Rainwater Basin Joint Venture

Research, Inventory, and Monitoring Plan

An Assessment of Key Uncertainties Related to Bird Conservation

By the

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Rainwater Basin Joint Venture

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INTRODUCTION

The Rainwater Basin Joint Venture (RWBJV) partnership was formed in 1992 with a primary focus of protecting, restoring, and enhancing wetland habitat in the Rainwater Basin (RWB) wetland complex. The RWB contains a high density of playa wetlands, which provide critical stopover habitat for many species of migratory waterfowl, waterbirds, landbirds, and shorebirds. Although it was not within the RWBJV's initial purview, the RWBJV Management Board adopted a broader landscape approach to conservation planning, expanding the partnership's geographic focus and objectives to those species identified in all four of the national bird conservation plans (i.e., the North American Waterfowl Management Plan [NAWMP], Partners in Flight [PIF] North American Landbird Conservation Plan, North American Waterbird Conservation Plan, and the United States Shorebird Conservation Plan).

The 1999 North American Bird Conservation Initiative divided North America into 62 ecologically distinct regions called Bird Conservation Regions (BCRs). Each BCR is a region with similar bird communities, habitats, and resource management issues. In 1999, the RWBJV expanded its responsibilities to include conservation actions for all bird habitats within a larger geographic region—consisting of the Nebraska portions of BCR 11 (Prairie Pothole Region) and BCR 19 (Central Mixed-grass Prairies). Based on landscape characteristics and for planning purposes, the RWBJV Administrative Area was divided into eight Geographic Focus Areas (GFAs): 1) Central Loess Hills, 2) central and North Platte River, 3) Missouri River, 4) Northeast Prairies/Elkhorn River, 5) Rainwater Basin, 6) Republican River/Blue River Drainages and Loess Canyons, 7) Sandhills, and 8) Verdigris/Bazile Creek Drainages (Figure 1).

As efforts in the RWBJV continue toward integrated bird conservation, the partnership adopted the use of "Strategic Habitat Conservation" (USFWS 2008) as its basis for conservation. Strategic habitat conservation is a science-based framework for making management decisions, especially at a landscape level. Four elements make up the framework: 1) biological planning, 2) conservation design, 3) conservation delivery, and 4) research, inventory, and monitoring. In the biological planning phase, priority species are selected based on the national bird plans,

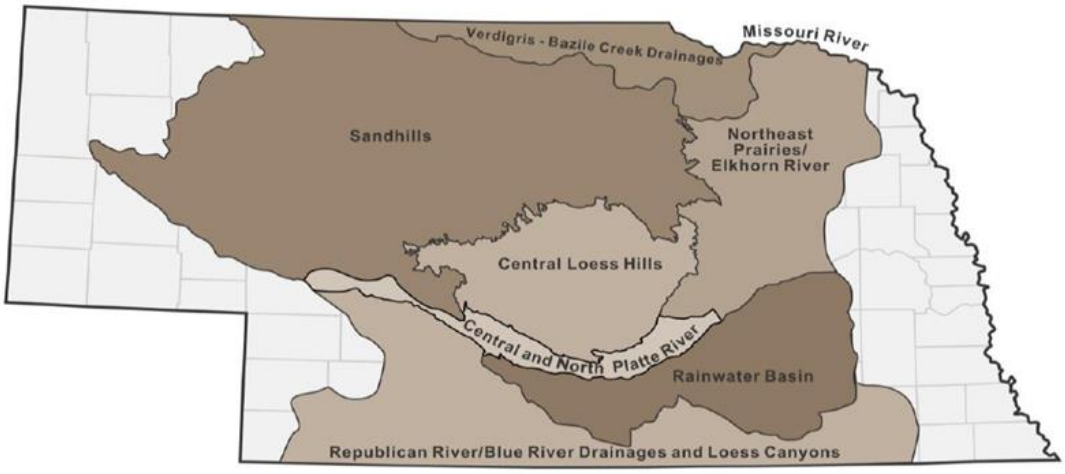

Figure 1. Geographic Focus Areas in the RWBJV Administrative Area.

population objectives are established, and empirical or conceptual models are used to quantify species-habitat relationships. During the conservation design process, current landscape carrying capacity is established, limiting factors are identified, habitat objectives are defined, and "Decision Support Tools" are developed to identify locations on the landscape that have the greatest potential to benefit priority species. This is important, since relative conservation efficiency (e.g., biological benefits per acre) varies across landscapes. In the conservation delivery phase, decision support tools are used to guide delivery of conservation programs in a manner that will achieve desired habitat conditions and develop and implement new programs to address limiting factors, if needed. The research, inventory, and monitoring element of strategic habitat conservation uses directed research projects and monitoring to evaluate the key uncertainties identified during the planning and design phases and collect inventory data needed to improve conservation delivery.

Research, Inventory, and Monitoring

Research, inventory, and monitoring activities should be designed to help to maximize the effectiveness and efficiency of conservation programs. Research helps to increase our understanding of ecological communities and processes, find solutions to known issues, and improve existing conservation delivery techniques. Inventory activities are used to measure and

document current resources and identify needs and limitations. Long-term monitoring documents changes in species or communities and helps to determine whether conservation delivery is in fact moving the conservation estate in the direction necessary to support target populations.

Testing key uncertainties and measuring responses to management actions is critical in completing the strategic habitat conservation framework. For example, monitoring and evaluation efforts may focus on species response to pre- and post-management and vegetation treatments, particularly if a decision support tool was used to identify suitable landscapes where habitat enhancement would most likely benefit targeted species. One of the most common methods of evaluation is casual observation, which is subjective and opportunistic. Although there is some value to this approach, the RWBJV will continue to encourage and conduct more structured and targeted research, inventory, and monitoring activities to quantitatively address key uncertainties and evaluate the assumptions identified in the planning process.

The RWBJV collaborates with the U.S. Geological Survey, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, Natural Resources Conservation Service, Landscape Conservation Cooperatives, universities, and other partners to help facilitate directed research projects that investigate key uncertainties. Projects often focus on measuring cause-effect relationships as they pertain to wetland and grassland habitats or species response to habitat conditions. Most deal with specific questions that can be addressed as part of a two- to five-year research project. Habitat inventory projects have often been conducted by the RWBJV and focused on comparing historic and contemporary habitat conditions (Bishop et al. 2010). Long-term monitoring projects have been collaborative efforts that often leverage RWBJV partner resources. Examples of previous long-term monitoring efforts include projects designed to understand the temporal variation of available wetland habitat or to quantify the impacts of different wetland vegetation management practices. The RWBJV will continue to pursue funding that supports research, inventory, and monitoring to directly test assumptions on which the RWBJV Implementation Plan and associated bird plans are based, or assumptions used in directing management decisions.

Biological Foundation

To further facilitate integrated bird conservation and to advance the improvement and revision of the RWBJV bird conservation plans, we have developed a list of research, inventory, and monitoring needs. Finding answers to the research questions identified in this document will reduce uncertainties and improve decision-making capacity. Work products will include:

1. Population goals that originate from national bird conservation plans. Population-based habitat objectives expressed across multiple spatial scales.
2. Biological models with explicitly-stated, testable assumptions.
3. Research directed at testing models and assumptions.
4. Population and habitat inventory and monitoring programs.

We created this plan, using input from many RWBJV partners, to outline the key uncertainties and biological questions that we have identified in regards to management of migratory landbirds, shorebirds, waterbirds, and waterfowl that use the RWBJV Administrative Area. Emphasis is also placed on human dimensions concerns that impact stakeholders in the RWBJV Administrative Area. The RWBJV Research, Inventory, and Monitoring Plan is a living document that will undergo frequent revisions as the RWBJV applies the principles of adaptive science-based management (USFWS 2008) to bird conservation throughout its GFAs.

PURPOSE: To identify assumptions and uncertainties pertaining to conservation and management of birds and their habitats in the RWBJV Administrative Area and to provide a comprehensive list of research tasks that may help address these key questions.

GOALS:

1) To improve our understanding of wetland, grassland, and avian ecology in order to allow for more efficient and effective use of limited conservation and management resources.
2) To explore human dimensions of natural resources in order to increase support for conservation activities among stakeholders in the Rainwater Basin Joint Venture Administrative Area.

WATERFOWL

Although habitat objectives have historically been stated as acreage benchmarks, the NAWMP called for increased attention to the relationship between waterfowl populations and their habitats (NAWMP 2004, NAWMP 2012). In both recent versions of the NAWMP, priority landscapes were identified to meet the annual life-cycle needs of waterfowl. As a result of its mid-latitude juxtaposition, the RWBJV Administrative Area contains migration stopover, breeding, and wintering habitat for waterfowl.

The RWBJV's Conservation Planning Workgroup established energetic objectives to determine habitat needs (RWBJV 2013a). Estimated energetic needs were calculated based on the proportion of each waterfowl species that is anticipated to use the RWB GFA during spring migration if NAWMP population goals are met (NAWMP 2004). These energetic objectives are linked to population carrying capacity based on the assumption that foraging resources are the primary determinant of carrying capacity within the RWB. Spring waterfowl population numbers within the RWB GFA have been estimated from a combination of directed research projects and published reports (Bellrose 1980, Benning 1987, Gersib et al. 1989, Vrtiska and Sullivan 2009, Pearse et al. 2011). It has been estimated that, at one time, as much as 90% of the mid-continent population of greater white-fronted geese, approximately 50% of mid-continent mallards, and 30% of the continental Northern pintail breeding population used the area (Gersib et al. 1989). Current lesser snow goose population estimates fall between 1.5-7.0 million, which varies with annual changes in water and wetland conditions (Vrtiska and Sullivan 2009). Waterfowl migrations during the fall appear to involve far lower numbers, with shorter stays over a more extended migration season (Bellrose 1980, Bishop and Vrtiska 2008).

Bellrose (1980) noted that the Sandhills may contain some of the highest quality duck breeding habitat south of the Prairie Pothole Region. The Sandhills GFA may become even more important to duck populations in the future as breeding habitat loss in the Prairie Pothole Region accelerates due to increases in tillage agriculture, fossil fuel development, and climate change. Although the Sandhills contain a high amount of grassland nesting habitat for ducks, recent

research has indicated that nest success is low (Walker et al. 2008). The Sandhills also provide breeding and non-breeding habitat for a majority of the High Plains flock of trumpeter swans. The number of waterfowl breeding in other parts of the RWBJV Administrative Area is not known, but assumed to be low (Harding 1986).

If NAWMP population goals are reached, it is estimated that at least 8.6 million waterfowl will use the RWB GFA and adjacent central Platte River GFA during spring migration (RWBJV 2013*a*). Mallard and Northern pintail numbers would reach approximately 4.2 million and 800,000, respectively. The balance of duck numbers would primarily consist of Blue-winged teal, Green-winged teal, Northern shoveler, American wigeon, and gadwall. It is expected that more than 400,000 Canada geese in the Great Plains, Western Prairie, and Tall Grass Prairie populations and millions of lesser snow geese and Ross's geese will also utilize stopover habitat in the RWBJV Administrative Area.

The RWBJV used the strategic habitat conservation (USFWS 2008) framework to select a subset of priority species: mallard, Northern pintail, greater white-fronted goose, lesser snow goose, and trumpeter swan (RWBJV 2013*a*). These five species were selected because of their national priority and because their habitat needs were likely to represent the full spectrum of roles that wetlands in the RWBJV Administrative Area play during both the non-breeding (Webb et al. 2010, Pearse et al. 2011) and breeding seasons (Harding 1986, Grosse et al. 2012). New research or monitoring projects should focus on one or more of these five priority species. As the RWBJV moves forward in pursuit of waterfowl conservation in its Administrative Area, several research, inventory, and monitoring issues need to be addressed.

Issues of Concern and Related Tasks

Issue 1: Recent estimates of breeding ducks in the Sandhills GFA range from 77,000-124,000, but may be as high as 275,000 in some years (Vrtiska and Powell 2011). There are uncertainties associated with breeding duck population objectives derived for the Sandhills based on these

estimates. The current and future importance of the Sandhills to continental breeding duck populations is not known.

Task 1.1: Refine estimates and describe settling patterns of breeding duck populations in the Sandhills using 4-square mile survey methodology.

Task 1.2: Determine whether carrying capacity for breeding ducks in the Sandhills may be limited by availability of pre-breeding foraging resources, upland nesting habitat, brood-rearing wetlands, or some other factor.

Task 1.3: Explore and annually monitor the available habitat during the breeding season in the Sandhills using GIS and/or remote sensing.

Task 1.4: Establish quantifiable population objectives based on more recent population estimates for breeding ducks in the Sandhills.

Issue 2: The Sandhills contain a large amount of grassland duck breeding habitat, but it appears low nest success greatly reduces recruitment.

Task 2.1: Initiate research to better understand which habitat features influence nest site selection, nest success, and recruitment of ducks in the Sandhills.

Task 2.2: Compare nest survival rates on publically-owned National Wildlife Refuge lands to those on nearby privately-owned properties.

Task 2.3: Explore how different grazing systems may affect breeding ducks.

Task 2.4: Identify which breeding habitat management strategies are most compatible with cattle production in the Sandhills.

Task 2.5: Explore possible predator management actions to increase duck nest success.

Issue 3: The High Plains flock of trumpeter swans has exceeded the most recent population goal and continues to increase at a rate of about 4% per year. The carrying capacity for trumpeter swans in the RWBJV Administrative Area is not known.

Task 3.1: Identify and create an inventory of potential breeding and non-breeding habitat available to trumpeter swans in the RWBJV Administrative Area.

Task 3.2: Estimate breeding and non-breeding carrying capacity of trumpeter swans.

Issue 4: Population estimates for migrating waterfowl in the Central Loess Hills, Sandhills, Northeast Prairies/Todd Valley, Republican/Blue Rivers, and Verdigris-Bazile/Missouri River GFAs are unavailable. There is recognition of the interchange between the RWB and the central

Platte River GFAs during intense climatic events or periods of extreme drought, and this may occur to some extent with these other landscapes.

Task 4.1: Conduct waterfowl surveys on the central Platte River to determine the timing and extent of use during spring migration and factors that are associated with movements between the RWB and central Platte River.

Task 4.2: Conduct spring waterfowl population surveys in the Central Loess Hills, Sandhills, Northeast Prairies/Todd Valley, Republican/Blue Rivers, and Verdigris-Bazile/Missouri River GFAs to determine the importance of these areas as alternative habitats during times of low habitat availability within the RWB and central Platte River.

Issue 5: Historically, the RWB in south-central Nebraska has served as an important spring staging area for white-fronted geese, hosting more than 90% of the total Mid-continent Population. Significant declines have been noted in the RWB in recent years, although there has been little change in the total size of the Mid-continent population.

Task 5.1: Conduct research to determine whether the decline in numbers of spring migrating white-fronted geese in the RWB is due to changes in migration routes, timing, or some other factor.

Task 5.2: Determine whether this change in spring migration habits may eventually have a negative impact on the Mid-continent population overall.

Issue 6: Currently, RWBJV habitat objectives for the RWB GFA are set based on different ownership classes (i.e. public lands, private lands enrolled in conservation programs, and private lands not enrolled in conservation programs). It is unclear whether this method of allocating habitat objectives is the most effective and useful approach to setting objectives.

Task 6.1: Explore the appropriateness of using alternative categories when setting objectives.

Issue 7: Plant foods, especially moist-soil plant seeds, are important for spring-migrating waterfowl in the RWB. A better understanding of how abundance of these foods varies under different management and ownership scenarios is needed. In particular, grazing may be the most common management technique used in the area and more information is needed regarding the waterfowl forage production potential of grazed wetlands.

Task 7.1: Evaluate spring foraging resources available under different ownership classes and how they are impacted by various management treatments.

Task 7.2: Construct models linking management activities to kilocalorie production.

Issue 8: Some of the numbers used in creating the model of energetic requirements of migratory waterfowl in the RWB were based on assumptions, rather than empirical data. For example, uncertainty exists regarding the energetic values assigned to different habitat types (e.g., moist-soil units, cropped wetlands, etc.) and residency time of some waterfowl species.

Task 8.1: Conduct a sensitivity analysis to measure the effect of changes in each parameter in the bioenergetics model.

Task 8.2: Estimate the available kilocalories in various habitat types.

Task 8.3: Construct models linking management activities and changes in ponded wetland availability to kilocalorie production.

Task 8.4: Determine the residency times for migrating waterfowl in the RWB.

Task 8.5: Integrate new data into the existing bioenergetics model as it becomes available and identify remaining data gaps.

Issue 10: There is a need for waterfowl population monitoring programs in the RWB and central Platte River GFAs that will help to further refine our current understanding of waterfowl use/habitat interrelationships.

Task 10.1: Develop standardized waterfowl population monitoring procedures that allow survey objectives to be linked to management questions and to help us determine how birds are distributed across the landscape in relation to habitat.

Task 10.2: Create and utilize a waterfowl species-habitat model to develop decision support tools to help prioritize wetland conservation and restoration.

Issue 11: The RWBJV Implementation Plan focuses on the need to restore wetlands and their watersheds in the RWB, particularly for the benefit of waterfowl. However, we don't fully understand the best restoration approaches to implement to obtain an increase in wetland function for the targeted species and the related cost/benefits of these actions.

Task 11.1: Evaluate and compare current wetland and watershed restoration techniques to determine which are the most effective at restoring wetland function.

Task 11.2: Conduct a cost-benefit analysis to determine which wetland and watershed restoration methods result in the greatest increase in waterfowl foraging resources while incurring the lowest costs over the long-term.

Task 11.3: Implement a long-term monitoring program to determine whether the positive effects of restoration decrease over time.

Issue 12: Currently, the RWBJV partnership conducts an Annual Habitat Survey which uses color-infrared aerial photography to document spring habitat conditions in the RWB each year. This valuable data is used to inventory available waterfowl habitat and document changes over time. Additionally, a database of GIS map layers is being maintained and continually updated with new information. These data may also be used to improve conservation design and delivery for the benefit of waterfowl and other birds.

Task 12.1: Continue to maintain and update geographic and habitat databases using the most up-to-date technologies and methodologies available.

LANDBIRDS

To help guide landbird conservation, the RWBJV developed an initial set of priority species, established population objectives and habitat goals necessary to sustain those priority species at target levels (RWBJV 2013*b*). Based on the PIF North American Landbird Conservation Plan (Pashley et al. 2000), a set of six vulnerability factors were used as criteria to scale down regional priority species and identify which landbird species require attention within the RWBJV Administrative Area. The RWBJV refined the PIF North American Landbird Conservation Plan list of 31 landbird species of regional concern and the 13 stewardship species to create a list of priority species that could be positively influenced by conservation delivery in the RWBJV Administrative Area. Priority was given to species designated in the PIF North American Landbird Conservation Plan as being in need of Critical Action, Immediate Action, Management Action, or Long-term Planning and Responsibility. Because of their value as game species, the RWBJV also included Ring-necked pheasant and Northern bobwhite as priority species in the RWBJV Landbird Plan. While the PIF North American Landbird Conservation Plan designates species of concern and stewardship species within each BCR, the RWBJV Administrative Area

is limited to Nebraska's portion of BCR 19 and BCR 11. Therefore, any species whose populations mainly fall outside of Nebraska were eliminated from the planning process. Based on these criteria, the RWBJV identified 19 priority species, and new or ongoing research, inventory or monitoring projects should focus on these 19 priority landbird species (RWBJV 2013*b*).

To establish landbird conservation benchmarks, the RWBJV used the Hierarchical All-Bird Strategy database developed by the Playa Lakes Joint Venture and refined by the Nebraska Bird Partnership. Species-specific estimates of landscape carrying capacity were calculated by integrating multiple species density estimates from directed research projects and land cover data describing the RWBJV Administrative Area (RWBJV 2013*b*). Estimates of landscape carrying capacity for individual species were used in conjunction with Breeding Bird Survey population trend data to establish species population goals for the next 20 years. For priority landbird species demonstrating drastic declines over the last 60 years, a goal was set to double the current landscape carrying capacity for each species by 2030. Population goals were established at 1966 population levels for species that have undergone moderate declines. Finally, goals were set to maintain current population levels for species that have seen no declines in the RWBJV Administrative Area. Key issues and tasks for research, inventory and monitoring efforts were identified to help meet objectives outlined for landbird conservation in the RWBJV Administrative Area.

Issues of Concern and Related Tasks

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

> ***Task 13.1:*** Assess the utility of scaling down BCR Breeding Bird Survey trends to establish population goals.

Task 13.2: Re-evaluate species' density estimates reported in the literature and whether they can be used to determine current carrying capacity in the RWBJV Administrative Area.

Task 13.3: If species' density estimates are found to be useful, they should be updated as new literature is published, especially for studies within the RWBJV Administrative Area.

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

***Task 14.1*:** Create species distribution models for all other priority species that do not yet have one to help prioritize conservation delivery and identify opportunities for habitat restoration.

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

Task 15.1: Develop additional strategies to improve habitat conditions on existing grasslands in the RWBJV Administrative Area.

Task 15.2: Use an adaptive management approach to determine whether current grassland restoration and management techniques are being used in the most effective and efficient manner.

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

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

Task 16.1: Establish new density estimates in habitat types congruent to those used to establish population objectives by conducting point counts and utilizing distance sampling methodology.

Task 16.2: Compare the species density estimates per habitat type throughout the RWBJV Administrative Area.

Task 16.3: If necessary, revise population objectives to account for surrounding landscape composition, fragmentation, configuration, and edge effects.

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

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

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

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

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

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

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

Task 20.1: Use spatial modeling to identify opportunities to create or improve habitat for these species with emphasis on increasing public hunting access.

Task 20.2: Determine possible causes of and solutions to declines for these game bird species in the RWBJV Administrative Area.

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

Task 21.1: Conduct a complete inventory of spring breeding greater prairie chicken leks in the RWBJV Administrative Area.

Task 21.2: Estimate average size of greater prairie chicken leks and use this data to generate regional population estimates.

Task 21.3: Create a species distribution map using lek survey data.

SHOREBIRDS

Recent estimates suggest the RWBJV Administrative Area supports over 411,000 breeding shorebirds and 1.7 million migrating shorebirds (RWBJV 2013*c*). If population goals described in the U.S. Shorebird Conservation Plan (USFWS 2004) are reached, it is estimated that habitats in the RWBJV Administrative Area will need to support at least 3.4 million shorebirds.

The diversity of wetlands found in the RWB attracts a diversity of shorebird species and a significant proportion of the population for some species. To guide conservation planning, the RWBJV developed a bioenergetics model that estimated that the RWB GFA will need to provide 207 million kilocalories or 20,260 acres of suitable foraging habitat at U.S. Shorebird Conservation Plan goal levels and wetland habitats within the entire RWBJV Administrative

Area will need to provide another 2.1 billion kilocalories or 202,815 acres of suitable foraging habitat (RWBJV 2013*c*). Recent habitat inventories suggest there may be adequate total wetland acres to meet estimated kilocalorie needs in the RWB GFA; however sufficient acres of ponded, or available, habitat are not present for shorebirds during migration.

To make the RWBJV Shorebird Plan relevant to managers, shorebirds were aggregated into four primary foraging guilds with habitat objectives described for each guild. The four foraging guilds are: agri-probers and upland associates (e.g. killdeer), small-bodied probers/gleaners (e.g. piping plover), large-bodied probers (e.g. willet), and swimmers (e.g. Wilson's Phalarope).red phalarope). The bioenergetics model outputs and habitat inventories indicate a habitat deficiency for species in the small-bodied probers/gleaners and large-bodied probers foraging guilds (RWBJV 2013*c*). Conservation delivery strategies for migrating shorebirds mirror the strategies described in the RWBJV Waterfowl Plan. These strategies focus on: 1) wetland/watershed conservation to increase wetland acres; 2) improved hydrologic function (number of acres that pond water) to increase available habitat during shorebird migration; and 3) appropriate management to promote desired habitat conditions. Conservation delivery will be completed along the major riverine systems found in the RWBJV Administrative Area to provide suitable nesting habitat for piping plovers. In the Sandhills GFA, conservation actions will need to be further developed to provide opportunities to increase habitat for breeding shorebirds and complement existing cattle production operations. The following is a list of research, inventory, and monitoring issues that, if addressed, will advance shorebird conservation in the RWBJV Administrative Area.

Issues of Concern and Related Tasks

Issue 22: Population growth for migratory birds may be limited by events or circumstances on the breeding or wintering grounds or during migration. For many shorebird species, the factors that are most limiting to population growth are not known. It would be more efficient and effective to focus resources and efforts on those species that are having their population growth rates most limited by factors that occur in the RWBJV Administrative Area.

Task 22.1: Collaborate with partners locally, regionally, nationally and internationally to identify specific limiting factors during individual species' annual cycle and when and where they occur.

Task 22.2: Identify those species that would benefit the most from actions in the RWBJV Administrative Area.

Issue 23: The majority of migrating shorebird population estimates used to establish population goals for the RWBJV Administrative Area were stepped down from a regional survey and all surveys have limitations. Thus, current estimates of shorebird use could be refined and improved. Additionally, while a coordinated shorebird monitoring program exists, it does not currently facilitate the refinement of population and habitat objectives.

Task 23.1: Design and implement research to further develop and refine shorebird use estimates and population goals within the RWBJV Administrative Area.

Task 23.2: Develop and implement a long-term statistically-based shorebird monitoring program that addresses multiple objectives (e.g., evaluating population targets, habitat objectives, and assessing population trends through collaboration with regional partners).

Issue 24: Some of the breeding shorebird estimates presented in the RWBJV Shorebird Plan are based on expert opinion, rather than empirical data. For some species, these estimates need to be validated in the RWBJV Administrative Area.

Task 24.1: Establish a research project to refine breeding population estimates and objectives, especially within the Sandhills GFA.

Issue 25: Broad, overarching habitat objectives have been established for the entire RWBJV Administrative Area. Unfortunately, these objectives lack description of wetland types, attributes, and landscape characteristics required to support or increase shorebird populations. Habitat suitability indices are used to predict a species use of a specific habitat type. Some of the information used to build many habitat suitability indices, however, is based on hypothesized species-habitat relationships, rather than empirical data.

Task 25.1: Establish a habitat assessment protocol to better refine the shorebird habitat suitability indices for different wetland types.

Task 25.2: Initiate a research project studying shorebird habitat use across seasons and in the different GFAs in the RWBJV Administrative Area and use the data to create better and more specific habitat suitability indices.

Issue 26: Invertebrate abundance is directly related to the carrying capacity of different wetland habitats for non-breeding shorebirds. While some research has been conducted on invertebrate communities in the RWB GFA, the ability of different wetland types to support invertebrate foraging resources, and thus, non-breeding shorebirds, is largely unknown in other areas of the RWBJV Administrative Area.

Task 26.1: Assess invertebrate abundance in the different wetland habitat types found throughout the RWBJV Administrative Area using field data and published literature.

Task 26.2: Use the invertebrate abundance estimates to improve the bioenergetics model and habitat suitability indices for shorebirds.

Issue 27: Vegetation structure, water depth, and other habitat features may limit the ability of shorebirds to access some invertebrate food resources (i.e. foraging efficiency) in certain habitat types. The bioenergetics model assumes shorebird foraging efficiency is uniform across different habitat types and that shorebirds stopover for a period of 7 days during spring migration.

Task 27.1: Initiate a research project to identify if shorebird foraging efficiency changes within different habitat types and adjust the shorebird bioenergetics model as needed.

Task 27.2: Review published literature to see if there is any indication of impacts to foraging efficiency by the context of the surroundings (e.g. cropped wetlands compared to managed sites).

Task 27.3: Design and conduct a field study to assess turnover rates of shorebirds migrating through the RWBJV Administrative Area during spring migration.

Issue 28: Standardized procedures and protocols are needed for maintaining an up-to-date inventory of shorebird habitat capabilities on public lands in the RWBJV Administrative Area.

Task 28.1: Improve the process for maintaining and refining the GIS database of shorebird habitat on public lands throughout the RWBJV Administrative Area.

Issue 29: There is a lack of spatial data depicting the availability and distribution of shorebird habitat across the landscape.

Task 29.1: Develop GIS data layers, including updating National Wetland Inventory data, that depict current and potential shorebird habitat to allow for more efficient and effective conservation delivery.

Issue 30: There is uncertainty about which management actions produce the best shorebird nesting habitat.

Task 30.1: Identify management actions that produce shorebird nesting habitat.

Task 30.2: Establish a research project to gain a better understanding of the different grazing systems and their effects on shorebird nesting, recruitment, and cattle production.

Issue 31: Riverine habitats found in the Loup (Central Loess Hills GFA), Missouri, and Platte (central Platte River GFA) rivers are identified as critical breeding habitat to support the recovery of piping plovers (RWBJV 1013*c*). Nesting piping plovers require bare or sparsely vegetated expanses of sand adjacent to water. More information is needed to determine how different flow regimes impact nesting piping plovers.

Task 31.1: Design and implement a research study to help better understand piping plover nesting habitat availability under different flow regimes.

Task 31.2: Use spatial modeling to identify the highest-priority lands for conservation within the river systems that support piping plovers.

Issue 32: Agriculture fields (row-crop and hay fields) provide food and habitat, of unknown quality, for some shorebird species, including killdeer, buff-breasted sandpiper, and upland sandpiper. Research suggests that shorebirds prefer to forage in soybean fields, despite a lower invertebrate density compared to other habitats (Jorgensen et al. 2007, Jorgensen et al. 2009).

Task 32.1: Conduct research to determine the importance of agricultural resources to nesting and spring migrating shorebirds.

Task 32.2: Conduct research to determine invertebrate densities and food resources in agricultural fields used by shorebirds.

Task 32.3: Explore whether agricultural chemicals pose risks to shorebirds that use crop fields.

WATERBIRDS

The RWBJV Waterbird Plan provided a conservation blueprint to guide biological planning and conservation delivery to benefit waterbirds that depend on habitats in the RWBJV Administrative Area (RWBJV 2013*d*). 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. Among breeding species, least terns are the best understood. Several geospatial projects have been recently completed or are in progress to evaluate habitat for least terns along the central Platte River under different flow regimes.

Nearly all of the breeding waterbirds in the RWBJV Administrative Area occur in the Sandhills GFA. Over 97% of this GFA in private ownership, and conservation delivery will need to account for agricultural land uses, such as cattle grazing. 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.

Significant data have been collected on sandhill cranes and whooping cranes using the RWBJV Administrative Area during the migratory portion of their annual life-cycle (Anteau et al. 2011, Kinzel et al. 2006, Krapu et al. 2011). 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 (RWBJV 2013*d*). An estimated 560,000 sandhill cranes use the RWBJV Administrative Area (RWBJV 2013*d*). Approximately 12,000 acres of functional wet meadow habitat, 80,700 acres of corn fields, with at least 88 kg/ha of waste grain, are needed for the cranes to acquire sufficient nutrient reserves during migration (Pearse et al. 2010, RWBJV 2013*d*). A key assumption of the RWBJV bioenergetics model is that there will continue to be 80,700 acres of suitable corn fields with at least 88 kg/ha of waste grain under current harvest practices (RWBJV 2013*d*).

Several national priority species can be found in the RWBJV Administrative Area, including king rail, black tern, American bittern, and black-crowned night-heron, but little information exists on reliable population estimates or habitat use of these species. There are a number of research, inventory, and monitoring issues that must be addressed in order to improve waterbird conservation in the RWBJV Administrative Area.

Issues of Concern and Related Tasks

Issue 33: Breeding population estimates and trends are unknown for many waterbird species, preventing attempts to establish regional population targets in RWBJV Administrative Area.

Task 33.1: Gather and assess any existing breeding waterbird population information for the RWBJV Administrative Area.

Task 33.2: Conduct research to determine breeding waterbird species abundance and distribution.

Task 33.3: Develop population targets for breeding waterbirds in the RWBJV Administrative Area.

Issue 34: A lack of habitat objectives exists for most spring migrating and breeding waterbird species in the RWBJV Administrative Area.

Task 34.1: Conduct research to determine waterbird habitat use and selection during spring migration and breeding.

Task 34.2: Develop research projects and obtain additional population information necessary to set foraging and breeding habitat objectives.

Issue 35: Knowledge and understanding of how the temporal variation of flow regimes on the Loup River impact habitat for the least tern is not fully developed.

Task 35.1: Obtain existing data on how flow regimes can alter habitat for the least tern and evaluate if further efforts to better understand the species-habitat relationships are necessary.

Task 35.2: Establish a field-based monitoring program to evaluate the change in preferred habitat for least terns over time and track the flow intensity of the river.

Issue 36: Achieving the recovery goals for the least tern in the RWBJV Administrative Area may be limited by the availability of suitable nesting habitat, due to alterations of the Platte and Loup Rivers, increased nest depredation, and disturbance by humans.

Task 36.1: Investigate possibilities for creation of additional habitat, or rehabilitation of degraded habitat.

Task 36.2: Determine whether and where predator control may be needed.

Task 36.3: Determine whether and where public education regarding the species and disturbance threats may be needed.

Issue 37: There is not currently a biological model that relates waterbird populations to habitats in the RWBJV Administrative Area. Such models allow for more effective and efficient conservation delivery.

Task 37.1: Develop a biological model that relates waterbird populations to habitats within the geographic boundaries.

Issue 38: In the bioenergetics model for sandhill cranes, it was assumed that the foraging efficiency in wet meadows and associated grasslands is 20%, due to their tactile foraging strategy (RWBJV 2013*d*).

Task 38.1: Develop a research project to whether the foraging efficiency of sandhill cranes in wet meadow or other grassy habitats is 20%.

Task 38.2 Develop a research project to investigate the available invertebrate and other food resources biomass available to foraging sandhill and whooping cranes in those wetlands.

Issue 39: Selection of habitats (e.g. roost sites, wet meadows, crop fields) by sandhill cranes is not well understood. In particular, the influence of spatial juxtaposition (e.g. size, proximity to roost, distance to disturbance features, longitude) is unknown.

Task 39.1: Develop research projects to determine species-habitat relationships for sandhill cranes and if these relationships hold true in varying landscapes.

Task 39.2: Create predictive models of probability of habitat use based on landscape configuration and composition to help target conservation efforts on the ground.

Issue 40: There is a lack of spatial data depicting the availability and distribution of certain waterbird habitats across the landscape.

Task 40.1: Develop GIS data layers that depict potential waterbird habitat.

Issue 41: A coordinated waterbird monitoring program that facilitates the refinement of population and habitat objectives and contributes to national objectives stated in the North American Waterbird Conservation Plan is needed.

Task 41.1: Develop and implement a waterbird monitoring program that specifies standardized procedures and protocols for achieving multiple objectives.

Issue 42: The RWB and central Platte River provide vital stopover habitat for the endangered whooping crane. In the past, the RWBJV has assumed that if the conservation targets and strategies outlined in the RWBJV Waterfowl Plan are met, there will also be sufficient habitat for whooping cranes (RWBJV 2013*d*). More recent data suggests, however, that this may not be the case. Many sites that are available to waterfowl may not be available to whooping cranes due to visual obstructions and other disturbances.

Task 42.1: Continued monitoring is needed to test these assumptions.

Task 42.2: Collect more data to help determine whooping crane habitat availability, selection, and use with a focus on distance to visual obstructions and disturbances.

HUMAN DIMENSIONS

Recently, there has been growing interest in the science of human dimensions among typically avian-focused conservation groups. The revision of NAWMP (NAWMP Plan Committee 2012) included a goal of "growing numbers of waterfowl hunters, other conservationists and citizens who enjoy and actively support waterfowl and wetlands conservation". Toward that end, a Human Dimensions Working Group and the Public Engagement Team have been formed to help meet that goal and "…support development of objectives for people and ensure those actions are informed by science..." (NAWMP Plan Committee 2012). Additionally, PIF (e.g., Berlanga et al. 2010) and the North American Bird Conservation Initiative have held workshops to share information and discuss the importance of the social sciences in bird conservation. Thus, it has become recognized that avian and habitat conservation will not occur at appropriate rates without garnering general public support that may eventually drive policies or programs at national levels. The RWBJV must also find new methods to quantify and communicate the ways in

which having an abundant and diverse bird and habitat community benefits people. Addressing human dimensions issues also can help to increase interest and investment in bird conservation among stakeholders.

All people who live in or visit the RWBJV Administrative Area are directly or indirectly impacted by upland and wetland habitats in the area and avian and/or habitat conservation activities. For example, some own land that contains wetland or grassland habitat while residents and visitors may directly engage with birds through hunting or bird watching. Most people influenced by avian and/or habitat conservation activities have a direct and/or indirect financial connection. Direct connections could include paying taxes, while indirect contributions could include making donations that fund conservation agencies or organizations that implement conservation activities. Some benefit financially from the hunting and bird watching tourism industry.

Because avian or habitat conservation may not be priority to all residents, the RWBJV will need to ensure that both residents and visitors understand and value ecosystem goods and services that healthy ecosystems provide (e.g. groundwater recharge, nutrient cycling, soil erosion control, floodwater retention). Healthy ecosystems are linked to sufficient and quality air, soil and water that all people depend. A landscape without wetlands and grasslands is not able to sustain desired populations of priority bird species, but will also likely not provide the ecosystem services that are valued and needed by residents within the RWBJV Administrative Area.

Many who do not live in the RWBJV Administrative Area also have an interest in the state of avian conservation here because the area is a vitally important stopover area for migrating birds that breed and/or winter elsewhere. It is important to learn about and consider the attitudes, opinions, and desires of all of these stakeholders when making conservation decisions.
As the RWBJV moves forward in pursuit of avian conservation in the RWBJV Administrative Area, several human dimensions issues need to be addressed through directed research.

Issues of Concern and Related Tasks

Issue 43: There is little information available concerning the current opinions, understanding, and behaviors of landowners, residents, and visitors in regards to their support for avian and habitat conservation within the RWBJV Administrative Area.

Task 43.1: Compile and review available information about landowner, resident, and visitor support or opinions regarding avian or habitat conservation.

Task 43.2: Assess the opinions, support, and understanding of landowners, residents, and visitors to the RWBJV Administrative Area regarding upland and wetland habitats, ecological goods and services they may provide, and avian conservation among the GFAs.

Issue 44: Increasing support for avian and habitat conservation will require changing the opinions, understanding, and behaviors of landowners, residents, and visitors by developing relevant, appropriate messages through various lines of communication.

Task 44.1: Assess the opinions, understanding, and behaviors of landowners, residents and visitors to the RWBJV Administrative Area after implementation of communication messages to evaluate their effectiveness.

Issue 45: The Rainwater Basin and central Platte River regions are popular birdwatching destinations during spring migration, mainly due to the sandhill crane migration. Additionally, many waterfowl and upland game bird hunters travel to these areas during hunting seasons. While some researchers have reported estimates for the local and statewide economic impacts of birdwatching, additional research is needed to obtain a more accurate estimate that also includes the effects of hunters.

Task 45.1: Design, conduct and estimate the socio-economic impacts of tourism related to recreational opportunities (e.g., birdwatching and hunting) within the RWBJV Administrative Area.

Issue 46: Ecological goods and services are the tangible and intangible benefits people receive from a healthy, functioning ecosystem. Examples of ecological goods and services in the RWBJV Administrative Area may include clean air and water, pollination of crops, groundwater

recharge, and aesthetic beauty. The value of these and other goods and services has not been determined.

Task 46.1: Inventory and measure the value of ecological goods and services provided by grassland and wetlands conservation.

Issue 47: Acquisition of new public lands and conservation easements is a costly endeavor. Over time, however, those costs may be recovered at least in part by grazing fees, public use, and ecological goods and services.

Task 47.1: Evaluate the return on investment from purchases of new public lands and conservation easements.

Task 47.2: Identify ways to use this information to gain public support for grassland and wetland conservation.

Issue 48: Based on an energetics approach, the RWBJV has estimated that the RWB will need to provide 4.4 billion kilocalories of wetland-derived foraging resources for migrating waterfowl (RWBJV 2013a). In order to meet this goal, the participation of private landowners will be needed to increase the number of acres of wetland habitats under long- and short-term programs, as well as the number of ponded, early succession wetland acres.

***Task 48.1*:** Survey private landowners to determine which incentives are most effective at encouraging participation in conservation programs.

Task 48.2: Survey private landowners to determine what are the most effective methods to communicate information about conservation programs.

Issue 49: Many row-crop fields contain wetlands or atypical upland areas which cannot be farmed very effectively. Because those acres do not produce much, if any, crops, this amounts to a financial loss for the farmer. However, some or all of that loss may be recovered by taking advantage of conservation programs that can transition these areas from row-crop production to cattle grazing or other more productive uses.

Task 49.1: Initiate an economic study of cropped wetlands and other marginal farm lands to determine the best way for farmers to recover financial losses caused by poor yields.

Issue 50: Many conservation programs rely on our ability to communicate with and recruit landowners. Some current methods used to reach landowners include direct mailings, informational seminars, and a website.

Task 50.1: Explore new communication techniques and ways to improve existing messaging efforts.

Task 50.2: Survey landowners and stakeholders to determine how to improve or increase the appeal of conservation programs.

Issue 51: Cattle production is the primary land use in the Sandhills region and requires large expanses of grassland habitat for grazing. However, some studies have found that the nesting success rates of birds that use grazed grasslands are low.

Task 51.1: Based on avian survey data and research, determine which grazing regimes provide the greatest benefit to breeding or migrating birds.

Task 51.2: Survey landowners to determine the extent to which they would be willing to participate in grassland conservation by altering cattle grazing regimes.

Task 51.3: Develop tools to encourage landowner participation.

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APPENDIX A

List of Common and Scientific Names Used

Common Name	Scientific Name
American Bittern	*Botaurus lentiginosus*
American Wigeon	*Anas americana*
Black Tern	*Chlidonias niger*
Black-crowned Night Heron	*Nycticorax nycticorax*
Blue-winged Teal	*Anas discors*
Buff-breasted Sandpiper	*Tryngites subruficollis*
Canada Geese	*Branta canadensis*
Gadwall	*Anas strepera*
Greater Prairie Chicken	*Tympanuchus cupido*
Greater White-fronted Geese	*Anser albifrons*
Green-winged Teal	*Anas carolinensis*
Interior Least Tern	*Sterna antillarum athalassos*
Killdeer	*Charadrius vociferus*
King Rail	*Rallus elegans*
Lesser Snow Goose	*Chen caerulescens*
Mallards	*Anas platyrhynchos*
Northern Bobwhite	*Colinus virginianus*
Northern Pintail	*Anas acuta*
Northern Shoveler	*Anas clypeata*
Piping Plover	*Charadrius melodus*
Red Phalarope	*Phalaropus fulicarius*
Ring-necked Pheasant	*Phasianus colchicus*
Ross's Geese	*Chen rossii*
Sandhill Crane	*Grus canadensis*
Trumpeter Swan	*Cygnus buccinator*
Upland Sandpiper	*Bartramia longicauda*
Whooping Crane	*Grus americana*
Willet	*Tringa semipalmata*