



SAVING THE LAST GREAT PLACES ON EARTH

# *Guide to Native Grassland Management in Nebraska*

*Presented by*



NEBRASKA GAME &  
PARKS COMMISSION



PLATTE HABITAT  
PARTNERSHIP



ConAgra Foods Foundation      Peter Kiewit Foundation

# Guide to Native Grassland Management in Nebraska

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OXIDE DESIGN CO.  
WWW.OXIDEDESIGN.COM

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## **Acknowledgements**

I would like to thank Chris Helzer, Jill Jeffrey, and Brent Lathrop of The Nature Conservancy, Tim McCoy of the Nebraska Game and Parks Commission, Bill Whitney of Prairie Plains Resource Institute, and Dr. Susan Tunnell of the University of Nebraska for their review of this document.

I would also like to thank The Nature Conservancy, Nebraska Chapter, Nebraska Game & Parks Commission, United States Fish & Wildlife Service, ConAgra Foods Foundation, and Peter Kiewit Foundation for funding to support the development of this publication and the Platte River Habitat Partnership.

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# introduction



*Photo by Chris Helzer*

The purpose of this reference guide is to provide basic information on how to preserve and enhance the natural qualities of one of the greatest resources of the Great Plains—native grassland and its biodiversity. Proper management of native grasslands benefit the livestock producer whose enterprise is based on sustaining a high level of production and income. Improved grassland management also benefits wildlife enthusiasts such as hunters, photographers, and wildlife watchers by enhancing habitat value. **This guide is intended to provide fundamental information to aid in grassland management decisions.**

Improving grasslands are as important to the productivity and profitability of livestock grazing operations as are breeding animal selection, marketing strategies, vaccination programs, planting, and harvesting dates. To a producer, the main objective of a farm or livestock enterprise is sustained maximum production, which is the foundation for sustained maximum income. These can only be realized when forage production is maintained at a maximum level.

Unfortunately, many native grasslands have deteriorated, yielding only a fraction of their production capacity for forage and livestock, not to mention wildlife. Additionally, every grassland presents a different problem related to management, so there is not a single answer for manipulating the factors related to management of that particular grassland. Good grassland management depends mainly on an understanding of key factors concerning rangeland ecology and livestock behavior, which is supplemented



by management experience and good judgment. Knowledge of livestock grazing habits and plant growth can be used to determine good grazing practices that benefit not only livestock production but also wildlife.

There are two critical components for management plans that enhance native grasslands for livestock and achieve wildlife benefits. The first component is that plant diversity is a positive aspect of any grassland or rangeland. A grassland of one type of grass (i.e., smooth brome or Kentucky bluegrass) that grows to the same height each year and is cut, burned, or left idle does not exhibit the required structural and compositional diversity that is required for most wildlife species and can also affect the grazing potential of livestock. If all grasses in a pasture are cool-season (i.e., grasses that are actively growing during early-spring and late-fall), the grazing potential of the pasture is decreased during the warm-season months, and the livestock may require supplementation to make it through the season in good condition.

The second component is that native plants just make sense. Native plants are adapted to local soil and climate conditions and are generally more resilient to drought and disturbance than non-native plants. In addition to supporting a variety of wildlife species, native warm-season grasses provide good forage for livestock during the summer months when cool-season grasses are dormant. Additionally, many native forbs are highly nutritious. But, there may be many non-native plants in the area, and increasing native plant diversity may require considerable effort. In the long run, however, native plants may be more economical to sustain.

The next few chapters will provide information concerning management of native grasslands for the benefits of livestock production and grassland wildlife habitat. The information covered will include common range plant identification, grazing management, prescribed burning, prairie hay management, undesirable or alien plants, and a discussion of wildlife habitat. Each section will include information for enhancing the native qualities of grassland habitat.



2

native grasslands



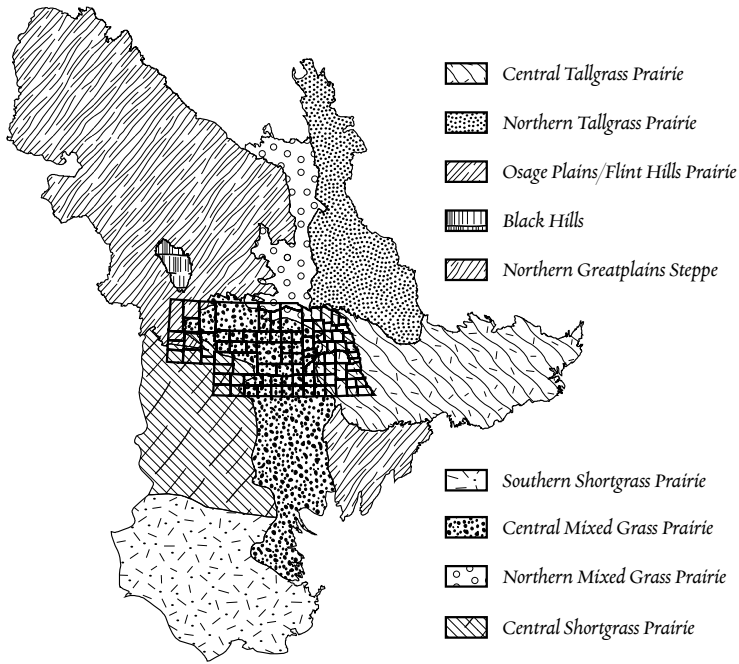
*Photo by Chris Helzer*

The term native grasslands, rangeland, and prairie can be used interchangeably, but there are differences that should be clarified. Grasslands include fields planted to native grasses, prairies that have some of their historic plant diversity (e.g., survived as hay meadows cut annually for livestock forage), and rangeland. Whereas prairie and native grassland are terms that refer to a general land cover type, rangeland is a different category referring to land used for grazing. In the Great Plains, rangeland refers to large, uncultivated lands in which the native vegetation is predominantly grasses, grasslike plants, forbs, or shrubs and is extensively managed based on ecological principles with a history of livestock grazing (not all grasslands evolved with large herbivores and heavy grazing). Rangeland can also have trees as a savanna plant community. In short, not all prairie is rangeland - that is, it is not all grazed.

**Rangeland Characteristics:**

1. Suitable for grazing or browsing
2. No periodic cultivation
3. Extensively managed based on ecological principles
4. History of livestock grazing
5. Multiple sustainable products
6. Marginal for row-crop agriculture

There are 16 different rangeland types within the United States used for livestock production. These rangeland types differ in forage production and in plant species found in each rangeland, based on the physical characteristics of the area and climate. The Great Plains consist of tallgrass prairie, mixed-grass prairie, and shortgrass prairie, and all three of these prairie types are found in Nebraska (figure 1).



**Figure 1.** *Prairie Types of the Great Plains*

The tallgrass prairie is situated between the eastern deciduous forest and the mixed-grass prairie. The tallgrass prairie has four main grass species, big bluestem, little bluestem, Indiangrass, and switchgrass. This area is known for periodic drought and fire. Historically, fires occurred every 3 to 5 years. However, today most natural fires are suppressed. Annual precipitation on the eastern side of the tallgrass prairie ranges from 30 to 40 inches, and on the western edge average annual precipitation is 25 to 30 inches, with

most of the precipitation occurring from April to October.

The mixed-grass prairie is located between the tallgrass prairie and the shortgrass prairie. Much of this area evolved under grazing pressure from bison, therefore, most of the plants found here are grazing tolerant. Because this area receives less precipitation than the tallgrass prairie, it contains both mid- to shortgrasses. The eastern portion of the mixed-grass prairie receives about 20 to 25 inches of annual precipitation and the western portion receives about 12 to 15 inches of precipitation annually.

The shortgrass prairie is located on the west side of the mixed-grass prairie. It receives 12 to 20 inches of annual precipitation with over 60% falling in the summer growing season. The main grasses are blue grama and buffalograss which are both grazing tolerant.

3

common range plants



*Photo by Chris Helzer*

Range plants can be classified into 4 main categories; grass, grasslike, forb, and woody. Most native grasslands are comprised of representatives from all classes. Because each class has different strategies for growth and resistance to grazing, it is helpful for range managers to be able to identify them for effective management.

The life span, season of growth, and origin of plants have important management implications. Plants may live for a single season (annuals), two years (biennials), or multiple years (perennials).

Annuals complete their entire life cycle in one growing season and their survival strategies tend to be opportunistic. Because annuals have a short life span, they typically grow rapidly and are prolific seed producers, often making them weedy. Management for annuals must ensure viable seed production, whereas perennial management tends to focus more on the health of leaves and roots. Biennial plants take two years to produce seed and complete their life cycle. Biennials remain vegetative during the first growing season, survive a dormant period, and become reproductive during the second year of growth. Perennials produce new leaves from the same plant for three or more years.

The season of growth controls the timing of forage production and forage quality. Consequently, this affects the grazing preferences of animals. Generally, cool-season plants have higher forage quality whereas warm-season plants tend to be more



productive and use water more efficiently. Cool-season plants grow primarily during the spring and fall, but can remain active during the winter. Examples of cool-season grasses include Canada wildrye, western wheatgrass, and smooth brome. The optimum temperature for cool-season plant growth is 77°F. Warm-season plants grow from late-spring to early-fall, with optimum growth temperatures being about 95°F. Nebraska rangelands can be dominated by warm-season plants, such as big bluestem, little bluestem, and blue grama, depending on rangeland condition.

Native plants are part of the historic plant community and are well adapted to coexist with grazing animals, but a number of plants have been accidentally or purposely brought into the United States. These introduced species are often difficult to manage because they lack natural control agents. Others, such as smooth brome, musk thistle, and tall fescue have caused widespread degradation of rangelands.

## **Grasses**

Grasses have long, narrow leaves with parallel veins and nondescript flowers. The stems are hollow or pithy in cross-section. Grasses are members of the plant family Poaceae. There are two basic groups of grasses based upon physiological characteristics. Cool-season grasses (C<sub>3</sub>) grow best in the spring and fall when it is cooler and usually wetter, and warm-season (C<sub>4</sub>) grasses grow best in the summer. **Pages 18-24**

## **Grasslike Plants**

Grasslike plants include rushes and sedges. These plants are similar to grasses in general appearance and have leaves with parallel veins, but the stems are solid in cross-section, lacking joints, and often have triangular stems. **Page 25**

## **Forbs**

Forbs are broad-leaved plants that die back each winter and have net-like veins in the leaves. Forbs are commonly called weeds, but are more accurately termed forbs because weeds are

undesirable plants of any class. Unidentified forbs should not be assumed to be weeds, because many provide desirable forage for livestock and wildlife. **Pages 26-30**

## **Legumes**

A legume can either be a forb or woody plant, which has nitrogen-fixing abilities. A legume is a highly desirable plant for both livestock and wildlife production purposes, because they usually have protein-rich seeds in pods, similar to alfalfa. **Page 31**

## **Woody Broadleaf Plants**

A woody broadleaf plant, typically referred to as a tree or shrub, exhibit woody stems that remain for multiple years.

**Pages 32-33**

## **Noxious Weeds and Species of Concern**

A noxious weed is any plant designated by a Federal, State or county government as injurious to public health, agriculture, recreation, wildlife or property. These noxious plants are a serious threat to native species, communities, and ecosystems in many areas. They can compete with and displace native plants, animals, and other organisms that depend on them, alter ecosystem functions and cycles significantly, hybridize with native species, and promote other invaders. Species of concern are plants that are not labeled as “Noxious” in the legal sense, but are highly invasive species in native communities and efforts should be taken to suppress them. The species are highlighted with a star (\*).

# Grasses

## NATIVE WARM-SEASON PERENNIAL

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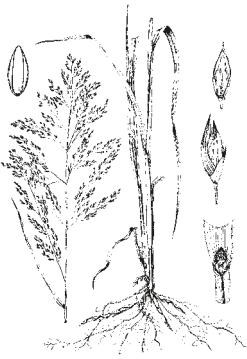
*Big Bluestem*



*Little Bluestem*



*Indiangrass*



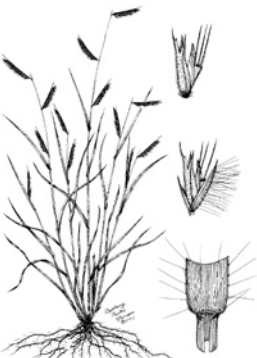
*Switchgrass*



*Blue Grama*



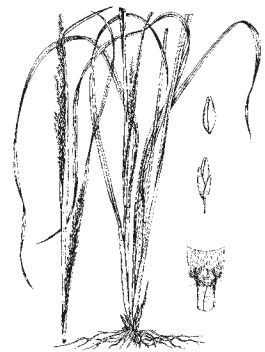
*Buffalograss*



*Hairy Grama*



*Sideoats Grama*



*Tall Dropseed*

# Grasses

## NATIVE WARM-SEASON PERENNIAL

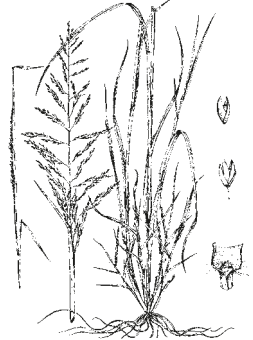
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*Purple Lovegrass*



*Sand Lovegrass*



*Sand Dropseed*



*Prairie Cordgrass*



*Prairie Sandreed*



*Perennial Threawn*



*Tumblegrass*

# Grasses

## NATIVE WARM-SEASON ANNUAL

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*Common Witchgrass*



*Field Sandbur*



*Prairie Threeawn*

## NATIVE COOL-SEASON PERENNIAL

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*Mutton Bluegrass*



*Sandberg Bluegrass*



*Bluejoint Reedgrass*



*Foxtail Barley*



*Indian Ricegrass*

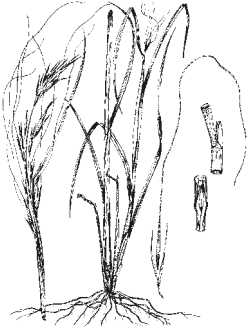


*Green Needlegrass*

# Grasses

## NATIVE COOL-SEASON PERENNIAL

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*Needlelandthread*



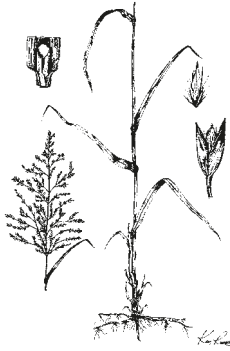
*Porcupinegrass*



*Scribner Panicum*



*Wilcox Panicum*



*Northern Reedgrass*



*Prairie Junegrass*



*Squirreltail*



*Slender Wheatgrass*



*Western Wheatgrass*

# Grasses

## NATIVE COOL-SEASON PERENNIAL



Canada Wildrye



Prairie Wedgegrass



Reed Canary\*

## NATIVE COOL-SEASON ANNUAL



Little Barley



Sixweeks Fescue



Barnyardgrass

## INTRODUCED WARM-SEASON ANNUAL



Green Bristlegrass



Yellow Bristlegrass



Stinkgrass

# Grasses

## INTRODUCED COOL-SEASON PERENNIAL

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Canada Bluegrass



Meadow Brome



Creeping Foxtail\*



Orchardgrass



Redtop Bent



Timothy



Russian Wildrye



Smooth Brome\*



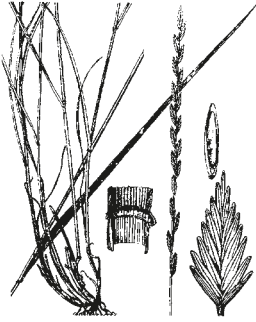
Tall Fescue\*



# Grasses

## INTRODUCED COOL-SEASON PERENNIAL

---



*Tall Wheatgrass\**



*Crested Wheatgrass\**



*Intermediate Wheatgrass\**



*Kentucky Bluegrass\**

## INTRODUCED COOL-SEASON ANNUAL

---



*Downy Brome*



*Japanese Brome*

# Grasslikes

## NATIVE COOL-SEASON PERENNIAL (SEDGES)

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*Nebraska Sedge*



*Needleleaf Sedge*



*Sunset Sedge*



*Threadleaf Sedge*



*Fescue Sedge*



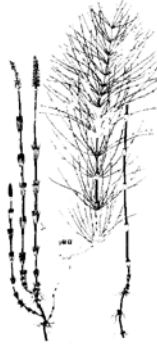
*Broom Sedge*

## NATIVE COOL-SEASON PERENNIAL (RUSHES)

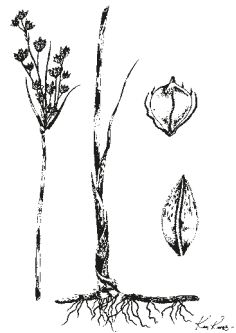
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*American Bulrush*



*Field Horsetail*



*Hordstem Bulrush*

# Forbs

## NATIVE PERENNIAL

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Western Yarrow



Western Ragweed



Heath Aster



Flodman Thistle



Wavyleaf Thistle



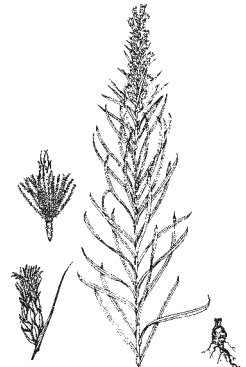
Blacksamson



Wild Licorice



Stiff Sunflower



Gayfeather

# Forbs

## NATIVE PERENNIAL

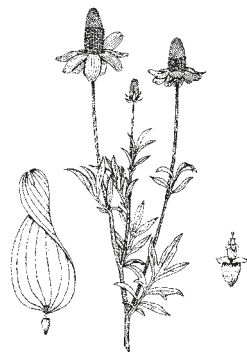
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*Serrate-Leaf Primrose*



*Shell Leaf Penstemon*



*Upright Prairie Coneflower*



*Stiff (Rigid) Goldenrod*



*Prairie (Missouri) Goldenrod*



*Long-Bracted Spiderwort*



*Western Ironweed*

# Forbs

## INTRODUCED PERENNIAL

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*Canada Thistle\**



*Bull Thistle\**



*Purple Loosestrife\**



*Leafy Spurge\**

## NATIVE ANNUAL

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*Rocky Mountain Bee Plant*



*Marestalk*



*Texas Croton*

# Forbs

## NATIVE ANNUAL



*Daisy Fleabane*



*Snow-on-the-Mountain*



*Common Sunflower*



*Plains Sunflower (Prairie Sunflower)*



*Maximilian's Sunflower*



*Horse Mint*



*Bitter Sneezeweed*



*Plains Coreopsis*



*Blue (Prostrate) Vervain*

# Forbs

## NATIVE ANNUAL

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*Common Ragweed*

## NATIVE BIENNIAL

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*Common Evening Primrose*



*Black-eyed Susan*

## INTRODUCED BIENNIAL

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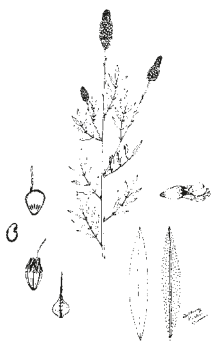


*Musk Thistle\**

# Legumes

## NATIVE PERENNIAL

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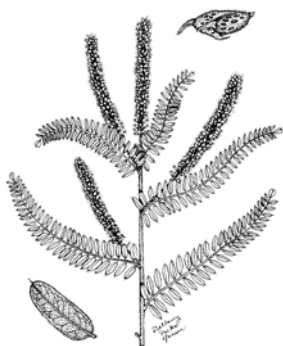
*White Prairie Clover*



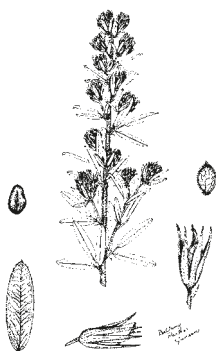
*Purple Prairie Clover*



*Illinois Bundleflower*



*Leadplant*



*Roundheaded Lespedeza*



*Catclaw Sensitivebriar*

## NATIVE ANNUAL

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*American Deervetch*



# Woody Plants

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*Eastern Red Cedar\**



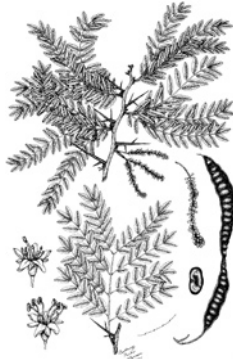
*Eastern Cottonwood*



*Hackberry*



*Rough-Leaf Dogwood*



*Honey Locust*



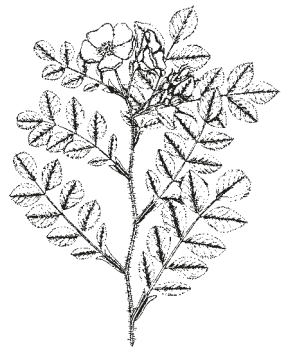
*Smooth Sumac*



*Buckbrush*



*American Elm*



*Prairie Wild Rose*

## Woody Plants

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Russian Olive\*



Salt Cedar\*

\* - *Noxious weeds and species of concern*

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# 4

## grazing management



*Photo by Chris Helzer*

Grazing is the primary tool used to manage rangeland for livestock production, but grazing can also be used to enhance wildlife habitat. In a native rangeland, the foundation of plant production is in the plant growth, primarily grasses. Harvesting this production is accomplished by grazing of herbivores such as cattle, bison, horses, sheep, or goats. Optimum grazing use maintains the most palatable and productive forage species over time and under a wide range of environmental conditions (drought, etc.). Grazing management requires knowledge of the grassland plant community and all of the environmental factors influencing it and from the standpoint of livestock production. It requires an understanding of the relationship of timing, frequency, and intensity of livestock grazing and how these factors affect native grasslands.

**Factors of Grazing Management:**

1. Timing of defoliation - the time of year that a pasture is grazed or rested
2. Frequency of defoliation - the number of days a pasture is stocked with livestock
3. Intensity of defoliation - the stocking rate for a pasture for one grazing period

Grazing has impacts on species composition and range condition by selecting for some plants (decreasers) and against

others (increasers). Depending on stocking rate, livestock grazing can alter the composition of the forage base by changing the proportions of plant species present, and perhaps cause the introduction of other species (invaders) due to the increase in bare ground or reduced competition. Livestock grazing can also increase the productivity of selected species, increase the nutritive quality of the forage, and alter vegetation structure. A manager must have an understanding of plant growth, soil quality, fencing, water development, harvesting, resting, and much more to maintain a grassland that benefits both livestock and wildlife.

## **Stocking Rate**

Selection of the correct stocking rate, the number of animals (kind and classes) grazing a unit of land for a specified time period (see Appendix A) is the most important decision in grazing management from the standpoint of economic return, vegetation, livestock, and wildlife. Stocking rate will influence how well the plants recover from grazing during the growing season, have a negative or a positive impact on future forage production of the pasture, and affect the quality of the available forage. Ultimately, the effects of the stocking rate will influence livestock performance and the bottom line of the producer.

In general, forage production is greater under moderate or light grazing, which is also compatible with improvement of range condition. The recommended stocking rates for rangelands are based on light to moderate use of forage production on an annual basis. This level of grazing will ensure high and stable profits while benefiting grassland health and wildlife habitat. Research supports the concept that the optimum stocking rate for beef cattle performance (on an individual animal basis) is light to moderate, not heavy.

## **Overstocking**

In general, there has been a historical tendency to overstock rangelands with subsequent land deterioration and reduced profits. If livestock are continually grazed at a stocking rate higher than

the carrying capacity, the production of forage species and livestock production will decline and requirements for supplemental feed and weed control increase. Although a heavy stocking rate may make a producer more income in the short term, overstocking results in increased economic risk and degradation of the grassland over time. Large fluctuations in income can be disastrous if a producer encounters a series of unfavorable weather conditions (drought), low prices, and/or high production costs.

### **Effects of Overgrazing**

Overuse by livestock means that the residual leaf area is inadequate for the plant to maintain its vigor and presence on the site. When grasslands are overgrazed, ground cover is reduced, which reduces the amount of water that is able to infiltrate due to greater evaporative loss, increased runoff, and reduced snow capture. The decrease in soil moisture results in reduced plant growth, or leaf area. The reduced leaf area decreases the potential to convert sunlight into energy and further impairs plant and root growth resulting in further reductions in plant vigor and leaf area. If the overuse continues over a period of years, preferred grazing plants begin to decline and eventually die and plants usually less palatable to the grazing animal replace them. Overuse and overgrazing have also contributed to the decline in habitat quality by contributing to fire suppression and an increase in woody plants.

Through proper grassland management, you can increase the amount of rainfall retained in the soil to enhance plant growth and enhance forage production while sustaining livestock production and wildlife habitat quality. Overgrazing is easily reversed in wetter climates by a change in management over a relatively short period of time, but in drier climates it may take many years for measurable change to occur. The good news is that native plant communities are resilient and adapted to a variety of severe disturbances such as high grazing pressure, drought, and wildfire.

## Grazing Systems

Grazing systems refer to the different combinations of the distribution of livestock in relation to space and time. In a more general way, it is the control of animal behavior in relation to the forage resource. Grazing systems range from simple (year-round stocking) to very complex (multiple-paddock rotations). The management (e.g., fence, water, time) required to operate a grazing system will increase as the number of pastures or paddocks increase.

**The objective of a grazing system is mostly influenced by plant/site factors and animal/economic factors:**

- From a plant perspective, grazing systems are designed to restore plant vigor, raise and maintain vegetation condition, allow distribution of grazing based on goals, and reduce plant selectivity by grazing animals.
- From the animal or economic perspective, a grazing system should provide acceptable animal gains and maintain forage at a high nutritional level to meet animal nutritional requirements during critical times.
- From a manager's perspective, a grazing system must fit with defined goals for the land and fit within limits of an operation and infrastructure available.
- From a wildlife perspective, a grazing system should provide for a disturbance regime that provides for quality habitat throughout the year as defined by habitat goals.

Although grazing systems are intended to improve the carrying capacity of the land, distribution of livestock, and harvest efficiency, there are limits and tradeoffs involved in controlling livestock grazing behavior. For example, we can force animals to graze more uniformly, but in order to obtain uniform grazing we force animals to eat lower quality forage. This can reduce livestock performance and negatively affect the compositional and structural integrity of the grassland. When making decisions

concerning grazing systems, keep in mind that different grazing systems produce different landscape patterns. These patterns can result in differing plant composition and habitat structure, which can influence livestock and wildlife production.

**Avoid intensively-managed rotational grazing systems for two reasons:**

1. High densities of cattle in small areas can lead to nest trampling and other damage to wildlife
2. Repeated short-duration grazing of a particular pasture every year leads to increased homogeneity of the plant species and structure across the whole pasture

## **Summary**

It is important to recognize that in any grazing unit, all plants of a given key species are not equally palatable or available to animals. Even when the average degree of utilization is moderate, as recommended, there will be individual plants that will be overgrazed and plants that will be undergrazed (even of the same species). This can be caused by individual variation in the plants, uneven grazing distribution, topography, distance from water, and most importantly, by livestock grazing selection. Range management has emphasized uniform utilization as a goal. Given the reasons above, and the fact that livestock seem to exhibit a high degree of selectivity, achieving uniform utilization may not be possible, and if wildlife habitat and rangeland heterogeneity is a goal, it is not desirable.



5

prescribed fire



*Photographer Unknown*

Fire was a natural ecological process on Great Plains grasslands before European settlement, and native vegetation evolved under periodic burning, as well as grazing. Prescribed burning is a valuable and safe practice. When planned and implemented properly, prescribed burning can effectively suppress trees and shrubs and enhance native grass production. In order to realize the full benefits of prescribed burn on range, livestock, and wildlife, careful and considerate pre- and post-burn management must be considered. Prescribed burning follows guidelines that establish the conditions and manner in which fire will be applied to a specific area on the landscape in order to accomplish management and ecological objectives.

**A successful burning program involves three basic steps:**

1. Thorough planning, which includes pasture selection, management goals, written fire plan, training for conducting a safe burn, and preparations for the burn
2. Sound range, livestock, and wildlife management before and after the burn
3. Safe and effective execution of the burn on the specified area

Prescribed burning is both a science and art requiring a background in weather, fire behavior, fuels, and plant ecology along with the courage to conduct burns, good judgment, and

experience to integrate all aspects of weather and fire behavior to achieve planned objectives safely and effectively. Prescribed burning contrasts with wildfires. Wildfires can occur at any time fuels will burn, often under extremely hazardous conditions (e.g., summertime, low rainfall, low humidity, high temperatures) and at unplanned or unexpected times. The conditions (i.e., prescription) selected for a prescribed burn must be conducive to safe and effective burning (see Appendix B). Management objectives determine the fire characteristics needed to maximize benefits, minimize damage, and conduct a safe burn.

## **Objectives**

**The most commonly recognized management objectives that can be accomplished by using prescribed burning include:**

- Improved pasture accessibility
- Increased seed production
- Increased production of forage and browse
- Brush suppression
- Control or suppression of selected forbs and/or grass species (exotics)
- Improved herbaceous composition
- Improved grazing distribution of livestock and wildlife
- Increased available forage and browse
- Improved forage quality and/or palatability
- Increased animal production
- Removal of excessive mulch and debris
- Control of certain parasites and pests
- Improved nutrient cycling

Each management objective requires a particular set of conditions for burning and a specific type of fire to achieve the desired response. Therefore, carefully evaluate objectives before a fire plan is developed in order to plan for the right prescription. The planning process for burning should start 9

to 12 months before the burn is conducted. Adjustments in the grazing management plan may be required in order to insure that adequate fuel (i.e., grass and other plants that will burn when dry) is available for the burn. Firebreaks must be established and equipment must be prepared for the burning season. Finally, a prescription detailing the objectives of the burn and the conditions (season, wind speed, wind direction, temperature, relative humidity, type of fire, and fuel load) must be developed.

## **Fire Behavior**

Several factors that determine a fire's intensity are fuel quantity and continuity, air temperature, relative humidity, wind speed, soil moisture, and direction of the flame front movement relative to the wind. Generally, the intensity of a fire increases with greater quantity and continuity of fuel, higher temperature and wind speed, and lower humidity and soil moisture. A fire set to move in the same direction as the wind (headfire) tends to be more intense than a flame moving against the wind (backfire). Controlling the fire's intensity through correct firing techniques under appropriate conditions is a key factor in achieving the desired response from a prescribed burn.

## **Training and Experience**

Depending on the complexity and the size of the burn unit, most prescribed burns should only be led by a trained fire leader with several years of experience and a crew of 4 to 5 people that understand the concept of prescribed burning, are familiar with the equipment and burn unit, and most importantly are dependable. Easier burns, those that are smaller and surrounded by sufficient firebreaks (e.g., crop fields, county roads, or riparian areas) are much easier to conduct with limited resources and experience. Developing burning cooperatives with neighboring landowners can be beneficial in forming burn crews, preparing firebreaks, and reducing legal action. In the absence of a burn cooperative, it is still best to inform neighbors of the intention to burn. The Natural Resources Conservation Service (NRCS)

and other conservation organizations offer prescribed burning training across the state and can help with technical and financial assistance. Regardless of the size or complexity of a prescribed burn, all local Nebraska fire departments require a burn permit to be issued before conducting a prescribed burn.

## **Weather**

Knowledge of the latest weather conditions and a 2-day forecast are essential to the safety and success of a prescribed burn. Burning should be avoided when a known front is expected within 24 hours after the burn is scheduled to be complete. The unpredictable changes in wind speed and direction with a front can cause severe problems with an active fire. Sources of weather information include the local television stations, National Weather Service, local offices of the forestry agencies, and the National Oceanic and Atmospheric Administration (NOAA).

## **Summary**

Successful prescribed burning involves the correct combination of firing techniques, seasonal timing, and appropriate weather conditions on the day of the burn. However, these are not the only factors that influence plant response after a burn. The amount of precipitation may have a significant effect on rangeland recovery following a prescribed burn. To ensure proper recovery of the rangeland following a prescribed burn, grazing management practices may need to be adjusted.



# 6

## prairie hay management



*Photographer Unknown*

Many high-quality prairies have survived modern settlement through cutting the prairie for hay or by light intermittent grazing. This section is designed to give you a closer look at some of the key components of prairie hay management. These are the recommendations resulting from research and practice for enhancing the native qualities of your hay meadow.

### **Time of Cutting**

Harvest date is the most important factor in hay meadow management that can be easily controlled. It affects yield, forage quality, stand composition, and regrowth, all of which influence future production. Maximum yield and highest quality do not occur at the same time and usually cannot be achieved in the same harvest. Hay quality peaks early in the growing season (around May) and progressively declines during summer. Total pounds of crude protein are higher in July than in August or September and declines as the grass plants mature. Highest herbage yield occurs late-in the growing season (August). Cutting in late-June to mid-July is the best compromise between yield and quality. Cutting after mid-July reduces the time available for plants to rebuild root reserves for next year's growth, thereby reducing next year's hay yield by as much as 50 percent. Haying in August and September will change stand composition, as desirable warm-season grasses are weakened by late-cutting and undesirable plants invade. Varying the timing will help the diversity of the grasslands.



Haying at the same time every year will always favor some plants over others – those that complete their life cycle before haying will be favored over those that are stressed or do not get a chance to flower. It might be a good idea to hay for quality one year and quantity the next – and then have different hay meadows or portions of the same hay meadow on different schedules at any one time.

## **Cutting Height**

Harvesting at a 3 to 4 inch height normally leaves sufficient stubble for regrowth and soil cover. This cutting height leaves more leaf area for rapid regrowth to rebuild root reserves for next year's production. Litter left on the ground in the fall can help to protect against erosion and conserve soil moisture, improving hay yield the following year. These plants are also better able to cope with drought. Under drought conditions, harvest date and cutting height are critical in maintaining a productive meadow. Cut no later than mid-July and leave at least 3 to 6 inches of stubble. If the forage is not tall enough by mid-July to justify harvesting, the area can be grazed after the first killing frost. Cutting native hay in August or September does not give the warm-season perennial grasses sufficient time to rebuild carbohydrate root reserves before frost. Regardless of the amount of regrowth, avoid taking a second cutting, which can reduce yields over time by as much as 50% and encourage undesirable weeds.

## **Grazing**

From wildlife and biodiversity perspectives and from a long-term production standpoint as well long-term hay management is detrimental. Introducing grazing in some years will allow the species that do poorly under annual haying to reinvigorate themselves and remain in the system. It also allows for some nutrient cycling that does not take place under a haying system, where nutrients are always removed but never returned. Grazing after haying or taking a second cutting is not recommended because this does not allow warm-season grasses time to rebuild

their root reserves, will encourage weeds, and will reduce next year's production. Part of the regrowth may be grazed after a killing freeze stops growth, but at least 4 inches of stubble should be left as cover for the plants and soil through the winter. The main drawback to dormant grazing is that it reduces fuel for prescribed burns and encourages invasion of cool-season grasses. However, early-season grazing might be beneficial if you are trying to reduce the vigor of smooth brome or other undesirable species. Fall grazing in wet years could help in the same way.

## **Prescribed Burning**

Spring burning 2 or more years in succession will usually suppress invading cool-season grasses, broadleaf weeds, red cedar and certain deciduous tree sprouts, improve both forage quality and yield, and remove mulch and old growth that reduces hay quality. The best time to burn native hay meadows to suppress cool-season grasses is mid- to late-April or even into early-May. To increase desirable warm-season grass production, hay meadows should be burned at least every 2 or 3 years. Prescribed burning in late-spring is an important tool for controlling brush and undesirable cool-season grasses. However, a consistent pattern of spring burns every 2 to 3 years will limit the diversity of the plant community over time. This pattern will favor grasses over forbs and can reduce both habitat quality (no structural or species diversity) and forage quality (lack of legumes and other favorable plants).

## **Fertilization**

Nitrogen fertilizer (along with adequate rainfall) increases hay growth, but its effect on native warm-season grass production is limited. The health, vigor, and productivity of the warm-season grass components of a prairie must have been restored through proper management before a favorable response to fertilizer can be expected. If annual grasses or forbs are present in the hay meadow, nitrogen fertilization increases their production and does little for the native warm-season grasses. To reduce competition from cool-

season grasses and weeds prior to fertilizing, conduct a late-spring burn. Do not attempt to restore poorly managed prairie through fertilization, and do not fertilize unless used in conjunction with prescribed burning. The economics of fertilizing native hay prairies depend on the value of the increased hay produced (1/2 to 1 ton/acre) and the cost of fertilizer and application. Even then, nitrogen fertilization may not be economically feasible. Serious consideration needs to take place before a decision to fertilize because the long term cost/benefit may fall far short of expectations and actually end up costing money in unforeseen ways.

### **Rotational-Haying**

Rotate haying so that some portion of the meadow is rested each year and shifted across the hay meadow over a 3- to 4-year period. This portion may be from 1/4 to 1/3 of the area, as preferred. The rested portion will provide nesting and winter cover for wildlife, can be a great source of native grass seed, and will often produce up to 1 ton more forage the year after resting to compensate for production lost the year of rest. This technique is especially valuable for restoring abused prairies because high value forage is able to rest for an entire growing season, go to seed, and enhance root reserves.

### **Summary**

Harvest date is the most important factor in managing native hay meadows. Cutting by mid-July to mid-August is best for obtaining both high forage quality and yield. Cutting later in the growing season reduces hay quality and shifts the plant population to undesirable weedy species, but changing the harvest date from year to year (rotational-haying) can help to increase species diversity and increase warm-season grasses. Nitrogen fertilization may increase hay yields, but usually favors forb and cool-season grass production unless applied in conjunction with annual prescribed burning. Fertilization and annual burning will typically decrease plant diversity and wildlife habitat quality.



7

## undesirable and alien plants



*Photo by Tim Tunnell*

Weeds are termed as plants that are undesirable. In native prairie, these include noxious weeds, non-native invaders like smooth brome, Kentucky bluegrass, musk thistle, and leafy spurge, to name a few, and can also include trees and shrubs like eastern red cedar and Russian olive. In general, weeds are opportunistic plants that compete with forage for moisture, nutrients, and space.

Grazing intensity influences the relative abundance of undesirable forbs and grasses. Perennial forbs such as verbena, goldenrod, and ironweed and many annual forbs such as broomweed and snow-on-the-mountain are not eaten by cattle and increase on overgrazed rangeland. Annual bromes (Japanese brome and wild oats) will persist in lightly and moderately stocked pastures. Annual bromes also provide forage in the early growing season, although extensive stands will reduce warm-season grass production and overall livestock gains. Some weeds are unpalatable when mature but are grazed when young. For example, Western ragweed contains over 20% crude protein and is palatable in the early growing season, but cattle will not eat the mature plants.

Invasion of grasslands by woody plants is another problem that has occurred at an accelerated rate in the recent past due to excessive grazing, control of fire by humans, and government policies promoting indiscriminate tree planting. Historically, woody plants in the Great Plains were mostly confined to areas along creeks, streams, rivers, and steep slopes/bluffs where soil moisture was high or fire frequency was low. Three factors

prevented woody plants from encroaching into the prairie: recurrent fires, continuous grazing pressure from numerous herbivores such as bison herds, and periodic drought. Excessive grazing reduces competition with herbaceous plants and the availability of fuel to carry fires. By assuming that all fires were bad in the past, humans have caused greater problems (e.g., high fuel loads in forests, understory of eastern red cedar). It has been only recently that the ecological importance of natural fires in maintaining certain vegetation types has been recognized by land managers.

Brush or woody vegetation competes with desirable forage for moisture, light, and nutrients, and can be a major limitation to rangeland productivity. Promotion of herbaceous vegetation alone may not be sufficient to prevent woody plant invasion, although it may reduce the rate of encroachment.

## **Control Methods (Weeds)**

Poisonous, noxious, and invading weeds that are not compatible with range forage should be targeted for control (see Appendix C). However, many weeds are actually beneficial to livestock and wildlife, and the consequence of their removal should be considered before a control program begins. Because species respond differently to control attempts, accurate identification of the undesirable weed is important for successful management.

Forage production decreases as weed encroachment increases. At some level, weed populations become high enough to warrant control. However, initiating a control program before identifying the target weed can be costly. If undesirable weed populations are at a high enough level that they are a concern, it is possible that other factors of management (i.e., overgrazing) are to blame and spraying may not be the answer to the problem. Control of undesirable species must increase forage production or availability for livestock to be justified. Reducing unwanted plants to a tolerable level is generally more economical than attempting to eliminate them. Cost effectiveness increases when weeds are

controlled on sites with high production potential such as lowlands and meadows.

### **Grazing Management**

Grazing management is the most economical way to manage weeds. Livestock will graze many weeds early in the growing season. Also, the grazing selectivity by different kinds of animals can affect weed populations. Livestock and wildlife species prefer different types of forage. For example, horses eat very few forbs and their intense grazing pressure on grasses can favor weed establishment, especially when overstocked for an extended period of time. Sheep eat less grass and more forbs than cattle and will consume many forb species that are unpalatable to cattle. Deer and goats primarily consume forbs and browse, and generally do not compete with cattle for forage.

Continuous, moderate stocking allows cattle to select weeds and cool-season grasses that are growing before the warm-season perennial grasses begin to grow. Because their growing points are exposed, forbs are weakened more than grasses by repeated grazing. The competitive ability of warm-season perennial grasses is improved if rangeland is periodically rested during the last half of the growing season. The absence of late-season grazing supplies abundant fuel for burning the following spring which can negatively impact some weeds and positively impact warm-season grasses. Good grass vigor is the best weapon against weed invasions and weed control without good grass vigor creates a never-ending cycle.

### **Prescribed Burning**

The response of forbs to fire depends upon the timing of the burn. Prescribed burning in late-spring when the forbs are actively growing is the best time to control most weedy forbs. Burning in early spring increases perennial forbs, but generally reduces warm-season grass production as a result of competition from cool-season grasses. Early-spring burns tend to favor plants that grow earlier in the season, like cool-season grasses and early-season forbs.



An important factor to consider when planning a burn to accomplish specific objectives is the stage and type of growth of desirable and target species. For example, if the goal is to suppress smooth brome and enhance native warm-season grasses, the ideal timing of the burn would be late-spring. This will allow for the smooth brome to become actively growing and then the burn will set it back while enhancing the native warm-season grasses. For another example, the growth stage of forbs at the time of the burn greatly affects the current and following year's production. Forbs are prolific seed producers, but an untimely fire can lower forb reproduction and wildlife food. Forb seedlings are highly susceptible to fire; therefore a late-winter burn after many winter annuals or biennials have germinated can reduce their population. Burns conducted during early- to mid-winter with good soil moisture result in late-winter annuals and allow rapid recovery of perennials in the following growing season.

### **Mechanical Control**

Mechanical controls such as hoeing and grubbing are effective, but can be labor intensive and expensive on a large scale. Consequently, mechanical control measures are only feasible for small or scattered patches. Often, grubbing initial invading weeds can prevent severe infestations. If tap-rooted weeds such as musk thistle are dug, the root must be cut several inches below ground to prevent regrowth. Mowing weed-infested areas temporarily removes top growth but often stimulates vigorous regrowth. Because desirable forage is also clipped, mowing should be limited to dense weed stands. Undesirable annual grasses should be mowed after the seed stalk has elongated but before seeds mature.

Annual forbs can be controlled by cutting below the lowest leaf early in the growing season. Annual forbs also may be mowed before seed formation, but many species become woody at maturity and remnant stems can injure livestock feet. Mowing may be aesthetically satisfying, but it seldom eliminates annual weeds because viable seed in the soil and dispersal from surrounding areas continually invade. Mowing generally is not effective in

controlling perennial forbs, although repeated mowing will reduce their vigor and limit their spread.

## **Herbicides**

Applications of herbicides can reduce forb populations on grasslands. Removing all forbs from rangeland with indiscriminate spraying is not desirable. Elimination or large scale reduction of beneficial forbs will reduce animal gains, alter wildlife habitat, and produce a low diversity plant community. Although more time-consuming, the spot control of weeds rather than broadcast herbicide application may be worthwhile in the long-term (see Appendix E). By spraying only the infested portions of a pasture or the individual weed plants themselves, other portions of the pasture can remain diverse and vigorous. A stronger plant community, both vigorous and diverse, will be more resistant to invasion by weeds in the long run.

In addition, spot spraying is more effective at maintaining the plant species diversity and habitat structural diversity that is important for good wildlife habitat. Herbicides are most effective on annual weeds that are in the seedling stage or less than 8 inches tall. Biennial species are easiest to control in the rosette stage. Perennial weeds are most susceptible to herbicides during the bud to early-bloom stage. Optimum weed control is obtained if conditions that are favorable for plant growth follow the herbicide application. Careful and selective use of herbicides, combined with proper management, can hasten recovery of weed-infested areas. Apply only herbicides labeled for the target species and registered for rangeland use; always read and follow label instructions.

## **Control Methods (Trees)**

### **Prescribed Burning**

Effective control of woody plants with fire depends upon the species, amount of fuel (grass), when (season) the burn occurs, and burning frequency. Non-sprouting shrubs are more susceptible to fire even when all of the foliage is not consumed (for example,

eastern red cedar) and are killed by a single burn if they are less than 5 feet tall and adequate fuel is available. Most sprouting shrubs sprout from a bud zone at or below the soil surface. These plants are difficult to kill after the seedling stage. However, top kill is often achievable and greatly reduces competition with perennial grasses and native forbs for several years. Because of the extensive root system on mature brush plants, sprouts often grow rapidly and produce canopies similar to pre-burn conditions in 3 to 5 years (depending on species). Resprouting species require 2 or 3 consecutive years of burning at the proper time for successful control.

The best time to control most species with fire is when the plant reaches its low point in food reserves, which normally occurs in mid- to late-April immediately after leaf-out or when dominant warm-season, perennial grasses (e.g., big bluestem and Indiangrass) are 1 to 2 inches tall. Smooth sumac has root reserve cycles that are similar to warm-season perennial grasses and is unharmed by late-spring burning. In this case, timing of the burn may have to occur in the summer or fall in order to achieve control of these species. Always keep in mind the effect of summer or fall burning on warm-season perennial grasses and wildlife species.

**To reduce shrub and tree invasion with prescribed fire, management must include:**

1. Grazing management that allows periodic fires (mid- and tallgrass regions historically burned every 3 to 6 years)
2. Repeated fires every 6 to 7 years in combination with another control, as some species (resprouters, seed activation) are stimulated by fire

**Mechanical**

Mechanical brush control is labor intensive, expensive, and generally only feasible for small or scattered patches. Non-sprouting trees can be killed any time if cut off at ground level. Resprouting species need to be cut when their root reserves are low or must be pulled out of the ground (including roots). Mowing

or cutting in late-April will control species like buckbrush, but smooth sumac must be cut in early-June. To kill most woody species, 2 or 3 consecutive years of cutting at the proper time is required. Resprouting of some trees, such as ash, honey locust, and Russian olive can be prevented by applying herbicide to the stump immediately after cutting. Dense stands of trees or brush can be cleared with heavy equipment such as bulldozers and excavators. This method can destroy or alter the native vegetation of the site so reseeding is usually needed.

## **Herbicides**

Most woody plants are vulnerable to properly applied herbicides, and the effectiveness depends on using the right chemical at the correct time and rate (see Appendix D & E). Each species has a period when it is most susceptible, and for herbicides to be effective environmental factors such as precipitation, temperature, and wind must be taken into account. Herbicides can be applied in several ways, but methods used in combination with mechanical control are time consuming and only practical for individual trees or small patches.

### *Broadcast Spray*

Foliar herbicides may be applied either with ground equipment or aircraft. Ground equipment sprays are suited for individual plants or scattered brush stands, but aerial applications may be necessary for dense stands, large areas, or rugged terrain. Timing is the most critical factor concerning successful brush control using herbicides. Foliar herbicides are normally applied in the spring after leaves have fully expanded and the plant is actively growing. Good spray coverage is important, and sometimes dense brush may require high application volumes to ensure coverage on understory plants. Foliar herbicides must be absorbed and translocated to be effective. However, broadcast spraying can have huge negative impacts on the diversity of the grassland by killing most broadleaf plants, including native legumes. Many of these species are highly palatable and nutritious for livestock and are important food and

cover to wildlife. Broadleaf herbicides will eliminate these plants, lowering the quality of the prairie hay and wildlife habitat. Be sure to use herbicides that are selective as possible to avoid killing non-target plants.

### *Soil-Applied and Basal Bark*

Applying pellet, granular, or liquid herbicides to the soil surface in a grid pattern or evenly spaced under the drip line controls many brush species. Treatment should be timed to coincide with anticipated rainfall in early- to late-spring. Soil-applied herbicides should not be applied when the soil is frozen or saturated with water. As with broadcast spraying, this method can negatively impact the diversity of plants within a pasture.

Applying herbicide to the lower portion of the trunk will control many species. Large trees or species with thick bark may not be effectively controlled with this treatment. On some species, the entire circumference of the trunk up to 18 inches above ground should be soaked, on others only one side of the trunk needs to be covered.

### *Girdle and Cut Stump*

For trees larger than 5 inches in diameter, grooves or notches can be cut in the trunk and herbicides applied to the cuts will penetrate the sapwood and control most species. Cutting woody species at ground level and immediately applying the proper herbicide to the cut surface will usually prevent resprouting.

## **Summary**

Weed management is an important factor in properly managing rangeland. Determining whether or not a “weed” is detrimental is the first step of a control program. Weed infestations are often the symptom of underlying problems, and unless the problem is corrected, weeds will recur. The key to weed management is recognizing potential problems and controlling them before they become serious. Most importantly, a strong vigorous grassland plant community will be more resistant to weed

invasions than a degraded grassland.

Selecting a brush control method depends on the plant species, size of invasion, topography, economics, adjacent land use, and management objectives. Combinations of methods often are less costly and more effective than a single method. Prescribed burning followed by herbicide application on the regrowth improves control of persistent species. Because successful brush control normally requires follow-up treatments, applying herbicides to prevent sprouting is more efficient than repeatedly killing regrowth. The key to brush management is recognizing potential problems and controlling them before they become severe. Once brush is reduced to tolerable levels, proper grazing and pasture management with an active prescribe burning program can limit recurrences and enhance the native component of the pasture while enhancing biodiversity.

8

wildlife habitat



*Photo by Tim Tunnell*

Range management and livestock grazing are forms of habitat management that can be positive or negative to wildlife depending on how they are applied. When wildlife habitat is an objective, a manager must recognize the habitat conditions needed to provide habitat for the wildlife species of interest. Grazing can be used to improve wildlife habitat by providing a disturbance regime needed to alter or enhance most grassland ecosystems. Grazing has impacts on grassland structure by regulating the height and density of the vegetation (e.g., heterogeneity). The more structural diversity and plant species present in a grassland leads to increased wildlife diversity.

From a wildlife perspective, one of the most important attributes of the landscape found in the Great Plains to encourage grassland wildlife species such as pheasant, quail, and other grassland songbirds, is to provide large areas (over 100 acres) of habitat completely free of trees. Within this area, there should be tall vegetation structure (50 acres or more).

This can be accomplished either through light stocking rates or rest for most or all of a season (within a rotational system). Normally, large, treeless patches of tall, dense vegetation are missing within existing grassland landscapes. Providing this kind of cover can increase populations of many species across a whole neighborhood by providing nesting or brood-rearing cover. Ensuring that the grazing intensity shifts across a site from year to year means that plants in any one location experience different



conditions each year. This will help to ensure long-term diversity of plants, because every plant species will have favorable conditions to reproduce and sustain itself in the grassland. Plant diversity encourages insect diversity and structural diversity – both of which lead to increased wildlife abundance and diversity.

One of the many challenges of managing a grassland for multiple use is to provide adequate year round habitat for wildlife while supporting a livestock grazing operation. Patch-burning or patch-haying is a system where an area (i.e., patch), up to  $\frac{1}{3}$  of a management unit, is burned each year (fall and/or spring) or hayed each year (mid- to late-summer) and livestock are given free access to the entire pasture for the grazing season. The idea is that livestock will spend more time grazing the most recently burned or hayed patch while resting, or underutilizing, the remainder of the pasture. This allows for rest from grazing pressure on the unburned or unhayed patches within the pasture. The difference in this system when compared to a rotational system is that the livestock are not restricted to the burned area and are free to graze outside of the burned or hayed patch to utilize forbs, sedges, and annual grasses that are highly nutritious only at certain times of the year, but have a short life cycle. Livestock will tend to return to the burned or hayed patch throughout the grazing season to take advantage of the new growth, especially once the warm-season grasses start responding to the burn.

Management the following year should include another adjacent portion of the pasture being burned or hayed, resulting in the livestock grazing pressure shifting to that area, allowing the previous patch to rest. As a result of the previous year's burn or haying and intense grazing, the recovering patch will most likely be relatively short and have adequate amounts of bare ground with diversity of forb species. This weedy response will be short-lived and will quickly give way to grasses again, but during the meantime it helps to provide the diversity of habitat pattern, structure, and plant composition that many declining wildlife species require.

## **Summary**

The keys to the patch-burn, patch-hay grazing system are a light to moderate stocking rate and burning or haying a different patch every year in order to distribute grazing pressure throughout the pasture. This system promotes spatially variable distribution of livestock on an annual basis, which is counter to traditional livestock practices that promote uniform grazing distribution within a year. Patch-burning or patch-haying promotes even utilization and distribution over several years, creating in a shifting mosaic of disturbance patches that promotes biodiversity and provides improved wildlife habitat.

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# glossary

**ANIMAL-UNIT (AU):** rate of forage consumption equal to 26 pounds of dry matter per day. An animal unit is one mature cow of approximately 1,000 pounds and a calf up to weaning, usually 6 months of age, or their equivalent.

**ANIMAL UNIT EQUIVALENT (AUE):** a number expressing the energy requirements of a particular kind or class of animal relative to one AU.

**ANIMAL-UNIT-MONTH (AUM):** the amount of forage required by an animal unit for 1 month:

$$\begin{aligned} &= 365 \text{ Days} * 26 \text{ Pounds of Forage a Day} \\ &= \frac{9,490 \text{ Pounds of Forage a Year}}{12 \text{ Months}} \\ &= 790.8 \text{ Pounds of Forage a Month} \end{aligned}$$

**ANNUAL PLANT:** a plant that completes its life cycle and dies in 1 year or less.

**BIENNIAL:** a plant that lives for 2 years, producing vegetative growth the first year, usually blooming and fruiting in the second year, and then dying.

**BIODIVERSITY:** a measure of the number and distribution of native species found in a natural system. In general, the stability

and vigor of a natural system are better when diversity is high. Individual plant and animal species benefit from biodiversity because they have more choices of food and cover available. Also, a plant community (i.e. grassland) is more resistant to invasion by weeds or other invasive species when it is diverse.

**COOL-SEASON PLANT:** a plant which generally makes the major portion of its growth during the winter and early spring. Optimum temperature for growth of 60-80°F. (C-3 plant).

**CARRYING CAPACITY:** a stocking rate that will sustain the vegetation and related resources.

**CLASS OF ANIMAL:** description of age and/or sex-group for a particular species of animal; e.g., cow, calf, yearling, ewe, doe, or fawn.

**COMMUNITY:** an assemblage of populations of plants and/or animals in a common spatial arrangement.

**CRUDE PROTEIN:** an estimate of protein content based on nitrogen concentration.

**DIVERSITY:** the distribution and abundance of different plants and animal communities within an area.

**DECREASERS:** dominant species that decline when grazing pressure increases

**DEFERRED GRAZING:** postponing grazing or resting an area for a prescribed period, usually to meet a specific management objective.

**DORMANT:** a living plant that is not actively growing aerial shoots.



**ECOLOGY:** the study of the interrelationships of organisms with their environment.

**ECOSYSTEM:** organisms together with their abiotic environment, forming an interacting system, inhabiting an identifiable space.

**EXOTIC:** an organism which is not native to the region in which it is found.

**FIREBREAK:** a natural or manufactured barrier used to prevent or retard the spread of fire that is in existence or made before a fire occurs. It is usually created by the removal of vegetation.

**FORBS:** any broad-leafed herbaceous plant other than those in the Gramineae (or Poaceae, the grass family), Cyperaceae, and Juncaceae families.

**FORAGE:** is all plant material available and acceptable to grazing animals, or that may be harvested for feeding purposes.

**FORAGE DEMAND:** is the amount of any specified forage required to meet nutrient requirements of an animal over a specified period

**GRASS:** common name for a family of flowering plants with jointed stems, flowers in spikelets, and slender, sheathing leaves.

**GRASSLIKE PLANT:** a plant of the *Cyperaceae* or *Juncaceae* families which vegetatively resembles a true grass of the *Gramineae* family.

**GRAZING CAPACITY:** the total number of animals which may be sustained on a given area based on total forage resources

available, including harvested roughages and concentrates.

**GRAZING DISTRIBUTION:** dispersion of livestock grazing within a management unit or area. Syn., livestock distribution.

**GRAZING INTENSITY:** the number of animals per unit of land at any instant of time. It may be expressed as animal-units per acre, animal-units per section, or AU/acre.

**GRAZING MANAGEMENT:** the manipulation of livestock grazing to accomplish a desired result.

**GRAZING SYSTEM:** a tool of grazing management which alters the timing of periods of occupation and periods of non-use among two or more pastures within a grazing period and their sequence between years.

**GROWING SEASON:** in temperate climates, that portion of the year when temperature and moisture are usually most favorable for plant growth. In tropical climates it is determined by availability of moisture.

**GRUBBING:** dig roots out of the ground; uproot

**HABITAT:** place where a plant or animal lives

**HETEROGENEITY:** the condition of differing in structure and/or quality.

**HOEING:** to dig, cultivate, weed, etc with a hoe.

**HOMOGENEITY:** the quality or condition of being the same in structure and/or quality.

**INCREASER:** plant species of the original vegetation that increase in relative amount, at least for a time, under continued disturbance in excess of the norm, such as overuse or drought.

**INTRODUCED SPECIES:** a species not a part of the original fauna or flora of the area in question. Syn., exotic.

**INVADER:** plants that are not a part of the original plant community that invade an area as a result of disturbance, or plant community deterioration, or both.

**KIND OF ANIMAL:** an animal species or species group such as sheep, cattle, goats, deer, horses, elk, antelope, etc. cf. class of animal.

**LITTER:** the uppermost layer of organic debris on the soil surface; essentially the freshly fallen or slightly decomposed vegetal material.

**MODERATE GRAZING:** a comparative term which indicates that the stocking rate of a pasture is between the rates of other pastures.

**MULTIPLE USE:** harmonious use of range for more than one purpose: i.e., grazing of livestock, wildlife production, recreation, watershed and timber production. Not necessarily the combination of uses that will yield the highest economic return or greatest unit output.

**MIXED GRASS PRAIRIE:** plant community that occurs in the transition area between tall and short grass prairie.

**NATIVE SPECIES:** A species which is a part of the original fauna or flora of the area in question.

**NOXIOUS WEED:** an unwanted plant specified by Federal

and State laws as being especially undesirable, troublesome, and difficult to control.

**PERENNIAL PLANT:** a plant that has a life cycle of three or more years.

**PRESCRIBED BURNING:** the use of fire as a tool to achieve a management objective on a predetermined area under conditions where the intensity and extent of the fire are controlled.

**REST:** is the nonuse of a pasture for a full year. This gives all plants a chance to complete a growth cycle without grazing by livestock, and provide wildlife with an area free of livestock during the critical dormant season.

**RESIDUAL COVER:** forage remaining after a grazing period or grazing season.

**ROTATIONAL GRAZING:** a type of grazing system that involves moving grazing animals from one pasture to another to achieve a desired management objective.

**RESILIENCE:** the speed with which a community returns to its former state after it has been disturbed.

**SHRUBS:** plants that have persistent, woody stems, a relatively low growth habits, and generally produce several shoots at the base instead of single trunks. A shrub differs from a tree in its low stature and form. Maximum height is generally 4 meters.

**SPECIES COMPOSITION:** the proportions of various plant species in relation to the total on a given area. It may be expressed in terms of cover, density, weight, etc.

**STOCKING RATE:** the area of land allowed per animal unit for a

particular period of the year. For example, AUM/ac or ac/AU/year.

**SPECIES:** group of potentially interbreeding populations reproductively isolated from all other populations.

**TALL GRASS PRAIRIE:** plant community dominated by tall grasses, which grow four to eight feet high. These grasses are usually abundant in higher rainfall areas and along streams and moist valleys.

**VEGETATION TYPE:** kind of existing plant community with distinguishable characteristics described in terms of the present vegetation that dominates the aspect or physiognomy of the area.

**WARM-SEASON PLANT:** a plant that makes most or all of its growth during the spring, summer, or fall and is usually dormant in winter. Optimum temperature for growth is above 90°F (C-4 plant).

**WEED:** any plant growing where unwanted.



# appendix a

**To determine how many animals your land will support (stocking rate), you need to know two things:**

1. How much forage you have available
2. How much forage the particular animal or group of animals you have on your rangeland will consume

The animal unit month (AUM) concept is the most widely used way to determine the carrying capacity of grazing animals on rangelands. The AUM provides us with the approximate amount of forage a 1000 lb cow with calf will eat in one month. It was standardized to the 1000 lb cow with calf. All other animals were then converted to an “Animal Unit Equivalent” of this cow. For example, a yearling calf has an Animal Unit Equivalent of 0.60. This means a yearling eats about 60% of the forage a cow will eat in one month.

## **Animal Unit Equivalents**

---

Cow	dry	1000 lb	<b>0.92</b>
Cow	with calf	1000 lb	<b>1.00</b>
Cow	with calf	1200 lb	<b>1.20</b>
Cow	with calf	1400 lb	<b>1.40</b>
Cow	with calf	1600 lb	<b>1.60</b>
Bull	mature		<b>1.35</b>
Cattle	1 year old		<b>0.60</b>
Cattle	2 years old		<b>0.80</b>

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### Stocking Rate:

1. Determine total production of the area
2. Calculate total “available” forage by using the “take half, leave half” method, either divide total production by 2, or multiply by  $\frac{1}{2}$ .
3. Determine pounds of forage eaten by cattle per month. This is generally 80% of the body weight of a 1000 lb cow, but often ranges from 600 to 900 lb.
4. Calculate proper stocking rate for cattle:

$$\text{Stocking Rate} = \frac{\text{Available Forage}}{\text{Pounds Eaten a Month}}$$

5. Convert for animal type you are using with Animal Unit Equivalents:

$$\text{Animal Unit Months for your Animal} = \frac{\text{Stocking Rate}}{\text{Animal Unit Equivalent}}$$

6. Determine number of animals you can keep over the time needed:

$$\text{Number of Animals} = \frac{\text{Animal Unit Months for Your Animal}}{\text{Number of Months on Pasture}}$$

### Stocking Rate Example:

1. Determine Total Production of the Area.

*After clipping and weighing plots, the total production of the 200 acre pasture is determined to be 3000 lb/ac.*

2. Calculate Total Available Forage:



Total Available Forage = Total Production \*  
(how much you can use) \* 0.5 \* Pasture Size

Total Available Forage = 3000 Pounds an Acre \*  
0.5 \* 200 Acres

*50% is the most common use factor. This can vary based on management and species present.*

Total Available Forage = 300,000 Pounds an Acre

3. Determine pounds per month intake for a 1000 lb animal:

1000 lb Animal \* (80% of Bodyweight) = 800 Pounds a  
Month

4. Calculate Proper Stocking Rate:

$$\text{Stocking Rate} = \frac{\text{Available Forage}}{\text{Pounds Eaten a Month}}$$

$$\text{Stocking Rate} = \frac{300,000 \text{ Pounds an Acre}}{800 \text{ Pounds a Month}}$$

$$\text{Stocking Rate} = 375 \text{ Animals/Month}$$

5. Convert for animal type you are using with Animal Unit  
Equivalents:

*The cow herd on the pasture has an average weight of 1400 lb.*

$$\text{Animal Unit Month for} \\ \text{Class of Livestock} = \frac{\text{Stocking Rate}}{\text{Animal Unit Equivalent}}$$

$$\text{Animal Unit Month for Class of Livestock} = \frac{375 \text{ Animals}}{\text{Month}}$$

$$\text{Animal Unit Month for Class of Livestock} = \frac{375 \text{ Animals a Month}}{1.4}$$

$$\text{Animal Unit Month for Class of Livestock} = \frac{268 \text{ Animals}}{\text{Month}}$$

6. Determine amount of animals that can be grazed over allotted time:

*The pasture can be grazed for 5 months*

$$\text{Number of Animals} = \frac{\text{Animal Unit Month for Class of Livestock}}{\text{Number of Months on Pasture}}$$

$$\text{Number of Animals} = \frac{268 \text{ Animal Unit Months}}{5 \text{ Months}}$$

$$\text{Number of Animals} = 54 \text{ Animals}$$

# appendix b

## **Prescribed Burn Plan**

The plan identifies the recommended guidelines, procedures, preparations, and resources needed for conducting a prescribed burn. The plan should describe ignition procedures, location of control crews, location of firelines, and neighbor and emergency personal contact information. This plan should also have a contingency plan for control of an escaped fire. Discuss this with your crew and your volunteer fire chief in advance of the burn. All fire departments within the immediate area should be notified of the burn date and burn plan and all appropriate permits should be obtained prior to starting fire.

## **Several Points to Remember in Planning a Burn Are**

- Pre-burn grazing management is necessary to allow adequate fuel build-up and improved desirable plant vigor
- Prescribed burns require adequate preparation, equipment, and experienced personnel
- Fire plans and prescriptions are only guidelines.
- Fire behavior must be predictable for effective containment
- Fire intensity is determined by weather, fuel conditions, and type of fire
- The greater the intensity of the fire, the greater the risk of escape
- Vegetation recovery rate is dependent on species, their vigor, fire temperature, weather conditions, and management before and after the burn

- Post-burn management of livestock and wildlife is critical to recovery and improvement of desirable plant species.

### **Red Flag Conditions for Prescribed Burns:**

- Wind speed greater than 20 mph
- Relative humidity less than 20%
- Air temperature greater than 80° F

### **Fine Fuel Loads for Effective Burns:**

- Minimum of 1,500 to 2,000 pounds/acre
- Optimum of 3,000 pounds/acre or more (kill cedar or other brush)

### **Optimum Weather Conditions for Winter Backfires:**

- Relative humidity between 60° and 40%
- Air temperature between 40° and 60° F
- Wind speed between 5 and 8 mph

### **Optimum Weather Conditions for Winter Headfires:**

- Relative humidity between 25 and 40%
- Air temperature between 70° and 80° F
- Wind speed between 8 and 15 mph

### **Minimum Downwind Protection (Backfire + Fireline Width):**

- Slightly volatile fuels = 50 to 100 feet
- Moderately volatile fuels = 100 to 200 feet
- Highly volatile fuels = 300 to 500 feet

### **Diesel: Gasoline Mixture for Drip Torches:**

- 60 to 75% diesel plus 25 to 40% gasoline

# appendix c

## chemical control of noxious weeds & other important invasive species

<b>SPECIES</b>	<b>CONTROL</b>
Musk Thistle =	8-12 oz/ac of Tordon 22K in the fall (best time) 2-4 pts./ac of Grazon P+D in the spring rosette to early bolting 1/4 oz/ac of Escort & 1 qt Amine per ac from bolting to bloom 1 qt/ac 2,4-D amine & 8 oz/ac of Clarity if water table concerns
Leafy Spruge =	In the spring, 32-48 oz/ac of Amine 2,4-D for a burn down to keep from seeding. In the spring, 32-48 oz/ac of Amine 2,4-D for a burn down to keep from seeding. Then 8-10 oz/ac of Plateau in the Fall with 32 oz of MSO
Canada Thistle =	<b>Pastures</b> 1-2 qt/ac of Clarity OR 1 qt/ac of Tordon 22k in spring during early flower bud, or fall during active growing <b>Crop Ground</b> 0.3-1.3 pt/ac Stinger in rosette to pre-bud or in the fall when actively growing
Purple Loosestrife =	<b>Aquatic Conditions</b> 4-6pts/ac of Rodeo 80-95% control 3-5pts/ac of amine 2,4-D 70-90% control on young stands <b>Dry Conditions</b> 1-2oz/ac Escort 80-90% control 4-6pts/ac Arsenal 95-100% control
Plumeless Thistle =	8-12 oz/ac of Tordon 22Kin the fall (best time)

2-4 pts/ac of Grazon P+D in the spring rosette to early bolting

1/4 oz/ac of Escort & 1 qt Amine per ac

1 qt/ac amine & 8 oz/ac of Clarity if water table concerns

Spotted and Diffuse  
Knapweed = 1 pt/ac Tordon 22K rosette to bud stage

2-3pt/ac Grazon P+D rosette stage

1 pt/ac Transline from mid-bolt to bud stage

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# appendix d

## chemical control of woody species

<b>SPECIES</b>	<b>CONTROL</b>
Buckbrush	= 1-2 qt/ac Of 2-4,D ester in full foliage 2-4 pt/ac Of Grazon P+D in full foliage (mid-May)
Cottonwoods, Willows and Elms	= 2-3 qt/ac of 2-4,D ester in full foliage 1 gal/ac Crossbow in full foliage 1-2 gal Brushmaster in 100 gal of water apply to point of runoff Pellet forms are: Spike 20P, Veteran 10G, Pronone Power Pellets
Honey and Black Locust	= 2 qt/ac Banvel/Clarity in full foliage 2-4 qt/ac Grazon P+D in full foliage 2-4 pt/ac Remedy 1-2 gal/ac Brushmaster in 100 gal water Spike 20P, Veteran 10G, or Pronone Power Pellets
Russian Olive	= 2 qt/ac of 2,4-D ester and 1 qt/ac of Banvel/Clarity in full foliage ½ oz per 1" diameter of tree of Spike 20P 4% solution of Crossbow - basal treat or dormant brush treat
Eastern Red Cedar	= 4ml of Tordon 22K per 3 foot of tree height 4 ml of Velpar L per 1" tree diameter 1-2 pellets of Pronone Power Pellets per 1" diameter of tree 1-2 gal/ac Brushmaster in 100 gal water

# appendix e

## herbicide application rates to dilution rates

Follow all federal, state and local regulations regarding herbicide use. You **must** read and follow product labels. It is a violation of federal law to use an herbicide in a manner inconsistent with its label. You should also understand that certain Range and Pasture Herbicides have grazing restrictions. *The Guide for Weed Management in Nebraska* and *The Nature Conservancy's Weed Control Methods Handbook* are great resource for specific information pertaining to the use of herbicides and their effects on plants and livestock.

The table on the following page will help to calculate the desired concentration for individual and spot treatment for various amounts of total volume of spray mix.



**HERBICIDE CONCENTRATION DESIRED  
FOR INDIVIDUAL PLANT AND SPOT TREATMENT**

**SPRAY VOLUME**

	<b>1/4 %</b>	<b>1/2 %</b>	<b>3/4 %</b>	<b>1 %</b>	<b>1 1/2 %</b>	<b>2 %</b>
1 gallon =	1/3 oz	2/3 oz	1 oz	1 1/3 oz	2 oz	2 2/3 oz
3 gallons =	1 oz	2 oz	3 oz	4 oz	6 oz	8 oz
5 gallons =	1 2/3 oz	3 1/3 oz	5 oz	6 1/2 oz	10 oz	13 oz
10 gallons =	3 1/3 oz	6 2/3 oz	10 oz	13 oz	19 oz	26 oz
25 gallons =	8 oz	1 pt	24 oz	1 qt	48 oz	2 qt
50 gallons =	1 pt	1 qt	48 oz	2 qt	3 qts	1 gal

	<b>3 %</b>	<b>4 %</b>	<b>5 %</b>	<b>10 %</b>	<b>15 %</b>	<b>25 %</b>
1 gallon =	4 oz	5 1/4 oz	6 1/2 oz	13 oz	19 oz	1 qt
3 gallons =	12 oz	15 1/2 oz	19 oz	38 oz	57 oz	3 qt
5 gallons =	19 oz	26 oz	1 qt	2 qt	3 qt	1 1/4 gal
10 gallons =	38 oz	51 oz	2 qt	1 gal	1 1/2 gal	2 1/2 gal
25 gallons =	3 qt	1 gal	1 1/4 gal	2 1/2 gal	3 3/4 gal	6 1/4 gal
50 gallons =	1 1/2 gal	2 gal	2 1/2 gal	5 gal	7 1/2 gal	12 1/2 gal
100 gallons =	3 gal	4 gal	5 gal	10 gal	15 gal	25 gal

Source: <http://cnrit.tamu.edu/rsg/exsel/work/herbic.html>

**Example:**

If the application rate calls for  $x$  lb acid equivalent of herbicide per acre, just change that to a dilution rate of  $x$  percent. For example, if you want to apply 1 1/2 lb acid equivalent *Roundup*, dilute it to 1 1/2 %. Spray the plant so it is wet, but not dripping.

To prepare 5 gallons of a spray mixture (herbicide, water and surfactant) containing 1 1/2 % herbicide, add 10 ounces of herbicide. Add 1/4 % to 1/2 % commercial, non-ionic surfactant for mixtures using only water as the herbicide carrier.

If you are using a backpack sprayer or a small sprayer (less than 100 gallons) to cover a larger area (such as a dense infestation of musk thistle, leafy spurge, smooth brome, etc.), you must first calibrate your application rate carefully before you can convert herbicide application rates to dilution rates.

## To calibrate your sprayer follow these steps:

### *Step 1:*

Get your sprayer ready just as you would for an herbicide application, but use water in the tank instead of herbicide. Carefully measure how much water you put in the tank.

### *Step 2:*

Use your rig to spray the ground until you run out of water (doing this on asphalt or concrete will help you see if you skip spots). Measure the area you covered: the area = length \* width (for a rectangular area). It is important you do this calibration just like you would in the field, walking the same speed, spraying at the same height, keeping the pressure in the tank the same, etc.

### *Step 3:*

Perform the following calculations.

The number of acres sprayed is:

$$\frac{\text{Area You Sprayed (Square Feet)}}{43,560} = \text{Acres You Sprayed}$$

The gallons/acre sprayed is:

$$\frac{1 \text{ Gallon}}{\text{Acres You Sprayed}} = \text{Gallons an Acre You Sprayed}$$

If you used a volume of water other than 1 gallon, use it in the equation above.

*Step 4:*

Making you tank mix. To calculate dilution rate, divide the desired application rate (e.g. ounces per acre) by the spray rate (gallons/acre). For example, if you wanted to apply herbicide at 32 ounces per acre, and you have determined that through calibration of you spray rig that you are spraying at 10 gallons fluid acre per acre, your tank mix should be:

$$\frac{32 \text{ Ounces an Acre}}{10 \text{ Gallons an Acre}} = 3.2 \text{ Ounces a Gallon}$$

If you are using a 5 gallon tank, you can use  $3.2 \text{ oz} * 5 \text{ gal} = 16$  oz of herbicide in your tank, diluted with water.

Source: Barry Rice, Ph.D., Invasive Species Specialist, Wildland Invasive Species Team, The Nature Conservancy.

# appendix f

## Common Conversions

### AREA

---

1 acre	=	43,560 square feet
		209 feet x 209 feet
		69½ yards x 69½ yards
1/10 acre	=	4,356 square feet
		66 feet x 66 feet
		22 yards x 22 yards
1/100 acre	=	436 square feet
		21 feet x 21 feet
		7 yards x 7 yards
1 section	=	640 acres
		1 square mile
1 hectare	=	2.471 acres

### LENGTH

---

1 mile	=	5,280 feet
		1,760 yards
		1.61 kilometers
1 rod	=	16½ feet
1 chain	=	66 feet
1 kilometer	=	0.62 miles
1 roll of barbed wire	=	¼ mile
		1,320 feet
1 roll of net wire	=	330 feet
		20 rods

## WEIGHT

---

1 short ton	=	2,000 pounds
1 long ton	=	2,240 pounds
1 pound	=	453.6 grams 16 ounces
1 kilogram	=	2.2 pounds

## LIQUID MEASURE

---

1 gallon	=	128 ounces 3,785.4 millimeters 16 cups 4 quarts 8,355 pounds 256 tablespoons
1 quart	=	0.946 liters 2 pints 32 ounces
1 pint	=	16 ounces 2 cups
1 cup	=	8 ounces
1 millimeter	=	1 cubic centimeter (cc)
1 teaspoon	=	5 milliliters
1 cubic foot of water	=	62.43 pounds 7.48 gallons
1 ac inch of water	=	27,154 gallons
1 barrel of water	=	55 gallons
1 barrel of oil	=	40 gallons

## CALCULATION OF WATER STORAGE CAPACITY

---

Round tank (gallons)	=	$3.1416 \times \text{radius squared (ft)} \times \text{height (ft)} \times 7.48$
Rectangular tank (gallons)	=	$\text{height (ft)} \times \text{width (ft)} \times \text{length (ft)} \times 7.48$

## PRESSURE

---

1 foot lift of water	=	0.433 psi
1 psi will lift water	=	2.32 feet

---

## Useful Weights & Measures

### LIQUID

---

<b>US</b>	6 teaspoons (tsp) =	tablespoons (Tbl) 1 fluid ounce (oz)
	16 ounces =	2 cups (cu) 1 pint (pt)
	2 pints =	1 quart (qt)
	1 gallon (gal) =	4 quarts 8 pints 128 fluid ounces weighs 8.34 pounds (lb)
<b>Metric</b>	1 cubic centimeter (cc) =	1 milliliter (ml) 1 gram (gm) <b>water only</b>

### DRY

---

<b>US</b>	1 pound =	16 ounces
<b>Metric</b>	1,000 grams =	1 kilogram (kg)

### LINEAR

---

<b>US</b>	1 mile (mi) =	1,760 yards (yds) 5,280 (ft)
	1 acre (ac) =	43,560 square feet (ft <sup>2</sup> ) a swath 8¼ feet wide, one mile long a swath 16½ feet wide, ½ mile long a swath 33 feet wide, ¼ mile long
	1 section =	640 acres
	1 township =	36 sections
<b>Metric</b>	1 kilometer (km) =	1,000 meters (mtr)
	1 meter =	100 centimeters (cm) 1,000 millimeters (mm)

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## Conversions & Formulas

### CONVERSIONS

---

1 acre	=	.405 hectare
1 hectare	=	2.471 acres
1 kilometer	=	.62 miles
1 mile	=	1.61 kilometers
1 meter	=	39.37 inches
1 kilogram	=	2.2 pounds
1 pound	=	.454 kilograms
1 liter	=	1.057 quarts
1 quart	=	.946 liters
1 gallon	=	3.79 liters
1 mile per hour	=	88 ft per minute
		1.46 ft per second
1 gallon per acre	=	9.35 liters per hectare

### SIMPLE SPRAYER CALIBRATION

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$$\frac{\text{total gallons used} \times 43,560 \text{ feet}}{\text{boom width (ft)} \times \text{distance traveled (ft)}} = \text{Gallons per acre (GPA)}$$

---

# appendix g

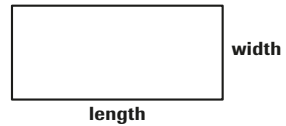
## calculating acreage of a field or pasture

### AREA

---

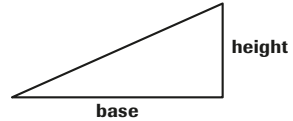
#### Rectangular

$$\frac{\text{length (ft)} \times \text{width (ft)}}{43,560 \text{ ft}} = \text{acrage}$$



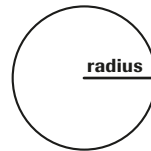
#### Triangular

$$\frac{\frac{1}{2} \text{ base (ft)} \times \text{height (ft)}}{43,560 \text{ ft}} = \text{acrage}$$



#### Circular

$$\frac{\text{radius}^2 \text{ (ft)} \times 3.1416}{43,560 \text{ ft}} = \text{acrage}$$









SAVING THE LAST GREAT PLACES ON EARTH

*The mission of The Nature Conservancy is to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.*



NEBRASKA GAME &  
PARKS COMMISSION

*The mission of the Nebraska Game and Parks Commission is stewardship of the state's fish, wildlife, park, and outdoor recreation resources in the best long term interests of the people and those resources.*



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