Benefits of Farm Bill Grassland Conservation Practices to Wildlife

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ABSTRACT Various Farm Bill conservation practices apply to rangelands with prescribed grazing, prescribed burning, range planting, and restoration of declining habitats showing some of the greatest benefits to wildlife. Prescribed grazing has been shown to produce both positive and negative responses by wildlife. Prescribed burning has also been shown to have both positive and negative effects, but benefits generally outweigh detriments of this practice. Range planting and restoration of declining habitats have been shown to benefit wildlife, but determining appropriate comparisons can be problematic. Grassland ecosystems have been found to need greater heterogeneity and better representation of historical ecosystem diversity, challenges that make comparisons to “native” ecosystem conditions complex. Additional practices including fencing, brush management, tree planting and shelterbelts, and pest management can all be used to improve wildlife habitat, although each can also cause problems for wildlife in certain situations. Bird responses to practices have received the greatest attention, with generally inadequate information available for most other taxa. Even for birds, considerable information is lacking including effects of practices on many species, effects of surrounding landscape factors on wildlife responses, and responses in reproductive rates or survival rates to various practices. Yet, rangeland practices offer some of the greatest potential for conservation benefits to wildlife. Grassland ecosystems and wildlife are considered among the most at risk, and rangeland practices can be used to maintain, enhance, and restore needed plant communities and habitat conditions.

Programs of the Farm Bill contain a number of conservation practices that are either directly or partially directed at grasslands. There are many types of grasslands in the United States, some of which are transient successional stages in systems that quickly become shrub- or forest-dominated communities, while other grasslands, particularly in the Great Plains, were historically the dominant plant community. This diversity of occurrences and types of grasslands makes summarizing wildlife responses to grassland practices complicated, especially if generalized to all grasslands. Because of the historical and current importance of grasslands in the Great Plains to a wide array of wildlife species, we will focus this chapter on wildlife responses to grassland conservation practices in grasslands and associated shrub ecosystems of the Great Plains.

The grasslands of the Great Plains historically occurred across approximately 585 million acres of the United States and Canada. These grasslands displayed considerable variation from north to south and east to west, with shrub species such as sagebrush occurring on sites protected from frequent fire on the western fringes, eastern forests occurring on fire-protected areas on the eastern fringe, aspen parklands occurring on the fringes to the north, and ponderosa pine and juniper forests occurring in rougher (i.e., shallow or rocky soils) or higher elevation areas within the interior. Grasslands have been identified as among the most endangered ecosystems in the United States (Samson and Knopf 1994, Samson et al. 2004), and many grassland-associated wildlife species are considered species at risk. Maintaining and improving the condition and diversity of grasslands are therefore significant conservation objectives.

In the United States, the grasslands of the Great Plains have been divided by the USDA/NRCS into approximately 60 Major Land Resource Areas (MLRAs) that delineate areas with similar geo-climatic characteristics (USDA/NRCA 2006a). Within each MLRA, ecological site descriptors identify the types of ecological communities that occurred within each ecological site and the various states and transitions that have occurred under current management practices. These provide a reference and information base for planning and implementing grassland management practices.

Various conservation practices included under Farm Bill programs are directed at native grasslands and are directly applicable to the untilled portions of the Great Plains. While Jones-Jones-Farrand et al. (this volume) discussed grassland practices associated with tilled or converted lands, emphasizing those associated with the Conservation Reserve Program, our chapter discusses those conservation practices that target untilled landscapes and focus on improving or restoring grassland conditions.

Programs that Utilize Grassland Conservation-Related Practices

Grassland conservation practices are widely used within the Grasslands Reserve Program (GRP), Wildlife Habitat Incentives Program (WHIP), Conservation Security Program (CSP), and Environmental Quality Incentives Program (EQIP). These programs focus on enabling and maintaining stewardship on working lands, which are those lands that are used to produce agricultural products. With a focus on untilled lands, this chapter primarily addresses practices applicable to rangelands.

The Wetlands Reserve Program (WRP) focuses primarily on wetland restoration and improvement. However, upland habitat adjacent to wetlands is typically also restored and enhanced. Such uplands are recognized as providing critical breeding habitat for many wetland species. They also significantly benefit wetlands by acting as buffers and filters from soil erosion, human disturbance and noise, and pesticides and fertilizers. Uplands that are maintained or restored to grassland and shrub cover types commonly utilize the kinds of practices discussed here.

Commonly Used Grassland-Related Practices

The kinds of conservation practices commonly used on grasslands address five main functions:

1. Establish and maintain desired plant species and communities,
2. Suppress and control invasive or undesirable plants and/or animals,
3. Provide food, water, or cover for desired native wildlife or domestic animals,
4. Manage domestic animals to minimize adverse

impacts to water bodies, soil resources, and desired wildlife and plant communities, and
5. Reduce wildfire hazard.

The following practices are those most commonly applied on grasslands. However, most of them can be utilized with many other land uses.

Brush Management

Brush management includes removal, reduction, or manipulation of non-herbaceous plants to achieve a particular objective (USDA NRCS 2006b; Conservation Practices Standard 314). On grasslands, brush management is used to restore natural plant community balance, create a desired plant community, improve forage accessibility for livestock, maintain or enhance wildlife habitat, reduce wildfire risk, and restore desired vegetation cover to protect soils, control erosion, reduce sediment, improve water quality, and enhance stream flow. Most often, brush management is used to control undesirable and invasive shrubs and trees through mechanical, chemical, biological, or prescribed burning treatments. Although the primary objective of brush management is usually to increase herbaceous vegetation for livestock, increasingly it is prescribed and applied to thin or eliminate woody vegetation such as juniper (*Juniperus* spp.) and mesquite (*Prosopis* spp.) that have encroached into grasslands, or to thin stands of Wyoming big sagebrush that have become too dense or decadent to provide many desired wildlife benefits (Olsen and Whitson 2002).

Prescribed Burning

Prescribed burning involves the application of controlled fire to a predetermined area (USDA NRCS 2006b; Conservation Practices Standard 338). Most grassland ecosystems in the United States evolved with frequent fire return intervals (Wright and Bailey 1982), which have largely been suppressed following extensive settlement (Seig 1997). Fire suppression in these areas has been linked with several ecological concerns, most notably the expansion of woody plants into areas in which they did not historically occur (Archer 1994). In grassland ecosystems, prescribed burning, as a conservation practice, is applied to control undesirable vegetation, prepare sites for planting or seeding, reduce wildfire hazards, improve wildlife habitat, improve plant productivity, remove debris or litter, alter distribution of grazing or browsing animals (Biondini et al. 1999, Fuhlendorf and Engle 2001), and to restore and maintain ecological sites.

Prescribed burning in eastern Wyoming. (Photo by A. Ganguli, EMRI)

Aerial application of herbicide on a recently burned site to control invasive cheatgrass *(Bromus tectorum).* (Photo by A. Ganguli, EMRI)

Prescribed Grazing

Prescribed grazing is the act of managing the controlled harvest of vegetation with grazing animals (USDA NRCS 2006b; Conservation Practices Standard 528). Important components of developing grazing prescriptions are to specify the type of grazer, as well as the season, duration, and intensity of grazing that is needed to accomplish specific management objectives (Frost and Launchbaugh 2003). Prescription grazing is used in grassland ecosystems to improve or maintain the health and vigor of plant communities, control invasive plant species (Popay and Field 1996, Olsen et al. 1997), improve the quality and quantity of forage for livestock and wildlife

(Short and Knight 2003), maintain water quality and riparian area integrity (Sedgewick and Knopf 1991), improve wildlife habitat (Vavra 2005), reduce wildfire risk, and reduce soil erosion.

Grazing Land Mechanical Treatment

Grazing land mechanical treatments utilize mechanical tools to modify soil and/or plant conditions with treatments such as pitting, contour furrowing, and ripping or subsoiling (USDA NRCS 2006b; Conservation Practice Standard 548). As a conservation practice it carries the restriction of only being applied to pastures where slopes are less than 30 percent. Mechanical treatments on grasslands are generally applied to fracture compacted soil layers to improve soil permeability, reduce water runoff and increase infiltration, break up sod-bound plant communities or thatch to increase plant vigor, and increase plant community productivity.

Range Planting

Range planting involves the establishment of adapted perennial grasses, forbs, legumes, shrubs, and trees (USDA NRCS 2006b; Conservation Practices Standard 550). Range planting is used as a conservation practice in grassland ecosystems to provide forage and habitat for livestock and wildlife, reduce soil erosion, improve water quality, increase carbon sequestration, and restore plant communities to a condition that is similar to historical conditions or to an identified desired plant community. Important considerations in developing range planting conservation practices include the economic feasibility, economic efficiency, and cost-effectiveness of the planting practice (Workman and Tanaka 1991), as well as an assessment of the potential competitive interactions of the species that will be used in the planting practice (Pyke and Archer 1991).

Stream Crossing

Stream crossings include stabilized areas or structures that are constructed across streams to provide crossing access for people, livestock, equipment, or vehicles that do not impede the natural passage of water, fish, or other organisms within the stream channel (NRCS NHCP; Conservation Practices Standard 578). The stream crossing conservation practice was established to reduce streambank and streambed erosion, provide crossing for access to adjacent land units, and to improve water quality by reducing sediment, nutrient, organic, and inorganic stream loading. This practice is discussed by Knight and Boyer (this volume).

Water Development

Water development conservation practices include those that either collect, store, or deliver water. These include a variety of specific practices addressing water collection, watering facilities, creation of ponds or dams, water wells, and water distribution systems including irrigation, water conveyance, and pipeline practices. Water development practices are often aimed at protecting water sources and water supplies from contamination, as well as providing water for livestock and wildlife where water was previously unavailable. Water development practices for grasslands primarily serve to distribute livestock use evenly across pastures in order to maximize the use of forage resources without causing heavy grazing effects surrounding water source areas.

Windmill watering tank for livestock. (Photo by J. Haufler, EMRI)

Pest Management

The conservation practice of pest management involves utilizing prevention, avoidance, monitoring, and suppression strategies in an environmentally sensitive manner to manage weeds, insects, diseases, animals, and other organisms that cause damage or annoyance in a direct or indirect fashion (USDA NRCS 2006b; Conservation Practices Standard 595). Pest management is used to enhance the quantity and quality of commodities while minimizing any negative impacts to the environment or humans. Increasingly, pest management is applied as a part of Integrated Pest Management (IPM) programs which utilize chemical, cultural, and biological methods to control pests based on ecological, sociological, and economic factors (Allen and Bath 1980, Masters and Sheley 2001).

Tree and Shrub Establishment

Tree and shrub establishment includes the practices of planting seedlings or cuttings, direct seeding, and natural regeneration (USDA NRCS 2006b; Conservation Practices Standard 612). Tree and shrub planting in grasslands was initiated at settlement by pioneers from eastern states who longed for the trees they left behind in the East and needed timber for fuel, building materials, and aesthetics (Droze 1977). The United States government promoted tree planting through a number of programs including the Timber Culture Act of 1873, which granted homesteads of 160 acres, provided trees were planted on 40 of those acres (Droze 1977). In an effort to cope with the decline of soil and wildlife resources associated with unsustainable farming practices and droughts of the 1930s and 1950s, tree and shrub planting was promoted by federal action agencies (e.g., SCS), which culminated in modern state and federal planting programs for conservation (Glanz 1994). In grasslands, trees and shrubs are often planted to create windbreaks, shelterbelts, or hedgerows. The benefits associated with tree and shrub plantings include reduction of soil erosion, protection of plants from wind-related damage, retention of snow, enhancement of wildlife habitat, and provision of shelter for structures, animals, or recreational areas.

Fence Establishment

Fencing is constructed to form a physical barrier to animals or people (USDA NRCS 2006b; Conservation Practices Standard 382). As a conservation practice, fencing is intended to provide the means to control movement of animals and people to facilitate the application of other conservation practices. Examples of fencing conservation practices include riparian zone exclusion (Keller and Burnham 1982), implementation of different grazing systems, modifications of fences to allow wildlife passage (Gross et al. 1983), and fencing to reduce livestock predation (Linhart et al. 1982, Nass and Theade 1988).

Restoration and Management of Declining Habitats

The conservation practice of restoring and managing declining habitats and associated wildlife is aimed at conserving biodiversity (USDA NRCS 2006b; Conservation Practices Standard 643). This conservation practice focuses on sites that either provide or previously provided habitat for rare and declining species. When compared to the other conservation practices reviewed in this chapter, this conservation practice involves incorporating several conservation practices to achieve objectives that may include restoration of lands degraded by human activity, restoration and conservation of native plant communities to provide habitat for rare and declining wildlife species, and increasing native plant community diversity.

Status of Great Plains Grassland Ecosystems

Grassland ecosystems of the Great Plains, like a majority of the ecosystems in the United States, have experienced considerable change. Historically, grasslands of the Great Plains covered vast tracts that were maintained and influenced by the interactions of fire and grazing in response to varying weather patterns. These grasslands have been generally classified into tallgrass, mixed grass, and short grass regions, depending upon the structure of the dominant species that historically occupied a site. Climate is a primary driver of where each type of grassland occurred, but fire and grazing played a role in determining the composition, structure, and function of grassland ecosystems as well (Knapp et al. 1999). While the extent and types of change affecting each category differ somewhat; all three types of grassland have undergone significant alterations. The extent of change has led some to consider grassland ecosystems among the most at-risk ecosystems in the country (Samson and Knopf 1994, Noss et al. 1995).

Grassland ecosystems have evolved with fire as a primary driver (Wells 1970, Brockway et al. 2002), particularly in the tallgrass and mixed grass ecosystems. Without fire as a disturbance process, many of these ecosystems would succeed to shrub or tree-dominated areas (Archer 1994). Fire was less of an influence in short grass ecosystems, but still played a critical role in shaping species compositions, nutrient cycling, and discouraging the invasion of drought-tolerant shrubs or trees (Wright and Bailey 1982). The role of fire, with rare exceptions, has been largely eliminated in grassland ecosystems. This has modified the composition of species, altered nutrient cycling, and influenced grazing patterns of native herbivores, which in turn has influenced the structure of the vegetation. Grazing by native herbivores, especially bison (*Bison bison*), played a significant role in shaping and maintaining grass and shrub ecosystems in the Great Plains (Knapp et al. 1999, Hart and Hart 1997) and interacted with fire to create a shifting mosaic of conditions (Knapp et al. 1999, Fuhlendorf and Engle 2001). Although grazing by domestic animals is currently the primary use of grasslands, the foraging ecology of grazers that historically occupied the Great Plains differs from those used today, (Plumb and Dodd 1993) and the current grazing practices in grassland ecosystems have been found to dramatically differ from the historical role of herbivores (Fuhlendorf and Engle 2001). Existing livestock grazing practices have been focused on achieving even distribution of animals and even utilization, which produce relatively uniform or homogeneous vegetation conditions, a condition referred to by Fuhlendorf and Engle (2004) as "management to the middle." Several grassland conservation practices of the Farm Bill, including water developments and grazing prescriptions, have been used to distribute grazing intensity relatively evenly across pastures, thus contributing to these uniform conditions.

Disruption of historical disturbance regimes has affected all types of grasslands in the Great Plains (Brockway et al. 2002). Conversion of grassland ecosystems to cultivation and other land uses has also had a significant influence. This influence has been greatest in the tallgrass ecosystems, where more than 99 percent conversion of sites with soils and topography favorable for cultivation has been reported (Samson and Knopf 1994). Conversion levels in mixed grass and short grass ecosystems have been less than in tallgrass ecosystems, but can still have significant local impacts on wildlife species.

The net effect of the above impacts has resulted in serious concerns about reductions in grassland biodiversity. Grassland bird population declines are on a track to create a conservation crisis in these ecosystems unless current trends are reversed (Brennen and Kuvlesky 2005). Various studies have investigated mammals associated with Great Plains grasslands (see below for examples), but little information exists on current status of most mammals with respect to historical conditions and distributions. It is known that grizzly bears (*Ursus horribilis*) and wolves (*Lupus canadensis*) have been extirpated from the Great Plains. The black-footed ferret (*Mustela nigripes*), listed as a federally endangered species, was extirpated from the Great Plains but is currently in the process of being reintroduced to several locations (Dobson and Lyles 2000). Recent attention has provided considerable information on the status of the black-tailed prairie dog (*Cyonomys ludovicianus*) and its role in creating ecosystems that help provide habitat for a number of associated species (Miller et al. 1994, Kotlier et al. 1999). Less is known about the effects of the above changes on other taxa. The current status of many species, including most grassland-supported reptiles, amphibians, insects, and many plants, remains largely unknown.

In addition to grassland species, sagebrush and other shrub ecosystems evolved in areas of the Great Plains that were not as heavily influenced by fire, although some shrub species in some areas are adapted to fire and quickly resprout following burning. Sagebrush-steppe ecosystems in the western United States, comprising some 44 million acres (Miller and Edelman 2000), are not specifically addressed in this chapter, although they share many of the concerns for sagebrush and other shrub systems associated with the Great Plains, including invasion by exotic species such as cheatgrass (*Bromus tectorum*). Concern exists for various species of wildlife associated with sagebrush ecosystems (Paige and Ritter 1999). Greater sage-grouse (*Centrocercus urophasianus*) have experienced significant declines (Schroeder et al. 1999) and have been considered for listing under the endangered species act. Major initiatives have been established to address the conservation of this species.

Wildlife Response to Grassland Conservation Practices of the Farm Bill

Grassland conservation practices can affect wildlife species in a number of ways. For example, conservation practices can affect the compositions, structures, nutritional quality, and other habitat features of specific sites. Wildlife use of an area is also influenced by the kinds of habitat features occurring in the surrounding area. This is particularly true where patchy or linear arrangements of grasslands occur, as discussed by Clark and Reeder (this volume). The overall status of a wildlife population in a given area will depend on the total availability of suitable habitat in a larger planning landscape or region. Thus, wildlife populations will be influenced by the overall types and arrangement of grassland ecosystems within a region as well as the occurrence of detrimental factors including barriers to movements, source areas for competing species, non-habitat related mortality factors, and other types of population threats.

Studies that specifically addressed Farm Bill-funded grassland conservation practices were not identified in the literature. However, considerable information on wildlife responses to grassland practices in general is available.

Grazing Practices

Great Plains grasslands, as discussed above, were historically dependent on grazing by native herbivores and fire as disturbance factors that shaped ecosystem diversity (Knapp et al. 1999, Fuhlendorf and Engle 2001). Current grazing by domestic livestock has been documented to create different responses in ecosystem diversity than historical conditions, but grazing can be used as an important management tool to achieve a variety of conservation objectives. Wildlife responses to grazing will depend on the type and intensity of grazing applied to specific ecological sites. Milchunas and Lauenroth (1993) conducted an extensive review of literature on effects of grazing. Among their findings was that grazing has a more significant effect on ecosystems that did not have an evolutionary history of extensive grazing. Great Plains grasslands have a well-documented history of grazing by native herbivores, while the historical role of grazing in sagebrush-steppe ecosystems is not well documented and is likely to have been a more minor influence.

The effects of grazing can be difficult to characterize because effects vary depending on the type of ecosystem and its evolutionary history, specific site differences, weather patterns during a study, surrounding land uses, intensity of grazing, response variable used to assess grazing effects, and other factors (Milchunas and Laurenroth 1993, Curtin 2002). Furthermore, studies often fail to account for many of these factors and may use quasi-experimental designs, so conclusions must be viewed cautiously (Jones et al. 2000).

Prescribed grazing as a Farm Bill conservation practice can be used to achieve a variety of conservation benefits. Two of the identified uses, improving or maintaining the health and vigor of plant communities and improving or maintaining the quantity and quality of food and/or cover available for wildlife, can have a wide range of interpretation. Current development of ecological site descriptions for grassland and sagebrush ecosystems identifies the range of specific states and their transitions that occurred under historical disturbances and current uses. Under historical disturbances, specific locations within a landscape may have experienced heavy levels of grazing by native herbivores, while other locations may have had light levels of grazing depending upon the landscape, proximity of water, history of fire events, surrounding topography, and other factors. Providing for all wildlife within a landscape may require that the full complexity of ecosystem diversity that occurred historically be represented within a landscape (Haufler et al. 1996, Haufler 2000). This makes understanding and specifically defining the desired health and vigor of plant communities — as well as the quantity and quality of food and/or cover for wildlife — complex.

Grazing effects on bird populations have received the most research relative to other taxa. Saab et al. (1995) summarized the findings of a number of studies on 43 grassland, shrubland, or riparian bird species. They reported that 17 species were negatively affected by grazing, 18 species were neutral, and eight species were positively affected by grazing. When compared with other grassland taxa, such as above- and below-ground macroarthropods, rodents, and rabbits, birds were found to be particularly responsive to grazing. Milchunas et al. (1998) and Brennan and Kuvlesky (2005) discussed how ecosystem diversity in grasslands must be maintained and restored to address the needs of all grassland bird species. Milchunas and Lauenroth (1993) reported on results of a number of studies conducted on birds.

A number of studies have reported on the response of mammals to grazing. Phillips (1936) investigated use of sites receiving different levels of grazing by various rodents and lagomorphs in Oklahoma and found some species prefer heavily grazed areas while others were more abundant in "normal" areas. Grant et al. (1982) and Clark et al. (1989, 1998) studied the response of small mammals to grazing of grasslands and found that species respond differently to grazing. Deer mice (*Peromyscus maniculatus*) tended to increase on grazed sites, while species that require more grass cover or litter such as harvest mice (*Reithrodontomys* spp.) or voles (*Microtus* spp.) tended to prefer ungrazed areas. Matlack et al. (2001) compared deer mice use of areas grazed by both cattle and bison following burning in a tallgrass prairie in Kansas and noted different abundances in various seasons they investigated. This illustrates that providing habitat conditions for all species of native small mammals, as with birds, requires providing representation of the full range of ecosystem diversity. Prescribed cattle grazing has been successfully used to achieve more specific management objectives, such as improving forage quality on rough fescue grasslands for elk and deer (Short and Knight 2003).

Effects of grazing in grasslands on other taxa have not received extensive research. Kazmaier et al. (2001) reported on the response of Texas tortoises (*Gopherus berlandieri*) to moderate levels of grazing, and found no effects. Similary, Ballinger and Jones (1985) reported no effects of grazing on a lizard community in western Nebraska. Joern (1982) and Quinn and Walgenbach (1990) investigated the response of grasshoppers to grazing.

Effects of grazing in sagebrush ecosystems have received less attention than in grassland ecosystems. Beck and Mitchell (2000) compiled available literature and discussed the influences of livestock grazing on sage-grouse. They found both positive and negative impacts of livestock grazing and related these impacts to both direct and indirect effects. They reported that indirect effects of livestock grazing (e.g., herbicide or mechanical reductions in sagebrush to increase forage production) have had greater impacts to sage-grouse than direct impacts. Direct impacts include loss of food and cover for sage-grouse associated with livestock consumption of grasses and forbs. Crawford et al. (2004) reported that livestock grazing can have negative or positive effects on sage-grouse depending on the timing and intensity of grazing. However, judiciously applied livestock grazing prescriptions can be a valuable tool to help restore sagebrush ecosystems for sage-grouse (Vavra 2005).

In total, these studies indicate that wildlife responses to grazing can range from beneficial, to neutral, to negative. Great Plains grasslands evolved with considerable grazing pressure from bison and other herbivores. However, current grazing by domestic livestock is often conducted in intensities and durations across large landscapes that produce different conditions when compared with historical grazing by native herbivores. Prescribed grazing as a Farm Bill conservation practice can be used as an effective tool to produce desired plant community conditions, but can also produce negative effects.

Prescribed Burning

Fire, as discussed above, is an integral process to the maintenance and potential restoration of grasslands in the Great Plains and plays an important role in periodically setting back sagebrush ecosystems. Effects of the prescribed burning practice under the Farm Bill have not been specifically researched, however, a number of studies on wildlife responses to burning in grassland and sagebrush ecosystems have been conducted.

The influence of prescribed burning on wildlife varies by species, the season fire is applied, and by the fire return interval. Fire (and its exclusion from some areas) can be important to maintaining grassland heterogeneity. Several studies have reported on the importance of grassland heterogeneity to an area, as species with different habitat needs respond to the various conditions provided by this heterogeneity (Fuhlendorf and Engle 2001, Fay 2003, Bechtoldt and Stouffer 2005, Powell 2006). The season that fire is applied can influence wildlife species by altering habitat, forage, potential prey species, or by causing direct mortality. Spring burning has been found to have direct detrimental effects to several vertebrate species in grasslands (Erwin and Stasiak 1979). However, most often the effects of season of prescribed fire on wildlife are indirect, such as modification of nesting habitat, insect populations, or forage availability (Towne and Ownesby 1984, Pyle and Crawford 1996, Fischer et al. 1996, Bechtoldt and Stouffer 2005). Prescribed burning programs that promote fire regimes that are not consistent with the historical fire regime of an area can be detrimental. This was demonstrated in the Flint Hills of Kansas where annual spring burning with intensive grazing was found to reduce the abundance of grassland birds (Powell 2006).

For management of biological diversity in the Northern Great Plains, Sieg (1997) recommended applying fire at different times of the year and at intervals that vary to better mimic how fire historically occurred on the landscape. The concept of increasing habitat heterogeneity through patch burning, which creates a shifting mosaic of vegetation successional stages, has been tried in tallgrass prairies (Fuhlendorf and Engle 2001, Fuhlendorf and Engle 2004) and has been recommended as an appropriate strategy to manage biological diversity in systems that were historically maintained by fire and grazing (Bechtoldt and Stouffer 2005, Fuhlendorf et al. 2006, Powell 2006, Wilgers and Horne 2006).

Range Planting and Restoration and Management of Declining Habitats

As stated previously, providing representation of the full ecosystem diversity that occurred in an area historically may be a desirable objective for grassland management, which may be addressed using various conservation practices and their combinations. Many grassland areas lack this representation as a result of past management practices that have produced relatively uniform conditions in terms of ecosystem diversity. Management of declining habitats is a grassland conservation practice that directly addresses the need to maintain or restore plant communities that are lacking in some way and are suspected of causing a decrease in populations of desired species. Restoring these plant communities on existing grasslands may require the use of a number of other specific conservation practices including range planting, prescribed burning, prescribed grazing, control of invasive or undesirable species, brush management, and others.

A number of studies have investigated wildlife responses to grassland restoration, where restoration was from croplands back to grasslands (Blankespoor 1980, Fletcher and Koford 2002, 2003, Farrand et al. this volume). One investigative approach used in these studies was to compare restored grasslands with wildlife use of croplands, as used in many of the studies cited in Jones-Farrand et al. (this volume). This approach has demonstrated conservation benefits from CRP programs, but does not provide good insights into grassland restoration efforts applied to working rangelands where grasslands currently occur but may be in relatively uniform or undesirable compositions or structures. A second approach used in restoration studies is to compare wildlife, typically birds, in the restored areas with wildlife in "native" prairies. Two questions arise in such investigations; how did the "restored" area compare with historical conditions, and what was the condition of the "native" area that was being used as a comparison. CRP practices, discussed by Jones-Farrand (this volume) restore croplands to permanent grass cover (usually for a 10-year commitment). Many of these restored sites use native seed mixtures. But were these seed mixtures designed to restore the compositions of specific plant communities that would have occurred on a site historically and, if so, under what type of grazing and fire regime? It is known from ecological site descriptions (USDA NRCS 2003) that various historical states occurred on each ecological site, depending on fire and grazing effects. Restoration needs can be prioritized to target those states most lacking in the landscape (see Thunder Basin case study in Franklin et al. this volume), and appropriate seed mixtures and other practices utilized to restore these needed plant communities. For comparative purposes in restoration studies, "native" communities selected for comparison should be identified to represent specific historical states appropriate for a site and not assumed to represent all "native" communities in the landscape. Thus, studies of grassland restoration have a number of key questions to address to accurately reflect the measurement of restoration.

Evaluation of range planting within working landscapes (e.g., rangelands) needs additional research. Studies are needed that compare a "restored" site with an established baseline condition. Range planting has been identified as a successful method of reducing weed species in tallgrass prairie and as having the potential to reduce the ability of invasive plant species to successfully invade a plant community (Blumenthal et al. 2003). Range planting has also been successfully used as a component of IPM to accomplish multiple management objectives such as suppression of an invasive species, establishment of desirable native species, and to increase forage productivity (Masters et al. 2001, Masters and Shelley 2001).

Recent efforts to improve specific habitat for declining species have shown successes. EQIP funding was specifically targeted for sage-grouse habitat improvements, and various projects were initiated to improve sagebrush ecosystems for this species. Practices have included control of cheatgrass, mechanical treatment of decadent stands of sagebrush, range planting with species utilized by sage-grouse, and prescribed grazing. While most of these efforts are ongoing, and information on their effectiveness has not been reported to date, they indicate the ways that restoration of declining habitat can be implemented.

Tree and Shrub Establishment

Tree and shrub establishment in the Great Plains grasslands has provided a form of wildlife habitat enhancement, especially in areas that have experienced higher levels of conversion to production agriculture. Several species of birds and mammals have been documented to use tree and shrub plantings for habitat (Johnson and Beck 1988, Schroeder et al. 1992). Characteristics such as size, width, height of the tallest tree or shrub, snag density, and foliage height diversity of shelterbelts have been identified as important determinants of the diversity of avian species that use shelterbelts (Schroeder et al. 1992).

While a form of wildlife habitat enhancement is accomplished by tree planting in prairies, many species that use planted trees and shrubs for food and cover are habitat generalists that thrive at the expense of native prairie habitat specialists (Henzlick 1965, Coppedge et al. 2001a, 2001b, Clark and Reeder this volume). In fact, tree planting and woody plant expansion are associated with loss of grassland biodiversity including the recent decline of grassland birds (O'Leary and Nyberg 2000, Coppedge et al. 2001a), the fastest declining bird guild in North America (Knopf 1994, Herkert 1995). Furthermore, nesting success has been shown to decrease in some species that use trees and shrubs established along fencelines, which are similar to the linear habitats provided by windbreaks and shelterbelts, indicating that these linear habitat features can act as habitat sinks because they attract higher rates of predation (Yosef 1994).

Several species that have been planted for conservation practices are either non-native to the United States, such as Russian olive (*Elaeagnus angustifolia*) and multiflora rose (*Rosa multiflora*), non-native to the region in which they are planted, or native but invasive in the absence of historical disturbances such as eastern redcedar (*Juniperus virginianus*) expansion in the absence of fire. To avoid further degradation of grassland ecosystems, it is critical to select species for conservation planting practices that are listed in the historical climax plant community within ecological site descriptions that are appropriate for the site and are not likely to invade. Ecological risk assessment can provide a valuable tool to screen and evaluate the invasive potential of species currently used in planting programs, as well as prevent the introduction of new invasive species (Lodge and Shrader-Frechette 2003).

Fencing

Fencing is used in grasslands to keep livestock in designated areas and out of others. This allows areas to be protected from grazing, trampling, and other impacts from livestock. Benefits include development of better habitat for various species as well as protection of stream banks, water quality, and aquatic habitat (Knight and Boyle this volume). However, fencing can also have detrimental effects on wildlife. Poorly designed fencing can create barriers to animal movements, keeping animals from important habitat areas, and can ensnare wildlife (Jackson Hole Wildlife Foundation no date).

Research Needs

Considerable information, as identified in this chapter, is available on wildlife responses to many of the conservation practices applicable to grasslands. However, due to the complexities of wildlife responses, interactions among practices, varying responses in different locations, and temporal differences due to varying weather patterns, much more information and monitoring are needed. For example, Winter et al. (2005) pointed out that unlike forest ecosystems, vegetation structure in grasslands can vary dramatically from year to year. They noted that no large scale studies have been conducted that have evaluated grassland bird densities and nesting success as responses to vegetation dynamics across large areas or long time spans. They also noted differences in responses to vegetation dynamics of three species they examined.

One of the greatest needs is establishing definitions and understanding of what are "native" grasslands. This term is loosely used, often referring to unplowed areas that support some mix of predominantly native plant species. However, do such areas actually represent native grassland conditions in terms of compositions, structures, and processes, or do they represent the conditions resulting from the "management to the middle" (Fuhlendorf and Engle 2004) that has caused reductions in grassland heterogeneity and declines in many wildlife species? Until a better baseline is established and recognized that describes an appropriate range of states for ecological sites across delineated planning areas such as Major Land Resource Areas delineated by NRCS, references to native grassland ecosystems will be problematic.

Many of the practices described in this chapter result in mixed responses by wildlife species. The literature review clearly documented this for prescribed burning and prescribed grazing. With various species benefiting while others are impacted by any specific practice, it is clear that a mix of practices must be utilized to maintain and increase grassland heterogeneity. Research is needed that addresses the most effective and efficient ways of creating this heterogeneity in different grassland ecosystems.

Most available information has examined responses by wildlife species to changes in habitat conditions at specific sites. Information is lacking on landscape influences that can result in varying responses by a wildlife species to conditions at a specific site. While some studies, especially a number of the more recent investigations, often include measurements of these factors, complexities in experimental designs required to effectively address landscape factors make these studies difficult. With annual differences in weather often confounding results, as noted by Winter et al. (2005), larger scale and longer term studies are needed.

Grassland birds are the most studied of the grassland taxa. Considerably more information is needed on all of the other taxa. However, as noted above, even many basic questions about grassland birds still remain unanswered.

As conservation practices are applied, they should be monitored, and when feasible, use an adaptive management approach (Franklin et al. this volume). Providing replicated application of practices can be challenging, but is important to incorporate if the deficit of information on grassland responses to conservation practices is to be corrected. ■

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