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Wetlands Reserve Program
Grassland Workgroup Report

Migratory Bird Responses to Grazing

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Preface

This report by the Grassland Workgroup was developed for use by field conservationists to determine whether grazing as a compatible use with migratory birds is appropriate for a particular Wetland Reserve Program (WRP) or similar easement. It can also be used by state biologists to develop guidance for grassland types in their state.

The workgroup was established as a result of an Oversight and Evaluation study completed in 2000. The members of this workgroup are representatives from the USDA Natural Resources Conservation Service (NRCS), the U.S. Department of Interior Fish and Wildlife Service (FWS) and U.S. Geological Survey offices (USGS), Ducks Unlimited, Inc., Iowa State University, and the University of Missouri (MSU). They are listed below.

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Executive Summary

The Wetlands Reserve Program (WRP), as authorized by Congress under the Food Security Act of 1990 and amended in the 1996 and 2002 Farm Bills, is a *voluntary* program to restore and protect wetlands on private property. Special emphasis is given in WRP to the provision of habitat for migratory birds and wetland dependent wildlife, including threatened and endangered species. On acreage subject to a WRP easement, participants control access to the property and may lease the land for hunting, fishing, and other undeveloped recreational activities. At any time, the landowner may request that additional activities be evaluated to determine if they are compatible uses for the site. Only activities that further both the long-term protection and enhancement of the wetland and other natural values of the project area may be authorized as a compatible use.

An Oversight and Evaluation study conducted in 2000 found instances of grazing and timber harvest on WRP easements that appeared to be inconsistent with program goals. Consequently, a critical preliminary finding was issued that resulted in the NRCS National Office putting a hold on all grazing and timber harvesting uses of WRP easements until the states reviewed them to ensure they were compatible with the easement purpose. Under a management action plan developed by the deputy chief for programs, two workgroups were established to look at the compatibility of grazing and timber harvest of WRP easements. The Grassland Workgroup was charged with reviewing information on migratory bird responses to grazing and development of management guidelines for use by NRCS resource managers when evaluating and developing compatible uses of WRP easements involving grazing.

Whereas guidance clearly is needed regarding the compatibility of all proposed activities on WRP grasslands, the Grassland Workgroup's report was narrowly focused on the effects of grazing of WRP grasslands on migratory birds. The report consists of an executive summary, introduction, and four major elements:

- Overview on the role of disturbance in maintaining grassland systems
- Review of bird responses to grazing
- Proposed framework (decision matrix) for assessing grazing effects on migratory birds
- Comprehensive list of literature on grazing effects on wildlife

The first two elements provide important background information on the dynamic processes responsible for maintaining grassland systems and bird responses to changes in habitat associated with grazing.

Based on a review of the literature and expert opinion provided by workgroup members, tables were developed depicting the anticipated numeric responses to grazing by selected species of migratory birds for Northern Tallgrass Prairie, Northern Mixed-grass Prairie, Dissected Till Plains, West River, and Central and Southern California Coast and Valleys physiographic areas (appendix 1). Physiographic areas are vegetative communities recog-

nized by The Nature Conservancy and adopted by Partners In Flight for bird conservation planning. Selected physiographic areas are those where WRP grasslands are thought to occur. (Note that identification and ranking of physiographic areas based on the frequency of occurrence of WRP projects is not feasible because data needed to precisely map WRP sites by wetland category are not available at this time.) Responses were indicated simply as positive (+), neutral (0), or negative (–) for two treatment categories: annual and multiyear. Recognizing that periodic disturbance is necessary to maintain the viability of grassland ecosystems, the multiyear treatment category was that frequency and intensity of disturbance recommended by managers to maintain function and diversity of the indigenous vegetative community. Species included in the tables are those designated by bird conservation groups as being of greatest concern.

The focused approach adopted by the Grassland Workgroup seeks to reduce the ambiguity associated with considering all birds. The approach developed in this report builds on the planning activities undertaken by the bird conservation community and is consistent with the draft Memorandum of Understanding (MOU) (dated 4–22–02) between USDA Natural Resources Conservation Service, USDA Farm Service Agency, and U.S. Fish and Wildlife Service on Migratory Bird Conservation. The approach outlined in this report has broad application to management of grasslands for migratory birds. If the approach is adopted by program managers, then expanded species response tables could be readily generated to provide guidance to land managers regarding the effects of other activities (e.g., haying/mowing, burning, food plots) on migratory birds.

Wetlands Reserve Program

Migratory Bird Responses to Grazing

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Wetlands Reserve Program
Migratory Bird Responses to Grazing

Introduction

Wetlands Reserve Program

The Wetlands Reserve Program (WRP), as authorized by Congress under the Food Security Act of 1990 and amended in the 1996 and 2002 Farm Bills, is a *voluntary* program to restore and protect wetlands on private property. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) administers WRP in consultation with the Farm Service Agency (FSA) and other federal agencies. NRCS's goal is to restore wetland functions and values while optimizing wildlife habitat on every acre enrolled in the program. Specifically, WRP objectives are to:

- help eligible landowners protect, restore, and enhance the original hydrology, native vegetation, and natural topography of eligible lands;
- restore and protect the functions and values of wetlands in agricultural landscapes;
- help achieve the national goal of no net loss of wetlands; and
- improve the general environment of the country.

Special emphasis is given to the provision of habitat for migratory birds and wetland dependent wildlife, including threatened and endangered species. Additionally, WRP seeks to protect and improve water quality, attenuate water flows from flooding, recharge ground water, protect and enhance open space and aesthetic quality, protect native flora and fauna, contribute to the Nation's natural heritage, and contribute to educational and scientific scholarship.

Since authorization of the program in the 1990, landowner interest has resulted in enrollment of over 1 million acres in permanent easements (76%), 30-year easements (18%), and 10-year cost-share agreements (6%). An additional 500,000 acres of unfunded projects had been offered for enrollment into the program at the time of reauthorization in 2002. Current enrollments consist of former bottomland hardwood wetlands (55%), emergent wetland and open water complexes (15%), and nonwetland buffer areas (30%). Although current WRP enrollments have resulted in establishment of diverse wetland habitats, few quantitative data have been published depicting actual wildlife benefits of wetlands restored under the program. Studies on a variety of non-WRP wetland restoration projects were used by Heard et al. (2000) to make inferences on the wildlife benefits derived from wetlands restored under WRP. They concluded that the published literature on wildlife response to wetland restoration supports the premise that WRP is making a substantial contribution to the habitat needs of wetland wildlife throughout the country, particularly in areas where significant enrollments are occurring (e.g., lower Mississippi Alluvial Valley and California's Central Valley).

The 2002 Farm Bill authorized continuation of WRP by enabling the Secretary of Agriculture to enroll up to 250,000 acres into the program annually to a ceiling of 2,275,000 acres.

Compatible uses

On acreage subject to a WRP easement, participants control access to the property and may lease the land for hunting, fishing, and other undeveloped recreational activities. At any time, the landowner may request that additional activities be evaluated to determine if they are compatible uses for the site. Only activities that further the long-term protection and enhancement of the wetland and other natural values of the project area may be authorized as a compatible use. Activities for which compatible use permits were granted include (activities ordered from most frequent to least frequent occurrences) haying/mowing, food plots, water management/shallow water management, burning, grazing, disking, levees, trails, roads, crawfish harvest, timber harvest, plantings, hunting blinds, wells, weed control, firebreaks, education, seed harvest, maintenance, oil and gas, hunting and trapping, livestock access, off-road parking, fences, culverts, beaver dam removal, wood duck nest boxes, green tree reservoirs, pipeline, irrigation canal, firewood harvest, water line, draining, and barge mooring.

The Grassland Workgroup

An Oversight and Evaluation study conducted in 2000 found instances of grazing and timber harvest on

WRP easements that appeared to be inconsistent with program goals. Consequently, a critical preliminary finding was issued that resulted in the NRCS National Office putting a hold on all grazing and timber harvesting compatible uses until NRCS state offices reviewed them to ensure they were compatible with the easement purpose. Under a management action plan developed by the deputy chief for programs, two workgroups were established to look at the compatibility of grazing and timber harvest of WRP easements. The Grassland Workgroup was charged with reviewing information on migratory bird responses to grazing and development of management guidelines for use by NRCS resource managers when evaluating/developing compatible uses of WRP easements involving grazing. Whereas grazing is the most commonly applied activity in some regions, it was acknowledged that guidance regarding the compatibility of other uses also was needed.

The Grassland Workgroup included invited representatives from NRCS national headquarters and state offices (California, Iowa, and South Dakota); Grazing Lands Technology Institute (GLTI); Wetland Sciences Institute (WSI) and Wildlife Habitat Management Institute (WHMI); U.S. Department of the Interior Fish and Wildlife Service (FWS) and Geological Survey-Biological Resources Division (USGS–BRD); Iowa State University (ISU); South Dakota State University (SDSU); University of Missouri (UMO); and Ducks Unlimited (DU), a nongovernment organization. Members of the workgroup were Mike Anderson (NRCS–HQ), Jim Ayen (NRCS–IA), Lou Best (ISU), Larry Butler (NRCS–GLTI), Alan Forkey (NRCS–CA), Wendell Gilgert (NRCS–WHMI), Ken Higgins (USGS–BRD, SDSU), Bill Hohman (NRCS–WHMI), Douglas Johnson (USGS–BRD), Norman Melvin (NRCS–WSI), Roger Pederson (DU), Ron Reynolds (FWS), Mark Ryan (UMO), and Connie Vicuna (NRCS–SD). A draft report was assembled by Bill Hohman. Roger Pederson contributed the section on the role of disturbance in maintaining grassland systems. The section summarizing bird responses to grazing treatments was prepared by Mark Ryan, Bob Pierce, II, Kimberly M. Suedkamp-Wells, and Courtney K. Kerns.

Scope and organization of report

Whereas guidance clearly is needed regarding the compatibility of all proposed activities on WRP grasslands, this report is narrowly focused on the effects of grazing of WRP grasslands on migratory birds. This report consists of an executive summary, introduction, and four major elements:

- Overview on the role of disturbance in maintaining grassland systems
- Review of bird responses to grazing
- Proposed framework (decision matrix) for assessing grazing effects on migratory birds
- Complete list of literature on grazing effects on wildlife

Approach

The first two elements provide important background information on the dynamic processes responsible for maintaining grassland systems and bird responses to changes in habitat associated with grazing.

Species response tables

Based on a review of the literature and expert opinion provided by workgroup members, tables were developed depicting the anticipated numeric responses to grazing by selected species of migratory birds for Northern Tallgrass Prairie, Northern Mixed-grass Prairie, Dissected Till Plains, West River, and Central and Southern California Coast and Valleys physiographic areas (appendix 1). Physiographic areas are vegetative communities recognized by The Nature Conservancy (fig. 1) and adopted by Partners in Flight (PIF) for bird conservation planning (http://www.partnersinflight.org). Selected physiographic areas are those where WRP grasslands are thought to occur. (Note that identification and ranking of physiographic areas based on the frequency of occurrence of WRP projects are not feasible because data needed to map WRP sites by wetland category precisely are not available at this time.) Responses were indicated simply as positive (+), neutral (0), or negative (–) for two treatment categories: annual and multiyear. Recognizing that periodic disturbance is necessary to maintain the viability of grassland ecosystems, the multiyear treatment category was that frequency and intensity of disturbance recommended by managers to maintain function and diversity of the indigenous plant community. Species

included in the tables are those designated by bird conservation groups as being of greatest concern.

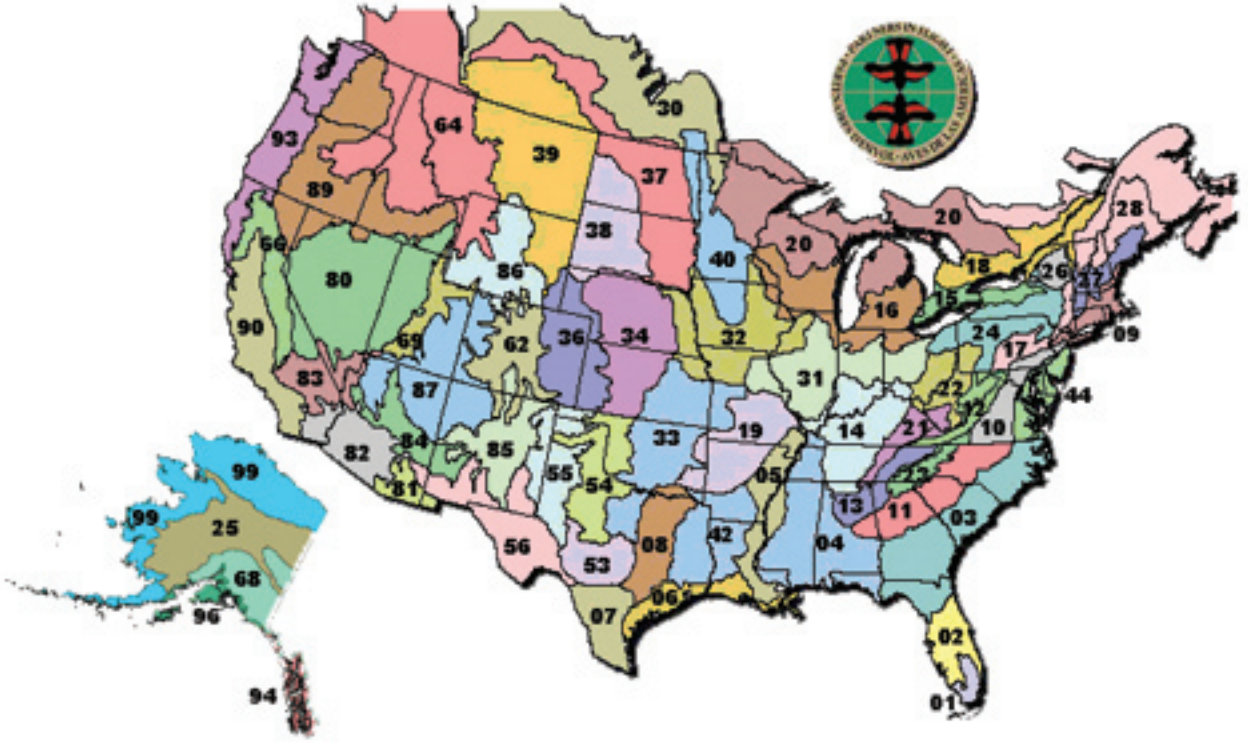
Justification for approach

Variable responses by birds to habitat manipulations contribute to confusion among planners about the net effect of management on bird conservation. For example, with respect to grazing effects on grassland birds, some species show strong preferences for grazed areas that have reduced vegetative structure, whereas others select undisturbed grasslands where vegetative structure is intact. Thus, it is apparent that consensus among conservation interests and a priority selection of target species are critical to successful planning, implementation, and evaluation of conservation activities. The focused approach adopted by the Grassland Workgroup seeks to reduce the ambiguity associated with considering all birds. The approach developed in this report builds on the planning activities undertaken by the bird conservation community and is consistent with the draft Memorandum of Understanding on Migratory Bird Conservation (MOU) (dated 4–22–02) among the USDA NRCS, FSA, and FWS. The draft MOU requires that signatories:

"Within established authorities and in conjunction with the adoption, amendment, or revision of agency management plans, programs and technical guidance, ensure that agency plans and actions promote programs and recommendations of the comprehensive planning efforts for migratory birds such as Partners in Flight Bird Conservation Plans, U.S. National Shorebird, North American Waterfowl Management Plan, North American Colonial Waterbird Plan, and the integration of these and other bird conservation planning efforts through the North American Bird Conservation Initiative."

The North American Waterfowl Management Plan is the oldest and most established bird conservation plan; however, some sites where WRP has been implemented fall outside of established joint venture areas, and species priorities are not designated in joint venture areas. Shorebird and colonial waterbird plans

Figure 1 Partners in Flight physiographic regions



are in early stages of development. Although plans have not been finalized for some physiographic areas, emphasis in this report was placed on priority species identified in PIF Bird Conservation Plans because conservation plans are available for all regions of the country and procedure used to rank species is consistent across physiographic regions (Carter et al. 2000). Additionally, focus species include many of those species closely associated with grasslands.

Generality

The approach outlined in this report has broad application to management of grasslands for migratory birds. If the approach is adopted by program managers, then expanded species response tables could be readily generated to provide guidance to land managers regarding the effects of other activities (e.g., haying/mowing, burning, food plots) on migratory birds.

Disturbance and grassland ecosystems

(This section is written by Roger L. Pederson, Ducks Unlimited, Inc., 18654 Esquire Way, Farmington, MN 55024.)

Present throughout temperate regions of the world, grassland ecosystems are the intermediate biomes among deserts, savannas, and woodlands. Grasslands transition toward deserts in the drier regions of the globe near the equator, whereas in higher rainfall areas (>110 cm/yr) grasslands intergrade into temperate deciduous forest. If intact, grasslands can support huge assemblages of grazing animals and associated large predator communities. Through human intervention, grasslands have also been changed to:

- monodominant cropland,
- pastures for domestic livestock,
- forests (when ecological schedules of intermittent grazing and fire have been altered), or
- deserts, where through overgrazing or excessive tillage, sensitive ecological balances required to maintain grass systems were disrupted (e.g., Dust Bowl of the Central United States in the 1930s or current global desertification, Schlesinger et al. 1990).

Before European settlement of North America, grasslands occurred over large areas of the interior part of the continent. There existed an east-west transition of rich tallgrass prairies (warm-season, sod-forming grasses) in the moister Midwest to the more desert-like shortgrass prairies (bunch grasses) that developed in the rain shadow of the Rocky Mountains in the western Great Plains. Grasslands became more arid as distances from the Gulf of Mexico and Atlantic Ocean (major sources of moisture for the eastern half of the continent) increased and dominant grass species changed accordingly. Although perennial grasses formed the dominant vegetation over much of the Great Plains, many perennial forbs (broad-leafed herbaceous plants) were common as well. Periodic droughts, as well as fire tended to keep woody plants and trees from invading these areas. Vast herds of buffalo, elk, antelope, and deer; large numbers of prairie dogs; and a host of other vertebrate and invertebrate grazers influenced prairie vegetation.

As characterized by Saab et al. (1995), major forces creating and maintaining North American plains grasslands, besides climate, were fire and grazing (particularly grazing by bison and prairie dogs), although these disturbance forces were not equal in all plains grasslands. They contend that fire was the major force preventing tree and shrub encroachment in the tallgrass prairie and parklands. Farther west, short-statured bunch grasses, such as blue grama and buffalograss, became dominant because of their equal tolerance to drought and grazing. In the desert and semidesert grasslands of the Southwest, fire and lack of grazing were thought to be the major factors preventing those areas from turning into desert shrublands.

As with many ecosystems, disturbance (grazing, fire, wet cycles, floods, drought) is an important component in vegetation dynamics, community structure, and primary productivity of grassland biomes. Many plant species depend on, and are adapted to, disturbance, particularly for reproduction or regeneration. From a vegetation community point of view, disturbance promotes species diversity by reducing coverage of the dominant vegetation and providing varied "safe sites" for propagule regeneration by many species of plants (Harper 1977). Reduction of dominant vegetation in productive habitat almost always increases the abundance of rare and infrequent species, which typically compose 60 to 90 percent of all species in ecological communities (Howe 1999). Although disturbance for the sake of species diversity is generally a good thing, many exotic species (cheatgrass, brome grass, Kentucky bluegrass, leafy spurge) have also spread prolifically in native grasslands and serve as examples of deleterious effects of disturbance.

With respect to herbivory, productivity of many prairie species increases after a grazing episode where remaining leaves of a plant are stimulated to function with a greater photosynthetic efficiency after partial defoliation (Harper 1977). However, effects of severe defoliation can affect the very survival of the plant. Under heavy grazing pressure, grasses draw upon reserves used for root development to favor shoot and leaf growth, and a dramatic reduction in root growth occurs (Harper 1977). Seed production also is curtailed if the plant is subjected to heavy grazing. Grazing when a plant species is actively growing (e.g., spring grazing on cool-season grasses) can be expected to harm plants more than if grazing occurs when the plant is senescing (fall grazing). In relation to forbs and woody species, grazing by herbivores that includes buds, as well as leaves is most likely to be especially damaging to the plant. Many browsing animals, such as elk and deer, as well as sheep and horses, are choosy eaters and take young shoots and buds of forbs, shrubs, and trees. The most damaging herbivore for the life of a tree is one that takes cambial tissue and destroys the transport link between the root and shoot system. Porcupines, rabbits, gray squirrels, and the domestic goat are all known to be capable of feeding in this manner (Harper 1977).

Some animals, such as cattle, are more generalist feeders as their method of feeding is to roll their tongue around a tuft of vegetation and pull the entire herbage up. Sheep, on the other hand, have a precise small bite and are capable of extreme precision. Whether coarse or precise eaters, herbivores can be surprisingly selective as to which plants they eat, and in general, prefer to feed on the most succulent young plant growth. Seasonal changes and species-specific differences in the availability of this type of growth cause grazers to wander in the course of feeding. This pattern of feeding causes grazed areas to develop a patchy configuration. If a plant is not eaten, it may pass from palatable to unpalatable in its phenology and be ignored if the animal returns to it. Such a plant will then be at an advantage over its grazed neighbors and develop into a vigorous tussock or individual. This patchy grazing habit of animals leads to heterogeneities in the pasture with heavily grazed areas interspersed among lightly grazed tussocks and dense areas not grazed at all (Harper 1977).

In addition to defoliation, grazing animals impact vegetation when they lie, paw, walk on, urinate, and deposit dung on vegetation. The localized effect of each of these activities is to produce a mosaic of vegetation. Illustrating trampling as one example, a cow walks 2 to 3 miles a day and sheep 3 to 8 miles (Hafez and Schein 1962). Hoof pressures are surprisingly great and when animals are concentrated, the effects are extremely damaging to plants and soil structure. Thus, activities of even a single grazing animal disrupt any trend to homogeneity in vegetation (Harper 1977).

With the introduction of millions of domestic cattle, horses, and sheep, grazing has greatly increased as an influence on the remaining North American grass-

lands not already converted to cropland. The degree to which domestic animal grazing interacts with fire and rainfall, both before and after these abiotic episodes, probably has equal, if not greater, significance than the effects of grazing alone. In desert and semiarid grasslands of North America, grazing (in combination with droughts) has degraded many grasslands into permanent desert shrub lands (Schlensinger et al. 1990). Riparian zones are particularly affected (Minshall et al. 1989). In shortgrass prairies on the central plains, introduction of millions of domestic ungulates has shifted dominance among grass species, increased the land-scape's susceptibility to drought, and allowed many non-native plant species to flourish. Increased grazing pressure and decreased fire frequency in the midgrass zones have led to increased establishment of woody vegetation, cool-season exotic grasses, and annual weeds (Bock et al. 1993). In the tallgrass prairie zone, nearly complete conversion of these rich prairie habitats to cultivation has left only small, isolated remnants of prairie that predominantly exist in an ecological state of fire suppression and unabated invasion by woody species.

Other negative effects of livestock grazing include aesthetic issues, such as extensive fencing, and concentrations of dung and insects (Kirby et al. 1992). Grazing reduces fire occurrence, increases numbers of brown-headed cowbirds, and impacts the soil structure through compaction and resultant erosion (Kirby et al. 1992). Impacts from grazing generally are more pronounced along watercourses, around wetlands, and in areas where cattle tend to congregate (Bue et al. 1952). Rumble (1979) found excessive grazing of wetland shoreline vegetation increased water turbidity and reduced biological productivity. Vegetation species composition of the stand is changed as grazing animals selectively reduce the occurrence of more palatable plant species, and increase grazing-adapted sod grasses, forbs, and shrub cover. The greater and more prolonged the grazing intensity, the greater the domination by woody, unpalatable, and spiny species (Ellison 1960).

Many authors suggest that the buildup and amount of plant litter on a particular site should determine whether a management action to rejuvenate stand vigor is warranted. Naugle et al. (2000) proposed a generalized management regime where vegetation manipulation occurs when plant litter exceeds 10 centimeters. Gilbert et al. (1996) recommended grazing only when residual cover was so thick as to prevent any new growth although Kirsch et al. (1978) observed there was no evidence for grass stands that were “too tall or too dense” for use by upland nesting ducks. Management activities to rejuvenate stands should be avoided in years of extreme conditions, such as droughts or wetter-than-normal periods, or when vegetation has been excessively harvested by rodents or insects or matted by snow pack. Many of these extreme conditions, in effect, act as a management action that improves the vegetative condition of the stand (Kirsch et al. 1978).

If vegetation management is warranted, the productivity and condition of the stand should dictate the management interval. Grazing pressure that could easily be sustained in the tall grass prairie zone would devastate grasslands in the short grass prairie. Although many authors caution that management intervals should not be “cook booked,” commonly recommended intervals between vegetation management are every 1 to 5 years for tall grass prairie, 3 to 10 years for mixed grass prairie, and more than 3 to 10 years for short grass prairie. During droughts, the interval between management actions should be lengthened. In more xeric areas (e.g., short grass prairie) management activity to rejuvenate stands may not be warranted as recovery periods from events, such as severe grazing, might well exceed 10 years (Naugle et al. 2000). During wet periods in the northern Great Plains, scheduled vegetation management is often unnecessary as vegetation stands naturally improve because of the more favorable growing conditions. If the need for vegetation management is in doubt, managers are encouraged to under manage (Naugle et al. 2000).

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Assessing bird population responses to grazing

(This section was written by Mark R. Ryan; Robert A. Pierce, II; Kimberly M. Suedkamp-Wells; and Courtney K. Kerns, Department of Fisheries and Wildlife Sciences, University of Missouri, Columbia, Missouri.)

Introduction

In his classic *Game Management*, Aldo Leopold (1933:321) wrote:

> *Sweeping statements are often made as to the detrimental effects of fire, grazing (emphasis added)…. Such statements cannot possibly be true. It is self-evident that the effect varies with the kind of game, the composition and interspersion of food and cover, and the intensity, frequency, size, and season of these influences. The game manager should be aware of rules of thumb.*

After nearly 70 years, his comments are still highly applicable. Only recently, Fleischner (1994) and Noss (1994) wrote sweeping condemnations of grazing and its detrimental effects on biodiversity. More temperate responses by Brussard et al. (1994) and Brown and McDonald (1995) helped bring the topic into perspective, but grazing remains a polarizing issue. The impacts of grazing on birds or other wildlife are further confused by the inconclusive, often contradictory, evidence that has accumulated.

To one of the most commonly asked questions "Is grazing bad (or good) for wildlife?"—the answer must be that *it depends.* What it depends on is the subject of this review. Our purpose here is to identify those factors that potentially influence how grazing affects bird habitat use and demographics. We also suggest some rules of thumb that land managers might find useful in determining whether, and how much, grazing of WRP grasslands is appropriate. As such, our brief synopsis of the impacts of grazing on birds will be most useful for land managers without substantial experience with the issue.

We make no attempt at a comprehensive review of the large, and often contradictory, literature on grazing and birds. Such a review, although much needed, is beyond the scope of this paper. The following sources offer useful, if limited, reviews of grazing effects on birds: Ryder (1980), Kantrud and Kologiski (1982), Skinner et al. (1984), Bock et al. (1993), Kie et al. (1994), Herkert et al. (1996), Koford and Best (1996), Lamey and Devries (1997), Sample and Mossman (1997), Dechant et al. (1999 a-m, 2000, 2001) and series of species-specific reports available through Northern Prairie Wildlife Research Center (www.npwrc.usgs.gov/resource/literatr/grasbird/grasbird.htm)

Bird responses

At the outset, recognizing that grazing effects, within, as well as among studies, vary depending on the response variable measured is important. Grazing effects are most commonly reported on species richness, abundance of individual species, nest density, and nesting success (variably measured as nest hatching success or fledging success). Grazing patterns that negatively affect species richness may have positive effects on the reproductive success of individual species. Land managers need to determine which objectives (e.g., regional biodiversity, high reproductive success of individual species) they wish to meet.

Any decisionmaking regarding the appropriateness of grazing must begin with a clear set of objectives for the wildlife community under consideration (e.g., maximize diversity or species-specific abundance, minimize species-specific nest loss). It is intuitive that different species respond positively or negatively to the same grazing-related disturbance (Saab et al. 1995). Land managers need to consider the life history and habitat requirements of focal species. Focal species (PIF species of concern) and goals for those species (presence, high levels of recruitment) must be clearly identified at the outset. Once the management objectives are determined, the resource conditions necessary to meet them can be identified. In the case of habitat conditions, once basic food and cover requirements are known, appropriate plant species composition or vegetative structure conditions can be identified. Table 1 shows broadly defined conditions for selected grassland species. At this point, wildlife managers need to assess the probable interactions

among grazing elements and modifying factors to predict whether desired wildlife outcomes will be achieved. The difficulty for managers is that a grazing regime that may be acceptable for an individual species in one environmental context may be unacceptable in another (Saab et al. 1995).

Table 1 Grazing tolerances and preferred vegetative characteristics of selected grassland birds [a]

Species	Partners in Flight physiographic areas [b]	Preferred vegetative characteristics [c]	Grazing tolerance [d]	References
Highly grazing tolerant/dependent				
Ferruginous hawk	34, 36–39	S (f), MED (n);	H–M	Kantrud and Kologiski 1982, Dechant et al. 1999
Mountain plover	34, 36, 38–39	very S;	H–M	Wallis and Werschler 1981, Johnson et al. 1998.
Killdeer	16–40	S;	H	Skinner et al. 1984
Willet	37–39	S–MED; SP;	H–M	Ryan and Renken 1987, Dechant et al. 1999
Marbled godwit	37–39	S–MED; SP;	H–M	Ryan et al. 1984, Johnson et al. 1998
Mourning dove	16–40	S;	H–M	George et al. 1979, Kantrud and Kologiski 1982
Burrowing owl	36–39	S; SP;	H	McCracken et al. 1985, Dechant et al. 1999,
Common nighthawk	16–40	S; SP (n);	H	Kantrud and Kologiski 1982, Kantrud and Higgins 1992
Horned lark	16–40	S; SP;	H	Kantrud 1981, Kantrud and Kologiski 1982
Vesper sparrow	16, 20, 30–40	S; SP;	H–M	Temple et al. 1999, Dechant et al. 2000
Lark sparrow	16, 30–40	S; SP;	M–H	Bock and Webb 1984, Dechant et al. 2001
Lark bunting	36–39	S; ;SHRUB	M–H	Kantrud and Kologiski 1982, Dechant et al. 1999
Chestnut-collared longspur	36–39	S;	H–L	Kantrud and Kologiski 1982, Johnson et al. 1998

Table 1 Grazing tolerances and preferred vegetative characteristics of selected grassland birds[a]—Continued

Species	Partners in Flight physiographic areas [b]	Preferred vegetative characteristics [c]	Grazing tolerance [d]	References
Highly grazing tolerant/dependent (continued)				
McCown's longspur	37–39	S;	H	Kantrud and Kologiski 1982, Dechant et al. 1999
Brown-headed cowbird	16–40	S (f) w/ livestock;	H–M	Morris and Thompson 1998, Goguen and Mathews 1999
Moderately grazing tolerant				
Northern pintail	30–39	MED–T; D;	N–L	Austin and Miller 1995
Northern harrier	16, 20, 30–40	S–MED (f), T (n);	L–mod; N	MacWhirter and Bildstein 1996 Johnson et al. 1998
Sage grouse	38–39	MED; open SHRUB	L	Braun et al. 1977, Beck and Mitchell 2000
Greater prairie-chicken	20, 30–38, 40	S–MED–T;	N–L–M	Kirsch 1974, McKee et al. 1998
Northern bobwhite	31–36, 40	MED;	L	Wilkins and Swank 1992, Spears et al. 1993
Upland sandpiper	16, 20, 30–40	MED;	L–M–H	Dechant et al. 1999, Houston and Bowen 2001
Long-billed curlew	34–39	S;	L–M	Bicak et al. 1982, Dechant et al. 1999
Loggerhead shrike	20, 32–40	S–MED (f);	L–M	Smith and Kruse 1992, Johnson et al. 1998
Sprague's pipit	37–39	MED–T;	L–M–H	Kantrud and Kologiski 1982, Johnson et al. 1999
Brewer's sparrow	34–39	MED; SHRUB	L	Kantrud and Kologiski 1982,
Savannah sparrow	16, 20, 30–40	MED	N–L	Kantrud 1981, Swanson 1998
Grasshopper sparrow	16, 20, 30–40	S–MED;	M	Saab et al. 1995, Dechant et al. 1998
Bobolink	16, 20, 30–40	MED–T; D;	L–M	Bollinger and Gavin 1992, Dechant et al. 1999
Western meadowlark	20, 30–40	MED;	L–M	Kantrud and Kologiski 1982, Dechant et al. 1999
Eastern meadowlark	16, 20, 30–40	MED;	L–M	Skinner et al. 1984, Baker and Guthery 1990
Brewer's blackbird	16, 20, 30–40	MED; SHRUB	M–H	Kantrud and Kologiski 1982
Dickcissel	16, 30–40	MED–T; D;	N–L	Zimmerman 1997, Dechant et al. 1999

Table 1 Grazing tolerances and preferred vegetative characteristics of selected grassland birds[a]—Continued

Species	Partners in Flight physiographic areas [b]	Preferred vegetative characteristics [c]	Grazing tolerance [d]	References
Moderately highly grazing intolerant				
American bittern	16, 20, 30–40	MED–T; D (n);	N	Duebbert and Lokemoen 1977, Dechant et al. 1999
Mallard	16, 20, 30–40	MED–T;D;	N–L	Kirsch 1969, Kruse and Bowen 1996
Gadwall	16, 20, 30–40	MED–T; D;	N–L	Kruse and Bowen 1996
Blue-winged teal	16, 20, 30–40	MED; D	N–L–M	Bennett 1937, Glover 1956
Sharp-tailed grouse	20, 30–40	MED (n), S (c);	N–L	Kirsch et al. 1978, Giessen and Connelly 1993
Yellow rail	16, 20, 30, 37, 40	MED; D;	N	Eddleman et al. 1988, Bookhout 1995
Wilson's phalarope	16, 20, 30, 32, 34–40	S–MED; D;	N–L	Dechant et al. 1999, Renken and Dinsmore 1987
Short-eared owl	16, 20, 30–40	MED–T; D;	N–L	Kantrud and Higgins 1992, Johnson et al.1998
Sedge wren	16, 20, 30, 32, 37, 40	T; D;	N	Belanger and Picard 1999, Herkert et al. 2001
Common yellowthroat	16, 20, 30–40	T; D;	N	Stewart 1953, Guzy and Ritchison 1999
Clay-colored sparrow	20, 30, 37–40	MED; SHRUB;	N–L	Owens and Myres 1973, Johnson et al. 1998
Baird's sparrow	30, 37–39	MED–T; D;	N–L	Sutter et al. 1995, Johnson et al. 1998
Henslow's sparrow	16, 31–33, 40	T; D;	N	Skinner et al. 1984, Herkert 1998
Le Conte's sparrow	16, 20, 30, 33, 37, 40	T; D;	N–L	Murray 1969, Dechant et al. 1999
Nelson's sharp-tailed sparrow	30, 37, 39, 40	T; D; WET	N	Greenlaw and Rising 1994, Dechant 1999
Swamp sparrow	16, 20, 30–40	T; D;		Mowbray 1997

a See Dechant et al. (1999 a-m, 2000, 2001) for a more indepth review of grazing tolerances.
b Partners In Flight physiographic region numbers in which the species occurs.
c Vegetative characteristics (stature; density; other) preferred by feeding (f), nesting (n), or courting (c) birds.
Vegetative stature: S=short, MED=medium, and T=tall. Density: SP=sparse or D=dense.
Terrestrial herbaceous vegetation (i.e., grass, grass-sedge, or grass-forb) unless otherwise noted as SHRUB=shrubby or WET=wetland.
d Grazing tolerance by feeding or nesting birds: H=heavy, M=moderate, L=light, or N=none or intolerant.

Understanding potential grazing effects on bird populations

The seeming inconsistencies in the data on grazing effects on birds are not just a problem of weak science (but see Walker and Richardson 1986, Kirby et al. 1992). Although much progress could be made in experimental design of grazing studies, answers to the question of grazing impacts are confounded by varying conservation objectives and a host of modifying, interrelated abiotic and biotic factors (e.g., Milchunas and Lauenroth 1993). For land managers the key in assessing the ecological costs and benefits of grazing lies in understanding the interactions among these factors.

Success in predicting the effects of grazing, in any specific situation, will be predicated upon an understanding of the complex interactions among grazing components, existing vegetation, soil attributes, climatic conditions, and land-use history, all of which combine to affect habitat conditions that influence avian population responses (fig. 2).

Avian responses to grazing

Grazing potentially affects bird response variables both through direct and indirect pathways. The most common are indirect pathways by which grazers alter the condition of vegetation, thereby altering food abundance (seeds, insects); foraging site conditions (food availability); and cover for protection (thermal), escape, or breeding (courtship, nests). Grazing directly affects plant communities via reductions in biomass, changes in structural conditions (plant height and density, litter depth), and changes in species composition (Vallentine 1990, p. 330–335, Milchunas and Lauenroth 1993).

Grazers also may directly impact the presence of avian species and their reproductive success (data on direct or indirect effects of grazing on adult survival are lacking). Some avian species may actively avoid or disproportionately use areas with livestock present. Nesting success could be directly affected by trampling loss of eggs (possibly nestlings) or via increased activity of brood parasites (such as brown-headed cowbirds that lay their eggs in nests of other birds, thereby reducing reproductive success of host species), or predators.

Direct effects on suitability of bird habitats

Evidence for direct impacts of grazing on bird populations is limited. Studies of the effect of livestock trampling on nest losses are limited to those using simulated nests or artificial nests (i.e., clay pigeons as surrogate nests). Paine et al. (1997) reported potential upward bias in trampling rates with use of clay pigeons to simulate nests. Data on natural nest loss to trampling are largely anecdotal. Current literature indicates higher nest loss with increased stocking rates (nonlinear, asymptotic relationship; Koerth et al. 1983, Bareiss et al. 1986, Jensen et al. 1990) and little difference in nest loss among grazing system types (Paine et al. 1996). Stocking rates of 10 head per hectare (Jensen et al. 1990) to as low as 2.5 head per hectare (Bareiss et al. 1986, Jensen et al. 1990) have been suggested as thresholds above which "significant disturbance of ground nesting birds" might occur (Jensen et al. 1990).

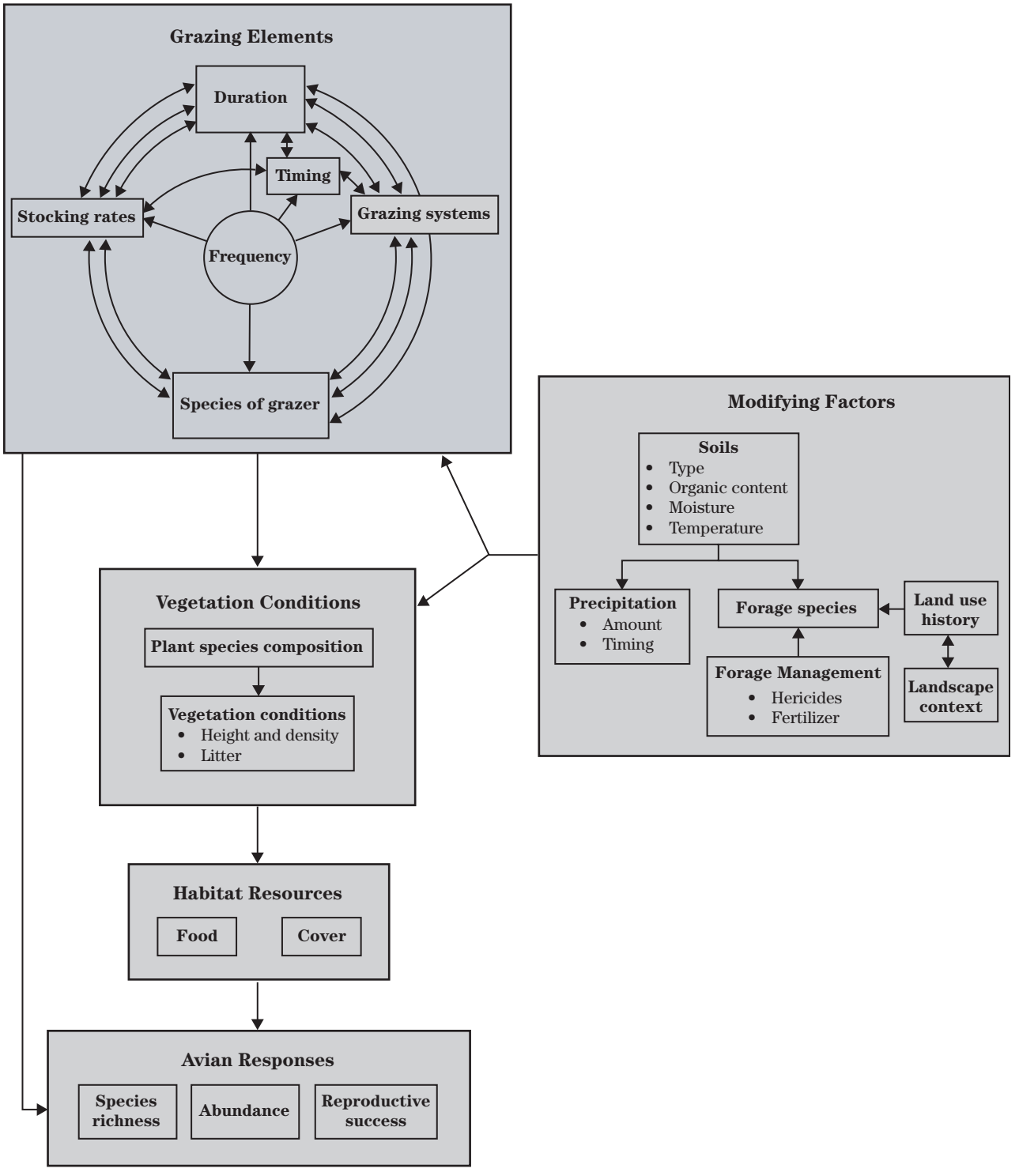
Data on active avoidance of livestock by birds are scant. Smith et al. (1993) presented evidence that the presence of cattle was sufficient to prevent piping plovers from establishing territories along alkali wetland beaches in pastures.

Several bird species have been documented to associate with large grazers, seemingly benefiting from increased foraging opportunities (e.g., cattle egrets, Dinsmore 1973; brown-headed cowbirds, Morris and Thompson 1998, Goguen and Mathews 1999). Inconclusive evidence for increased cowbird parasitism of nests near active cattle pastures has been suggested by several investigators (Goguen and Mathews 1999). No literature documenting increased activity by mammalian or reptilian nest predators in actively grazed areas was found.

Management recommendations

Based on the current, but very limited data on direct grazing impacts on birds, managers should be concerned about cattle presence during the nesting season. Colonial or semicolonial nesting birds may be vulnerable to disturbance by livestock (e.g., piping plovers). Until additional data are collected, habitats occupied by such species, especially those threatened or endangered (e.g., common terns) should be protected from grazing or other disturbances during breeding seasons. Likewise, managers should be concerned about grazing breeding habitat occupied by species of conservation concern (e.g., PIF conservation plans, Herkert et al. 1996, Thompson et al. 1993) that are

Figure 2 Grazing effects on avian populations including factors that may modify avian responses



highly vulnerable to cowbird parasitism (e.g., Bell's vireo, Budnik et al. 2000). Direct nest loss to trampling may be a concern for species likely to be nesting in high densities within pastures that have high stocking rates (short-duration grazing systems).

Indirect effects on suitability of bird habitats

Assessing possible indirect grazing effects on avian wildlife is more difficult than those related to direct effects. Once appropriate habitat (vegetative) targets have been identified, managers need to consider the complex interactions among grazing elements and the host of abiotic and biotic factors to ultimately provide the desired management outcomes.

Grazing elements

As diagramed in figure 2, *grazing* is a highly variable treatment, and managers should take care in examining the research literature to note the specific grazing conditions being reported. Many of the seeming contradictions in grazing effects are because vastly different grazing conditions are being compared. Variations in the combinations grazing intensity (stocking rates, duration, grazing systems), timing, frequency, and grazing species can yield dramatically different habitat conditions. Understanding of bird responses to grazing is further confounded by the arbitrary selection of focal bird species and focus on immediate versus multiyear responses.

***Grazing intensity*—**As grazing intensity (number of grazing animals per area and duration) increases, vegetation height, density, and litter are reduced. Some research reports grazing intensity as a measure of impact on vegetative conditions (Kantrud and Kologiski 1982). More frequently, grazing intensity is expressed via stocking rates, such as animal unit months (AUMs: 1 cow-calf pair/month), with vegetation impacts assumed to be typical for specific soil types and forage species. However, actual effects on vegetation (and thus wildlife) can be strongly modified by prior land-use history (Milchunas and Lauenroth 1993), recent climatic conditions (precipitation and temperature; Milchunas and Lauenroth 1993, Bock and Bock 1999), and soil conditions (moisture and temperature; Kantrud and Kologiski 1982, Milchunas and Lauenroth 1993). These interactions make transferring conclusions from research conducted under one set of conditions to management scenarios under different conditions imprecise at best. Said another way, what constitutes **moderate** grazing in one circumstance may be **heavy** grazing in another, even within physiographic regions (such as those identified by PIF). Furthermore, wildlife responses to grazing intensity may not be linear (Kie et al. 1994). Generalization of research findings is difficult because many studies failed to provide detailed descriptions of grazing elements.

***Frequency of grazing*—**Frequency of grazing disturbance is another element that affects vegetation response. Year-long or continuous versus rotational (within-year to multiyear rest intervals) grazing systems produce substantially different vegetative structural conditions and can strongly impact plant species composition (Vallentine 1990, Milchunas and Lauenroth 1993). More frequent grazing is generally analogous to high grazing intensity, but the effects are mediated by differences in stocking rates, variations in within-year timing of grazing, and the host of modifying factors identified in figure 2.

***Timing of grazing*—**Timing of grazing can directly affect vegetation conditions and interacts with stocking rates and duration to yield variable habitat and wildlife responses. As previously noted, grazing during the nesting season most likely has different effects than grazing later in the season. Research on how grazing influences wildlife often considers the effects of grazing systems. Vallentine (1990) reviews different grazing systems in his publication *Grazing Management*. Grazing systems, such as rest-rotation and short duration, incorporate different levels of stocking rates and duration and timing of grazing.

Although many distinct types of systems are identified, the effects of grazing using different types are not necessarily different. Because of the complex interactions among grazing elements and other factors, different systems may yield similar impacts on birds, or the same system may have different impacts over time or at different locales. Systems that defer grazing on some pasture units during the nesting season are generally considered more compatible with wildlife management goals (Pierce and Clubine 1999). Grazing systems also vary in the scale (size and number of pasture cells) within as well as among types. Scale differences can substantially alter the effect of grazing on birds or other wildlife. (See Fuhlendorf and Smeins 1999 for general information on scale and grazing.)

***Species of livestock*—**The species of livestock is another element of grazing that can yield variable habi-

tat and bird responses. Literature documents variation in foraging selectivity among grazers (see Vallentine 1990, p. 222–245). For example, sheep tend to selectively graze forbs more than cattle (Vallentine 1990, p. 224). These differences, especially over several years, can noticeably affect plant species composition (Vallentine 1990, p. 254–258). The land manager needs to remember that a given level of grazing intensity by one species of grazer will likely yield considerable differences in habitat conditions versus those produced by the same grazing intensity of another species.

Modifying factors

Soil conditions—Soil conditions, especially organic content, moisture, and temperature, interact with different grazing elements to strongly alter the impact on vegetation. In one of the most extensive studies of its kind, Kantrud and Kologiski (1982) reported significant interaction effects between grazing intensity and soils on bird species richness and species abundances in their northern Great Plains study area. Specifically, they detected higher species richness on better-quality soils when grazing was light to moderate and on lower-quality soils when grazing intensity was moderate. Knowledge of local soil types is important to wildlife managers in assessing optimal grazing pressure relative to specific avian population objectives.

Precipitation—Grazing effects also are mediated by variation in ambient temperatures and amount of precipitation before and during grazing (Milchunas and Lauenroth 1993). Climatic variables interact substantially with soil types. Kantrud and Kologiski (1982) noted that increased soil temperature, a function of the effects of soil type, grazing intensity, and recent climatic conditions, had the largest negative effect on avian species richness.

History of prior land use—Prior land use can considerably modify grazing effects on avian habitat. Frequent, long-term disturbances (grazing, fire, mowing) affect plant species composition, initial biomass, vegetative structure, litter, and possibly soil conditions. Variation among sites in disturbance history yield substantially different responses to similar grazing intensity. Even recent defoliation events alter the tolerance of plants to further disturbance via grazing. Burning, grazing, and other such activities alter root systems and affect within-plant nutrient distribution and seed production. Managers should garner all available history of a site to better predict the effects of grazing on bird populations.

Landscape composition—Landscape composition has been widely recognized as an important determinant of wildlife habitat use and productivity (Turner 1989). The availability of other grassland habitats, the amount of forest cover (especially edge), and possibly the amount of cropfield in the adjacent landscape generally interact with environmental modifying factors (fig. 2) and grazing elements to affect avian use of grazed lands. Some evidence suggests that field-scale conditions (e.g., vegetation structure) may be more, but not exclusively, important than landscape condition in determining bird use. The relative importance of field-scale habitat conditions versus landscape attributes to avian nest success is uncertain (McCoy 2000). No substantive literature was found that examines the role of landscape composition on livestock grazing-avian population interactions. Until more information is available, generalizations about how landscape composition interacts with bird responses to grazing are premature.

Although unlikely to be an issue on WRP grasslands, the effects of all of the previously described grazing elements and modifying conditions may be further altered by the extent to which forage is managed via fertilizer and herbicide applications. Fertilization of pastures may slightly reduce the effects of grazing intensity on plant structure. However, no literature searched directly examined pasture fertilization effects on bird populations. Herbicides generally are used to alter the plant community, and effects can be interpreted directly by considering the habitat requirements of target species. Most commonly, herbicide use has been cited as a negative effect on shrub/brush-dependent bird species, such as sage grouse (Beck and Mitchell 2000).

Effects on birds—Any effort to synthesize the literature of grazing effects on bird populations is fraught with the dangers of oversimplification and misinterpretation. The literature is not sufficiently complete to allow definitive interpretation of the impacts of various grazing elements either alone or in concert with other grazing or modifying factors. Koford and Best (1996) observed that most research on grazing and passerine species has been done in the Western United States. The transfer of results among environmentally

divergent locales should be done cautiously. Careful experimentation to tease apart isolated effects of specific grazing elements remains to be done. More useful would be strong science addressing realistic combinations of interacting variables.

Given these caveats, the following tentative generalizations regarding grazing impacts on birds are offered in the spirit of Leopold's rules of thumb. These generalizations should be applied to specific management situations only after careful consideration of the of grazing elements and the local modifying conditions.

Healthy grassland ecosystems are best maintained by use of fire and grazing applied with temporal and spatial variation and intensity (Ryan 1990). Grazing implemented to simulate the activity of native herbivores is necessary to maintain avian species richness throughout prairies of North America. Skinner et al. (1984) said it well when they noted that "grassland managers must provide a wide range of cover heights during all seasons….Grazing [is] the most versatile management practice."

Evidence suggests that heavy grazing reduces overall avian species richness in grassland ecosystems (Kantrud 1981, Kantrud and Kologiski 1982). Total avian abundance, however, seemingly is little affected as grazing intensity increases, with species adapted to short, sparse cover becoming highly abundant (Kantrud and Kologiski 1982). Alternatively, many grassland species, including several of conservation concern, are dependent on grazing under almost any environmental conditions (table 1). Mountain plovers and burrowing owls, for example, require habitats characterized by short, sparse vegetation. Others may be most abundant where grazing creates short-grass habitat for feeding (ferruginous hawks and loggerhead shrikes) or nesting (common nighthawk), or both (killdeer, marbled godwits, horned larks).

Most prairie-adapted species are tolerant of (or thrive under) light to moderate grazing intensity under most modifying environmental conditions (table 1). Grazing-tolerant species generally are adapted to moderately tall-dense vegetation. Many investigators refer to these as midgrass species, usually referring to vegetation structural preferences rather than necessarily being species of the mid (mixed) grass prairie ecosystem. This moderate vegetation height-density category seemingly covers an array of habitat conditions. Thus, managers will have difficulty determining optimal grazing intensities for these moderately grazing-tolerant species. For example, such species as upland sandpipers or grasshopper sparrows clearly are compatible with grazing and may under some environmental situations reach maximum densities only with grazing. But, optimal grazing conditions most likely vary substantially across the broad environmental gradients that characterize the ranges of these species. In fact, nearly all possible responses to grazing (detrimental to beneficial) have been reported for upland sandpipers (Ailes 1980, Kirsch and Higgins 1976, Skinner et al. 1984, Bowen and Kruse 1993).

Those species adapted to tall-dense grassland vegetation are most likely to show negative response to grazing. Although some studies indicate waterfowl can tolerate light to moderate grazing, optimal habitat conditions probably occur in the absence of grazing (Kirsch 1969, Braun 1978, Bryant 1982, Kruse and Bowen 1996, Lamey and Devries 1997, but see Barker et al. 1990). Many species adapted to moist or wet meadow habitats, such as Wilson's phalarope, common yellowthroats, sedge wrens, and Le Conte's sparrow, probably are intolerant of all but very light grazing (although direct data on response to grazing for these species are largely lacking). In contrast, some wetland-associated species, such as willets and marbled godwits, are dependent on grazing around wetland shorelines for feeding habitat (Ryan et al. 1984, Ryan and Renken 1987). Various other grassland species seemingly are adapted to ungrazed or lightly grazed habitats. Some examples are the sharp-tailed grouse, short-eared owl, Baird's sparrow, Henslow's sparrow, and clay-colored sparrow.

Much of the preceding information and summarization presented in table 1 is derived from literature on local abundance in relation to grazing. Fewer studies have investigated reproductive success as a response variable to grazing. When data on abundance and reproductive success are available for a species, the results tend to be largely parallel (e.g., waterfowl). However, for many species optimal level of grazing based on reproductive success may be quite different than that apparent from abundance response data. Not enough data for enough species are available to identify general patterns. Several studies do suggest that negative effects of grazing, if any, are exacerbated by grazing during the active nesting period (Bowen and Kruse 1993; Knopf et al. 1988).

Recommended grazing treatment

Managers are cautioned that the following guidelines are not supported by strong research. However, these rules of thumb may serve as starting points for adaptive management efforts and, hopefully, may be seen as testable hypotheses by the research community.

Sample and Mossman (1997), writing about management of grasslands in Wisconsin, suggested **light to moderate** grazing as best for grassland bird communities. They stated, as a general guideline, that grazing management leave vegetation at least 10 inches (25 cm) high over more than 50 percent of management units. Explicitly recognizing the difficulty in identifying appropriate stocking rates because of interacting factors, Sample and Mossman (1997) suggested that 0.4 to 0.5 head of cattle per acre (no duration specified) would be considered **light** under average soil and precipitation conditions. They further recommended that grazing cease by early to mid September on cool-season grasses or early August on warm-season grass pastures.

Skinner et al. (1984) considered grazing the "most versatile" grassland management tool in their study of grasslands in Missouri. They recommended using a variety of grazing intensities across grassland regions to promote bird species richness and abundance at a large scale. Specifically, they recommended leaving idle or light grazing on 40 percent of managed lands, moderate grazing on 20 to 40 percent, and heavy grazing on 20 percent. (They suggested haying could replace some of the moderate grazing.) Although Skinner et al. did not specify stocking rates, they cited Launchbaugh and Owensby (1978) who reported that rates that remove between 40 and 60 percent of the vegetation within the growing season yielded the greatest "sustained carrying capacity" of birds.

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Appendix 1 Tables depicting bird responses to grazing

Table A Projected responses to grazing by Partners in Flight's priority bird species in the Dissected Till Plains physiographic area (No. 32)

Species[1]	Habitat[2]	PIF total score[3]	Ranking criteria[4]	Residence status[5]	Grazing response[6] Annual	Grazing response[6] Periodic[7]
Greater prairie-chicken	**GR**	**27**	**1**	**RES**	**+(c)/–(n)**	**+**
Black rail	WE	26	1	MBR	–	+
Henslow's sparrow	**GR**	**25**	**1**	**MBR**	**–**	**+**
Piping plover	BR	25	1	MBR	+	–
Cerulean warbler	RF–DF	25	1	MBR	–	–
Dickcissel	GR	25	1	MBR	–	+
Red-headed woodpecker	SA	24	1	MBR	–	+
Bell's vireo	GR–SH	23	1	MBR	–	+
Prothonotary warbler	RF	22	1	MBR	–	–
Field sparrow	**GR–SH**	**22**	**1**	**MBR**	**–**	**+**
Bobolink	**GR**	**21**	**1**	**MBR**	**–**	**+**
Northern bobwhite	GR–SH–SA	21	2	RES	–	+
Brown thrasher	SA	21	2	MBR	–	+
Grasshopper sparrow	GR	20	2	MBR	–	+
Baltimore oriole	SA	21	2	MBR	–	+
Chimney swift	RF–U	20	2	MBR	–	–
Loggerhead shrike	**GR–SH**	**20**	**2**	**MBR**	**0**	**+**
Orchard oriole	GR–SH	20	2	MBR	–	+
Eastern phoebe	RF	19	2	MBR	–	–
Eastern kingbird	RF–SA	19	2	MBR	–	–
Short-eared owl	GR	20	3	MBR	–	+
Least tern	BR	16	4	MBR	–	+
Harris sparrow	GR–SH	24	1	WTR	–	+
Northern harrier	GR	20	2	WTR	–	+
Long-eared owl	GR–SH–RF	20	2	WTR	–	+
Bald eagle	BR	20	2	WTR	?	?
American tree sparrow	GR–SH	20	2	WTR	–	+

1 Species: Official common name from the AOU Checklist, 7th Edition. Species in bold type are shown as highest priority species on the PIF Web site (http://www.partnersinflight.org/).

2 Habitats: BR = beach; DF = deciduous forest; FS = farmland/suburban, GR = grassland, OW = open woodland, RF = riparian forest, SA = savanna, SH = shrubland, U = urban, WE = wetland.

3 PIF total score: A total score that sums the following individual scores (range, 1–5): Global relative abundance, usually based on Breeding Bird Survey data; Global scores for North American breeding distribution and wintering distribution; Global score for threats in the nonbreeding season; Threats to successful breeding in physiographic area; Importance of physiographic area for breeding of the species (AI), calculated, if possible, by comparing relative abundance on the Breeding Bird Survey within physiographic area to the species' highest relative abundance in any physiographic area; and Population trend for physiographic area (PT), usually determined from the Breeding Bird Survey.

4 Ranking criteria for inclusion on priority species list: 1 = PIF total score $\geq$22; 2 = PIF total score 19–21 22 with sum of A1 and PT scores $\geq$ 8; 3 = Total PIF score 19–21 and percentage of population breeding in physiographic area >9; 11C =19–21, TB $\geq$4; 3 = PIF "watch list" species with A1 $\geq$3 (watch list species are those with highest PIF prioritization scores based upon the species rank across their entire range); 4 = Federally listed as endangered or threatened.

5 Residence status: RES = permanent, year-round resident, MBR = migrant breeder, MIG = migrant, and WTR = migrant wintering bird.

6 Grazing response: + = positive, – = negative, 0 = neutral, or ?=unknown effect on species' abundance (default), feeding (f), nesting (n, RES and MBR only) or courtship (c). Treatment assumed to be complete (i.e., no internal fencing), thereby impacting both wetland and upland vegetation. Grazing by cattle would be delayed until after completion of the nesting season between July 15 and January 1. Animals will be removed when 50 percent of available forage has been consumed. More frequent or intensive treatments assumed to be deleterious to species associated with SH or SA. Grazing always negative for RF species. Species unlikely to occur at sites smaller than minimum area requirement of species, so response to treatment anticipated to be neutral.

7 Recommended frequency of treatment for maintenance of grasslands in Dissected Till Plains physiographic area is every 2 to 5 years.

Table B Projected responses to grazing by Partners in Flight's priority bird species in the Northern Mixed-grass Prairie physiographic region (No. 37)

Species[1]	Habitat[2]	PIF total score[3]	Ranking criteria[4]	Residence status[5]	Grazing response[6] Annual	Grazing response[6] Periodic[7]
Baird's sparrow	**GR**	**29**	**1**	**MBR**	**–**	**+**
Nelson's sharp-tailed sparrow	**WE**	**27**	**1**	**MBR**	**–**	**+**
Yellow rail	**WE**	**27**	**1**	**MBR**	**–**	**+**
Greater prairie-chicken	**GR**	**26**	**1**	**RES**	**+(c)/–(n)**	**+**
Piping plover	**BR**	**26**	**1**	**MBR**	**+**	**–**
Sprague's pipit	**GR**	**26**	**1**	**MBR**	**–**	**+**
McCown's longspur	**GR**	**25**	**1**	**MIG**	**+**	**–**
Wilson's phalarope	WE	25	2	MBR	–	+
Chestnut-collared longspur	GR	24	4	MBR	+	–
Marbled godwit	**WE**	**24**	**1**	**MBR**	**+**	**0**
Willet	WE	24	2	MBR	+	0
Bell's vireo	**GR–SH**	**22**	**1**	**MBR**	**–**	**+**
Ferruginous hawk	GR	22	6	MBR	+(f)/–(n)	+
Le Conte's sparrow	**GR**	**22**	**1**	**MBR**	**–**	**+**
American bittern	WE	21	2	MBR	–	+
Black-billed cuckoo	RF	21	4	MBR	–	–
Bobolink	GR	21	3	MBR	–	+
Clay-colored sparrow	GR	21	4	MBR	–	+
Franklin's gull	WE	21	3	MBR	–	+
Lark bunting	GR	21	3	MBR	–	+
Northern harrier	GR	21	2	MBR	–	+
Sedge wren	GR	21	4	MBR	–	+
Upland sandpiper	GR	21	4	MBR	–	+
Grasshopper sparrow	GR	20	2	MBR	–	+
Marsh wren	WE	20	4	MBR	–	+
Red-headed woodpecker	RF	20	3	MBR	–	–
Sharp-tailed grouse	GR–SH	20	4	MBR	–	+
Short-eared owl	GR	20	3	MBR	–	+
Black tern	WE	19	4	MBR	–	+
Dickcissel	GR	19	3	MBR	–	+
Horned grebe	WE	19	4	MBR	–	+
Virginia rail	WE	19	4	MBR	–	+
Willow flycatcher	WE	19	4	MBR	–	–
Bald eagle	RH	18	5	MBR	?	?
Burrowing owl	GR	18	6	MBR	+	0
Western kingbird	GR	18	4	MBR	–	–
Least tern	RH	17	5	MBR	–	+
Eastern kingbird	GR	16	4	MBR	–	–
Loggerhead shrike	GR–SH	16	6	MBR	0	+
Pied-billed grebe	WE	16	4	MBR	–	+
Warbling vireo	RH	16	4	MBR	–	–
Sora	WE	15	4	MBR	–	+
Vesper sparrow	GR	15	4	MBR	+	0
American coot	WE	14	4	MBR	–	+

1 Species: Official common name from the AOU Checklist, 7th Edition. Species in bold type are shown as highest priority species on the PIF Web site (http://www.partnersinflight.org/).
2 Habitats: FS = farmland/suburban, GR = grassland, OW = open woodland, RF = riparian forest, SH = shrubland, or WE = wetland.
3 PIF total score: A total score that sums the following individual scores (range, 1–): Global relative abundance, usually based on Breeding Bird Survey data; Global scores for North American breeding distribution and wintering distribution; Global score for threats in the non-breeding season; Threats to successful breeding in physiographic area (TB); Importance of physiographic area for breeding of the species (AI), calculated, if possible, by comparing relative abundance on the Breeding Bird Survey within physiographic area to the species' highest relative abundance in any physiographic area; and Population trend for physiographic area (PT), usually determined from the Breeding Bird Survey.

4 Ranking criteria for inclusion on priority species list: 1 = PIF total score ≥23 and species occurs in manageable numbers; 2 = PIF total score 19–22 with sum of AI and PT scores ≥ 8; 3 = PIF "watch list" species with AI ≥3; 4 = percentage of population in planning unit is >5% for planning units <200,000 km^2 or 10% for planning units >200,000 km^2; 5 = species Federally listed as threatened or endangered; 6 = species of local concern, as identified by Nongame Technical Committee of the Prairie Pothole Joint Venture.

5 Residence status: RES = permanent, year-round resident, MBR = migrant breeder, MIG = migrant, and WTR = migrant wintering bird.

6 Grazing response: + = positive, – = negative, 0 = neutral, or ?=unknown effect on species' abundance (default), feeding (f), nesting (n, RES and MBR only) or courtship (c). Treatment assumed to be complete (i.e., no internal fencing), thereby impacting both wetland and upland vegetation. Grazing by cattle would be delayed until after completion of the nesting season between July 15 and January 1. Animals will be removed when 50 percent of available forage has been consumed. More frequent or intensive treatments assumed to be deleterious to species associated with SH or SA. Grazing always negative for RF species. Species unlikely to occur at sites smaller than minimum area requirement of species, so response to treatment anticipated to be neutral.

7 Recommended frequency of treatment for maintenance of grasslands in Northern Mixed-grass Prairie physiographic area is every 3 to 10 years.

Table C Projected responses to grazing by Partners in Flight's priority bird species in the West River physiogrphic area (No. 38)

Species[1]	Habitat[2]	PIF total score[3]	Ranking criteria[4]	Residence status[5]	Grazing response[6] Annual	Grazing response[6] Periodic[7]
Baird's sparrow	**GR**	**29**	**I**	**MBR**	**–**	**+**
Chestnut-collared longspur	**GR**	**27**	**I**	**MBR**	**+**	**–**
Greater prairie-chicken	**GR**	**26**	**I**	**RES**	**+(c)/-(n)**	**+**
McCown's longspur	**GR**	**25**	**I**	**WTR**	**+**	**–**
Ferruginous hawk	GR	24	I	MBR	–	+
Marbled godwit	GR	24	I	MBR	+	–
Grasshopper sparrow	GR	23	I	MBR	–	+
Northern harrier	GR	22	I	MBR	–	+
Upland sandpiper	GR	22	I	MBR	–	+
Long-billed curlew	**GR**	**22**	**I**	**MBR**	**0**	**+**
Sprague's pipit	GR	22	I	MBR	–	+
Dickcissel	GR	22	I	MBR	–	+
Swainson's hawk	GR	21	IIC	MBR	–	+
Killdeer	GR	21	IIA	MBR	+	–
Short-eared owl	GR	21	IIC	MBR	–	+
Say's phoebe	GR	20	IIA	MBR	?	?
Bobolink	GR	20	IIC	MBR	–	+
Burrowing owl	GR	19	IIC	MBR	+	?
Prairie falcon	GR–CL	22	I	MBR	–	+
Lark bunting	**GR–SH**	**23**	**I**	**MBR**	**–**	**+**
Dark-eyed junco	CF	?	?	MBR	?	?
Sharp-tailed grouse	GR–SH	19	IIB	RES	–	+
Black-billed cuckoo	SH	23	I	MBR	–	+
Bell's vireo	SH	23	I	MBR	–	+
Greater sage-grouse	SH	22	I	MBR	–	+
Wilson's phalarope	WE	27	I	MBR	–	+
Piping plover	WE	26	I	MBR	+	–
Trumpeter swan	WE	25	I	MBR	?	?
American white pelican	WE	22	I	MBR	?	?
American dipper	WE	22	I	MBR	?	?
Marsh wren	WE	21	IIB	MBR	–	+
Redhead	WE	20	IIC	MBR	–	+
Ruddy duck	WE	20	IIB	MBR	–	+
Black tern	WE	20	IIC	MBR	–	+
Yellow-headed blackbird	WE	20	IIB	MBR	–	+
Wood duck	WE–RF	19	IIC	MBR	–	–
Red-headed woodpecker	WL	21	IIC	MBR	–	–
Black-backed woodpecker	WL	20	IIC	MBR	?	?
Lewis's woodpecker	WL–RF	22	I	MBR	?	?
Mountain bluebird	WL–SA	21	IIA	MBR	–	+

1 Species: Official common name from the AOU Checklist, 7th Edition. Species in bold type are shown as highest priority species on the PIF Web site (http://www.partnersinflight.org/).

2 Habitats: CF = conifer forest, CL = cliff, FS = farmland/suburban, GR = grassland, OW = open woodland, RF = riparian forest, SH = shrubland, WE = wetland or WL = woodlands.

3 PIF total score: A total score that sums the following individual scores (range, 1–5): Global relative abundance, usually based on Breeding Bird Survey data; Global scores for North American breeding distribution and wintering distribution; Global score for threats in the non-breeding season; Threats to successful breeding in physiographic area (TB); Importance of physiographic area for breeding of the species (AI), calculated, if possible, by comparing relative abundance on the Breeding Bird Survey within physiographic area to the species' highest relative abundance in any physiographic area; and Population trend for physiographic area (PT), usually determined from the Breeding Bird Survey.

4 Ranking criteria for inclusion on priority species list: I = PIF total score $\geq$ 22; IIA = PIF total score 19–21 with sum of AI and PT scores $\geq$ 8; IIB = Total PIF score 19–21 and high percentage of breeding population in physiographic area; IIC = 19–21, TB $\geq$ 4+.

5 Residence status: RES = permanent, year-round resident, MBR = migrant breeder, MIG = migrant, and WTR = migrant wintering bird.

6 Grazing response: + = positive, – = negative, 0 = neutral, or ?=unknown effect on species' abundance (default), feeding (f), nesting (n, RES and MBR only) or courtship (c). Treatment assumed to be complete (i.e., no internal fencing), thereby impacting both wetland and upland vegetation. Grazing by cattle would be delayed until after completion of the nesting season between July 15 and January 1. Animals will be removed when 50 percent of available forage has been consumed. More frequent or intensive treatments assumed to be deleterious to species associated with SH or SA. Grazing always negative for RF species. Species unlikely to occur at sites smaller than minimum area requirement of species, so response to treatment anticipated to be neutral.

7 Recommended frequency of treatment for maintenance of grasslands in West River physiographic area is ≥ 10 years.

Table D Projected responses to grazing by Partners in Flight's priority bird species in the Northern Tallgrass Prairie physiographic region (No. 40)

Species[1]	Habitat[2]	PIF total score[3]	Ranking criteria[4]	Residence status[5]	Grazing response[6] Annual	Grazing response[6] Periodic[7]
Greater prairie-chicken	**GR**	**26**	**1**	**RES**	**+(c)/-(n)**	**+**
Nelson's sarp-tailed sparrow	**GR–WE**	**25**	**1**	**MBR**	**–**	**+**
Sedge wren	**GR**	**25**	**1**	**MBR**	**–**	**+**
Trumpeter swan	WE	25	1	MBR	–	+
Yellow rail	**WE**	**25**	**1**	**MBR**	**–**	**+**
Black-billed cuckoo	**RF–OW**	**24**	**1**	**MBR**	**–**	**–**
Dickcissel	GR	24	3	MBR	–	+
Bobolink	**GR**	**23**	**1**	**MBR**	**–**	**+**
Marsh wren	WE	23	2	MBR	–	+
Red-headed woodpecker	RF–OW	23	2	MBR	–	+
Hooded merganser	RF–WE	22	1	MBR	–	–
Marbled godwit	WE	22	3	MBR	+	0
Wilson's phalarope	WE	22	7	MBR	–	+
Franklin's gull	WE	21	3	MBR	–	+
American bittern	WE	20	7	MBR	–	+
Grasshopper sparrow	GR	20	2	MBR	–	+
Wood duck	RF–WE	20	2	MBR	–	–
Clay-colored sparrow	GR	19	7	MBR	–	+
Vesper sparrow	GR	19	5	MBR	+	0
Black tern	WE	18	7	MBR	–	+
Bald eagle	RF	17	6	MBR/WTR	?	?
Loggerhead shrike	SH–GR	17	7	MBR	0	+
Virginia rail	WE	17	7	MBR	–	+
Pied-billed grebe	WE	16	5	MBR	–	+
Sora	WE	15	7	MBR	–	+
House wren	RF–FS	14	5	MBR	–	–
Northern flicker	RF–OW	13	4	MBR	–	–

1 Species: Official common name from the AOU Checklist, 7th Edition. Species in bold type are shown as highest priority species on the PIF Web site (http://www.partnersinflight.org/).

2 Habitats: FS = farmland/suburban, GR = grassland, OW = open woodland, RF = riparian forest, SH = shrubland, or WE = wetland.

3 PIF total score: A total score that sums the following individual scores (range, 1–5): Global relative abundance, usually based on Breeding Bird Survey data; Global scores for North American breeding distribution and wintering distribution; Global score for threats in the nonbreeding season; Threats to successful breeding in physiographic area; Importance of physiographic area for breeding of the species (AI), calculated, if possible, by comparing relative abundance on the Breeding Bird Survey within physiographic area to the species' highest relative abundance in any physiographic area; and Population trend for physiographic area (PT), usually determined from the Breeding Bird Survey.

4 Ranking criteria for inclusion on priority species list: 1 = PIF total score $\geq$ 23 and species occurs in manageable numbers; 2 = PIF total score 19–22 with sum of AI and PT scores $\geq$ 8; 3 = PIF "watch list" species; 4 = AI and PT scores both are 5, 5 = percentage of population in planning unit is >5% for planning units <200,000 km^2 or 10% for planning units >200,000 km^2; 6 = species Federally listed as threatened or endangered;
7 = species of local concern, as identified by Nongame Technical Committee of the Prairie Pothole Joint Venture.

5 Residence status: RES = permanent, year-round resident, MBR = migrant breeder, MIG = migrant, and WTR = migrant wintering bird.

6 Grazing response: + = positive, – = negative, 0 = neutral, or ?=unknown effect on species' abundance (default), feeding (f), nesting (n, RES and MBR only), or courtship (c). Treatment assumed to be complete (i.e., no internal fencing), thereby impacting both wetland and upland vegetation. Grazing by cattle would be delayed until after completion of the nesting season between July 15 and January 1. Animals will be removed when 50 percent of available forage has been consumed. More frequent or intensive treatments assumed to be deleterious to species associated with SH or SA. Grazing always negative for RF species. Species unlikely to be occur at sites smaller than minimum area requirement of species, so response to treatment anticipated to be neutral.

7 Recommended frequency of treatment for maintenance of grasslands in Northern Tallgrass Prairie physiographic area is every 2 to 5 years.

Table E Projected responses to grazing by Partners in Flight's priority bird species in the Central and Southern Coast and Valleys physiographic area (No. 90)

Species[1]	Habitat[2]	PIF total score[3]	Ranking criteria[4]	Residence status[5]	- - - - Grazing response[6] - - - - Annual	Periodic[7]
Ferruginous hawk	GR	NA	NA	WTR	–	+
Grasshopper sparrow	GR	NA	NA	MBR/RES	–	+
Mountain plover	GR	NA	NA	WTR	+	–
Northern harrier	GR	NA	NA	RES/WTR	–	+
White-tailed kite	GR–SH	NA	NA	RES	–	+
Western meadowlark	GR	NA	NA	RES/WTR	–	+
Savannah sarrow	GR	NA	NA	RES/WTR	–	+

1 Species: Official common name from the AOU Checklist, 7th Edition.
2 Habitats: DF = deciduous forest; FS = farmland/suburban, GR = grassland, OW = open woodland, RF = riparian forest, SA = savanna, SH = shrubland, U = urban, or WE = wetland.
3 PIF total score: A total score that sums the following individual scores (range, 1–5): Global relative abundance, usually based on Breeding Bird Survey data; Global scores for North American breeding distribution and wintering distribution; Global score for threats in the nonbreeding season; Threats to successful breeding in physiographic area; Importance of physiographic area for breeding of the species (AI), calculated, if possible, by comparing relative abundance on the Breeding Bird Survey within physiographic area to the species' highest relative abundance in any physiographic area; and Population trend for physiographic area (PT), usually determined from the Breeding Bird Survey. NA = not available.
4 Ranking criteria for inclusion on priority species list: 1 = PIF Total Score ≥22, declining population trend with PT/PTU of 5/1 or 5/2, and/or percentage of population breeding in physiographic area >20; 2 = Monitoring species; 3 = Local concern; 4 = Nonpriority; NA = not available.
5 Residence status: RES = permanent, year-round resident, MBR = migrant breeder, MIG = migrant, and WTR = migrant wintering bird.
6 Grazing response: + = positive, – = negative, or 0 = neutral effect on species' abundance and reproductive performance (RES and MBR only). Treatment assumed to be complete (i.e., no internal fencing), thereby impacting both wetland and upland vegetation. Grazing by cattle would be delayed until after completion of the nesting season between July 15 and January 1. Animals will be removed when 50 percent of available forage has been consumed. More frequent or intensive treatments assumed to be deleterious to species associated with SH or SA. Grazing always negative for RF species. Species unlikely to be occur at sites smaller than minimum area requirement of species, so response to treatment anticipated to be neutral.
7 Recommended frequency of treatment for maintenance of grasslands in California's Central and Southern Coast and Valleys physiographic area is every 3 to 5 years.

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