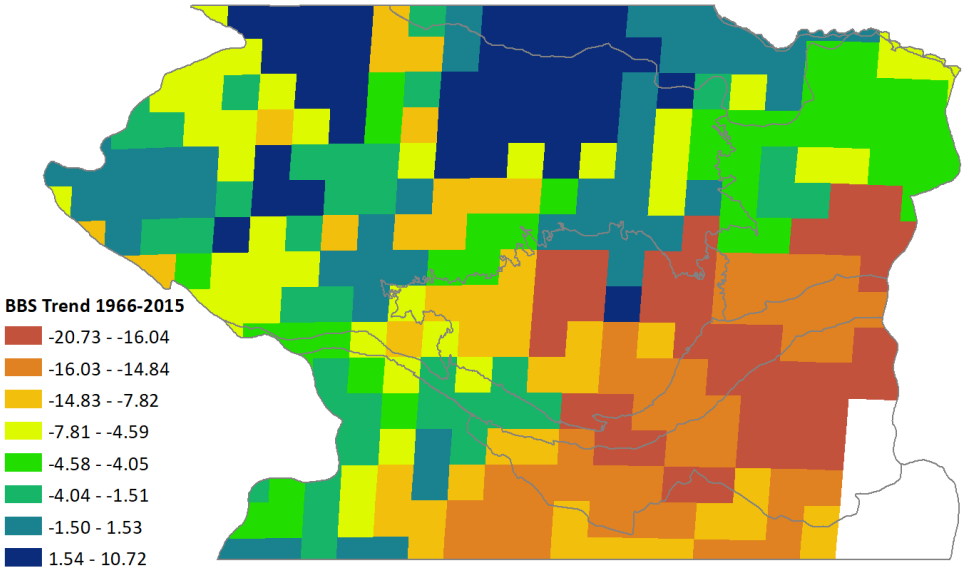


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Nests on the ground in grasslands, wetlands, and wet meadows, and
- Avoids forested habitats

Population status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Woody encroachment into grassland habitats, especially eastern red cedar,
- Loss and fragmentation of grassland and wetland habitats due to agricultural conversion,
- Overgrazing and early season haying, and
- Reduced prey availability due to rodenticide and insecticide use

Management actions

- Light to moderate grazing, prescribed fire, and deferred haying, and
- Preservation of existing native grasslands and wetlands via acquisition, conservation easements or incentives

Information needs

- Identify factors limiting population growth, and
- Determine which management practices produce optimal breeding habitat

Links to more info

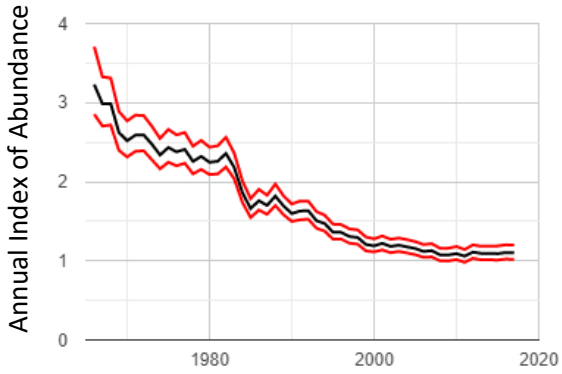
https://birdsoftheworld.org/bow/species/norhar2/cur/introduction

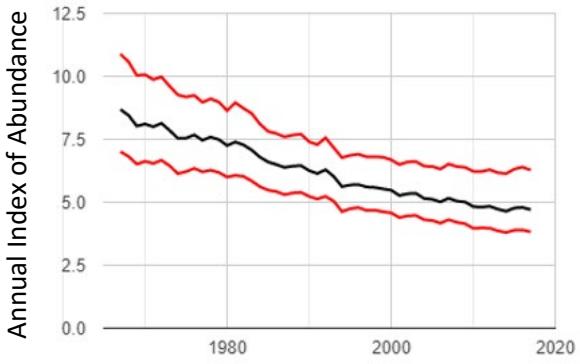
RED-HEADED WOODPECKER

(*Melanerpes erythrocephalus*); Planning Species

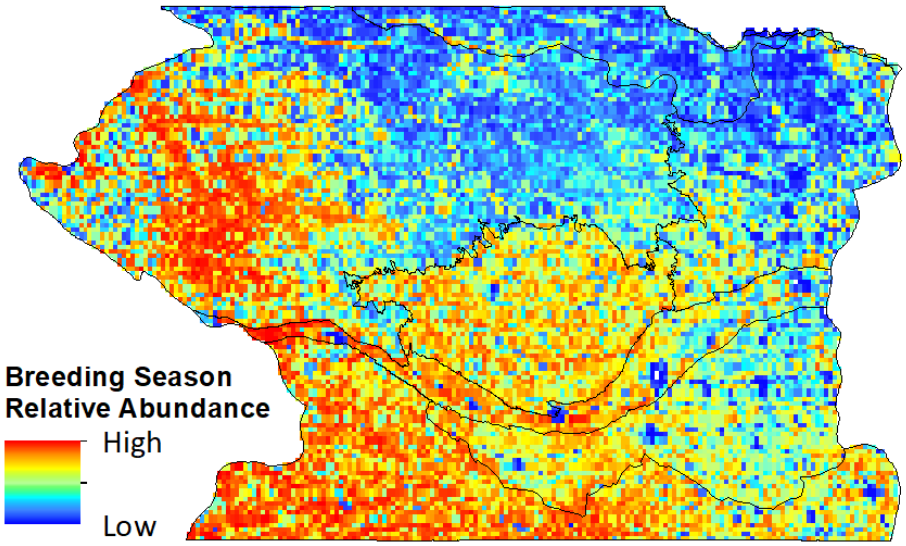
Rationale:

- Population change of -67% from 1970-2014,
- Partners in Flight Yellow Watchlist Species,
- Partners in Flight Species of Regional Concern in BCR 19, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)





Distribution

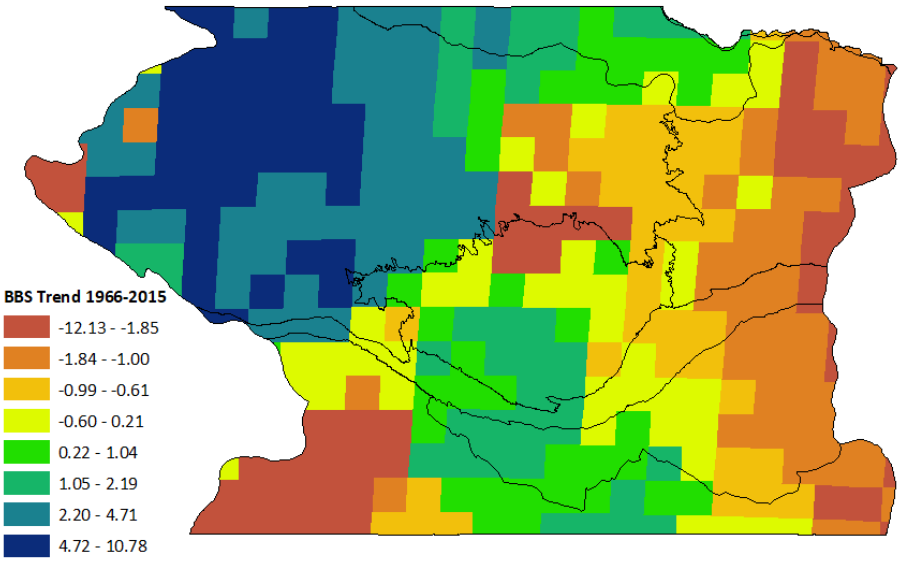


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Deciduous woodlands and grasslands with scattered trees, and
- Nests in dead trees or dead parts of live trees in fields or open forests with little to no vegetation or understory

Population status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Removal of snags and dead trees, and
- Loss of wooded riparian zones

Management actions:

- Create and maintain dead snags in and around known red-headed woodpecker territories, and
- Maintain wooded riparian zones and encourage growth of mature trees

Information needs

- Assess impact of management actions.

Links to more info

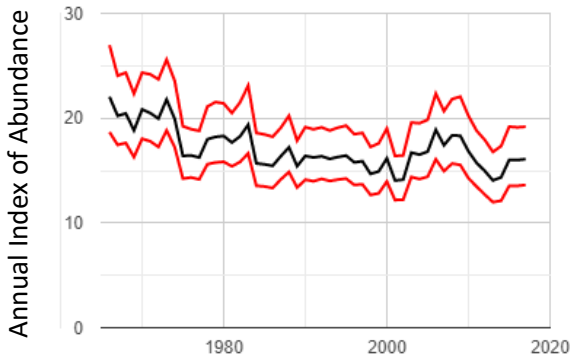
https://www.allaboutbirds.org/guide/Red-headed_Woodpecker/overview

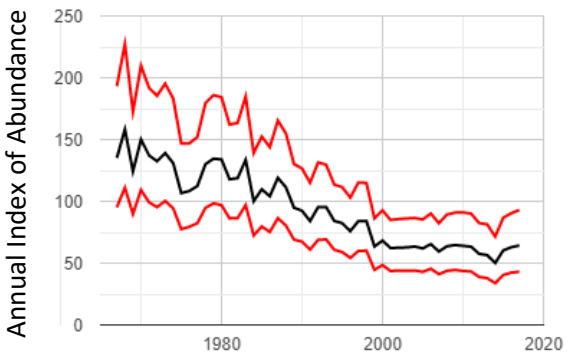
RING-NECKED PHEASANT

(*Phasianus colchicus*); Planning Species

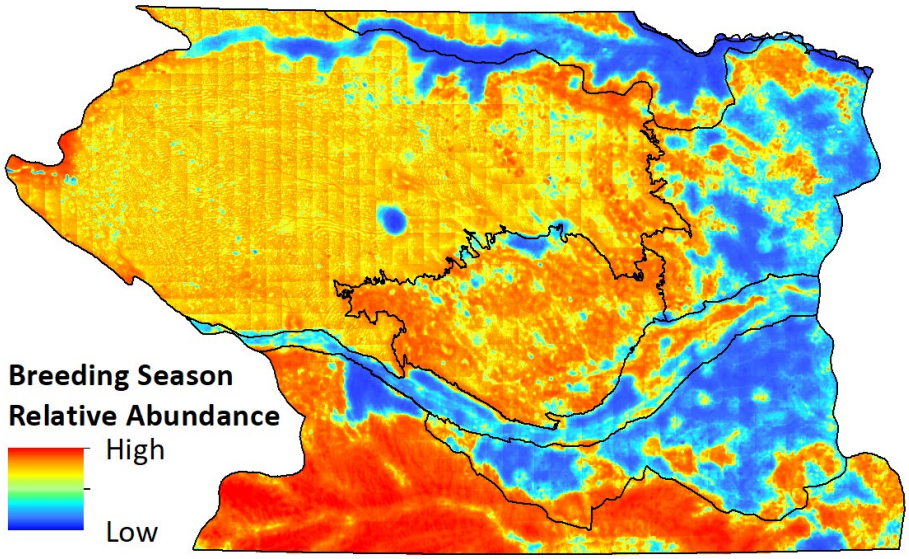
Rationale:

- High priority game species for Nebraska Game and Parks Commission partners, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)





Distribution

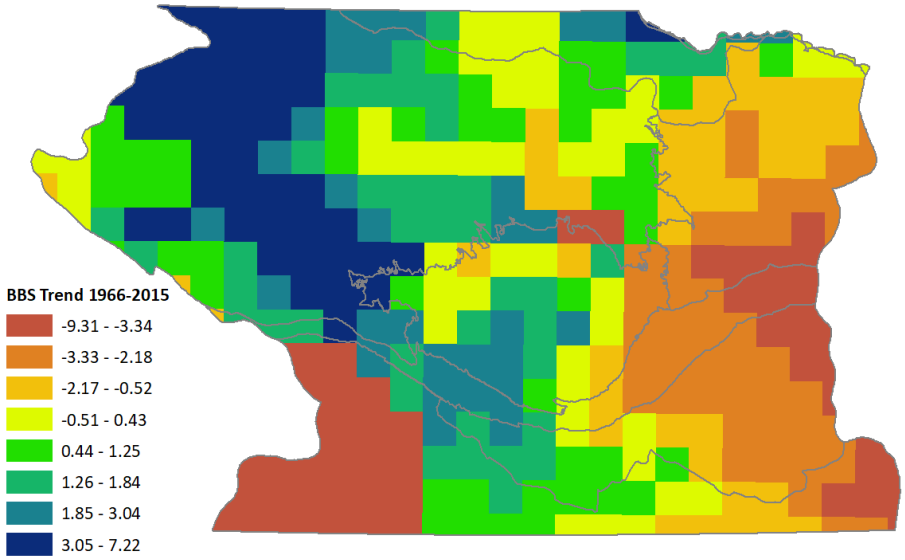


Map adapted from Jorgensen et al. 2014

Breeding habitat:

- Nests on the ground in patches of tall grasses, forbs, shrubs, or residual cover,
- Reproductive success is higher in managed CRP lands when compared to unmanaged tracts, and
- Grassland buffers of wetlands are often used for nesting in highly agricultural landscapes

Population status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Reduction of small grain and hay crops in favor of row crops, and
- Clean agricultural practices that eliminate fencerows, grassy field corners, and weeds

Management actions

- Herbicide spraying, disking, and prescribed fire to control invasive grasses, such as reed canary grass and smooth brome,
- Cattle grazing at appropriate intensities and intervals to help maintain native plant communities, and
- Planting and seeding of native forbs, legumes, and grasses

Information needs:

- Identify locations where habitat management is likely to be most effective, and
- Develop long-term monitoring to more accurately estimate population numbers

Links to more info

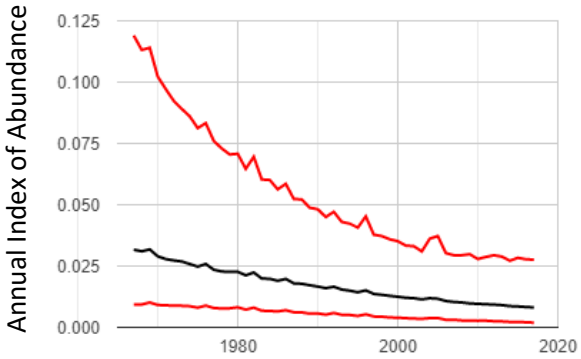
http://digital.outdoornebraska.gov/i/686820-the-berggren-plan/0?
https://birdsoftheworld.org/bow/species/rinphe/cur/introduction

SHORT-EARED OWL

(*Asio flammeus*); Stewardship Species

Rationale:

- Poplation change of -65% from 1970-2014,
- Partners in flight Common Birds in Steep Decline Species,
- Tier I species of greatest conservation need in Nebraska State Wildlife Action Plan, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)



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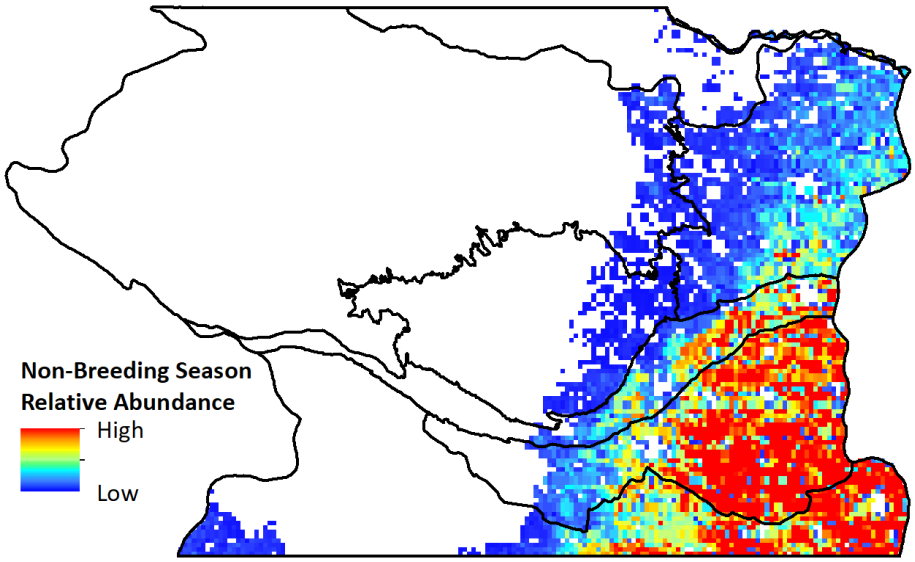


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Nests in open, undisturbed grasslands with standing cover, and
- Selects sites with a high availability of prey

Population status

Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Woody encroachment into grassland habitats, especially eastern redcedar,
- Loss and fragmentation of grassland habitats due to agricultural conversion,
- Direct human disturbance during nesting,
- Overgrazing and early season haying,
- Reduced prey availability due to rodenticide and insecticide use, and
- Collisions with fences and other low objects

Management actions:

- Light to moderate grazing, prescribed fire, and deferred haying, and
- Preservation of existing native grasslands via acquisition, conservation easements or incentives

Information needs:

- Need to better delineate nesting range in the RWBJV Region, and
- Determine which management practices produce optimal breeding habitat and high reproductive success.

Links to more info

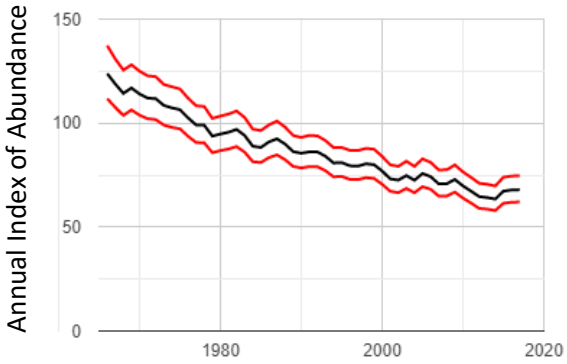
https://birdsoftheworld.org/bow/species/sheowl/cur/introduction

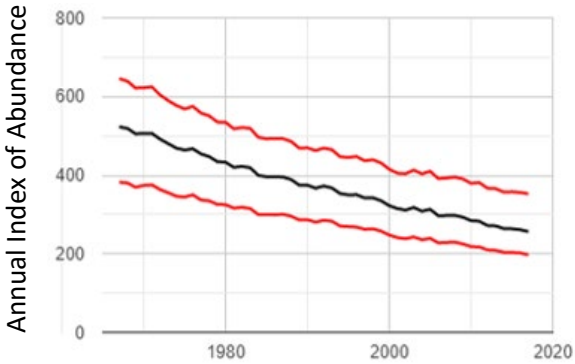
WESTERN MEADOWLARK

(*Sturnella neglecta*); Planning Species

Rationale:

- Population change of -42% from 1970-2014,
- Expected to lose 50% of current population within 50 years,
- Partners in Flight Species of Regional Concern in BCR 19, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)





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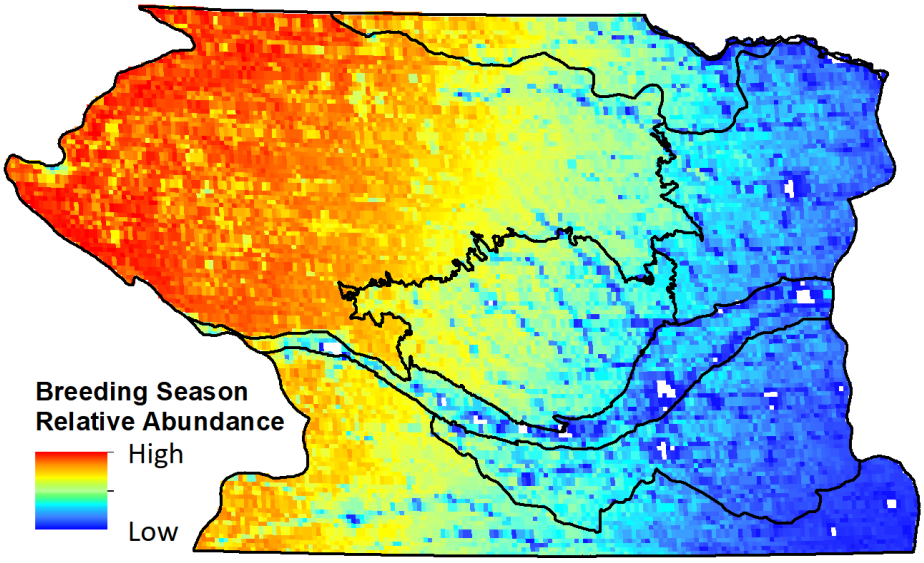
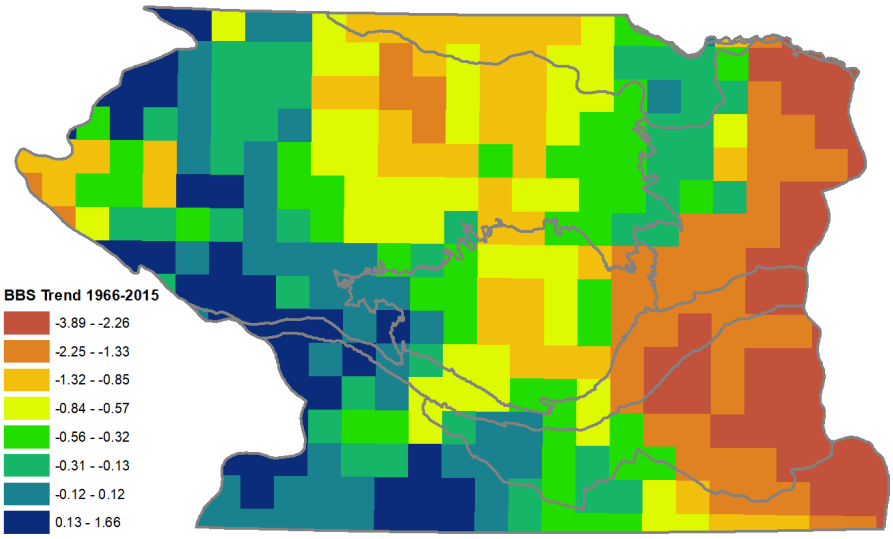


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Nests in large tracts of open grassland habitats
- Prefers tall and mixed-grass prairies, hayfields, wet meadows, and weedy edges of croplands,
- Avoids shrubby or forested habitats, and
- Sometimes found in short-grass and sage dominated plains

Population Status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Woody encroachment into grassland habitats, especially eastern red cedar,
- Loss and fragmentation of grassland habitats due to agricultural conversion, and
- Overgrazing and early season haying

Management actions:

- Light to moderate grazing, deferred haying, and infrequent prescribed fire,
- Preservation of existing native grasslands via acquisition, conservation easements or incentives, and
- Restoration and reclamation of pasture, hay fields and grassland establishment

Information needs:

- Identify factors limiting population growth, and
- Determine which management practices produce optimal breeding habitat

Links to more info

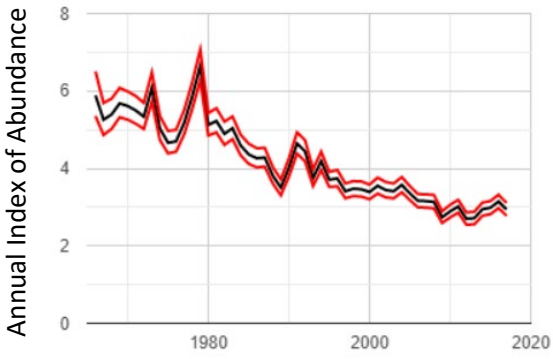
https://birdsoftheworld.org/bow/species/wesmea/cur/introduction

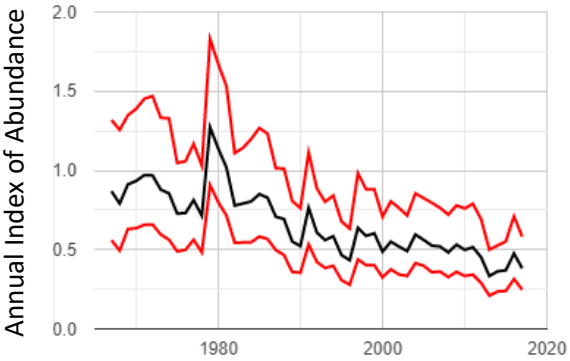
YELLOW-BILLED CUCKOO

(*Coccyzus americanus*); Stewardship Species

Rationale:

- Population change of -54% from 1970-2014,
- Expected to lose 50% of current population within 29 years,
- Partners in Flight Common Birds in Steep Decline Species,
- Partners in Flight Species of Regional Concern in BCR 19,
- Tier II species of greatest conservation need in Nebraska State Wildlife Action Plan, and
- Negative BBS trends both survey-wide (left) and in Nebraska (right)





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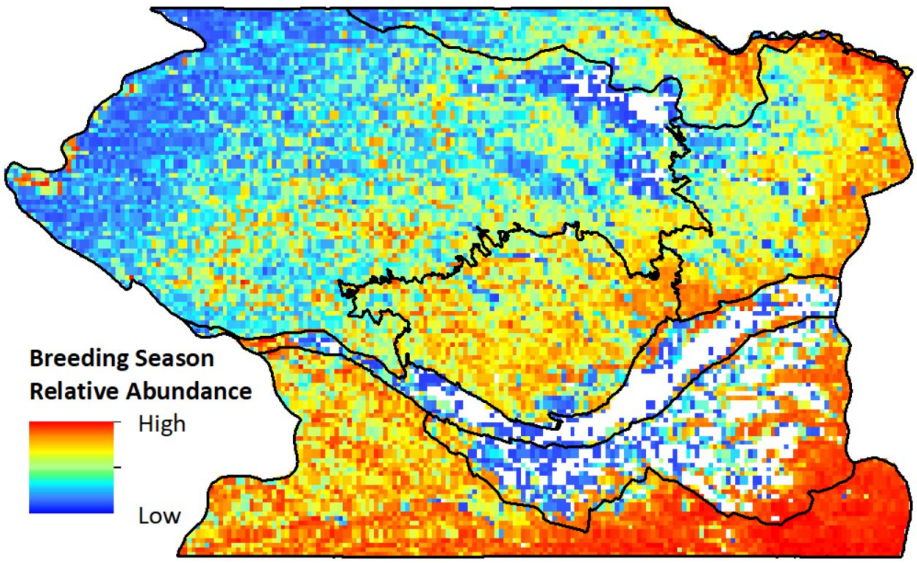
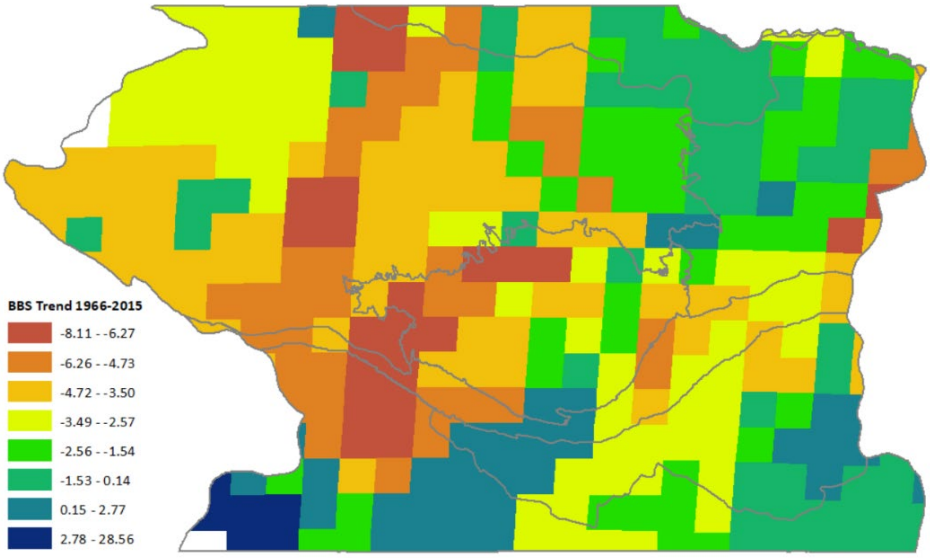


Map created using eBird data from 2014-2018 (Fink et al. 2020)

Breeding habitat:

- Open woodland with clearings and low, dense, scrubby vegetation,
- Often associated with watercourses, and
- Nests are most frequently placed in willows, but cottonwoods are used extensively for foraging

Population status



Map created using Breeding Bird Survey data from 1966-2015 (Sauer et al. 2017)

Threats:

- Reduced understory cover and density,
- Destruction or modification of preferred habitat due to agricultural and grazing activities,
- Conversion of habitat to cropland, and
- Conversion of woody cover to invasive nonnative vegetation, such as salt cedar

Management actions:

- Conservation and restoration of preferred riparian habitat for western subspecies is imperative,
- Eliminate pesticide spraying in orchards adjacent to riparian areas,
- Sustain ≥25 pairs per subpopulation, as per Nature Conservancy goal for habitat management, to, allow for interchange with other subpopulations to avoid extinction due to stochastic events, and
- Removal of invasive tamarisk, which reduces suitability of riparian habitat for nesting cuckoos

Information needs:

- Detailed censuses of declining western populations to determine effective population sizes necessary for future conservation programs,
- Identification of high-quality habitats and landscapes for breeding and migration in the RWBJV Region,
- Population limiting factors potentially related to nesting success, adult and juvenile survival, and related habitat and landscape features, and
- Many aspects of this species' life history require further study; including spacing and site tenacity; fecundity and mortality; mating system; and population structure and regulation

Links to more info

Hughes, J. M. (2020). Yellow-billed Cuckoo (*Coccyzus americanus*), version 1.0. In Birds of the World (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.yebcuc.01

Appendix 2. Methods For Ranking Threats/Limiting Factors

To help prioritize conservation actions and strategies for landbirds, the Rainwater Basin Joint Venture (RWBJV) Landbird Plan writing team conducted an expert elicitation exercise to prioritize threats/limiting factors in terms of their anticipated impacts on the populations of various bird-habitat groups over the next 30 years.

Compiling Lists of Threats/Limiting Factors and Species Groups

The Landbird Plan working group compiled a list of potential threats or limiting factors to landbirds using a standard lexicon of threats developed by Salafsky et al. (2008) as a guide (Table 1). Threats are defined as proximate human activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity targets. Threats can be past (historical), ongoing, and/or likely to occur in the future (Salafsky et al. 2008).

Table 1. List of threats or limiting factors to landbirds in the Rainwater Basin Joint Venture Region with a crosswalk to Salafsky et al. (2008) threat categories.

Threat or Limiting Factor	Salafsky Threat Category
Changing agricultural practices (e.g., clean practices that remove perches/trees/ fencerows/shelterbelts and reduce waste grain)	Agriculture and Aquaculture
Past or ongoing conversion to agriculture (i.e., row crops)	Agriculture and Aquaculture
Sensitivity to grazing regime (i.e., too much or too little)	Agriculture and Aquaculture
Human take – poaching, over-harvest, or pest control	Biological Resource Use
Climate change (e.g., warmer and wetter climate, extreme weather events, etc.)	Climate Change and Severe Weather
Energy infrastructure (e.g., gas/oil wells, wind turbines)	Energy Production and Mining
Ecotourism/Recreation	Human intrusions and disturbance
Altered mammal predator communities (i.e., cats or overabundant native meso-predators)	Invasive and Other Problematic Species and Genes
Avian brood parasites (i.e., Brown-headed Cowbirds)	Invasive and Other Problematic Species and Genes
Disease – direct mortality (e.g., West Nile Virus)	Invasive and Other Problematic Species and Genes

Threat or Limiting Factor	Salafsky Threat Category
Disease – indirect effects (e.g., plague effects on prairie dog colonies)	Invasive and Other Problematic Species and Genes
Invasive/non-native grasses and forbs and associated low plant community diversity	Invasive and Other Problematic Species and Genes
Woody encroachment (e.g., eastern red cedar, deciduous species)	Invasive and Other Problematic Species and Genes
Alteration of hydrological processes (e.g., damming rivers, surface and groundwater diversion)	Natural System Modifications
Early haying or burning (i.e., during the nesting season)	Natural System Modifications
Fire suppression (e.g., frequency, intensity, timing)	Natural System Modifications
Agricultural pesticides – direct mortality via bioaccumulation or acute toxicity	Pollution
Agricultural pesticides – indirect mortality via reductions in prey populations or reduced nest success	Pollution
Collisions with structures or vehicles	Residential and Commercial Development
Urban/suburban sprawl	Residential and Commercial Development

Table 2. List of bird-habitat groups, vegetation community associations, and corresponding planning and stewardship species identified in the Rainwater Basin Joint Venture Landbird Plan update.

Bird-Habitat Group	Vegetation Community Association	Priority Species
Birds Associated with Sparsely Vegetated Grassland	-Shortgrass Prairie -Grazed Pasture -Prairie Dog Towns -Heavily Grazed Grassland	-Burrowing Owl
Birds Associated with Low to Intermediately Vegetated Grassland	-Short- and Mixed-Grass Prairie -Low to Intermediate Grass Height -Limited Litter Cover -Sparse Woody Cover -Lightly or Moderately Grazed Grassland	-Chestnut-collared Longspur -Ferruginous Hawk -Grasshopper Sparrow -Greater Prairie-Chicken -Lark Bunting -Swainson's Hawk -Western Meadowlark

Bird-Habitat Group	Vegetation Community Association	Priority Species
Birds Associated with Densely Vegetated or Mesic Grassland	-Tallgrass Prairie -Wet Meadow -Hayland -High Grass Cover -High Litter Cover -Moderate to Tall Vegetation	-Bobolink -Dickcissel -Eastern Meadowlark -Ferruginous Hawk -Northern Bobwhite -Northern Harrier -Ring-necked Pheasant -Short-eared Owl
Birds Associated with Wooded Grassland or Savannah	-Grasslands or Pastures with Trees or Shrubs Present -Thickets -Shelterbelts -Savannah	-Brown Thrasher -Eastern Kingbird -Ferruginous Hawk -Lark Sparrow -Loggerhead Shrike -Northern Bobwhite -Ring-necked Pheasant -Swainson's Hawk
Birds Associated with Forest/Woodland	-Upland Forest/Woodland -Riparian Forest/Woodland	-Baltimore Oriole -Black-billed Cuckoo -Red-headed Woodpecker -Yellow-billed Cuckoo

Rather than prioritize all threats for all Landbird Plan planning and stewardship species, the Landbird Plan working group defined five bird-habitat groups based on vegetation community associations and assigned each planning and stewardship species to the bird-habitat groups (Table 2). Membership in a group was not mutually exclusive (i.e., several species occurred in more than one bird-habitat group).

Ranking Threats/Limiting Factors

We used a modified Delphi method (Hassan et al. 2000) to score and rank threats/limiting factors for each of the five bird-habitat groups. The Delphi method begins with a panel of experts answering questions on an individual basis. Then a facilitator provides an anonymized summary of the experts' input and the experts are encouraged to interact, ask one another questions and revise their earlier answers in light of the replies of other members of their panel. It is believed that during this process the range of the answers will decrease and the group will converge towards a "better" answer.

A panel was created consisting of members of the Landbird Plan working group and additional landbird experts. Panel members were: Andrew Pierson (Audubon), Andy Caven (Crane Trust), Kaylan Kemink (Ducks Unlimited), Joel Jorgensen (NGPC), Sarah Nevison (NGPC), T.J. Walker (NGPC), Andy Bishop (RWBJV), Roger Grosse (RWBJV), Niki Messmer (RWBJV), Brad Thornton (RWBJV), Dana Varner (RWBJV), Jeff Drahota (USFWS), Jim Dubovsky (USFWS), Orien Richmond (USFWS), Scott Somershoe (USFWS), and Larkin Powell (UNL).

Panel members were provided with a spreadsheet and asked to individually and anonymously score the impacts of the 20 threats/limiting factors listed in Table 1 by distributing 100 points across all threats for each bird-habitat group listed in Table 2. Higher points designated greater likelihood of causing harm to the bird-habitat group or preventing the recovery of the bird-habitat group within the RWBJV Region

over the next 30 years. Threats expected to have negligible impact on a given bird-habitat group were assigned zero points.

When considering each bird-habitat group, members focused on only the populations of those species assigned to that bird-habitat group, and their use of the affiliated vegetation community associations. Threats associated to species outside the bird-habitat group were not to be considered in the scoring. If a threat impacted only some of the species in a bird-habitat group, participants were instructed to adjust their scores accordingly.

Panel members were asked to consider the scope, severity, and irreversibility of each threat/limiting factor within the RWBJV Region when developing their scores:

- Scope is defined as the proportion of the bird-habitat group's populations that are likely to be affected by the threat within 30 years under current circumstances;
- Severity is defined as the level of damage to the bird-habitat group from the threat that can be expected over the next 30 years; and
- Irreversibility is defined as the degree to which the effects of the threat cannot be undone even if the threat is stopped.

Dana Varner compiled the individual threat scores from 10 of the panel's landbird experts into a single spreadsheet and calculated average scores, which were interpreted as the central tendencies of the panel as a whole. The threats were then sorted from the highest to the lowest average score. The threat scoring summary was reviewed by the full panel. Panel members were asked whether they agreed with the ranking of the threats across each of the bird-habitat groups and were given the opportunity to make any changes to the priority order of threats/limiting factors. The final ranked threat table is provided in Table 3.

Table 3. Threats/limiting factors to bird-habitat groups in the Rainwater Basin Joint Venture Region ranked from highest average score (greatest negative impacts on bird-habitat groups) to lowest average score (smallest negative impacts on bird-habitat groups).

Threats	Average of BIRDS ASSOCIATED WITH SPARSELY VEGETATED GRASSLAND (i.e., Shortgrass Prairie, Grazed Pasture, Prairie Dog Towns, Heavily Grazed)	Average of BIRDS ASSOCIATED WITH LOW TO INTERMEDIATELY VEGETATED GRASSLAND (i.e., Short- and Mixed-Grass Prairie, Low to Intermediate Grass Height, Limited Litter Cover, Sparse Woody Cover, Lightly or Moderately Grazed)	Average of BIRDS ASSOCIATED WITH DENSELY VEGETATED/MESIC GRASSLAND (i.e., Tallgrass Prairie, Wet Meadow, Hayland, High Grass Cover, High Litter Cover, Moderate to Tall Vegetation)	Average of BIRDS ASSOCIATED WITH WOODED GRASSLAND OR SAVANNAH (i.e., Grasslands or Pastures with Trees or Shrubs Present, Thickets, Shelterbelts, Savannah)	Average of BIRDS ASSOCIATED WITH FOREST/ WOODLAND (i.e., Upland or Riparian Forest/Woodland)
Past or ongoing conversion to agriculture (i.e., row crops)	24.50	32.50	31.00	31.40	22.70
Woody encroachment (e.g., eastern red cedar, deciduous species)	5.30	17.40	18.30	3.30	4.00
Climate change (e.g., warmer and wetter climate, extreme weather events, etc.)	6.70	6.10	5.50	8.00	12.70
Sensitivity to grazing regime (i.e., too much or too little)	11.50	9.30	10.05	3.60	0.00
Fire suppression (e.g., frequency, intensity, timing)	1.00	7.20	7.50	10.50	6.80
Changing agricultural practices (e.g., clean practices that remove perches/trees/ fencerows/shelterbelts and reduce waste grain)	3.50	1.80	3.30	13.70	8.50
Invasive/non-native grasses and forbs and associated low plant community diversity	4.60	5.00	4.30	4.10	4.50
Agricultural pesticides – direct mortality via bioaccumulation or acute toxicity	1.00	1.80	2.50	7.00	8.50
Altered mammal predator communities (i.e., cats or overabundant native meso-predators)	5.00	3.30	3.70	4.20	2.30

Threats	Average of BIRDS ASSOCIATED WITH SPARSELY VEGETATED GRASSLAND (i.e., Shortgrass Prairie, Grazed Pasture, Prairie Dog Towns, Heavily Grazed)	Average of BIRDS ASSOCIATED WITH LOW TO INTERMEDIATELY VEGETATED GRASSLAND (i.e., Short- and Mixed-Grass Prairie, Low to Intermediate Grass Height, Limited Litter Cover, Sparse Woody Cover, Lightly or Moderately Grazed)	Average of BIRDS ASSOCIATED WITH DENSELY VEGETATED/MESIC GRASSLAND (i.e., Tallgrass Prairie, Wet Meadow, Hayland, High Grass Cover, High Litter Cover, Moderate to Tall Vegetation)	Average of BIRDS ASSOCIATED WITH WOODED GRASSLAND OR SAVANNAH (i.e., Grasslands or Pastures with Trees or Shrubs Present, Thickets, Shelterbelts, Savannah)	Average of BIRDS ASSOCIATED WITH FOREST/ WOODLAND (i.e., Upland or Riparian Forest/Woodland)
Disease – indirect effects (e.g., plague effects on prairie dog colonies)	14.00	1.30	0.50	1.00	0.00
Avian brood parasites (i.e., Brown-headed Cowbirds)	0.00	3.00	2.60	3.30	7.00
Human take – poaching, over-harvest, or pest control	14.00	0.70	0.00	0.60	0.00
Urban/suburban sprawl	2.00	2.60	1.80	2.50	6.00
Energy infrastructure (e.g., gas/oil wells, wind turbines)	1.70	2.80	3.10	1.80	0.50
Agricultural pesticides – indirect mortality via reductions in prey populations or reduced nest success	1.00	0.50	1.50	3.00	2.50
Early haying or burning (i.e., during the nesting season)	0.00	3.50	2.95	0.50	0.00
Collisions with structures or vehicles	3.00	0.50	0.70	0.50	2.00
Alteration of hydrological processes (e.g., damming rivers, surface and groundwater diversion)	0.00	0.00	0.70	0.00	5.50
Disease – direct mortality (e.g., West Nile Virus)	0.20	0.70	0.00	1.00	2.50
Ecotourism/Recreation	1.00	0.00	0.00	0.00	0.00

Appendix 3. Grassland Conversion Analysis

The Rainwater Basin Joint Venture developed two grassland assessments to measure the rate of grassland loss to conversion in recent years. The first stepped-down method was used in an assessment across eight Migratory Bird Joint Ventures in the Great Plains (Fields & Barnes 2019). This biome assessment identified grassland losses in the Great Plains through agricultural conversion. The RWBJV adapted the Fields and Barnes (2019) methods to explore how grasslands have diminished within each of the RWBJV's eight Geographic Focus Areas (GFAs).

The second method used an analysis of annual Cropland Data Layer from the National Agricultural Statistics Service (CDL, NASS) geospatial data published by Lark et al. (2020). Two methods were employed because both the CDL and CLU datasets contain uncertainty. Generating a predicted range for rate of loss allowed for a more accurate estimate. By quantifying grassland loss, the most appropriate way to preserve and restore grasslands can be determined within each of the eight GFAs and also align with regional goals and efforts across the Great Plains. The results of this analysis will be used to develop grassland objectives within the RWBJV Implementation Plan.

Methods

Potentially Undisturbed Lands (PUDL)

To evaluate agricultural conversion, contemporary grasslands were identified using the RWBJV's Nebraska Land Cover (Bishop et al. 2020, land status current to 2016). Annual cropping extent was identified using Farm Service Agency Common Land Units (FSA, CLU) from 2008-18. As described in the regional assessment (Fields & Barnes 2019), cropland CLU polygons were identified by the CLU classification code *two* or cropland indicator 3cm code *one.* Using the annual cropping extents, the annual rate of cropland conversion was determined.

The annual extents of cultivated lands were aggregated to create "Potentially Undisturbed Lands" acreage (Fields & Barnes 2019). Any lands that had no history of cropping within the dataset were identified as PUDL lands (Figure 2). It is important to note however, grasslands may have been previously converted to production and returned to grassland, prior to the first year of data (2008). PUDL grasslands have a greater potential to possess native grass and forb species, than disturbed grasslands.

The annual agricultural conversion rate (using the PUDL 2008-2018 analysis) was used to project future grassland loss to agricultural conversion. If conversion continues at this rate, by 2050, the Rainwater Basin Joint Venture Region may lose another 1.5 million acres of grassland. This does not take into account grassland habitat losses from causes other than agricultural conversion.

Cropland Data Layer

Lark et al. (2020) mapped cropland expansion in the United States. The geospatial layers used in Lark et al.'s analysis were published online, which provided a second data source to estimate recent conversion rates in the each of the GFAs. Data from years 2008-2016 were used. Total percent converted from grass to crop was calculated by overlapping Lark et al.'s (2020) raster (which maps acres converted to agriculture) with the 2008 CDL grassland layer. Total number of 2008 grassland acres converted to agriculture from 2008-2016 in each GFA was measured. Next, the total number converted in each GFA was divided by the total number of grassland acres in 2008 in each GFA. This total percent was then used to calculate an annual rate of loss in each GFA for the 8-year period.

Conservation Estate and Non-irrigated Capability Class

While the PUDL analysis process allows us to estimate annual rate of grassland conversion to agriculture, there are also factors that constrain conversion to agriculture. The two primary constraints are soils classes that are less suitable to crop production, and grasslands currently under conservation. Non-irrigated capability class from the Gridded Soil Survey Geographic Database (gSSURGO) was used as the constraining soil factor for conversion to cropland. The descriptions of non-irrigated capability classes are shown in Table 1. Soil class 4 and above were selected as having low probability of conversion. The contemporary grassland (all grass) and conservation estate layers were resampled to 10m cells, to match the gSSURGO cells. The combined area of the gSSURGO and conservation estate layers was then used to mask the all-grass layer; producing the low likelihood of conversion grasslands.

Table 1. Non-Irrigated Capability Class Descriptions

Soils Having Higher Probability of Conversion to Cropland	
Class 1	Soils have few limitations that restrict their use
Class 2	Soils have moderate limitations that reduce the choice of plants or that require moderated conservation practices
Class 3	Soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both
Soils Having Low Probability of Conversion to Cropland	
Class 4	Soils have very severe limitations that reduce the choice of plants or that require very careful management, or both
Class 5	Soils are subject to little or no erosion but have other limitations, impractical to remove, that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat
Class 6	Soils have severe limitations that make them generally unsuitable for cultivation and that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat
Class 7	Soils have very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, forestland, or wildlife habitat
Class 8	Soils and miscellaneous areas have limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or esthetic purposes

Results

Based on CLU data, the areal extent of agricultural production across the RWBJV Region increased every year from 2008-2018 (Table 2). The average rate of increase was 45,000 acres/year. The highest conversion rates occurred between 2008 and 2014, corresponding with higher commodity prices. This appears to indicate that during times of depressed commodity prices, opportunities may exist to reduce, eliminate, or even reverse expansion by providing alternative income opportunities for landowners.

Looking at individual GFAs, there were two data points where total area of agricultural production decreased substantially: Republican/Blue River Drainages & Loess Canyons 2010 and Sandhills 2018, a small amount of reduction occurred in Missouri River GFA 2016. However, while total area of agricultural production continues to increase, individual tracts of land are still being taken out of production and returned to grassland (Figure 1).

Using Lark et al.'s (2020) CDL-based geospatial data, the rates of loss were found to be lower for most GFAs. The Sandhills was the only region that indicated a higher rate of loss with this method, likely related to the weak ability of CDL to accurately identify grasslands which dominate the region (Lark et al. 2021). Stark differences in estimates were particularly notable in the Missouri River and Rainwater Basin GFAs. Since CDL methods likely underestimate conversion and CLU data overestimates, a mean of the

two rates is the closest available approximation to the true rate. When the two rates were averaged, each GFA fell into one of three levels of conversion. The highest rates occurred in the Missouri River, Northeast Prairies/Elkhorn River, and Rainwater Basin GFAs and ranged from -1.6 to -1.9%. Rates between -0.3 and -0.4% were identified in the Central and North Platte River, Central Loess Hills, Republican River/Blue River Drains & Loess Canyons, and Verdigris-Bazile Drainage GFAs. The lowest rate (-0.03%) was found in the Sandhills.

Table 2. Annual row crop agriculture by region classified from Common Land Units.

		2008	2009		2010		2011		2013		2014	
Geographic Focus Area	Total Acres	Crop Acres	Crop Acres	Acres Difference from Previous Year	Crop Acres	Acres Difference from Previous Year	Crop Acres	Acres Difference from Previous Year	Crop Acres	Acres Difference from Previous Year	Crop Acres	Acres Difference from Previous Year
Central and North Platte River	1,985,877	1,228,041	1,235,975	7,934	1,240,667	4,693	Incomplete Data	Incomplete Data	1,243,882	3,214	1,247,280	3,398
Central Loess Hills	3,598,458	1,361,358	1,379,940	18,581	1,391,330	11,390	Incomplete Data	Incomplete Data	1,412,304	20,974	1,418,060	5,756
Missouri River	82,731	25,484	25,599	115	25,614	16	25,615	1	25,790	175	26,430	640
Northeast Prairies/ Elkhorn River	3,953,677	3,004,758	3,035,108	30,350	Incomplete Data	Incomplete Data	3,054,690	19,582	3,079,180	24,489	3,093,676	14,497
Rainwater Basin	3,830,156	3,100,771	3,122,558	21,788	3,127,294	4,736	3,142,864	15,570	3,157,063	14,199	3,165,084	8,021
Republican River/Blue River Drainage & Loess Canyons	5,796,877	2,877,649	2,915,461	37,812	2,914,287	-1,173	Incomplete Data	Incomplete Data	2,951,524	37,236	2,966,161	14,638
Sandhills	13,517,078	929,198	937,139	7,941	944,607	7,467	Incomplete Data	Incomplete Data	951,102	6,495	959,067	7,965
Verdigris- Bazile Drainage	1,986,870	543,802	549,939	6,137	553,303	3,364	560,423	7,120	575,523	15,100	582,086	6,564
Total	**34,751,724**	**13,071,062**	**13,201,719**	**130,657**	**Incomplete Data**	**Incomplete Data**	**Incomplete Data**	**Incomplete Data**	**13,396,366**	**121,883**	**13,457,844**	**61,479**

Table 2 Continued. Annual row crop agriculture by region classified from Common Lands Units

		2015		2016		2017		2018			
Geographic Focus Area	Total Acres	Crop Acres	Acres Difference from Previous Year	Crop Acres	Acres Difference from Previous Year	Crop Acres	Acres Difference from Previous Year	Crop Acres	Acres Difference from Previous Year	Average Annual Acre Increase	Crop Acre Difference 2008-2028
Central and North Platte River	1,985,877	1,247,735	455	1,248,670	935	1,248,899	229	1,249,340	441	2,130	21,299
Central Loess Hills	3,598,458	1,423,143	5,083	1,427,309	4,166	1,429,448	2,139	1,429,631	183	6,827	68,272
Missouri River	82,731	26,436	6	26,427	-10	26,449	22	26,446	-4	96	961
Northeast Prairies/ Elkhorn River	3,953,677	3,097,819	4,143	3,103,585	5,766	3,105,308	1,724	3,106,301	993	10,154	101,543
Rainwater Basin	3,830,156	3,169,269	4,185	3,173,164	3,895	3,175,565	2,401	3,176,879	1,314	7,611	76,108
Republican River/Blue River Drainage & Loess Canyons	5,796,877	2,971,060	4,899	2,976,693	5,633	2,979,954	3,261	2,981,461	1,507	10,381	103,812
Sandhills	13,517,078	962,371	3,305	963,050	679	964,972	1,922	964,136	-836	3,494	34,938
Verdigris- Bazile Drainage	1,986,870	584,369	2,282	587,085	2,717	587,561	476	587,745	183	4,394	43,942
Total	**34,751,724**	**13,482,203**	**24,358**	**13,505,984**	**23,781**	**13,518,157**	**12,173**	**13,521,938**	**3,781**	**45,088**	**450,877**

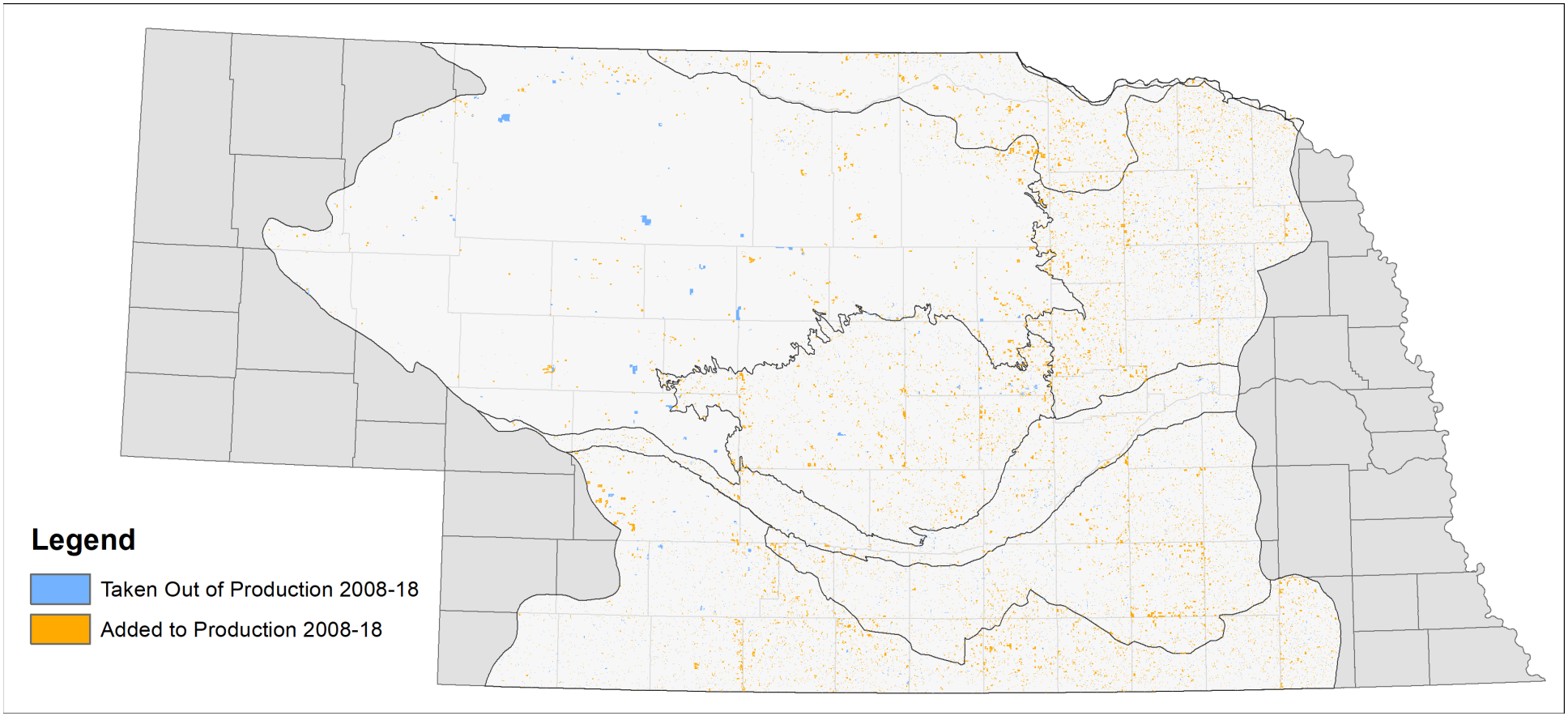


Figure 1. Difference in areal extent of agricultural production comparing 2008 and 2018.

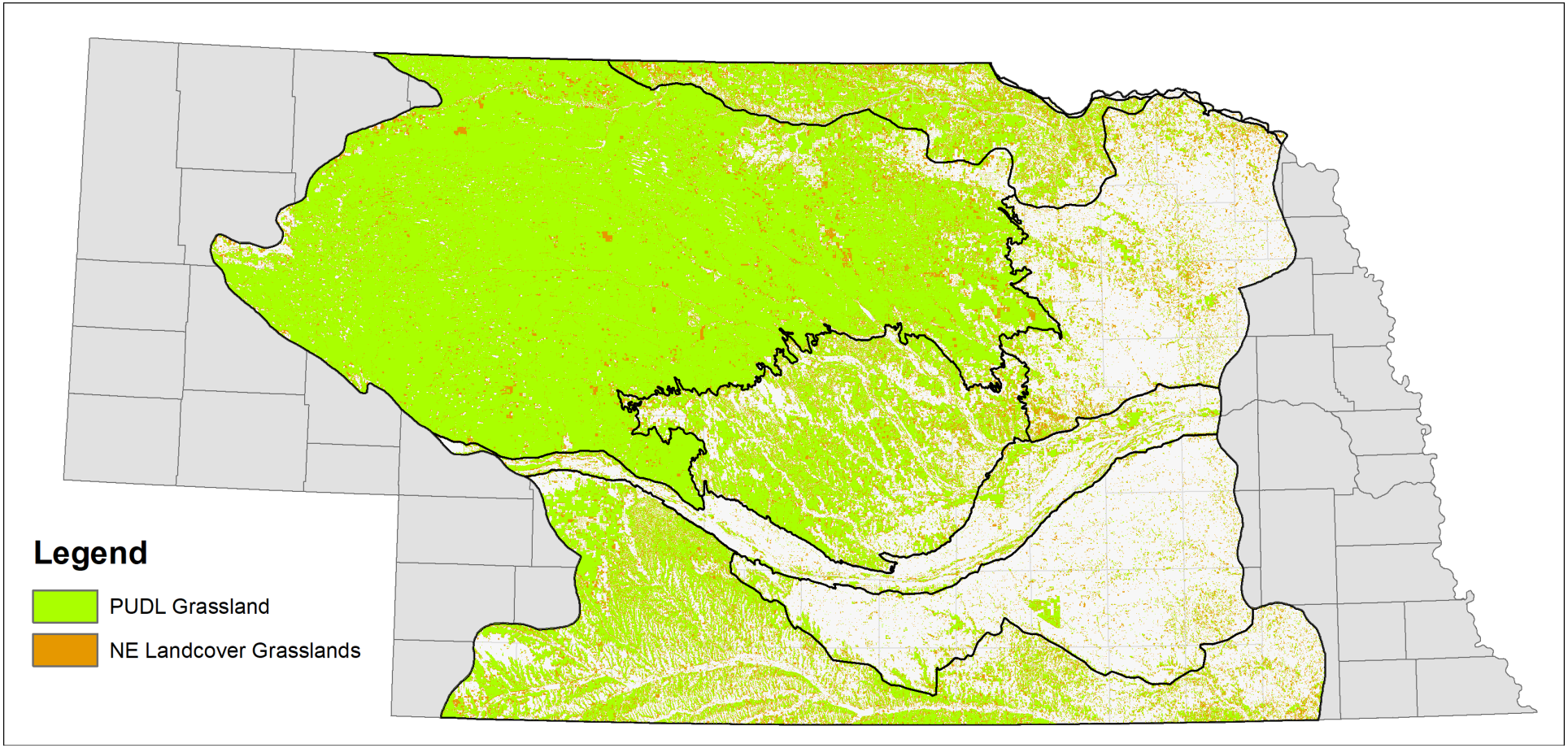


Figure 2. RWBJV Nebraska Land Cover (Bishop et al. 2020, land status current to 2016) and Potentially Undisturbed Land grasslands (Fields and Barnes 2019).

Appendix 4. Woody Encroachment Analysis

Grassland assessment completed across the Great Plains (Fields and Barns 2019) identified two causes of grassland loss: agricultural conversion and woody encroachment. The RWBJV used comparable methods to stepdown the assessment across the eight Geographic Focus Areas with the RWBJV Region. By quantifying grassland loss due to these two factors, it can be determined the most appropriate way to preserve and restore grasslands and align RWBJV's objectives with Great Plains goals and efforts.

Methods

For analysis of grassland loss due to woody encroachment, the Rangeland Analysis Platform (RAP, University of Montana 2018) data was used. The average percent canopy (band 6) for 2009-2011 was compared with the average percent canopy for 2017-2019. Since RAP is available annually, averaging three years allowed reduced artifacts caused by unusually high or low vegetative moisture content in any given year.

Creation of Data Layers

Rangeland Analysis Platform (RAP)

The RAP dataset applies an algorithm to 30-meter satellite imagery to model percent cover of tree canopy. The model produces a percent canopy value across the entire satellite scene, regardless of whether it is applicable. This happens because the model is trying to quantify percent tree cover associated with spectral values and does not attempt to classify features themselves. For example; reservoirs, croplands and wetlands all possess high percent canopy values in the model output, as they have reflectance values similar to higher tree canopy densities. While percent canopy values are not applicable to these features, they do have meaning for other features that may not be classified as trees, e.g., interspersed trees imbedded in grassland features, or savannahs.

The RAP website uses a mask to remove non-applicable features. This mask was recreated and refined to evaluate percent tree cover in upland habitats across each GFA. Since upland bird habitat is the focus, the refined data masked more features, including masking out riparian canopy. Three datasets were used: Cropland Data Layer (CDL), National Wetland Inventory (NWI), and Gridded Soil Survey Geographic Database (gSSURGO) to create the masks used in this assessment. Two masks were created for use with each averaged canopy series, 2009-11 and 2017-19. The masks address the same years as the cropland data used.

Cropland Data Layer (CDL)

The Cropland Data Layer was used primarily to eliminate features of row crop agriculture in the RAP tree canopy layer. The Cropland Data Layer is annually produced by the National Agricultural Statistics Service (NASS 2019) and spatially identifies crop production by crop type. For this mask, the last year of the start series (2009-2011) and end series (2017-2019), specifically 2011 and 2019, were used to capture the largest agricultural expansion in the series. The CDL layer was reclassified so all crop codes were zero. All other codes, with the exception of water/open water and wetlands, were reclassified as one. The result is crop areas were defined as the *NoData* value (Table 1). Water, open water, and wetland classes, obtained from the National Land Cover Dataset (NLCD 2016), were included and used for non-cropped classes in CDL. This information is more current than NWI data.

Table 1. Cropland Data Layer Mask Crosswalk. Mask values of *zero* will be retained in the output, while mask values of *one* will be changed to the average percent tree cover value identified by RAP.

Class Value	Class Name	Mask Value
0	Background	1
1	Corn	0
4	Sorghum	0
5	Soybeans	0
6	Sunflower	0
12	Sweet Corn	0
13	Pop or Orn Corn	0
14	Mint	0
21	Barley	0
23	Spring Wheat	0
24	Winter Wheat	0
26	Dbl Crop Win Wht/Soybeans	0
27	Rye	0
28	Oats	0
29	Millet	0
32	Flaxseed	0
36	Alfalfa	0
37	Other Hay/Non Alfalfa	0
39	Buckwheat	0
41	Sugarbeets	0
42	Dry Beans	0
43	Potatoes	0
44	Other Crops	0
47	Misc Vegs & Fruits	0
48	Watermelons	0
51	Chick Peas	0
52	Lentils	0

Class Value	Class Name	Mask Value
53	Peas	1
58	Clover/Wildflowers	0
59	Sod/Grass Seed	0
60	Switchgrass	0
61	Fallow/Idle Cropland	0
68	Apples	0
69	Grapes	0
111	Open Water	0
121	Developed/Open Space	0
122	Developed/Low Intensity	0
123	Developed/Med Intensity	0
124	Developed/High Intensity	0
131	Barren	1
141	Deciduous Forest	1
142	Evergreen Forest	1
143	Mixed Forest	1
152	Shrubland	1
176	Grassland/Pasture	1
190	Woody Wetlands	0
195	Herbaceous Wetlands	0
205	Triticale	0
225	Dbl Crop WinWht/Corn	0
228	Dbl Crop Triticale/Corn	0
229	Pumpkins	0
236	Dbl Crop WinWht/Sorghum	0
237	Dbl Crop Barley/Corn	0
254	Dbl Crop Barley/Soybeans	0

National Wetland Inventory (NWI)

National Wetland Inventory is produced by the U.S. Fish and Wildlife Service (USFWS 2020) and inventories all wetlands in the United States. For of the broadest classifications (riverine and lacustrine) were focused on. Both masks developed for the percent canopy comparison analysis masked lacustrine features. In addition to lacustrine features, the upland grassland analysis also masks all riverine features. NWI palustrine wetlands were left unmasked, as wetlands unassociated with upland habitats will get masked in the soil layer.

Gridded Soil Survey Geographic (gSSURGO)

Eastern red cedar control in the Sandhills GFA is one of the RWBJV's grassland landscape priorities. Ensuring the accuracy of a comparison analysis within the Sandhills is likewise a priority. The Sandhills is the largest intact grassland landscape in the RWBJV Region with many lakes, wetlands, and wet meadows scattered throughout. These water features are created and maintained by the porous soils

connecting ground and surface water. The high moisture content of the vegetation causes the RAP canopy cover data to often include these water features as high canopy which necessitates masking.

The gSSURGO dataset is a 10-meter rasterized version of the Natural Resource Conservation Service's SSURGO (NRCS 2020) vector data. Their ecosite descriptions were identified as the most accurate soil attribute from the SSURGO data to describe wetlands and wet meadows. The standard gSSURGO geodatabase was downloaded from NRCS Data Gateway; however updated ecosite descriptions from the Imperial, Nebraska NRCS Office were obtained. Ecosite descriptions corresponding with 'wetland' and 'wet sub-irrigated' soils were reclassified as *zero* and all other soils assigned as *NoData*.

RAP Mask Application

The three input mask layers were resampled (or converted to raster), re-projected, and snapped to the RAP data prior to mosaicking. In the resulting mask, masked features contain cell values of *zero*, while all other features were assigned *NoValue* (Figure 1). Each of the 3 years of RAP data in the start and end series of the RAP data were averaged together and the masks were subsequently mosaicked on top of the averaged RAP outputs so that mask features contain percent cover values of *zero*, while all other features possess the average RAP value.

Results

Average percent woody canopy cover increased across all regions; ranging from 0.08% in the Missouri River region to nearly 0.8% in the Verdigre-Brazile Drainage (Table 2). It's important to note, the acres indicated in the table are the mean increase in canopy cover in each GFA times the GFA's total area. The total impacted area is much larger and encompasses nearly all grasslands (Figure 2). The last three columns in Table 2 are estimates of the area within each GFA that would meet NRCS treatment requirements at one, three, and five percent annually at the current rates of encroachment. This represents the amount of treatment required annually to maintain the current level of woody canopy, if treating at one of these three thresholds.

Table 2. Upland Canopy Summary and Treatment Cost Estimates for Each GFA and for the Entire RWBJV Region.

		Upland Tree 2009-2011			Upland Tree 2017-2019			Difference			1% Threshold	3% Threshold	5% Threshold	1% Threshold	3% Threshold	5% Threshold
Region	Total GFA Acres	Mean	STDV	Canopy Acres	Mean	STDV	Canopy Acres	Mean	STDV	Canopy Acres	Annual Treatment Acres	Annual Treatment Acres	Annual Treatment Acres	Estimated Treatment Cost (USD)	Estimated Treatment Cost (USD)	Estimated Treatment Cost (USD)
Central Loess Hills	3,598,431	1.5	5.1	54,240	2.0	6.1	73,292	0.53	1.03	19,052	188,612	61,601	36,198	3,389,355	1,106,961	650,482
Central and North Platte River	1,985,904	0.8	3.5	16,004	0.9	3.9	18,786	0.14	0.42	2,782	27,546	8,996	5,287	495,001	161,667	95,000
Missouri River	80,630	2.1	8.8	1,713	2.2	9.4	1,778	0.08	0.60	65	640	209	123	11,499	3,756	2,207
Northeast Prairies/Elkhorn River	3,953,681	1.3	5.1	52,392	1.6	6.1	61,562	0.23	1.00	9,170	90,785	29,650	17,423	1,631,408	532,817	313,098
Rainwater Basin	3,830,133	0.7	3.7	28,144	0.9	4.8	34,954	0.18	1.15	6,810	67,420	22,019	12,939	1,211,529	395,685	232,516
Republican/Blue River Drainages & Loess Canyons	5,796,719	1.5	5.6	87,385	1.7	6.4	99,838	0.21	0.76	12,452	123,276	40,262	23,659	2,215,275	723,507	425,154
Sandhills	13,517,038	0.6	3.4	81,919	1.0	3.9	132,563	0.37	0.48	50,644	501,375	163,749	96,224	9,009,715	2,942,567	1,729,137
Verdigris-Bazile Drainage	1,986,731	4.2	10.9	82,847	5.0	11.6	98,517	0.79	0.69	15,670	155,129	50,665	29,772	2,787,673	910,452	535,008
Total	**34,749,267**			**404,640**	**15**	**52**	**521,288**			**116,645**	**1,154,783**	**377,151**	**221,625**	**20,751,456**	**6,777,412**	**3,982,603**

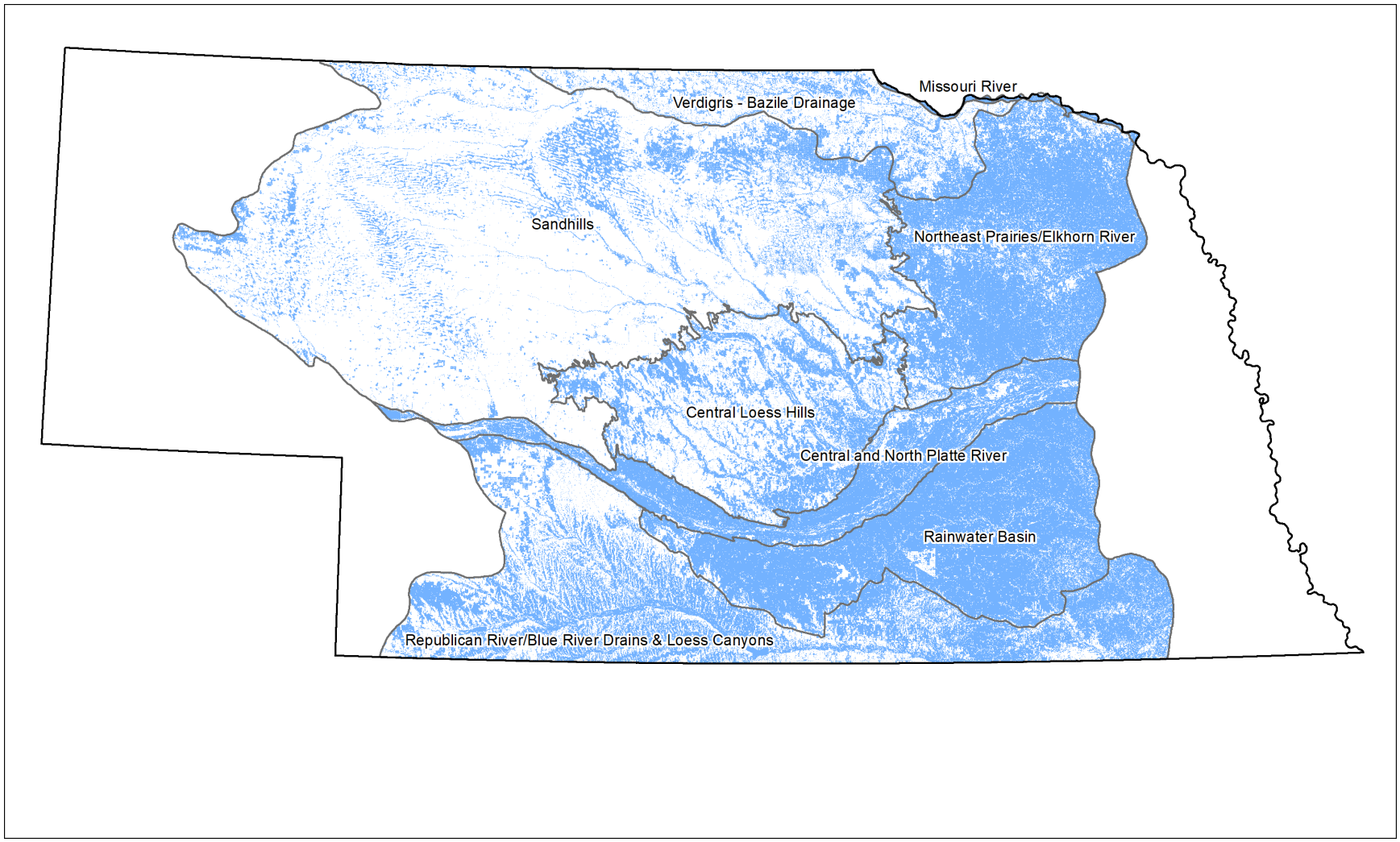


Figure 1. Rangeland Analysis Platform Mask 2017-19. Blue represents areas with features that are not subject to woody encroachment (e.g., wetlands, croplands, human development).

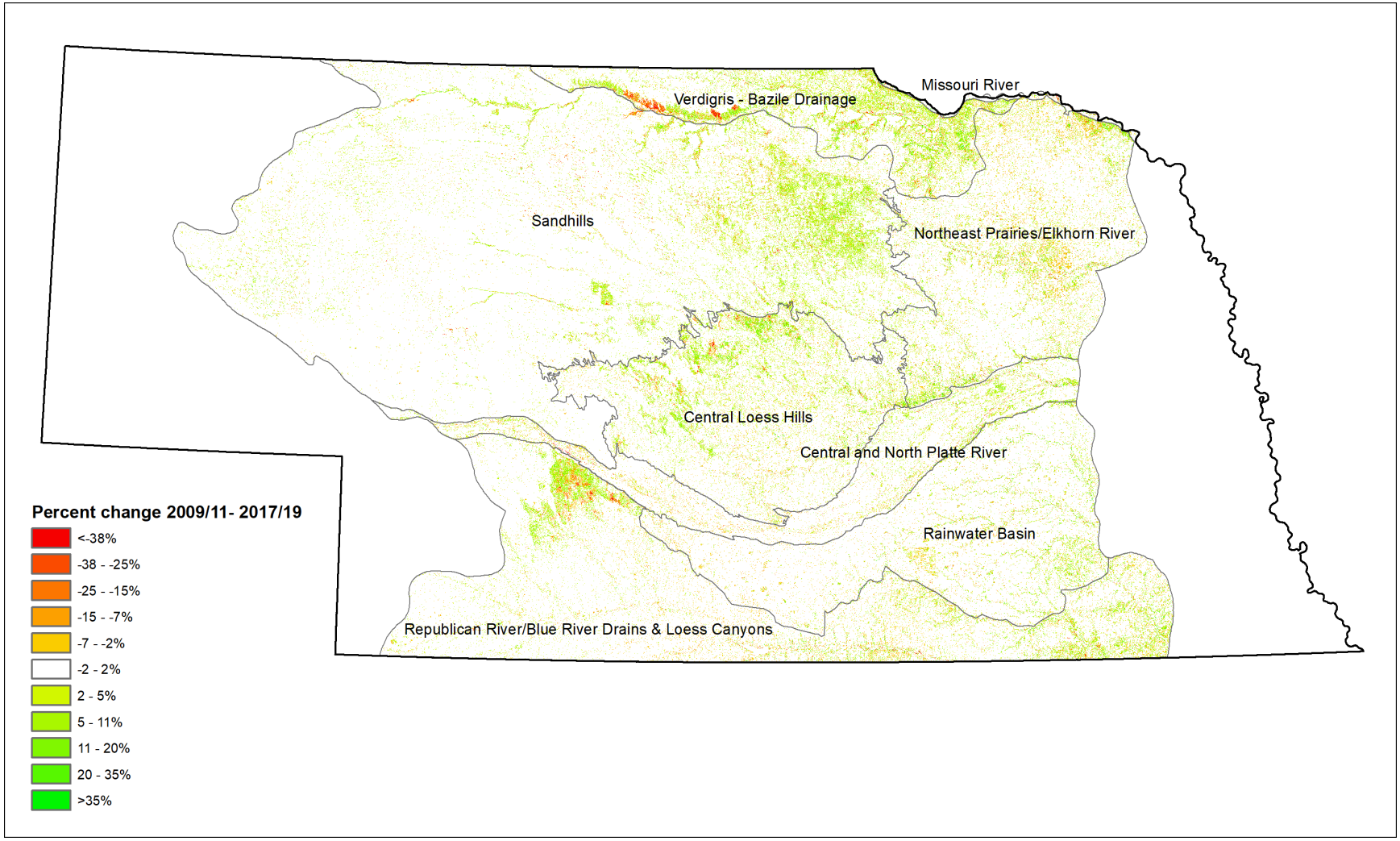


Figure 2. Upland Canopy Change from 2009-11 through 2017-19

Appendix 5. Landbird Research Needs

In 2015, the RWBJV completed its Research Inventory and Monitoring Plan. This plan lists 51 conservation issues or concerns related to landbirds, waterfowl, shorebirds, waterbirds, and human dimensions in the RWBJV Region. For each issue, one to five tasks were listed that, if completed, would help advance the RWBJV mission. Below is listed all the issues and associated tasks related to landbirds. The current status (2021) of each issue is also listed.

Issues of Concern and Related Tasks

Issue 13: Except for populations with limited distributions, reliable population estimates are unknown for most landbird species, resulting in population targets being established from regional Breeding Bird Survey population trends and species density estimates per habitat type identified in scientific literature.

> ***Task 13.1:*** Assess the utility of scaling down BCR Breeding Bird Survey trends to establish population goals.
> ***Task 13.2:*** Re-evaluate species' density estimates reported in the literature and whether they can be used to determine current carrying capacity in the RWBJV Region.
> ***Task 13.3:*** If species' density estimates are found to be useful, they should be updated as new literature is published, especially for studies within the RWBJV Region.
>
> **CURRENT STATUS:** Partners in Flight maintains a Population Estimates Database that contains population size estimates by species at several different geographical scales, including state-by-BCR. By retrieving the estimates for the portions of BCRs 11, 17, and 19 that lie in Nebraska, the most up-to-date and scientifically sound estimates have been included in planning efforts. BBS trends at the GFA scale were used to set population objectives.

Issue 14: A goal of the RWBJV is to have spatially explicit models that help describe habitat relationships for all priority species with the RWBJV Region. These models will allow conservation agencies to identify where in the landscape various species occur, where core populations exist, and what population responses may result from implementation of future conservation actions. Several of these models have already been created.

> ***Task 14.1*:** Create species distribution models for all other priority species that do not yet have one to help prioritize conservation delivery and identify opportunities for habitat restoration.
>
> **CURRENT STATUS:** Updated seasonal relative abundance models, created using eBird data, are now available. Using these data products, adequate information about distribution for all priority species is now available.

Issue 15: A majority of the priority landbird species identified by the RWBJV rely on grassland habitats. Currently, two strategies are being used to achieve landscape carrying capacity goals for priority species in grasslands: eastern red cedar removal and Conservation Reserve Program enrollment (RWBJV 2013*b*). It is often assumed that species will respond positively to cedar removal and other grassland management actions without consideration to timing, intensity, or composition of the surrounding landscape. Additionally, the future of the Conservation Reserve Program is uncertain.

> ***Task 15.1*:** Develop additional strategies to improve habitat conditions on existing grasslands in the RWBJV Region.
> ***Task 15.2:*** Use an adaptive management approach to determine whether current grassland restoration and management techniques are being used in the most effective and efficient manner.

Task 15.3: Assess the effectiveness of management actions for priority species using an experimental design that will test for effects of treatment timing and intensity, particularly if the landscape has been previously deemed suitable for a priority species based on a decision support tool.

CURRENT STATUS: Although several additional strategies for grassland conservation have been outlined in this plan, information is still lacking on the impacts of these actions. Further study is needed.

Issue 16: The Hierarchical All-Bird Strategy database assumes that carrying capacity estimates are constant for each habitat type, regardless of the landscape context. However, edge effects are not accounted for in the Strategy.

Task 16.1: Establish new density estimates in habitat types congruent to those used to establish population objectives by conducting point counts and utilizing distance sampling methodology.
Task 16.2: Compare the species density estimates per habitat type throughout the RWBJV Region.
Task 16.3: If necessary, revise population objectives to account for surrounding landscape composition, fragmentation, configuration, and edge effects.

CURRENT STATUS: Enough information has not been obtained to refine population objectives based on fine-scale habitat characteristics. This plan assumes that populations will increase linearly with increases in habitat area, although it is realized this rarely occurs. Planning efforts based on continued and future monitoring of populations and habitats is expected to be refined and revised.

Issue 17: Although some resources are available for public lands, standardized procedures and protocols are needed for keeping inventories of grassland restoration and enhancement on both public and private lands in the RWBJV Region.

Task 17.1: Develop GIS databases to facilitate the collection, storage, analysis, and sharing of grassland restoration data on public and private lands.

CURRENT STATUS: The RWBJV has established a database to facilitate inventory of grassland conservation activities. The newly released spatial data resources (RAP and RaBET) have helped to improve the ability to measure landscape change over time. These monitoring efforts are expected to continue, allowing for more accurate inventory of the conservation estate.

Issue 18: Seed broadcasting, prescribed burning, inter-seeding, and grazing are some of the grassland restoration techniques currently being used in the RWBJV Region. It is not known which of these are the most effective or cost-efficient at providing suitable long-term habitat for grassland landbirds.

Task 18.1: Conduct long-term monitoring (>5 years) to investigate the impacts of current grassland restoration and habitat management practices on vegetative structure, diversity, and landbird populations.

CURRENT STATUS: Two studies have been completed since 2015 that describe impacts of grazing and the CRP on grassland birds in the RWBJV Region. See the below citations for more information.

Hiller, T.L., Taylor, J.S., Lusk, J.J., Powell, L.A. and Tyre, A.J., 2015. Evidence that the conservation reserve program slowed population declines of pheasants on a changing landscape in Nebraska, USA. Wildlife Society Bulletin, 39(3), pp.529-535.

Sliwinski, M.S., Powell, L.A. and Schacht, W.H., 2020. Similar bird communities across grazing systems in the Nebraska Sandhills. The Journal of Wildlife Management, 84(4), pp.802-812.

Issue 19: Decision support tools and species distribution models are often used to make decisions about landbird habitat restoration and improvement. There is uncertainty about whether landbird species are responding to habitat management as predicted by the decision support tool and/or spatial modeling.

Task 19.1: Conduct research to test the underlying assumptions and effectiveness of the decision support tool and/or spatial modeling, particularly regarding species responses to management activities.

CURRENT STATUS: Progress has not yet been made in addressing this issue.

Issue 20: Ring-necked Pheasant and Northern Bobwhite are priority species for many of the RWBJV partners due to their value as a game species. Both species have experienced steep population declines in recent years.

Task 20.1: Use spatial modeling to identify opportunities to create or improve habitat for these species with emphasis on increasing public hunting access.
Task 20.2: Determine possible causes of and solutions to declines for these game bird species in the RWBJV Administrative Area.

CURRENT STATUS: In 2016, the NGPC finalized The Berggren Plan, which aims to improve pheasant hunting for recreationists in Nebraska. This plan identifies priority landscapes and practices that will help improve habitat for pheasants. Similar efforts have yet to be made for Northern Bobwhite.

Issue 21: While Greater Prairie Chickens have experienced population declines through most of their range, numbers in Nebraska have been stable or increasing. Greater Prairie Chicken habitats in the RWBJV Region will become even more important to the persistence of the species in the coming years if populations outside the area continue to decline. More information is needed to effectively manage this species.

Task 21.1: Conduct a complete inventory of spring breeding Greater Prairie Chicken leks in the RWBJV Region.
Task 21.2: Estimate average size of Greater Prairie Chicken leks and use this data to generate regional population estimates.
Task 21.3: Create a species distribution map using lek survey data.

CURRENT STATUS: Better estimates of population size and distribution for Greater Prairie Chickens can be made using the PIF Population Estimates Database and eBird data products. Additionally, NGPC has recently initiated a long-term prairie grouse monitoring project that will help improve the understanding of Greater Prairie Chickens.

New Research Issues and Tasks Identified Since 2015

Issue A: Much of the habitat available to breeding birds in the RWBJV Region is located in small patches adjacent to or within a larger agricultural landscape. Currently it is unknown whether these edge or ecotone habitats are suitable for use by breeding landbirds. If breeding success is too low, these habitats may be a population sink.

Task A.1: Measure nest survival and fledging success of priority landbird species breeding in field borders or buffers.
Task A.2: Determine optimal restoration methods to increase breeding success in edge habitats.

Issue B: Measuring past landcover transitions has long been a challenge that limits the ability to predict future habitat conditions. In order to understand and formulate habitat objectives, more information is needed about current conditions and recent trends in land use.

Task B.1: Explore new data resources to potentially replace traditional methods.
Task B.2: Field studies are needed to evaluate and compare accuracy of traditional and novel methods of landcover detection and classification.