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Native Grassland Management Guidelines for Nebraska's Wildlife Management Areas

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Table of Contents

Chapter 1 - Introduction

This document is one of a four part series produced by the Nebraska Game and Parks Commission to provide direction to managers of Wildlife Management Areas (WMAs) in Nebraska. Other documents in the series cover management of woodlands, wetlands, and converted habitats.

Prior to EuroAmerican settlement grasslands covered 98% of the Nebraska landscape and supported the majority of the state's biodiversity. Since settlement, Nebraska's native grasslands have suffered serious decline. For example, approximately 98% of eastern Nebraska's tallgrass prairie has been lost to development. In central and western Nebraska grassland losses have been less dramatic though still substantial. Remnant grasslands are threatened by development, exotic plant invasion, and mismanagement. Only through sound management can the prairies on our WMAs, as well as the native plants and wildlife dependent on them, be preserved for the citizens of Nebraska. .

This document is directed towards management that maintains and enhances the ecological character and biodiversity of native grasslands on WMAs. Though plant community-based, the management objectives and strategies promoted within this document will provide benefits for wildlife including game species.

The specific objectives of this document are as follows:

1) Develop a philosophy of native grassland management for WMA managers.
2) Provide background of information on the need for and benefits of sound grassland management.
3) Provide information that will help land managers identify grassland types and their ecological quality.
4) Provide information on grassland management techniques.
5) Provide minimum management requirements and management options for native grasslands on WMAs.

Grassland Definition

Grasslands are plant communities dominated by graminoids and with < 10% tree cover. Those communities with a graminoid-dominated groundlayer with > 10% tree cover are known as savannahs or woodlands. This guide deals only with native grasslands, those communities with unplowed native soil profiles and dominated by native vegetation. Formerly plowed grasslands are covered in the converted habitat guide.

Grasslands Types

The presettlement distribution of Nebraska's grassland types were based on several factors, primarily climate, soils and topography. Annual precipitation ranges from 12 inches in the northwest Nebraska to 34 inches in southeast Nebraska. The mean annual temperature also varies from about 46 degrees F in northwest Nebraska to about 54 degrees F in the southeast corner of the state. In response to climate, the plant species composition of prairies and therefore prairie types vary across the state in a primarily east/west gradient. Nebraska's soils vary from mainly loess-derived soils in eastern and central Nebraska, eolian sand-derived soils in north central Nebraska, and

soils weathered from sandstone, siltstone, shale and other materials in the Panhandle. Stream valleys soils are mainly formed in alluvium.

For the purpose of this document Nebraska's grassland were lumped into five general systems: tallgrass prairie, central mixedgrass prairie, sand prairie, western mixedgrass prairies, and wet meadows. These types are described in greater detail later in this document.

Threats to Nebraska's Native Grasslands

A large percentage of the Nebraska's presettlement grasslands has been plowed or otherwise developed. For example, roughly only two percent of Nebraska's tallgrass prairie remains. For comparison, roughly 50 percent of Nebraska's mixedgrass prairies remain and only about 10 percent of the Sand prairies has been plowed. Most remaining prairies are on soils too poor, dry or steep for farming. Today, high-quality native prairies are rare, though they can still be found on both conservation and private lands. Most remnant prairies are in fair or poor ecological condition, the exception being in the Sandhills where most upland dune prairies are still in good condition.

The small size and isolated nature of many prairie remnants has resulted in increased edge effects and invasion by non-native species, possibly low genetic diversity of plant and animal species, and increased localized extinction rates. An objective on WMAs is to mitigate threats and stresses to remnant prairies. The primary existing threats and stresses to Nebraska's prairies are as follows:

1) Overgrazing – Overgrazing or poor grazing management has impacted many of Nebraska's grasslands leading to loss of native plant diversity and abundance, invasion by non-native species, and uniform structure for wildlife.
2) Extended rest – This threat occurs mainly on public lands. Long-term rest from disturbance leads to litter accumulation, invasion by non-native plants and eventual loss of native plant diversity and abundance. In drier regions, excess litter can reduce infiltration of precipitation leading to reduced plant growth and reduced spring and stream flow. Dense litter accumulation can also increase the risk and severity of wildfires in some western landscapes. Extended rest is the major source of grassland degradation on WMAs and other conservation lands managed for wildlife. It is especially severe in productive wet meadow habitats where litter accumulates rapidly. Many wet meadows on WMAs have become dominated by smooth brome and Kentucky bluegrass due to lack of active management. This results in long-term ecological degradation, loss of native plant diversity, loss of structural diversity for wildlife and increase in nest predators. Active management is needed to restore these sites to more productive wildlife habitat. of the site as wildlife habitat
3) Repetitive management - Conducting the same management (haying, grazing, prescribed fire, or rest) each year at the same time often leads to reduce native plant diversity and invasion of non-native plants. For example, annual mid-summer haying can promote non-native cool-season grasses, which have completed most of their growth cycle by mid-summer, and stresses native warm-season plants which are at peak growth.

4) Woody invasive species – Lack of integrated fire and grazing management, among other factors, has led to an increased rate of tree and shrub invasion in Nebraska prairies, especially in eastern and central Nebraska and on Pandhandle escarpments. Invasive woody species include both native and non-native species and deciduous and coniferous species. Woody invasion can reduce native plant diversity and abundance, promote invasive herbaceous species, such as smooth brome, fragment wildlife habitat, and reduce soil moisture levels. Trees also provide habitat and perch sites for nest predators, such as raccoons and raptors.
5) Herbaceous invasive species – Invasive herbaceous species compete with and displace native plants and degrade wildlife habitat. In addition, some control measures, such as broadcast herbicide spraying, can be damaging to native vegetation.
6) Herbicide spraying – Grasslands are often broadcast sprayed to control noxious weeds or other weeds. Dependent of timing of application and which chemical is used, herbicide spraying can lead to the loss of plant diversity and abundance. Herbicide spraying can also open space for other undesirable plant species to invade.
7) Fragmentation – Fragmentation of grasslands by crop fields, housing, towers, fences, woody species, or other factors increases edge effect. This can lead to increase invasion by non-native species, loss of genetic diversity, species extinction, and degradation of wildlife habitat.
8) Plowing – Plowing of native grasslands is an ongoing problem. This directly destroys prairies and their unique soil profile and leads to increase soil erosion, subsequent stream degradation, and release of soil carbon.

Chapter 2 - Philosophy and Principals of Grassland Management on WMAs

Management Philosophy

Management philosophy can be just as critical to sound grassland management as choosing the proper management technique. The management philosophy for native grasslands on WMAs should include the following considerations:

1) Grassland management is a long-term process - Grassland management is a long-term process. However, some management objectives, for example, reducing downy brome or modifying vegetation structure, can be accomplished in the short term. Some management objectives, such as increasing native forb abundance, may take decades. Managers should choose management strategies that will accomplish both short-term and long-term objectives.
2) Strive to meet management objectives - Management objectives are defined for all grassland types in this document. Managers should strive to meet these objectives in a set period of time.
3) Use adaptive management – Adaptive management is simply the process of setting objectives, taking action, then measuring progress and adjusting strategies

if necessary. Once management plans are implemented they need to be regularly evaluated after a period of years to see if management objectives are being met. Frequently altering management plans in response to short-term goals or perceived problems is not adaptive management.

4) Be flexible and use diverse management – Flexibility is key to sound grassland management. Managers must be willing to use diverse management practices, changing management methods, timing, and intensity on any given grassland to meet management objectives if necessary. The primary management tools to be used on grassland are fire, grazing, and rest. Diverse management promotes both species diversity and structural diversity. Simplified management, for example, use of only spring prescribed fire, can simplify a prairie's species and structural diversity. Unpredictable factors may also require managers to be flexible. For example, drought may require that prairie not be grazed or burned in a given year or for several years.
5) Know how to identify native and exotic plants – Being able to identify prairie plants, as well as exotic plants, is vital to sound prairie management. The presence of certain prairie plants and exotic plants, are indicators of prairie condition and management needs. Changes in a prairie's ecological condition, both positive and negative, will be reflected in its species composition. Also, some prairie plants are especially beneficial to wildlife, for example, deer vetch is a forage species for game birds, and the ability to identify these species is valuable to wildlife managers. At-risk plant species may also be management priorities and managers must be able to identify these in the field.
6) Make native grassland management a priority – WMA managers have high work loads and if grassland management objectives are to be met grassland management will need to be become a priority task. Extensive time and resources can be put into management planning, but if time is not allocated to on-the-ground management this effort will be in vain. Additional funds will likely need to be directed to management of native grasslands on WMAs to meet the management objectives stated in this document.
7) Prioritize management to highest quality grasslands – Many high-quality native grasslands occur on WMAs. Such prairies are uncommon and they need proper management to ensure their survival. However, management resources are limited and it is likely not all native grasslands on WMAs will receive proper management. It is essential that the highest quality grasslands (Grade A and B sites) be given management priority.

<u>Guiding Ecological Principals</u>

Guiding ecological principals are general rules agreed upon by WMA managers to guide management of native grasslands on WMAs. Individual guiding principals may not apply to all management situations. For example, it may not be feasible to provide structural diversity nor do large scale management on a small prairie. Mangers are to follow these guidelines where applicable during grassland management.

1) Manage for native species diversity - Grasslands with a high diversity of native plants provides habitat and food for a greater variety of wildlife species than less

diverse grasslands. Diverse grasslands are also more resilient to drought, invasive species and other disturbances. Reducing exotic species and providing variability in the timing and intensity of management generally allows for the greatest plant diversity in grasslands. Avoid uniform management at the same time each year, such as annual mid-summer haying or repetitive spring burning, as such management favors certain species and leads to their dominance in a grassland at the expense of other species.

2) Restore natural disturbance regimes – Restoring to the greatest extent possible the natural disturbance regime to prairies will promote the greatest plant and wildlife diversity. Fire and large ungulate grazing were the primary presettlement disturbances in Nebraska grasslands.
3) 3) Strive for structural heterogeneity - Where possible managers should strive to provide heterogenous vegetation structure for wildlife. Avoid using grazing systems or burn regimes that produce uniform structure. Specifically avoid rapid rotation grazing as when applied within small paddocks and at high stocking stock rates they often promote uniform vegetation structure and loss of plant species diversity. Slower rotations with lower stock densities and larger paddocks might mitigate some of the impacts of this grazing system. In general, additional interior fencing and watering facilities can contribute to uniform grazing. Providing structural heterogeneity in small grasslands may be difficult as management options are often limited.
4) Decrease fragmentation - Manage for large, unfragmented prairies where possible as many grassland species require unfragmented habitats and/or habitats of specific size. Remove all invasive or nonnative shrubs and trees, food plots, and fences where possible from native grasslands. Do not place food plots or other soils disturbances in unbroken native prairie.
5) Restore natural communities – In situations converted habitats can be restored to native plant communities providing ecological benefits. For example, providing native grass buffers to high-quality native prairies can help alleviate edge effects. Where possible, restore converted habitats (e.g. old fields) within higher-quality native grasslands using local ecotype seed.
6) Emphasis large-scale management - Where possible, provide for large-scale management with regard to prescribed fire and grazing systems. Large scale management is more efficient than small-scale management and allows more management to be accomplished.
7) Control invasive species - Manage prairies to have as few exotic species as possible. Treat all populations of invasive plant species using ecologically sensitive methods. Herbicide use should be minimized. Spot spraying is the recommended form of herbicide application. Use the most specific herbicide available for problematic weeds and spray at the most effective time of year for specific species. Use mowed firebreaks. Disced and plowed firebreaks can promote invasive species encroachment and soil erosion.
8) Manage for at-risk species – Where present in grasslands on WMAs at-risk species should be given management consideration. Their habitat, however, can often be improved through management at the plant community level.

Quality Grades

The first step in grassland management on WMAs is to map all native plant communities and converted habitats then assign condition grades to these areas. The condition grades will facilitate management decisions and planning (see below). Native grassland condition is determined by native plant diversity and abundance and abundance of invasive species. Detailed criteria for ranking are provided for each Nebraska grassland type in Chapter 5. Condition grades for grasslands range from A through D, with Grade A grasslands being in the highest ecological condition, and Grade D grasslands being the most highly disturbed.

Levels of Improvement

In many situations it is possible to improve a prairie's condition grade through management. In most cases, however it is unlikely a prairie can be improved more than one condition rank as components of its plant diversity have been permanently lost. For example, it may be possible to convert a Grade C prairie to a Grade B prairie, but not to a Grade A prairie. Some Grade D prairies are so degraded, for example, invaded by exotics and lacking native plants, that it is likely not possible to improve their condition. Management objectives for all Grade B and Grade C prairies should be to improve their condition grade at least one grade. The management objectives for Grade A prairies is to maintain Grade A condition.

Prairie Restoration

Prairie restoration is here defined as the process of planting a prairie from seed on a site that is presently cropland or other converted habitat type including previously seeded grasslands (e.g. CRP plantings). Prairie restorations can serve many valuable functions on WMAs, such eliminating fragmented areas within existing native grasslands, providing buffers to native grasslands, and providing habitat for native plants and wildlife. The following guidelines are to be followed when conducting prairie restorations on WMAs:

1) Use only local ecotype seed if available (if local ecotype seed is not available for harvest or sale, local cultivars are acceptable in certain circumstances). The definition of local ecotype seed varies among ecologists, but as a general rule seed should be collected within a 100-mile radius of the restoration site. The use of local ecotype seed has many advantages: a) it will likely have genetics similar to native plants formerly growing on the site, b) resulting plants will be well-adapted to the climate and soils of a restoration site, c) use of local-ecotype seed prevents contamination of local native plant gene pools, which can occur when cultivar seed or non-local ecotype seed is used, and d) many cultivars are often highly aggressive and can spread from restoration sites into native grasslands.
2) Seed of native plant cultivars or non-native species is not to be interseeded into existing native grasslands or planted adjacent to higher quality (Grade A and Grade B) grasslands.
3) The number of species used in local ecotype prairie plantings can vary. If a goal is high plant diversity use seed from as many species as possible. Many Nebraska prairie restorations contain over 100 plant species. If the goal is to provide a

buffer for native grasslands or provide a specific wildlife habitat fewer species can be seeded.

4) Due to the expense of high-diversity ($\geq$ 40 species), local ecotype plantings these plantings not be broken out at a later date.
5) High-diversity, local ecotype plantings are to be management as Grade B prairies of similar type. Lower diversity (< 40 species), local ecotype plantings can include management practices suitable for Grade C prairies of similar type.

Seed harvesting, processing, and planting methods for local ecotype prairie restorations are outlined in Steinauer (2003).

Chapter 3 – Grassland Ecology

Need for Management

Nebraska's presettlement prairies were highly adapted to disturbance. They burned frequently, were grazed by both large and small herbivores, and endured droughts and sometimes flooding. Periodic disturbance is essential to maintain and enhance prairie quality, plant and animal communities and ecosystem processes. Natural disturbances in presettlement Nebraska prairies operated at a variety of scales, intensities and duration. Climate operated at a large scale, fire and grazing at intermediate scales, and insect herbivory and numerous other factors at small scales. Interaction of disturbances, for example, fire, grazing, and landscape features increased the range of patch types within grasslands with varying species composition and structure.

It is important to remember that in presettlement Nebraska, the disturbance regimes occurred within a large grassland landscape. Now most prairies are managed within a fragmented landscape with a limited disturbance regime applied on regular intervals. This has resulted in a much simpler grassland ecosystem.

A primary goal of prairie management on Wildlife Management Areas is to mimic the natural disturbance regime of prairies to the greatest extent possible. Circumstances in today's world often make this difficult. For example, a prairie may be located near a housing subdivision making prescribed burning challenging or a small prairie may not have the infrastructure needed for grazing. In addition, specific management challenges may require use of a somewhat unnatural disturbance regime. For example, efforts to control of the highly invasive smooth brome in a prairie may require several consecutive years of early spring fire followed by intense spring grazing.

As previously mentioned, disturbance is critical to maintain and enhance the ecological quality and diversity of native prairies and to maintain habitat for native plants and wildlife. Nebraska's prairies are typically dominated by warm-season grasses. The exceptions are western mixedgrass prairies and wet meadows where cool-season graminoids often co-dominate. Though, dominated by warm-seasons, historically Nebraska's grasslands also supported a diversity of non-dominant, cool-season grasses, sedges, forbs (broadleaf plants that die back to the ground each year), and short shrubs. Mismanagement and other factors have greatly reduced the diversity of plants found in most Nebraska prairies. Many of Nebraska's grasslands are now dominated by exotic cool-season grasses; common, native warm-season grasses with relatively few conservative forbs.

Prairie forbs are a vital component of prairies, providing the majority of the plant diversity and are diagnostic of ecological condition. Forbs are largely responsible for the pattern of small- and mid-scale vegetation diversity (heterogeneity) in native grasslands (Biondini et al. 1989). Forbs also fix nitrogen, serve as a resource base for vertebrate and invertebrate consumers, protect bare ground from erosion, draw nutrients from deep in the soil, and provide a variety of niches for wildlife. Managers should strive to increase native forb diversity and abundance, as well as the diversity and abundance of native grasses, sedges, and shrubs, in grasslands.

From a range management perspective, diverse prairies provide stable forage production by consistently having a species or group of species available to capitalize on the present environmental and management conditions. When properly managed, native grasslands will have stratified root distribution, use water and nutrients efficiently, and produce abundant above ground growth. Many native forbs provide significant nutritious forage and macronutrients not found in grasses. In addition, grasslands with a diversity of native plants better repel invasive and noxious plant species.

Though, grassland plant diversity is increased through periodic disturbance, it can also be decreased if the disturbance is too frequent, too intense or poorly timed. It is therefore critical, that managers implement management regimes with well planned timing, intensity and duration.

A major consequence of lack of disturbance in Nebraska grasslands is excess litter accumulation. Dense litter limits infiltration of precipitation, limits sunlight from reaching the soil surface, cools soils, and limits space for native seed germination and seedling growth. These factors often lead to the invasion of exotic, cool-season grasses and other weedy plants. Dense litter also interferes with large ungulate grazing and ground foraging by many wildlife species, and in general reduces the diversity and abundance of forage species available for wildlife.

In previous decades, land managers often assumed that little or no management of grasslands resulting in dense vegetation and litter provided benefits to wildlife. For example, such management was thought to produce dense nesting cover that benefits game birds and waterfowl. Research has shown that this assumption is generally false. On the Crescent Lake Wildlife Refuge, dense litter in wet meadows has led to increased populations of small mammal species which thrive under such condition (Steinauer 2009). These mammals are a food sources for predators, such as bullsnakes, whose populations may subsequently increase due to the increased food source, resulting in increased nest predation including predation of game birds nests. Grazing of the meadows on the Refuge was found to increase duck nesting success.

The plant diversity created through disturbance can provide a diversity of niches for wildlife. Many prairie arthropods, for example, are dependent on specific prairie plant species as food sources or habitat. Case in point, the small snout beetles (*Tychius liljebladi*) lay their eggs only on the seed pods of Canada milkvetch. Without the milkvetch the species would vanish. In general, prairies with a diverse flora and structural heterogeneity will have maximum arthropod diversity. The greater the arthropod diversity in a prairie, the greater will be the diversity of plant pollinators, decomposers, and wildlife food sources.

Many grassland wildlife species are dependent on a variety of structural components throughout the season. For example, sharp-tail grouse prefer to nest in areas

of dense grass cover, but their leks are located in areas with short vegetation, and most brood rearing occurs in areas with high forb cover. Diverse grassland structure can be provided through management. Further, using certain management practices, such as patch burn grazing, a diversity of vegetation structures can be provided within individual management units.

In conclusion, Nebraska's grasslands evolved with fire and large ungulate grazing as key disturbance factors. The frequency and intensity of these disturbances were critical to ecological processes, biological diversity and heterogeneity across multiple spatial scales (Collins 1992; Fuhlendorf and Smeins 1999). Recreating these natural disturbances, primarily through prescribed fire and planned grazing, but also other management practices, is key to maintaining both species and structural diversity within grasslands. On larger prairies, there is greater potential for diversification of management and to manage using a diversity of tools to create various habitat patches. In many cases, especially on small prairies or those near urban areas, management may be limited to specific actions, such as haying, and it may be unrealistic to try to simulate presettlement disturbance conditions. Collins and Steinauer (1996) proposed a "flexible regional scheme that includes consideration of realistic goals relative to factors such as size of a given reserve, surrounding landuse, distance to the nearest reserve, management objectives, and available natural and human resources."

Fire in Grasslands

Lightning-set and Indian-set fires were a primary disturbance in presettlement Nebraska grasslands. The presettlement fire return interval was estimated to be 3 to 5 years for tallgrass prairie, 5 to 10 years for moist mixedgrass prairie, and 25 years for dry mixedgrass prairie (Samson and Knopf **1996**). Indian-set fires occurred primarily in two periods: March through May, with a peak in April, and July through early November, with a peak in October. Lightning-set fires occurred during summer and early fall, with most in July and August (Higgins 1986).

Managers need not exactly mimic presettlement fire return intervals for particular prairie types, as more frequent or infrequent fire return intervals may be needed to manage native grasslands in today's altered environment. Also, season of fire need not follow historic season of fire as invasive species and limited resources and burn windows require that prescribed fire be used during all seasons of the year when management objectives can be achieved. Engle and Bidwell (2001) concluded that a variety of composition and production responses to season of fire are possible, and that the native grasslands of Kansas and Oklahoma are more resilient to burning in any season than is commonly held by conventional wisdom. Burning can be justified for any season of the year as long as management objectives are met. For example, winter fires can be used to control cedars, which are at low moisture content at this time of year, and to prepare grasslands for spring grazing. Late spring fires can be used to control exotic cool-season grasses, whereas, mid- and late-summer fires can be used to reduce warm-season grasses and stimulate forbs, and control some brush species. Fall fires can be used to reduce litter and also prepare grasslands for spring grazing.

The effects of season of fire are well covered in the literature and a few examples are provided here. Wright and Bailey (1982) stated that wildfire during the growing season is detrimental to arid (9.6 to 16 inches mean annual precipitation) mixedgrass

prairie, but that on wetter sites (16 to 20 inches or annual precipitation) the vegetation is better able to withstand growing season fire. In mesic mixedgrass and tallgrass prairie, studies have shown the frequent use of spring fire tends to increase in warm-season grass dominance and overall homogeneity and decreases cool-season grasses, forb cover, biomass, native annuals, and the richness of some aspects of the plant, bird, small mammal and forb-feeding invertebrate populations. At Prairie State Park in Missouri forbs, native cool-season grasses, native annuals, the earlier blooming spring species responded more strongly the year after fall and winter fires than spring fires (McCarty et.al 1997**)**. Fall burns can also increase the amount of green forage available in fall, winter, and early spring. McCarty et al. (1997) found fall and winter burns increases production of many strong seed-producing annuals, biennials, and perennials, particularly forbs of value to wildlife. If cool-season exotics are present in grasslands dormant season fires may promote their increase.

Populations of many early-season forbs are affected directly by spring burning, whereas mid- to late-season forbs are affected indirectly by fire-induced increases in the competitive vigor of dominant warm-season grasses. Howe (1994) stated that it can be assumed that if abundant before a fire, forbs should increase after a fire if the fire reduces the competitiveness of other species and if the timing is not coincident with a susceptible stage of development of the forbs in question.

Plant species diversity is greatest at intermediate fire frequency (very 3 to 6 years) in tallgrass prairie. Very infrequent fire in tallgrass prairie results in a reduction in both warm-season grass and forb species and increases in woody vegetation. A long-term study on ungrazed sites on Konza Prairie indicate that fire frequencies of every 4 years or less allows significant increases in woody plant densities (Hartnett 1995).

Timing is also critical when using fire to control invasive species. This can be illustrated with an example from North Dakota (Manske 2005). Prescribed burns conducted in early summer (mid-late April), spring (May-mid June), and mid summer (early-mid August) resulted in decreased western snowberry shoot frequency and shrub biomass. These burns coincided with the first two carbohydrate drawdown periods of western snowberry. The first drawdown occurs during early spring (mid April to early June) when the plants are in rapid growth to full leaf expansion stages. The second carbohydrate drawdown period occurs during the major portion of fruit fill stage, mid July to mid August. Fire in late June and early July did not impact snowberry.

Fire may lead to the direct mortality of some at-risk wildlife. For example, massasauga rattlesnakes that inhabit southeast Nebraska tallgrass prairies have slow metabolic rates in early spring when fresh out of hibernation. Early spring fires near hibernaculums can kill the snakes. In such cases, managers should avoid burning at the time of year when at-risk species are vulnerable.

It is sometimes recommended to burn only portions of prairies at a given time to prevent harm to local insect populations. In most Nebraska landscapes this is not a great concern as other prairies are nearby from which insects can recolonize the burned site. For certain, isolated tallgrass prairies, it may be desirable to burn only portions of the site at a given time.

Grazing in Grasslands

Bison were the primary presettlement large ungulate grazer of Nebraska prairies. Today, under many management scenarios cattle can be used as a substitute for bison to attain management goals. When properly applied, cattle grazing can be used to alter grassland species composition, reduce litter, diversify vegetation structure, increase the amount of bare ground, reduce exotic species, increase the productivity of selected species, and increase the nutritive quality of the forage (Tunnell 2004). When misapplied, however, livestock grazing can degrade prairies, reduce native plant diversity and abundance, encourage nonnative plant invasion, and homogenize or degrade wildlife habitat. Grazing is a tool that allows managers flexibility with regard to timing, frequency and intensity of plant defoliation, and to some extent which specific species or group of species are defoliated.

There are two basic methods of using grazing as a management tool in grasslands. One is to use them infrequently (every few years), for limited periods to address a particular management issue. For example, short-term, intense spring grazing to reduce exotic cool-season grasses. The other scenario is to use cattle as part of a permanent grazing method or system, such as rotational grazing or patch burn grazing. Grazing systems are a specialization of grazing management that defines reoccurring periods of grazing, rest, and deferment for two or more pastures (Heitschmidt and Taylor 1991). Which grazing system is best for specific grasslands depends on the land management objectives, grassland size and condition, available grazing infrastructure, and other factors.

The most critical issue when planning livestock grazing for biodiversity management (e.g. to impact grassland plant diversity, composition or structure) or livestock production is stocking rate (animal unit days per acre or animal unit months per acre). Stocking rate influences the overall intensity of herbivory and physical impacts. Light stocking rates allow cattle to select favored grazing species or areas. Heavy stocking rates forces cattle to consume more plant species. It is critically important for managers to understand stocking rate. If in doubt, managers can seek assistance from Natural Resource Conservation Service (NRCS) staff or other range managers who can help estimate needed stocking rates taking into consideration objectives, topography, soils, and current vegetation condition. Managers should not operate on the assumption that the stocking rate will always remain the same on their grasslands without taking into consideration that overtime tree encroachment, invasive species, and loss of grazing plant vigor, can reduce available forage.

The second most important issue in livestock grazing is summer pasture use sequence. In grazing systems the summer pasture use sequence should vary for a pasture from year to year so as to not graze during the rapid growth period or other critical live stage of plant species in consecutive years. This can overly stresses particular plant species. For example, grazing a tallgrass prairie every summer in July and August is likely to stress native tall grasses and mid-summer blooming plants such as compass plant.

The third most critical issue is season of grazing. There is a need to provide full season deferment (from spring green up to killing frost) at minimum once every three to four years in any grazing system so plants can restore root energy, grow new roots, develop buds, and complete reproductive cycles. Longer-term rest and reduced stocking

rates, especially during periods of favorable plant growth, contribute to the sustainability and recovery of grasslands (Muller et al. 2007). The year after deferment the forage potential of deferred pastures will be greater and there will be more grass for cattle to graze providing less chance that native forbs and shrubs will be grazed.

Managing native grasslands to enhance prairie condition and wildlife habitat can be accomplished using low, moderate, and high livestock stocking rates dependent on management objectives, grazing systems, grassland size and condition, and other factors. According to Natural Resource Conservation Service standards, moderate stocking rates are generally projected to result in 50 percent utilization of annual aboveground net primary production. High stocking rates should generally be used only for short-term grazing periods or longer periods if a pasture is to be grazed only every few years. Light and moderate stocking rates are well suited for grazing systems that utilize longer grazing periods. From a tenants or producers perspective, in many grazing systems, forage production and beef cattle performance is greater under light to moderate stocking rates (Tunnell 2004).

Conservation land managers often avoid using high stocking rates in fear of damaging native plant communities and wildlife habitat. Nebraska's grasslands are adapted to severe periodic disturbances, such as heavy ungulate grazing, fire, and drought. Grasslands will recover quickly from high-intensity, short-duration grazing if it is not repeated from year to year. In some circumstances, however, it may be necessary to conduct intense short-duration grazing for consecutive years. For example, several years of intense spring grazing can be an effective method to reduce smooth brome abundance. Light and moderate stocking rates are suitable for many situations.

There are several grazing methods and systems that can be used on WMAs to benefit native prairies, biodiversity, and wildlife and that are acceptable to tenants. Several of these are in Chapter 4. Some traditional grazing systems designed for livestock production, such as deferred rotational grazing and high intensity/short duration grazing generally promote uniform disturbance through uniform distribution of grazing animals within a year. Uniform disturbance generally does not promote the plant community heterogeneity desired by ecologists and wildlife biologist. In addition, deferred rotational grazing and high intensity/short duration grazing systems often require extensive grazing infrastructure and management and are not recommended for use on WMAs. Some grazing systems, such as fire-driven rotational grazing or patch burn grazing offer an alternative heterogeneity-based approach to traditional grazing systems. The heterogeneity associated with patch burn grazing and some other grazing systems may be critical for conservation of many grassland species, for example, grassland birds.

Patch burn grazing is based on the tendency of grazers (e.g. cattle and bison) to continuously graze selected areas (grazing lawns) repeatedly during the year due to the palatable and nutritious regrowth. This is also why grazing animals are attracted to recently burned areas and will graze them almost exclusively. In turn, they avoid areas with tall rank growth and unpalatable plants. Historically, fires occurred in areas with rank vegetation and litter resulting from limited grazing and high plant vigor. This grazing pattern is often compared to that of migratory herbivores because it is associated with a period of intense grazing, often early in the season, followed by a long period of little grazing or no grazing.

Following this line of logic, forcing cattle to graze an entire grazing unit every year with the traditional "take half, leave half approach" may not replicate historic conditions. As mentioned above, native plants best regain vigor and restore root systems after grazing if given long rest periods over at least an entire growing season rather than several shorter rest periods during a single growing season as occurs in many deferred rotation and rapid rotation systems. An added advantage, long rest periods provide more fuel for burning while repeated grazing in a single season leaves little litter or standing fuel to carry a fire. In ways this intensive grazing/extensive rest concept still fits the "take half, leave half approach", but the process occurs over several years rather than during one grazing season.

There are even reasons to promote grazing systems that use intensive season-long grazing (up to 2-3 times the traditional stocking rate) in areas while other areas are rested for extended period (2 to 3 years in some cases). Such systems promote heterogeneity of vegetation structure with both short and tall vegetation within grasslands, which is important to wildlife. Native plant species may also be more adapted to such disturbance regimes than exotic species. In addition, prairie grasses rested for one or two years then burned are highly nutritious and palatable for large ungulates and other wildlife. For tenants, the increase in forage quality and quantity should make up for any perceived loss in forage due to the extended rest period. A disadvantage of such grazing is that it puts equal grazing pressure on all plant species, including grazing sensitive forbs, which may stress them.

Fire and Grazing Interaction in Grasslands

The fire-grazing model argues that on presettlement Great Plains grasslands fire and grazing interacted through a series of positive and negative feedbacks to cause a shifting mosaic of vegetation pattern across the landscape (Fuhlendorf and Engle 2004). The interruption of landscape scale processes, such as the fire-grazing interaction, may be primary mechanism for loss of biodiversity in Great Plains grasslands. Recently burned sites are typically preferred grazing sites for large ungulates, and the combination of burning and grazing impacts vegetation composition and diversity to a greater extent than each acting alone (Collins and Steinauer 1996).

Fuhlendorf and Engel (2004) write that "According to the model, the probability of fire is greatest on areas with high biomass accumulation within a grazed grassland landscape. A positive feedback occurs when a recent fire event attracts grazing animals, which further disturbs the site. On tallgrass prairie landscapes grazed by bison *Bos bison* L., the most recently burned patches are preferentially selected from a diverse landscape that includes patches with variable fire histories. The model predicts that tall graminoid species decrease in dominance, and bare ground and forbs increase on recently burned patches that are focally grazed. These changes in composition and productivity are associated with a negative feedback because focal grazing reduces biomass. This reduces the probability and intensity of fire, which in turn lowers the probability that the patch will be grazed. The grazing animals subsequently focused on other patches that have been burned more recently and the tall graminoid species eventually recover dominance. So, the fire-grazing model predicts that grazing animals and fire interact through positive and negative feedbacks to cause a shifting mosaic. The landscape includes local patches

that have been burned and heavily grazed, dispersed within a patchwork of areas in various states of recovery."

Biondini et al. (1999) concluded since the historic bison-fire management regime results in between-year rotations of grazing and rest, rather than within-season rotations of grazing deferment, there are larger and longer contrast in vegetative cover on different parts of the landscape for wildlife species to use. They further state, species preferring high residual cover for nesting, such as waterfowl and Henslow's sparrow, would use areas unburned and avoided by bison for several years. Species preferring short-statured vegetation structure for nesting, feeding or lekking, such as upland sandpipers, chestnut-collared longspurs and greater prairie chickens, would use recently burned and heavily grazed areas. In addition, forb-rich food areas are created by intense grazing and wallowing (by bison) of late summer burn patches, which experience short-term increase in early successional plants. They also conclude that the almost exclusive grazing of graminoids that has been documented for bison should lead to an increase in forb diversity and abundance.

In Oklahoma patch burning has been used for over twenty years in different configurations to benefit bobwhite quail, mourning dove, bison, and elk on relatively small areas (<10,000 ac). Here patch burning increases landscape heterogeneity, structural diversity, and the diversity of grassland birds without affecting livestock performance. As the literature indicates the interaction of fire and grazing has the potential to provide more benefits for prairie vegetation and wildlife including game species than fire and grazing alone. However, since patch burn grazing is a relatively new management practice there are some still unanswered questions regarding its ecological impact. For one, there has been little research on the impact of patch burn grazing on exotic cool-season grasses or its impact on conservative native prairie plants. It is recommended that patch burning grazing not be used on the highest quality prairies on WMAs at this time. The exception being highly disturbance-tolerant grasslands, such as Sandhills upland prairie, which appears well suited for patch burn grazing.

Haying in Grasslands

Haying of grasslands is often less effective than grazing, burning or a combination of the two for managing wildlife habitat. Like burning, haying is a nonselective management practice which removes all vegetation. From a vegetation standpoint, haying stresses actively growing desirable and undesirable plants species equally. Though, if properly timed, haying can stress undesirable species. For example, summer haying can be effective in controlling some woody species or early haying can impact exotic cool-season grasses.

Timing of haying is often dictated by the forage quality of the hay. Producers prefer to hay when forage quality is high. In tallgrass prairie, maximum yield and highest quality hay occur at different times. The greatest hay yields are obtained in August, while the hay's highest crude protein and digestibility for cattle is in May (Missouri Dept of Conservation 2001).

Many Nebraska producers prefer to hay in July to compromise between forage quality and quantity. Many nesting prairie birds don't complete hatching until late June, and others nest until mid-July. Early- to mid-summer haying can destroy nest or kill chicks. In addition, continual annual, mid-summer haying stresses native warm-season

plants and promotes exotic cool-season grasses, such as smooth brome and timothy. Many of Nebraska hay meadows are now dominated by exotic cool-season grasses due to this practice.

Late summer or fall haying does not appear to degrade the native plant species composition of prairies to the extent resulting from mid-summer haying. Warm-season grasses may be weakened, but forb diversity of these prairies is often high. Many of eastern Nebraska's highest quality prairies are late summer or early fall hayed meadows.

Resting portions of hay meadows or haying on alternative years is a management option. Rest periods will allow native plants to restore root reserves and complete reproductive cycles. Rest from haying should also increase forage production. On rested meadows the previous year's growth usually settles below the four inch cutting height by early July and does not impede mowing. Rested prairies can also be spring burned to remove thatch and allow for easier hay removal.

Native prairies should not be cut closer than four inches to allow for rapid regrowth. Cutting grass too low will remove the growing point, or node, on the grass stem where new growth occurs and regrowth will be slower as it must initiate from dormant buds lower on the stem.

Periodic haying can also be effective in controlling woody plants and removing litter and exposing the soil to increased sunlight. Mowing, however, does not blacken nor deposit ash on soil surface, both of which increase production following fire.

Native hay meadows should not be fertilized, especially with nitrogen. Most native plants grow well under low nutrient levels. Fertilizing hay meadows will promote exotic cool-season grasses and weeds to the detriment of conservative prairie plants.

Chapter 4 - Grazing Systems

There are several grazing methods and systems that can be used by managers to increase native plant diversity and abundance, reduce exotic species and enhance wildlife habitat on WMAs. These are discussed below and include: 1) one time, short-duration, high intensity grazing, 2) season long continuous grazing, 3) winter grazing, 4) rest-rotation grazing, 5) fire-induced, rest-rotation grazing, and 6) patch burn grazing.

<u>One Time, Short-duration Grazing</u>

This is the practice of grazing livestock in a pasture for a short period (days to a few months) at low to high stocking rates to meet specific objectives, such as control of exotics, removal of excess litter, formation of grazing lawns (fresh regrowth) to attract native ungulates or short-vegetation structure, and stimulation of early successional plants for wildlife. In many circumstances high stocking rates and shorter grazing periods are preferred as this prevents cattle from being overly selective in choosing forage species and shortens the overall period of defoliation. As an example of this method, 4 to 6 weeks of heavy spring grazing followed by summer and fall rest for several consecutive years can reduce smooth brome abundance and increase native forb and warm-season grass abundance in grasslands. Fall, winter, or early spring prescribed fire prior to the intense grazing makes this practice even more effective by removing litter and making the exotic grasses more accessible to cattle grazing. Another example, mid-summer grazing can reduce native warm-season grasses and promote forbs.

This type of grazing can be used to prepare grasslands prior to entering into other grazing systems. Short-duration, high intensity, spring grazing, for example, may be used on degraded grasslands to reduce exotic cool-season grass abundance of a grassland prior to patch burn grazing.

It is recommended that this type of grazing not be used over extended periods, but used as a corrective measure to deal with immediate problems. Native grasslands that are properly managed with an integrated fire and grazing regime should not require this type of management. However, this may be the only suitable grazing method for small prairies where rotations are not possible.

System Requirements:

- A reliable water source is needed. If a high-density of cattle are used it will need high storage capacity.
- Must have a producer willing to bring cattle onto the site for a short period of time and then remove them.

Assumptions:

- Short periods of intense grazing will benefit native plants by removing thatch and by providing long periods of rest until the next grazing event.
- Land managers must know the appropriate timing and intensity of grazing to have desired impact on the vegetation.
- On large grasslands it may be difficult to get a cattle herd large of enough to have the desired impact.

Potential Advantages:

- No cross fencing or rotation of cattle is needed.
- Can be timed so it does not interfere with high public use periods.
- Can be used to remove litter and fuel levels reducing wildfire threats.
- Can be timed to impact certain plant species groups, such as exotic cool-season grasses, and not impact other species groups.
- Can be used to created intense disturbance and stimulate early successional plants.
- Can be used to prepare fire breaks for prescribed burning (the short-grazed pasture serves as a fire break).
- Can be used to create grazing lawns for wildlife.
- Can be used to promote native vegetation diversity and short-term short vegetation structure for wildlife.
- Can be used on smaller grasslands.

Potential Disadvantages:

- It may be inconvenient for producers to bring there cattle into pastures for only a short period.
- Intense disturbance may promote noxious weeds.

System Variations:

- Can be used in combination with prescribed fire, for example, a pasture can be burned in winter or early spring and then grazed intensively in late spring to decrease exotic cool-season grasses.
- Can be used at any time of the year for various grazing periods and at various intensities.
- Multiple pastures on an area can be grazed in a given year by rotating cattle among pastures.
- Can use be used for a single year or consecutive years.

Use and Limitations:

This method works well for small grasslands not suitable for grazing systems. It also works well for grasslands where grazing is not desired every year. It allows great flexibility in the timing, intensity and duration of grazing. If permanent water is not available at a site, tenants may be able to haul water for the duration of the grazing period.

Season-Long Grazing

Repetitive, season-long grazing at high stocking rates will degrade native grasslands. However, when practiced under sound management, at low to moderate stocking rates, it can be used on certain grasslands to meet native plant and wildlife management objectives. At light to moderate stocking rates season long grazing can create the diverse vegetation structure needed by many grassland birds including prairie grouse. Cattle have preferred grazing areas and when given access to these sites for several years may lead to localized overgrazing. It is recommended that season-long grazing not be used for several consecutive years on a grassland, but altered with years of rest.

System Requirements:

- May need several reliable water sources for good cattle distribution.
- May not be suitable for all grasslands, for example, in areas that include steep slopes and flats. Here, cattle may excessively graze flats and valleys for extended periods and avoid grazing areas with steeper topography.

Assumptions:

- Season long grazing at light stocking rates will provide needed habitat requirements for targeted wildlife species.
- Some areas of the pasture will likely be heavily grazed and some areas lightly grazed.

Potential Advantages:

- No cross fencing or rotation of cattle is needed
- Can create some habitat heterogeneity by having heavily grazed and lightly grazed patches within the same pasture, the levels of variability in the structure will not be as great as in some other grazing systems, such as patch burn grazing.

Potential Disadvantages:

- Areas near water, shade trees or on flats will likely be heavily grazed and potentially overgrazed.
- Cattle have access to highly palatable plant species and may stress these by grazing them for extended periods.

System Variations:

- If only lightly grazed there may be sufficient fuel at the end of the grazing season for prescribed fire.
- Can use be used for a single year or consecutive years.
- Length of the grazing season can be varied.

Use and Limitations:

This system is not looked upon favorably by many grazing managers, though it may have applications in particular situations. It is sometimes used to create mid-height structure for prairie chickens. In larger moderate to good quality prairies, light summer grazing can be effective in stressing to native warm-season grasses and promoting forb diversity. Good distribution of cattle is required or areas may be overgrazed. For example, in some wet meadows cattle will concentrate on sand ridges and overgraze them.

Winter Grazing

Winter grazing is grazing after fall dormancy and before spring green up. During this period plants are not actively growing and therefore are not stressed by grazing. Winter grazing reduces litter while allowing for full growing season deferment. Winter grazing is commonly practices in some regions of the Sandhills and western Nebraska. These winter grazed pastures are often vegetatively diverse compared to their summer grazed counterparts. Winter grazing can leave little winter cover for wildlife, however it does not need to be implemented every year or over an intire WMA. Winter grazing can also be incorporated into rotational grazing systems. In parts of the state, pastures are often rotated between winter and summer grazing.

System Requirements:

- A winter water source is required
- Cross-fencing is not needed

Assumptions:

- Winter grazing reduces litter but does not stress native vegetation.
- There may be little winter cover for wildlife the year the site is grazed.

Potential Advantages:

- No cross fencing or rotation of cattle is needed
- Can be timed so it does not interfere with high use periods on public lands (e.g. implemented after the hunting season).
- Can be used to reduce ground litter and fuel levels.

- Can be used to prepare fire breaks for spring prescribed burning (grazed pastures serve as a fire break).
- Can be used to create spring and summer grazing lawns for ungulates without damaging native vegetation.
- Promotes native vegetation diversity.
- If sites are grazed into the spring, exotic cool-season grasses can be stressed.

Potential Disadvantages:

- Pastures may have to be checked often to make sure water is available and this may not be convenient for tenants if pastures are remote or cannot be frequently checked.
- May remove winter cover for wildlife.
- The dense litter accumulation that has occurred on many WMA grasslands may provide poor forage for winter grazing. These areas may require burning or growing season grazing before they are suitable for winter grazing.
- Some sites may not provide suitable forage quality for winter grazing. In general, short and mid grasses provide better winter forage than tall grasses.

System Variations:

- Winter grazing can be included in rest-rotation grazing systems by extending the grazing season into late fall and early winter, beginning the grazing season in late winter, or grazing the entire winter.
- Grazing period can be modified to various lengths.
- Winter grazing can be extended into the spring to impact exotic cool-season grasses.
- Can use winter grazing for a single year or multiple consecutive years.

Use and Limitations:

This system appears to be effective in the Sandhills to create diverse native grasslands and would likely be effective in other areas of the state. In the Sandhills, some pastures are rotated between summer and winter grazing or pastures are annually winter grazed. This method can reduce excess litter build up while not impacting actively growing plants. The loss of one year's winter cover should not concern managers as the overall benefits to the grasslands may be significant and have long-term benefits to wildlife. Removing litter will provide improved grazing for big game the following growing season.

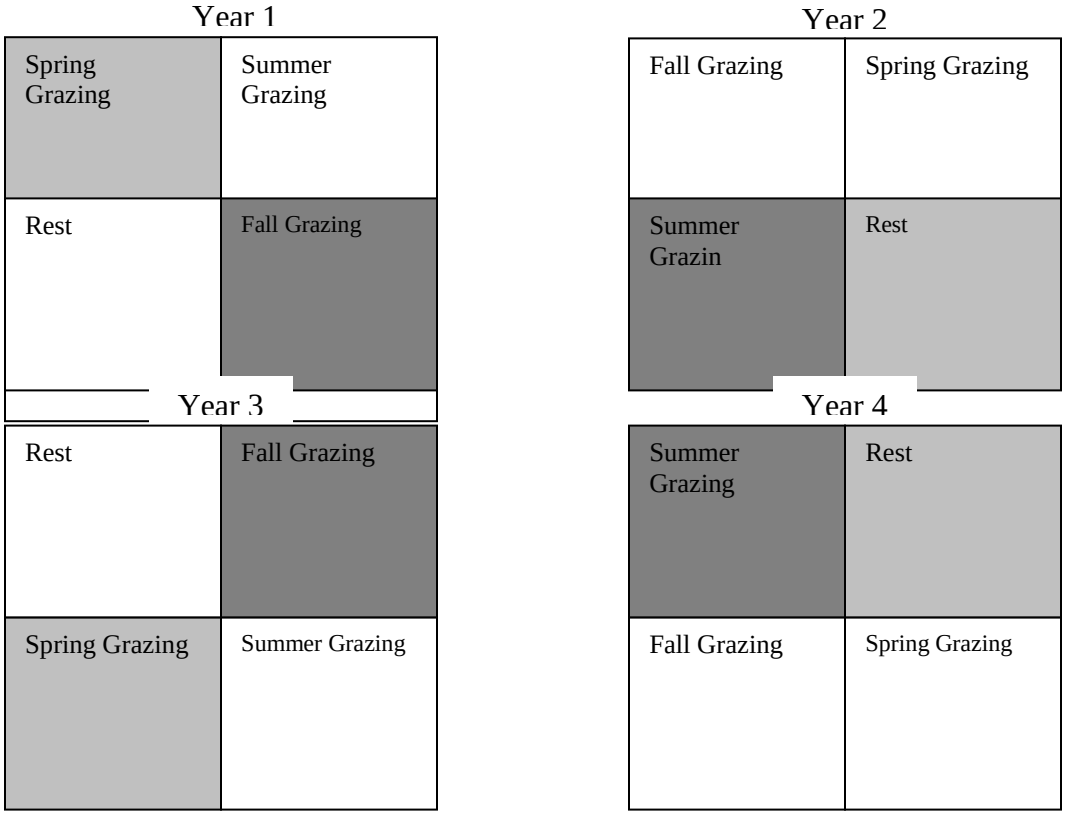
Rest-rotation Grazing

Rest-rotation grazing systems include multiple pastures, three to six is often most practical, with at least one pasture being rested for an entire growing season and each pasture being grazed only once each year. Individual pastures are grazed at different times each year. Four to six pasture systems may be most practical for WMAs. Private producers often increase the stocking rate in grazed pastures in this system to compensate for non-use in rested pastures. This practice is not recommended on conservation lands. The benefits of full season rest are discussed above.

On WMAs rest-rotation systems can be used at light to moderate stocking rates over the entire growing season, or a portion of the year or growing season. Modifications can be made to standard rest-rotation system to meet specific management objectives. For example, if specific pastures have an abundance of exotic cool-season grasses, these pastures can be grazed in spring at higher stocking densities, and then the densities reduced for late season grazing in other pastures.

In rest-rotation grazing the pasture rested the previous year and the pasture grazed first the preceding year will often contain the highest densities of litter needed for nesting by certain grassland and game birds. Deferring grazing in these pastures until mid-June or early July will ensure optimal use of nesting or brood-rearing cover (Reece, et al. no date). If nesting cover is a management objective, a six-pasture, rest-rotation system might be used to provide denser cover on 33 percent of the land area by resting two pastures and using four pastures for grazing each year. A staggered schedule of resting pastures within a six-pasture system would provide year-to-year continuity of dense cover and a sequence of four years of grazing followed two years of rest. Winter grazing, as well as prescribed fire (see below), can be incorporated into rest-rotation grazing systems.

Table 1. A typical grazing cycle for a four–pasture rest-rotation grazing system.



System Requirements:

- Typically 4 pastures (3-6 pasture systems are also possible).
- Pastures that are similar in size with reliable water and cross-fencing.

- Must move cattle between pastures.

Assumptions:

- Periodic year-long rest periods are necessary to recover plant root systems and avoid plant community shifts to less desirable species.
- Grazing with longer rotation periods is the best way to harvest forage.
- The investment of a full year rest will benefit native plants and provide for long-term stable forage production, though it may not benefit grasslands as much as longer rest periods.

Potential Advantages:

- Less fencing, water development and time investment than most high-intensity short-duration systems.
- Cattle make greater individual gains because they can select for quality forage.
- Rested pastures can function as emergency forage reserves in extreme situations.
- At least ¼ of the grassland has heavy litter accumulation which conserves soil moisture.
- Provides diverse habitats at different scales for wildlife (tall and short vegetatoin, dense litter and little litter, and grass dominance and forb dominance).

Potential Disadvantages:

- More fencing, water development and time investment than patch burning.
- Noxious weeds problems could increase in the early years of implementation.
- This system severely stresses a portion of the grassland each year. Disturbed grasslands may require a year or two of summer deferment to increase warm-season grass vigor prior to implementation of this system to avoid the need to destock mid-season or graze rested pastures.

System Variations:

- Stocking rates can be varied to meet objectives.
- Can burn the rested pasture prior to grazing if woody encroachment becomes a problem.
- Can vary the number of pastures dependent on objectives.
- With more than 4 pastures areas can be rested more than one year.
- With more rested pastures to rotate in, the grazing system can be extended into the winter.
- Length of the grazing season may be modified.

Use and Limitations:

If a manager is dedicated to grazing ever year this system is ecologically sound and feasible. It takes into consideration the annual and long-term physiological demands that grazing puts on root systems and how that influences plant competition and plant community composition. This system also consistently provides fairly diverse wildlife habitats during all times of the year. This system provides annual disturbance to grasslands without making managers plan for this each year. This system requires a fair amount of fencing and water development to function and requires a multiple year lease

with a cattle operator. This system is more suitable for larger grasslands. Multiple rested pastures may be desired on WMAs.

Fire-driven Rest-rotation Grazing

Historically, fire and grazing were closely linked natural processes and were primarily responsible for the development and maintenance of Nebraska's grasslands. Fire-driven rest-rotation grazing systems attempt to mimic this linkage within a fairly conventional rotational grazing framework. The following description is for a four pasture system. In this system each pasture goes through a four-year cycle of 1st year rest, 2nd year rest, 3rd year spring burn followed by spring and fall grazing, and 4th year summer grazing. The rotation is then repeated. Forage quality and production is good on the spring/fall pasture due to high plant vigor resulting from two years of rest, a flush of nutrients due to spring burning, and high forage palatability due to short cropping. Native plants in the grazed pastures will be stressed over the short-term, especially in the summer grazed paddock. However, plant root reserves will be replenished the next two years of complete rest.

System Requirements:

- Typically 4 pastures (3-6 pastures are also feasible).
- Pastures which are similar in size with reliable water and cross-fencing.
- Move cattle twice between pastures each year.
- Dedication to burning 25 % of the grazing unit each year.

Assumptions:

- Year-long rest periods are necessary to recover root systems and avoid plant community shifts to less desirable species.
- Grazing intensively for relatively long periods is the best way to harvest forage.
- The investment of two full years of rest has greater long-term benefits to plant species composition and forage production then one year of rest or less in a rotation.

Potential Advantages:

- Less fencing, water development and time investment than most high-intensity short-duration systems.
- Cattle make greater individual gains because they can select for quality forage.
- Rested pastures can function as emergency forage reserves in extreme situations.
- At least ¼ to ½ of the grassland has some litter accumulation which conserves soil moisture.
- Fuel for prescribed burning accumulates on ¼ to ½ of the grazing unit every year.
- Provides diverse vegetative structure at different scales for wildlife (very tall, very short, dense litter, and no litter).

Potential Disadvantages:

- More fencing, water development and time investment than patch burn grazing.
- Weeds problems could increase in the early years of implementation.

- This system can stress a portion of a grassland each year. Abused grasslands may require a year or two of summer deferment to increase warm-season grass vigor prior to implementation of this system to avoid the need to destock mid-season or graze rested pastures.

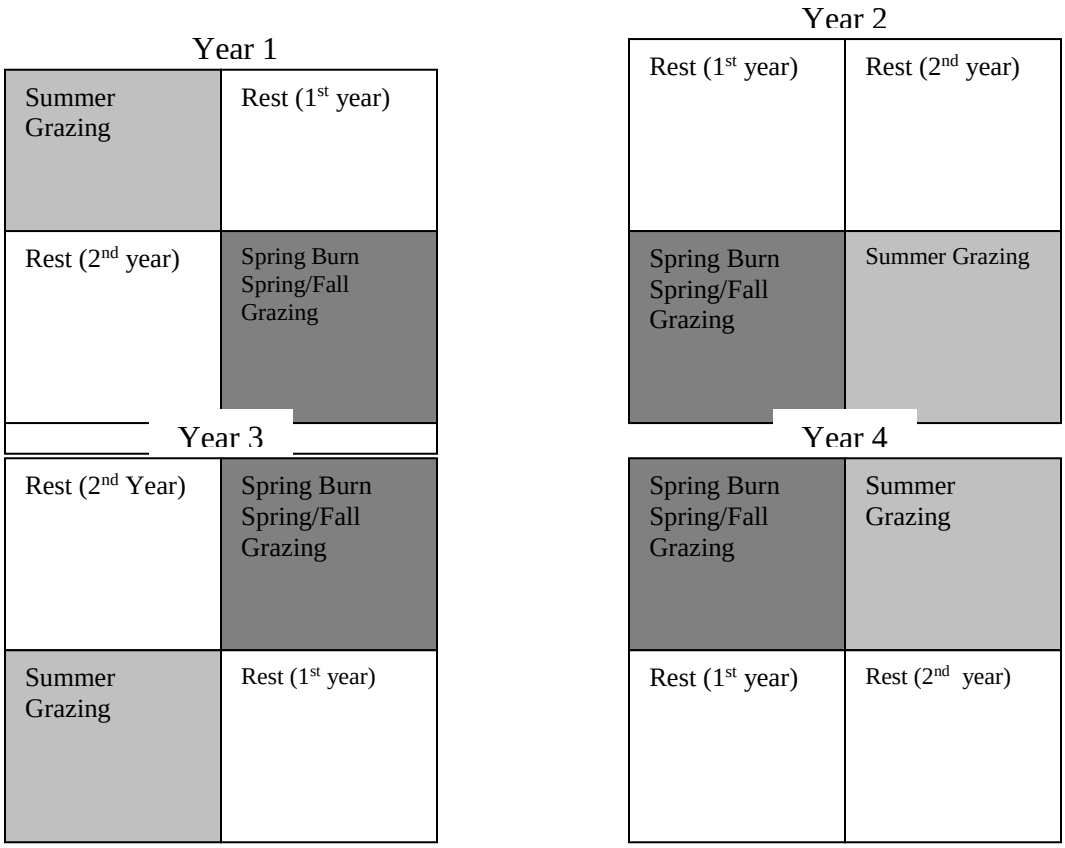
System Variations:

- Rested pastures can be burned.
- The number of rested pastures can be increased by adding more pastures.
- Use five pastures allowing for three years of rest for each pasture (if stocking rates are reduced more litter will accumulate)
- With more rested pastures in the rotation the grazing period can be extended into the winter or more pastures can be burned.

Use and Limitations:

This system consistently provides varied wildlife habitats during all times of the year as well as adequate fuel for periodic burning. This system includes a summer grazed pasture which provides the small scale patchiness often not found in other rotation grazing systems and provides annual disturbance to grasslands without making managers plan for it each year. This system requires a fair amount of fencing and water development to function and may require a multiple year lease with a cattle operator. This system is more suitable for larger grasslands. Multiple rested pastures may be desired on WMAs.

Table 2. A typical fire and grazing cycle for a fire-driven, rest-rotation grazing system.



Patch Burn Grazing

Patch burn grazing attempts to mimic the historic association between fire and bison grazing. In this system a pasture is divided into 3 or 4 patches (potentially more) with no internal fences and grazing animals are allowed freedom of movement. Each year one patch is burned, usually in the spring, though burning can be conducted during the dormant season or late summer. Cattle are added to the unit just prior to or after the burn or they can be present on the site at the time of burning. In southern tallgrass prairie cattle have been shown to preferentially graze the burned patch approximately 75 percent of the time and spend roughly 20 percent of their time on the patch burned the previous year. Other patches receive little grazing pressure allowing them to recover.

The following year another patch is burned, usually the patch with the greatest litter. Cattle will then switch their grazing focus to this patch. Once all patches are burned the cycle is repeated. If there are three patches, the patches would go through a three-year cycle; the 1st year of burning and heavy grazing, the 2nd and 3rd year would be periods of extended rest. Forage quality and production is excellent on the burned patch due to high plant vigor resulting from two preceding years of rest, a flush of nutrients due to spring burning, and high forage palatability and quality due to short cropping. The short-term production on burned areas is maximized at the expense of the root reserves of the most palatable species. However, the root reserves are replenished during the following two years of complete rest. Grazing in patch burn grazing systems is generally conducted only during the growing season, May through October. However, on larger grasslands livestock may be grazed year-long using this system.

Patch burn grazing provides habitat heterogeneity needed by wildlife within a single management unit. Stocking rate is critical to obtaining the desired habitat conditions. In central Platte River valley restored grasslands, for example, grazed at light to moderate stocking rates under patch burn grazing, cattle preferentially graze grass regrowth in burned patches leaving many forbs in this patch ungrazed. The resulting structure, open below with a scattered tall forb canopy, provides good brood rearing habitat for game birds. Adjacent unburned/lightly grazed patches provide nesting and winter habitat. Under heavy stocking rates the forbs may be more heavily grazed.

Much of the research on patch burn grazing has been conducted in Oklahoma and Missouri. Little research has been conducted in more northern states where exotic cool-season grasses are more abundant in native grasslands. Presently, the impact of patch burn grazing on exotic cool-season grasses is relatively unknown. In addition, the impact of patch burn grazing on conservative native prairie forbs, such as butterfly milkweed or Indian plantain, is also relatively unknown. Caution must be practiced if high-quality prairies with conservative plant species are to be patch burned grazed.

System Requirements:

- A fairly large pasture (possible minimize size of 120 to 160 acres for tallgrass prairie, larger for drier grassland types) with no internal fences.
- Reliable water source.
- Dedication to burning 25 to 33 percent of the grazing unit every year in the dormant season, spring, or late summer.

Assumptions:

- At minimum two-year rest periods are necessary for each patch to recover root systems and avoid plant community shifts to less desirable species.
- Grazing intensively for long periods is an efficient way to harvest forage.
- The investment of long rest periods has greater long-term benefits for plant species composition and forage production than one year of rest or less in a rotation.
- Cattle weight gains using this system are at least comparable to other grazing systems.
- The habitat heterogeneity created through patch burn grazing will benefit wildlife.
- Patch burn grazing will reduce or at least not increase invasive species.
- Patch burn grazing will improve native plant species diversity and abundance.

Potential Advantages:

- Less fencing, water development and time investment than needed for many other grazing systems.
- Cattle may make good individual gains because they can select quality forage – regrowth on burned patches.
- Unburned patches can serve as reserve forage under drought or other extreme situations.
- A high percentage of the pasture has heavy litter which conserves soil moisture.
- Provides sufficient fuel for prescribed burning. This can aide in controlling eastern red cedar trees and other invasive woody species on 25 to 50 % of the property every year.
- Provides diverse habitats at different scales for wildlife needs (tall and short vegetation heights and variable densities, variable litter levels, abundance of annual and biennial forbs) at all times of the year.
- This is the only grazing system that provides highly variable habitat patches with soft edges due to the absence of interior fences.

Potential Disadvantages:

- Investment in annual prescribed burning is required.
- Noxious weeds could increase in the initial years of implementation.
- This system severely stresses a portion of the grassland each year.
- There has been little research on the impacts of patch burn grazing on exotic cool-season grass abundance or conservative native plant species. The effectiveness of this system on many typical Nebraska pastures with an abundance of exotic cool-season grasses, depressed warm-season grasses is relatively unknown.
- Abused grasslands may require a year or two of rest to build sufficient fuels to implement this system in an effective manner.

System Variations:

- The number of patches can vary. In large grasslands six or more patches can be used. When using many patches more than one patch may be burned each year.

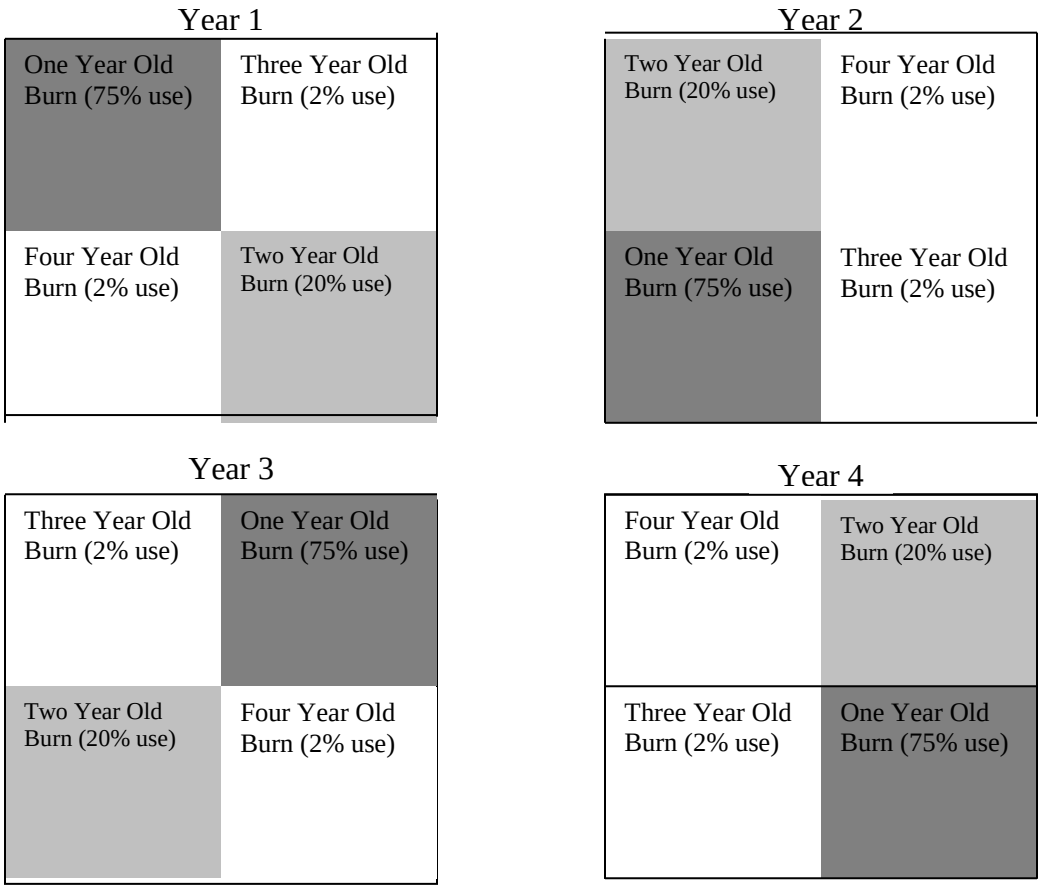
- Timing of burns can vary depending on management objective and other factors. Burns can occur during the dormant season, spring, and late summer. If burning more than one patch a year the timing of these burns can vary. For example, one burn could be conducted in the spring and one burn conducted in summer.
- To impact exotic cool-season grasses, such as smooth brome, livestock could be turned out in early spring to graze cool-season grasses on the previous year's burn. In mid-spring that year's prescribed burn could be conducted on another patch. Cattle would then shift their grazing to the cool-season grasses in this patch. In theory this would stress cool-season grasses in two patches each spring and possibly provide better invasive cool-season control.

Uses and Limitations:

If the manger is dedicated to burning a patch every year this system is ecologically sound and feasible in many situations. This system also consistently provides highly varied vegetation structure for wildlife at all times of the year as well as adequate fuel for periodic burning. This system provides annual disturbance to grasslands without making managers plan for this each year. The system may not properly function if a pasture is not burned in a given. The systems does not require internal fence. It is more feasible with a multiple year lease with a cattle operator. This system is more suitable for larger grasslands, though it is presently being tested on smaller pastures (as small as 80 acres in size) in tallgrass systems.

Patch burn grazing is a fairly new grazing system. At this time, patch burn grazing should not be used or used with caution on high quality prairies (Grade A and B) in most areas of Nebraska as there is little information on the impact of this system on conservative forb species. The exception to this rule is sand prairies as these prairies are fairly resilient to high disturbance levels. Therefore, patch burn grazing can be implemented on higher quality (Grade A and B) sand prairies, This system also appears to work well in prairie restorations where it creates high levels of heterogeneity.

Table 3. A typical fire and grazing cycle for a patch burn grazing system.



Deferred-rotation Grazing

This system consists of using four or more pasture with one grazing period per pasture each year and no pastures rested for an entire growing season. It is very similar to the rest-rotation system described above, except that no pasture is given a full year's grazing deferment. This grazing system is not recommended for conservation lands because it does not provide for full year deferment.

Intensively Managed Grazing

This grazing system consists of multiple pastures grazed with a rapid rotation with each pasture often getting grazed several times during a year. The system requires extensive fencing, water development, and livestock movement. This system is not recommended for WMAs due to these factors. In addition, there is evidence that this system leads to habitat homogeneity and can be destructive to grassland nesting birds due to trampling.

Intensively managed grazing systems are often highly promoted and are likely a significant improvement over some historic season-long grazing practices because they address the need for recovery periods for palatable species. However, there are still some ecological flaws in the typical high-intensity short-duration grazing system. The high-intensity short-duration system attempts to eliminate grazing selection by applying short,

frequent, and highly intense grazing events, separated by short recovery periods (days, weeks, or months). The basic premise is that plants, palatable species as well as unpalatable species, will be grazed equally and extensively. Many of these species may need longer recovery periods than provided by this system.

For example, in eastern Nebraska, the intensive annual grazing doesn't allow tallgrass species to recover fully and out-compete more weedy, less palatable species. In tallgrass prairie this system can lead to a shift to more shorter, shallow rooted plants, such as cheatgrass, Kentucky bluegrass, and annual ragweed; unpalatable species, such as eastern red ceder, Baldwin's ironweed, and some goldenrods; and species that are grazing resistant in the absence of fire, such as little bluestem and switchgrass. Other consequences of intensive managed grazing systems are extensive time investments, high fencing and water costs, little litter accumulation for wildlife or prescribed fire, and forcing livestock to consume poor forage species.

Chapter 5 – System Descriptions, Quality Grades and Management Guidelines

Tallgrass Prairie System

Range

Tallgrass prairie occurs mostly in the eastern quarter of the state, but extends westward in the eastern Sandhills and in the valleys of the Platte and Loup rivers. Soils are usually deep, well-developed loams formed in loess, glacial till or eolian sand.

Communities Included

The following natural communities described in Steinauer and Rolfsmeier 2010 are included in the Tallgrass Prairie System:

Upland Tall-grass Prairie
Dakota Sandstone Tall-grass Prairie
Lowland Tall-grass Prairie
Northern Loess/Shale Bluff Prairie
Missouri River Floodplain Terrace Grassland
Great Plains Gravel/Cobble Prairie
Sandhills Mesic Tall-grass Prairie

Dominant Species

big bluestem (Andropogon gerardii), switchgrass (Panicum virgatum), Indiangrss (Sorghastrum nutans), little bluestem (Schizachrium scoparium), side-oats grama (Bouteloua curtipendula), porcupine grass (Hesperostipa comata), prairie dropseed (Sprorbolus heterolepis)

Primary Invasive Plants
smooth brome (Bromus inermis), Kentucky bluegrass (Poa pratensis), tall fescue (Festuca pratensis), annual bromes (Bromus spp.), reed canary grass (Phalaris arundinacea) sericea lespedeza (Lespedeza cuneata), musk thistle (Caardus nutans), leafy spurge (Euphorbia esula), eastern red cedar (Juniperus virginiana), honey-locust (Gleditsia triacanthos), Osage orange (Maclura pomifera), Siberian elm (Ulmus pumila)

System Quality Grades
Grade A Tallgrass Prairies – Grade A tallgrass prairies are rare. Nearly all Grade A tallgrass prairies are hay meadows, though, all hay meadows are not Grade A sites. Most Grade A tallgrass prairies are small, less than 80-acres in size. These sites have had little disturbance from grazing, herbicide spraying and other anthropogenic disturbance. Grade A sites are dominated by native warm-season grasses, though native cool-season graminoids including Junegrass (Koehleria micrantha), porcupine grass, Brevior's sedge (Carex brevior) and Bicknell's sedge (C. bicknellii), can be abundant. Smooth brome, Kentucky bluegrass and other exotic cool-season grasses have limited abundance in Grade A tallgrass prairies. There is little invasive tree encroachment in Grade A sites. Conservative forb species are widespread and abundant and include the following species (not all species may be present at a site): purple prairie coneflower (Echinacea angustifolia), prairie clovers (Dalea spp.), compass plant (Silphium integrifolium), plains yellow primrose (Calyophus serrulatus), prairie turnip (Pediomelum esculentum), bastard's toadflax (Commandra umbellatum), candle anemone (Anenome cylcindrica), prairie ragwort (Senecio plattensis), downy gentian (Gentiana puberulenta), New Jersey teas (Ceanothus spp.), leadplant (Amorpha canescens), gayfeahers (Liatris spp.), prairie phlox (Phlox pilosa), golden Alexander (Zizia aurea), butterfly milkweed (Asclepias tuberosa), and prairie violet (Viola pedatifida). An example of a Grade A tallgrass prairie is the University of Nebraska's Madigan Prairie in Saunders County.

Grade B Tallgrass Prairies – Grade B tallgrass prairies are uncommon, though more common than Grade A sites. Most Grade B prairies are hay meadows or grazed prairies that occupy steep slopes less accessible to cattle and herbicide spraying. Grade B sites are dominated by native warm-season grasses, though native cool-season graminoids are conspicuous. Exotic cool-season grasses are more abundant than in Grade A prairies, though they are not widespread or dominant, the exception being Kentucky bluegrass, which can be widespread in Grade B prairies. Invasive trees and shrubs are limited in Grade B prairies and not abundant. Conservative forbs are abundant in Grade B prairies, though their diversity and abundance is less so than in Grade A prairies, these include: leadplant, stiff sunflower (Helianthus pauciflorus), prairie clovers, Missouri goldenrod (Solidago missouriensis), silverleaf scurf pea (Pediomelum argophyllum), wild alfalfa (Psoralidium tenuiflorum), wild rose (Rosa arkansana), and prairie violet. Examples of Grade B tallgrass prairies are found on Table Rock WMA and Osage South WMA.

Grade C Tallgrass Prairies - Grade C tallgrass prairies are common and include many grazed native pastures and some hay meadows. Grade C tallgrass prairies have had fairly severe past disturbance from overgrazing, annual haying, herbicide spraying, invasive species, or woody species encroachment. Grade C grasslands are dominated by native

warm-season grasses. Mid and short grasses, such as sideoats grama and blue grama are often more conspicuous than in higher quality prairies. Exotic cool-season grasses are also conspicuous and may co-dominant over large areas. Woody encroachment can be severe in areas. Conservative native forb diversity and abundance is limited in Grade C prairies compared to higher quality prairies, with most conservative species being absent. Disturbance-tolerant native forbs are often the dominant forbs in Grade C prairies, these include daisy fleabane (Erigeron strigosus), hoary vervain (Verbena stricta), heath aster (Aster ericoides), rigid goldenrod (Soidago rigida), Baldwin's ironweed (Veronia baldwinii), yellow coneflower (Ratibida columnifera), and black-eyed Susan (Rudbeckia hirta). Common and widespread exotic forbs in Grade C prairies include white clover (Trifolium repens), red clover (T. pratense), alfalfa (Medicago sativa), black medic (M. lupulina), sweet clovers (Melilotus spp.), dandelion (Taraxacum officinale), and sulfur cinquefoil (Potentillia recta). Examples of Grade C tallgrass prairies are found on Twin Lakes WMA, Bowwood WMA, and Rose Creek WMA.

Grade D Tallgrass Prairies – Grade D tallgrass prairies are common and include pastures that have been severely overgrazed, sprayed intensively with herbicide, or have severe woody plant encroachment. Some Grade D prairies may have been cultivated for a short time in the distant past. Grade D tallgrass prairies are typically dominated by exotic cool-season grasses, mainly smooth brome, Kentucky bluegrass and cheatgrass. Native grasses occur as scattered individuals. Conservative forbs are absent, though native weedy forbs can be common. Examples of Grade D tallgrass prairies occur on Meridan WMA and Greenvale WMA.

Management Objectives and Guidelines for Various Grade Tallgrass Prairies

Grade A Tallgrass Prairies
Management Objective: Maintain and enhance Grade A condition.

Minimum Management:

1) Conduct variably timed prescribed burns once every 3 to 4 years, minimum of every 2 to 3 years if grazing or haying are not part of management.
2) Variably timed grazing once every 3 years. If grazing is not practical, haying is an option, it should also be variably timed. Areas with a history of haying should probably be maintained as hay meadows, but the timing of haying should be varied from year to year with complete deferment at least once every 3 years (hayed prairies can also be burned).
3) Spot herbicide control of smooth brome, reed canary grass, musk thistle, leafy spurge, and other invasive plants.
4) Cut all eastern red cedars and other woody invaders not controlled by burning.

Management Options:

1) If exotic cool-season grasses start to become prominent, 1 to 2 years of dormant season or early spring burning followed by heavy, short-duration (4 to 6 weeks) spring grazing is recommended until the exotics are reduced in abundnace.

2) Including Grade A prairies in grazing systems is not recommended unless they are part of large prairie complex that is managed as a unit. No patch burn grazing at this time until more research is conducted to determine its impact on conservative plant species.

Grade B Tallgrass Prairies

Management Objective – Enhance site quality to Grade A condition.

Minimum Management:

1) Conduct variably timed prescribed burns every 3 to 4 years, minimum of every 2 to 3 years if grazing or haying is not part of management.
2) Variably timed grazing once every 3 years, variably timed haying is also an option. Areas with a history of haying should probably be maintained as hay meadows, but the timing of haying should be varied from year to year with complete deferment at least once in every 3 years (hayed prairies can also be burned).
3) Spot herbicide control of smooth brome, musk thistle, leafy spurge and other invasive species.
4) Cut all eastern red cedar and other woody invaders not controlled by burning.

Management Options:

1) If exotic cool-season grasses become prominent, 1 to 3 years of dormant season or early spring burning followed by heavy, short-duration (4 to 6 weeks) spring grazing is recommended until the exotics are reduced.
2) 2) Rest-rotation grazing at light stocking rates.
3) Fire-driven, rest-rotation grazing at light to moderate stocking rates.
4) Patch burn grazing with light to moderate stocking rates is an option, though it should be closely monitored

Grade C Tallgrass Prairies

Management objectives – Enhance site quality to Grade B condition.

Minimum Management:

1) Conduct spring burns once every 3 to 5 years, minimum of every 3 years if grazing is not an option.
2) Variably timed grazing once every 3 years.
3) Spot herbicide control of musk thistle, leafy spurge, and other noxious weeds.

Management Options:

1) If exotic cool-season grasses become prominent, 1 to 3 years of dormant season or early spring burning followed by heavy, short-duration (4 to 6 weeks) spring grazing is recommended until the exotics are reduced.
2) Rest-rotation grazing at light to moderate stocking rates,
3) Fire-driven rest-rotation grazing at light to moderate stocking rates.
4) Patch burn grazing at light to moderate stocking rates.

5) Season-long grazing at light to moderate stocking rates to create habitat heterogeneity. Give pastures periodic season long rest every 3 to 4 years.
6) Interseed local ecotype, native plant seed to improve plant diversity and wildlife habitat.
7) Invasive tree cutting if prescribed burning is ineffective at controlling them.

Grade D Tallgrass Prairies

Management Objective - Improve wildlife habitat and provide buffers for and corridors between other native plant communities. Where native plant species remain, manage for these species as wildlife habitat. Protect native soil profiles on these previously unplowed sites from plowing and deep disking. Where feasible, use interseedling of local-ecotype seed to restore these sites to more diverse grasslands.

Minimum Management:

1) Prescribed burning at least once every 5 years to stimulate native plants and reduce exotic plants.
2) Variably timed grazing at least once every 5 years.
3) Spot herbicide control of musk thistle, leafy spurge, and other noxious weeds.

Management Options:

1) Dormant season or early spring burning followed by heavy, short-duration grazing (4 to 6 weeks) to reduce exotic-cool-season grasses and stimulate remaining native plants and early successional plants.
2) Rest-rotation grazing at light to moderate stocking rates
3) Fire-driven rest-rotation grazing at moderate stocking rates
4) Patch burn grazing at moderate stocking rates.
5) Season-long grazing at light to moderate stocking rates to create habitat heterogeneity.
6) Interseed local ecotype, native plant seed to improve plant diversity and wildlife habitat. Herbicide application will likely be needed to reduce exotic cool-season grasses prior to interseeding.
7) Light disking (1 to 2 inch depth with straight disc blades) to stimulate early successional and other native plants. This is to be used only if grazing management and herbicide application are not successful or feasible at stimulating native plants. Disking is not allowed on highly erosive soils.
8) Cut eastern red cedar and other woody species.

Central Mixedgrass Prairie System

Range

Central mixedgrass prairie occurs mostly on the loess-mantled hills and plains of central and south-central Nebraska, and on loess soils in areas of southwestern and northeastern Nebraska. This system is also found, though less abundant, on sand/gravel soils in northern Nebraska, mostly on the shoulders and bluffs tops of stream valleys in the Niobrara River drainage from Cherry County eastward to Knox County. It is also found on sand/gravel soils in southern Nebraska, specifically on eroded slopes, rolling uplands,

and shallow draws on the north side of river valleys (mainly on soils of the Meadin Series).

Communities Included
The following natural communities described in Steinauer and Rolfsmeier 2010 are included in the Central Mixedgrass Prairie System.

Loess Mixed-grass Prairie
Northern Loess/Shale Bluff Prairie
Great Plains Gravel/Gobble Prairie

Dominant Species
Silty soils
big bluestem (Andropogn gerardii), switchgrass (Panicum virgatum), little bluestem (Schizachrium scoparium), side-oats grama (Bouteloua curtipendula), blue grama (B. gracilis), western wheatgrass (Elymus smithii), buffalo grass (Buchloe dactyloides), western ragweed (Ambrosia psilosytachya), slender-flower scurfpea (Psoralidium tenuiflorum)

Sandy soils
purple three-awn (Aristida purpurea), forktip three-awn (A. basiramea), blue grama hairy grama (B. hirsuta), sand lovegrass (Eragrostis trichodes), little bluestem, sand dropseed (Sporobolus cryptandrus), prairie sandreed (Calamovilfa longifolia), yucca (Yucca glauca), western sagewort (Artemisia campestris), hairy golden aster (Heterotheca villosa), western rageweed, ledge spike-moss (Selaginella ruprestris)

Primary Invasive Plants
smooth brome (Bromus inermis), Kentucky bluegrass (Poa pratensis), annual bromes (Bromus spp.), musk thistle (Carduus nutans), leafy spurge (Euphorbia esula), eastern red cedar (Juniperus virginiana), Siberian elm (Ulmus pumila)

System Quality Grades
Grade A Central Mixedgrass Prairies – Grade A mixedgrass prairies are extremely rare if they exist at all. They likely will be found on steep slopes that have received limited cattle grazing and herbicide spraying and be relatively small in size. Higher quality mixedgrass prairies are more likely to occur on sand/gravel soils that are less susceptible to exotic cool-season grass invasion than silty soils.

On silty soils Grade A sites are dominated by big bluestem, Indiangrass, and switchgrass on lower slopes, with little bluestem, sideoats grama, blue grama, and buffalo grass on upper slopes and hilltops. Native cool-season graminoids including Junegrass (Koehleri macrantha), western wheatgrass, needle-and-thread (Hesperostipa comata), and sun sedge (Carex heliophylla) are abundant. Smooth brome, Kentucky bluegrass and annual bromes have limited abundance. There is little invasive tree encroachment in Grade A sites. Conservative forbs are widespread and abundant in Grade A prairies and include the following species (not all species may be present at a site): purple prairie coneflower (Echinacea angustifolia), purple prairie clover (Dalea purpurea), Missouri

goldenrod (Solidago missouriensis), penstemons (Penstemon spp.), plains yellow primrose (Calyophus serrulatus), silver leaf scurfpea (Pediomelum argophyllum), slender-flower scurfpea (Psoralidium tenfuiflorum), prairie turnip (Pediomelum esculentum), leadplant (Amorpha canescens), and downy gentian (Gentiana puberula).

On sand/gravel soils Grade A sites are dominated by sand lovegrass, hairy grama, and little bluestem with scattered tall warm-season grasses, including prairie sandreed. Native cools-season graminoids including Junegrass, needle-and-thread and sun sedge are abundant. Annual bromes and other invasive species have limited abundance. There is little invasive tree encroachment in Grade A sites. Conservative forbs are widespread and abundant in sandy Grade A prairies and include the following species: plains yellow primrose, yellow woollywhite (Hymenopappus tenuifolius), cutleaf ironplant (Xanthisma spinulosum), scurfpeas (Psoralidium spp. and Pediomelium spp,), penstemons, snake cotton (Froelichia gracilis), hairy golden aster, stiff greenhead (Thelesperma filifolium), fringed sage (Artemisia frigida), ledge spike-moss (Selaginella rupestris), and flame flowers (Talinum spp.).

Grade B Cental Mixedgrass Prairies – Grade B mixedgrass prairies are also rare, especially on silty soils. They are most likely to occur on steep slopes less accessible to cattle grazing and herbicide spraying.

On silty soils, compared to Grade A sites, Grade B sites are still dominated by native warm-season grasses, though western wheatgrass, blue grama, and buffalo grass may be more prominent, especially on bottoms and flats. Also, invasive exotic grasses, including smooth brome, Kentucky bluegrass, and annual brome are more abundant than in Grade A sites, though they are not widespread or co-dominant. Invasive trees are limited in Grade B prairies and not abundant. Conservative native forbs are still common, though less abundant and more scattered than in Grade A prairies.
On sand/gravel soils, hairy grama and sand dropseed may be more prominent than on Grade A sites. Invasive exotic grasses are more abundant than in Grade A sites, though they are not widespread or co-dominant. Invasive trees occur only as scattered individuals. Conservative forbs are still common, though less abundant than Grade A sites. Examples of Grade B central mixedgrass prairies occur on Red Willow Reservoir SRA and Medicine Creek Reservoir SRA.

Grade C Central Mixedgrass Prairies - Grade C mixedgrass prairies are common and include many grazed pastures. Grade C prairies have had fairly severe disturbance from overgrazing, herbicide spraying, exotic plant invasion and tree encroachment.

On silty soils, Grade C prairies are often co-dominated by native grasses and exotic cool-season grasses. Native, mid and short grasses including blue grama, western wheatgrass, buffalo grass, and little bluestem are often prominent. The exotics, smooth brome, Kentucky bluegrasses and annual bromes are are also often prominent to co-dominant. Weedy native forbs including western ragweed, hoary vervain (Verbena stricta), and daisy fleabane (Erigeron strigosus) may be abundant, as well as exotic forbs, such as sweet clovers (Melilotus spp.), clovers (Trifolium spp.), black medic (Medicago lupulina), dandelion (Taraxacum officinale), and sulfur cinquefoil (Potentilla recta). Woody encroachment can be severe in areas. Conservative native forb diversity and abundance is limited compared to higher quality prairies.

On sand/gravel soils, Grade C prairies are often dominated by native grasses, primarily hairy grama and sand dropseed, though invasive exotic grasses can be prominent to co-dominant. Weedy native forbs, primarily western ragweed, may be abundant, as well as exotic forbs. Woody encroachment can be severe in areas. Conservative native forb diversity and abundance is limited compared to higher quality pr prairies. An example of a Grade C central mixedgrass prairie occurs on Enders Reservoir WMA.

Grade D Central Mixedgrass Prairies - Grade D prairies are common and include many heavily grazed pastures, especially the bottoms and flats in these pastures, which often have been severely overgrazed. Also included here are prairies intensively sprayed with herbicide or with severe woody plant encroachment. Grade D prairies may have been cultivated for a short time in the distant past. On both silty and sandy soils, Grade D mixedgrass prairies are dominated by exotic cool-season grasses, mainly smooth brome, Kentucky bluegrass and annual bromes. Native grasses occur as scattered individuals. Conservative forbs are absent, though native weedy forbs can be common. An example of a Grade D central mixedgrass prairie occurs on Red Willow Reservoir WMA.

Management Objectives and Guidelines for Various Grade Central Mixedgrass Prairie

Grade A Central Mixedgrass Prairies
Management Objective - Maintain and enhance Grade A condition.

Minimum Management:

1) Conduct variably timed burns once every 3 to 4 years, minimum of every 3 years if grazing or haying are not part of management.
2) Variably timed grazing once every 3 years. Variably timed haying is also an option if grazing is not feasible.
3) Spot herbicide control of smooth brome, musk thistle, leafy spurge, and other noxious weeds.
4) Cut all eastern red cedar and other woody invaders not controlled by burning.

Management Options:

1) If exotic cool-season grasses become prominent,1 to 2 years of dormant season or early spring burning followed by heavy, short-duration (4 to 6 weeks) spring grazing is recommended until the exotics are reduced.
2) 2) Including Grade A prairies in grazing systems is not recommended unless they are part of large prairie complex that is managed as a unit. No patch burn grazing at this time, until more research is conducted to determine its impact on conservative plant species.

Grade B Central Mixedgrass Prairies
Management Objective – Enhance site quality to Grade A condition.

Minimum Management:

1) Conduct variably timed burns once every 3 to 4 years, minimum of every 3 years if grazing or haying is not an option
2) Variably timed grazing once every 3 years. Variably timed haying is an option if grazing is not feasible.
3) Spot herbicide control of musk thistle, leafy spurge, and other noxious weeds.
4) Cut all eastern red cedar and other woody invaders not controlled by burning.

Management Options:

1) If exotic cool-season grasses become prominent, 1 to 3 years of dormant season or early spring burning followed by heavy, short-duration (4 to 6 weeks) spring grazing is recommended until the exotics are reduced.
2) Rest-rotation grazing at light to moderate stocking rates.
3) Fire-driven rest-rotation grazing at light to moderate stocking rates.
4) Patch burn grazing at light to moderate stocking rates is an option, though it should be closely monitored.
5) Winter grazing.

Grade C Central Mixedgrass Prairies

Management objectives – Enhance site quality to Grade Be condition.

Minimum management:

1) Conduct spring burns once every 3 to 4 years, minimum of every 3 years if grazing is not an option.
2) Variably timed grazing once every 3 years (spring grazing may be preferred to reduce exotic cool-season grasses).
3) Spot herbicide control of noxious weeds.

Management Options:

1) If exotic cool-season grasses are prominent, one to three years of dormant season or early spring burning followed by heavy, short-duration (4 to 6 weeks) spring grazing is recommended until the exotics are reduced.
2) Rest-rotation grazing at light to moderate stocking rates.
3) Fire-driven rest-rotation grazing at light to moderate stocking rates.
4) Patch burn grazing at light to moderate stocking rates.
5) Season-long grazing at light to moderate stocking rates.
6) Winter grazing.
7) Interseed local ecotype, native plant seed to improve plant diversity and wildlife habitat.
8) Invasive tree cutting may be necessary if low fuel loads or large tree size makes prescribed burning ineffective at controlling trees.

Grade D Central Mixedgrass Prairies

Management Objective - Improve wildlife habitat and provide buffers for and corridors between other native plant communities. Where native plant species remain manage for these species as wildlife habitat. Protect native soil profiles on these previously

unplowed sites from plowing and deep disking. Where feasible, use interseedling of local-ecotype seed to restore these sites to more diverse grasslands.

Minimum Management:

1) Spring burn at least once every 5 years to stimulate native plants and early successional plants.
2) Graze at least 1 in every 3 years (spring grazing may be preferred to reduce exotic cool-season grasses).
3) Spot herbicide control of noxious weeds.

Management Options:

1) Dormant season or early spring burning followed by heavy, short-duration grazing (4 to 6 weeks) to reduce exotic-cool-season grasses and stimulate remaining native plants and early successional plants.
2) Rest-rotation at light to moderate stocking rates.
3) Fire-driven rest-rotation grazing at light to moderate stocking rates.
4) Patch burn grazing at light to moderate stocking rates.
5) Season-long grazing at light to moderate stocking rates.
6) Interseed local ecotype, native plant seed to improve plant diversity and wildlife habitat. Herbicide application will likely be needed to reduce exotic cool-season grasses prior to interseeding.
7) Light disking (1 to 2 inches depth with straight disc blades) to stimulate early successional and other native plants. This is to be used only if grazing management and herbicide application are not successful or feasible. This practice is not allowed on erodible soils.
8) Cut eastern red cedar and other woody species.

Sand Prairie System

Range

Sand prairies occur throughout the Sandhills of north-central Nebraska and on outlying dune fields in nearly all areas of the state except southeastern Nebraska. Soils range from loamy fine sands to coarse sands.

Communities Included

The following natural communities described in Steinauer and Rolfsmeier 2010 are included in the Sand Prairie System:

Sandhills Dune Prairie
Sandhills Dry Valley Prairie
Sandsage Prairie
Eastern Sand Prairie
Sandhills Mesic Tall-grass Prairie
Great Plains Gravel/Cobble Prairie

Dominant Species
sand bluestem (Andropogon hallii), switchgrass (Panicum virgatum), little bluestem (Schizachrium scoparium), needle-and-thread (Hesperostipa comata), prairie sandreed (Calamovilfa longifolia), sand lovegrass (Eragrostis spectabilis), blue grama (Bouteloua gracilis), hairy grama (B. hirsuta), sun sedge (Carex heliophila)

Primary Invasive Plants
smooth brome (Bromus inermis), Kentucky bluegrass (Poa pratensis), annual bromes (Bromus spp.), leafy spurge (Euphorbia esula), eastern red cedar (Juniperus virginiana),

System Quality Grades

Sand prairie is somewhat unique among Nebraska's grassland types with regard to quality grades. Many of these prairies are in relatively good condition as there are few exotic plants that invade the drier, sandy soils. Sand prairies also recover rather quickly from disturbance. Some sites plowed and farmed in the distant past now have a native species composition similar to unplowed sand prairies. In addition, there is less distinction in plant composition between higher and lower quality sand prairies than prairie types on more loamy soils.

Grade A Sand Prairies – Grade A sand prairies are fairly common, though not as abundant as Grade B and Grade C prairies. Grade A sand prairies are primarily light to moderately grazed pastures, often winter grazed pastures, or hay meadows. Grade A sites are dominated by native warm-season tall grasses, with an abundance of sand bluestem and prairie sandreed. Native cool-season graminoids including Junegrass (Koeleria macrantha), needle-and-thread, and sun sedge can be abundant. The exotics smooth brome, annual bromes, and Kentucky bluegrass have only limited abundance on low slopes and in swales. Disturbance-tolerant natives, such as sand dropseed (Sporobolus cryptandrus), plains sunflower (Helianthus petiolaris), annual wild buckwheat (Eriogonum annuum), western ragweed, and sixweek fescue, are a natural component of more open sandy soils and may be fairly abundant in Grade A sites. There is little invasive tree encroachment in Grade A sites. Conservative perennial forbs and shrubs are widespread and abundant in Grade A sand prairies including white, purple, and silky prairie clover (Dalea spp.), New Jersey tea (Ceanothus herbaceous), leadplant (Amorpha canescens), plains gayfeahers (Liatris squarrosa), hairy puccoon (Lithospermum caroliniense), narrowleaf beardtonque (Penstemon angustifolius),Missouri goldenrod (Solidago missouriensis), sand milkweed (Asclepias arenaria), sand cherry (Prunus pumila), showy ipomopsis (Ipomopsis longiflora), and stiff sunflower (Helianthus pauciflorus). Examples of Grade A sand prairies occur on The Nature Conservancy's Niobrara Valley Preserve.

Grade B Sand Prairies – Grade B sand prairies are common. Most Grade B prairies are moderately grazed pastures. They are dominated by native warm-season tall grasses. Sand bluestem and prairie sandreed may be less common in Grade B prairies than Grade A prairies. Sand dropseed, hairy grama, blue grama, and western ragweed can be more abundant in Grade B prairies than in Grade A prairies though they are not dominant. Native cool-season graminoids are conspicuous. Exotic cool-season grasses including

smooth brome, annual bromes, and Kentucky bluegrass have limited abundance in Grade B prairies mainly on low slopes and in swales. Invasive trees are limited in Grade B prairies. Conservative forbs and shrubs are still diverse and abundant common in Grade B prairies, though less so than in Grade A prairies. Common conservative forbs in Grade B prairies include leadplant, stiff sunflower, prairie clovers, Missouri goldenrod, cutleaf ironplant (Xanthisma spinulosum), wild rose (Rosa arkansana), palm-leaf scurfpea (Pediomelum digitatum), and woollywhite (Hymenopappus tenuifolius). Examples of Grade B sand prairies occur on the McKelvie National Forest (Steer Creek Pasture) and Calamus Reservoir WMA.

Grade C Sand Prairies - Grade C sand prairies are common and include many moderate to heavily grazed pastures. Though native warm-season tall grasses are still common, Grade C sand prairies have an abundance of disturbance tolerant native grasses, including sand dropseed, sand muhly (Muhlenbergia pungens), hairy grama, blue grama, and sixweek fescue. Smooth brome, annual bromes, and Kentucky bluegrass may dominate in localized areas and the annual bromes may be conspicuous throughout. Woody encroachment can be severe in areas. The dominant forbs of Grade C prairies often include western ragweed, Texas croton (Croton texensis), cactus (Opuntia spp.), field sagewort (Artemisia campestris), annual buckwheat and annual sunflowers. Conservative graminoids and forbs may be present, but they are not abundant. Examples of Grade C sand prairies occur on the South Pine WMA

Grade D Sand Prairies – Grade D sand prairies have had severe disturbance from past plowing, use as feedlots or other major disturbance. Grade D sand prairies are less common than higher grade sand prairies. They are dominated by exotic cool-season grasses, mainly annual bromes, Kentucky bluegrass and smooth brome, and/or weedy forbs including Russian thistle (Salsola spp.) western ragweed, buffalo-bur (Solanum rostratum), annual sunflowers, and Rocky Mountain bee plant (Cleome serrulata). Disturbance-tolerance native grasses, such as sandbur (Cenchrus longispinus), purple three-awn (Aristida purpurea), and sand dropseed may also be prominent. These sites may recover given time. An example of a Grade D sand prairie occurs on Plum Creek Valley WMA.

Management Objectives and Guidelines for Various Grade Sand Prairies

Grade A and B Sand Prairies
Management Objective - Maintain and enhance the condition of Grade A sites, enhance the site quality if Grade B sites to Grade A condition.

Required Management:

1) Variably time prescribed burned at least once every 5 years.
2) Variably timed grazing at least once every three years.
3) Spot herbicide control of smooth brome, leafy spurge, and other invasive plants.
4) Cut all eastern red cedar and other woody invaders not controlled by burning.

Management Options:

1) If exotic cool-season grasses are becoming prominent, dormant season or early spring prescribed fire followed by heavy, short-duration (4 to 6 weeks) spring grazing is an option.
2) Rest-rotation grazing at light (preferred) to moderate stocking rates.
3) Fire-driven rest-rotation grazing at light (preferred) to moderate stocking rates
4) Patch burn grazing at light (preferred) to moderate stocking rates.
5) Winter grazing.

Grade C Sand Prairies

Management Objective – Enhance site quality to Grade B condition.

Minimum Management:

1) Variably timed prescribed burns at least once every 5 years.
2) Variably time grazing at least once every 3 years.
3) Spot herbicide control all noxious weeds.
4) Cut all eastern red cedar and other woody invaders not controlled by burning.

Management Options:

1) If exotic cool-season grasses are become problematic, dormant season or early spring prescribed fire followed by heavy, short-duration (4 to 6 weeks) spring grazing is an option.
2) Season-long grazing at light to moderate stocking rates to create habitat heterogeneity.
3) Rest-rotation grazing at light to moderate stocking rates.
4) Fire-driven rest-rotation grazing at light to moderate stocking rates.
5) Patch burn grazing at light to moderate stocking rates.
6) Winter grazing

Grade D Sand Prairies

Management Objectives – Improve wildlife habitat and provide buffers for and corridors between other native plant communities. Where native species remain manage for these species as wildlife habitat. Protect native soil profiles on these previously unplowed sites from plowing or deep disking. Where feasible, use interseedling of local-ecotype seed to restore these sites to more diverse grasslands.

Minimum Management:

1) Conduct prescribed burns at least once every 10 years
2) Variably timed grazing at least once every 3 years.
3) Spot herbicide control all noxious weeds.

Management Options:

1) Dormant season or early spring burning followed by heavy, short-duration grazing (4-6 weeks) to reduce exotic-cool-season grasses and stimulate remaining native plants and early seral plants.

2) Season-long grazing at light to moderate stocking rates to create habitat heterogeneity.
3) Rest-rotation at light to moderate stocking rates.
4) Fire-driven rest-rotation grazing at light to moderate stocking rates.
5) Patch burn grazing at light to moderate stocking rates.
6) Season-long grazing at light to moderate stocking rates to create habitat heterogeneity.
7) Interseed local ecotype, native plant seed to improve plant diversity and wildlife habitat. Herbicide application will likely be needed to reduce exotic cool-season grasses prior to interseeding.
8) Light disking (1 to 2 inches depth with straight disc blades) to stimulate early successional and other native plants. This is to be used only if grazing management and herbicide application are not successful or feasible. This practice is not allowed on erosive soils.
9) Cut eastern red cedar and other woody species.

Western Mixedgrass Prairie System

Range

Western mixedgrass prairie occurs primarily in the Nebraska Panhandle, but extends eastward on dry stream river bluffs. Soils are well to poorly drained, shallow to deep and range from clays to loamy sands formed in colluvium, loess, eolian sand, or weathered siltstone, shale, and sandstone.

Communities Included

The following natural communities described in Steinauer and Rolfsmeier 2010 are included in the Western Mixedgrass Prairie System:

Western Floodplain Terrace Grassland
Silver Sagebrush Shrub Prairie
Greasewood Shrub Prairie
Threadleaf Sedge Western Mixed-grass Prairie
Northwestern Mixed-grass Prairie
Western Sand Prairie
Wheatgrass Playa Grassland (partially included)

Dominant Species

side-oats grama (Bouteloua curtipendula), blue grama (B. gracilis), western wheatgrass (Elymus smithii), green needlegrass (Nassella viridula), buffalo grass (Buchloe dactyloides), prairie sandreed (Calamovilfa longifolia), needle-and-thread (Hesperstipa comata), threadleaf sedge (Carex filifolia), purple three-awn (Aristida purpurea), sixweeks fescue (Vulpia octoflora)

Primary Invasive Plants
smooth brome (Bromus inermis), Kentucky bluegrass (Poa pratensis), annual bromes (Bromus spp.), crested wheatgrass (Agropyron cristatum), intermediate wheatgrass (Elymus hispidus)

Grade A Western Mixedgrass Prairies – Grade A western mixedgrass prairies are rare and mostly occur on steeper, often shallow-soiled topography that is fairly inaccessible to livestock and too dry to support abundant exotic grasses. Native cool-season graminoids including needle-and-thread, green needlegrass or threadleaf sedge are dominant to co-dominant in Grade A prairies. Exotic grasses have limited abundance. There is little invasive tree encroachment in Grade A prairies. Conservative forbs are widespread and abundant in Grade A western mixedgrass prairies including star-lily (Leucocrinum montanum), Nuttall's violet (Viola nuttallii), purple prairie coneflower (Echinacea angustifolia), prairie clovers (Dalea spp.), Missouri goldenrod (Solidago missouriensis), plains yellow primrose (Calyophus serrulatus), milkvetches (Astragalus spp.), purple locoweed (Oxytropis lambertii), dotted gayfeather (Liatris punctata), silver-leaf scurfpea (Pediomelum argophyllum), penstemons (Penstemon spp.). An example of a Grade A western mixedgrass prairie occurs on Chimney Rock Historical Area.

Grade B Western Mixedgrass Prairies – Grade B western mixedgrass prairies are uncommon. Similar to Grade A prairies, Grade B prairies occur on steeper, often shallow-soiled topography that is fairly inaccessible to livestock and too dry to support abundant exotic grasses. Needle-and-thread, green needle grass or threadleaf sedge dominant Grade B prairies, though blue grama, buffalo grass and western wheatgrass may be co-dominant. Exotics grasses, especially annual cheatgrasses are more abundant than in Grade A prairies, though they are not widespread or co-dominant. Invasive tree encroachment is limited in Grade B prairies. Conservative native forbs are still common, though less abundant and more scattered than in Grade A communities. Examples of Grade B western mixedgrass prairies occur on Ash Hollow State Historical Park and Enders Reservoir WMA.

Grade C Western Mixedgrass Prairies - Grade C western mixedgrass prairies are abundant and include most grazed native pastures in the Pandhandle. These sites have had fairly severe disturbance from past overgrazing and invasive species encroachment. In many Grade C prairies the needlegrasses and threadleaf sedge are less prominent that in Grade A and B prairies due to grazing pressure. Western wheatgrass, blue grama, and buffalo grass are often dominant or at least co-dominant. In addition, the exotics smooth brome, intermediate wheatgrass, crested wheatgrass, Kentucky bluegrass and annual bromes may be prominent to co-dominant. The most common perennial forbs include cactus (Opuntia spp.), broom snakeweed (Gutierrezia sarothrae), scarlet glove mallow (Sphaeralcea coccinea), white sage (Artemisia ludoviciana) and fringed sage (A. frigida). Native and exotic annuals and biennials forbs can be prominent, including fluffweed (Filago arvensis), sweetclovers (Melilotus spp.), yellow goat's-beard (Tragopogon dubius), woolly plantain (Plantago patagonica), and fetid marigold (Dyssodia papposa). Conservative native forb diversity and abundance is limited compared to Grade A and

Grade B sites. An example of a Grade C western mixedgrass prairie occurs on Soldier Creek Wilderness area and Fort Robinson State Park (Buffalo Pasture).

Grade D Western Mixedgrass Prairies – Grade D western mixedgrass prairies are fairly uncommon. Grade D sites include severely overgrazed pastures, old feedlots, some prairie dog towns, and distant past plowed and farmed sites. Grade D sites are frequently dominated by exotic cool-season grasses and exotic forbs such as Russian thistles (Salsola spp) and kochia (Kochia scoparia). Native graminoids occur only as scattered individuals in Grade D sites. Conservative forbs are very rare to absent.

Many old farm fields in western Nebraska have been seeded with little bluestem and are now sometimes difficult to distinguish from disturbed native grasslands. Other old fields have been seeded to crested and intermediate wheatgrass and are being reinvaded by native plants.

Management Objectives and Guidelines for Various Grade Western Mixedgrass Prairies.

Grade A Western Mixedgrass Prairies
Management Objective - Maintain and enhance Grade A condition.

Minimum Management:

1) Conduct variably timed prescribed burns every 4 to 5 years, minimum of every 3 years if grazing is not possible.
2) Variably timed grazing at least once every 3 to 4 years.
3) Spot herbicide control of noxious weeds, smooth brome, and exotic wheatgrasses.
4) Cut all eastern red cedar, young pines and other woody invaders not controlled by burning.

Management Options:

1) If exotic cool-season grasses become prominent, 1 to 3 years of dormant season or early spring (late March) prescribed fire followed by heavy, short-duration (3 to 5 weeks) grazing is recommended until the exotics are reduced. Fall or early spring prescribed burning is also an option.
2) Winter grazing.

Grade B Western Mixedgrass Prairies
Management Objective – Enhance the site quality to Grade A condition.

Minimum Management:

1) Conduct variably timed prescribed burns every 4 to 5 years, minimum of every 3 years if grazing is not possible.
2) 2) Variably timed grazing at least once every 3 to 4 years.
3) Spot herbicide control of noxious weeds, smooth brome, and exotic wheatgrasses.

4) Cut all eastern red cedar, young pines and other woody invaders not controlled by burning.

Management Options:

1) If exotic cool-season grasses become prominent, 1 to 3 years of dormant season or early spring (late March) prescribed fire followed by heavy, short-duration (3 to 5 weeks) grazing is recommended until the exotics are reduced. Fall or early spring prescribed burning is also an option.
2) Rest-rotation grazing at light to moderate stocking rates.
3) Fire-driven rest-rotation grazing at light to moderate stocking rates.
4) Patch burn grazing at light to moderate stocking rates.
5) Winter grazing.

Grade C Western Mixedgrass Prairies

Management Objectives – Enhance the site quality to Grade B condition.

Minimum Management:

1) Conduct variably time prescribed burns every 4 to 5 years, minimum of every 4 years if grazing is not possible (early spring fires may be preferred to impact annual bromes, or later spring fires if Kentucky bluegrass or smooth brome are problematic).
2) Variably timed grazing at least once every 3 to 4 years.
3) Spot herbicide control of noxious weeds.

Management Options:

1) If exotic cool-season grasses become prominent, one to three years of fall or early spring (late March) prescribed fire followed by heavy, short-duration (3 to 5 weeks) grazing is recommended until the exotics are reduced.
2) Rest-rotation grazing at light to moderate stocking rates.
3) Fire-driven rest-rotation grazing at light to moderate stocking rates.
4) Patch burn grazing at light to moderate stocking rates.
5) Winter grazing.
6) Interseed local ecotype, native plant seed to improve plant diversity and wildlife habitat.
7) Invasive tree cutting may be necessary if low fuel loads or large tree size makes prescribed burning ineffective at controlling trees.

Grade D Western Mixedgrass Prairie

Management Objective - Improve wildlife habitat and provide buffers for and corridors between other native plant communities. Where native plant species remain manage for these species as wildlife habitat. Protect native soil profiles on these previously unplowed sites from plowing and deep disking

Minimum Management:

1) Prescribed burn at least once every 5 to 10 years to stimulate native plants and reduce fuel loads.

2) Short-duration grazing at moderate to heavy stocking rates at least 1 in 4 years to stimulate native plants, to reduce fuel loads, and improve wildlife habitat.
3) Spot herbicide control of all noxious weeds.

Management Options:

1) Dormant season or early spring prescribed burning followed by heavy, short-duration grazing (3 to 5 weeks) to stimulate remaining native plants and early successional plants.
2) Rest-rotation grazing at light to moderate stocking rates.
3) Fire-driven rest-rotation grazing at light to moderate stocking rates.
4) Patch burn grazing at light to moderate stocking rates to stimulate early seral plants.
5) Light disking (1 to 2 inches depth with straight disc blades) to stimulate early successional and native plants. This is to be used only if grazing management and herbicide application are not successful or feasible. This practice is not allowed on erosive soils.
6) Cut eastern red cedar and other woody species.

Wet Meadow Prairie System (Includes Freshwater, Alkaline, and Saline Meadows)

Freshwater meadow

Range

Wet meadows occur on stream floodplains and low terraces nearly statewide, and often occur as bands along stream channels. They can also occupy ravines and drainages in uplands. Soils are deep, poorly drained and range from clay loams to sands and are mainly formed in alluvium. These soils often remain saturated much of the season, particularly in winter or spring or following heavy rains.

Communities Included

The following natural communities described in Steinauer and Rolfsmeier 2010 are included in the Wet Meadow Prairie System

Eastern Cordgrass Wet Prairie
Eastern Sedge Wet Meadow
Northern Cordgrass Wet Prairie
Sandhills Wet Meadow
Western Sedge Wet Meadow
Wheatgrass Playa Grassland (partially included)

Dominant Species

Wet meadows are dominated by native warm-season and cool-season graminoids. Lower wetter sites have a greater abundance of sedges and rushes than higher and drier sites which have a greater abundance of warm-season grasses. In general, forbs are not as diverse or abundant in wet meadows as in upland prairies. Dominant species in wet

meadows include prairie cordgrass (Spartina pectinata), bluejoint (Calamograstis canadensis), sedges (Carex spp.), spikerushes (Eleocharis spp.), rushes (Juncus spp.), dark-green bulrush (Scirpus atrovirens), pale bulrush (S. pallidus), three square bulrush (Schoenoplectus pungens), and switchgrass (Panicum virgatum). Big bluestem (Andropogon gerardii) may be common on the drier upslope margin of this community.

Primary Invasive Species
reed canary grass (Phalaris arundinacea), Garrison creeping foxtail (Alopecurus arundinaceus), timothy (Phleum pretense), redtop (Agrostis gigantea), smooth brome (Bromus inermis), Kentucky bluegrass (Poa pratensis), leafy spurge (Euphorbia esula), purple loosestrife (Lythrum salacaria), Canada thistle (Cirsium arvense), Russian olive (Elaeagnus angustifolia), eastern red cedar (Juniperus virginiana)

Quality Grades

Grade A Freshwater Wet Meadows – Grade A freshwater wet meadows are rare. Nearly all Grade A wet meadows are hay meadows. In eastern Nebraska most Grade A meadows are small, usually less than 80-acres, in size. Westward they can be larger in size, especially in the Sandhills. The natural hydrology of Grade A meadows is mainly intact, though it can be slightly modified by ditching or stream alteration. Grade A sites are dominated by native grasses, sedges, and rushes. Exotic cool-season grasses have very limited abundance in Grade A meadows. There is little invasive tree encroachment. Conservative forbs are widespread in Grade A meadows including winged loosestrife (Lythrum alatum), great blue lobelia (Lobelia silphictica), closed gentian (Gentiana andrewsii), blue vervain (Verbena hastata), swamp milkweed (Asclepias incarnata), common water-hemlock (Cicuta maculata), skullcaps (Scutellaria spp.), water horehounds (Lycopus spp), yellow star-grass (Hyposix hirsuta), wood lily (Lilium philadelphicum), swamp lousewort (Pedicularis lanceolata), and fieldmint (Mentha arvensis). An example of a Grade A freshwater wet meadow occurs on the South Pine WMA.

Grade B Freshwater Wet Meadows – Grade B freshwater wet meadows prairies are uncommon, though more abundant than Grade A meadows. Most Grade B wet meadows are hay meadows. In eastern Nebraska most Grade B meadows are, small, usually less than 80 acres, in size. The natural hydrology of Grade B meadows is often somewhat altered by ditching and stream alteration. Grade B sites are dominated by native grasses, sedges, and rushes. Exotic cool-season grasses are more abundant than in Grade A meadows, though they are not widespread or dominant. The exceptions to this are Kentucky bluegrass, timothy, and redtop, which can be widespread in Grade B meadows. Invasive trees are limited in Grade B meadows. Conservative forbs are still diverse and common in Grade B meadows, though less so than in Grade A meadows. Examples of Grade D wet meadows occur on Kent Diversion Dam WMA, Wood Duck WMA, and Calamus Reservoir SRA.

Grade C Freshwater Wet Meadows - Grade C freshwater wet meadows are common and include many hayed and grazed sites. Grade C meadows may have had fairly severe past

disturbance from annual haying, overgrazing, herbicide spraying, invasive species, or woody species encroachment. The natural hydrology of many Grade C meadows has been substantially altered through ditching and stream alteration. Exotic cool-season grasses are often co-dominant with native grasses, sedges and rushes. Woody encroachment can be severe in areas. Conservative native forb diversity and abundance is limited compared to Grade A and Grade B, with most conservative species being absent. The most abundant forbs in Grade C meadows are often disturbance-tolerant native species including daisy fleabane (Erigeron strigosus), annual fleabane (E. annum), heath aster (Symphyotrichum ericoides), tall thistle (Cisium atlitissimum), Flodman's thistle (Cirsium flodmanii), western ironweed (Veronia fasiculata), wild licorice (Glycyrrhiza lepidota), Canada goldenrod (Solidago canadensis), and yarrow (Achillea millifolium). Exotic forbs, such as sweet clovers (Melilotus spp.), clovers (Trifolium spp.), alfalfa (Medicago sativa), black medic (M. lupulina), and dandelion (Taraxacum officinale) may be common in Grade C wet meadows. Examples of Grade C wet meadows occur on Milburn Dam WMA and the Winnebago Indian Reservation.

Grade D Freshwater Wet Meadows – Grade D freshwater wet meadows are common. They have had severe disturbance from overgrazing, herbicide spraying, invasive species and possibly distant past plowing. The natural hydrology of Grade D meadows has often been greatly modified through ditching, stream alteration and other factors. Grade D meadows are dominated by exotic cool-season grasses. Native graminoids occur as scattered individuals. Invasive woody encroachment may be severe. Conservative forbs are absent, though native weedy forbs can be common.

Eastern Saline Meadow

Range

Eastern saline meadows are restricted to Lancaster and southern Saunders counties in southeastern Nebraska, primarily in the valleys of Salt Creek, Little Salt Creek, and Rock Creek.

Communities Included

The following natural communities described by Steinauer and Rolfsmeier 2010 are included in the Eastern Saline Meadow system:

Eastern Saline Meadow

Dominant Species

foxtail barley (Hordeum jubatum), annual marsh-elder (Iva annua), prairie cordgrass (Spartina pectinata), inland saltgrass (Distichlis spicata), plains bluegrass (Poa arida), saltmarsh spearscale (Atriplex dioica), saltwort (Salicornia rubra), seablite (Suaeda calceoliformis).

Primary Invasive Plants

reed canary grass (Phalaris arundinacea), narrow-leaf cattail (Typha angustifolia), tallwheat grass (Elymus elongatus), Kentucky bluegrass (Poa pratensis), smooth brome (Bromus inermis)

Quality Grades

Grade A Eastern Saline Meadows - Grade A saline meadows are extremely rare or may no longer exist. The hydrology of the meadows and soil salinity levels have only minor alteration from stream downcutting, ditches, drains, sedimentation and/or diking (nearly all remaining saline wetlands have degraded hydrology from stream downcutting and sedimentation). Native saline seeps as well as salt flats are still present in Grade A meadows. Plant species diversity is naturally low in saline meadows. Grade A saline meadows are dominated by saltgrass, foxtail barley, plains bluegrass, prairie cordgrass, annual marsh-elder, and saltmarsh spearscale. In less saline areas buffalo grass, western wheatgrass, and blue grama may dominate. Drying mudflats within meadows are dominated by the native annuals saltwort and seablite. Invasive plants including narrow-leaf cattail, reed canary grass, exotic wheatgrasses, and Kentucky bluegrass, occur only as widely scattered individuals.

Grade B Eastern Saline Meadows – Grade B saline meadows are rare. The hydrology of the meadows and soil salinity levels have been moderately altered by stream downcutting, ditches, drains, sedimentation, and/or diking. Grade B meadows are dominated by the same species that dominate Grade A meadow though reed canary grass, narrow-leaf cattail and other exotic species may dominate localized areas and have a moderate overall abundance. In localized areas soil salinity levels have decreased to the extent that saline-tolerant vegetation no longer dominate. These areas are often dominated by narrow-leaf cattail, reed canary grass, smooth brome or other non-halophytic vegetation. Mudflats are usually still present in Grade B meadows and are dominated by native annuals, though narrow-leaf cattail may also dominate localized areas of the mudflats. Examples of Grade B saline wetlands include The Nature Conservancy's Little Salt Fork Marsh and Arbor Lake WMA.

Grade C Eastern Saline Meadows – Grade C saline meadows are a relatively commonly occurring type The hydrology and soil salinity of Grade C saline meadows has usually been significantly altered by stream downcutting, ditches, drains, sedimentation, and/or diking. Saline seeps may no longer function in Grade C saline meadows and areas of the meadows may have converted to freshwater systems. Portions of Grade C saline meadows may have been farmed in the past. These meadows are often co-dominated by native salt-tolerant vegetation, such as saltgrass, foxtail barley, plains bluegrass, and prairie cordgrass, and exotic cool-season grasses, predominantly reed canary grass and smooth brome. Mudflats dominated with saltwort and seablite are rare in Grade C wetlands. Examples of Grade C saline meadows occur on the Jack Sinn WMA.

Grade D Eastern Saline Meadows - Grade D saline meadows are the most frequently occurring type. They include wetlands that have been recently farmed and wetlands

whose hydrology and soil salinity have been extensively modified by stream downcutting, ditches, drains, sedimentation and/or diking. Grade D saline meadows are dominated by invasive species, primarily narrow-leaf cattail, reed canary grass, and smooth brome. Widely scattered patches of halophytic vegetation may still occur in Grade D meadows. Saline meadows that have totally converted to freshwater meadows are included here. Examples of Grade D saline meadows occur on the Jack Sinn WMA.

Western Alkaline Meadow

Range

Western Alkaline meadows are most abundant in the "closed basin" region of the western Sandhills in Garden, Morrill, and Sheridan counties, and they are also scattered in other areas of the Sandhills and the North Platte River, Niobrara River and other stream valleys in the Panhandle.

Communities Included

The following natural communities described by Steinauer and Rolfsmeier 2010 are included in the Coniferous Woodland system:

Western Alkaline Meadow
Western Subirrigated Alkaline Meadow

Dominant Species

foxtail barley (Hordeum jubatum), Nuttall's alkali grass (Puccinellia nuttalliana), clustered field sedge (Carex praegracilis), inland saltgrass (Distichlis spicata), scratchgrass (Muhlenbergia asperifolia), alkali sacaton (Sporobolus airoides)

Primary Invasive Plants

Russian olive (Elaeagnus angustifolia), reed canary grass (Phalaris arundinacea), tall wheatgrass (Elymus elongatus), Kentucky bluegrass (Poa pratensis), smooth brome (Bromus inermis), Canada thistle (Cirsium arvense), strawberry clover (Trifolium fragiferum)

Quality Grades

Grade A Western Alkaline Meadows - Grade A western alkaline meadows are fairly common in the Sandhills, though much less common in Pandhandle stream valleys. The meadows' hydrology and soil alkalinity levels have only minor alterations from ditches, drains, sedimentation, lowered groundwater levels and/or diking. Grade A alkaline meadows have had little disturbance from grazing, haying or herbicide spraying. Plant species diversity is naturally somewhat low in alkaline meadows, though they are often dominated by a fairly diverse mix of native graminoids including clustered field sedge, Nuttall's alkali grass, scratchgrass, saltgrass, alkali cordgrass (Spartina gracilis), and alkali sacaton. Grade A meadows also contain a mix of the following conservative plants including ladies-tresses orchids (Spiranthes spp.), prairie-gentian (Eustoma grandiflorum), lanceleaf gayfeather (Liatris lancefolia), Nebraska sedge (Carex

nebrascensis), blue-eyed grass (Sisyrinchium montanum, bog aster (Aster junciformis), and shooting star (Dodecantheon pulchellum). Drying mudflats within meadows are dominated by dwarf alkali arrowgrass (Triglochin maritime) and seablite (Suaeda calceoliformis). Invasive plants occur only as widely scattered individuals. Examples of Grade A alkaline meadows are common on private lands in the western Sandhills.

Grade B Western Alkaline Meadows – Grade B western alkaline meadows are fairly common in the Sandhills, though less common in Pandhandle stream valleys. The hydrology of the meadows and soil alkalinity levels have been only moderately altered by ditches, drains, sedimentation, lowered groundwater levels and/or diking. Grade B alkaline meadows have had limited disturbance from grazing, haying or herbicide spraying. The meadows are often dominated by the native graminoids listed above for the Grade A meadows, though native more weedy graminoids, such as foxtail barley, saltgrass, western wheatgrass, inland bluegrass (Poa arida), and the exotic spreading alkali grass (Puccinellia distans) may be more prominent in areas. Conservative native plants are still present in these meadows though they are not as abundant as in Grade A alkaline meadows. Invasive plants are prominent only in localized areas of the meadow though they may be scattered throughout the meadow. Mudflats are present. Examples of Grade B western alkaline meadows occur on Facus Springs WMA.

Grade C Western Alkaline Meadows – Grade C western alkaline meadows are uncommon in the Sandhills though a common type in Panhandle stream valleys. The hydrology and alkalinity of Grade C alkaline meadows has often been significantly altered by ditches, drains, sedimentation, lowered groundwater levels and/or diking. Portions of the meadows may have been farmed in the past. Grade C meadows may have had fairly severe past disturbance from overgrazing, annual haying and herbicide spraying. More disturbance-tolerant native grasses, such as foxtail barley, saltgrass, western wheatgrass, and inland bluegrass dominate the meadow zones, though exotic grasses can be co-dominant. Russian olive trees may be scattered in these meadows. Conservative native plants occur only as widely scattered individuals. An example of a Grade C alkaline meadow occurs in the Pumpkin Creek valley on Platte River Basins Environments, Inc's Hampton Tract.

Grade D Western Alkaline Meadows – Grade D western alkaline meadows are rare in the Sandhills though somewhat common in Panhandle stream valleys. They include meadows that have been recently farmed and meadows whose hydrology and soil alkalinity have been extensively modified by ditches, drains, sedimentation, lowered groundwater levels and/or diking. Grade D meadows are dominated by invasive species, primarily tall wheatgrass, reed canary grass, and smooth brome. Russian olive infestations may be severe in Grade D alkaline meadows. Widely scattered patches of halophytic vegetation may still occur in Grade D meadows. Alkaline meadows that have totally converted to freshwater meadows are included here. An example of a Grade D western alkaline meadow occurs on the Clear Creek WMA.

Management Objectives and Guidelines for Various Grade Wet Meadows (Including Freshwater, Saline, and Alkaline Meadows)

Grade A and B Wet Meadows

Management Objective – For Grade A meadows maintain and enhance site quality, for Grade B meadows enhance site quality to Grade A condition.

Minimum Management:

1) Variably timed prescribed burns once every 3 to 4 years, minimum of every 3 years if grazing or haying is not possible.
2) Variably timed grazing once every 3 years. Variably timed haying every one in three years is also an option. Meadows that have history of haying and support a high native plant diversity should probably be maintained as hay meadows, but the timing of haying should be varied from year to year with complete deferment at least every third year (these hay meadows can also be burned).
3) Spot herbicide control of smooth brome, reed canary grass, Garrison creeping foxtail, musk thistle, Canada thistle, leafy spurge, and other noxious weeds.
4) Cut all eastern red cedar and other woody invaders not controlled by burning.
5) Grade A and Grade B meadows cannot be converted to deeper water wetlands through excavation or diking, nor can spoil from wetland excavations be placed in these meadows.
6) Plug ditches or make other hydrologic enhancements to restore the meadows natural hydrology. Making these meadows deeper water habitats is not an option

Management Options:

1) If exotic cool-season grasses become prominent, 1 to 3 years of dormant season or early spring burning followed by heavy, short-duration (4 to 6 weeks) spring grazing is recommended until the exotics are reduced.
2) Including smaller Grade A and B wet meadows in grazing systems is not recommended unless they are part of large prairie complex (that may include uplands) which are managed as a unit. No patch burn grazing at this time, until more research is conducted to determine its impact or conservative plant species.

Grade C Wet Meadows

Management Objective – Enhance site quality to Grade B condition.

Minimum Management:

1) Variably timed prescribed burns once every 3 to 4 years, minimum of every 3 years if grazing is not an option.
2) Variably timed grazing at least once every 3 years, spring grazing is preferred to reduce exotic cool-season grasses. Variably timed haying every one in three years is also an option.
3) Spot herbicide control of noxious weeds.

4) Grade C meadows cannot be converted to deeper water wetlands through excavation or diking nor can spoil from wetland excavations be placed in these meadows.

Management Options:

1) If exotic cool-season grasses become prominent, 1 to 3 years of dormant season or early spring burning followed by heavy, short-duration (4 to 6 weeks) spring grazing is recommended until the exotics are reduced.
2) Rest-rotation grazing at light to moderate stocking rates.
3) Fire-driven rest-rotation grazing at light to moderate stocking rates.
4) Patch burn grazing at light to moderate stocking rates.
5) Interseed local ecotype seed to improve plant diversity and habitat values.
6) Invasive tree cutting may be necessary if fuel loads or tree size makes burning ineffective.
7) Plug ditches or make other hydrologic enhancements to restore the meadows natural hydrology. Making these meadows deeper water habitats is not an option.

Grade D Wet Meadows

Management Objective - Improve wildlife habitat and provide buffers for and corridors between other native plant communities. Where native plant species remain, manage for these species as wildlife habitat. Protect native soil profiles on these previously unplowed sites from plowing and deep disking. Where feasible, use interseedling of local-ecotype seed to restore these sites to more diverse grasslands.

Minimum Management:

1) Spring burn once every 5 years to stimulate native plants.
2) Graze or hay at least once every 3 years.
3) Spot herbicide control of noxious weeds.

Management Options:

1) Dormant season or early spring burning followed by heavy, short-duration grazing (4 to 6 weeks) to reduce exotic-cool-season grasses and stimulate remaining native plants and early successional plants.
2) Rest-rotation at light to moderate stocking rates.
3) Fire-driven rest-rotation grazing at light to moderate stocking rates.
4) Patch burn grazing at light to moderate stocking rates.
5) Season-long grazing at light to moderate stocking rates to create habitat heterogeneity (not to be practiced every year).
6) Interseed local ecotype, native plant seed to improve plant diversity and wildlife habitat. Herbicide application will likely be needed to eliminate exotic cool-season grasses prior to interseeding.
7) Light disking (1 to 2 inches depth with straight disc blades) to stimulate early seral plants. This is to be used only if grazing management and herbicide application are not successful or feasible. It is not allowed on erodible soils.
8) Cut invasive trees if fuel loads or tree size makes burning ineffective.

9) Deeper wetlands may be excavated or created through diking in Grade D meadows and spoil from wetland excavations may be placed in these meadows.

Sandhills Fens

Range

Sandhills fens occur in inter-dunal valleys in the Sandhills, primarily in the lakes region of Cherry and a few surrounding counties, but also in other areas of the Sandhills.

Communities Included

The following natural communities described by Steinauer and Rolfsmeier 2010 are included in the Coniferous Woodland system:

Sandhills fen

Dominant Species

Shrubs - meadow willow (Salix petiolaris)
Herbaceous - sedges (Carex spp.),,bluejoint (Calamogrostis canadensis), fowl mannagrass (Glyceria striata), bog spikerush (Eleocharis elliptica), sensitive fern (Onoclea sensibilis), common reed (Phragmites australis ssp. americanus), common arrowhead (Sagittaria latifolia), hardsterm bulrush (Schoenoplectus acutus), marsh fern (Thelypteris palustris), broadleaf cattail (Typha latifolia)

Primary Invasive Plants

reed canary grass (Phalaris arundinacea), narrow-leaf cattail (Typha angustifolia), timothy (Phleum pretense), redtop (Agrostis gigantea), red clover (Trifolium pratense). Potentially purple loosestrife (Lythrum salicaria) and the European variety of common reed (Phragmites australis ssp. australis)

Quality Grades

Grade A Sandhills Fens – Grade A Sandhills fens are rare. These occurrences are virtually undisturbed or have experienced light disturbance from haying, grazing, fire suppression, shrub clearing, land leveling, and/or seeding with exotic forage species. The hydrology of Grade A Sandhills fens is virtually intact having only minor alterations from ditching, stream channelization and/or artificial flooding of localized areas. The topography of Grade A fens is often uneven due to the presence of peat mounds and ridges and standing water often occurs in low areas. A dense to scattered tall shrub layer of meadow willows, red osier dogwood (Cornus sericea) and false indigo (Amorpha fruiticosa) is often present in most Grade A Sandhills fens. Grade A Sandhill fens are dominated by a diverse mix of conservative native plant species including sedges, spikerushes, bluejoint, fowl mannagrass, hardstem bulrush, common arrowhead, and ferns. Near monoculture stands of broad-leaf cattail and the native variety of common reed commonly occur in low areas with standing water as these are natural features of Sandhills fens. Fen indicator species, such as bog bean (Meyanthes trifoliata), bog aster,

cotton-grasses (Eriophorum spp.), marsh marigold (Caltha palustris), water sedge (Carex aquatilis), adder's tonque (Ophioglossum pusillum) and others are common in Grade A fens. Invasive exotic plants occur only as widely scattered plants in Grade A fens. An example of Grade A Sandhills fens is the privately-owned Allen Valley Fen in Cherry County.

Grade B Sandhills Fens – Grade B Sandhills fens are uncommon. They have had limited disturbance from haying, grazing, fire suppression, shrub clearing, land leveling and/or seeding with exotic forage species. The hydrology of Grade B fens can be somewhat altered by ditching, stream channelization and/or artificial flooding of localized areas. Grade B fens often have a less variable topography and fewer pools of standing water than Grade A fens due to past limited leveling and ditching (they often have a more meadow-like appearance). Grade B fens are dominated by conservative plants, but their diversity and abundance is less so than Grade A fens. Fen indicator species occur in Grade B fens though their abundance and diversity is also less than in Grade A fens. Exotic plants may dominate only localized areas, often drained areas near ditches and on spoil piles, though they have only moderate abundance throughout the site. An example of a Grade B Sandhills fen occurs on Steverson Lake WMA.

Grade C Sandhills Fens - Grade C Sandhills fens are common on private lands in the Sandhills. They have been significantly altered due to haying, grazing, shrub clearing, land leveling, and/or seeding with exotic forage species. The hydrology of Grade C fens is often significantly altered from ditching or stream channelization. Grade C fens have often suffered some loss of organic soils due to peat oxidation caused by ditching and drainage. Grade C fens are usually dominated by a near equal mix of exotic cool-season grasses and native graminoids. Other exotic plants, such as clovers and narrow-leaf cattail may be prominent. Conservative native forbs are uncommon. Fen indicator species are rare if they occur at all.

Grade D Sandhills Fens – Grade D Sandhills fens are common on private lands in the Sandhills. Grade D fens have been extensively altered from ditching, shrub clearing, land leveling, peat decomposition and exotic plant invasion. The hydrology of these fens has been extensively modified. Some Grade D fens may no longer support organic soils due to peat oxidation. The vegetation of Grade D fens is most often dominated by reed canary grass, but often by other cool-season grasses. Native plants may dominate only localized areas, but for the most part they occur only as scattered individuals. Fen indicator plants are absent.

Management Objectives and Guidelines for Various Grade Sandhills Fens

Grade A and B Sandhills Fens
Management Objective - Maintain and enhance Grade A site quality, for Grade B fens enhance site quality to Grade A condition.

Minimum Management:

1) Variably timed prescribed burns once every 3 to 4 years. If exotic cool-season grasses are becoming problematic, spring burning is preferred. Winter burning may be feasible on some sites to reduce litter levels. Do not burn when the organic soils are dry to avoid peat fires.
1) Spot herbicide control all reed canary grass, Garrison creeping foxtail, narrow-leaf cattail, European phragmites, Canada thistle, and purple loosestrife.
2) Plug ditches or make other hydrologic enhancements to restore the fens natural hydrology. Any necessary earth moving activities should be conducted in winter when soils are frozen. Often spoil piles from ditching can be pushed back into ditches to plug them. Water control structures may be needed in other cases.

Management Options:

1) Portions of Grade A and Grade B fens may be dry enough to hay. Occasional haying (about every 3 years) can be used to remove excess litter, although prescribed fire is the preferred option.
2) The drier periphery of Sandhills fens can sometime be grazed (often in conjunction with surrounding wet meadows, but one must be extremely careful as cattle can disturb the soft organic soils and cause hummocks to form. If grazing occurs on fens it should be limited to one in every three years. Winter grazing may be the best option.
3) Grade A and Grade B Sandhills fens cannot be converted to deeper water wetlands through excavation or diking nor can spoil from wetland excavations be placed in fens.

<u>Grade C Sandhill Fens</u>

Management Objective – Enhance site quality to Grade B condition.

Minimum Management:

1) Variably timed prescribed burns once every 3 to 4 years, if exotic cool-season grasses are common, spring burning is preferred.
2) Spot herbicide control of European phragmites and all noxious weeds.

Management Options:

1) Portions of Grade C fens may be dry enough to hay. Occasional haying (about every 3 years) can be used to remove excess litter, although prescribed fire is the preferred option.
2) The drier periphery of Grade C fens may be grazed one in every three years (see grazing comments above under Grade A and B fens).
3) Plug ditches or make other hydrologic enhancements to restore the fens natural hydrology.
4) Grade C fens cannot be converted to deeper water wetlands through excavation or diking nor can spoil from wetland excavations be placed in these meadows.

Grade D Sandhills Fens

Management Objective - Improve wildlife habitat and provide buffers for and corridors between other native plant communities. Where native species remain manage for these species as wildlife habitat. Protect native soil profiles on these previously unplowed fens.

Minimum Management:

1) Spring burn once every 5 years to stimulate native plants and remove excess litter.
2) Spot herbicide control all noxious weeds and European phragmites.

Management Options:

1) Portions of Grade D fens may be dry enough to hay or graze. Occasional haying or grazing (about one in every three years) can be used to remove excess litter, although prescribed fire is the preferred option.
2) Grade D Sandhill fens can be diked or excavated to form deeper water wetlands, however, if organic soils are still intact excavation is not recommended.

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Chapter 6 – References

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