Rainwater Basin Joint Venture Waterbird Plan

A regional contribution to the

North American Waterbird Conservation Plan

and the

Rainwater Basin Joint Venture Implementation Plan

By the Rainwater Basin Joint Venture

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Executive Summary

The Rainwater Basin Joint Venture partnership (RWBJV) was formed in 1992 with a primary focus of protecting, restoring, and enhancing wetland habitat in the Rainwater Basin Wetland Complex (RWB). The RWB contains a high density of playa wetlands, which provide vital stopover habitat for various species of migratory waterfowl, waterbirds, and shorebirds. Due to its diversity of wetland types and mid-latitude landscape juxtaposition, the RWB is the focal point of spring migration for millions of waterfowl. Although it was not within the RWBJV's initial purview, in 2004 the RWBJV Management Board embraced the North American Bird Conservation Initiative, expanding the partnership's geographic focus and acknowledging the conservation objectives outlined in all four of the national bird conservation plans (North American Waterfowl Management Plan, North American Waterbird Conservation Plan, Partners in Flight North American Landbird Conservation Plan, and the United States Shorebird Conservation Plan). The expanded RWBJV Administrative Area includes the portions of Bird Conservation Regions 11 (BCR 11; Prairie Pothole Region) and 19 (BCR 19; Central Mixed-grass Prairies) that lie within Nebraska.

The RWBJV Waterbird Plan is the first step by the RWBJV to develop a conservation blueprint to guide biological planning and conservation delivery to benefit waterbirds that depend on the RWBJV Administrative Area. The term "waterbirds," as used within this plan, includes all species (except shorebirds and waterfowl) that depend on wetland habitats to complete a portion of their life cycle. There is a wide range of data and information about waterbirds that use the RWBJV Administrative Area.

Among breeding species, Least Terns are the best understood, however, there is almost no information on the other breeding waterbirds that use this region. Several geospatial projects have been completed to evaluate habitat for Least Terns along the Central Platte River under different flow regimes. These projects, in conjunction with additional Least Tern surveys, will need to be continued to understand Least Terns' response to habitat projects and flow regime modifications.

Significant data have been collected on Sandhill Cranes and Whooping Cranes using the RWBJV Administrative Area during the migratory portion of the non-breeding phase of the annual life cycle. This information has been used to develop a set of bioenergetics models and geospatial models to describe the acres and distribution of habitat needed to support these species. An estimated 560,000 Sandhill Cranes use the RWBJV Administrative Area. To acquire sufficient nutrient reserves during migration, approximately 12,000 acres of wet meadow habitat and just over 80,700 acres of corn fields, with at least 35.6 kg/acre (88.8 kg/ha) of waste grain, are needed. A key assumption of the RWBJV bioenergetics model is that there will continue to be 80,700 acres of corn fields under current harvest practices. With 97% of Nebraska's land in private ownership, conservation delivery will need to align with agriculture land uses. In the Sandhills and other grassland-dominated landscapes, projects will need to complement cattle production, while in the other Geographic Focus Areas, the RWBJV will need to strike a balance with row-crop agriculture and cattle production. All conservation programs will be developed on a voluntary basis with willing participants.

The RWBJV will continue to support research, inventory, and monitoring activities to address key uncertainties and validate current planning assumptions. Future priority research, inventory, and monitoring projects include establishing population objectives for waterbirds breeding in the RWBJV Administrative Area and estimating use of different habitats by breeding waterbird species. Research and monitoring will also focus on habitat availability and selection by breeding Least Terns using the Central Platte River. For non-breeding waterbirds, inventory and monitoring need to be completed to determine the local and landscape factors that influence roost site selection by Sandhill Cranes. These same types of studies will need to be completed to understand habitat features that influence selection of wet meadows as foraging and secondary roost sites. To refine the bioenergetics model, invertebrate abundance in wet meadows and the foraging efficiency of Sandhill Cranes will need to be evaluated.

Introduction

The term "waterbirds" as used within this plan includes all species, except shorebirds and waterfowl, that depend on wetland habitats to complete portions of their life cycle. Continentally, this group of birds is probably the least studied and managed. National concern for the conservation of waterbirds prompted the development of the North American Waterbird Conservation Plan, commonly referred to as the Waterbird Plan (Kushlan et al. 2002). It is one of four national plans that address conservation of the major bird groups: waterfowl, shorebirds, waterbirds, and landbirds. The plan was authored by a partnership of individuals from agencies and organizations with a strong interest in the conservation of waterbirds. Their goal is to support a vision in which the distribution, diversity, and abundance of populations and habitats of breeding, migrating, and nonbreeding waterbirds are sustained or restored throughout the lands and waters of North America, Central America, and the Caribbean (Kushlan et al. 2002).

In 1992, the Rainwater Basin Joint Venture partnership (hereinafter RWBJV) was formed and focused on conservation delivery to support waterfowl using the Rainwater Basin Wetland Complex (RWB). Beginning in 1999, there was a national movement for joint ventures to provide a North American framework of conservation partnerships that would implement the goals and objectives outlined in the four national bird plans. In response, the RWBJV expanded its administrative boundary to include the portions of Bird Conservation Regions (BCRs) 11, the Prairie Pothole Region, and 19, the Central Mixed-grass Prairies Region, that lie within Nebraska. In addition to the geographic expansion, the RWBJV began to evaluate the conservation bottlenecks limiting all-bird conservation in this Administrative Area.

In 2006, the RWBJV adopted the Strategic Habitat Conservation (SHC; National Ecological Assessment Team 2006) framework. This framework builds upon the Department of Interior's Adaptive Resource Management framework and integrates geospatial planning tools to target project implementation. The framework has four core elements: 1) Biological Planning, 2) Conservation Design, 3) Conservation Delivery, and 4) Research and Monitoring. The SHC framework helped the RWBJV identify priority species, evaluate current habitat conditions, determine landscape carrying capacity for priority species, and estimate habitat deficiencies. It also provided the RWBJV partners a mechanism to identify model assumptions and key research questions as well as monitoring needs that should be priorities as part of the Research/Inventory/Monitoring element. Under the SHC framework, directed research projects are used to address key uncertainties in the biological planning process, while monitoring is used to evaluate outcomes and refine future conservation delivery actions. The SHC framework provided the RWBJV Management Board a mechanism to describe its role in supporting the conservation of priority species in the RWBJV Administrative Area. The RWBJV Management Board committed to providing Biological Planning and Conservation Design tools, as well as support for Research/Inventory/Monitoring projects, to refine conservation needs, according to the SHC framework, for priority species identified in the four national bird plans. The RWBJV Management Board adopted this role because numerous conservation agencies and non-governmental organizations already implement conservation projects in the RWBJV Administrative Area, but lack the Biological Planning and Conservation Design tools that would allow them to leverage their conservation actions. The RWBJV Management Board believed that if these tools were available, projects could be implemented more strategically in the

RWBJV Administrative Area, resulting in landscapes that were better able to support populations of priority species at goal levels.

Although it has been ten years since the RWBJV expanded its conservation responsibility, the partnership is still in the early stages of waterbird conservation. The Rainwater Basin Joint Venture Waterbird Plan reflects this early stage, but also highlights the significant accomplishments the RWBJV has made in the Biological Planning, Conservation Design, and Research/Inventory/Monitoring elements needed to support conservation of waterbirds throughout the RWBJV Administrative Area. Although the Conservation Delivery element of the RWBJV remains focused on protection, restoration, and enhancement of wetland habitats within the RWB, many of these projects, especially in the western portion of the RWB, provide mid-latitude stopover habitat for migrating Whooping Cranes, one of the priority species identified in the Rainwater Basin Joint Venture Waterbird Plan.

The Rainwater Basin Joint Venture Waterbird Plan outlines the RWBJV's current understanding of waterbird conservation needs in the RWBJV Administrative Area. Each element of the SHC framework is addressed, providing the partners a foundation to guide future conservation planning and project delivery for waterbirds.

The RWBJV Administrative Area

Approximately 90% of the RWBJV Administrative Area is in Bird Conservation Region 19 (BCR19), the Central Mixed-grass Prairies Region, while 10% is in BCR 11, the Prairie Pothole Region, (North American Bird Conservation Initiative 1999). The area of BCR 11 that is administered by the RWBJV is at the southern edge of the Prairie Pothole Region. This area has no true prairie pothole wetlands, 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. 2009; Bishop et al. 2011). To define the RWBJV Administrative Area, all of BCRs 11 and 19 in Nebraska were therefore combined into a single unit.

The RWBJV Administrative Area is part of the Great Plains, a region known for its wide variations in temperature and precipitation. West of the 100th meridian, evaporation and transpiration exceed precipitation, commonly drying up wetlands even in wetter years. Precipitation occurs sporadically, which results in variable amounts of water in wetland systems. 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. This temporal variation of precipitation alters the phenology, species composition, and structure of the wetland vegetation communities.

A wide variety of human alterations that impact the palustrine and riverine wetlands are found in the RWBJV Administrative Area. Modifications include water concentration pits, land leveling, culturally accelerated sedimentation, road ditches, drainage ditches, invasive species, stream channelization and degradation, dams, diversions, water withdrawals, and other watershed modifications. These modifications directly impact wetland numbers, size, and function (LaGrange 2005; LaGrange et al. 2011).

Grasslands dominated by mixed-grass, tallgrass, and sandhill prairie communities once occupied a majority of the RWBJV Administrative Area. Outside of the Sandhills, many of these grasslands have been converted to row-crop agriculture. The grasslands that remain are generally associated with the region's riverine systems, or lands not suitable for row-crop agriculture due to the potential for wind and/or water erosion. The remaining grasslands are often integrated into agricultural operations for grazing or haying, which, depending on timing and intensity, can significantly impact the habitat values these lands provide to wildlife.

Woodlands are generally confined to the drainages of the major river systems found in the RWBJV Administrative Area. Along the Loup, Missouri, Platte, and Republican rivers the woodlands are generally composed of deciduous species. Russian olive and eastern red cedar are the primary invasive species impacting these woodlands. Along the Niobrara River there is a greater diversity of species, including both deciduous and coniferous woodlands. Invasion by eastern red cedar is a major threat to these communities as well.

Geographic Focus Areas in the RWBJV Administrative Area

For planning purposes the RWBJV Administrative Area is divided, based on landscape characteristics, into eight Geographic Focus Areas (Figure 1): 1) Central Loess Hills, 2) Central and North Platte River, 3) Missouri River, 4) Northeast Prairies/Elkhorn River, 5) Rainwater

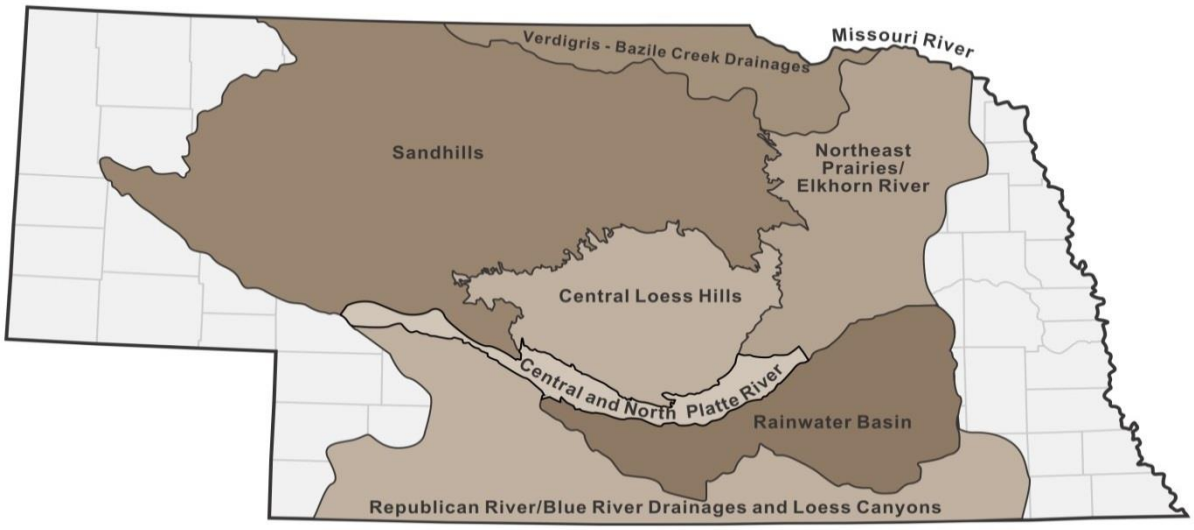

Figure 1. Geographic Focus Areas in the RWBJV Administrative Area.

Basin 6) Republican River/Blue River Drainages and Loess Canyons, 7) Sandhills, and 8) Verdigris – Bazile Creek Drainages (Figure 1).

In order for states to receive federal funds through the Wildlife Conservation and Restoration Program and the State Wildlife Grants Program, Congress charged each state to develop a State Wildlife Action Plan. Nebraska's plan is the *Nebraska Natural Legacy Project* (Schneider et al. 2011), which was developed as a state-wide plan to direct and focus the actions of conservation partners in Nebraska. To provide geographic focus, biologically unique landscapes (BULs) were identified, including 23 located within the RWBJV Administrative Area. These geographic areas

were determined to have the highest probability of meeting the criteria of representing the various habitats within the state, and keeping common species common, while not overlooking pockets of habitat that support at-risk species. The 23 BULs in the RWBJV Administrative Area are:

Calamus River	Elkhorn Confluence	Middle Niobrara	Sandstone Prairies
Central Loess Hills	Keya Paha	North Loup River	Snake River
Central Platte River	Loess Canyons	Panhandle Prairies	Southeast Prairies
Cherry County Wetlands	Lower Loup River	Platte Confluence	Verdigris-Bazile
Dismal River Headwaters	Lower Niobrara River	Rainwater Basin	
Elkhorn River Headwaters	Middle Loup River	Sandhills Alkaline Lakes	

The RWBJV Administrative Area encompasses approximately 35 million acres and contains over 2.3 million acres of wetland habitats and over 20 million acres of grasslands (Table 1). Wetlands comprise nearly 7% of the RWBJV Administrative Area, while grasslands cover approximately 60% of the landscape (Table 1). Each Geographic Focus Area contains a variety of wetland, grassland, and woodland habitats. Over half of the wetlands found within the RWBJV Administrative Area are located in the Sandhills, with a majority of these acres being classified as sub-irrigated wet meadows (palustrine wetlands). The RWB Geographic Focus Area contains the highest density of playa wetlands (palustrine wetlands), followed by the Central Loess Hills (Central Table Playa Complex), Northeast Prairies/Elkhorn River (Todd Valley Wetland Complex), and Republican River/Blue River Drainages and Loess Canyons (Southwest Playa Wetland Complex) GFAs. The Republican River/Blue River Drainages and Loess Canyons GFA contains the most human-made wetland features (reservoirs, stock dams, and irrigation reuse pits; Table 1). Outside of the Sandhills, grasslands are generally confined to the floodplains of the major river systems or on environmentally sensitive lands. The primary Geographic Focus Areas with significant grasslands are the Central Loess Hills, Northeast Prairies/Elkhorn River, Republican River/Blue River Drainages and Loess Canyons, Sandhills, and Verdigris - Bazile Creek Drainages GFAs(Table 1).

Table 1. Wetland and grassland acres and their distribution by Geographic Focus Area (Bishop et al. 2011).

Geographic Focus Area	Geographic Focus Area (Acres)	Total Wetland (Acres)	Lakes & Reservoirs (Acres)	Palustrine Wetlands (Acres)	Riverine Wetlands (Acres)	Lacustrine Wetlands (Acres)	Grassland (Acres)
Central Loess Hills	3,598,453	169,185	20,504	12,473	136,209	0	2,166,456
Central and North Platte River	1,035,879	107,514	6,597	1,590	99,327	0	160,448
Missouri River	77,852	40,858	12,309	7,714	20,835	0	6,279
Northeast Prairies/ Elkhorn River	4,792,660	339,339	19,676	16,774	302,889	0	1,320,359
Rainwater Basin	3,830,130	120,852	25,703	44,198	50,950	0	677,965
Republican River/Blue River Drainages and Loess Canyons	5,826,800	226,427	60,937	5,437	160,054	0	3,140,230
Sandhills	13,587,519	1,253,724	25,719	1,120,700	22,331	84,974	11,535,386
Verdigris – Bazile Creek Drainages	2,004,581	91,833	7,766	4,770	79,297	0	1,383,183
Total	**34,753,873**	**2,349,733**	**179,212**	**1,213,656**	**871,891**	**84,974**	**20,390,306**

Central Loess Hills

The Central Loess Hills GFA, located in the center of the RWBJV Administrative Area, contains rolling to steep loess hills dissected by the valleys of the 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). Based on 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), it is estimated that there were once over 6,300 playas covering more than 18,000 acres. Based on an assessment of aerial photography completed in 2010, just over half of the playas (3,470 individual wetland footprints) continue to demonstrate some level of function, such as ponding water or growing hydric vegetation (Bishop et al. 2011). These playa wetlands are generally smaller than the playas found in the RWB and are characterized by seasonal and temporary water regimes.

The steep, erodible side slopes of the Central Loess Hills drop off into the broad floodplains of the Loup rivers. The Central Loess Hills GFA contains the lower reaches of the Middle Loup, North Loup, and South Loup rivers, all of which are spring-fed and originate in the Sandhills. These broad and shallow sand-bed rivers maintain relatively constant year-round stream flow. Sandbars and shallow side channels are typical features within and adjacent to the active river channels.

Based on a 2011 habitat assessment, the Central Loess Hills GFA contains approximately 12,500 acres of palustrine wetlands, 136,000 acres of wet meadows and other riverine wetlands, and approximately 2.2 million acres of grasslands (Table 1). The playa wetlands found in this Geographic Focus Area provide important migration stopover habitat for the endangered Whooping Crane (Austin and Richert 2001), as well as numerous other species of migratory waterbirds (e.g., waterfowl, shorebirds, and wading birds). The riverine wetlands associated with the Loup rivers provide breeding habitat for the threatened Northern Great Plains population of Piping Plovers and endangered Interior population of Least Terns. The wet meadows and associated grasslands found in the Central Loess Hills currently support an estimated 875,000 grassland nesting birds (RWBJV 2013*a*).

Row-crop agriculture and ranching are dominant land uses in the Central Loess Hills. Row-crop agriculture is generally confined to the river valleys and areas of limited topographic relief. Crops generally include alfalfa, corn, milo, soybeans, and wheat. Most of the steep, more erodible slopes remain as native grasslands dominated by mixed-grass prairie communities. Higher commodity prices and the guaranteed income provided by the Federal Crop Insurance Program have contributed to the conversion of environmentally sensitive grasslands and wetlands to row-crop agriculture. This conversion has reduced the quantity and distribution of grassland, wetland, and wet-meadow habitats found throughout the Central Loess Hills. The encroachment of undesirable plant species (i.e., eastern red cedar, Russian olive, smooth brome, etc.) has occurred on thousands of acres of native habitats. Fire suppression is believed to be a major factor that has contributed to the expansion of invasive species throughout this Geographic Focus Area.

Central and North Platte River

The Central Platte River is a 90-mile segment of the Platte River, extending from Lexington, Nebraska to Chapman, Nebraska. Historically, the Platte River was a wide, shallow river with multiple channels that meandered across an expansive floodplain. Large, scouring floods regularly set back vegetation succession and maintained a diversity of habitats across the floodplain. Following European settlement, the Platte River was extensively regulated, and the 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 on islands and along river banks. For example, a comparison of average annual discharge levels at the city of North Platte, Nebraska, before 1930 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 60% to 80% of the open riverine/sandbar habitat and 55% of wet

meadow habitat had been lost in this reach of the Platte River due to 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 supplies continues to attract millions of wetland-dependent migratory birds each year. The 60,000 acres of palustrine and riverine wetlands and over 140,000 acres of grassland that occur along the Central Platte River continue to provide necessary roosting, loafing, and foraging habitat for millions of migratory birds. These habitats are used by the endangered Whooping Crane (USFWS 1978) and approximately 90% of the world's Sandhill Crane population, and provide migration and wintering habitat for millions of waterfowl, migration habitat for a myriad of waterbirds, and non-breeding habitat for numerous shorebirds. In addition, the Central Platte River provides breeding habitat for the threatened Piping Plover and endangered Interior population of Least Tern, and for an estimated 160,000 priority grassland-nesting birds (RWBJV 2013*a*).

Today, the Central Platte River Valley is intensely cultivated. Based on the 2009 United States Department of Agriculture (USDA) Cropland Data Layer, over 60% of the historic floodplain is planted to corn, soybeans, or alfalfa (USDA 2009). In 2004, due to the diversion of water for irrigation, much of the Platte River was declared over-appropriated by the Nebraska Department of Natural Resources (DNR). This designation required new groundwater and surface water depletions to be offset, with the intent of managing the system in a sustainable manner. Although cropland conversion has slowed, gravel mining and residential and commercial development continue to result in the loss of riverine and wet-meadow habitats. Invasive plant species also continue to degrade in-channel habitats and adjacent wet meadows. Primary threats include: eastern red cedar, Kentucky bluegrass, *Phragmites*, purple loosestrife, reed canary grass, and smooth brome.

The North Platte River is one of the two 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 approximately 36,000 acres of wet meadows and 16,000 acres of grasslands dominated by mixed-grass prairie species (Bishop et al. 2011).

The wetland and grassland habitats in this 80-mile stretch of river from Lewellen, Nebraska to North Platte, Nebraska have also 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 the portion of the mid-continent population of Sandhill Cranes (approximately 56,000 individuals) that do not stage in the Central Platte River valley (Krapu et al. 2011).

Although the conversion of grasslands and wet meadows to 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. 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.

Missouri River

The Missouri River GFA forms the northeast boundary of the RWBJV Administrative Area. This 125-mile stretch of river, between Ponca, Nebraska and Spencer, Nebraska, is 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 was an unmanaged, natural river that supported a tremendous number and diversity of fish and wildlife. The river occupied a sandy channel and flowed between erodible banks, from 1,500 feet to over one mile apart, with braided, sinuous channels twisting among 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 character of the Missouri was drastically altered between 1930 and 1970, as channelization and main-stem dams narrowed and deepened the river channel, and associated floodplain wetlands disappeared. The six main-stem dams in the Dakotas, Montana, and Nebraska have changed water quality, quantity, and timing throughout the Missouri River system (LaGrange 2005). The controlled release of water from the upstream dams has reduced the flood pulse that was a key factor in maintaining the in-channel habitat and adjacent floodplain wetlands. Although the stretch of the Missouri River in the Geographic Focus Area is not channelized, it is still negatively impacted by the upstream dams. 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 off-channel wetlands historically associated with this system have been altered to increase row-crop agriculture. Today 18,000 acres, or 25% of the landscape, are under row-crop agriculture production (USDA 2009).

Based on a 2011 habitat assessment, the Missouri River GFA contains approximately 28,500 acres of palustrine and riverine wetlands and just over 6,000 acres of grassland (Table 1). Despite the numerous alterations to the system, these wetlands still provide vital stopover habitat for numerous migratory waterfowl and shorebirds, as well as breeding habitat for the threatened Northern Great Plains population of Piping Plovers and endangered Interior population of Least Terns.

The greatest threat to the unchannelized portion of the Missouri River is riverbed degradation (LaGrange 2005). Other key threats include residential/agricultural/commercial development, transportation, 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 dynamics. Invasive species also impact habitat for migrating waterfowl, shorebirds, and other wetland-dependent species. 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 Basin is located in the northeastern portion of the RWBJV Administrative Area. The Geographic Focus Area is intensely farmed and has a higher human population density than other GFAs in the RWBJV Administrative Area, creating a fragmented landscape. At one time, the uplands were dominated by grasslands with a diverse assemblage of tallgrass and mixed-grass prairie species (Schneider et al. 2011). Some localized regions in this Geographic Focus Area contained a high density of playa wetlands. The playa wetland complex associated with this GFA is described as the Todd Valley Playa Wetland Complex (LaGrange 2005).

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 region. The remaining playa wetlands contain a diverse mix of early successional wetland vegetation communities.

Despite the intensive row-crop and agricultural/urban/suburban development, this Geographic Focus Area contains significant grassland and wetland acres. Approximately 320,000 acres of palustrine and riverine wetlands and over 1.3 million acres of grassland occur throughout the Northeast Prairies/Elkhorn River GFA (Table 1). This landscape provides breeding habitat for numerous grassland nesting birds, while the Elkhorn River provides breeding habitat for the threatened Northern Great Plains population of Piping Plovers and endangered Interior Least Terns. The Elkhorn River and Todd Valley wetlands provide secondary habitat for migrating wetland-dependent species (shorebirds, waterbirds, and waterfowl).

As with most of eastern Nebraska, this region is intensely cultivated. Nearly all of the grasslands have been converted, and many of the embedded playa wetlands drained to promote row-crop agriculture. Based on the 2009 USDA Cropland Data Layer, 55% of this landscape is cultivated to corn, soybeans, or alfalfa (USDA 2009; Bishop et al. 2011). Nearly 10% of the grassland cover has been re-established through the Conservation Reserve Program (CRP). Although many of these acres were not planted exclusively to native species, the acres complement the native tallgrass remnants scattered throughout the region. A majority of the CRP contracts are expiring, and current high commodity prices, plus the safety net provided by the Federal Crop Insurance Program, are accelerating conversion of these acres back to row-crop agriculture.

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 in this region. The loss of grasslands in the region has resulted in higher stocking rates and a shift to year-long grazing regimes. The transitions in grazing practices, as well as fire suppression, are believed to be a major factor contributing to the encroachment of undesirable plant species (i.e., Kentucky bluegrass, eastern red cedar, and smooth brome, etc.).

Rainwater Basin

The RWB encompasses 6,150 square miles, including parts of 21 counties in the south-central portion of the RWBJV Administrative Area. Condra (1939) identified this landscape as the Loess Plains Region of Nebraska. This region has expansive rolling loess plains formed by deep

deposits of wind-blown silt, with a high density of clay-pan playa wetlands. Overland runoff from intense summer storms and melting winter snowfall fill these playa wetlands.

Analysis of the historic soil surveys (1910 – 1917), NWI (1980 – 1982), and SSURGO data (1961 – 2004) indicates that playa wetlands were once a prominent feature of this landscape. Combined, these datasets identified approximately 11,000 individual playa wetlands (204,000 acres) that were historically part of the landscape. It has been estimated that there were over 1,000 semi-permanent and seasonal wetlands, which covered over 70,000 acres, and more than 10,000 temporary wetlands that accounted for an additional 134,000 acres.

A Nebraska Game and Parks Commission (NGPC) breeding waterfowl habitat survey (McMurtrey et al. 1972) used the historic soil surveys as a reference to evaluate the distribution of remaining wetlands. McMurtrey et al. (1972) reported that 82% of the major wetlands had been converted to agriculture, removing approximately 63% of the total wetland acres from the landscape. The fast-paced degradation continued, and by 1985 only 10% of the surveyed wetlands remained. The remaining wetlands represented only 22% of the original surveyed acres, and virtually all were hydrologically impaired (Schildman and Hurt 1984). Due to the extensive wetland loss and continued degradation, RWB wetlands were given a Priority 1 ranking, the most imperiled status, in the Nebraska Wetlands Priority Plan (Gersib 1991).

Land use in the RWB is dominated by row-crop agriculture (70% of the acres), predominantly in a corn and soybean rotation. Grassland habitats make up approximately 20% of the region, while 3% of the area is covered by savannahs, woodlands, and forest communities that are confined to the steeper drainages associated with the Republican and Blue river systems. Riverine wetlands associated with these systems comprise about 2% of the landscape. Of the historic 204,000 RWB wetland acres, roughly 40,000 acres remain, or about 17% of the historic distribution. Today, playa wetlands in the RWB make up less than 1% of the total landscape (Bishop and Vrtiska 2008; Bishop et al. 2011).

Approximately 44,000 acres of palustrine wetlands, 51,000 acres of riverine wetlands, and 678,000 acres of grassland presently occur throughout the RWB Geographic Focus Area (Table 1). Despite the extensive wetland loss, this region still hosts one of the greatest wildlife migration spectacles on earth. During spring migration, the RWB provides roosting, loafing, and foraging habitat for millions of migratory waterfowl and other wetland-dependent species. The RWB provides essential staging habitat for an estimated 8.6 million waterfowl (RWBJV 2013*c*) and nearly 600,000 shorebirds (RWBJV 2013*b*), as well as vital stopover habitat for the endangered Whooping Crane.

Over the years, a variety of wetland rules and laws have helped to significantly reduce active wetland drainage; however, wetland function across the landscape continues to decline as a result of intentional human activity, such as active drainage, and through ecological processes, including natural and culturally accelerated sedimentation (LaGrange et al. 2011). In addition, wetland modifications, including water concentration/irrigation reuse pits, land leveling, culturally accelerated sediment, and drainage ditches, directly impact the wetlands or limit the amount of runoff reaching the wetlands. Furthermore, the combination of sedimentation and altered watershed hydrology leads to conditions that promote invasive species. Depending on the water regime and duration of saturated conditions, primary threats include 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 Administrative Area. A limited surface and groundwater supply differentiates the region from other Geographic Focus Areas within the RWBJV Administrative Area. As a result, a significant proportion of the cropland is cultivated with dry-land farming practices. Despite the limited ground- and surface-water resources, significant irrigation development occurred in the Republican River drainage through 2004. The unsustainable irrigation development ultimately led the Nebraska DNR to designate the Republican River drainage as an over-appropriated river basin. This designation led to a combination of restrictions on new acres developed for irrigation and on irrigation water allocations. The Blue River basins are defined by the drainage area of the Big and Little Blue rivers. At this time, the Blue river basins have no limitations on groundwater development, but triggers are in place should further groundwater depletions occur.

In the western portion of this region, 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 (mostly less than 5 acres), temporarily and seasonally flooded wetlands. Most have no natural outlet for water. In most years, these wetlands dry up early enough in the growing season to be farmed. Southwest Playa wetlands are similar to RWB wetlands farther east, except that the RWB complex receives greater rainfall, and the wetlands there tend to be larger (LaGrange 2005).

The topography and soils of this Geographic Focus Area vary from steep hills and canyons with highly erodible soils in the west, to relatively flat and highly 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. Fire suppression and year-long grazing regimes are believed to be major factors contributing to the establishment of invasive species in many of the grasslands in this GFA.

Approximately 5,000 acres of palustrine wetlands, 160,000 acres of riverine wetlands, 61,000 acres of lakes and reservoirs, and 3.1 million acres of grassland occur throughout the Republican River/Blue River Drainages and Loess Canyons GFA (Table 1). With the exception of Harlan County Reservoir, a 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. The grasslands in this Geographic Focus Area provide breeding habitat for an estimated 1.5 million grassland nesting birds (RWBJV 2013*a*).

Habitat loss from grassland conversion and wetland drainage for row-crop agriculture has occurred to varying degrees throughout this Geographic Focus Area. Row-crop agriculture development has been slower in the Republican River Basin, primarily due to a limited groundwater aquifer and moratoriums on irrigation development. Invasive species continue to threaten habitat quality of both wetlands and uplands in this GFA. *Phragmites*, purple loosestrife, and reed canary grass have played a role in reducing habitat, constricting river channel widths, and depleting surface water flows.

Sandhills

The Sandhills are a 19,300 square-mile sand dune formation located in north-central Nebraska. Although located in a semi-arid climate, the Sandhills contain an abundance of lakes, wetlands, wet meadows, and spring-fed streams scattered across the largest contiguous grass-stabilized dune system in North America (Schneider et al. 2011).

Between the dune formations are long, gently sloping valleys containing spring-fed meandering streams, lakes, wetlands, and wet meadows. 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). This volume represents twice the volume of Lake Erie. Most of the area's lakes, wetlands, and streams are sustained by groundwater discharge from adjoining dunes. About 90 percent 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 North Platte and Platte rivers flow along part of the southern boundary. The Calamus, Cedar, Dismal, Elkhorn, and Loup rivers originate within the Sandhills.

Approximately 1.1 million acres of palustrine and riverine wetlands, 85,000 acres of lacustrine wetlands, and over 11.5 million acres of grassland occur throughout the Sandhills GFA (Table 1). The mosaic of wetlands and grasslands was 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 annually nest in the Sandhills. 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 4 million grassland birds (RWBJV 2013*a*). A significant proportion of the estimated 400,000 breeding shorebirds found in the RWBJV Administrative Area occur in the Sandhills (RWBJV 2013*b*). Nearly all of the nesting waterbirds in the RWBJV Administrative Area occur in the Sandhills.

Wetland loss in the Sandhills has occurred primarily through draining 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 for the Sandhills, 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, due to very extensive past losses (Gersib 1991). Sandhills wetlands continue to be threatened by drainage ditches, generally created to increase hay acreage. This drainage directly impacts the lake or wetland where the project occurs and also can lead to cumulative wetland loss, both downstream and upstream, as the channel becomes entrenched, lowering the water table and causing lateral drainages that impact adjacent wetlands. Many smaller wetlands are also 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. Many of the lands originally developed for row-crop production have been planted back to grasslands. This was incentivized by the CRP program. However, CRP acres could be rapidly converted to row-crop agriculture. As CRP contracts expire, there are multiple factors that could influence conversion of these lands back to row-crop agriculture. For example, current commodity prices, land values, and cash rent

remain at all-time highs, and the Federal Crop Insurance Program provides a source of guaranteed income for cultivation of these environmentally sensitive lands.

Verdigris – Bazile Creek Drainages

This landscape, located in the northern portion of the RWBJV Administrative Area, is defined by the watersheds of Verdigris and Bazile creeks, which originate in and flow through Cedar, Knox, Holt, and Antelope counties, emptying into the Niobrara and Missouri rivers in northeast Nebraska.

Topography is variable, resulting in a mosaic of cropland, grasslands, and woodlands. This Geographic Focus Area is located at the transition zone between the tallgrass and mixed-grass prairie ecoregions. As a result, the grasslands contain a diverse assemblage of tallgrass and mixed-grass prairie communities. Tallgrass prairie communities dominate the native grasslands along the eastern boundary, while species associated with mixed-grass prairie prevail in the grasslands along the western boundary. 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 are dominated by deciduous species. The dominant cultivated crops in this region include corn, soybeans, and alfalfa (Bishop et al. 2009).

Approximately 4,800 acres of palustrine wetlands, 79,000 acres of riverine wetlands, 7,800 acres of lakes and reservoirs, and 1.4 million acres of grassland occur throughout the Verdigris-Bazile Creek Drainages GFA (Table 1). The CRP program has been utilized to re-establish 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 re-established grassland acres complement the native tallgrass and mixed-grass remnants scattered throughout the region. It is estimated that this landscape provides nesting habitat for 600,000 grassland breeding birds (RWBJV 2013*a*). The Niobrara River provides breeding habitat for the threatened Piping Plover and endangered Interior population of Least Tern.

A majority of the CRP contracts are expiring, and current high commodity prices, plus the safety net provided by the Federal Crop Insurance Program, are accelerating conversion of these acres back to row-crop agriculture. Grassland conversion is also occurring as a result of current farm economics and farm policy. Fire suppression and year-long grazing regimes are suspected of creating conditions that allow eastern red cedars, Kentucky bluegrass, and smooth brome to invade grasslands. Eastern red cedars have also invaded the woodlands and forests associated with the Verdigris – Bazile Creek Drainages.

Continental Priority Waterbird Species

The North American Waterbird Plan divides North America into 16 Waterbird Conservation Planning Regions (WCPR; Kushlan et al. 2002). The RWBJV Administrative Area lies entirely in the Central Prairies WCPR. The Waterbird Plan highlights the importance of this region for breeding Black Terns, Eared Grebes, Black-crowned Night-Herons, American Bitterns, Virginia Rails, and the Interior population of Least Terns. The Plan also recognizes the Platte River as providing vital habitat for Whooping Cranes and Sandhill Cranes.

Within the Waterbird Plan, the population status of many species, particularly solitary breeders or marsh birds, has not been determined. Nebraska provides breeding and stopover habitat for 59 species of waterbirds (Farrar 2004). Fifty-two species have been documented in the RWBJV Administrative Area. Eighteen species are considered solitary breeders (Table 2), while the remaining thirty-four are described as colonial or semi-colonial breeders (Table 3). Tables 2 and 3 are derived from the lists contained in the North American Waterbird Conservation Plan (Kushlan et al. 2002), Birding Nebraska (Farrar 2004), and Birds of Nebraska (Sharpe et al. 2001). The lists include loons, grebes, pelicans, cormorants, herons, bitterns, ibises, spoonbills, rails, gallinules, coots, cranes, jaegers, gulls, and terns. Wandering vagrants of other species that incidentally traveled through Nebraska were not included. Only twenty-four species have been recorded as breeding in the state. Fourteen species are considered common breeders. Nebraska is on the outer edge of the remaining ten species' breeding ranges.

The International Union for Conservation of Nature (IUCN http://www.iucnredlist.org/details/106002796/0), which classifies the survival status of all wildlife species, lists fifty-eight Nebraska waterbird species as "Least Concern." The Least Concern designation means a species' overall population is widespread, its population size is large, and any decline in population is low enough to keep the species from being considered "Vulnerable." Only the Whooping Crane has a different classification, that of "Endangered," because of its extremely small population.

Table 2. Solitary- breeder waterbird species documented within the RWBJV Administrative Area and their breeding and non-breeding status (Sharpe et al. 2001).

Solitary-Breeder Waterbird Species		
Common Name	**Breeding Status**	**Non-breeding Status**
Red-throated Loon		Rare
Pacific Loon		Rare
Common Loon		Rare
Pied-billed Grebe	Common	Common
Horned Grebe		Fairly Common
Red-necked Grebe		Rare
American Bittern	Uncommon	Uncommon
Least Bittern	Rare	Rare
Yellow Rail		Rare
Black Rail		Rare
King Rail		Rare
Virginia Rail	Locally common	Locally common
Sora	Fairly common	Fairly common
Common Moorhen	Uncommon	Uncommon
American Coot	Abundant	Common
Sandhill Crane	Rare	Abundant
Common Crane		Rare
Whooping Crane		Rare

The U.S. Fish and Wildlife Service (USFWS) listed the Whooping Crane as endangered in 1970 (Federal Register 35, Number 199). The July 2006 population estimate for the wild population was 338 individuals. At that time the wild population was composed of 215 individuals in the Aransas-Wood Buffalo population, 59 captive-raised individuals released in an effort to establish a non-migratory Florida population, and 64 individuals introduced to develop an eastern migratory population (CWS and USFWS 2007). The captive population in July 2006 consisted of 135 birds (CWS and USFWS 2007).

The only self-sustaining wild population is the Aransas-Wood Buffalo population. This population breeds in Canada and winters in southeastern Texas. The 2007 revision of the Whooping Crane Recovery Plan (CWS and USFWS 2007) identified the loss and degradation of migration stopover habitat and the construction of power lines as two threats that occur within the RWBJV Administrative Area. The RWBJV Administrative Area annually provides migration habitat for a significant proportion of the Aransas-Wood Buffalo population of Whooping Cranes. Whooping Cranes have been observed using Central Table Playa wetlands, the Middle and North Loup rivers, the Niobrara River, Central Platte River, western Rainwater Basins, and Sandhills wetlands in the RWBJV Administrative Area. The Central Platte River is officially designated as critical habitat (USFWS 1978).

Table 3. Colonial and semi-colonial waterbirds documented within the RWBJV Administrative Area, and their breeding and non-breeding status (Sharpe et al. 2001).

Colonial & Semi-Colonial Waterbirds		
Common Name	**Breeding Status**	**Non-breeding Status**
Eared Grebe	Common	Common
Western Grebe	Locally common	Common
Clark's Grebe	Rare	Rare
American White Pelican		Abundant
Brown Pelican		Rare
Neotropic Cormorant		Rare
Double-crested Cormorant	Locally common	Abundant
Great Blue Heron	Locally common	Common
Great Egret	Accidental	Fairly common
Snowy Egret		Uncommon
Little Blue Heron		Uncommon
Tricolored Heron		Rare
Cattle Egret	Fairly common	Locally common
Green Heron	Rare	Rare
Black-crowned Night-Heron	Locally common	Fairly common
Yellow-crowned Night-Heron	Rare	Rare
White-faced Ibis	Uncommon	Fairly common
Roseate Spoonbill		Rare
Laughing Gull		Rare
Franklin's Gull	Accidental	Abundant
Ring-billed Gull		Abundant
California Gull		Locally common
Herring Gull		Locally common
Thayer's Gull		Rare
Lesser Black-backed Gull		Rare
Glaucous Gull		Accidental
Great Black-backed Gull		Rare
Sabine's Gull		Rare
Caspian Tern		Uncommon
Common Tern		Uncommon
Forster's Tern	Locally common	Common
Least Tern	Locally common	Fairly common
Black Tern	Common	Common

Although the IUCN classified the Least Tern as a species of "Least Concern", the U.S. Fish and Wildlife Service has ruled that the Interior subspecies is endangered (50 Federal Register 21, 784-21, 792). The species also has a state designation of endangered. Within the RWBJV Administrative Area, Least Terns breed on bare sand and gravel bars of the Niobrara, Platte, Loup, and Elkhorn rivers (USFWS 1990). Hydrologic alteration of river flows is identified as

the primary cause of the population's decline. Stabilization of major rivers has reduced the dynamic processes that create and maintain open sandbars. Some Least Terns nest on sand piles associated with gravel mining adjacent to the Platte, Middle Loup, North Loup, and Elkhorn rivers.

Priority Waterbird Species for the RWBJV Administrative Area

With the limited information available for breeding and migratory waterbirds that use the RWBJV Administrative Area, the RWBJV identified three priority species to guide initial waterbird conservation efforts: Least Tern, Whooping Crane, and Sandhill Crane. In accordance with the SHC framework, the RWBJV has prioritized waterbird monitoring to help inform and refine our conservation planning and implementation activities. An integrated waterbird monitoring effort across the RWBJV Administrative Area will provide information necessary to describe the value of the RWBJV Administrative Area to several national priority species, including King Rail, Black Tern, American Bittern, and Black-crowned Night-Heron.

Sandhill Crane was included with the two endangered species as an initial priority because nearly the entire mid-continent population stages in the RWBJV Administrative Area during its spring migration (Krapu et al. 2011). Between 2009 and 2011, the population averaged 600,000 individuals (Kruse et al. 2012). This is approximately 40,000 individuals above the national population goal established for the mid-continent population of Sandhill Cranes (Case and Saunders 2006). Some of the habitat needs of Whooping Cranes and Sandhill Cranes are similar, so it is assumed that management actions that benefit one will also benefit the other along the Central Platte River. The monitoring of changes in Sandhill Crane use along segments of the Platte will provide feedback on the effect of management actions.

The health and stability of most other waterbird populations in the RWBJV Administrative Area are directly tied to the success of waterfowl and shorebird populations. Actions taken by the Joint Venture to improve, restore, and protect wetland habitats for waterfowl and shorebirds will also likely benefit many other waterbirds.

Least Tern

The USFWS listed the Interior population of Least Terns as an endangered species in 1985. The recovery plan (USFWS 1990) identifies Nebraska as supporting one of the largest breeding populations. Least Terns nest on sandbars with sparse vegetation within wide, unobstructed river channels (USFWS 1990). Hydrologic and geomorphic alterations are identified as the main cause for their population decline. Within the Central Platte River, alterations in stream flow have resulted in narrowing stream channels and woodland encroachment. The low flows inhibit the formation of large macro-form sandbars and allow older sandbars to become vegetated. When riverine habitat is unavailable, Least Terns also nest on large, bare sand piles created by gravel mining operations. However, human disturbance and predation can reduce nest success and chick survival at sandpit sites.

The recovery plan states that Nebraska's contribution toward the subspecies' recovery would require 400 adults on the Missouri River, 200 adults on the Niobrara River, 170 adults on the Loup River, and 750 adults on the Platte River. Almost all of the Least Tern production on the

Missouri, Niobrara, and Loup rivers occurs within the RWBJV Administrative Area. Least Tern production along the Platte River system is greatest on the lower reach of the Platte River.

Whooping Crane

The 2006 population estimate for the Whooping Crane was 338 individuals in the wild and 135 in captivity (CWS and USFWS 2007). The Whooping Crane Recovery Plan has an objective of achieving three or more self-sustaining populations. If multiple populations of Whooping Cranes cannot be established, the secondary objective is to have over 1,000 individuals, with 250 breeding pairs, in the Aransas-Wood Buffalo population. Separate populations will offer Whooping Cranes a better chance of surviving a catastrophic event. For instance, 60 - 80% of known mortality occurs during migration (Lewis et al. 1992). Collision with power lines is believed to be the primary cause. The National Research Council (2005) stated that if Whooping Crane deaths were to increase by only three percent, the viability of the Aransas-Wood Buffalo population would not be genetically stable.

Strategic conservation of habitats throughout the flyway will provide the stopover habitat needed to address the species' annual life cycle needs and improve the likelihood of continued population growth. The habitat needs within Nebraska are solely for migration. The birds generally migrate through the region from late March to early April and again in late October through early November. Migration habitat is primarily in wetlands greater than 10 acres in size and within 0.6 miles of suitable foraging sites (Austin and Richert 1999).

Whooping Cranes in the Aransas –Wood Buffalo population use a variety of palustrine and riverine wetland habitats in the RWBJV Administrative Area (Figure 2; Tacha et al. 2010). Recent landscape-oriented analysis suggests that the RWB wetlands and adjacent Central Platte River, as well as the Central Table playas and the Middle and North Loup rivers, function as macro-wetland complexes: the riverine and wetland habitats complement one another. The Central Platte River is officially designated as critical habitat, extending 90 miles from Lexington, Nebraska to Denman, Nebraska (USFWS 1978). The National Research Council (2005) stated that 7% of the total Whooping Crane population uses this area in any one year, and many, if not all, of the Aransas – Wood Buffalo population of Whooping Cranes use the Central Platte River and western RWB wetlands (USFWS 2009) at some point in their lives. Austin and Richert (1999) noted that the Central Table Playas and associated Middle and North Loup rivers received significant use by family groups during fall migration, especially those family groups making their initial migration.

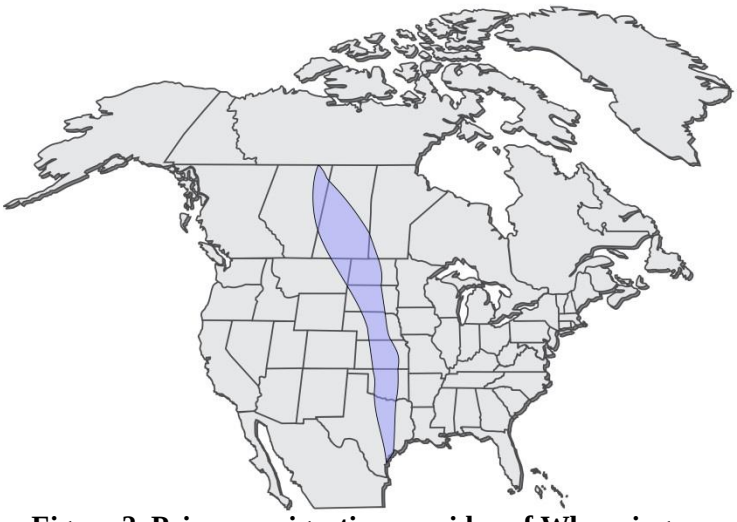

Figure 2. Primary migration corridor of Whooping Cranes derived from Tacha et al. 2010.

Loss of habitat in the Central Platte was the catalyst for the creation of the

Platte River Recovery Implementation Program (PRRIP). The program was established to manage land and water resources to provide benefits for the Whooping Crane, Interior population of Least Tern, Piping Plover and pallid sturgeon. The program's long-term goal is to protect and manage 29,000 acres of suitable habitat along the Central Platte River for the three bird species. As of 2010, 8,000 acres had been acquired (PRRIP 2010). In addition to land acquisition, PRRIP is also focused on minimizing hydrologic depletions. Ensuring sufficient target flows within the system will provide for adequate flows to sustain wet meadows during migration for the benefit of Whooping Cranes, to scour sandbars to provide roosting habitat for Whooping Cranes, and to support the prey base for Least Terns during periods of low flows.

Sandhill Crane

The mid-continent population of Sandhill Cranes is the largest population of all North American crane populations. A significant majority of the mid-continent population stage in the RWBJV Administrative Area during spring migration. It is estimated that approximately 90% of the population concentrates on the Central Platte River during spring migration (Krapu et al. 1982, Reinecke and Krapu 1986 Kinzel et al. 2006, and Krapu et al. 2011), while the remaining 10% of the population uses the North Platte River Valley (USFWS 1981, Krapu et al. 2011). The population is comprised of both Lesser and Greater subspecies of Sandhill Cranes (USFWS 1981, Krapu et al. 2011). The population has remained relatively stable since the early 1980s (Kruse et al. 2012).

Population Objectives

At all scales, the Waterbird Plan advocates integration of waterbird conservation with other bird conservation initiatives, when appropriate, in order to efficiently provide the best management options for local wildlife and habitat managers. In the last 15 years, natural resource managers have tried to more explicitly link conservation delivery to a population response by priority species. Past forms of accounting have focused on the number of acres protected and dollars spent, but with new technology we can report on acres, financial expenditures, and estimates of biological integrity, such as population response or an increase in landscape carrying capacity (National Ecological Assessment Team 2006). The RWBJV recognizes the difficulty in evaluating the biological response to conservation actions. The partnership has, however, benefited from recent assessments that highlighted the biological return provided by implementation of different conservation strategies. As a result the RWBJV continues to develop tools and planning frameworks that inform the partnership about the impact of conservation actions towards meeting regional population objectives.

Breeding Species

At present, the RWBJV cannot set valid population objectives for a majority of the priority breeding species identified in the Waterbird Plan (Kushlan et al. 2002). Waterbird surveys and research studies are nearly non-existent within the RWBJV Administrative Area. Data are needed to develop estimates of population densities associated with various habitat types and long-term population trends. Species with insufficient data include Black Tern, Black-crowned Night-Heron, American Bittern, Eared Grebe, and Virginia Rail.

The long-term goal is to use the Hierarchical All Bird System (HABS) (McLachlan et al. 2007) to develop population objectives and habitat recommendations. HABS combines Geographic Information System (GIS) databases of habitat abundance and quality and associated bird population densities.

Least Terns

The Interior population of Least Tern was designated as an endangered species by the USFWS in 1985 (USFWS 1990). To aid in the recovery of Interior Least Terns, the USFWS developed a recovery plan: Interior Population of the Least Tern, *Sterna antillarum,* Recovery Plan (Least Tern Recovery Plan; USFWS 1990). The Least Tern Recovery Plan calls for a population of 7,000 individuals and provides specific population objectives necessary to achieve conservation success for this species. Objectives for the RWBJV Administrative Area include a Niobrara River system that can support 100 breeding pairs, 85 breeding pairs dispersed along the Loup rivers, and a Platte River system that supports 375 breeding pairs (USFWS 1990). The RWBJV has adopted the population objectives outlined in the Least Tern Recovery Plan. Therefore the RWBJV Administrative Area needs to support 1,120 individuals, or 16% of the Interior population of Least Terns at goal. Currently the Least Tern Recovery Plan is undergoing a five-year review. Recent surveys suggest the population may be significantly greater than outlined in the 1990 Least Tern Recovery Plan (Lott 2006). As new information is made available, it will be incorporated into the RWBJV Waterbird Plan to guide conservation for this species.

Populations and production remain stable on the Missouri, Niobrara, and Loup river systems. Populations on the Central Platte River have declined due to lower stream flows and the invasion of vegetation on sandbars. Lutey (2002) reported the average number of Least Tern pairs along the Central Platte River between 1987 and 1998 to be 74. The National Research Council (2005) reported that from 2001 to 2003, the number of pairs along the same river segment had dropped below 12, and the Central Platte River subpopulation declined 47% from 1991 to 2001 (National Research Council 2005). In drought years, portions of the Central Platte River become dry and support no nesting pairs. The RWBJV partners include PRRIP, USFWS, and NGPC, all of which have staff dedicated to achieving conservation of Least Terns. The RWBJV office assists USFWS and NGPC staff with habitat monitoring and GIS habitat assessments.

Non-breeding Species

Numerous species of waterbirds migrate through the RWBJV Administrative Area during spring and fall migration. Whooping Cranes and Sandhill Cranes are the two priority waterbird species that use habitats within the RWBJV Administrative Area during both spring and fall migration.

Whooping Cranes

The Whooping Crane Recovery Plan (CWS and USFWS 2007) proposed the establishment of multiple migratory populations to support recovery of the species. If multiple self-sustaining populations cannot be established, the contingency plan is to have 1,000 individuals in the Aransas/Wood Buffalo population, with at least 250 productive pairs. The Whooping Crane Recovery Plan outlined strategic conservation of habitats throughout the Central Flyway for the Aransas-Wood Buffalo population to ensure available habitat to meet the Whooping Crane's annual life cycle needs and improve the likelihood that this species will continue to experience population growth.

The 2007 revision of the Whooping Crane Recovery Plan divides the Whooping Crane's annual life cycle into three periods (wintering, migration, and nesting) and highlights habitat-related goals for each period. The Central Platte River was designated as critical habitat for Whooping Cranes by the USFWS in 1978; since then, additional research projects have identified other landscapes within the RWBJV Administrative Area. Austin and Richert (1999) identified the Central Table Playas Wetland Complex (Central Loess Hills), Middle and North Loup rivers (Central Loess Hills), and Niobrara River (Sandhills and Verdigris-Bazile Creek Drainages) as important, while the National Research Council (2005) highlighted western RWB wetlands (Rainwater Basin) as an important habitat for migrating Whooping Cranes. The Recovery Plan places a priority on migration stopover sites, with an emphasis on the potential impacts of climate change on these habitats. For migration habitat, the Whooping Crane Recovery Plan specifically identifies the importance of wetland complexes, further suggesting that these complexes should be identified, mapped, and protected (CWS and USFWS 2007).

Recent landscape-oriented analyses suggest that the Central Platte River, western Rainwater Basins, Central Table Playas, and Middle/North Loup rivers function as a macro wetland complex. The riverine and playa wetland complexes complement one another. The riverine systems experience higher use during dry years, while playa wetlands provide suitable habitat during years with average precipitation and especially during years when the Platte and Loup rivers are at flood stage (National Research Council 2005).

Sandhill Cranes

Sandhill Cranes extensively use the Central and North Platte River GFA. Numerous research projects have documented that nearly the entire mid-continent population of Sandhill Cranes use the RWBJV Administrative Area. Approximately 90% of the mid-continent population of Sandhill Cranes stage in the Central Platte River Valley (CPRV) between Lexington, Nebraska and Chapman, Nebraska (Figure 3.), while the remaining birds utilize the North Platte River Valley (NPRV) between Lewellen, Nebraska and North Platte, Nebraska (Krapu et al. 1982, Reinecke and Krapu 1986, Kinzel et. al. 2006, Krapu et al. 2011). While staging in the CPRV and NPRV, Sandhill Cranes rely on the river for roosting, while the adjacent wet meadows provide opportunities to forage for invertebrates, which provide calcium and protein resources. The numerous row-crop agriculture fields have an abundance of waste grain that provides carbohydrates, which are easily converted to lipid reserves.

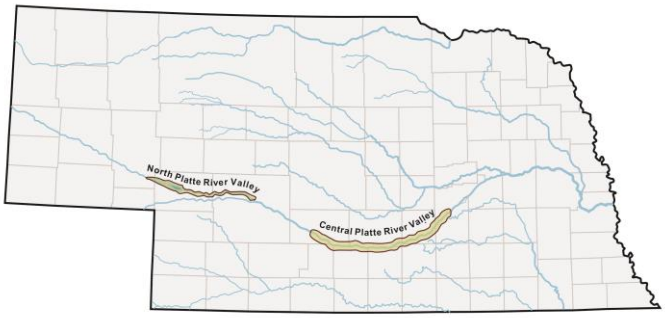

Figure 3. Central and North Platte River.

Based on the current population goal of 560,000 individuals (Case and Sanders 2009), the CPRV would need to support 504,000 Sandhill Cranes, while the NPRV would need sufficient habitat to support an estimated 56,000 individuals. To better inform conservation delivery, the RWBJV developed a bioenergetics model to quantify energetic needs and evaluate the ability of these landscapes to support this number of individuals.

The energetics model for each region (Appendices A and B) was calibrated based on subspecies distribution, average residency time, and specific daily energetic requirements by subspecies and sex. Individuals using the CPRV need a minimum of 9.2 billion kcals during spring staging, with wet meadows providing 463 million kcals of the total energetic requirements. The estimated energetic need of Sandhill Cranes using the NPRV is 1.1 billion kcals, with 54 million kcals coming from wet meadows and associated grassland habitats.

Primary Waterbird Habitat in the RWBJV Administrative Area

Each of the Geographic Focus Areas in the RWBJV Administrative Area contains a unique abundance, distribution, and diversity of wetland types. This landscape composition influences the species and number of waterbirds each landscape can support.

Breeding Waterbird Habitat in the RWBJV Administrative Area

Least Terns are the principal breeding waterbirds that use riverine wetlands during the breeding phase of the annual life cycle. Least Terns select for sparsely vegetated sandbars as their primary nesting habitat. They have also been documented nesting at sand and gravel mining operations within the floodplains of the larger river systems. Riverine wetlands associated with the Elkhorn (Northeast Prairies/Elkhorn River GFA), Loup (Central Loess Hills GFA), Missouri, and Platte (Central and North Platte River GFA) rivers are identified as critical breeding habitat to support the recovery of the Interior population of Least Terns. The palustrine and riverine wetlands also provide a forage resource for Least Terns.

Outside of the Sandhills, the low wetland densities, seasonality of wetlands, and lack of grasslands limit the number of waterbirds that successfully nest in the RWBJV Administrative Area. In the Sandhills, the extensive amount of intact grassland, high wetland density, interspersion, and greater number of semi-permanent wetlands provide good nesting and foraging habitat for waterbirds. Although the grassland landscape has remained relatively intact, wetland drainage continues, but at a slower pace compared to years before the "Swampbuster" provision of the 1985 Farm Bill. Recent spikes in commodity prices may have increased conversion of grassland to cropland. The increased commodity prices and guaranteed income provided by the Federal Crop Insurance Program have made it more profitable for some producers to opt out of USDA farm programs. As a result, wetlands within such operations are not protected by "Swampbuster" provisions and are subject to drainage and filling. The Clean Water Act may protect some wetlands from drainage, but many of the Sandhills wetlands are considered to be geographically isolated and may no longer be protected under the Clean Water Act.

The large expanse of grassland (95% of 12.4 million acres within the Sandhills; Schneider et al. 2011) is vulnerable to wind development. Development of large-scale wind farms could fragment the landscape and lead to increased nest predation and aversion to the area. The spread of invasive species is also a concern. As wind farms are constructed, there will be significant disturbance of the vegetative communities and soils on-site. These disturbed conditions will provide optimal germination conditions for invasive species, while service vehicles will provide a vector to transport seeds throughout the landscape. Establishment of these species will degrade

nesting and wetland habitats. Smooth brome, Canada thistle, leafy spurge, eastern red cedar, hybrid cattail, *Phragmites*, and reed canary grass pose the greatest current threat.

Non-breeding Waterbird Habitat in the RWBJV Administrative Area

Playa wetlands, like those found in the RWB and the Central Loess Hills (Central Table Playas Wetland Complex), are used by Whooping Cranes during spring and fall migration (Austin and Richert 1999). Within the RWB and Central Table Playa Wetland Complexes there are numerous wetlands; however wetland and watershed modifications reduce the reliability with which the wetlands provide ponded-water habitat for Whooping Cranes during spring and fall migration. Conservation work by the RWBJV in the RWB has focused, and will continue to focus, on providing reliable habitat for wetland-dependent species during the non-breeding phase (primarily migration) of their annual life cycle. Waterbird conservation strategies in the RWB are consistent with those outlined in the RWBJV Waterfowl and Shorebird Plans. These strategies include wetland restoration activities to increase wetland function, watershed restorations to increase runoff to the wetland, and management to promote desired habitat conditions.

The close proximity of the playa wetland complexes (RWB and Central Table Playas) to adjacent riverine wetland systems (Loup and Platte rivers) creates multiple macro wetland complexes. The diversity of wetland types provides a complementary set of habitat conditions for migrating waterbirds. Within this region, localized weather events and long-term weather patterns (el Niño, la Niña, and drought) have a significant impact on the number of wetlands ponding water. During periods of extreme drought, with above-average winter temperatures and below-average precipitation, limited playa wetland habitat is available (Robichaux 2010, Uden 2012), and the riverine systems provide critical habitat (National Research Council 2005).

Conservation Design

Wildlife management is achieved at the most basic level by addressing two driving forces: survival and recruitment. During the non-breeding phase of the annual life cycle, the overarching goal is survival. During migration, long distance migrants also try to acquire sufficient nutrient reserves so that once on the breeding grounds, they can initiate nesting as soon as possible. During the breeding phase, the goal is to recruit as many young into the population as possible. Most research on avian population demographics describes a relationship between shrinking populations and loss of habitat (forcing species to emigrate to less suitable habitat patches) or failure to successfully recruit young and replace individuals lost to annual mortality.

Breeding Waterbirds

Least Terns

The Central Platte, Middle Loup, and North Loup rivers are identified as critical habitat for recovery of the Interior population of the Least Tern. Along the Central Platte River, land and water resources are actively managed by multiple conservation partners, including National Audubon Society, PRRIP, The Crane Trust, The Nature Conservancy, USFWS, and NGPC. Management promotes desired habitat conditions and in-stream flows to support successful

nesting by Least Terns. The Loup rivers have not faced the intense threats and degradation that have occurred on the Platte River. The goal of the RWBJV is to maintain habitat conditions and flows in the North and Middle Loup rivers for nesting Least Terns.

Non-breeding Waterbirds

The "Cross Seasonal Effects" hypothesis (Krapu 1981) is the foundation of the RWBJV's conservation actions. The hypothesis suggests that habitat conditions at mid-latitude staging areas influence subsequent reproductive performance in migratory birds. In highly altered systems, like the RWB, habitat loss and degradation are thought to negatively influence waterfowl and other wetland-dependent species that rely on this region. The contemporary habitat conditions and the significant increase in wetland-dependent species using the RWB and Central Platte River are considered to be creating increased competition for resources, resulting in individuals leaving the area in reduced physical condition compared to a scenario in which habitat goals are achieved (LaGrange and Dinsmore 1988).

Based on the lipid limitation (Devries et al. 2008) and the "Cross Seasonal Effects" hypotheses, mid-latitude stopover sites are critical to migratory waterbird reproductive success. Quantifying their contributions to known measures such as fall flight numbers, however, is difficult. Recent research has documented that wetland-dependent species (waterfowl and waterbirds) leaving migratory stopover sites in poor condition must acquire significantly more lipid and protein reserves on the breeding grounds to survive, initiate nesting, and successfully recruit new individuals into the population. Waterfowl arriving on the breeding grounds with low lipid and protein reserves demonstrate later nest initiation, smaller clutch sizes, and a lower propensity to re-nest—resulting in lower recruitment.

The overarching objective of the RWBJV is to provide adequate habitat to promote survival of waterbirds during residency in the RWBJV Administrative Area, as well as necessary acres of foraging habitat to ensure that migrating waterbirds have the opportunity to acquire sufficient nutrient reserves to complete migration, initiate nesting, and produce viable offspring. It is assumed that large concentrations of migratory waterfowl found in the RWB and Central Platte River greatly increase intra- and inter-specific competition for habitat and increase the risk of a catastrophic disease outbreak. Both of these indirect and direct threats have the potential to negatively impact waterbird populations. An ongoing priority of the RWBJV is to increase both the quantity and quality of habitat within these two areas, as well as in the Central Loess Hills (Central Table Playa wetland complex). The intent is to increase the habitat base and better distribute individuals and species, reducing competition for habitat and exposure to disease vectors.

Whooping Cranes

Landscape-oriented analysis suggests that the Central Platte River, western RWB, Central Table Playas and Middle/North Loup rivers function as a macro wetland complex. Along the Central Platte River, land and water resources are actively managed by multiple conservation partners, including National Audubon Society, PRRIP, The Crane Trust, The Nature Conservancy, USFWS, and NGPC. Management promotes desired habitat conditions and in-stream flows for Whooping Cranes. Currently the RWBJV is developing a set of conceptual models to better target conservation actions along the Central Platte River for Whooping Cranes. These geospatial models were developed by analyzing habitat conditions at known roost locations and

landcover data in a GIS. Future research and monitoring data will be analyzed to further refine these models and develop additional Decision Support Tools (DSTs) to guide conservation delivery.

The Loup rivers have not faced the intense threats and degradation that have occurred on the Platte River. The goal of the RWBJV is to maintain habitat conditions and flows in the North and Middle Loup rivers, which will also provide desirable habitat conditions for Whooping Cranes.

Both the RWB and Central Table Playa wetland complexes have been significantly altered for row-crop agricultural production. Although significant wetland drainage has occurred, numerous playas still demonstrate some level of function. Nearly all wetlands, however, are negatively impacted by wetland and watershed modifications. To help guide protection, restoration, and enhancement of playa wetlands, the RWBJV has developed several spatially explicit Habitat Suitability Index (HSI) models (Bishop et al. 2010).

HSI modeling identifies the key habitat characteristics to which a priority species responds. Characteristics are scored (from 0.0 – 1.0) based on reported literature, expert opinion of life history requirements, or statistical analysis. Two decades of Whooping Crane observations were used to evaluate landscape and local characteristics' influence on crane use. Characteristics included in the model were migration corridor, wetland size, wetland density, and potential disturbance.

A HSI model developed for the RWB allowed the RWBJV to identify priority wetlands and specific conservation targets. Twenty-six wetlands covering 7,952 hydric soil acres were identified as conservation priorities (Figure 4). Eight wetlands are entirely in private ownership, representing 1,559 acres. Portions of the remaining 18 wetlands are owned and managed by either NGPC or USFWS. The publicly owned portions of these 18 wetlands represent 4,721 acres. Management or protection of the adjoining 1,672 acres is critical to optimize Whooping Crane habitat on publicly owned wetlands. The RWBJV will work closely with private landowners interested in enhancing their portions of the 26 priority wetlands (Figure 4).

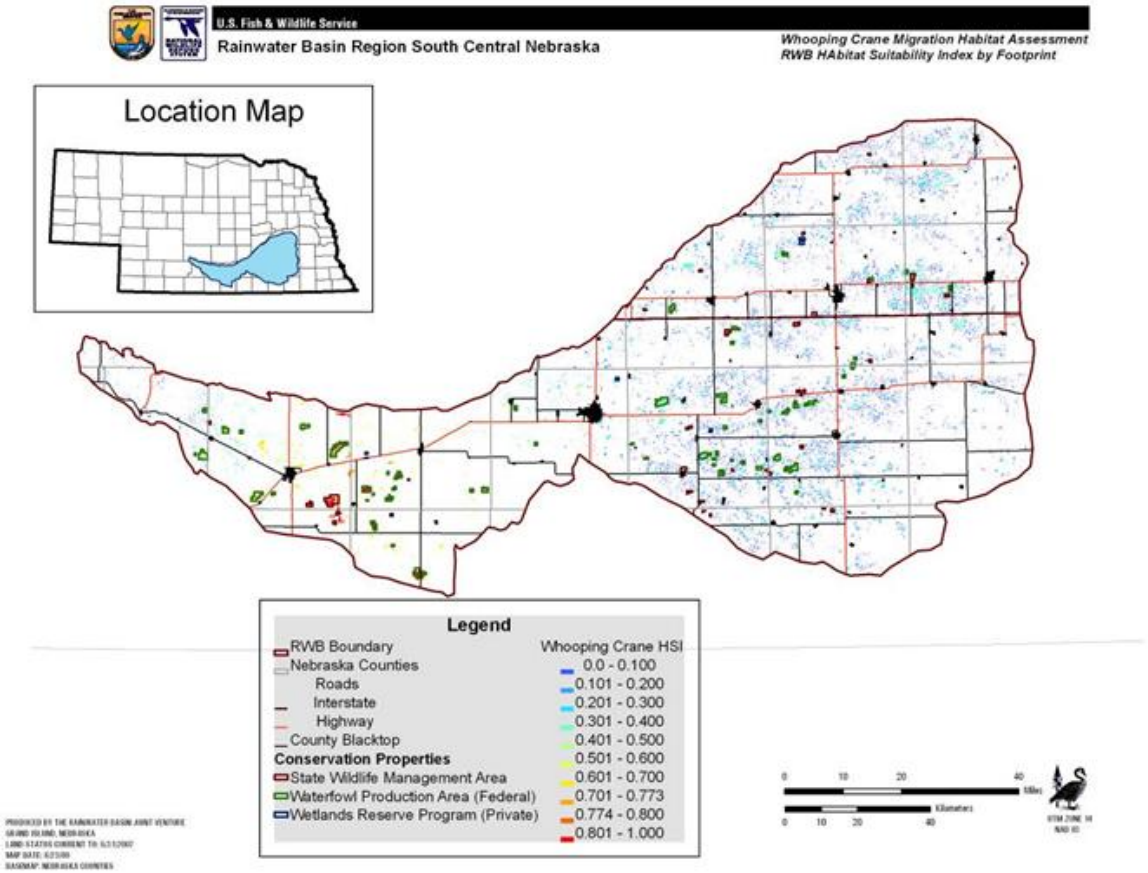

Figure 4. Whooping Crane habitat suitability index of wetlands within the Rainwater Basin.

As stated, most public areas do not totally encompass the entire historic wetland footprint, a situation that hinders the ability both to restore full hydrologic function and to conduct intensive vegetation management. By focusing new acquisition efforts on roundout acres (1,672 acres), a more sustainable wetland system can be created. Advantages of such actions include reducing the amount of management needed to increase ponding frequency and to maintain desirable vegetation.

The RWBJV seeks to acquire sufficient upland buffers to reduce the effect of agricultural runoff, which impairs wetland functions. Typically, a 1:1 wetland-to-upland ratio has been used as a guide to upland acquisition. Therefore, as part of this strategy, an additional 1,672 acres of adjacent upland acres would be targeted to provide sufficient buffer around the wetlands, meaning that, in total, 3,344 acres of new acquisitions need to be completed. The acquisition acres are a portion of the total land protection goals identified in the Rainwater Basin Joint Venture Waterfowl Plan (RWBJV 2013*c*), since these same acres will benefit waterfowl as well.

Ponding frequency on public wetlands needs to be improved from the present annual average of 17.4% to 45%. Increasing ponding frequency to more natural, historic levels will require restoring the wetland (on-site) and the natural watershed (off-site) hydrology. By filling 75% of the 306 upland pits now affecting the watersheds of 18 public wetlands, we estimate that we would increase ponding frequency on these wetlands to 45% in an average year. Restoration within the wetland (e.g., plugging drains and removing culturally accelerated sediment) will also result in improved wetland ponding.

A conceptual model was completed in the Central Table Playas region, based on the HSI model criteria used in the RWB. The model identified 236 of the 1,926 wetland footprints as conservation priorities (Figure 5). Of these, only one playa is currently under fee title ownership, therefore conservation actions will need to be developed through agreements with willing landowners. The HSI model is being used to prioritize protection, restoration, and enhancement activities to maximize benefits to Whooping Cranes.

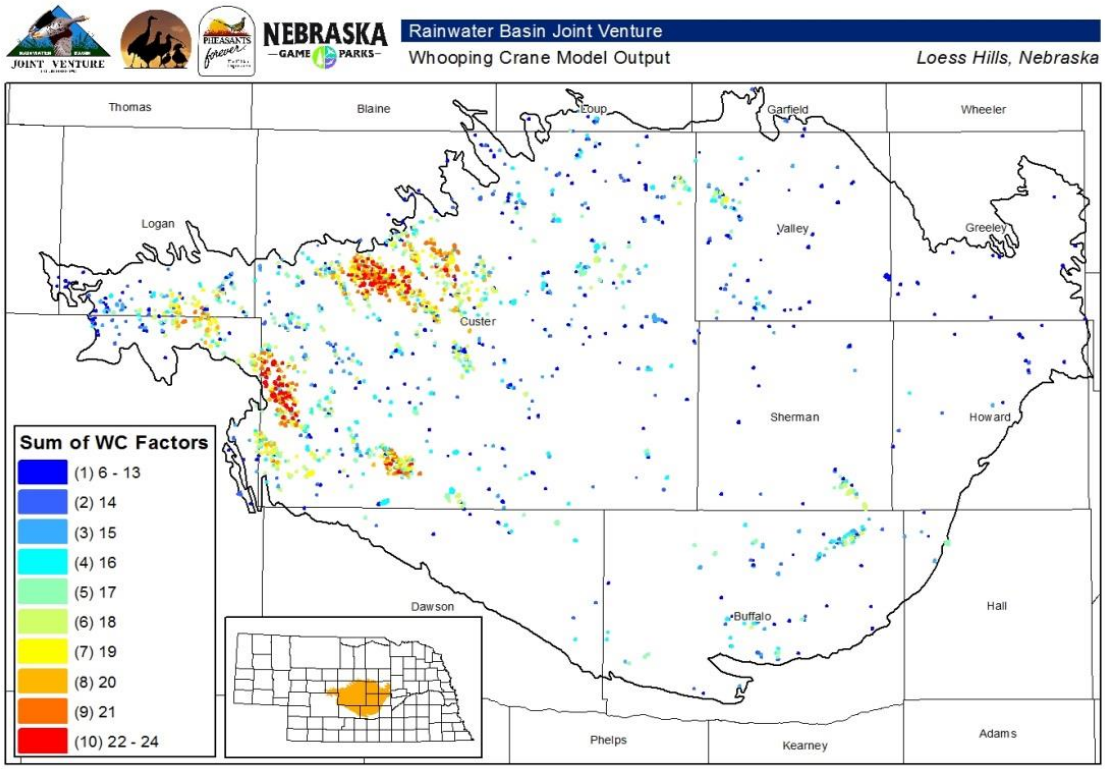

Figure 5. Whooping Crane habitat suitability index of Central Table Playas located within the Central Loess Hills.

Sandhill Cranes

The RWBJV used existing data on Sandhill Cranes to develop bioenergetics models for the CPRV and NPRV regions during migration. The models estimate the energetic requirements and potential habitat (wet meadow and waste grain) acres needed to support desired populations. The models are not spatially explicit and cannot incorporate species-habitat relationships, such as patch size, disturbance, and spatial context of other habitats. Therefore, the estimates should be viewed as a baseline or minimal amount of necessary habitat.

The CPRV model (Appendix A) estimates that 9.4 billion kcals of foraging resources are needed, with 4.6 million kcals coming from wet meadows and 8.8 billion from waste grain (corn). This equates to 11,125 acres of high quality wet meadow and associated grasslands and 72,200 acres of harvested corn fields containing at least 35.6 kg/acre of available waste grain.

The NPRV model (Appendix B) estimates that 1.08 billion kcals of foraging resources are needed, with 54.2 million kcals coming from wet meadows and 1.03 billion from waste grain. This equates to 1,300 acres of wet meadow and associated grasslands and 8,500 acres of harvested corn fields containing at least 35.6 kg/acre of available waste grain. A better understanding of habitat size and juxtaposition to other grassland habitats is needed to expand patch characteristics for which Sandhill Cranes select in this region.

Breeding Waterbird Habitat Strategies

There are three primary breeding habitats needed for waterbirds using the RWBJV Administrative Area. Least Terns nest almost exclusively on riverine habitats associated with the four major river systems in the RWBJV Administrative Area (Elkhorn, Loup, Missouri, and Platte rivers). Loss of sufficient high-quality waterbird nesting habitat along these riverine systems continues to be a major threat within the RWBJV Administrative Area. Loss of nesting habitat is primarily due to the reduction of in-stream flows and the degradation of these major rivers. Stream flows of significant magnitude and duration are necessary to maintain sandbars and braided stream channels.

A dramatic increase in irrigation in recent decades has caused groundwater levels to drop, affecting stream flows and the rivers' ability to maintain bare sandbars and flooded wet meadows. As a result of this irrigation development, all or portions of the Platte and Republican river basins have been declared fully or over-appropriated, limiting new irrigation development.

The expansive palustrine and lacustrine wetlands found in the Sandhills provide some of the best nesting habitat for the other priority breeding species (Black Tern, Black-crowned Night-Heron, American Bittern, Eared Grebe, and Virginia Rail) identified in the Waterbird Plan (Kushlan et al. 2002). The Sandhills contain over 1.2 million acres (Table 1) of lakes and associated marshes. The RWBJV habitat goal for this area is to assure no net loss of existing wetland distribution and abundance. To successfully implement this goal, the RWBJV will need to expand the partnership and more effectively coordinate with organizations like the Sandhills Task Force. The Sandhills Task Force is composed of ranchers, Nebraska Cattleman members, conservation organizations, and government agencies. Their goal is to enhance the Sandhills wetland-grassland ecosystem in a way that sustains profitable private ranching, wildlife and vegetative diversity, and associated water supplies.

As described earlier in this plan, there are insufficient data to establish population objectives for the five priority breeding species (Black Tern, Black-crowned Night-Heron, American Bittern, Eared Grebe, and Virginia Rail) identified in the Waterbird Plan (Kushlan et al. 2002). Despite the lack of data to define empirical estimates of needed habitat, species experts are working to evaluate current conditions and describe, in a conceptual manner, habitat objectives.

Although the management of RWB wetlands is targeted towards providing optimal foraging habitat for waterfowl and shorebirds, late successional emergent marsh is a common habitat in the RWB. The quality of breeding habitat for waterbirds in the RWB depends on both management and climatic factors. Management has created a vegetative continuum ranging from emergent to early successional plant species. Those wetlands left unmanaged or idled remain dominated by perennial emergent vegetation. Our long-term goal is to protect over 62,500 acres of playa wetlands in the RWB (RWBJV 2013*c*). It is estimated that between 2,500 and 5,000 acres of those wetlands will be dominated by late-succession emergent marsh habitat.

The following Conservation Target and associated strategies are not absolute but represent a scenario allowing the RWBJV to help meet habitat objectives for waterbirds. Changes in policies, programs, public support, and funding can and will determine which conservation opportunities will arise. As one target is exceeded, other target numbers will be adjusted.

Central Loess Hills Conservation Targets and Strategies

Target 1. Work with partners to maintain stream flows necessary for maintenance of in-channel habitat conditions, through scouring and other ecological processes, to provide nesting habitat for Least Terns.

Strategy A: Provide technical resources necessary to complete geospatial analysis to quantify and map the habitat conditions found on the Loup River systems.

Strategy B: Provide technical resources necessary to describe available in-channel nesting habitat for Least Terns to better target conservation activities.

Platte, Loup, Missouri, and Niobrara River Conservation Targets and Strategies

Target 1. Work with partners to increase the frequency of in-stream target flows that maintain in-channel habitat conditions, through scouring and other ecological processes, to provide nesting habitat for Least Terns.

Strategy A: Provide technical resources for geospatial analysis to quantify and map the habitat conditions under different flow regimes.

Strategy B: Provide technical resources necessary to quantify the impacts of different flow regimes on available in-channel habitat for Least Terns.

Target 2. Work with partners to assess the capability of the Central Platte River to provide suitable nesting habitat for Least Terns and provide guidance for strategic habitat conservation.

Strategy A: Provide technical resources for geospatial analysis to quantify and map current nesting habitat for Least Terns.

Strategy B: Provide technical resources necessary to develop decision support tools to assist conservation partners and land managers in prioritizing restoration and management projects to provide the greatest biological return for Least Terns.

Sandhills Conservation Targets and Strategies

Target 1. Work with partners to identify conservation opportunities that can be developed to provide nesting waterbird habitat on private lands.

Strategy A: Provide technical resources necessary to complete landscape-level surveys that can be used to define species-habitat relationships and identify priority landscapes for waterbird conservation.

Strategy B: Develop conservation programs and strategies that will promote waterbird nesting habitat and complement cattle operations in the Sandhills.

Non-breeding Waterbird Habitat Strategies

The two priority non-breeding waterbirds using the RWBJV Administrative Area are Whooping Cranes and Sandhill Cranes. Whooping Cranes use a diverse assemblage of wetland habitats found in the RWBJV Administrative Area. Whooping Cranes extensively use playa wetlands in the RWB and Central Table Playa wetland complexes, as well as riverine wetlands in the CPRV and in the Middle and North Loup river valleys. Sandhill Cranes stage primarily in two geographic areas: the CPRV and NPRV.

Precipitation events and weather patterns are highly variable throughout the Great Plains. Precipitation in this region determines the availability of habitat for wetland-dependent species, especially non-breeding migrants during both spring and fall migration. The RWBJV recognizes the importance of having non-breeding waterbird habitat distributed across the landscape to maximize the probability of available habitat during migration. Therefore, the RWBJV has established habitat conservation targets for playa wetlands located in the RWB and Central Table Playas, as well as riverine habitat benchmarks for the Central and North Platte River. These habitat benchmarks were established based on current species-use estimates and habitat needs and incorporate habitat resilience or wetland function. By increasing functional playa wetlands and in-stream flows in the Platte and Loup rivers, the RWBJV will provide a reserve habitat base for waterfowl, waterbirds, and shorebirds during the non-breeding phase of the annual life cycle.

Central Loess Hills Conservation Targets and Strategies

Target 1. Enroll 4,000 acres of playa wetlands in existing or newly developed conservation programs that fully restore wetland and watershed function. At goal, these wetlands should, under average climate conditions, provide 2,000 acres of reliable wetland habitat during spring and fall migration to support the Whooping Cranes that use this region.

Strategy A: Strategically market wetland conservation programs that provide financial and technical assistance to restore wetland functions.

Sub-strategy 1: Annually enroll 200 acres of playa wetlands in the Natural Resources Conservation Service (NRCS) Wetlands Reserve Program or similar programs in the Central Table Playas.

Sub-strategy 2: Develop a CRP Conservation Practice, like CP 23A, that provides a ten-year contract to restore playa wetlands and adjacent upland buffer enrolled in the program. The RWBJV will pursue opportunities to compensate enrolled acres at county irrigated rental rates, since a majority of the Central Table Playa wetlands are embedded in center pivot-irrigated crop fields. Programs should be structured

to require full hydrologic restoration to the extent technically feasible and also require mid-contract management.

Sub-strategy 3: Enroll 75 acres annually (50 acres of wetland and 25 acres of adjacent upland buffer) in these conservation programs.

Sub-strategy 4: Integrate geospatial habitat prioritization tools to promote conservation programs to high-priority landowners and producers.

Strategy B: Develop a watershed restoration program to fill irrigation reuse pits that are negatively impacting Central Table Playa wetlands.

Sub-strategy 1: Analyze existing geospatial datasets to determine the number of watershed modifications (e.g., irrigation reuse pits, road ditches, etc.) and the potential impacts (storage volume) of these features on wetland function.

Sub-strategy 2: Analyze existing irrigation practices to identify irrigation reuse pits that have been abandoned and are no longer actively used due to a transition to pivot irrigation systems.

Sub-strategy 3: Develop a prioritization tool to identify those abandoned irrigation reuse pits that have the greatest impact on existing playa wetlands in the Central Table Playas.

Sub-strategy 4: Develop and implement conservation initiatives to remove 75% of these abandoned irrigation reuse pits by 2030.

Strategy C: Develop infrastructure to integrate Central Table Playa wetlands into producers' operations for either forage or cattle production. Such activities (grazing and haying) emulate the ecosystem processes under which these wetlands evolved and will promote desired vegetation communities and habitat conditions for priority species.

Sub-strategy 1: Develop and implement programs that will provide cost-share for agriculture producers to install cross fence, perimeter fence, and livestock water systems to integrate these wetlands into agriculture operations.

Central Platte River Conservation Targets and Strategies

Target 1. Work with partners to increase the frequency of in-stream target flows that maintain in-channel habitat conditions through scouring and other ecological processes, as well as functioning wet meadows, to provide roosting and foraging habitat for Sandhill Cranes and Whooping Cranes.

Strategy A: Provide technical resources necessary for geospatial analysis to quantify and map suitable roosting and foraging habitat for Sandhill Cranes and Whooping Cranes under different flow regimes.

Target 2: When necessary, implement active management (disking, herbicide treatment, tree removal) to promote desired habitat conditions within the active channel, plus a matrix of wetland habitats to benefit Sandhill Cranes and Whooping Cranes.

Target 3. Work with partners to provide foraging habitat for Sandhill Cranes and Whooping Cranes.

Strategy A: Ensure that there is sufficient wet-meadow habitat in the right landscape juxtaposition and spatial configuration to provide 11,125 acres of high-quality wet meadow foraging habitat for Sandhill Cranes and Whooping Cranes.

Strategy B: Continue to monitor waste grain availability to ensure that at least 72,200 acres of harvested corn fields contain at least 35.6 kg/acre of available waste grain to provide sufficient foraging habitat.

Strategy C: Provide technical resources necessary to develop decision support tools to assist conservation partners and land managers in prioritizing restoration and management projects to provide the greatest biological return from habitat projects for Sandhill Cranes and Whooping Cranes.

North Platte River Conservation Targets and Strategies

Target 1. Work with partners to increase the frequency of in-stream target flows that maintain in-channel habitat, through scouring and other ecological processes, and provide roosting habitat for Sandhill Cranes.

Strategy A: Provide technical resources for geospatial analysis to quantify and map suitable roosting habitat for Sandhill Cranes under different flow regimes.

Target 2: When necessary, implement active management (disking, herbicide treatments, tree removal) to promote desired habitat conditions within the active channel, plus a matrix of wetland habitats to benefit Sandhill Cranes.

Target 3. Work with partners to determine habitat preferences of foraging Sandhill Cranes.

Strategy A: Ensure that there is sufficient wet-meadow habitat in the right landscape juxtaposition and spatial configuration to provide 1,300 acres of wet meadows and associated grasslands to meet the foraging needs of Sandhill Cranes.

Strategy B: Continue to monitor waste grain availability to ensure that at least 8,500 acres of harvested corn fields contain at least 36.5 kg/acre of available waste grain to provide sufficient foraging habitat.

Strategy C: Provide technical resources necessary to develop decision support tools to assist conservation partners and land managers in prioritizing restoration and management projects to provide the greatest biological return from habitat projects for Sandhill Cranes in the NPRV.

RWB Conservation Targets and Strategies

Target 1. Ensure that publicly owned wetlands are capable of providing wetland habitat to support Whooping Cranes during migration.

Strategy A: Through management, maintain 80% of public wetland acres in early successional plant communities. Management will be targeted at reducing the distribution of invasive species to provide hemi-marsh conditions.

Strategy B: Increase ponding frequency under average moisture conditions from 17.7% to 45% on public lands.

Sub-strategy 1: Restore the natural hydrologic characteristics of each wetland to the greatest feasible degree.

Sub-strategy 2: Increase the function of associated watersheds by reclaiming irrigation reuse pits and implementing other conservation practices to increase water conveyance to the wetlands.

Sub-strategy 3: Provide additional supplemental water delivery by increasing the use of high-volume wells.

Sub-strategy 4: Develop a long-term funding mechanism to operate high-volume wells.

Target 2. By 2030, develop long-term conservation programs on 12,690 acres of RWB wetlands (Table 4).

Strategy A: Through management, maintain 75% of these wetland acres in early-succession plant communities.

Strategy B: Increase ponding frequency under average weather conditions to 45% (Table 5).

Sub-strategy 1: Restore the natural hydrologic characteristics of each wetland to the greatest feasible degree.

Sub-strategy 2: Increase the function of associated watersheds by reclaiming irrigation reuse pits and implementing other conservation practices.

Sub-strategy 3: Provide additional supplemental water delivery by increasing the use of high-volume wells.

Sub-strategy 4: Develop a long-term funding mechanism to operate high-volume wells.

Conservation Delivery

Similar conservation approaches will be taken for breeding and non-breeding waterbirds, relying on partners' expertise, staff, existing conservation programs, and new conservation programs, when needed, to achieve targets. Conservation programs are grouped into two basic categories: short-term or long-term.

Short-term programs are typically carried out under ten-year agreements. The agreements are designed to complement existing environmental and socio-economic conditions and can be tailored to the specific wishes of the landowner. They often provide financial as well as technical assistance for practices such as wetland restoration, riverine management, watershed restoration, and vegetation management.

Acquisition and long-term programs (30 years or more) generally involve the fee-title purchase of lands, or the purchase of perpetual conservation easements. Easement acquisitions are accomplished by various partners within the Joint Venture, with individual partners taking the leadership in their own acquisitions. In some Geographic Focus Areas in the RWBJV Administrative Area, the RWBJV partners collaborate to identify potential properties, leverage funding, and help facilitate management of lands enrolled in long-term conservation programs. The NRCS Wetlands Reserve Program will be an important program, especially outside of the RWB. All acquisitions and program participation are strictly on a voluntary-seller basis.

In the RWB, publicly owned wetlands will play a critical role; however, in other GFAs, acquisition of public lands will be very limited. The focus will be on both long- and short-term conservation programs. Partners will work with willing landowners to establish conservation programs that ultimately help integrate palustrine, riverine and upland habitats into the producer's operation and provide desired waterbird habitats.

Research and Monitoring

The RWBJV needs to develop a waterbird monitoring protocol to obtain population estimates and to better understand species-habitat relationships, species-specific density estimates by habitat type, and population trends. These data can be integrated into the HABS database to develop refined habitat objectives for Black Terns, Black-crowned Night-Herons, American Bitterns, Eared Grebes, and Virginia Rails.

The RWBJV needs to address at least two key uncertainties to strengthen planning and conservation delivery for Sandhill Cranes. The efficiency of Sandhill Cranes' foraging for invertebrates in wet meadows is not well understood and needs to be evaluated. In the bioenergetics model it was assumed that 20% of the invertebrates available in wet meadows and associated grasslands were consumed. This assumption needs to be tested and could dramatically influence habitat objectives. The second key uncertainty that needs to be evaluated is the influence of spatial juxtaposition (size, proximity to roost, and distance to disturbance features) on selection and use of habitat (roost sites, wet meadows and crop fields) by Sandhill Cranes.

The RWBJV will work closely with the USFWS, NGPC, PRRIP, and other partners to collect habitat assessment data and integrate future research and monitoring data into our geospatial models used to guide conservation for Whooping Cranes and Least Terns.

Summary

The RWBJV Administrative Area has an abundance and variety of wetlands that provide habitat for both breeding and non-breeding waterbirds. These habitats support a significant proportion of the continent's Sandhill Cranes and Whooping Cranes during the non-breeding phase of their annual life cycle. On-the-ground conservation by the RWBJV, for non-breeding waterbirds, will be focused in the CPRV and to a lesser degree in the NPRV, RWB, and Central Table Playas. Conservation delivery to benefit breeding waterbirds will be focused along the Central Platte River, Loup rivers, and Missouri River for Least Terns, and in the Sandhills for the other priority breeding species. Conservation focus will be placed on efforts to restore and maintain suitable nesting habitat along high-priority riverine systems (e.g., Central Platte River, Loup rivers, and Niobrara River) for the federally listed Interior Least Tern.

With 97% of Nebraska in private ownership, conservation delivery will need to align with agriculture land uses. In the Sandhills, projects will have to complement cattle production, while in other regions, the RWBJV will have to strike a balance with row-crop agriculture and cattle production. All conservation programs will be developed on a voluntary basis with willing participants.

The RWBJV will support research and monitoring activities to address key uncertainties and validate current planning assumptions. Future priority research and monitoring projects include: (1) establishing population objectives for all breeding waterbird species, (2) estimating use of different habitats by breeding waterbirds, (3) identifying the local and landscape factors that influence roost site selection by Sandhill Cranes along the Central and North Platte Rivers, and (4) determining invertebrate abundance and forage efficiency of Sandhill Cranes in wet meadows. Along major river systems such as the Central Platte River, research and monitoring will also focus on habitat availability and habitat selection and use by Least Terns and Whooping Cranes.

Appendix A

Energetic Requirements of Sandhill Cranes Staging in the Central Platte River Valley

The Rainwater Basin Joint Venture (RWBJV) partnership relies on a diverse set of biological planning and conservation design tools to guide project delivery in landscapes that have the greatest potential to positively influence priority species. This appendix describes a bioenergetics model which provides a quantifiable method to compare the energetic needs of Sandhill Cranes against the resources the Central Platte River Valley (CPRV) provides—based on the most recent Geographic Information Systems (GIS) land cover data.

To estimate the energetic requirements of the mid-continent population of Sandhill Cranes, several model inputs were defined. They included composition of the two subspecies; subspecies-specific average residency time and specific daily energetic requirements by subspecies, age class, and sex. Also estimated were the proportions of diet that should be derived from invertebrates (found in wet meadows and associated grasslands) and from waste grain in harvested cornfields.

It is estimated that about 90% of the mid-continent Sandhill Crane population stage in the CPRV during spring migration (Krapu et al. 1982, Reinecke and Krapu 1986, Kinzel et al. 2006). Based on the current population estimate, (Case and Sanders 2009) approximately 504,000 Sandhill Cranes rely on the CPRV during spring migration.

Estimation of Spring Use by Different Subspecies

Two principal subspecies of Sandhill Cranes stage in the CPRV (Jones et. al 2005, Krapu et. al 2011). Approximately 66% are Lesser Sandhill Cranes and 34% are Greater Sandhill Cranes (Krapu et. al 2011) (Table A-1). For the bioenergetics model, the RWBJV assumed 66% were Lessers and 34% were Greaters, based on Krapu et al. 2011.

Table A-1. Mid-continent population of Sandhill Cranes using the Central Platte River Valley (Case and Saunders 2009, Krapu et. al 2011).

Mid-Continent Statistics	Individuals / Proportion of Population	Citation
Mid-Continent Population	560,000	Case and Saunders 2009
Proportion using CPRV	90%	Krapu 1982, Krapu et al. 2011
Number using CPRV	504,000	
Population Dynamics Within the CPR		
Proportion being Greater Sandhill Cranes	34%	Krapu et al. 2011
Population of Greaters	171,360	
Proportion being Lesser Sandhill Cranes	66%	Krapu et al. 2011
Population of Lessers	332,640	

Average Residency Time

Radio telemetry work conducted in the early 1980s (USFWS 1981) suggested a 30-day residency time for Sandhill Cranes in the CPRV. Recent advances in technology allow birds to be tracked through multiple migrations. This reduces the proportion of data that may contain some of the stress-related behavioral effects that may be associated with the initial capture and attachment of the telemetry transmitter. Based on the information collected from the multi-year VHF telemetry, different residency times have been documented for the two subspecies (Krapu USGS personal comm. 2011). The research suggests a 25-day residency time for the Lesser Sandhill Crane and a 20-day residency time for the Greater Sandhill Crane (A. Pearse USGS personal communication 2011).

Daily Energetic Requirements by Subpecies

Daily Energy Expenditure (DEE) was calculated for each of the subspecies (Table A-2). DEE is defined as the energy (kilocalories) expended by wild birds engaged in routine daily activities (e.g., feeding, resting, and flight) and not engaged in reproduction, molt, migration, or other activities (Baldassarre and Bolen 2006). The DEE was calculated by multiplying the Basal Metabolic Rate (BMR) by a factor of three (Prince 1979, Miller and Eadie 2006, Reinecke and Uihlein 2006, Pearse et al. 2010). The BMR is the energy required for normal cellular function and replacement of worn tissue. Protein, the most abundant component of tissue, is replaced at an average daily turnover rate of 4.4%; thus BMR is directly tied to body mass (Baldassarre and Bolen 1994).

Average body mass estimates (Table A-2) for male and female of both subspecies of Sandhill Crane were based on established research (Krapu et al. 2004, Pearse et al. 2011). The RWBJV assumed an equal sex ratio.

Table A-2. Average body mass, BMR and DEE by subspecies and sex (Pearse et al. 2011).

Subspecies & Gender	Average Body Mass (Kg)	BMR kcal/day	DEE kcal/day
Greater Sandhill Crane, Male	4.50	224.2	672.7
Greater Sandhill Crane, Female	3.90	207.8	623.4
Lesser Sandhill Crane, Male	3.80	204.9	614.8
Lesser Sandhill Crane, Female	3.30	190.1	570.4

The subspecies-specific average body mass was used in the BMR equation: $\alpha Mass^{b}$ (Kendeigh et al. 1977, USFWS 1981). The equation can be expressed as $423.5 \times Mass^{0.5316}$.

To estimate energetic needs for lipid acquisition while in the CPRV, we used the modeled mass gains described in Pearse et al 2011. In addition, we used 12.7 kcal/g as the cost of lipid production (Pearse et al. 2010).

Table A-3. Energetic requirements for acquisition of exogenous lipid reserves by Sandhill Cranes in the Central Platte River Valley.

Species	# of Individuals	Residency Time (days)	Body Mass Gain (g/day)	Lipid Production Cost	kcals for Lipid Acquisition (thousands)
Greaters, Male	85,680	20	11.7	12.7	254,624
Greaters, Female	85,680	20	15.6	12.7	339.498
Lessers, Male	166,320	25	16.2	12.7	855,467
Lessers, Female	166,320	25	12.6	12.7	665,363
				Total	**2,114,952**

Total Energetic Requirements

The above steps provided estimates of Sandhill Crane use, average residency time, DEE, and lipid acquisition requirements by subspecies. To estimate total energy required by Sandhill Cranes in the CPRV we multiplied the spring use estimates, residency time, and energetic requirements for each subspecies and then added the energetic requirements for lipid acquisition (Table A-4).

Table A-4. Estimated energy needs of Sandhill Cranes staging in the Central Platte River Valley.

Subspecies by Sex	# of Individuals	Residency Time (days)	DEE Requirement (kcal/day)	kcals for Lipid Acquisition (thousands)	Total Energy (X 1000 kcals)
Greaters					
Male	85,680	20	672.7	254,624	1,407,304
Female	85,680	20	623.4	339,498	1,407,743
Lessers					
Male	166,320	25	614.8	855,467	3,411,985
Female	166,320	25	570.4	665,363	3,037,163
				Total	**9,264,195**

Energetic Requirements from Wet Meadows, Associated Grasslands, and Agriculture Habitats

Sandhill Crane foraging patterns are influenced by the diverse nutritional resources that are available from the different foraging habitats (USFWS 1981). Reinecke and Krapu (1986) found that Sandhill Cranes spent nearly equal amounts of time foraging in cornfields and grassland habitats. Their total esophageal content, however, was only 3% invertebrates, compared to 97% corn.

Table A-5. Estimated energy needs of Sandhill Cranes from wet meadows and associated uplands in the Central Platte River Valley.

Subspecies by Sex	Total Energy (X 1000 kcals)	Wet Meadow Forage Selection	Total Wet Meadow Energy (X 1000 kcals)
Greaters			
Males	1,407,304	5.00%	70,365.2
Females	1,407,743	5.00%	70,387.2
Lessers			
Males	3,411,985	5.00%	170,599.3
Females	3,037,163	5.00%	151,858.1
Total	**9,264,195**		**463,209.8**

Invertebrates, including snails, earthworms, and insects, were the primary forage resource consumed in grassland habitats. For planning purposes, the RWBJV estimated that 5% of the total energetic needs of Sandhill Cranes should be provided by wet meadows and associated upland grasslands. Five percent of the total kcals shown in table A-4 equals 463.2 million kcals. Table A-5 shows the breakdown by subspecies and sex.

Davis et al. (2006) documented average invertebrate biomass for CPRV wet meadows and associated grasslands during the spring at 14.7 g/m^2, or approximately 59,488.8 g/acre. True Metabolizable Energy (TME), or the amount of energy available from one gram of invertebrates, was defined by Prince (1979) as 3.5 kcal/g. This value is central to the bioenergetics model, as it allows the conversion of grams of invertebrates to be expressed as energy (kcals) per acre.

Based on this information, it is expected that one acre of wet meadow and associated uplands can provide approximately 210,000 kcal/acre in total energy. Sandhill Cranes use a tactile foraging strategy, probing in the soils for invertebrates. We estimated that only about 20% of the invertebrates that are available are effectively foraged by cranes. Therefore, wet meadows and associated grasslands provide 41,642.2 kcal/acre of available foraging resources. It would take 11,124 acres of this habitat to meet the energy requirement computed in table A-5.

The balance of energy required (8.8 billion kcals) would come from waste grain found in harvested corn fields. Krapu et al. (2004) reported that 71.7 - 102.8 kg/acre of corn was present in harvested corn fields (1997 –1999). Sherfy et al. 2011 reported waste corn between 21.9 kg/acre and 71.4 kg/acre in corn fields sampled from 2005 to 2007. Following the methods outlined in Pearse et al. 2010, we set the mean available corn at 35.6 kg/acre (88 kg/ha). Based on the observations of Sherfy et al. 2011 and Krapu et al. 2004, the forage threshold, or the point at which cranes give up foraging in a field, was set at 2.4 kg/acre (6 kg/ha).

Reinecke et al. (1989) determined the average TME for corn to be 3.67 kcal/gram. To estimate the kcals provided by one acre of corn in the CPRV, the following equation was used:

Energy Available in Corn Fields (kcal/acre) = (35.6 kg /acre – 2.4 kg/acre) x (1000 g/kg) x (3.67 kcal/g)

Energy Available in Corn Fields = 121,844 kcals/acre

At this production level, 72,230 acres of harvested corn fields would be needed to meet the foraging requirements of the CPRV crane population.

Sherfy et al. (2011) completed a GIS landcover assessment from 2004 to 2006 to document crop types in the CPRV. The assessment identified a range of 229,000 to 234,000 acres of corn. This represents three times the amount necessary to support Sandhill Crane populations at goal levels. This estimate, however, does not discount corn acres close to roads, shelterbelts and other disturbance areas that reduce or eliminate crane use. The estimate also does not account for the consumption of waste grain by the numerous migratory waterfowl that stage in the Central Platte River during spring migration.

Recent research (Krapu et al. 2004, Pearse et al. 2010, Anteau et al. 2011, and Sherfy et al. 2011) highlighted that the juxtaposition of agriculture, wet meadow, and open unobstructed river channels and their proximity to each other influence crane use. The habitat goal of 11,124 acres of wet meadow and 72,230 acres of corn fields needs to be better understood to ensure that restoration and enhancement projects target tracts of the appropriate size and juxtaposition to the other grassland habitats and river channel, in order to expand the patch characteristics that are selected by Sandhill Cranes.

Two key uncertainties need to be addressed to strengthen this plan. The first is a better understanding of the forage efficiency exhibited by cranes while foraging on invertebrates in wet meadows and associated grasslands. The second uncertainty is spatial juxtaposition (size, proximity to roost, and distance to disturbance features) and its influence on habitat selection.

Appendix B

Energetic Requirements of Sandhill Cranes Staging in the North Platte River Valley

The Rainwater Basin Joint Venture (RWBJV) partnership relies on a diverse set of biological planning and conservation design tools to guide project delivery in landscapes that have the greatest potential to positively influence priority species. This appendix describes a bioenergetics model which provides a quantifiable method to compare the energetic needs of Sandhill Cranes against the resources the North Platte River Valley (NPRV) provides—based on the most recent Geographic Information Systems (GIS) land cover data.

To estimate the energetic requirements of the mid-continent population of Sandhill Cranes, several model inputs were defined. They included average residency time and specific daily energetic requirements by age class and sex. Also estimated were the proportions of diet that should be derived from invertebrates (found in wet meadows and associated grasslands) and from waste grain in harvested cornfields.

It is estimated that about 10% of the mid-continent Sandhill Crane population stage in the NPRV during spring migration (Krapu et al. 1982, Reinecke and Krapu 1986, Kinzel et al. 2006). Based on the current population estimate (Case and Sanders 2009), approximately 56,000 Sandhill Cranes rely on the NPRV during spring migration (Table B-1).

Table B-1. Mid-continent population of Sandhill Cranes using the North Platte River Valley (Case and Saunders 2009, Krapu et. al 2011).

Mid-Continent Statistics	Individuals / Proportion of Population	Citation
Mid-Continent Population	560,000	Case and Saunders 2009
Proportion using NPRV	10%	USFWS 1981, Krapu et al. 2011
Number using NPRV	56,000	

Estimation of Spring Use

The portion of the mid-continent population of Sandhill Cranes staging in the NPRV is comprised almost entirely of the Lesser Sandhill Crane subspecies (Krapu et. al 2011).

Average Residency Time

Radio telemetry research conducted in the early 1980s (USFWS 1981) suggested a 30-day residency time for Sandhill Cranes in the NPRV. Recent advances in technology allow birds to be tracked through multiple migrations. This reduces the proportion of data that may contain some of the stress-related behavioral effects that may be associated with the initial capture and attachment of the telemetry transmitter. Based on the information collected from the multi-year VHF telemetry, Lesser Sandhill Cranes have an average residency time of 25 days.

Daily Energetic Requirements

Daily Energy Expenditure (DEE) was calculated (table B-2) for Lesser Sandhill Cranes. DEE is defined as the energy (kilocalories) expended by wild birds engaged in routine daily activities (e.g., feeding, resting, and flight) and not engaged in reproduction, molt, migration, or other activities (Baldassarre and Bolen 2006). The DEE was calculated by multiplying the Basal Metabolic Rate (BMR) by a factor of three (Prince 1979, Reinecke and Krapu 1986, Miller and Eadie 2006, Pearse et al. 2011). The BMR is the energy required for normal cellular function and replacement of worn tissue. Protein, the most abundant component of tissue, is replaced at an average daily turnover rate of 4.4%; thus BMR is directly tied to body mass (Baldassarre and Bolen 1994).

Research has established average body mass estimates for both sexes (Krapu et al. 2004, Pearse et al. 2011) (Table B-2). The RWBJV assumed an equal sex ratio.

Table B-2. Average body mass, BMR and DEE by subspecies and sex (Pearse et al. 2011).

Subspecies & gender	Average Body Mass (Kg)	BMR kcal/day	DEE kcal/day
Lesser Sandhill Crane, Male	3.80	204.9	614.8
Lesser Sandhill Crane, Female	3.30	190.1	570.4

The subspecies-specific average body mass was used in the BMR equation: $\alpha Mass^{b}$ (Kendeigh et al. 1977, USFWS 1981). The equation can be expressed as $423.5 \times Mass^{0.5316}$.

To estimate energetic needs for lipid acquisition while in the NPRV, we assumed the modeled mass gains described in Pearse et al 2011. In addition, we assumed 12.7 kcal/g as the cost of lipid production (Pearse et al. 2011) (Table B-3).

Table B-3. Energetic requirements to acquire exogenous lipid reserves by Sandhill Cranes in the North Platte River Valley.

Species	# of Individuals	Residency Time (days)	Body Mass Gain (g/day)	Lipid Production Cost	kcals for Lipid Acquisition (thousands)
Lessers, Male	28,000	25	16.2	12.7	144,018
Lessers, Female	28,000	25	12.6	12.7	112,014
				Total	**256,032**

Total Energetic Requirements

The steps described above provided estimates of use, average residency time, DEE, and lipid acquisition requirements by Lesser Sandhill Cranes. To estimate total energy required by Lesser Sandhill Cranes in the NPRV, we multiplied the spring use estimates, residency time, and

energetic requirements and then added the energetic requirements for lipid acquisition (Table B-4).

Table B-4. Estimated energy needs of Sandhill Cranes staging in the North Platte River Valley.

Lesser Sandhill Cranes	# of Individuals	Residency Time (days)	DEE Requirement (kcal/day)	kcals for Lipid Acquisition (thousands)	Total Energy (X 1000 kcals)
Males	28,000	25	614.8	144,018	574,408
Females	28,000	25	570.4	112,014	511,307
				Total	**1,085,715**

Energetic Requirements from Wet Meadows, Associated Grasslands, and Agriculture Habitats

Sandhill Crane foraging patterns are influenced by the diverse nutritional resources that are available from the different foraging habitats (USFWS 1981). Reinecke and Krapu (1986) found that Sandhill Cranes spent nearly equal amounts of time foraging in cornfields and grassland habitats. Their total esophageal content, however, was only 3% invertebrates, compared to 97% corn.

Invertebrates, including snails, earthworms, and insects, were the primary forage resource consumed in grassland habitats. For planning purposes, the RWBJV estimated that 5% of the total energetic needs of Sandhill Cranes should be provided by wet meadows and associated upland grasslands. Five percent of the total kcals shown in table B-4 equals 54.3 million kcals. Table B-5 shows the breakdown by sex.

Davis et al. (2006) documented average invertebrate biomass for wet meadows and associated grasslands within the CPRV during spring at 14.7 g/m^2 or approximately 59,488.8 g/acre. True Metabolizable Energy (TME), or the amount of energy available from one gram of invertebrates, was defined by Prince (1979) as 3.5 kcal/g. This value is central to the bioenergetics model, as it allows the conversion of grams of invertebrates to be expressed as energy (kcals) per acre. Based on this information, it is expected that one acre of wet meadow and associated uplands can provide 208,210.8 kcal/acre in total energy. Sandhill Cranes use a tactile foraging strategy, probing in the soils for invertebrates. We estimated that only about 20% of the invertebrates that are available are effectively foraged by cranes. Therefore, wet meadows and associated grasslands provide 41,642.2 kcal/acre of available foraging resources. It would take 1,302 acres of this habitat to meet the energy requirement computed in table B-5.

Table B-5. Estimated energy needs of Sandhill Cranes from wet meadows and associated uplands in the North Platte River Valley.

Lesser Sandhill Crane	Total Energy (X 1000 kcals)	Wet Meadow Forage Selection	Total Wet Meadow Energy (X 1000 kcals)
Males	574,408	5.00%	28,720.4
Females	511,307	5.00%	25,565.3
Total	**1,085,715**		**54,285.7**

The balance of energy required (1.03 billion kcals) would come from waste grain found in harvested corn fields. Krapu et al. (2004) reported that 71.7 - 102.8 kg/acre of corn was present in harvested corn fields (1997 –1999). Sherfy et al. (2011) reported waste corn between 21.9 kg/acre and 71.4 kg/acre in corn fields sampled between 2005 and 2007. Following the methods outlined in Pearse et al. (2010), we set the mean available corn at 35.6 kg/acre (88 kg/ha). Based on the observations of Sherfy et al. (2011) and Krapu et al. (2004), the forage threshold, or the point at which cranes give up foraging in a field, was set at 2.4 kg/acre (6 kg/ha).

Reinecke et al. (1989) determined the average TME for corn to be 3.67 kcal/gram. To estimate the kcals provided by one acre of corn in the CPR, the following equation was used:

Energy Available in Corn Fields (kcal/acre) = (35.6 kg /acre – 2.4 kg/acre) x (1000 g/kg) x (3.67 kcal/g)

Energy Available in Corn Fields = 121,844 kcals/acre

At this production level, 8,465 acres of harvested corn fields would be needed to meet the foraging requirements of the North Platte River Valley crane population.

To evaluate available foraging resources in the NPRV, a 4.8 km buffer from the outermost channel of the river was created and used to extract cropping patterns from the National Agriculture Statistics Survey dataset. Between 2008 and 2010, acreages planted to corn ranged from 31,000 to nearly 38,000 acres. Based on these estimates there would be over four times the necessary available waste grain to support the Sandhill Cranes using this region. This estimate, however, does not discount corn acres close to roads, shelterbelts and other disturbance areas that reduce or eliminate crane use. The estimate also does not account for the consumption of waste grain by the numerous migratory waterfowl that stage in the North Platte River Valley during spring migration.

Recent research (Krapu et al. 2004, Pearse et al. 2010, Anteau et al. 2011, and Sherfy et al. 2011) highlighted that the juxtaposition of agriculture, wet meadow, and open unobstructed river channels, and their proximity to each other, influence crane use. The habitat goal of 1,300 acres of wet meadow and 8,465 acres of harvested corn fields needs to be better understood to ensure that restoration and enhancement projects target tracts of the appropriate size and juxtaposition to the other grassland habitats and river channel, in order to expand the patch characteristics that are selected by Sandhill Cranes.

Two key uncertainties need to be addressed to strengthen this plan. The first is a better understanding of the forage efficiency exhibited by cranes while foraging on invertebrates in wet meadows and associated grasslands. The second uncertainty is spatial juxtaposition (size, proximity to roost, and distance to disturbance features) and its influence on habitat selection.

Appendix C

Common and Scientific Nomenclature for Species and Distinct Subspecies Described in the Rainwater Basin Joint Venture Waterbird Plan

Birds	
Common Name	**Scientific Name**
American Bittern	*Botaurus lentiginosus*
American Coot	*Fulica americana*
American White Pelican	*Pelecanus erythrorhynchos*
Black Rail	*Laterallus jamaicensis*
Black Tern	*Chlidonias niger*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Brown Pelican	*Pelecanus occidentalis*
California Gull	*Larus californicus*
Caspian Tern	*Hydroprogne caspia*
Cattle Egret	*Bubulcus ibis*
Clark's Grebe	*Aechmophorus clarkii*
Common Crane	*Grus grus*
Common Loon	*Gavia immer*
Common Moorhen	*Gallinula galeata*
Common Tern	*Sterna hirundo*
Double-crested Cormorant	*Phalacrocorax auritus*
Eared Grebe	*Podiceps nigricollis*
Forster's Tern	*Sterna forsteri*
Franklin's Gull	*Leucophaeus pipixcan*
Glaucous Gull	*Larus hyperboreus*
Great Black-backed Gull	*Larus marinus*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Green Heron	*Butorides virescens*
Herring Gull	*Larus argentatus*
Horned Grebe	*Podiceps auritus*
King Rail	*Rallus elegans*
Laughing Gull	*Leucophaeus atricilla*
Least Bittern	*Ixobrychus exilis*
Least Tern	*Sternula antillarum*
Lesser Black-backed Gull	*Larus fuscus*
Little Blue Heron	*Egretta caerulea*
Neotropic Cormorant	*Phalacrocorax brasilianus*
Pacific Loon	*Gavia pacifica*
Pied-billed Grebe	*Podilymbus podiceps*

Birds (continued)	
Common Name	**Scientific Name**
Piping Plover	*Charadrius melodus*
Red-necked Grebe	*Podiceps grisegena*
Red-throated Loon	*Gavia stellata*
Ring-billed Gull	*Larus delawarensis*
Roseate Spoonbill	*Platalea ajaja*
Sabine's Gull	*Xema sabini*
Sandhill Crane	*Grus canadensis*
Snowy Egret	*Egretta thula*
Sora	*Porzana carolina*
Thayer's Gull	*Larus thayeri*
Tricolored Heron	*Egretta tricolor*
Trumpeter Swan	*Cygnus buccinator*
Virginia Rail	*Rallus limicola*
Western Grebe	*Aechmophorus occidentalis*
White-faced Ibis	*Plegadis chihi*
Whooping Crane	*Grus americana*
Yellow Rail	*Coturnicops noveboracensis*
Yellow-crowned Night-Heron	*Nyctanassa violacea*

Plants	
Common Name	**Scientific Name**
Alfalfa	*Medicago sativa*
Canada thistle	*Cirsium arvense*
Cattail species	*Typha spp.*
Common reed grass/*Phragmites*	*Phragmites australis*
Corn	*Zea mays*
Eastern red cedar	*Juniperus virginiana*
Grain Sorghum/milo	*Sorghum bicolor*
Kentucky bluegrass	*Poa pratensis*
Leafy spurge	*Euphorbia esula*
Milo	*Sorghum bicolor*
Purple loosestrife	*Lythrum salicaria*
Reed canary grass	*Phalaris arundinacea*
River bulrush	*Schoenoplectus fluviatilis*
Russian olive	*Elaeagnus angustifolia*
Smooth brome grass	*Bromus inermis*
Soybeans	*Glycine max*
Wheat	*Triticum aestivum*

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