Partners in Flight
Bird Conservation Plan
for
The Northern Mixed-grass Prairie
(Physiographic Area 37)

American Bird Conservancy

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(Physiographic Area 37)

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by

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Partners In Flight
Northern Mixed-grass Prairie Bird Conservation Plan
(Physiographic Area 37)

Executive Summary:

Prior to European settlement, the Northern Mixed-grass Prairie was a mosaic of wetland, grassland and grass-shrub habitats, with riparian and floodplain forests along major drainages. Even today, the physiographic area can be characterized as being one of the largest still relatively intact grassland landscapes that persist in North America. It is the continent's most important production area for waterfowl and is the heart of the breeding range for some of North America's rarest species of grassland birds. A comparison of relative abundance estimates among physiographic areas sampled by the North American Breeding Bird Survey indicates that more than 40% of the world's population of Baird's Sparrows, 30% of Nelson's Sharp-tailed Sparrows and 25% of Sprague's Pipits are found in the physiographic area during the breeding season. Population objectives are to maintain or increase the abundance of all species in the grassland species suite. Because many priority grassland species have relatively large area requirements and large home ranges, habitat strategies include securing existing landscapes where native prairie exists in abundance and focusing habitat management prescriptions on units of 100 ha (250 acres) or greater.

Most of the priority wetland species appear to be stable or increasing in the physiographic area, perhaps because wetland loss has slowed in recent years as a result of Federal wetland protection regulations. The general population objective for the priority wetland species in this plan is to stabilize or increase current populations. Preservation and restoration of wetlands and wetland complexes should be emphasized and the amount of grassland in wetland landscapes should be maximized for Wilson's Phalaropes, Willets,

and Marbled Godwits.

The ecology of riparian systems of the Northern Mixed-grass physiographic area has received relatively little treatment to date, and warrants more research. However, most of the priority species associated with riparian zones also utilize habitat provided by shelterbelt and other tree plantings and probably are not habitat-limited in the physiographic area. Priority species in the Missouri River floodplain are all federally listed under the Endangered Species Act and are being managed under recovery plans developed by the U. S. Fish and Wildlife Service.

PREFACE:

Partners in Flight (PIF) is a voluntary, international coalition of government agencies, conservation groups, academic institutions, private businesses, and everyday citizens dedicated to “keeping common birds common”. PIF's goal is to direct resources toward the conservation of birds and their habitats through cooperative efforts in North America and the Neotropics. While PIF’s focus generally is limited to the conservation of landbirds, it is intended to complement similar efforts for waterfowl, shorebirds and other taxa. PIF now joins the North American Waterfowl Management Plan, United States Shorebird Conservation Plan, and North American Colonial Waterbird Conservation Plan in undertaking the kind of long-range planning necessary to help insure that viable populations of all native bird species continue to exist and that all our native ecosystems have full and functional avifaunal communities.

The foundation of PIF's bird conservation strategy is a series of Bird Conservation Plans, of which this document is one. These plans identify species and habitats most in need of conservation, and establish objectives for bird populations and habitats in physiographic areas (ecoregions) and states. The plans not only identify the general habitat requirements of priority species at the site-level, but also seek to identify the quantity and

quality of habitat required by birds at the landscape scale. Needed conservation actions are recommended and opportunities to accomplish them are suggested. Information and recommendations in the plans are based upon sound science and consensus among interested groups and knowledgeable individuals.

Many of the species that are part of the avifauna of the United States migrate through or winter in other countries in the Western Hemisphere. Most species have suffered habitat habitat loss in non-breeding areas, and some are exposed directly to toxicants and persecution (Basili and Temple 1995; Bird Conservation Fall 1996). While it is beyond the scope or desire of Bird Conservation Plans to recommend conservation objectives for other countries, PIF is working in concert with like-minded counterparts throughout the hemisphere to deliver integrated bird conservation at the necessary geographic scale. For more information about Partners in Flight, see the following web site: <http://www.partnersinflight.org/>.

Section 1: The planning unit

Background:

The Northern Mixed-grass Prairie physiographic area occupies roughly the eastern half of South Dakota and the central third and northwest quarter of North Dakota (see mapset at end of document) . It is part of the Prairie Pothole Region in which glacial lakes and wetlands are prevalent features of the landscape. In the more eastern part of the physiographic area known as the “Drift Prairie”, potholes occur in various densities ranging from a few to forty-seven or more per square kilometer (Batt 1996). These were once embedded in a matrix of mixed-grass prairie, but during the last century many of the wetlands have been drained and much of the prairie has been converted to cropland. The topography is level to gently rolling with elevation ranging from 200-900 m (700 - 3,000 ft) above sea level. The Drift Prairie area corresponds to sections 332 A, B and D of the

“Bailey” classification of ecological subregions (McNab and Avers 1994).

The western third-to-half of the physiographic area is coincident with section 331E of McNab and Avers (1994) and consists of the Missouri Coteau, the Prairie Coteau and the outwash plain along the northern and eastern sides of the Missouri River. Elevation can be as great as 1800 m (6,000 ft) in the coteaus, although the topography for the most part is gently rolling. Wetlands are interspersed throughout the landscape here as well, but there are larger expanses of unbroken grassland, much of which is still native prairie, than in the Drift Prairie to the east (see Appendix 1 for the current distribution of landcover types). Potential natural vegetation (Kuchler 1964) is wheatgrass-bluestem-needlegrass prairie. Western snowberry and prairie rose are common shrubs in the western part of the planning unit.

The Missouri River and its tributaries drain much of the physiographic area, but other well developed dendritic systems are present as well. Although level to gently rolling glacial till plains are characteristic, slopes adjacent to major river valleys can be steep. Floodplain and riparian forests occur along major drainages.

Conservation issues:

The Northern Mixed-grass Prairie is the most important production area on the continent for waterfowl and is the heart of the breeding range for some of the rarest species of grassland birds in North America. A comparison of relative abundance estimates among physiographic areas sampled by the North American Breeding Bird Survey indicates that greater than 40% of the world’s population of Baird’s Sparrows, 30% of Nelson’s Sharp-tailed Sparrows and more than 25% of all Sprague’s Pipits are found in the physiographic area during the breeding season (K.V. Rosenberg, unpublished data; see Rosenberg and Wells in press). Species that utilize grassland/wetland mosaics, such as Black Tern, Wilson’s Phalarope, and Marbled Godwit, also are found in great abundance.

Because rougher terrain and lower and less predictable precipitation make crop agriculture less profitable, a smaller percentage of land in the Northern Mixed-grass Prairie has been converted to cropland than in the adjacent Northern Tallgrass Prairie. More of the mixed-grass physiographic area has remained in native vegetation and large expanses of grassland still exist in some in some areas. However, removal of the effects of fire and bison herbivory with settlement has altered the structure of the native habitats that remain. The planting of trees around farms also altered the prairie landscape as did the loss of the many wetlands that were drained to accommodate the crop agriculture that does occur. Unfortunately, changes in bird abundance and distribution were not monitored as many of these changes in the landscape occurred, and we have no empirical benchmarks to compare with current conditions.

Today, in the mixed-grass as elsewhere, birds can be found breeding in all available habitats, from native prairie to cropland to urban landscapes. However, the consistent presence of a given species in a habitat over time can cause the population to appear stable, when it is in fact possible that few offspring are being produced by the individuals nesting there (Brawn and Robinson 1996). For example, species that are attracted to hayfields (i.e., Bobolink) may experience extremely low reproductive success due to the direct and indirect effects of mowing (Frawley 1989). Human intrusion into suitable habitat also can disrupt the breeding cycle of species such as Franklin's Gulls that can completely abandon large prairie lakes if disturbance is too great early in the breeding season (Burger 1974; Burger and Gochfeld 1994). Even birds that nest in native prairie appear to suffer high rates of nest predation and parasitism in the Northern Mixed-grass region (Davis 1994; Davis and Sealy 1998; Davis and Sealy in press). If a species is to persist over time, the sum of its reproductive success among all occupied habitats must at least be adequate to replace adult attrition. Unfortunately, little is known about the actual mechanisms that affect reproductive success across the array of habitat types and landscapes patterns that exist in the mixed-grass today.

Many species of prairie birds have rather large area requirements that must be satisfied if conservation is to be effective. For example, flocks of Greater Prairie-Chickens and Sharp-tailed Grouse may need patches of grassland habitat as large as 4000 hectares (10,000 acres) for populations to persist over time in fragmented landscapes (Temple 1992). Some wetland birds, such as Willets and Marbled Godwits, also must have tracts of grassland larger than 100 hectares (250 acres) to meet their requirements for nesting and brood-rearing cover (D. H. Johnson, unpublished data). Of those species requiring large blocks of habitat, Northern Harrier and Willet are showing recent signs of population decline in the physiographic area (Sauer et al. 1997) and one, Greater Prairie-Chicken, has declined dramatically both in North and South Dakota (Westmeier and Gough, unpublished data). Landscapes that still support healthy populations of birds with large area requirements need to be identified and conserved.

Several species in the physiographic area warrant conservation attention due to declining population trends or simply because a very large percentage of their global population breeds in the planning unit. Although some high priority species (eg. Baird's Sparrow) will utilize both native and non-native grasslands, endemic species such as Sprague's Pipit and Chestnut-collared Longspur show a strong habitat preference for native prairie vegetation (Davis et al. in press). If these species are to persist, it is critical that large expanses of native grassland be protected in perpetuity.

The vagrancies of short and long-term climate patterns can also affect prairie birds. For example, many individuals may not reproduce at all during droughts, species may use different habitats in wet versus dry years, or geographic distributions of some species may shift (George et al. 1992). Although difficult to study, a better understanding of the response of bird populations to fluctuations in climatic conditions is needed.

General conservation opportunities:

There are many ongoing initiatives in the Northern Mixed-grass Prairie physiographic area that will result in a better understanding of nongame bird ecology and those species' interactions with other taxonomic groups sharing the same the landscape. Some examples of resources include:

The Northern Mixed-grass Prairie comprises the central portion of the Prairie Pothole Joint Venture (PPJV), a component of the North American Waterfowl Management Plan. Among the PPJV partners, a Technical Committee has been established comprised of experts in waterfowl, wetlands ecology and nongame migratory birds. A subgroup entitled the Nongame Bird Technical Committee met in May 1997, and produced meeting minutes addressing population and management issues and opportunities for birds of the mixed-grass prairie (Pashley et.al., unpublished).

The PPJV and the U.S. Geological Survey's Biological Resources Division are funding a literature synthesis, entitled "Effects of Management Practices on Grassland Birds". The work is being done by Northern Prairie Wildlife Research Center in Jamestown, North Dakota, with numerous ornithologists contributing to the effort. To date, reviews for many species are available at http://www.npwrc.usgs.gov/resource/literatr/grasbird/grasbird.htm. Each document is a thorough synthesis of available literature for that species and its associated habitats. When the project is completed (estimated Spring 1999), there will be management documents available for 32 grassland bird species, most of which have ranges that broadly overlap the PPJV (Johnson et al. 1998). Additionally, a Baird's Sparrow Status Assessment and Conservation Plan (Jones and Green 1998) is available from the U. S. Fish and Wildlife Service's Region 6 office in Denver, Colorado.

Extensive research on shorebird utilization and habitat needs in the northern Great Plains has been conducted by the Midcontinent Ecological Science Center. A report entitled "Biogeographical Profiles of Shorebird Migration in Midcontinental North America" that graphically depicts habitat utilization of the region by shorebird species and species

groups during all times of the year is now available (Skagen et al. 1998). This as well as information developed on shorebird management in the prairies will be incorporated into a PPJV Shorebird Overview and Management Recommendations document.

As a result of on-going shorebird research, interest in management applications and PPJV activities with the Western Hemisphere Shorebird Reserve Network, a shorebird management workshop was held in Aberdeen, South Dakota in May 1998. The workshop brought together participants representing federal, state, yribal and non-governmental conservation groups from Canada, Mexico and the United States to discuss prairie shorebird ecology and management on the breeding, migration and wintering grounds. The workshop was held at Northern State University and at “Columbia Marsh” on Sand Lake National Wildlife Refuge (a North American Wetlands Conservation Act Project). Sand Lake NWR has just been designated as the 16th RAMSAR Wetland of International Importance in the U.S. and is the only such designated area in the PPJV. A Northern Plains Working Group for the National Shorebird Plan has been formed and is chaired by a member of the PPJV Management Board.

The U.S. Fish and Wildlife Service’s Habitat and Population Evaluation Team (HAPET) office in Bismarck, North Dakota, has produced a series of breeding waterfowl distribution maps based upon models that link wetland class, size and location with breeding duck abundance. These maps, commonly called “thunderstorm maps”, have been generated for most of the U.S. Prairie Pothole Region. The maps can be used to target conservation projects on areas that potentially have significant benefits for nesting waterfowl and other wetland birds. The Bismarck HAPET office is also working with Ducks Unlimited, Inc. to classify and map upland habitats and landuse for the PPJV area. In concert, these two mapping efforts can highlight the habitats available to wetland and grassland birds and predict where conservation efforts would yield the best results. In addition, the Multi Agency Approach to Planning and Evaluation process has been carried out on a majority of Wetland Management Districts in the PPJV, refining waterfowl objectives and

highlighting the need for conservation of wetland/grassland complexes.

U.S. agricultural policy has also had an impact on the birds of the mixed-grass prairie (Johnson and Schwartz 1993). PPJV partners have been aggressively pursuing Farm Bill policy and legislation that will provide additional protection for the prairies. The Conservation Reserve Program (CRP) has resulted in nearly five million acres of agricultural cropland being converted to perennial cover for periods of 10-20 years. To maximize the benefits of this program in the prairie pothole region, the USDA has designated the U.S. Prairie Pothole Joint Venture a Conservation Priority Area, where the CRP land set-aside program will place special consideration on wildlife and habitat benefits. Although grassland habitat provided by CRP is beneficial to many species of non-game birds today, more emphasis on the planting of native grasses and forbs would better benefit high priority species such as Sprague's Pipit and Chestnut-collared Longspur that largely are dependent upon native mixed-grass prairie (Johnson et al. 1998; Davis et al. in press; Brenda Dale, pers. comm). Conservation easements also are being offered by both Ducks Unlimited and the U. S. Fish and Wildlife Service and have become a popular conservation tool in the mixed-grass prairie. Easements are most effective when they are permanent or very long-term (eg. 30 or more years) and only when enforced (PPJV non-game technical committee meeting, unpublished minutes from 4 May 1999).

Newly developed research projects include "Integrating Conservation and Management Strategies for Nongame and Game Birds in Grasslands", under the direction of the Montana Cooperative Wildlife Research Unit. This project is a 5 year study that will evaluate nest site selection and factors associated with successful nesting for all upland-nesting birds in grassland habitats across a broad geographic range of the northern prairies.

Environmental education and outreach are also components of the joint venture approach. Activities such as The Shorebird Education Project, the new "Amazing Journey of the

Migrating Shorebirds" video, the comprehensive training program "Agricultural Pesticides and Wildlife", various "newspapers" for kids on shorebirds and neotropical migrants and other education products provide opportunities for learning and linking internationally. New projects in this area will include Shorebird "Sister Schools" linkages.

Opportunities for integration of objectives set forth in the PIF Bird Conservation Plan with other bird conservation initiatives in the Northern Mixed-grass Prairie are many. While the challenges associated with such a large scale effort are also numerous, the dedication of professional conservationists and private citizens to maintaining a healthy avifauna in the Northern Mixed-grass Prairie is even greater still, and bodes well for the future of bird conservation throughout the physiographic area.

Section 2: Avifaunal analysis

General characteristics:

At least 148 species of birds breed in the Northern Mixed-grass Prairie physiographic area (Sauer et al. 1997). Nearly two-thirds of those species use the wetland-grassland habitats characteristic of the "Prairie Potholes" region. Almost all of the grassland-wetland species with significant population trends are increasing (Breeding Bird Survey $p=0.10$ or less; Sauer et al. 1997). Only the Burrowing Owl, Sprague's Pipit and Northern Rough-winged Swallow have declined significantly at rates greater than 2% per year (-21.4%, -4.2% and -6.2%, respectively). However, the trends of several high-priority species such as Baird's Sparrow, Yellow Rail, McCown's Longspur, and Marbled Godwit remain unknown, perhaps because their habitat is undersampled by roadside point-counts (Sutter et al. in press). These are species whose distributions and abundances largely are centered upon the northern mixed-grass prairie physiographic area, and therefore warrant an increase in monitoring effort. The Canadian Wildlife Service has initiated a Grassland Bird Monitoring Project that concentrates roadside point-counts in areas with high

percentages of grassland cover based upon the assumption that population changes will be more easily detected on routes with substantial habitat and relatively high densities of the target species. This project provides a prototype for use in the United States.

Twenty-five percent of the Northern Mixed-grass avifauna are dependent upon forests or woodlands in various stages of succession. Although they occur on a relatively small number of survey routes, species associated with open woodlands with a grassy or shrubby understory, such as Chipping Sparrow, Indigo Bunting, Alder Flycatcher, Yellow-bellied Sapsucker, Eastern and Spotted Towhees, Cedar Waxwings and Orange-crowned Warblers, have increased at 7% or greater annually from the beginning of the Breeding Bird Survey approximately 30 years ago (Sauer et al. 1997). However, with the exception of a few species of woodland birds such as Black-billed Cuckoo, Northern Flicker, Warbling Vireo and Orchard and Baltimore Orioles, populations of woodland and forest birds in the Northern Mixed-grass largely are peripheral to their centers of abundance (see PIF area of importance scores for these species at: http://members.aol.com/cbopifdb). Historically, these species were associated with riparian and floodplain habitats (Rumble et al. 1998).

Priority Species:

Species are considered of conservation priority for PIF physiographic area Bird Conservation Plans if they meet one of six criteria (see Appendix 1). These criteria variously emphasize the species' vulnerability to extinction range-wide, the species population trend in the physiographic area and the degree to which the planning unit in question is a center of abundance for that species. Species that have a large proportion of their population breeding in the planning unit but that are not declining do not warrant immediate conservation action, but should be considered of high conservation responsibility and their needs considered in long-range planning. Species for which the planning unit is a center of abundance and that also show significant declining population

trends need more immediate conservation attention.

The priority species for the Northern Mixed-grass Physiographic Area are given in Table 1.

Table 1. Partners in Flight Priority Species for Physiographic Area 37: The Northern Mixed-grass Prairie.

Species	Criteria	Total Score	AI	PT	BBS Trend	% Pop.
Baird's Sparrow	I	28	5	3	-2.3	41.6
Yellow Rail	I	27	5	3	na	na
Greater Prairie-Chicken	I	27	2	3	na	na
Nelson's Sharp-tailed Sparrow	I	27	5	1	11.4*	34.5
McCown's Longspur	I	27	3	3	-12.3	
Sprague's Pipit	I	26	5	5	-4.2**	29
Piping Plover	I	25	2	3	na	na
Marbled Godwit	I	23	5	2	-0.5	22.8
Bell's Vireo	I	23	2	3	-9.3	1.2
Le Conte's Sparrow	I	23	4	2	9.7	16.9
Willet	II	22	5	4	-2.3	15.3
Wilson's Phalarope	II	22	5	3	-1.3	20.0
N. Harrier	II	21	5	4	-1.7	10.6
American Bittern	II	20	5	3	-1.3	10.7
Grasshopper Sparrow	II	20	4	4	-2.1	
Franklin's Gull	III	22	4	2	0.0	15.7
Short-eared Owl	III	20	3	3	-1.0	2.4
Lark Bunting	III	20	3	3	2.2	5.3
Bobolink	III	20	4	2	0.7	10.7
Red-headed Woodpecker	III	19	3	2	-0.9	3.5

Species	Criteria	Total Score	AI	PT	BBS Trend	% Pop.
Dickcissel	III	19	3	1	1.9*	5.8
Black Tern	IV	19	5	2	0.7	33.6
Virginia Rail	IV	17	5	3	63.6	33.0
Pied-billed Grebe	IV	15	5	2	4.6	30.2
Sora	IV	14	5	1	6.6**	29.0
Marsh Wren	IV	19	5	1	9.9**	27.2
American Coot	IV	13	5	2	6.2	25.1
Sharp-tailed Grouse	IV	19	5	3	8.9	25.1
Upland Sandpiper	IV	20	5	1	3.1**	22.8
Horned Grebe	IV	18	5	3	10.8	17.9
Clay-colored Sparrow	IV	22	4	4	-1.6	17.8
Chestnut-collared Longspur	IV	21	3	3	-0.4	15.3
Eastern Kingbird	IV	15	5	1	2.4**	13.9
Western Kingbird	IV	17	5	1	2.6**	13.3
Sedge Wren	IV	20	4	1	8.9*	13.1
Warbling Vireo	IV	16	4	1	4.4**	12.9[a]
Willow Flycatcher	IV	19	3	3	1.1	12.0[a]
Black-billed Cuckoo	IV	20	5	2	-0.1	10.2
Vesper Sparrow	IV	14	5	1	2.2**	10.2
Bald Eagle	V	18	2	3	na	<1
Least Tern	V	17	3	3	na	na
Ferruginous Hawk	VI	22	3	3	9.6	
Burrowing Owl	VI	19	4	3	-21.8**	
Loggerhead Shrike	VI	17	3	2	0.2	

* = significant at 0.10; ** = significant at 0.05; na = not available.

[A] = percentage of population of eastern race of the species.

AI = area of importance score, a measure of the species' intraspecific relative abundance among physiographic areas. PT = the species' population trend score. See Appendix 1 for further explanation of these variables and information regarding the Partners in Flight species prioritization process.

Section 3: Habitats and objectives

Habitat-species suites:

Priority species are grouped by suites into habitat types as shown in Table 2.

Table 2: Priority species by habitat type in the Northern Mixed-grass Prairie physiographic area.

Species	Habitat	Total Score	AI	PT	TB	Sum
Baird's Sparrow	GR	28	5	3	4	12
Greater Prairie-Chicken	GR	27	2	3	4	9
McCown's Longspur	GR	27	3	3	4	10
Sprague's Pipit	GR	26	5	5	3	13
LeConte's Sparrow	GR	23	4	2	4	10
Ferruginous Hawk	GR	22	3	3	4	10
Clay-colored Sparrow	GR	22	4	4	4	12
Northern Harrier	GR	21	5	4	4	13
Chestnut-collared Longspur	GR	21	3	2	4	9
Short-eared Owl	GR	20	3	3	4	10
Lark Bunting	GR	20	3	3	3	9
Bobolink	GR	20	4	2	4	10
Upland Sandpiper	GR	20	5	1	3	9
Sedge Wren	GR	20	4	1	3	8

Species	Habitat	Total Score	AI	PT	TB	Sum
Sharp-tailed Grouse	GR	19	5	3	3	11
Burrowing Owl	GR	19	4	3	4	11
Dickcissel	GR	19	3	1	4	8
Western Kingbird	GR	17	5	1	2	8
Loggerhead Shrike	GR	17	3	2	4	9
Eastern Kingbird	GR	15	5	1	2	8
Vesper Sparrow	GR	14	5	1	2	8
Yellow Rail	WE	27	5	3	3	11
Nelson's Sharp-tailed Sparrow	WE	27	5	1	4	10
Marbled Godwit	WE	23	5	2	4	11
Willet	WE	22	5	4	3	12
Wilson's Phalarope	WE	22	5	3	3	11
Franklin's Gull	WE	22	4	2	4	10
American Bittern	WE	20	5	3	3	11
Black Tern	WE	19	5	2	4	11
Marsh Wren	WE	19	5	1	4	10
Willow Flycatcher	WE	19	3	3	3	9
Horned Grebe	WE	18	5	3	2	10
Virginia Rail	WE	17	5	3	2	10
Pied-billed Grebe	WE	15	5	2	2	9
Sora	WE	14	5	1	2	8
American Coot	WE	13	5	2	2	9
Bell's Vireo	RH	23	2	3	4	9
Black-billed Cuckoo	RH	20	5	2	3	10
Red-headed Woodpecker	RH	19	3	2	4	9
Warbling Vireo	RH	16	4	1	2	7

Species	Habitat	Total Score	AI	PT	TB	Sum
Piping Plover	BR	25	2	3	4	9
Bald Eagle	BR	18	2	3	4	9
Least Tern	BR	17	3	3	4	10

Habitat codes: GR = grassland; WE = wetlands; RH = riparian associated habitats; BR = big river sandbar and floodplain habitats;
AI = area of importance score, a measure of the species' intraspecific relative abundance among physiographic areas. PT = the species' population trend score. See Appendix 1 for further explanation of these variables and information regarding the Partners in Flight species prioritization process.

Priority species group into four general habitat types: grasslands, wetlands, riparian woodlands and big river floodplain habitats. Eighty-four percent, however, use the grassland-wetland landscape characteristic of the Prairie Potholes region. Three-quarters of these grassland/wetland birds have Area Importance scores greater than 3, indicating that the region is a center of their abundance. Thus, changes in land use or conservation practices in the Northern Mixed-grass area could have significant impacts on their global populations. Known population trends of the species in these suites typically are stable or increasing, but trends for many species (30%) remain unknown and several (11%) are or appear to be in decline.

The three riparian woodland species, Red-headed Woodpecker, Black-billed Cuckoo and Warbling Vireo all have stable or increasing trends. This may be in response to the general increase in woody vegetation in the region due to fire suppression and the extirpation of bison (Murphy 1993; Campbell et al. 1994; Knopf 1994) as well as an increase in the park-like habitat of shelterbelt plantings (D. Johnson, pers. comm.). All three of the species of the big river floodplains, Bald Eagle, Least Tern and Piping Plover, are Federally listed

under the Endangered Species Act and have recovery plans in place. Bald Eagle and Bell's Vireo populations in the Northern Mixed-grass are peripheral to their centers of abundance. Piping Plovers also rely on saline wetlands throughout the physiographic area, with an estimated 24% of the North American population estimated to breed in the mixed-grass prairie region of Saskatchewan (S. K. Davis, pers. comm.).

Grasslands:

Ecology and conservation status:

Prior to European settlement, the Northern Mixed-grass Prairie was a mosaic of grassland and wetland habitats with trees largely restricted to river floodplains. Grasslands were maintained by bison herbivory, periodic drought and fires. Native prairie grasslands typically were intermediate in height between the short-grass prairie to the west and tallgrass prairie to the east. However, areas with either short-grass or tallgrass characteristics can be found within the planning unit depending upon topography, climatic patterns, disturbance, land use, etc.. Less of the mixed-grass than tallgrass prairie has been plowed because rougher terrain and a lower average annual precipitation render it less suitable for cropland. Woody vegetation has increased due to fire suppression and the planting of trees around farmsteads and along fencerows (Johnson 1995).

While populations of many priority bird species are stable or increasing in the physiographic area (Tab. 1), several species requiring relatively large expanses of native prairie (eg. Greater Prairie-Chicken, Sprague's Pipit and Northern Harrier; see Johnson et al. 1998) appear to have declined (Westmeier and Gough, unpublished data for Greater Prairie-Chicken; Sauer at al. 1997). Trends for other high priority species, such as Baird's Sparrow, McCown's Longspur, Ferruginous Hawk and Short-eared Owl remain unknown. Until we have better information from monitoring programs about the status of these species, it will be difficult to assess the overall ability of the physiographic area to support

viable populations of grassland birds.

<u>Bird habitat requirements:</u>

Priority species utilizing grassland habitats in the Northern Mixed-grass Prairie have been broken into the following suites of species that are found in slightly different kinds of grassland habitats. Available information is included about each species' general habitat requirements and responses to management techniques such as mowing, grazing and burning.

Large tracts of open, treeless grasslands: Greater Prairie-Chicken/Sharp-tailed Grouse/Northern Harrier/Short-eared Owl/Upland Sandpiper

The Greater Prairie-Chicken is an uncommon species in this physiographic area, essentially limited to its southeastern portions, while the Sharp-tailed Grouse occurs throughout. Both species (collectively known as prairie grouse) utilize a similar variety of habitats during their annual cycle (Manske and Barker 1987). In the spring, males of both species display for females on leks or booming grounds. Leks typically are located in relatively short grass on an exposed site like a hill or ridge top with idle, taller vegetation nearby (Kirsch et al. 1973, Manske and Barker 1987). Females mate with males at lek sites and often nest within a 1.5 km (1 mi.) radius of the lek (Pepper 1972, Sisson 1976, Nielson 1978, Schroeder and Robb 1993).

Prairie grouse nests found during a study at Sheyenne National Grasslands in southeastern North Dakota were in native grassland in which both the residual and growing vegetation were very dense (Manske and Barker 1987). Broods were mobile but spent much of their time in smaller, more intensively used areas within the larger home range. Individual brood rearing ranges varied from 22-2248 hectares (55-5620 acres), and averaged 487 hectares (1217 acres). Intensively used areas within the home range

averaged 40.4 ha (100 acres; Newell et al. 1987). Roughly 70 % of all brood locations were in native prairie, although the birds also seemed to prefer sites with concentrations of legumes such as alfalfa or sweet clover nearby. Areas that had been mowed or grazed in previous years sometimes were used for feeding, but hens avoided pastures with cattle present or that had been grazed earlier that same year. Shrubby areas were used for cover and shade during hot portions of the summer. Prairie grouse night roosts typically were in undisturbed vegetation that provided complete visual obstruction, although in winter they also made depressions or burrows in the snow (Toepfer and Eng 1987). The Sheyenne National Grasslands are in the transition between the Northern Tallgrass and Northern Mixed-grass Prairie Physiographic areas. The habitat associations the birds used most frequently were a mosaic of those grassland height and habitat types.

Kirsch (1974) published a subjective examination of the relationship between land use and prairie grouse populations in east-central North Dakota where he found leks only on or near tracts of retired (idled) cropland 24 hectares (60 acres) or greater in size. Greater Prairie-Chickens were not observed on any grazed grassland and only light-to moderate grazed grasslands appeared attractive to Sharp-tailed Grouse. Observations of the kinds of landscapes grouse were typically found in led him to suggest that prairie grouse management units should contain at least 3 sq km (2 sq. miles) of high-quality habitat within an area approximately 12 sq. km (8 sq. mi.). This is roughly equivalent to 580 hectares (1450 acres) of grassland interspersed throughout a 2300 (5700 acre) matrix, suggesting approximately 25% of the management unit be in high-quality habitat. It was suggested that patches of high-quality habitat should be at least sixty-five hectares (160 acres) in size, with a minimum width of 0.8 km (one-half mile). However, Ryan et al. (1998), found that Greater Prairie-Chicken populations in a Missouri landscape with scattered tracts of prairie declined over a 27 year period, while populations in a landscape with large acreages of contiguous prairie were stable. Where large tracts of continuous prairie are not available, Ryan and co-workers also recommend that habitat patches be a minimum of 65 ha (160 acres).

Both Short-eared Owls and Northern Harriers also prefer undisturbed areas of native prairie over fields under long-term grazing or where livestock are present. Both select nest sites in cover at least 30 cm (12 in.) in height with a large accumulation of residual litter and seem to prefer areas dominated by western snowberry *(Symphoricarpos occidentalis)*. Both feed mainly upon voles (*Microtus spp.*) and their populations may fluctuate in response to prey density. Neither were typically found in blocks of habitat less than 100 hectares (250 acres) in size in North Dakota (Johnson et al. 1998).

Upland Sandpipers prefer to nest in areas of relatively short grass between 15 - 31 cm (6-12 in.) in height (Kirsch and Higgins 1976). Most nests found by Higgins et al. (1969) in a North and South Dakota study were in ungrazed grasslands of medium density with abundant ground litter. In North Dakota, Kirsch and Higgins (1976) recorded the highest mean nest densities of Upland Sandpipers in native grasslands the second season after a prescribed burn. Areas with taller grasses are used for brood cover.

Management of relatively large tracts of native grasslands with prescribed burning appears to be a beneficial management tool for most of the species in this suite. However, undisturbed grass/legume cover such as that provided by the USDA Conservation Reserve Program in the Prairie Pothole area provides apparent benefits to some priority species. During recent waterfowl nesting studies in the PPJV, Short-eared Owl and Northern Harrier nests were commonly found in CRP cover and nest success was high. Sharp-tailed Grouse are common during the nesting season and nests also are often found in the cover type (Ron Reynolds unpublished data). Landscapes that provide a mosaic of habitat types, but in which maintenance of native prairie is emphasized, are likely to provide the array of habitat types needed by the priority species in this suite. More research is needed to determine the effects of landscape composition and patch size on reproductive success of nesting individuals.

Open, treeless grasslands, moderate height: Bobolink/Sedge Wren/Grasshopper

Sparrow/Dickcissel/Baird's Sparrow/Sprague's Pipit/LeConte's Sparrow

Although all the species in this suite are grassland species, not all are expected to co-occur at any single site at the same time. However, some of these species will occupy the same sites over time, with relative densities dependent upon rainfall patterns, time since disturbance, type of disturbance, etc.. Table 3 presents some basic microhabitat characteristics of breeding areas utilized by species in this suite, and indicates their general responses to management techniques such as burning, mowing, and grazing.

Table 3. Microhabitat associations and responses to management of the species suite utlilizing the open, treeless grasslands, moderate height (From Johnson et al. 1998 unless noted).

Species	Grass cover	Forb cover	Litter depth	Native/ tame[a]	Use mowed[b]	Use grazed[c]	Use burned[d]	Area sens[e]
Sedge Wren	dense	moderate to heavy	thick	both	not if done annually	light	yes	< 30 ha
Sprague's Pipit	sparse to moderate	moderate*	moderate	native	not if done annually	light-moderate*	yes	>150 ha
Dickcissel	dense	heavy	thick	both	not if done annually	light	yes	10- 30 ha
Baird's Sparrow	moderate to dense*	mod.	moderate	both	not if done annually	light-moderate*	yes	>50 ha*
Grasshopper Sparrow	sparse to moderate	light to moderate	light to moderate	both	yes	light to moderate	yes	30 -100 ha
LeConte's Sparrow	dense	heavy ?	thick	both	not if done annually	not clear	yes	< 30 ha
Bobolink	dense	light	thick	tame	yes	light	yes	< 30 ha

[a]Native/ tame:[c] refers to a whether a species shows a preference for nesting in native grass, non-native or "tame" grass, or uses both with no obvious preference. Different mixtures of tame or native grasses can result in differences in vegetation structure, which can influence the composition of the bird community at a site or affect a species preference for a cover type. For example, Davis and Duncan [in press] found that the frequency of occurrence of Baird's Sparrow was not significantly different in native and crested wheatgrass pastures in Saskatchewan, but attributed that to the fact that the vegetation structure in those over types was very similar).
[B]Use mowed: refers to whether the species utilizes mown areas as breeding habitat. Species with a "yes" are

those that will utilize the site the first breeding season after mowing; “not if done annually” refers to those species that typically don’t recolonize the site until at least 2 years after the disturbance. (Mowing should never be done during the breeding season to avoid nest destruction.)

[c]Use grazed: refers to whether the species will nest in areas that have been grazed. “No” means the species avoids grazed areas; “light” means the species will tolerate light grazing; “not clear” means the effect has not been determined.

[D]Use burned: refers to whether the species will nest in areas that have been burned. “Yes” means the species is attracted to sites that have been burned prior to the breeding season, although it may be 2 or more years after the disturbance before the site is recolonized. Relative densities of birds in the years following the burn can vary depending upon the habitat preferences of the species of birds present, the characteristics of the site and climate in a given year.

[E]Areas sens.: refers to whether a site must be of a certain size to attract moderate densities of a given species of bird. The sizes given are approximations of the smallest suitable site based upon a small number of existing studies, not all of which were done in the Northern Mixed-grass Prairie physiographic area. More research is necessary within the planning unit to adequately determine minimum area requirements for species in this suite.

*: additional information from Brenda Dale (Canadian Wildlife Service) and Steve Davis (Saskatchewan Wetland Conservation Corporation), unpublished data.

With the exception of Sprague’s Pipit and Grasshopper Sparrow, all of the species in this suite require moderate to dense grassland, and all prefer habitat that is disturbed periodically to maintain the vigor of grasses and forbs. All of the species respond favorably to native habitats that have been burned periodically, most tolerate light-to-moderate grazing and all will use areas that have been mowed at some point prior to the breeding season. However, relative densities of the species in the suite are likely to vary with time since disturbance as well as location of the site, and not all species may be present on given tract during the same breeding season. If disturbances are periodic, such as every 3-5 years, and rotated among tracts within a management unit, habitat should be provided for each of the species at any given point in time. The length of intervals between disturbances on a given site should be determined after consideration of edaphic and climatic conditions. For example, in areas where grass growth is more vigorous and during periods when rainfall is more plentiful, disturbances may need to occur at a three or four year intervals; the same site during drought periods may only need treatment after seven years or more. Areas should remain undisturbed long enough that

grass cover can become dense and thick litter layers can build up before succession is set back by disturbances such as mowing or burning, so that the needs of species utilizing habitat with those conditions are satisfied. Planted, cool season grass/legume cover such as that provided by the Conservation Reserve Program can also provide suitable habitat for many species in this suite (Johnson and Schwartz 1993, Reynolds et al. 1994). Baird's Sparrow, Sprague's Pipit and Chestnut-collared Longspur all respond positively to improved range conditions (Brenda Dale, pers. comm., George et al. 1992).

Open, short, sparse grasslands: Ferruginous Hawk/Burrowing Owl/Vesper Sparrow/ McCown's Longspur/ Chestnut-collared Longspur

All of the species in this suite prefer open expanses of native grasslands with moderate to heavy grazing pressure (Johnson et al. 1998), with the exception of Vesper Sparrow whose habitat preferences are much more generalized. Although minimum area requirements have not been investigated for all of the species in this suite, an estimate of 46 ha (115 acres) was calculated for Chestnut-collared Longspurs from data collected in southern Saskatchewan (S. K. Davis, unpublished data). Individual pairs of Ferruginous Hawks are known to hunt over areas greater than 2000 ha (4,900 acres; Wakeley 1978). Nest densities are inversely proportional to the amount of the landscape under cultivation (Schmutz 1987). Ferruginous Hawks forage on burrowing mammals such as ground squirrels (*Spermophilis* spp.), prairie dogs (*Cymomys ludovicianus*) and pocket gophers (*Geomys bursarius, Thomomys talpoides)*, and Burrowing Owls utilize burrows for nest sites (Johnson et al. 1998). Both species are dependent upon healthy prey populations for survival, and their density cycles with prey abundance. Widespread, government-subsidized eradication has resulted in a 98% or greater decline of prairie dogs across the Great Plains, and may have had severe negative impacts on prairie ecosystems and species such as Ferruginous Hawks and Burrowing Owls that are dependent upon them for food or nest sites (Miller et al. 1994). Little is known about the suites' response to burning, but management that maintains an abundance of burrowing mammals and healthy

native grassland habitat should be of benefit. However, relationships among reproductive success of ground-nesting grassland passerines, population dynamics of small mammals and reproductive success of avian predators such as Ferruginous Hawk and Burrowing Owl warrant further investigation.

Grasslands with a woody component: Loggerhead Shrike/Clay-colored Sparrow/Lark Bunting/Western Kingbird/Eastern Kingbird

Clay-colored Sparrows and Lark Buntings breed in shrubby grasslands, will nest in areas that have been light-to-moderately grazed, but avoid heavily grazed grasslands or areas that were mowed within a year prior to a given breeding season. Densities of Clay-colored Sparrows decline after habitats are burned, unless shrubby areas are unaffected by fire. Suggested fire intervals for this species are approximately 8-10 years for the Northern Mixed-grass Prairie. How populations of Lark Buntings respond to fire is unknown (Johnson et al. 1998). Bunting numbers are known to fluctuate from year -to -year, perhaps in response to climatic or other factors, although they are one of the most common nesting birds in CRP fields in the northern plains (Johnson and Schwartz 1993). Although minimum area requirements for these species have not been published, Lark Buntings, at least, appear to be area sensitive (D. Johnson, pers. comm.).

Loggerhead Shrikes, Eastern Kingbirds and Western Kingbirds require relatively open grassland habitats with sparsely scattered trees or tall shrubs (Brooks and Temple 1990, Knapton 1994, Yosef 1996). Shrike populations appear stable in the Northern Mixed-grass Prairie, although the species has declined significantly (average annual rate of 3.6%) throughout the range of the Breeding Bird Survey (BBS webpage). Both the Eastern and Western Kingbird have increased significantly in the past 30 years in the Northern Mixed-grass Prairie. Although shrikes and kingbirds are thought to have benefitted by the planting of trees around farm and urban areas, woody vegetation fragments prairie landscapes and should not be encouraged in the future.

Population objectives and habitat strategies:

The population objective for the grassland bird species suite is to maintain populations of all PIF priority species at their current levels in the Northern Mixed-grass Prairie, although increases would be considered favorable. (Note that for some species additional monitoring and inventory are needed to more adequately determine relative abundance and population trend). While we recognize that increased annual mortality or loss of habitat on the wintering grounds may contribute to population declines of migrant species, those factors are beyond the scope of this plan. Conservation on the breeding ground can contribute to long-term population stability by ensuring that suitable breeding habitat remains extant and that nest success remains high enough to compensate for annual mortality.

At the local scale, habitat in a given patch must satisfy both the microhabitat needs and minimum area requirements of each priority species (see “bird habitat requirements” for a synopsis of those requirements). Minimum area requirement, in this sense, is generally measured as the size a tract must be before there is a 50% probability that individuals of a given species are attracted to it as a breeding site. Minimum area requirements can vary across a species’ range and may be dependent to some degree upon the characteristics of the landscape in which the habitat patches are embedded. It is hypothesized that in landscapes with a certain threshold of grassland habitat, individuals will colonize smaller patches than in landscapes where a more dissimilar habitat type predominates in the matrix around the patch (Horn and Koford, unpublished data). More research is needed to clarify relationships between patch size requirements and land cover in the Northern Mixed-grass Prairie, but since many species with declining or uncertain trends (Sprague’s Pipit, Northern Harrier, Short-eared Owl, Ferruginous Hawk) typically are found nesting only in tracts of 100 hectares (250 acres) or greater, we recommend this be the minimum size used for grassland bird management units. Coordination among managers in a local area may be necessary to insure that an adequate amount of each grassland habitat type

needed by the various species in each suite is available at any given time. Thus, habitat probably is best managed in relatively large complexes.

Many of the species with larger minimum area requirements for nest sites, such as Greater Prairie-Chicken, Sharp-tailed Grouse, Ferruginous Hawk, Burrowing Owl, Short-eared Owl and Northern Harrier, also have relatively large home ranges within which they forage or raise broods. For these species, the matrix or landscape around the nest site must contain some amount of compatible habitat. For example, Kirsch (1974) recommended that at least 3 sq. km (2 sq. mi.) of high quality grassland be maintained in a 12 sq. km matrix for prairie grouse (i.e. roughly 25% of the landscape) in North Dakota. Density of Ferruginous Hawk nests in the prairie region of southeastern Alberta was negatively associated with the amount of cultivated land in 41 km^2 (25 mi^2) cells where almost all the land either was cropped or in pasture. Nest density peaked at 11-20% cultivation (i.e. greater than 80% grassland coverage), and declined linearly as the amount of grassland decreased (Schmutz 1987). All of the raptors depend to a large degree upon small mammals for prey. Therefore, whatever aspects of the grassland ecosystem small mammals respond to should be taken into account when developing management plans for a given site. In order to maintain current populations of priority species with large home range requirements, as much native prairie as possible should be maintained in the Northern Mixed-grass Prairie landscapes, and again, management units within those landscapes be 100 hectares or greater in size.

The term “minimum area requirement” also has been used to refer to the size a tract must be before it will sustain a level of reproductive success and numbers of individuals needed to ensure the viability of one or more bird species’ populations. Research has not addressed those sorts of questions as of yet in the within the U. S. portion of the Northern Mixed-grass physiographic area. However, studies in the mixed-grass region of Canada indicate that predation is the primary cause of nest failure in Baird’s Sparrow, and that cowbird parasitism significantly reduces the number of offspring fledged per nesting

attempt (Davis and Sealy 1998). Davis et al. (unpublished data) also have found that other species of ground-nesting passerines suffer high predation and parasitism rates, and suggest that tracts of land within the range of 700-1600 ha or greater (2150 - 4000 acres) might be needed before parasitism frequencies could be reduced by 50%.

Some of the highest priority species in the grassland suite (Baird's Sparrow, Sprague's Pipit, Ferruginous Hawk, McCown's Longspur, Chestnut-collared Longspur) reach greater densities in the coteaus and outwash plain than in the drift prairie. Therefore, greater emphasis on grassland bird conservation should be placed in the coteaus and outwash plain. Although preservation of existing landscapes and large blocks of native grassland should be the top conservation priority in those parts of the physiographic area, the conversion of additional cropland to perennial grass cover will benefit most of these species as well.

In the drift prairie, where grassland habitat is more fragmented by cultivation, areas where grassland covers 25% or more of the landscape should be maintained, especially where conditions resemble the configuration and block sizes of habitat described in the PIF grassland Bird Conservation Area (BCA) model. The BCA model recommends that a minimum 800 hectare (2,000 acre) block of high-quality grassland be maintained as a core area centered within a 1.6 kilometer (one-mile) wide matrix that provides another 1,000 hectares (2,500 acres) of additional grassland habitat of some sort, such as pasture, CRP or other tame or native grass (Fig. 1).The BCA design satisfies the habitat criteria recommended by Kirsch et al. (1973), Kirsch (1974) and Ryan et al. (1998) for conservation of Greater Prairie-Chickens, especially where BCA core areas can be centered around lek sites. In area where conservation of Greater Prairie-Chickens is not a goal (in, for example, the drift prairie of North Dakota where the species does not occur), blocks can be a minimum of 300 ha (750 acres) if the total amount of acreage in these relatively large blocks is 800 (2000 acres) or more in total. While suggested minimum size of satellite patches within the core is 40 hectares (100 acres) for other Midwestern

physiographic areas, 100 hectares (250 acres) is recommended as a minimum size for a majority of the patches in the Drift Prairie because of the large minimum area requirements of some priority bird species. Hayfields typically cut before July 15 do not qualify as suitable habitat due to an almost complete loss of nests during mowing. Woody vegetation should occupy less than 5% of the BCA, and the preference for agricultural use within the matrix is pasture and small grains over rowcrops. (See Appendix 2 for a more well developed list of statements and assumptions associated with the grassland bird BCA concept).

Little is known about the demographics of non-game grassland birds in the U. S. portion of the Northern Mixed-grass Prairie physiographic area. Habitat and landscape factors affecting nest success in an array of patch size and landscape configurations need to be evaluated in this region of the physiographic area. Results of that work should be used to modify grassland bird conservation strategies.

Grassland conservation opportunities:

The Northern Mixed-grass Prairie physiographic area overlaps the Prairie Pothole Joint Venture, and is part of the largest waterfowl production area in North America. Waterfowl biologists in the PPJV have used Geographic Information Systems (GIS) and National Wetlands Inventory data to develop maps that identify landscapes and regions of the PPJV where wetlands, and in turn waterfowl densities, are greatest. Several of these areas have been identified and are considered the areas within the PPJV where waterfowl benefits per unit of conservation investment can be maximized. Habitat in the uplands within these areas can range from large expanses of native grass to cropland. However, because duck reproductive success is partly a function of the percentage of grass cover in landscapes surrounding wetlands (Ron Reynolds, unpublished data), the most productive landscapes are those in which both wetland density and grass coverage are greatest.

Although one might assume that conservation efforts aren't needed in areas where landscapes still are largely intact, changes in global economies and the demand for various agricultural products provide incentives to increase the amount of land in cultivation in the northern prairies. It currently is far less expensive to protect rather than restore wetland/grassland complexes. Therefore, programs that protect existing intact landscapes should be given high priority for both waterfowl and non-game bird conservation. Further, some of the highest priority species in the grassland suite (Baird's Sparrow, Sprague's Pipit, Ferruginous Hawk, McCown's Longspur,Chestnut-collared Longspur) reach greater densities in the coteaus and outwash plains than in the drift-prairie, and as a result, conservation for grassland birds should get special emphasis in those areas. However, large tracts that still remain in the drift prairie should be protected as well.

Another priority for non-game grassland bird conservation should be to focus conservation efforts on restoration of grasslands where wetland complexes are relatively intact or have been restored. Areas where wetlands and grasslands both need to be restored may require large expenditures of conservation money per unit of habitat gained and should be targeted very judiciously. Although management opportunities currently are limited on most private and some public lands (PPJV Technical Committee, pers. comm.) in the physiographic area, management that maintains or improves the quality of large blocks of native prairie should be emphasized wherever possible.

Evaluation of assumptions - research and monitoring:

The following actions are needed to further conservation of grassland birds in the Northern Mixed-grass Prairie, and to help conservation efforts continue to evolve in a responsible and adaptive atmosphere:

1. Continue to monitor populations to determine whether population objectives are being met. Increase monitoring efforts for those species whose trends are unknown.

2. Evaluate different kinds of grassland habitats, patch sizes and landscapes relative to densities and demographics of grassland birds.

3. Determine the ability of grassland Bird Conservation Areas (BCAs) to support source populations of prairie grouse and other priority species of grassland birds. Determine the number of BCAs needed to stabilize or increase populations.

4. Investigate the dynamics of avian dispersal and colonization of sites in ephemeral systems such as Northern Mixed-grass Prairie grasslands.

5. Determine the influence of landscape patterns on movements and densities of brood parasites and predators of grassland birds.

8. Continue to evaluate the effects of management practices, including rotational grazing and other practices targeting range improvement, on both density and demography of grassland birds. Emphasis needs to be placed on those practices that not only improve bird habitat but maintain or improve economic conditions for landowners as well.

9. Continue to develop Geographic Information Systems to identify existing and potential grassland Bird Conservation Areas.

10. Evaluate the effects of PPJV waterfowl conservation efforts on non-game birds.

Outreach:

Outreach programs should encourage private landowners and agency biologists to implement the best management practices and to make the best use of USDA Farm Bill and other incentive programs to provide habitat for grassland birds. Outreach also should

make the public (especially private landowners) aware of the overlap of conservation efforts for waterfowl and nongame birds in the PPJV, and foster overall pride in the Region's prairie heritage. Partnerships should continue to be encouraged to accomplish cooperative conservation ventures. Conservation successes should be recognized and celebrated whenever possible. Coordination of conservation efforts with those of the Prairie Habitat Joint Venture in adjacent Canada should be pursued whenever possible.

Wetlands:

Ecology and conservation status:

Prairie pothole wetlands in the Northern Mixed-grass Prairie developed in natural non-integrated basins or kettles created during the middle advances of the Wisconsin stage glaciation from 100,000 to 10,000 years before present. The niches of bird species found in marsh habitats generally are characterized by plant life-form, vegetation zones and water depths. Weller and Spatcher (1965) recognized four general categories: 1) birds that nest in low trees or shrubs at the edge of the marsh, 2) birds that utilize edge or shallow water emergents, 3) species that prefer tall, robust emergents in standing water, and 4) species that use low mats of vegetation, often in open areas of the marsh. It is typically during the midpoint of the marsh cycle of semi-permanent wetlands, when the cover-water ratio is approximately 50:50, that these conditions occur simultaneously and bird species diversity is maximized (Weller and Spatcher 1965).

Plant species assemblages and vegetative structure of prairie ponds and lakes often is arranged in distinct, concentric bands. Zones include wetland-low-prairie, wet-meadow, shallow-marsh, deep marsh and permanent-open-water, all related to average water depth and its degree of permanence. Semi-permanent wetlands that hold water throughout the breeding season are likely to have all zones, but only the low-prairie zone may be present in ephemeral wetlands that can dry out by early May. Thus, horizontal and vertical habitat

heterogeneity typically increases with duration of standing water (Stewart and Kantrud 1971, Kantrud and Stewart 1984, Kantrud et al. 1989).

Zonation and cover-water ratios of wetlands also vary over time in response to annual variation in spring runoff, precipitation and evapotranspiration (reviewed by Kantrud et al. 1989). The general cycle is as follows: Droughts result in drawdowns that expose part or all of the marsh bottom, allowing seeds of perennial emergent and annual plants to become established. After reflooding, perennial plants spread by vegetative propagation and characteristic vegetative zones develop. Senescence in the marsh occurs primarily in response to prolonged flooding, although muskrats also can proliferate over time and largely eliminate the vegetation. When drought returns to the prairies, the cycle begins again.

Some wetlands in the Northern Mixed-grass physiographic area that previously were drained and converted to agriculture are now being restored. However, while previously drained wetlands quickly revegetate after artificial drainage is disrupted, there is marked variation in vegetative response, with low-prairie and wet-meadow zones absent at least at some recently restored sites (Delphy and Dinsmore 1993, VanRees-Siewert 1993). Vegetative response appears to be more rapid and complete at sites that were drained for less than 20 years or in basins where drainage was incomplete, perhaps due to the presence of seed banks that remain from the period prior to drainage (Hemesath and Dinsmore 1993). Wetlands restored in complexes or near naturally occurring wetlands also appear to revegetate more quickly and completely (VanRees-Siewert 1993). The effects of sedimentation on wetland vegetation have not been documented, nor have the impacts of nutrients and pesticides carried into the wetlands by those sediments, although observations suggest that sedimentation may represent a threat to wetland existence comparable to other current threats in the PPJV area (Ron Reynolds, pers. comm.). Macroinvertebrate populations and communities in restored wetlands have been found to be comparable to those of natural wetlands (VanRees-Siewert 1993).

Even though prairie wetlands historically experienced disturbance from fire and bison herbivory, little was documented with regard to the specific roles those forces played in wetland ecology. However, modern management activities such as grazing and burning are known to affect marsh structure (reviewed by Kantrud et al. 1989). Light to moderate grazing can result in greater plant species diversity or a change in dominance types, more complex distribution patterns and sharper boundaries between zones. Livestock trampling alters density and height of wetland vegetation. Overgrazing can decrease primary productivity, increase water turbidity and eliminate all vegetation in extreme cases. Burning also alters the composition of wetland vegetation, but the effects vary with fuel load, time of year and the species involved. Removal of plant litter by fire may expose the soil to erosion and reduce the trapping of snow during winter. (Snow accumulation may be the primary source of water for potholes in some years). However, Kantrud and Stewart (1984) suggest that burning or grazing, alone or in combination, enhance wetland conditions by decreasing the extent of monotypic stands of emergent vegetation and creating openings that allow insolation and greater biological productivity within shallow-water zones.

Although wetland drainage began with the advent of agriculture in the Northern Mixed-grass physiographic area, the greatest loss of wetlands occurred in the mid-1900's when Federal legislation, agricultural programs and high post-World War II commodity prices worked in concert to encourage and facilitate their conversion to cropland. The destruction of wetlands slowed in the 1980s, when Federal funding for wetland conversion was no longer available, and farmers who converted wetlands were made ineligible for Federal farm subsidy programs. Wetlands continue to be lost today, albeit at much slower rates (Johnson and Higgins 1997). Conservationists must remain aware that changes in protective legislation at both the state and Federal level, as well as changes in commodity prices and agricultural demands that could encourage the conversion of wetlands in the future, and take proactive steps toward protection of pothole and other wetland ecosystems.

Bird habitat requirements:

This section outlines the general habitat requirements of suites of wetland species of concern in the Northern Mixed-grass Prairie, and provides general management guidelines that will help maintain or establish those conditions.

Wet Meadows: Yellow Rail/Sedge Wren/Nelson's Sharp-tailed Sparrow

Very little is known about the habitat requirements of Nelson's Sharp-tailed Sparrow (Greenlaw and Rising 1994) so few specific recommendations can be made for the species. Sedge Wrens breed in wet meadows and grasslands with dense herbaceous vegetation (see grasslands section above) but have the least specific requirements of the suite. Therefore, management recommendations for this suite will be determined largely by the needs of Yellow Rails, although that species also is understudied. The following information on habitat requirements and management of Yellow Rails is taken from the Birds of North America species account by Bookhout (1995).

Breeding Yellow Rails typically inhabit sedge meadows and marshes that are largely devoid of cattails and woody vegetation. They generally prefer areas with saturated soils or water depths less than 15 cm (6 in.) Their diet is composed primarily of freshwater snails, but other aquatic invertebrates and seeds also are consumed. Nests are placed on or slightly above the ground, and concealed under a canopy of dead vegetation. Yellow Rails do not seem to exhibit fidelity to breeding sites; instead, numbers appear influenced by water depths with fewer birds present in drier years. Management of Yellow Rail habitat should focus on maintenance of wet sedge meadows and marshlands, with mowing or burning employed in dry years to prevent invasion of cattails and woody vegetation. Management of wetlands for hemi- or deep water marshes will not provide suitable habitat for Yellow Rails. Fens also may provide habitat for Yellow Rails in the Northern Mixed-grass physiographic area (Brenda Dale, pers. comm.).

Wetland/grassland complexes: Marbled Godwit/Willet/Wilson's Phalarope

Species in this suite require both grassland and wetland habitat during the breeding season (Tab. 4). The Willet and Marbled Godwit both appear to be area sensitive, and neither typically occurs where blocks of contiguous grassland are smaller than 100 ha (250 acres). Both prefer native grass, utilizing areas where there are patches of grass both of relatively short and of moderate height so that nesting and brood-rearing needs are met. Wilson's Phalarope, in addition, need patches of tall dense grass near wetlands for nest cover. Therefore, grass of a variety of heights should remain available in the landscape at any given time. Grazing, mowing and burning can be used to maintain grassland of the necessary height and structure, but treatments should not occur during the breeding season, from mid-May through July . Treatment units should be greater than 100 hectares and disturbance rotated among units and among years so that suitable habitat is available each breeding season. All of the species prefer sparse to moderate shoreline vegetation, so disturbance regimes of wetlands must be coordinated.

Table 4. General habitat requirements of priority bird species in the wetland/grassland complex suite.*

Species	Nest site vegetation	Foraging vegetation	Other
Wilson's Phalarope	Tall dense grassland vegetation within 100m (33 yds) of wetlands	Open water, flooded meadows.	High stem densities can impede movement, prefers wetlands in early stages of succession.
Marbled Godwit	Short to intermediate height grassland with < 40% dead vegetation and average cover height 17 cm (7 in.)	Forages along sparse to moderately vegetated shorelines; need wetland complex es containing a diversity of wetland classes from ephemeral to permanent.	Rarely occurs on blocks of contiguous grasslands <100 ha (250 acres); tall dense cover avoided; prefers native vegetation and avoid tilled fields.

Species	Nest site vegetation	Foraging vegetation	Other
Willet	Short, sparse grassland (<15 cm)	Forages in short, sparse grassland (<15 cm) and a range of wetland classes with short, sparse shoreline vegetation.	Prefers native vegetation; broods use taller, denser vegetation (>15 cm) in wetlands and uplands; rarely occurs on blocks of contiguous grasslands <100 ha (250 acres).

- Information on habitat requirements for species in Table 4 is from Colwell and Jehl (1994) for Wilson's Phalarope, Johnson et al. (1998) for Marbled Godwit and Willet.

Emergent wetlands without woody vegetation: Pied-billed Grebe/Horned Grebe/American Bittern/Virginia Rail/Sora/American Coot / Franklin's Gull/Black Tern

All of the species in this suite nest in or among stands of emergent vegetation of various height. Some species forage in shallow water or mudflats and others over deep water. Species such as Franklin's Gull require large lakes but others, like Sora, will utilize small wetlands (Tab 5). While no single wetland type will fill the needs of every species in this suite, conservation and restoration of wetland complexes would be the most effective way to manage for these birds.

Table 5. General habitat requirements of priority bird species in the emergent wetland suite.*

Species	Nest site vegetation	Foraging vegetation	Other
American Bittern	Tall, dense emergent vegetation; water depths 5-20 cm (2- 8 in.)	Vegetation fringes and shorelines; may avoid even-aged stands of older, dense or dry vegetation.	Nests also found in tall, dense upland cover in the Dakotas; 2-5 years of accumulated residual vegetation seemed essential (Duebbert and Lokemoen 1977)

Species	Nest site vegetation	Foraging vegetation	Other
Horned Grebe	Nest is a floating platform, often anchored in emergent vegetation.		
Pied-billed Grebe	Nest is a floating platform of decaying vegetation anchored in open water among reeds or rushes.		
Virginia Rail	Robust emergent vegetation; water depth < 30 cm (12 in.)	Mudflats and shallow water	Prefers a moderate cover:water ratio within wetland. Needs abundant macroinvertebrates.
Sora	Mix of robust and fine emergents: water depths 18-22 cm (8-9 in.)	Stands of robust emergent vegetation with shorter seed-producing emergents in understory.	Uses a wider range of water depths than Virginia Rails. Sedges are an important food item. Differences in breeding-habitat use were not discernable between Sora and Virginia Rails in an Iowa study (Johnson and Dinsmore 1986), although the two species did not always occur at the same restored Iowa wetlands studied by VanRees-Siewert (1993).
American Coot	Nest is a floating platform over water 0.3-1.3 m deep (1-4 ft.); anchored to tall, emergent vegetation.		

Species	Nest site vegetation	Foraging vegetation	Other
Franklin's Gull	Nests colonially over water on floating mats, muskrat houses or on floating debris. Prefers to nest in areas of low vegetation density or at edges of dense clumps.	Forages in on water for aquatic organisms, in wet pastures for worms and arthropods, and aerially on swarming insects.	Needs large prairie marshes for nesting; breeding range can expand and contract depending on water conditions. Water must remain deep enough to prevent drying before young fledge. Sensitive to human disturbance early in breeding cycle and will entirely desert a colony with excessive exposure.
Black Tern	Nests semi-colonially amidst emergent vegetation; many nests afloat. Predation appears to be greater if water levels drop below 30 cm (12 in.)	Forages primarily over water	

- The following Birds of North America accounts are the reference documents for the species in this suite unless otherwise noted. American Bittern: Gibbs et al. (1992); Virginia Rail: Conway (1995); Sora: Melvin and Gibbs (1996); Franklin's Gull: Burger and Gochfield (1994); Black Tern: Dunn and Agro (1995); Information on Horned grebe, Pied-billed Grebe and American Coot is from Ehrlich et al. 1988.;

Emergent wetlands with woody vegetation: Marsh Wren/Willow Flycatcher

All of the species in this suite are abundant in the Northern Mixed-grass Prairie Physiographic area. Although Red-winged Blackbirds have declined significantly over the last 30 years (-1.5% per year) it still occurs in tremendous numbers. Marsh Wrens, which are much more strictly associated with habitat conditions needed by this suite, have increased at roughly 10% per year. Therefore, habitat conditions appear secure for the suite at this time. Microhabitat requirements of the suite are given in Table 6.

Table 6. General habitat requirements of priority bird species in the emergent wetlands with cattails and woody vegetation suite.*

Species	Nest site vegetation	Foraging vegetation	Other
Willow Flycatcher	In shrubs or trees .7-3.5 m (2-10 ft.) above ground.		
Marsh Wren	Use diverse vegetation to support their nests. Nest height 75-95 cm (30-37 in.) or higher.	Forages near or at surface of water, among cattail (*Typha spp.*) stalks	

- The following Birds of North America accounts are the reference documents for the species in this suite unless otherwise noted. Marsh Wren: Kroodsma and Verner, 1997; Willow Flycatcher information from Ehrlich et al. 1988.

Wetland bird-habitat models and minimum area requirements:

Naugle (1997) generated habitat models and evaluated minimum area requirements (MARs) for wetland birds species in the Prairie Pothole region of eastern South Dakota. MARs were only derived from data on wetlands with intermediate cover-to-water ratios that correspond to the hemi-marsh phase of Weller and Spatcher (1965), and are based upon the size at which there was a 50% probability of the species' occurrence. Significant habitat variables and MARs associated with Northern Mixed-grass Prairie priority species are given in Table 7. Large MARs could not be assigned to species using seasonal wetlands, as none sampled were greater than 15 ha (38 acres).

Table 7: Habitat model variables and minimum area requirements (MARs) associated with PIF wetland priority species in the Northern Tallgrass physiographic area.

Species	Semipermanent wetland variables	Seasonal wetland variables	MARs sp = semiperm ss = seasonal
Black Tern	AREA, SEMIA, GRASS		sp: 5- 14.9 ha ss: few occurrences

Species	Semipermanent wetland variables	Seasonal wetland variables	MARs sp = semiperm ss = seasonal
American Bittern	COVER, AREA		sp: > 15 ha ss: few occurrences
Wilson's Phalarope	AREA, STEM(-), VEGNUM, GRASS	AREA, STEM (-)	sp: > 15 ha ss: no area requirement
Marsh Wren	COVER, AREA, STEM	STEM, COVER, SHORGRAZ (-), AREA, LANDUSE	sp: 5-14.9 ha ss: 5-14.9 ha
Pied-billed Grebe	AREA	AREA	sp: 5-14.9 ha ss: 5-14.9 ha
Sora	COVER, SHORGRAZ (-), AREA, SEMIA(-), VEGNUM		sp: no area requirement ss: no area requirement
Virginia Rail	COVER, AREA, STEM		sp: > 15ha ss: no area requirement
American Coot	AREA , STEM	AREA, SEASA	sp: 0.2-4.9 ha ss: 5-14.9 ha

Definition of variables:

AREA: natural log of the wetland area (ha)

SEMIA: natural log of total semipermanent wetland area within 25.9 km^2 (10 mi^2) cells

GRASS: proportion of untilled upland habitat within 25.9 km^2 (10 mi^2) cells

COVER: percent of vegetated wetland area

STEM: indicates whether herbaceous hydrophytes were thick-or-thin stemmed (eg. cattails, *Typha spp.*, present)

VEGNUM: number of emergent hydrophyte species composing $\geq$ 10% of the vegetated wetland area

SHORGRAZ: index to grazing intensity on shorelines adjacent to wetlands

LANDUSE: indicates whether land adjacent to wetland was tilled or untilled

Factors such as proximity to other types of wetlands, cover type, presence of trees and indices to grazing were included in the model, but were not significant.

With the exception of Wilson's Phalarope and Black Tern, the presence of dense stands of emergent vegetation was positively associated with the presence of the species suite. Neither Black Terns nor phalaropes forage in emergents, although the tern will place nests within it. The probability of occurrence of all the species except the phalarope increased with wetland area, the significance of which is discussed further in habitat objectives section. Wilson's Phalarope also was the only species negatively associated with thick-stemmed vegetation such as cattails around wetland perimeters; Virginia Rails and Marsh Wrens both seem to favor sites with such. Although there is some variation in microhabitat needs of these species, Naugle (1997) found a significant positive relationship between wetland area and the probability of detecting multiple area-dependent species within both seasonal and semipermanent wetlands and that species diversity was greater where wetland complexes were available.

Population objectives and habitat strategies:

None of the priority wetland species have exhibited significant population declines in the Northern Mixed-grass physiographic area during the 30-year period of the Breeding Bird Survey (Tab. 1; Sauer et al. 1997). Willet appears to have declined, but the trend is not significant. Nelson's Sharp-tailed Sparrow, Marsh Wren and Sora have shown significant increases in population trend, while Marbled Godwit's, Franklin's Gulls, Black Tern and Pied-billed Grebe appear stable. Trends of the other six species of wetland birds remain unknown, although only the phalarope and bittern appear to be decreasing slightly. However, increased monitoring using techniques more suited to wetland birds may be needed in the Northern Mixed-grass if population trends of those species are to be tracked over time.

The population objective for the priority wetland species in this plan is to stabilize or increase trends. In order to stabilize or increase trends, adequate habitat that currently meets minimum area requirements and microhabitat needs of breeding individuals and

young of the year needs to be secured. Preservation and restoration of larger wetlands and wetland complexes should be emphasized (Kantrud and Stewart 1984, Brown and Dinsmore 1986, Naugle 1997). Further, the amount of grassland in wetland landscapes should be maximized for breeding Wilson's Phalaropes, Willets, and Marbled Godwits. A minimum of 100 ha of relatively short native grasslands should be kept available around wetland complexes for Marbled Godwits, meaning over 400 ha of grassland are needed where disturbance is planned, for example, at 4-year intervals.

Nest predation is thought to be the factor most limiting recruitment of wetland birds. A wide array of predators pose potential threats, including gulls, snakes, striped skunks, ground squirrels, raccoons, etc. While some work has focused on habitat use by raccoons, fox, etc., and the impacts of those predators upon duck populations (e.g. Frizell 1978, Johnson et al. 1989, Sargeant et al. 1990), research to understand relationships among landscapes, predator populations and predation rates of both game and non-game wetland birds is needed. Once factors affecting the reproductive success of wetland birds are better determined, recommendations will be made regarding the integration of such knowledge into this conservation plan. Other research needs are identified later in this document.

Wetland conservation opportunities:

Consideration of wetland complexes that include relatively large seasonal and semi-permanent wetlands should overlap wherever possible with ongoing conservation efforts to provide adequate breeding habitat for waterfowl in the Northern Mixed-grass Prairie. Although dabbling ducks are known to use smaller wetlands, ducks also need larger semipermanent wetlands to move to with broods when seasonal ponds dry. More research is needed to determine more specific areas of overlap between management for waterfowl and nongame wetland birds. All indications are that conservation efforts that improve landscapes to increase waterfowl recruitment and survival are beneficial to most,

if not all, high priority nongame wetland bird species. The current health of these populations largely is due to a combination of three factors: retention of a significant wetland base, recent precipitation patterns that brought rains to the northern prairies and the increase in secure nesting cover as a result of PPJV activities and the USDA Conservation Reserve Program.

The numbers and dispersion of wetland complexes needed to sustain populations of priority nongame wetland birds has not been calculated, but estimates should be based upon results of the kind of research described below. Geographic information systems and National Wetland Inventory technology also would be useful in developing such estimates, as well as identifying the locations of potential sites for conservation. Partnerships will become ever more important as resources are gathered to accomplish cooperative projects.

Evaluation of assumptions - research, monitoring and outreach:

The following actions are needed to further conservation of wetland bird species of concern in the Northern Mixed-grass Prairie physiographic area, and to help conservation efforts continue to evolve in a responsible and adaptive atmosphere:

1. Determine how landscape characteristics affect recruitment rates of priority species.

2. Evaluate the effects of other conservation management practices (eg. waterfowl management) on non-game wetland species.

3. Develop monitoring techniques that will adequately assess changes in relative abundance and population trends of wetland bird species of concern.

Outreach:

Make those in the Northern Mixed-grass Prairie physiographic area aware that there are species of birds that occur in the region in greater numbers than anywhere else in the world. People should be aware that most wetland species appear to be doing well in portions of the mixed-grass region and that the current level of land use appears to be sustainable. Changes in land use, especially those that fragment grassland/wetland landscapes, should be carefully examined for their potential effect on bird populations, and discussed among stakeholders. Outreach also should include making the public (especially private landowners in the area) aware of the overlap of conservation efforts for waterfowl and non-game birds in the PPJV, and foster overall pride in the region's prairie heritage.

Riparian Habitats:

Ecology and conservation status:

The ecology of riparian systems of the Northern Mixed-grass physiographic area has received relatively little treatment to date. Several authors, however, suggest that trees and other woody vegetation grew in riparian areas of the Northern Great Plains, especially along larger rivers, or in other areas where ground water was sufficient and topography afforded protection from fire (Wells 1965, 1970; Axelrod 1985; Higgins 1986; Rumble et al. 1998). There is evidence that each of the priority species, with the exception of Bell's Vireo, was present in native riparian woodlands in South Dakota prior to widespread settlement by Europeans and that riparian corridors also served as migration habitat (Rumble et al. 1998).

Bird habitat requirements:

The following species are Partners in Flight priorities for riparian areas in the Northern Mixed-grass physiographic area: Bell's Vireo, Black-billed Cuckoo, Red-headed

Woodpecker and Warbling Vireo. Habitat requirements for these species are given in Table 8.

Table 8. Habitat requirements of priority riparian bird species in the Northern Mixed-grass physiographic area.

Species	Nest type	General Habitat Requirements*	Diet
Black-billed Cuckoo	Small platform in tree or shrub 0.7-2 m (2-6 ft.).	Open woodland and shrub habitat.	Especially caterpillars, but also molluscs, fish, small vertebrates, eggs, fruits and berries.
Red-headed Woodpecker	Primary or secondary cavity, usually in barkless dead tree or dead stub of live tree.	Open woodlands.	Mostly insects, but some vertebrates, seeds and fruits.
Bell's Vireo	Cup nest in shrub.	Riparian thickets, hedgerows.	Insects, some fruit.
Warbling Vireo	Cup nest in tree or shrub.	Riparian forests and thickets.	Mostly insects, little fruit.

* All habitat information from Ehrlich et al. (1988)

Population objectives and habitat strategies:

Population trends of each of the species in this suite are stable or increasing, with the exception of the somewhat peripheral Bell's Vireo, whose trend is unknown. It is possible that shelterbelt and other tree plantings are providing adequate habitat for the birds in this suite and that no conservation measures are needed at this point. However, tree regeneration in naturally-occurring riparian woolands may be impaired due to changes in flooding regimes. The paucity of literature on riparian ecosystems in the Northern Mixed-grass suggests that both their plant and avian communities warrant further study.

Riparian habitat conservation opportunities:

Several priority bird species use trees or shrubs in riparian areas as nest substrates. Incentive programs that encourage landowners to keep cattle from over-grazing riparian areas or to replant native vegetation in areas where it occurred historically should be encouraged.

Evaluation of assumptions - research, monitoring and outreach:

With so little information available about riparian systems in the Northern Mixed-grass Prairie and how they functioned historically, some measure of past conditions is sorely needed. Original land surveys may be the best existing source of such information, and should be used to provide a better understanding of the historical conditions associated with these systems.

Outreach:

Outreach plans for this habitat cannot be developed until we have a more adequate understanding of the ecosystem and the role that our priority species may have played.

The Missouri River:

Historically, the upper Missouri River meandered widely across its floodplain. Associated patterns of sediment removal and deposition were integral to the normal function of the river, and affected the spatial and temporal distribution of floodplain habitats such as emergent and shrub-scrub wetlands and riparian forests (U.S. Army Corps of Engineers 1994, Johnson 1992). These kinds of habitats still exist today in both North and South Dakota in the deltas and riverine reaches of river created by the mainstem dams. However, the riverine sandbar habitat that was maintained by dynamics of water depth, velocity and sediment transport (U.S. Army Corps of Engineers 1993) has been negatively affected by flood control strategies and management of the river for navigation. As a result,

species such as Least Tern and Piping Plover that depend upon sandbars for nesting habitat have suffered such precipitous population declines that both species currently are on the Federal Endangered Species list (Smith 1996). The existing floodplain and riparian forest is probably adequate to support nesting and wintering Bald Eagles, whose population declines resulted more from pesticide contamination than habitat loss. Since all the priority species in this suite are Federally listed and are subjects of active recovery efforts in place in the region, we will defer to the U. S. Fish and Wildlife Service recovery plans for recommendations about habitat requirements, population objectives and habitat strategies.

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Appendix 1: The Partners in Flight Prioritization Scheme and criteria for the development of priority species lists.

The Partners in Flight Species Prioritization Scheme was first developed in 1991, and has been continually reviewed and refined in the years following its inception (Carter et al., in press). The system ranks each species of North American breeding bird based upon seven measures of conservation "vulnerability". These factors include; 1) relative abundance (interspecific); 2) size of breeding range; 3) size of non-breeding range; 4) threats to the species in breeding areas; 5) threats to the species in non-breeding areas; 6) population trend; and 7) relative density (intraspecific) in a given planning unit compared to the maximum reached within its range. Each species is given a score of 1-5 in each category, with 1 indicating the least amount of vulnerability with regard to that parameter and 5 the most. Scores in each category are then summed to produce a composite score potentially ranging from 7-35. Species with relatively high overall scores are considered most vulnerable to extinction (although they often are not endangered at present) and need at least to be carefully monitored throughout their ranges. Scores for PIF species are posted on the internet at: http://members.aol.com/cobirdobs under "Partners in Flight prioritization process".

Perhaps one of the most influential factors that comes into play when identifying species of conservation priority is the species' population trend. Species whose populations are declining rangewide may or may not be declining in a given planning unit. It is important to

focus active management in those areas where declines should be stabilized or reversed and to identify the factors responsible for stable or increasing trends in other areas so that similar conditions can be achieved where needed. Again, a declining trend has the greatest affect on a species' total numbers where the populations are greatest, so population trend and measures of abundance often are considered together.

Another measure of a species' importance in a given planning unit is the percentage of its population that occurs there. Physiographic areas with large percentages are able to take greater conservation responsibility for that species because affecting an increase or decrease in a population trend has greater potential impacts in areas where numbers of individuals are greater. For example, many more individuals are lost by a sustained 3% per year decrease in an initial population of 10,000 than in a population of 100. The rationale for giving an Area Importance score in the PIF prioritization scheme is similar, although it is a relative density score that is independent of the size of a given planning unit while percentage of population is not. Thus, relative density could be the same in a 100,000 and 200,000 sq. kilometer planning unit, but the percentage of the population would be twice as great in the latter.

After taking into account the factors described above, a list of criteria were developed by which species in a given planning unit are identified as priority species. Species are listed only under the first criteria they meet, although they may qualify with regards to two or more. The criteria are as follows:

1. Its total score (based upon the Partners in Flight Prioritization Process) within the physiographic area is 23 or greater and it occurs in the region in manageable numbers. This is meant to highlight the species that appear most vulnerable based upon combination of the seven factors identified by the prioritization scheme.

2. Its total PIF score is 19-22, with the sum of Area Importance and Population Trend

equal to or greater than eight. Thus, species with moderate total scores and moderate relative densities in the planning unit are included only if their population trends are declining significantly. Species with high relative densities in the area are included if the population trends is unknown or declining.

3. It is a PIF "Watch List" species with an AI = 3 or greater. (Watch List species are those with the highest PIF prioritization scores based upon the species' ranks across their entire range. Some Watch List species may already have met criteria 1 or 2.)

4. The percentage of the population breeding in the planning unit is greater than 5% in planning units smaller than 200,000 sq. kilometers or 10% in areas greater than 200,000 sq. kilometers.

5. A species is federally listed as Threatened or Endangered.

6. The species is of local concern and was identified by the Nongame Technical Committee of the Prairie Potholes Joint Venture.

Partners in Flight species prioritization scores for all species in the physiographic area can be found at the Colorado Bird Observatory's homepage:
http://members.**aol.com/cobirdobs**

Appendix 2: Statements and assumptions associated with grassland Bird Conservation Areas.

The following is a list of statements, assumptions, corollaries, and addenda associated with the development of grassland Bird Conservation Areas:

1. The nature of habitat objectives for a region is determined in part by the total percentage of area covered by “natural” high quality habitat (as defined by the needs of priority bird species). Objectives for regions in which the percentage of quality habitat falls below an imprecisely defined threshold should be phrased in terms of habitat blocks. Within blocks, objectives are phrased in terms of maintenance of “healthy” populations rather than numbers of individuals. A “healthy” population is difficult to define, but includes the concepts that: 1) there is a low probability of extirpation over time, and 2) birds breeding within the block are producing enough young to replace adult attrition (population growth rate greater than or equal to 1). Populations producing at or above this level are considered “source” populations. Populations producing below replacement levels are called “sinks”. Areas with sink populations sometimes appear to have stable populations because the birds present are colonizing from other areas with source populations.

2. It is suggested that a block must equal or exceed 800 ha (2000 acres) of high quality protected grassland (in a polygon in which edge is minimized) in order to support source breeding populations of high priority bird species. In areas where conservation of Greater Prairie-Chickens is not an issue, blocks may be as small as 300 ha (750 acres), but the total amount of habitat in the blocks still must equal or exceed 800 ha (2000 acres). A “protected grassland” is one on which appropriate management is assured for a long period of time, including private land under long-term easements or land under public or private conservation organization ownership. The original recommendation for a 800 ha (2000 acres) block is based on a model developed by Wisconsin Department of Natural Resources, in which sustained populations of priority grassland birds have been related to block size. The modification of block sizes of 300 ha (750 acres) is based upon preliminary results of a test of the BCA concept in the Northern Tallgrass Prairie physiographic area and results of research in other grassland ecosystems in the Midwest. The assumption that large blocks of habitat in the Northern Mixed-grass prairie region will support source populations of non-game grassland birds is critical to all that follows, but is weakly supported and must be tested within the physiographic area.

3. Internal characteristics of identified quality blocks will vary, and no one block is presumed to be optimal for all breeding bird species. Any block should, nonetheless, consist almost entirely of quality habitat. Quality habitat can include native and/or restored prairie, old fields and non-native grasslands, appropriately grazed pasture, or properly managed CRP land (with the caveat that CRP land under short-term contracts does not enjoy the protection necessary to serve within a block designed for long-term conservation purposes). A block should contain a minimum of hostile habitat conditions (including woodlots, treed ditch and fencerows, and treed riparian habitat that provide habitat and perch sites for avian parasites and predators or early-mowed hayfields that serve as a sink for breeding grassland birds). This minimum is tentatively defined as no more than 1% of the total area of the block (this figure may be unrealistically low and should be evaluated as experience in establishing blocks is gained).

4. Internal characteristics of blocks will change over time in response to disturbance, succession, and management practices. The effects of various conditions and practices on priority birds, species suites, and their habitats must continue to be evaluated. It may be necessary to maintain a spatially shifting balance of habitat conditions over time to simultaneously and continuously provide habitat for all species of concern. Minimum necessary sizes for blocks should reflect these predicted needs.

5. Each block is embedded in a matrix that can have both positive and negative impacts on activities within the block. These impacts can include (but are not limited to): support of predators or parasites that have access to parts or all of the block; provision of additional foraging habitat for birds breeding within the block; additional breeding habitat that increases the functional size of populations within the block; habitat for birds dispersing from the block or as attractants to birds colonizing or re-colonizing the block. The distance from the edge of the block over which these impacts can originate is not defined, but can range from zero to several miles. This discussion tentatively settled on a matrix with a width of one mile (the side of one section) beyond the edge of an identified block. For a

square or near-square block of 800 ha (2000 acres), the total area of that block and its matrix would be approximately 4000 ha (10,000 acres). A block and its matrix make up a Bird Conservation Area (BCA, Figure 1).

6. Habitat in a matrix can be compatible, neutral, or hostile for bird populations within a block. Compatible habitat includes native or non-native grasslands, CRP land, pasture, old fields, and late-cut hayfields; neutral habitat includes most small-grain and some row crop agriculture; hostile habitat includes treed areas and early mowed hayfields (these designations must be more carefully considered). It is possible that the negative impacts of a matrix are more critical than the positive impacts. As a tentative step, it is recommended that a matrix include a minimum of 25% compatible habitat and a maximum of 5% hostile habitat. Of the 25% or more that is compatible, much should occur in patches of 100 hectares (250 acres) or greater (Fig. 1). The remainder should be neutral - an important point here is that it is implicit in this recommendation that many agricultural practices and a vibrant rural economy are desired features of these conservation recommendations.

7. Within a BCA, the relationship between the effective size of a block and the nature of its matrix is flexible. It is possible, for example, that a moderate increase in the size of the block can mitigate for some unavoidable hostile conditions in the surrounding matrix.

8. The nature of habitat within landscapes but outside of BCAs (blocks and their associated matrices) may be important. It is tentatively recommended that it be at least 15% compatible (as much as possible arrayed in patches exceeding 100 acres in size), no more than 10% hostile, and the remainder neutral.

9. Bird Conservation Areas should, to the extent feasible, coincide with the conservation of other natural communities and native vegetation and/or be integrated with objectives set for other bird taxa, such as waterfowl or shorebirds.

10. The distribution of BCA's should reflect concerns regarding interpopulational distances, colonization potential, gene flow, and representation of species over the extent of their ranges.

11. For those priority species that are rare, habitat specialists, and/or sparsely distributed, the total number and distribution of individuals supported under these objectives should be evaluated for sufficiency.

12. The assumptions inherent in the above objectives should be tested in both the short-term and long-term. In the short-term, a range of the above conditions, incorporating varying combinations of the assumptions regarding block size, the nature of matrices, and geographic juxtaposition among them, should be identified. These different situations should be investigated for the presence of high priority bird species and species suites, the health of populations (productivity, survivorship, etc.), and their ability to support source populations.

13. Principles of adaptive management should apply, in that all recommendations are subject to change as more and better information becomes available.

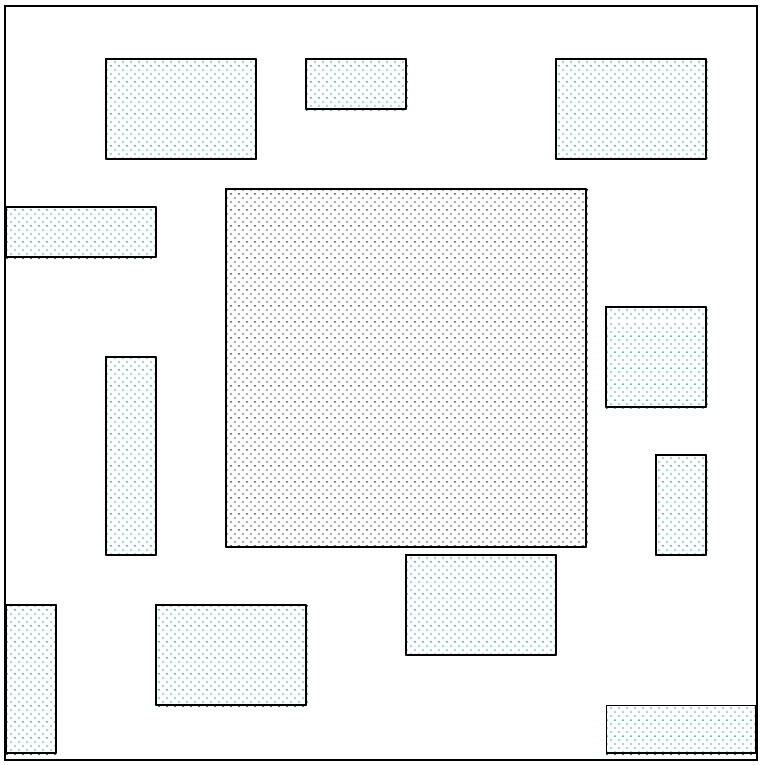

Fig. 1. The figure on the right depicts a Bird Conservation Area consisting of an 800 hectare (2,000 acre) block of permanent grassland as a core within an approximately 4,000 hectare (10,000 acre) matrix. 25% of the matrix contains compatible grassland habitat, with 51% in tracts greater than 40 hectares (100 acres).

Mapset for the Northern Mixed-grass prairie physiographic area.