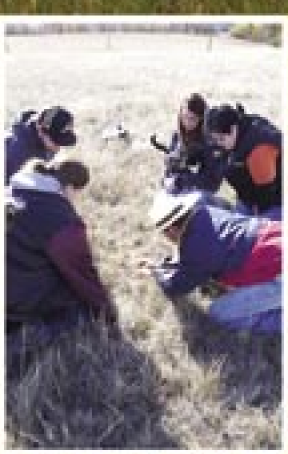
Managing Saskatchewan Rangeland

revised edition



Canada

Government of Saskatchewan

Managing Saskatchewan Rangeland

Revised Edition

Printed March 2008

This revised document, like the original, concentrates on rangeland management in Saskatchewan. The publication's purpose is to contribute to the sustainability of the province's rangeland resources.

Acknowledgements

This revised edition was made possible through the partnership of the Saskatchewan Forage Council, Ducks Unlimited Canada, Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration, Saskatchewan Ministry of Agriculture, Saskatchewan Watershed Authority and the University of Saskatchewan.

Editors:

Janice Bruynooghe, Ross Macdonald.

Contributors:

Larry Braul, Janice Bruynooghe, Bill Claffey, Allan Foster, Todd Jorgenson, Brant Kirychuk, Trevor Lennox, Ross Macdonald, Glen McMaster, Ron Moss, Steve Murrell, Daryl Nazar, Chris Nykoluk, Rod Piche, Jim Romo, Jeff Thorpe, Michel Tremblay, Heather Wiebe, Jason Williams.

Photos and Diagrams:

Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration, Kane Veterinary Supplies, Saskatchewan Forage Council, Janice Bruynooghe, Don Fontaine, Todd Jorgenson, Trevor Lennox, Ross Macdonald, Jim Romo, Leanne Tremblay, Michel Tremblay, Jason Williams.

Cover Photos:

Janice Bruynooghe, Don Fontaine, Ross Macdonald, Jim Romo, SIAST Beef Cattle Production.

The first edition of Managing Saskatchewan Rangeland was published in 1990 by the Economic Regional Development Agreement (ERDA) and the Agriculture Development Fund (ADF) as an initiative of the Grazing and Pasture Technology Program. The document was revised in 1995. The present authors recognize the vast number of contributors and editors of past editions of this publication.

Funding for the revision and printing of this publication was provided by Agriculture and Agri-Food Canada's Greencover Canada Program.

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Table of Contents

Introduction

Rangelands, a broad category of land comprising more than 40 percent of the earth's land area, are characterized by native plant communities, which are often associated with grazing, and are managed by ecological, rather than agronomic methods.

The term "range" also includes forestlands that have grazing resources, or seeded lands that are managed like rangeland. Range resources are not limited to forage, and may include other benefits such as water and wildlife habitat. The terms native rangeland and native prairie are often used when referring to rangelands characterized by native plant communities.

An understanding of how rangeland ecosystems function allows management plans to be developed and succeed. Efforts to restore rangeland productivity and ensure sustainability must be based on ecological principles. Rangeland planning is key to improved and sustainable land use. With planning, land managers and producers can achieve their goals.

Photo Credit: Jim Romo

Mixed Grass Prairie

The Key Steps

Identifying variables, setting goals, and determining limiting factors allows realistic planning for rangeland use to begin. Constant revision allows appropriate adjustments to be made to achieve management objectives.

This book is designed to assist range mangers in stewarding rangeland resources. Careful planning can save time and money as well as maintain and improve the ecological integrity of rangelands.

Identifying Questions

Most rangeland plans are derived from a question or a series of questions surrounding use of the rangelands. Clearly identifying these questions leads to identifying goals.

Common examples of questions that may surround rangelands:

- How can I manage rangelands for drought?
- How can I manage my rangelands for profit?
- How do I reduce the encroachment of invasive plants onto my rangelands?
- How can I manage for both livestock production and Species at Risk on my rangelands?

Goal Setting

Long-term goals can be achieved through many avenues.

Short-term goals aid in achieving long-term goals. A short-term goal, for example, may be to lengthen the grazing season without putting undue pressures on native prairie.

The Inventory

Conducting a baseline inventory of the rangelands in question will help identify limiting factors, and may add more questions or clarify others. A thorough inventory is critical to any further decision making.

Re-evaluation

By this stage, shortfalls or problems should be evident. Revised goals based on the evaluation and identification of limiting factors can spawn new ideas and lead to implementation of new techniques.

Techniques for Change

Assess various techniques according to suitability and whether they are ecologically and economically sound. An improved grazing system, more fencing, additional tame pasture, reseeding, fertilizing, burning, water developments, herbicide application, or diversification into different types of livestock can be useful approaches to direct change.

Base decisions on the merits and shortcomings of each technique and how it fits in with long-term goals.

Implementation

The new plan must be implemented in a logical sequence, however, flexibility in implementating the plan allows the 'art' of range management to be developed.

Monitoring

A range plan must be monitored to determine if desired changes are occurring at the desired rate because forage production can fluctuate with yearly weather patterns.

The following questions may be used to monitor a plan:

- Do I see positive ecological changes on my land?
- Have I lengthened the grazing season?
- Am I producing more beef per acre?
- Do animals have higher weaning weights?
- Am I finding it necessary to cull fewer animals?
- Have I reduced my overhead costs?
- Is my quality of life improving?
- Are my employees and family feeling more a part of the operation?

Goals Evaluation

Periodically re-examine goals to see if they require adjustment. Often goals change with time and experience.

References

Society for Range Management. 2007. http://www.rangelands.org/about_pos_rangeresources.shtml.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Cypress country

Grazing History

Open Range to First Ranches

Before settlement by Europeans, First Nations people had been calling the prairies "home" for at least 12,000 years. Without the bison, it is doubtful whether humans could have existed at all on the Great Plains. Bison were a life sustaining resource for First Nations. They followed the source of their sustenance in both daily and seasonal cycles - from the dry plains in summer, to the shelter of the Parkland and valleys in winter. It is difficult to find examples anywhere else in the world of a people's dependency on a single species.

Photo Credit: Jim Romo

Bison

When European explorers first viewed the great bison herds that blackened the prairie, they were aghast. They had never seen such countless multitudes of herbivores.

Across the prairies, other animals including elk, deer and antelope, were also sustained by grazing native rangelands and forest fringe. Rangelands were home to a great diversity of life and also supported a complex mix of predators and scavengers: plains grizzly bear, prairie wolf, coyote, swift fox, eagle, magpie and crow.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Mule Deer

Bison numbers quickly dwindled under settlement pressures. By the mid-1870s, Saskatchewan's last known herd of bison was confined to the Cypress

Photo Credit: Jim Romo

Pronghorn

Hills. Consequently, pressures on elk, antelope and deer populations by homesteaders and railway crews intensified and further reduced the native animal population.

During the 1880s growth of plants on the range was abundant. Greater moisture levels and destocking of native herbivores by settlers allowed the rangelands to flourish under light use. However, the increased needs of traders, First Nations people, settlers, North West Mounted Police, and builders of the Canadian Pacific Railway all contributed to an increased demand for livestock production. The grazing pressure on the West's vast sea of grass shifted from a few wild animals to large numbers of domestic livestock and gave rise to western Plains ranching.

In 1888, the 76 Ranch was registered. The 76 Ranches were comprised of ten, 10,000 acre parcels spread at intervals between Balgonie, Saskatchewan and Dunmore, Alberta. The ranch included a grain farm at Balgonie and sheep and cattle ranches at Rush Lake, Swift Current, Gull Lake, Crane Lake and Kincorth. However, capital shortages, lack of local experience, and bad luck resulted in significant animal losses from severe winters and disease. The result was the final break-up of the 76 Ranches by 1909.

Photo Credit: Jim Romo

Coteau Hills

In 1903 the Matador Ranch and Cattle Company Ltd. assembled 140,000 acres in the Coteau Hills north of the South Saskatchewan River. The Matador was the largest ranching empire in the world during its time. The company shipped young cattle from its large breeding ranches in Texas and Oklahoma to southern Saskatchewan to mature and fatten on the native prairie grasses. The final roundup occurred in 1921, when the Matador closed its books on the Canadian operation.

Other major Saskatchewan ranches of the period included the Turkey Track and the Gull Lake Ranching Company. Like most other large ranches these were directed and funded by absentee owners; they soon folded. Although Texas-based, the Matador was longer-lived in Saskatchewan, partly due to its resident and solid ranch management experience.

Between 1900 and 1905 at least 25 smaller ranches were established south of the South Saskatchewan River, mostly by former employees of these larger ranches.

Early Land Administration and Use

In the early ranching era, Saskatchewan rangeland administration was handled by the Government of Canada. The Palliser Triangle, deemed as unfit for farming, extended east from the Rockies into Saskatchewan.

Initially, rangeland was theoretically completely open to purchase, but in actual practice land tenure existed. In 1881, lease grants of 21 years on areas up to 100,000 acres in size were authorized. The annual rental was one cent per acre. Settlement and use conditions were very specific. Of note was a stocking requirement of one head of livestock per 10 acres. This later became one head per 20 acres and then one head per 30 acres. Initial stocking requirements had been grossly over estimated. Once the desired stocking level was attained, usually to the detriment of range health, the lessee could purchase up to five percent of the land at two dollars per acre.

The western land survey began in 1871, with the base line being the meridian of longitude immediately west of the Red River settlement boundary. Certain lands remained with the Hudson's Bay Company, two sections were reserved per township as school properties, large land grants went to the railways to encourage line construction, and homestead rights were made available.

From 1896 to 1914 the Canadian Government allocated millions of acres of homestead land in Saskatchewan. The height of prairie settlement subsequently occurred in 1912. In addition, railway and large land companies sold millions of additional acres.

As settlement increased, agriculture was influenced by climate, soil, topography, drainage, transportation, marketing facilities and government policy that favoured grain production. Generally, rougher land that was not easily cultivated remained as native prairie, either as large grazing tracts or as small areas within or adjacent to croplands.

Draft horses were a major user of Saskatchewan rangelands, increasing to a high of 2,250,000 head in 1926. Horse populations declined slowly until 1945, as horsepower was rapidly replaced by tractors.

Overgrazing and Range Research

Lease abandonments due to overgrazing were reported as early as 1912. By 1925, rancher groups in southern Alberta were pressing for review of their lease rates, arguing that the government's carrying capacities were too high and could not be sustainably achieved.

After meetings between Experimental Farm personnel and representatives of the Stockmens' Associations, a range survey of southern Alberta and southwestern Saskatchewan was undertaken in 1926 by L.B. Thompson and S.E. (Doc) Clark.

Experiments commenced in 1927 on continuous, rotational and deferred grazing systems, cattle

Photo Credit: Jim Romo

Overgrazed Fescue Prairie

behaviour as an aid to encouraging grazing, development of stock watering facilities, and reseeding abandoned land. Clark studied grazing of native range, the effects of various grazing practices, range reseeding, surface cultivation, and fertilization and growth of seeded forage crops.

This joint venture between ranchers and scientists become known as the Manyberries Range Experimental Station. In 1935 Mr. Thompson left Manyberries to direct the Swift Current Experimental Farm where similar and complementary scientific studies were initiated. Soon after that grassland research spread to numerous experimental farms, research stations, and universities across the prairies.

Great Depression Challenges

In 1935 the Land Utilization Act was passed to deal with the problem of farmland abandonment resulting from several drought years, unsuitable agronomic practices and the Great Depression. Carrying out the Act's responsibilities, including controlling soil erosion, was undertaken by the Land Utilization Board. Because the Board lacked the resources to address erosion effectively, the Prairie Farm Rehabilitation Administration (PFRA) was established.

Photo Credit: Jim Romo

Abandoned homestead

The PFRA began to tackle soil erosion, water development, and land use problems. By 1937 progress had been made in controlling soil drifting and water development expertise had increased. However, a solution to land abandonment still needed to be identified.

In 1937, provincial and federal officials held a conference in Regina to seek answers to this problem. It was decided that the federal government would take over abandoned agricultural lands and convert them into community pastures; these would be then operated by PFRA. By 1942 PFRA administered one million acres of community pasture land in Saskatchewan, eventually increasing to 1.8 million acres.

Beyond the Crown Land Transfer

When the Province of Saskatchewan was formed in 1905, Crown land and mineral resource titles remained with the Canadian Government. In 1930, the remaining titles were transferred to the province, bringing about the formation of a Lands Branch in the Department of Natural Resources. The Branch not only administered unpatented public lands, but also inspected homesteads and issued certificates of title to those meeting cultivation and residency requirements.

In 1946 the Lands Branch was transferred to the Department of Agriculture and then to Saskatchewan Rural Development of Agriculture and then to Saskatchewan Rural Development in 1988. Today the Saskatchewan Ministry of Agriculture administers approximately 6.5 million acres of rangeland.

About five million acres of provincial Crown land are presently leased to livestock producers, 459,000 acres are leased to PFRA for community pasture purposes, and 660,000 acres are leased to grazing associations and cooperatives. Nearly 768,000 acres of grazing lands are managed directly by Lands Branch in the form of provincial community pastures.

Of the 60 Saskatchewan federally managed PFRA pastures, 46 are composed of open grasslands. Forty of the 56 provincially managed community pastures are aspen grove or bush pastures. In these provincial pastures, large areas have been seeded to tame grasses.

On all lands, from the brief era of the open range to present day, Saskatchewan's grazing history has seen periods of increased grazing pressure followed by years of reduced grazing pressure. At times, increasing livestock numbers have been possible because of pasture land expansion, or increased productivity through improved grazing management. Other periods of increased livestock numbers coincided with high beef/low grain prices.

Large herbivores played a key role in the ecological evolution of Saskatchewan's native grasslands. These native grasslands play an important role in our province's colourful history. Today, Saskatchewan is the second largest beef producing province in Canada, and is home to about 1.5 million beef cows, representing about 30 percent of the Canadian herd. Provincial rangelands are an important economic resource for livestock producers.

The information in this handbook provides the foundation for better awareness of the principles of sustained management of Saskatchewan's grassland and forested pasture resources.

References and Suggested Readings

Bryan, L. 1991. The Buffalo People – Prehistoric Archaeology on the Canadian Prairies. The University of Alberta Press. Edmonton, AB.

Graber, S. 1995. The Last Roundup – Memories of a Canadian Cowboy. Fifth House Publishers. Saskatoon, SK.

Hammermeister, A. M., D. Gauthier, and K. McGovern. 2001. Saskatchewan's Native Prairie: Statistics of a Vanishing Ecosystem and Dwindling Resource. Native Plant Society of Saskatchewan Inc. Saskatoon, SK.

McCartney, D.H. 1993. History of grazing research in Aspen Parkland. Canadian Journal of Animal Science 73:749-763.

PCAP Partnership. 2003. Saskatchewan Prairie Conservation Action Plan, 2003-2008. Canadian Plains Research Centre, University of Regina. Regina, SK.

Weekes, M. 1939. The Last Buffalo Hunter. Reprinted 1994. Fifth House Publishers. Saskatoon, SK.

Understanding Ecology

Introduction

When ecologically based, grazing on rangelands can be the most sustainable form of agriculture. Because range management is applied ecology, sustainable use of rangelands can only be achieved by applying principles of ecology. Range managers must understand the principles of ecology, the interaction of ecosystem components, and how management influences ecosystems. Solutions for range management issues or problems always involve applying principles of ecology.

Ecology and Ecosystems

Ecology is the study of the relationships between organisms and their environment. Organisms include all forms of life ranging from microbes in the soil to algae on the soil surface to plants that provide habitats for a variety of insects and animals. Organisms also include large herbivores such as wildlife and livestock which impact other animals, plants, and soils. The environment includes the soil and the atmosphere in which the organisms exist. Together the organization and interaction of organisms and their environment is an ecosystem.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Ecosystems are the organization and interaction of organisms and their environment

Producers, consumers, and decomposers are vital components of all ecosystems (Figure 1). Plants are the ultimate producers of wealth because they capture the radiant energy of the sun and convert this energy through photosynthesis into forms that can be used by consumer organisms. Consumers, such as livestock, eat this plant material and convert it to products that are in turn used by other consumers, including man. Decomposers, primarily bacteria and fungi, break down and rearrange the organic materials from plants and animals, making nutrients available for use again.

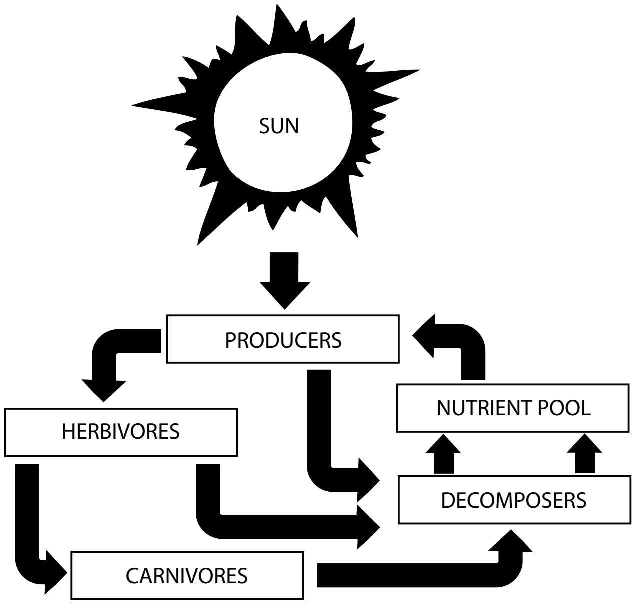


Figure 1: Simplified relationships between producers, consumers, and decompsers in an ecosystem

Interrupting or reducing efficiency in which producers capture energy reduces productivity and sustainability of all other components of the ecosystem. Plants must be allowed to capture and convert solar energy to useable energy forms at their maximum potential if the rangeland ecosystem is to function at its maximum. All components of the rangeland ecosystem function below their potential if production from plants is limiting.

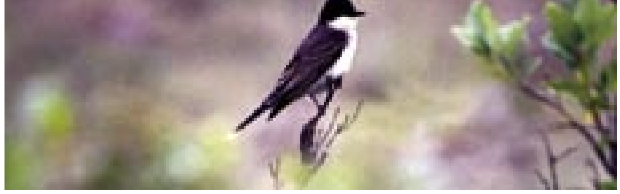


Photo Credit: Jim Romo

Eastern Kingbird

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Toad

The Range Ecosystem

In range management, the ecosystem is discussed in terms of the soil-plant-animal complex. The soil-plant-animal complex develops and functions within the limits that are imposed by the environment (Figure 2). Many processes operate within each component of the soil-plant-animal complex. The water cycle and nutrient cycle are always functioning as is photosynthesis, growth, reproduction, and death in plants. The model illustrates that soils, plants, and animals are interdependent upon one another. The welfare of animals depends on the productivity of plants, and the vigour of plants is related to the soils.

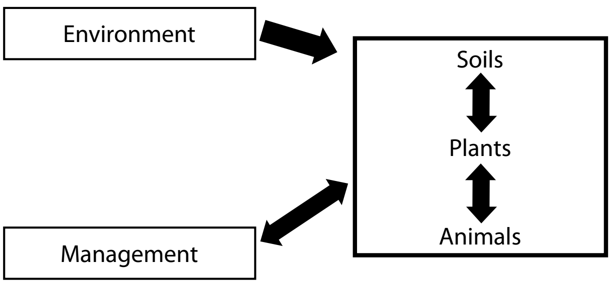


Figure 2: The Soil-Plant-Animal complex model

The soil-plant-animal complex also illustrates that interactions in rangeland ecosystems are complex and under the direct or indirect influences of management. Management decisions impact all components of the soil-plant-animal complex and these effects eventually impact management.

Evaluating the Management Focus

Range management is often centered on animal management, often to the detriment of plants and soils, and the rangeland ecosystem in general. Animal-centered management fails to recognize that healthy soils and plants are basic requirements for sustainable animal production. Animal-centered management can also fail to consider other aspects of the ecosystem that are important to humans such as water, wildlife and aesthetics. Soil, plants, and animals are not isolated from one another but rather they interact to form rangeland ecosystems.

The challenge to range managers is to develop management plans that minimize or eliminate potentially negative effects of livestock on all components of the soil-plant-animal system. Management plans must consider environmental limitations and plans must be directed toward the plants in ecosystems. When an animal-centered approach is applied in management, rangeland ecosystems function below their potential and maximum performance and stability in livestock performance cannot be realized. Eventually the inefficiencies in the rangeland ecosystem will ripple back through the soil-plant-animal system and impact the manager and the bottom line.

Applying Ecological Principles in Planning and Management

Range management that is based on ecological principles requires an inventory of all resources. Management goals can be established and sustainable management carried out with knowledge of the resources in the soil-plant-animal complex. A management strategy can then be developed to achieve desired changes in the soil-plant-animal complex. Management goals should be oriented toward maximizing and sustaining ecosystem health over the entire range. This management approach will also provide a buffer for all components of the rangeland ecosystem against environmental variations such as extremes in weather and insect outbreaks.

Cause-Effect Relationships

All management activities cause changes in the soil-plant-animal complex. Understanding cause-effect relationships on rangeland is essential if successful management strategies are to be implemented.

Weed infestations are often diagnosed as the cause of reduced plant and animal production on poor condition rangeland. Invariably the cause of reduced productivity in forages is not weeds. Undesirable plants are often symptoms of improper grazing management that has weakened the desired forage species and given weeds the opportunity to thrive. Long-term progress toward restoring or maintaining productivity is made only when management focuses on growth requirements of desired forages.

Grazing can either promote the health or condition of rangeland ecosystems or it can deplete resources.

For example, grazing can be used to maintain or promote development of a high producing Mixed Grass Prairie in Saskatchewan or grazing can cause deterioration and development of a weedy, low producing and frequently drought stricken range.

Photo Credit: Jim Romo

Improper grazing management can cause deterioration of range

Photo Credit: Jim Romo

Vigorous and high producing Mixed Grass Prairie

Grazing can cause indirect consequences in rangeland ecosystems. Removing plant litter or dead plant material by severely grazing Mixed Grass Prairie reduces productivity because of modifications to the environment in which plants must grow. This change in production reflects the complex responses of rangeland ecosystems to changes in the environment.

Improper grazing management is often the cause of problems in rangeland ecosystems, yet proper grazing management is also one of the most economical and ecologically sound techniques to permanently remedy problems.

Successional Considerations

Whether management actions give the desired results or not depends on the state of the rangeland ecosystem, the understanding of the soil-plant-animal complex, and the way in which ecological principles are applied. The following factors must be considered when developing a management plan to promote healthier rangeland.

Rangelands are composed of many ecosites or ecological sites. Ecosites are characterized by soil, landform, and climate. Different ecosites are capable of supporting a particular plant community and each ecosite has unique management needs because they do not respond identically to management. Range ecosites are fundamental units for inventory, planning, managing, and monitoring on rangelands.

Every ecosite has a carrying capacity or a maximum level of use that is possible and allows sustained production or improvement in vegetation and soils. Carrying capacity is based on the proper level of grazing and the ability of the ecosite to tolerate that use. Plant community response to management is not the same on an ecosite with loamy soils in the Black versus Brown soils. Likewise, the plants on a particular ecosite respond differently to cattle or sheep grazing. Rangeland ecosystems are composed of many ecosites and each needs specific management plans.

Ecological Principles at the Manager's Disposal

From a management perspective, disturbance is the most important ecological principle to understand because managers can apply this principle to direct plant community development. Disturbance of plant communities may occur in different forms and includes grazing, use of fertilizers or herbicides, mechanical treatments, prescribed burning or the combination of these disturbances. Past disturbance determines the present health, condition and composition of rangeland ecosystems, and present disturbance shapes the future composition and productivity of the range.

Photo Credit: Jim Romo

Range management involves applying disturbance or management activities to achieve a predetermined goal

Management impacts on the rangeland ecosystem are expressed immediately and for as long as it takes ecosystems to recover. Rangeland ecosystems that are heavily impacted by disturbance require more time to return to a situation similar to that occurring before it was damaged. The time needed for recovery is strongly influenced by environmental conditions and conditions on the surrounding area. The return to potential productivity will generally be more rapid in years of favourable environmental conditions than in years of less than optimal conditions.

Range management involves applying disturbance or management activities to achieve a predetermined goal. Managers can control when the disturbance is applied, how often it is applied, how long it is applied, and to what degree it is applied. These factors must be tailored to suit each rangeland ecosystem, the present state of that ecosystem, and management objectives. All range management plans must be customized for the resources, local conditions, and the desired goals of the manager. Managers can vary disturbance to either encourage or hinder the competitive ability, reproduction or demise of a particular species or group of plants.

Rangeland ecosystems tend to respond to disturbance in ways that minimize the effects of disturbance. This ecosystem buffering allows range to adjust and support a variety of plants that are best adapted to thrive under the particular combinations of time, frequency, intensity, and duration of disturbance. To illustrate, overgrazing leads to plant communities that are composed of low producing plants that avoid or tolerate grazing pressure. Another better-adapted group of plants will develop if grazing pressure is further increased or if grazing pressure is relieved.

The time that disturbance is applied to rangeland ecosystems is a major consideration in management. Soils and plants are more vulnerable to disturbances at certain times of the year than at other times. Clay soils are prone to compaction by grazing animals when they are wet, but they are less susceptible to compaction when dry. Similarly, plant species vary in their sensitivity to a disturbance, such as grazing, burning or herbicides. Stage of growth also influences plant sensitivity to these disturbances.

Photo Credit: Jim Romo

Controlling disturbance is an important management tool

The frequency, or how often a rangeland ecosystem is disturbed, is also important. Some rangeland ecosystems require disturbance to be maintained. For example, plant succession naturally proceeds toward forest in the Aspen Parkland region. Fires, herbicides, mechanical means, or grazing are required for maintaining grassland in the forest-like environment of the Aspen Parkland. However, burning or grazing too frequently will convert Fescue Prairie to an ecosystem that resembles the drier Mixed Grass Prairie.

The duration of ecosystem disturbance can also induce major changes. For example, recovery of plants will be longer for grazed plants that have endured 90 days versus 10 consecutive days with reduced leaf area. Longer duration of disturbance can always be expected to produce greater changes than a disturbance of shorter duration. This concept is one of the most important grazing management considerations.

The intensity or severity of disturbance required to change plant communities varies with the state of the plant community. Suppose, for example, that a rangeland ecosystem is in poor range condition and stocking rates are based on the maximum or potential forage production. Furthermore, assume the management goal is to achieve excellent range condition. A positive change in range condition will probably require major adjustments in management, stocking rates, and periods of rest because production is much less than the potential. By comparison, major changes in management would not be required if this same range was in good condition.

Summary

Range management can either be proactive or reactive. One of the challenges of range management is to promote positive reactions in rangeland ecosystems. Developing and implementing range management plans that are based on ecological principles improves the efficiency of the processes and increases the likelihood of favorable outcomes in the soil-plant-animal complex.

Functioning of the soil-plant-animal complex in rangeland ecosystems is orderly. Soils and plants are required to support livestock. Attempts to maximize livestock production without concern for the welfare of soil and plants are not effective or sustainable. Range management must be geared toward maximizing the health of rangeland ecosystems. Animal products are most likely to be maximized and sustained in rangeland ecosystems that are properly managed and healthy. Rangeland ecosystems can provide resources indefinitely when management is based on ecological principles.

Biodiversity and Wildlife

Saskatchewan's northern latitude, lack of ocean coastlines, and low annual precipitation limit its biodiversity relative to other areas of the world, however it is particularly vulnerable to species loss. Loss of species in an already limited system can greatly increase the vulnerability of remaining species.

Before settlement, rangeland biodiversity was a result of natural disturbances. Prairie fires started from thunderstorms and deliberate burning by Aboriginals along with grazing, rain, snow, and hail created a disturbance regime that allowed rangeland ecosystems to withstand and thrive under regular disturbance. Across the Saskatchewan landscapes, various plant communities and associated wildlife populations were limited and enhanced by natural disturbances. Biological diversity was a result of natural processes.

Photo Credit: Jim Romo

Before settlement, fire was a natural disturbance

Today the impact of prairie fires on the landscape is difficult to replicate on the fragmented landscape of Saskatchewan. Grazing as a disturbance can be scaled to the pastures and paddocks of today's farms and ranches.

As settlement has changed the potential for natural disturbances, rangeland biodiversity has responded accordingly. Increased woody cover across Saskatchewan rangelands is often attributed to lack of fire. Livestock grazing, cultivation, subdivision development, invasive species, oil and gas for housing, and mining all impact rangeland diversity.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Western Meadowlark

Since the late 1800s nearly 99 percent of the wild mammal biomass of the prairie and parkland biome has been eliminated. Up to 75 percent of prairie rangeland has been altered to suit anthropocentric needs: agricultural and urban centres.

Rangeland managers are improving their understanding of rangeland diversity. Management plans often consider maintenance and function of diverse plant species and the corresponding wildlife habitat while continuing to use rangelands for economic purposes.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Long-billed Curlew

Figure 3 illustrates differences in preferred habitat types by some Saskatchewan bird species. A diverse rangeland will support several bird species that have varying habitat requirements. The existence of these differences does not necessarily restrict the use of rangelands, but can be used to better understand the desired use and its impact across the diverse rangeland landscapes.

Grazing and Wildlife Diversity

Livestock grazing can be managed to produce varying levels of utilization. Large, extensively grazed pastures create patchiness. The diversity in grazing use across the pasture favours diversity in vegetation communities. A diverse pasture will support an increasing diversity of life across the landscape.

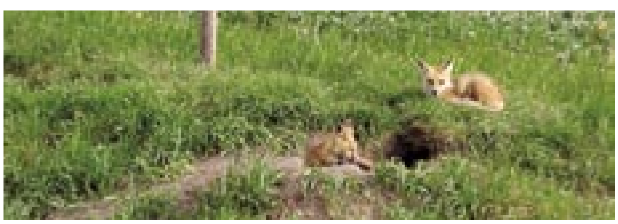
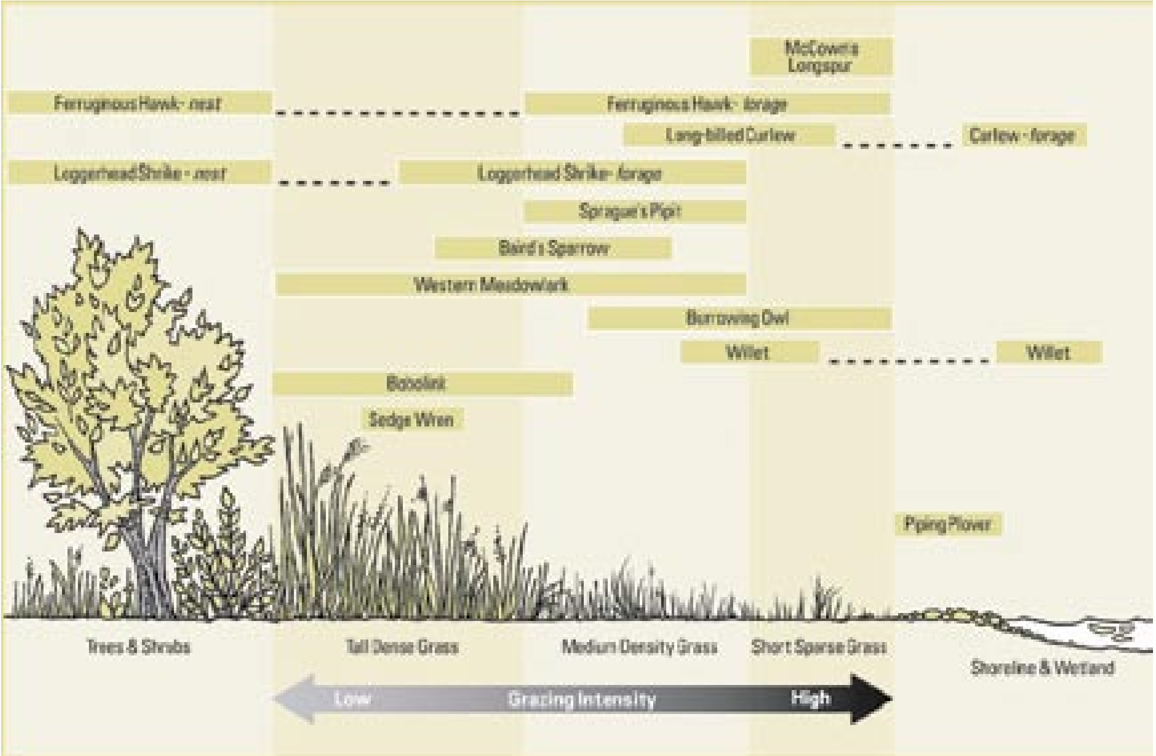


Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Red Fox



Source: Saskatchewan Watershed Authority, 2002.

Figure 3. Habitat associations of selected grasslands

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Mule Deer

Short vegetation provides birds and mammals with a clear view of prey and predators. Many rodents such as ground squirrels and pocket gophers, thrive in overgrazed sites. Ground squirrel and pocket gopher burrowing provide important contributions to the landscape by turning over soil, providing locations for establishment of new plants, and acting as a prey base for raptors and mammalian carnivores.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

White-tail Deer fawn

Photo Credit: Jim Romo

Sharp-tailed Grouse, Sharp-Tailed Grouse lek or dancing ground

Moderate grazing in brushy areas provides preferred habitat for game species such as deer and grouse. The woodland edges of the Aspen Parkland provide opportunities to view mule deer bounding, or white-tailed deer feeding on plants that other deer species do not prefer. Brush and taller vegetation provide ideal camouflage for new fawns. Fallen trees in the Parkland provide a stage for a ruffed grouse drumming display.

Rangelands that are lightly grazed are appealing to the sharp-tailed grouse, Saskatchewan's provincial bird. Males of this species perform courtship displays on leks in both grassland and parkland settings. The sharp-tailed grouse population continues to decline because of native grassland fragmentation.

Photo Credit: Jim Romo

American Avocet

Saskatchewan's 38 species of waterfowl need riparian areas. Dabbling ducks, those that sit on the surface and tip over to eat underwater, are often seen in potholes or sloughs. Waterfowl are not the only species that depend on riparian areas in native rangeland. The bird and mammal species at risk in Saskatchewan spend at least part of their life in this green zone.

Photo Credit: Jim Romo

Riparian areas provide important habitat for many bird and mammal species

Diversity at Risk

Saskatchewan's Wildlife Act listed 15 plants and animals as "at risk" in 1999. This designation provides protection for plants and animals from being disturbed, collected, harvested, captured, killed, and exported. Preparation and review of status reports is now in progress for an additional 35 species. Saskatchewan species are at risk for a variety of reasons. The most common factor is habitat loss and fragmentation.

Although human impact on the landscape through habitat loss and fragmentation is an enormous contributing factor to the decline of species at risk in Canada, Canadians as a whole appreciate wildlife. In the last survey on "The Importance of Nature to Canadians" by Statistics Canada (1996), 70 percent of the population participated in wildlife-related activities around their residence. These activities included feeding, watching, studying, or photographing wildlife. Some 6.6 million people put out special feed for wildlife. While some put out feed for wildlife, others seek wildlife for food. Although the number of hunters continues to decline, 1.5 million Canadians reported themselves as hunters and 5.5 million Canadians participated in recreational fishing. The hunters' and anglers' knowledge of the landscape is superb and the funding they provide is essential for habitat conservation.

Humans entering our remaining wild spaces compete for space with the wild occupants of that land. Most rural residents enjoy living close to wildlife and the green spaces that support them. Many invest time and money to enhance wildlife habitat on their land, from a bird feeder in the yard to wetlands and trees in fields. However, wildlife and agricultural activities don't always mix. Producers can lessen the susceptibility of their farms to wildlife damage through a variety of beneficial farm management practices.

Wildlife play a key role in agricultural processes such as pollination, germination, seed dispersal, soil generation, nutrient cycling, predation, habitat maintenance, waste breakdown, and pest control. For example, birds can be important in controlling insects such as grasshoppers. Grasshoppers, like burrowing rodents, provide an important role in the rangeland ecosystem; they are an excellent food source for birds and mammals.

Rangeland diversity is an indicator of successful landscape management. Conservation efforts for this disappearing landscape exist on community pastures, parks, and private lands.

References

Prairie Council of Agriculture Development and Diversification (ADD) Boards. 2007. Environmental Farm Plan. http://www.saskpcab.com/efp

Saskatchewan Watershed Authority. 2002. A Land Manager's Guide to Grassland Birds of Saskatchewan. Regina, SK. 56p.

Statistics Canada. 1996. http://www.statcan.ca

Natural Vegetation Zones

Ecoregion Classification

The first step in range ecosite classification is to divide the province into ecological regions or ecoregions. Ecoregions are broad classes that are determined mainly by climate. The composition and productivity of rangeland will be different in a moist climate compared to a dry climate, even if the soil type is the same. Classification of range ecosites must be nested within the broader ecoregions.

The original range site classification by Abouguendia (1990) used the Brown, Dark Brown, and Black soil zones as regions. In the driest of these, the Brown soil zone, a "Dry Brown" subzone was separated by the level of annual precipitation. Since Abouguendia's guide was published, Padbury and Acton (1994) developed a standard ecoregion classification for the province, integrated with Canada's national ecological land classification.

These ecoregions are closely related to the soil zones:

- **Aspen Parkland (Fescue Prairie)** – similar to Black soil zone
- **Moist Mixed Grassland** – similar to Dark Brown soil zone
- **Mixed Grassland (Mixed Grass Prairie)** – similar to Brown soil zone
- **Cypress Upland** – local area with strong elevation changes, rising from Brown to Dark Brown to Black soils

Both soil zones and ecoregions reflect patterns of climate across the province. Annual precipitation tends to be lowest in Mixed Grassland and increases through Moist Mixed Grassland to Aspen Parkland (Figure 4).

Photo Credit: Jim Romo

Mixed Grass Prairie

Growing degree days[1] generally decrease from south to north, but are also lower at higher elevations (Figure 4). In the Cypress Hills, precipitation increases and growing degree days decrease with rising elevation (Figures 4 and 5).

Photo Credit: Jim Romo

Fescue Prairie

The moisture available for plant growth depends partly on inputs from precipitation, but is also affected by losses to evaporation. A moisture index that takes both precipitation and evaporation into account usually shows a closer relationship to resultant vegetation patterns than precipitation alone.

Photo Credit: Jim Romo

Cypress Hills

[1] Growing degree days express the amount of heat available during the growing season. They are calculated by summing the amount by which daily mean temperatures exceed a base of 5°C.

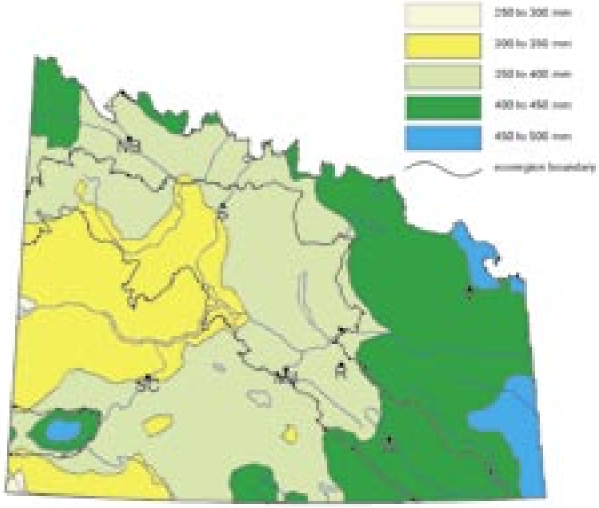


Figure 4: Annual precipitation (1961-90 normals) in southern Saskatchewan. Ecoregion boundaries are shown for comparison

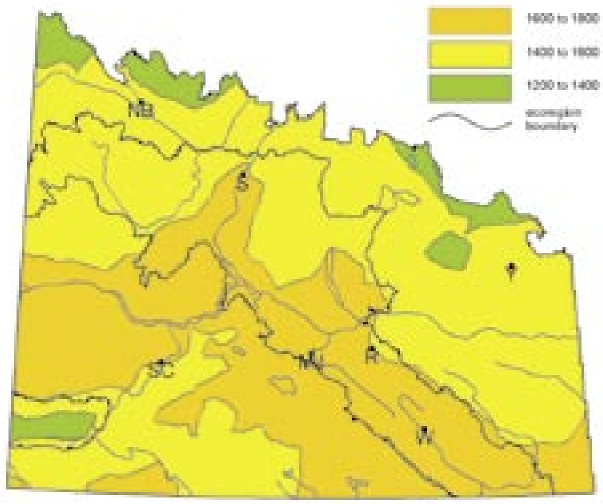


Figure 5: Growing degree days (1961-90 normals) in southern Saskatchewan. Ecoregion boundaries are shown for comparison

Photo Credit: Jim Romo

Forest

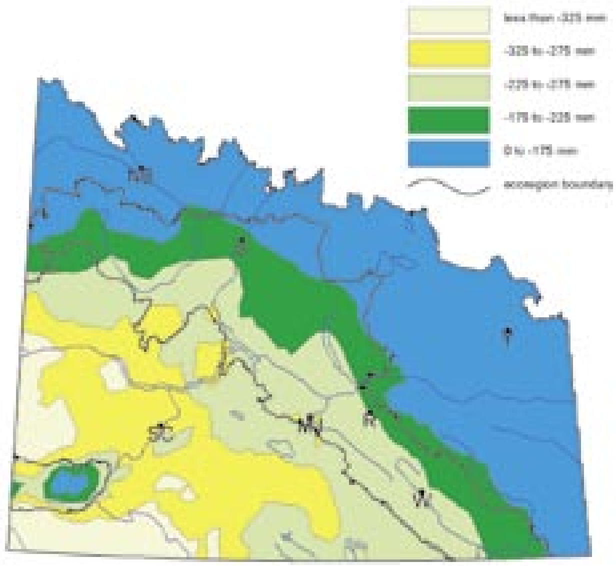


Figure 6: Climate moisture index (1961-90 normals) in southern Saskatchewan. Ecoregion boundaries are shown for comparison

Hogg calculated a "climate moisture index" as annual precipitation minus annual potential evapotranspiration[2]. Positive numbers indicate an excess of precipitation over evaporation, as occurs in moist forest climates. Negative numbers indicate drier climates, in which there is less moisture from precipitation than could potentially be evaporated. Moisture index values tend to be less than -250 mm in the Mixed Grassland, -250 to -175 in the Moist Mixed Grassland, and -175 to 0 mm in the Aspen Parkland (Figure 6). The Cypress Hills again shows the rise in moisture index with elevation.

Within the Prairie Ecozone of Saskatchewan (total land area of 240,966 km^2), recent statistics indicate that 21 percent remains as native dominant grassland (Hammermeister, 2001). The ecoregions within the ecozone differ in the percentage of remaining native dominant grasslands with Apen Parkland at 13 percent, Moist Mixed Grassland with 16 percent, Mixed Grassland with 31 percent and the Cypress Upland estimated at 71 percent native grassland. Within each of these ecoregions, the vast majority of the remaining land area has been converted to cropland and seeded pasture. Saskatchewan's native prairie is a vanishing ecosystem and a dwindling resource.

Ecosite Classification

The ecoregions indicated in Figure 7 are divided mainly according to broad patterns of climate. The general ecological differences among regions are

[2] Potential evapotranspiration is the amount of evaporation that would occur if there were no shortage of soil moisture. In the method used by Hogg (1994), potential evapotranspiration is estimated from monthly temperature and solar radiation.

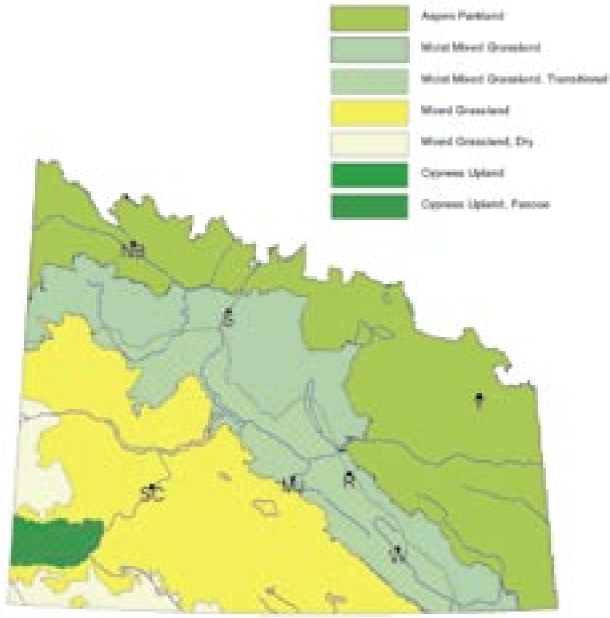


Figure 7: Modified ecoregion map used for classification of Saskatchewan range ecosites

summarized in Table 1. Within these ecological regions, rangeland is divided into ecological sites or ecosites, which are defined by more local factors. The Society for Range Management defines an ecological site, or ecosite, as: "A kind of land with a specific potential natural community and specific physical site characteristics, differing from other kinds of land in its ability to produce vegetation and to respond to management."

Within a local area such as a ranch or a community pasture, it can be assumed that the climate is more or less uniform. Therefore, the main way that rangelands are split up is by ecosites. Differences in physical site factors, such as landform, soil parent material, and soil profile development create different environments for plant growth. For example, part of a pasture may be mostly made up of rolling hills with well-drained, loam-textured soils. The potential plant community[3] on this land is grassland dominated by western porcupine grass and northern wheatgrass. However, depressions between the loamy hills may have moist to wet soils that support sedge meadows. Another part of the pasture may be a sand plain with lower water-holding capacity, on which the potential community is dominated by needle-and-thread and sand reed grass. The loamy upland, the wet meadows, and the sand plain are different ecosites: they have different physical site factors, and they support different potential plant communities.

Table 1. General differences among the ecoregions used in the classification of Saskatchewan range ecosites

Ecoregion	**Dry Mixed Grassland**	**Mixed Grassland** (also applies to drier parts of Moist Mixed Grassland, and lower elevations in Cypress Upland)	**Aspen Parkland** (also applies to moister parts of Moist Mixed Grassland)	**Cypress Upland** (higher elevations)
Moisture index	less than -325 mm	-325 to -225 mm	-225 to 0 mm	-225 to 0 mm
Zonal soils	Brown Chernozems	Brown and some Dark Brown Chernozems	Dark Brown and Black Chernozems	Dark Brown and Black Chernozems
Reference community on Loam Ecosite	northern wheatgrass needle-and-thread	western porcupine grass northern wheatgrass	plains rough fescue northern wheatgrass	plains rough fescue
Potential production on Loam Ecosite	500 to 1000 kg/ha	1000 to 1500 kg/ha	1500 to 2500 kg/ha	1500 to 2500 kg/ha

[3] The potential plant community is defined by The Society for Range Management (1989) as: "The biotic community that would become established on an ecological site if all successional sequences were completed without interferences by man under the present environmental conditions." This is usually interpreted to be the community that develops under ungrazed to lightly grazed conditions.

Photo Credit: Jim Romo

Physical site factors create different environments for plant growth

Abouguendia (1990) presented the classification of range sites that has been used in recent decades. The classification of range ecosites used in more recent publications, is based on Abouguendia's classification, with some modifications (Thorpe, 2007).

Climate and Vegetation

Two main climatic types are present in southern Saskatchewan. A cold semi-desert climate dominates the southwestern region. Semi-arid conditions prevail because potential evaporation is greater than the precipitation received. Grassland vegetation and soils are associated with this climate.

The grassland area is divided into two types or associations: Mixed Grass Prairie and Fescue Prairie. Aspen groves occur in Fescue Prairie and in eastern portions of Mixed Grass Prairie. A cold forest climate occurs north of the cold semi-desert climate zone. Subhumid conditions in this and other areas, such as the Cypress Hills, allow the growth of aspen groves and forest vegetation. Forest vegetation is comprised primarily of trembling aspen, jack pine and white spruce. Forest types include Aspen Grove, Cypress Hills Forest, Moose Mountain Forest and Mixedwood Forest.

Photo Credit: Jim Romo

Coulee

Complexes exist in localized areas where environmental conditions cause significant differences in vegetative cover. Sandhill, wetland, valley and saline complexes are the most common. Vegetation also varies with site drainage characteristics.

Mixed Grass Prairie

The Mixed Grass Prairie covers a large area of the north central region of North America. In Saskatchewan, Mixed Grass Prairie occupies a large area of the southwestern part of the province, bordering with the Fescue Prairie to the north and east. In southeast Saskatchewan, elements of Mixed Grass, Tall Grass and Fescue Prairies combine along transition zones occurring between grassland associations.

The Mixed Grass Prairie present in Saskatchewan has five community types.

Blue Grama/Wheatgrass

This community is common in the southwestern corner of the province on solonetzic soils. These soils are comprised of thin glacial deposits ranging from light loam to clay loam texture that are relatively impermeable. This characteristic, as well as the proximity of the area to the drier part of the Brown soil zone, causes solonetzic soils to be drought prone. Blue grama is the dominant grass over most of the area. The co-dominant, western wheatgrass, is most prevalent in eroded depressions called "burnouts" or "blowouts". Each of these species contributes equal amounts to forage yields. However, blue grama occupies about three to four times the ground area of western wheatgrass.

The proportion of blue grama to western wheatgrass remains relatively stable with abundant moisture and moderate grazing pressure. Periods of drought and/or heavy grazing result in a blue grama increase and a decrease in wheatgrass. This composition change dramatically affects landscape appearance, with the community taking on a shortgrass look. However, the shortgrass vegetation type only occurs in Saskatchewan as a disclimax caused by poor grazing management.

Some other principle grasses and sedges present are needle-and-thread, June grass, Sandberg's bluegrass, plains reed grass, thread-leaved sedge, and low sedge. Loamy sites tend to favour needle-and-thread while eroded sites favour thread-leaved sedge. Dense clubmoss may occupy up to 30 percent of the ground cover in well managed areas.

Forbs and shrubs represent a small part of the total vegetation, with pasture sage the most abundant forb. Prickly-pear cactus and moss phlox are two of the more common forbs. The most prevalent shrub is silver sagebrush. Winterfat and Nuttall's saltbush, two valuable shrubs, also occur in the area. These plants can provide late grazing, but require careful management to maintain productivity.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Prickly-pear cactus is common on sandy sites in the blue grama/wheatgrass community

Needlegrass (Needle-And-Thread)/Blue Grama

This community occurs in the drier part of the Brown soil zone. Medium-textured soils, developed from glacial deposits, and coarse-textured soils, developed from glacial and alluvial deposits, characterize this type. The dry climate and drought susceptible soils inhibit midgrass growth.

Blue grama is the dominant grass, occupying about three times as much area as needle-and-thread. However, due to the taller growth form of needle-and-thread, it contributes almost as much to total forage yields as blue grama. Together these two grasses represent about 70 percent of the plant cover.

Other principle grasses and sedges in order of importance are low sedge, June grass, northern wheatgrass, western wheatgrass, thread-leaved sedge and western porcupine grass. The secondary grasses and sedges are Sandberg's bluegrass, plains reed grass, plains muhly and sun-loving sedge. Sand grass and sand dropseed are abundant in localized areas with coarse soil. Dense clubmoss is not as abundant as in the blue grama/wheatgrass type, covering less than 10 percent of the ground surface.

Forbs and shrubs furnish approximately 15 percent of the community's composition. Pasture sage, the principle forb, contributes about 75 percent of this amount. Moss phlox is the second most abundant forb. Shrubs are more common in this type than the blue grama/wheatgrass community. The most common shrub is silver sagebrush, accounting for 90 percent of this component.

Overgrazing reduces midgrasses and increases low-growing grasses and sedges. Productivity declines as the midgrasses disappear, followed by increases of weed species. This community, like the blue grama/wheatgrass type, is often incorrectly referred to as a Shortgrass Prairie when overgrazed.

Response to Grazing

Decreasers	Increasers	Invaders
needle-and-thread	blue grama	Russian thistle
wheatgrasses	Sandberg's bluegrass	
June grass	plains reed grass	
western porcupine grass	plains muhly	
sand dropseed	pasture sage	
sand grass	moss phlox	
thread-leaved sedge	dense clubmoss	
winterfat	scarlet mallow	
Nuttall's saltbush	broomweed	
	silver sagebrush	
	rose, cactus	

Needlegrass/Blue Grama/Wheatgrass

This community occurs in the Brown soil zone and the drier parts of the Dark Brown soil zone. Associated soils are generally of medium texture, loam to sandy loam, and developed from undifferentiated glacial till. This type is also found on soils developed from glacial outwash with undulating topography.

Two needlegrasses, needle-and-thread and western porcupine grass, dominate this community. Needle-and-thread dominates on drier sites, while porcupine grass is prevalent on moister sites. The co-dominant grasses, blue grama and wheatgrasses, also share an inverse relationship with available moisture. Soils that retain moisture will support western porcupine grass and wheatgrasses, while drier soils support needle-and-thread and blue grama. In hilly topography, knolls and upper slopes are dominated by blue grama and needle-and-thread. Mid-slopes support needle-and-thread, blue grama, and wheatgrasses. Western porcupine grass and wheatgrasses occupy lower slopes.

Annual precipitation variations can dramatically change this community's appearance, with periods of drought causing a shift in species composition.

Photo Credit: Jim Romo

Mixed Grass Prairie, Matador Pasture

Favourable moisture conditions enable midgrasses to flourish, almost entirely masking the forbs. Forbs become very noticeable as the midgrass culms shorten or disappear.

Needlegrass, the dominant producer, produces from 35 to 40 percent of forage yields. Together, needlegrass and the co-dominant grasses and low sedge represent more than 50 percent of the community's composition. Several other grass species are present in this community.

Northern wheatgrass and June grass are found on moister sites with heavier soils. Coarse-textured soils in the area's drier part favour Sandberg's bluegrass and plains reed grass. Plains muhly and thread-leaved sedge are common where erosion has removed part of the topsoil layer. Species associated with more moist, sheltered sites (northern slopes) include rough fescue, Hooker's oatgrass and green needlegrass.

Dense clubmoss occupies between five and 10 percent of the soil surface. Pasture sage and moss phlox make up the bulk of the forbs. Some of the more common forbs include scarlet mallow, crocus, goldenrod, broomweed, spiny ironplant, silverleaf psoralea and skeletonweed. Shrubs grow in localized areas where moisture is available. Western snowberry, rose and wolfwillow are most common, while silver sagebrush occurs in drier areas.

Response to Grazing

Decreasers	Increasers	Invaders
rough fescue	blue grama	Russian thistle
western porcupine grass	Sandberg's bluegrass	dandelion
western wheatgrass	June grass	Kentucky bluegrass
green needlegrass	plains reed grass	
northern wheatgrass	plains muhly	
needle-and-thread	sedges	
	pasture sage	
	moss phlox	
	dense clubmoss	
	scarlet mallow	
	crocus	
	broomweed	

Wheatgrass/June Grass

This community is located in the moister part of the Brown soil zone, as well as the drier part of the Dark Brown zone. Associated soils are typically uniform lacustrine clays, deposited in glacial lakes. Due to its high value for annual crops, most of this type has been destroyed through cultivation.

Soil uniformity combined with a relatively low species diversity gives this grassland a very even appearance. The dominant grasses cover nearly 75 percent of the area. The wheatgrass component alone furnishes almost half the cover, of which over 80 percent is northern wheatgrass.

All species present are midgrasses, with northern wheatgrass the most abundant. June grass occurs more frequently in this type than elsewhere, contributing nearly 25 percent of the cover. Western wheatgrass supplies only five to seven percent to the community's composition. Green needlegrass, the only other major important grass, represents about 10 percent of the plant cover. Thread-leaved sedge is the only component of the grassland's lower layer, providing between 10 and 15 percent of the cover. Sandberg's bluegrass, early bluegrass, and plains muhly occur as secondary grasses.

Forbs are less frequent than in any other Mixed Grass Prairie types. Pasture sage and moss phlox represent approximately 75 percent of the forb component. Other forbs include aster and yarrow. Dense clubmoss is not present in any appreciable amount. As in most fine-textured soils, the shrub, winterfat, is present.

Overgrazing of these areas results in decreased amounts of winterfat and an increase of species usually associated with loamy soils. Severe overgrazing eventually leads to a dramatic increase in prickly-pear cactus.

Response to Grazing

Decreasers	Increasers	Invaders
northern wheatgrass	blue grama	Russian thistle
western wheatgrass	June grass	smooth bromegrass
green needlegrass	Sandberg's bluegrass	
western porcupine grass	early bluegrass	
	plains muhly	
	thread-leaved sedge	
	pasture sage	
winterfat	moss phlox	
	aster	
	yarrow	
	everlasting	
	prickly-pear cactus	
	rose	
	silver sagebrush	

Needlegrass/Wheatgrass (Western Porcupine grass/Northern Wheatgrass)

Prior to settlement, this type was the largest grassland association of the Mixed Grass Prairie. It occurs on Brown, Dark Brown and Black soils, occupying loamy sites in the moister part of the Brown soil zone and extensive area of the Dark Brown soil zone, generally on medium-textured soils. In southeastern Saskatchewan, the community occurs on Black soils associated with aspen groves.

This type tends to be a transition zone between the Mixed Grass and Fescue Prairies. Midgrasses represent from 70 to 80 percent of yields. Western porcupine grass is the dominant species, while northern wheatgrass is the co-dominant. The primary grasses and sedges associated with these two species are needle-and-thread, green needlegrass, western wheatgrass, June grass and thread-leaved sedge. Rough fescue, awned wheatgrass, slender wheatgrass, early bluegrass and Canada bluegrass are some of the other grasses growing in the community. Little bluestem, a warm-season grass associated with the Tall Grass Prairie, is also present. Blue grama is found locally on exposed slopes and dry soils.

Pasture sage is the most abundant forb. Moss phlox and dense clubmoss are present on drier sites, but are absent from the more favourable areas. Shrubs are similar to those of the needlegrass/blue grama/wheatgrass type, except for the absence of silver sagebrush. Western snowberry, rose and wolfwillow are the most common.

Overgrazing of this grassland initially leads to a reduction in western porcupine grass and wheatgrass. Surviving midgrasses, such as needle-and-thread and June grass, remain small and unproductive. Kentucky bluegrass is a common invader of this type's moister areas. Easily recognizable overgrazing indicators are everlasting, yarrow, broomweed and crocus.

Response to Grazing

Decreasers	Increasers	Invaders
western porcupine grass	blue grama	Kentucky bluegrass
wheatgrass	June grass	
rough fescue	needle-and-thread	dandelion
green needlegrass	Sandberg's bluegrass	Canada thistle
	Canada bluegrass	Russian thistle
	plains muhly	smooth bromegrass
	little bluestem	leafy spurge
	pasture sage	
	moss phlox	
	dense clubmoss	
	everlasting	
	yarrow	
	western snowberry	
	rose	

Fescue Prairie

Fescue grassland occurs in the Black soil zone in western and central Saskatchewan, as well as in the benchlands and upper slopes of the Cypress Hills. The associated dark colour of soil is the result of an accumulation of organic matter from rough fescue.

The climate of this grassland has greater moisture effectiveness (higher precipitation, lower temperatures) than the adjacent Mixed Grass Prairie. Rough fescue can comprise up to 90 percent of the cover in some Cypress Hills locations and northern Parkland areas.

In the Cypress Hills, shrubby cinquefoil is the characteristic shrub. Awned wheatgrass, timber oatgrass, Hooker's oatgrass and western porcupine grass are common. Several low-growing sedges occur among these plants, including low, sun-loving and blunt sedge. Secondary grasses include June grass, western and northern bedstraw. Violet, crocus, pasture sage and goldenrod are among the more common herbs.

Photo Credit: Jim Romo

Needlegrass/wheatgrass range in excellent condition

Photo Credit: Jim Romo

Fescue Prairie, Cypress Hills

In the northern Parkland, snowberry and wolfwillow are the characteristic shrubs. Further south, the relative abundance of rough fescue decreases as western porcupine grass increases. The southern part of the region is a transition zone between the Fescue and Mixed Grass Prairies.

Besides rough fescue and western porcupine grass, this community's primary parkland grasses are awned and slender wheatgrass, Hooker's oatgrass, low and sun-loving sedge and June grass. Western and northern wheatgrass, plains reed grass, timber oatgrass, little bluestem and bluegrasses make up the secondary grasses. The most common herbs are similar to those of the Cypress Hills region. The shrubs rose, western snowberry and wolfwillow occur in localized areas.

Although very productive, rough fescue is very sensitive to overgrazing. Continued heavy use can almost eliminate it from the community, causing a noticeable increase in needlegrass, June grass, blue grama and pasture sage.

Response to Grazing

Decreasers	Increasers	Invaders
rough fescue	western porcupine grass	smooth bromegrass
awned wheatgrass	June grass	Kentucky bluegrass
slender wheatgrass	western wheatgrass	Timothy
green needlegrass	needle-and-thread	
Hooker's oatgrass	blue grama	Canada thistle
	pasture sage	dandelion
	yarrow	leafy spurge
	everlasting	

Complexes

Areas occur in most grassland associations where local soils, climate and moisture conditions vary drastically from the norm. The plant cover in these areas often varies more than in the surrounding plant community.

Called complexes, these areas contain plant species that have adapted to local conditions. There are four common complexes that may be present in the Mixed Grass and Fescue Prairies.

Sandhill Complexes

Aridity is the most important factor influencing this area's vegetation survival. Only well-adapted species are present. Five types of sandhill complexes occur: active complex, stabilized blowouts, stabilized dunes, dune depressions and sand flats.

Active complexes are exposed areas of presently shifting sand. The first plants to colonize these areas have extensive root systems. These "sand binders" thrive on being buried. Bare sand pioneer grasses include northern wheatgrass, Indian rice grass, sand grass, Canada wildrye and sand dropseed. Lance-leaved psoralea, sunflower, skeleton weed and veined dock act as forb pioneers. Wolfwillow and sandbar willow are characteristic shrubs.

Stabilized blowouts show signs of recent erosion. Most of the pioneer plants have been replaced by more permanent species like needle-and-thread, June grass, sun-loving sedge, goldenrod and pale comandra. Pioneer plants which typically survive to this succession stage are northern wheatgrass, sand grass and lance-leaved psoralea. Bearberry and creeping juniper are the typical shrubs.

Stabilized dunes show no evidence of recent erosion. Needle-and-thread is the dominant species. Associated grasses and forbs are the previously described "sand binders", and those appearing in the needlegrass/blue grama and needlegrass/blue grama/wheatgrass types.

Photo Credit: Jim Romo

Sandhill complexes consist of active and stabilized dunes

Dune depressions and sand flats occur between stabilized dunes. Generally the water table is shallow, resulting in abundant growth of shrubs and other woody species. Rose is the most frequently found plant, while wolfwillow, western snowberry and chokecherry are common. Silver sagebrush is the dominant shrub species in the Great Sand Hills. Trees such as willow, trembling aspen and birch exist in locations where moisture is sufficient. Jack pine and white spruce occur in more northern regions.

Saline Complexes

Particularly common in the Mixed Grass ecoregion, saline complexes are generally associated with flat, low-lying areas having poor internal drainage. They are also found along watercourses, sloughs and dry lakes. The soils involved are usually alluvial and lacustrine deposits.

The soluble salts concentration and flooding frequency determine the vegetation present. Hydrophytic plants occur on areas experiencing periodic flooding. Halophytic species grow in dry areas where water does not accumulate on the surface. Salinity is often less in the former because periodic flooding flushes salts away.

Photo Credit: Jim Romo

Saline complexes are common in Saskatchewan

Distinct vegetation zones are found in saline complexes. In saline sloughs, the deeper depressions that retain water most of the growing season are dominated by prairie bulrush, sedges and rushes. Highest salt concentration occurs in the adjacent area, which is often bare. Red samphire, sea-blite, saline goosefoot and sea-milkwort can all survive in this region. The surrounding area is dominated by desert salt grass, foxtail barley, Nuttall's salt-meadowgrass, slender wheatgrass, arrowgrass, alkali cord grass, canby bluegrass and perennial sowthistle. Also present in less-saline areas are tufted hair grass, western wheatgrass, mat muhly and northern reed grass.

The response of these species to grazing varies according to the available moisture. Nutall's salt-meadowgrass and slender and awned wheatgrass are decreasers at all sites. Western wheatgrass increases on sites with abundant moisture. Mat muhly, canby bluegrass and foxtail barley are increasers. Continuous heavy grazing leads to a community dominated by foxtail barley.

Wetland Complexes

Most of Saskatchewan's prairie region is dotted with numerous shallow depressions, or sloughs. Sloughs are recharged each spring from adjacent uplands and overflowing streams. Wetland drainage has a large effect on existing vegetation. Wetlands that do not overflow, or closed drainage basins, tend to accumulate salts and are associated with salt-tolerant vegetation. Overflowing depressions regularly support freshwater vegetation.

Both freshwater and saline wetlands display distinct vegetation zones as the moisture gradient changes. Cattail and bulrush are common deep marsh emergents in freshwater wetlands. Reed grass and bulrush are also common in the deep marsh zone. Shallow marsh regions are often inhabited by creeping spike-rush, awned sedge, whitetop, smartweed, water parsnip, reed grasses, and tall manna grass. Plants found in the outer margin of the wetlands or wet meadow are marsh reed grass, tufted hair grass, baltic rush, sweetgrass, cattail and canby bluegrass. These margins are often lined with a shrub fringe, usually willows in the moister areas and western snowberry in the drier regions.

Photo Credit: Jim Romo

Wetlands provide water, grazing and cover for livestock and wildlife

Changing water depth, grazing, mowing, and fire are among several factors that can alter vegetation. As the water depth changes so does the vegetation, resulting in some basins being entirely dominated by cattails, bulrushes, whitetop, smartweed or willows. Grazing and mowing encourage spike-rush and whitetop dominance. Burning weakens cattails and bulrushes and in drier years, allowing expansion of species like whitetop.

Saline wetlands are characterized by dense stands of coarse emergents like bulrush. The saline mud flats contain the greatest salt concentration, supporting only the most salt-tolerant vegetation such as sea-blight, saline goosefoot and sea-milkwort. The outer zone vegetation is the same as that in saline complexes.

Although wetlands can produce much forage, careful management is necessary to sustain yield. Because soils are often marginally saline, continuous and heavy grazing can change the community composition to domination by foxtail barley.

Valley Complexes

Glacial drainage channels eroded through the plain provide a range of habitats from badlands to flood plains. Valley vegetation varies with degree and aspect of slopes and available moisture. North-facing slopes provide more favourable growing conditions than the prairie above. Species not commonly found in the area can exist on these sheltered slopes. Western snowberry, wolfwillow, willow and aspen are common here. Southern exposures support drought-tolerant species. Valley bottoms are wetland, saline or flood plain complexes. The wetland and saline complexes are similar to those previously described.

Photo Credit: Jim Romo

Big Muddy valley

Flood plains occur in valleys with a permanent watercourse. Soils in these areas are constantly eroded and deposited. The local vegetation varies with flooding frequency.

These landforms are often seen as "oases" of native habitat diversity within the vegetation zones they are found. This diversity is reflected in the number of wildlife species that inhabit these areas. Many unique, and in some cases, rare birds, mammals, reptiles and game species are found.

Forested Rangelands

Aspen Parkland

The Aspen Parkland area is climatically and ecologically a transition zone between grasslands and Boreal Mixedwood Forest. The Aspen Parkland occurs primarily in the Black soil zone and in eastern Saskatchewan in a portion of the Dark Brown soil zone. It is characterized by Chernozmic soil; aspen groves are interspersed with open grassland and shrub communities. Prairie fire suppression since settlement has caused the southward expansion of these groves into the grasslands.

Trembling aspen dominates groves in moist, well-drained sites, in association with fescue grassland in the west and needlegrass/wheatgrass in the east. Balsam poplar occupies localized areas where moisture is plentiful. A shrub transition zone between the grove and grassland exists with western snowberry, wolfwillow, rose, raspberry and buffaloberry being the most common species.

Where trembling aspen dominates, common understorey shrubs include rose, Saskatoon, western snowberry, wolfwillow, chokecherry, twining honeysuckle and narrow-leaved meadowsweet. Common forbs include asters, bedstraw, bunchberry, sarsaparilla, American vetch, peavine, two-leaved Solomon's seal and star-flowered Solomon's seal. Dominant grasses include purple oatgrass, wheatgrasses, reed grass, Canada and hairy wildrye and fringed bromegrass.

Understorey shrubs associated with balsam poplar on wetter sites are red-osier dogwood, willow species and currant. Common forbs in these sites include horsetail, coltsfoot, bedstraw and bishop's-cap. The grass component consists mainly of reed grass, bluegrasses and wheatgrass.

Cypress Hills Forest

A lodgepole pine/rough fescue association, this forest occurs on Black and Dark Brown soils at elevations greater than 900 metres above sea level. Lodgepole pine and trembling aspen dominate well drained upland sites, while white spruce and balsam poplar are common in moist areas. The understorey of pine stands is sparse, with shiny-leaved meadowsweet and bearberry the most common species. A rich understorey is present where trembling aspen is more abundant. Rough fescue dominates well-drained level uplands, with oatgrasses and shrubby cinquefoil common.

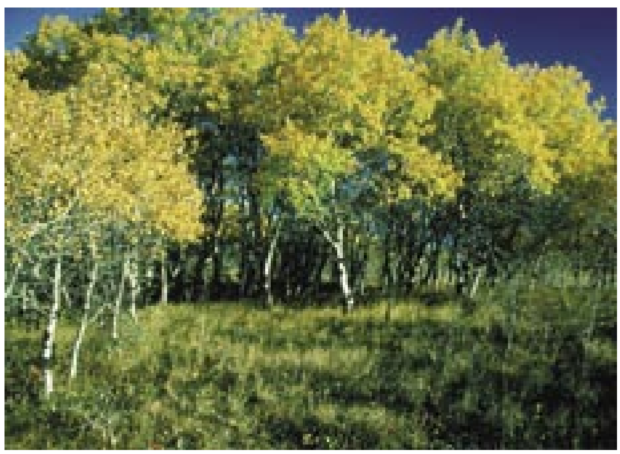


Photo Credit: Jim Romo

The Aspen Parkland is a broad transition zone, between the grasslands in southern Saskatchewan and northern Mixedwood Forest, which supports substantial cattle herds

Moose Mountain Forest

An aspen forest with interspersed wetlands and moist meadows, this area's soils are Black and Dark Gray, originating from glacial till. Trembling aspen dominates the area, with occurrences of birch, balsam poplar and green ash. Willows surround moist low areas. Common understorey species are fringed bromegrass, bluegrass, sarsaparilla, beaked hazelnut, rose, red-osier dogwood, Saskatoon, gooseberry, raspberry, wolfwillow, and western snowberry.

Slough complexes are dominated by sedges, bulrushes, cattails and reed grasses. Grass-covered upland areas are few, with the most common species present being western porcupine grass, wheatgrasses, rough fescue, and needle-and-thread.

Mixedwood Forest

The Boreal Mixedwood forest in Saskatchewan extends from the southeast to the northwest and is the transition area between the forests of the Boreal Upland to the north and the agriculturally developed Aspen Parkland to the south, varying in width from 30 to 130 km. It is dominated by trembling aspen stands on moderately moist, moderately well drained orthic and Dark Gray luvisolic soils, however, a large number of differing tree and understorey plant communities are found. These vegetation types and their associated understorey species are best described based on the site moisture regime. In general, the characteristic forest of well-drained uplands is a mixture of aspen, birch and white spruce. Balsam fir and balsam poplar occur locally on moist sites with balsam poplar found to be dominant on valley alluvium soils. Jackpine dominates on well-drained, sandy sites, but also occurs with aspen and birch on some of the drier till-derived soils. Poorly drained sites and peatlands support black spruce and tamarack.

Response to Grazing

Decreasers	Increasers	Invaders
fringed bromegrass	hairy wildrye	rough hair grass
reed grass	sheep fescue	Kentucky bluegrass
slender wheatgrass		smooth bromegrass
awned wheatgrass		
rice grass		
peavine	dewberry	silverweed
vetch	baneberry	Canada thistle
showy aster	sarsaparilla	sow-thistle
	bunchberry	dandelion
	pussytoe	absinth
	yarrow	
Saskatoon		bearberry
red-osier dogwood		alder
chokecherry		snowberry
hazelnut		twining honeysuckle

Detailed descriptions of Saskatchewan range plants, are available in a subsequent chapter of this publication or in field identification guides, as listed in the References section.

Photo Credit: Jim Romo

References

Abouguendia, Z. 1990. Range Plan Development - A Practical Guide to Planning for Management and Improvement of Saskatchewan Rangeland. New Pasture and Grazing Technologies Project. Regina, SK. 52p.

Banfield, A.W.F. 1974. The Mammals of Canada. University of Toronto Press. Toronto, ON.

Beckingham, J.D. 1991. Grazing in the Boreal Mixedwood Ecoregion of Alberta. Literature Review. Alberta Forestry, Lands and Wildlife. Edmonton, AB.

Budd, A.C., and K.F., Best. 1969. Wild Plants of the Canadian Prairies. Canada Department of Agriculture, Publ. No. 989. Ottawa, ON.

Corns, I.G.W., and R.M. Annas. 1986. Field Guide to Forest Ecosystems of West-Central Alberta. Canada Forest Service. Edmonton, AB.

Coupland, R.T. 1950. Ecology of Mixed Prairie in Canada. Ecological Monographs 20:271-315.

Coupland, R.T. 1961. A reconsideration of grassland classification in the Northern Great Plains of North America. Journal of Ecology 49:135-167.

Coupland, R.T., and T.C. Brayshaw. 1966. The Fescue grassland in Saskatchewan. Ecology 49: 958-968.

Ecological Stratification Working Group. 1996. A National Ecological Framework for Canada. Ecological Stratification Working Group. Agriculture and Agri-Food Canada and Environment Canada. Ottawa, ON.

Ehlert, G., and D. Downing. 1994. Managing Aspen Rangelands in Alberta's Boreal Mixedwood Ecoregion: The Northeast Region Benchmark Program Range Notes. Issue No. 17. Alberta Agriculture, Food and Rural Development. Edmonton, AB.

Godfrey, W.E. 1986. The Birds of Canada. National Museum of Canada. Ottawa, ON.

Hammermeister, A.M., D. Gauthier, and K. McGovern. 2001. Saskatchewan's Native Prairie: Statistics of a Vanishing Ecosystem and Dwindling Resource. Native Plant Society of Saskatchewan Inc. Saskatoon, SK.

Harris, W.C. 1980. Guide to Forest Understorey Vegetation in Saskatchewan. Tech. Bull. No. 9. Saskatchewan Department of Tourism and Renewable Resources, Forestry Branch. Regina, SK.

Hogg, E.H. 1994. Climate and the southern limit of the western Canadian Boreal forest. Canadian Journal of Forest Research 24:1835-1845.

Hulett, G.K., R.T. Coupland, and R.L. Dix. 1966. The vegetation of dune sand areas within the grassland region of Saskatchewan. Canadian Journal of Botany 44: 1307 - 1331.

Kabzems, A., A.L. Kosowan, and W.C. Harris. 1976. Mixedwood section in an ecological perspective. Tech. Bull. No. 8. Saskatchewan Tourism and Renewable Resources, Forestry Branch. Regina, SK.

Millar, J.B. 1976. A guide to marshes and shallow open water wetlands in the grasslands and parklands of the Prairie Provinces. Canadian Wildlife Service Report Series Number 37.

Padbury, G.A., and D.F. Acton. 1994. Ecoregions of Saskatchewan. Poster map at 1:2,000,000. Saskatchewan Property Management Corporation. Regina, SK.

Peterson, R.T. 1969. Field Guide to Western Birds. Houghton Mifflin Company. Boston, MA.

Richards, J.H., and K.I. Fung. 1969. Atlas of Saskatchewan. University of Saskatchewan. Saskatoon, SK.

Rose, J.S. 1959. Forest Regions of Canada. Canadian Forestry Branch. Bulletin No. 123. Department of the Environment. Ottawa, ON.

Saskatchewan Forage Council. 2007. Field Guide: Identification of Common Range Plants of Northern Saskatchewan, Compiled by Alicia N. Hargrave. 63p.

Saskatchewan Forage Council. 2007. Field Guide: Identification of Common Riparian Plants of Saskatchewan, Compiled by Alicia N. Hargrave. 59p.

Saskatchewan Forage Council. 2007. Field Guide: Identification of Common Range Plants of Southern Saskatchewan, Compiled by Alicia N. Hargrave. 59p.

Smoliak, S., M.R. Kilcher, R.W. Lodge, and A. Johnston. 1982. Management of Prairie Rangeland. Agriculture Canada. Ottawa, ON.

Smoliak, S., W.D. Willms, R.A. Wroe, B.W. Adams, and G. Ehlert. 1988. Range Pasture of Alberta Agriculture. Agdex 134/14-8. Edmonton, AB.

Society for Range Management. 1998. Glossary of Terms used in Range Management. Fourth Edition. Society for Range Management. Denver, CO.

Stewart, R.E., and H.A. Kantrud. 1972. Vegetation of prairie potholes, North Dakota, in relation to quality of water and other environmental factors. U.S. Geological Survey Professional Paper 585-D.

Thorpe, J. 2007. Saskatchewan Rangeland Ecosystems, Publication 1: Ecoregions and Ecosites. Saskatchewan Prairie Conservation Action Plan. Saskatchewan Research Council Pub. No. 11881-1E07. Saskatoon, SK.

Walker, B.H., and R.T. Coupland. 1968. An analysis of vegetation-environment relationships in Saskatchewan sloughs. Canadian Journal of Botany 46: 509-522.

Walker, B.H., and R.T. Coupland. 1970. Herbaceous wetland vegetation in the Aspen Grove and grassland regions of Saskatchewan. Canadian Journal of Botany 48:1861-1878.

Plant Characteristics and Processes

Identification

Plant identification on rangelands is one of the most important skills required to determine rangeland health, range condition, and to develop management plans. Learning to recognize range plants and the roles they play in a functioning ecosystem is a cornerstone of sustainable range management. More than 1,500 species of native plants have been identified in the prairie provinces. All of these native range plants fulfill a function in the ecosystem. Some of the benefits they provide are: food for herbivores, habitat for wildlife, stabilizing watersheds, protecting soil, operating as carbon sinks, providing recreational opportunities, and enhancing landscape beauty. About 150 species of the 1,500 found on the prairies are considered important livestock forage.

Photo Credit: Jim Romo

Lilies

Learning to identify range plants is essential to being able to to assess rangeland. Many books and field guides are available describing plants found in Saskatchewan. Line diagrams, descriptions and keys assist in identifying plants. Consulting one of the many agrologists and enthusiasts trained in plant identification is also a good way to identify plants.

Photo Credit: Saskatchewan Forage Council

Plant identification is an important skill in range assessment and management

Specimens can be compared to labelled collections. Gathering specimens for comparison with known samples provides not only plant names but a permanent collection that can be referred to year after year. Dried plant collections (herbaria) are located at the University of Saskatchewan and the University of Regina.

Several plant keys are available to help identify plants using characteristics of the leaves, stems, parts of the flowers, and seed heads. The use of a plant key is discussed later, while several helpful related publications are listed at the end of this chapter.

Range Plant Categories

Range plants are grouped by life form, life span, origin, growth season, and response to grazing.

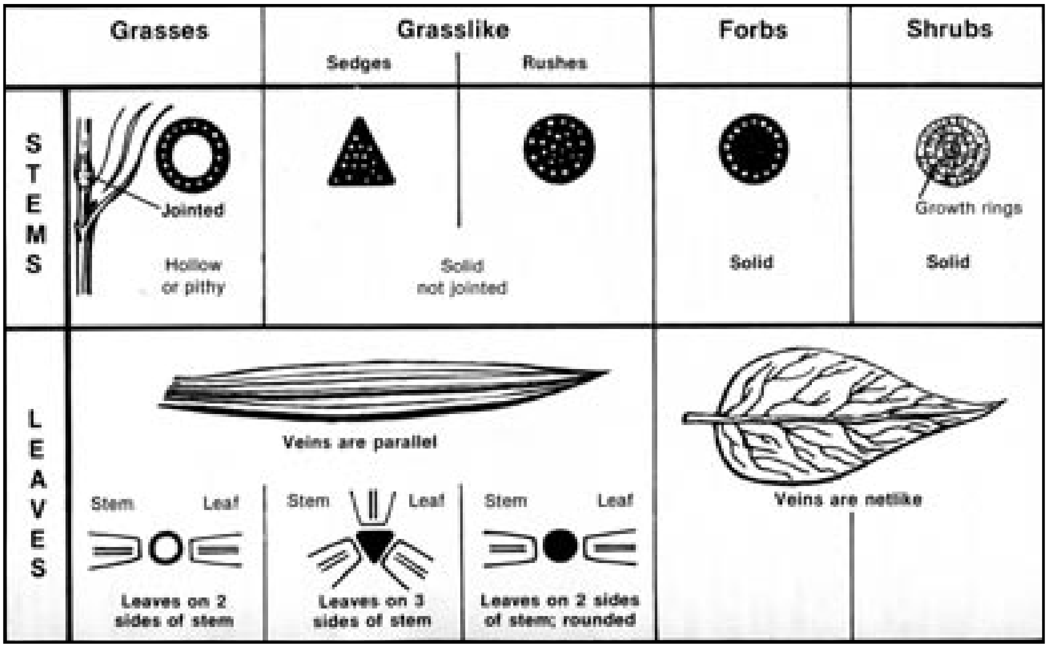
Life Form

Four broad groups of range plants are easily recognized: forbs, woody plants such as shrubs, grass-like plants, and grasses (Figure 8).

Forbs have non-woody stems and broad leaves often with net-like veins. They are herbaceous and generally die back every winter. Many colourful wildflowers belong to this group. Prairie coneflower, golden bean, and yarrow are some common examples.

Shrubs resemble trees, but have no definite trunk. They are woody plants that tend to branch out near the base and they are shorter than trees. Shrub leaves are broad and net-veined, usually dropping in fall. Winterfat, rose, and western snowberry are common examples.

Grass-like plants resemble grasses, but have long solid stems which are either three-sided (sedges) or round (rushes). They have no visible stem joints and their leaves have parallel veins. Sedge leaves are three-ranked (on all three sides of the stem), while rushes have two-ranked leaves. Male and female floral parts are usually found in separate florets. Sedges are usually associated with moist or wet areas, but some species are found on drier uplands. Baltic rush and sun-loving sedge are examples of rushes and sedges.



Source: Adapted from Holechek et al. 1989.

Figure 8: The four range plant groups

Grasses have jointed stems which are usually hollow. Their slender leaves, which have parallel veins, alternate in two rows on the stem. They have small green flowers that are usually complete. Male and female parts are present on the same flower. Plains rough fescue, northern wheatgrass, and needle-and-thread grass are common examples.

Life Span

The life span of range plants can be classed into three categories: perennial, biennial, and annuals. Perennials live three or more years, biennials two years, and annuals one year or less. Shrubs and trees are always perennials. Grasses, sedges and rushes are mostly perennials or annuals; however, there are a few species that are biennials.

Origin

The origin of plants growing in Saskatchewan are either classified as native or introduced. Introduced plants have been, and continue to be, brought into North America from other continents or regions. Most seeded pastures contain introduced species. The majority are valuable as forage plants, but some have become troublesome weeds in native rangelands. Examples of introduced forage grasses include smooth bromegrass and crested wheatgrass.

Photo Credit: Jim Romo

Cattle grazing crested wheatgrass

Growth Season

Cool-season plants complete most of their growth in spring before temperatures increase. They may grow again in fall, if moisture is available. Cool-season plants dominate and produce most of the forage in Saskatchewan. Examples include northern wheatgrass and western wheatgrass.

Warm-season plants begin growth when soil temperatures rise in late spring and grow mainly in the summer. They are well adapted to warm sites, such as south facing slopes, where they can photosynthesize at higher temperatures than cool-season plants. Only a few warm season species grow in the province, and they contribute a small amount to total forage production. Examples are little bluestem and blue grama.

Plant Characteristics

Basic Parts

The basic parts of any plant are the roots, crown, stem, leaves and flowers. Plant parts have distinctive shapes, sizes and textures which differ according to the species. A magnifying glass is often needed to examine these parts, but plant recognition is simple once one becomes familiar with the various components.

Grasses

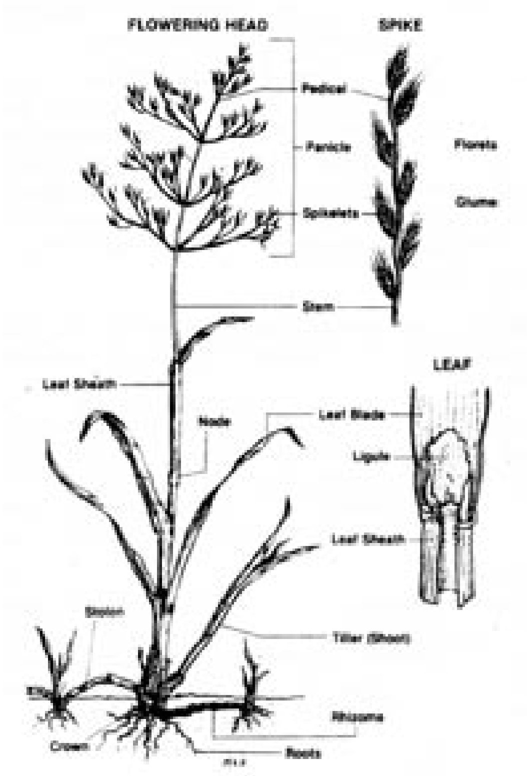
Most grasses look alike to the casual observer. However, different grass species have characteristics that set them apart.

To identify grasses it is necessary to look closely at differences in height, leaf shape, stems, hairiness and seed heads. The above-ground parts of grass plants can be divided into categories: flowering and vegetative.

Vegetative Parts

Vegetative parts include stems and leaves (Figure 9). Grass stems are hollow, jointed and compressed, or round. The joints, called nodes, are usually swollen. A leaf originates at each node. A plant that is flowering will have a seed head that is also made up of distinct parts.

Leaves can be either on alternate or opposite sides of the stem (Figure 9). Leaves have two parts, the blade and the sheath. The blade is the portion that extends away from the stem. Leaf blades have distinctive shapes and textures which help to identify the species. The sheath is the portion wrapped around the stem.



Source: Stubbendieck, J., et. al. 1982.

Figure 9: Grass parts

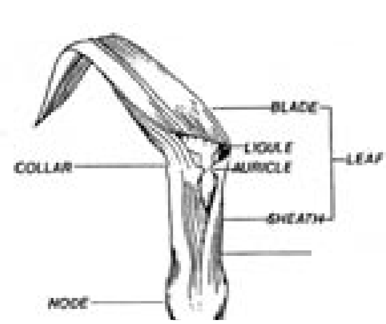
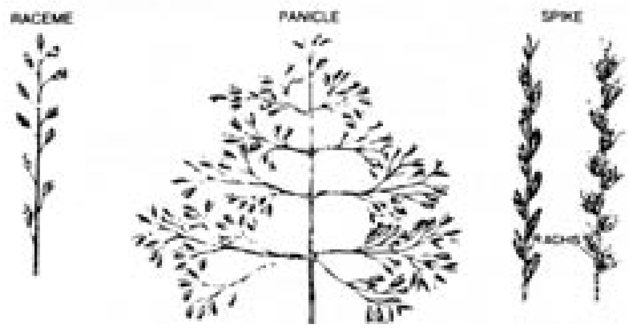


Figure 10: Leaf parts

The point where the sheath and blade join is called the collar (Figure 10). Here, a small membrane-like projection, the ligule, extends from the sheath. In some species the ligule is covered with a tuft of hair. Finger-like appendages, called auricles, may also wrap around the stem at the collar.

Flowering Parts

Flowering parts, known as the inflorescence, include the male and female floral parts and all their appendages. There are three main types of grass inflorescence: panicle, raceme and spike (Figure 11). The most common type of inflorescence is the panicle. Within the panicle the inflorescences have spikelets that are borne on branched stalks (pedicels). The panicle can either be closed or spreading. Kentucky bluegrass and needlegrasses have panicles.



Source: Stubbendieck, J., et. al. 1982.

Figure 11: Examples of a panicle, raceme and spike inflorescence

Racemes have spikelets that are borne on pedicels attached to the main axis. Little bluestem has a raceme inflorescence.

Spike inflorescences have the floral parts attached directly to the main axis or rachis. Wheatgrasses and blue grama grass have spike inflorescences.

Within the inflorescence there are smaller units called spikelets (Figure 12). Spikelets are composed of florets, the flower unit of a grass plant. The grass flower is not showy or coloured, and has no scent, because it is wind pollinated and does not require insects for pollination. The number of florets in a single spikelet varies from one, as in tickle grass, to 30 or more. At maturity each floret, if fertile, produces a seed.

Figure 12: Spikelet

Each seed is surrounded by two leaf-like bracts called the lemma and the palea (Figure 13) These bracts may have hairs that allow the seed to cling to clothing or livestock, to aid in dispersal. An example of a grass with hairy lemmas is northern wheatgrass.

Lemmas or glumes can have sharp projections called awns which assist in seed dispersal or "dig" itself into the ground. An example is western porcupine grass.

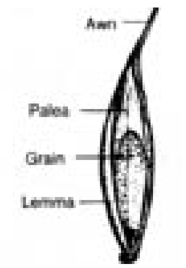
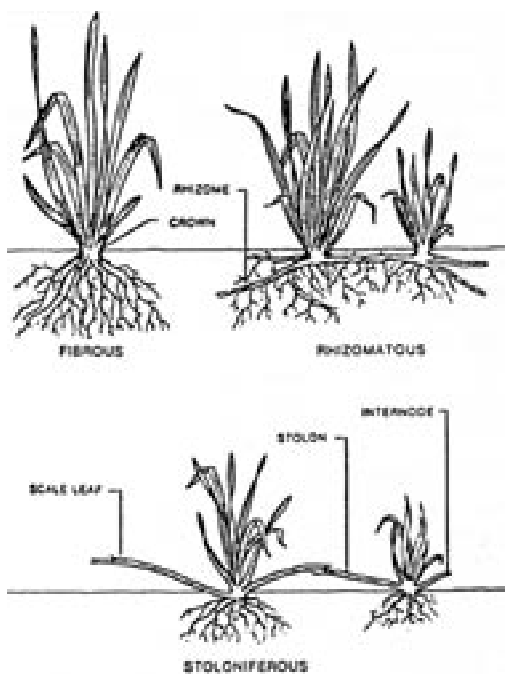


Figure 13: Floret (seed)

Roots and Crowns

There are three different types of grass root systems (Figure 14): fibrous (ie. "bunch grasses" like needle-and-thread), rhizomatous (ie. smooth bromegrass), and stoloniferous (buffalo grass). Roots anchor the plant and extract water and nutrients from the soil. The crown is near the soil surface and produces new roots and shoots.



Source: Looman, J. 1982.

Figure 14: Types of grass roots

Forbs and Shrubs

Shrubs and forbs with large, colourful flowers are often easier to identify than grasses. Color and shape of flowers, as well as leaf and growth characteristics, are often sufficient for identification.

Leaves of broadleaved forbs and shrubs are usually deciduous (falling off at the end of the growing season), or evergreen.

Broadleaf species are usually characterized by leaf shape and arrangement on the stem. An opposite arrangement refers to leaves growing opposite each other at a node. An alternate arrangement has leaf attachment points offset along the stem. If leaves are whorled, there are three or more leaves growing at one node (Figure 15).

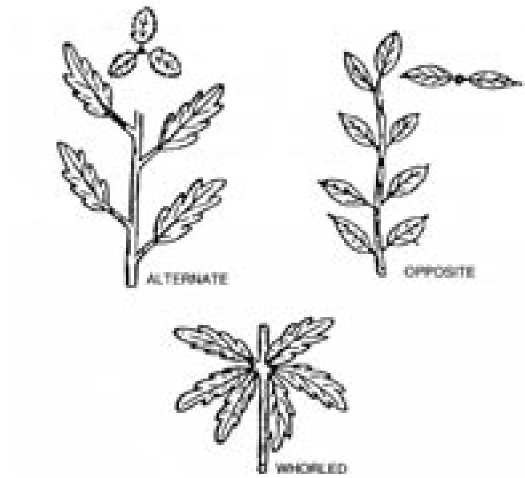


Figure 15: Leaf arrangements

Leaves are simple or compound. A simple leaf has only one distinct segment between the stem and the blade end (Figure 16). A compound leaf has distinctive segments, or leaflets. They may be pinnately (featherlike) or palmately (hand-shaped) compound (Figure 17).

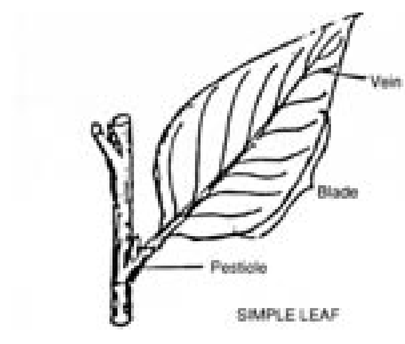


Figure 16: Simple leaf

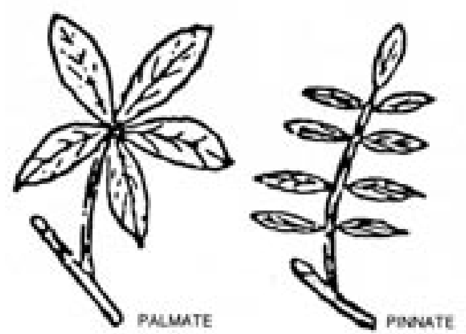
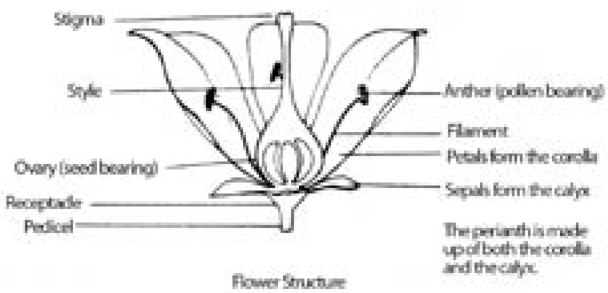


Figure 17: Compound leaves

The size, shape, color, hairiness and vein arrangement (venation) of a leaf blade are characteristics to note when identifying forbs and shrubs.



Source: Stubbendieck, J., et. al. 1982.

Figure 18: A complete flower

Parts of a complete flower (Figure 18) are arranged in a circle. The most colourful and conspicuous ring is called the corolla, which consists of segments called petals. Below the corolla is a ring of cuplike sepals, known as the calyx. The calyx is usually green and protects or encloses the bud petals. The calyx and corolla surround the male reproductive organs (stamens) and the female reproductive organs (pistils).

Plant Names

All plants have only one correct botanical (scientific) name, but may have several common, localized names. Botanical names allow universal reference to a particular species. Plants are classified according to family, genus, species, and sometimes sub-species, or varieties. Each plant's botanical name reflects its genus and species.

Collections

One of the best ways to learn to identify plants is to collect, press and name specimens for reference year after year. Such a collection becomes a natural library of the species in a pasture.

Plants can be collected and pressed when the opportunity occurs, and identified at a later date.

Plants should be gathered when they have produced seed heads, and before they begin to dry out and lose color. Select an average plant that is a representative sample, or collect several specimens showing the range of variation.

Each specimen should include some of the root system, flowering parts and fruit. Collecting flowers and fruit may require more than one specimen. Because plants differ in their growth seasons, collecting specimens can last from May until August.

After every field trip, remove any soil from roots, and arrange each specimen between newspapers or blotting paper. (Wilted or dried plants do not press well). Fold large plants to fit your equipment, making sure to display all parts. Include a note detailing the collection date, site, and associated species.

When the plants are secured between the papers, place specimens in a plant press. Commercial models are available, but two pieces of plywood bound together with straps, with cardboard sheets between, work well. If plants are not pressed immediately, place them in a black plastic bag to prevent them from wilting.

Examples of three common plant families

Family	Tribe	Genus	Species	Common Name	Variety
Poaceae	Triticeae	*Agropyron*	*smithii*	western wheatgrass	Walsh
(Grass)		*Agropyron*	*cristatum*	crested wheatgrass	Fairway
	Stipeae	*Stipa*	*comata*	needle-and-thread	
Rosaceae		*Rosa*	*woodsii*	wild rose	
(rose)		*Prunus*	*virginiana*	chokecherry	
Fabaceae		*Medicago*	*sativa*	alfalfa	Beaver
(legume)		*Oxytropis*	*campestris*	locoweed	

Most plants dry within a week and can then be glued to a permanent background. Choose a convenient size suited to your purposes. Once the plant is affixed to its background, label the specimen and record collection details for future use.

Plant Keys

A plant key is used by plant taxonomists to identify plants and includes a series of questions that the observer asks to compare and contrast similarities and differences about the structure and appearance of plants. Using a plant key requires a working knowledge of plant part terminology. A microscope (to help see the small parts of a plant), dissecting tools, and ruler are very helpful in separating and identifying the various plant parts.

Think of a plant key in terms of travelling a road that is a series of well-marked Y intersections. From each pair of statements in the key, first choose the one that applies to the plant in question. Then proceed to the next appropriate paired statements and so on until the specimen is identified.

Two opposing characteristics are always given. Always choose the one that best describes the specimen. Read to the end of the line to determine the next set of characteristics or the name of the plant.

Do not skip down the key. Take each contrasting pair of statements in order. When a specific name for the specimen is pinpointed, check the selection with the description and illustration in the text to verify your findings.

A specimen used for keying should have all its parts if possible, including roots, stem leaves, flowers and fruit. While plant keys rely heavily on reproductive parts, some keys identify common grasses by vegetative characteristics (Figure 19).

Plant Growth

Grass is the stockgrower's crop. Livestock, the saleable product, is a means of harvesting that crop.

An understanding of plant growth is key to successful livestock production. Only then can grazing animals be used to manipulate plants to achieve economic goals.

Grazing management practices should be based on knowledge of plant physiology and morphology. Both physiological (functional) changes and morphological (external structural) changes affects forage quality and/or survival of plants.

Paired True and False Statements:		
1. Sheath split and/or overlapping		If sheath is split down front, go to paired statement 2.
1. Sheath not split, notched near top	downy brome	If grass sheath is closed down the front, this is the answer. No need to proceed further
2. Auricles present	western wheatgrass	
2. Auricles absent	Go to paired statement 3	
3. Leaves folded in shoot at emergence	Go to paired statement 4	
3. Leaves rolled in shoot at emergence	Go to paired statement 5	
4. Ligule membranous, fringed with coarse hair on margin	June grass	
4. Ligule a fringe of hair	inland salt grass	
5. Ligule membranous, very conspicuous, spilt or fringed, to 4 mm long	needle-and-thread	
5. Ligule a dense fringe of hair, less than 0.5 mm long	blue grama	

Figure 19: An example of a vegetative key for six common grasses

Physiology

Photosynthesis

Photosynthesis is the basic reaction in green plants that converts solar energy to chemical energy (see Figure 20). It provides the energy for plant growth, maintenance, and reproduction. In fact, this reaction is directly or indirectly responsible for all life on earth. Water and nutrients are taken from the soil through plant roots. Carbon dioxide gas enters the plant through holes (stomata) in the leaf surface. Using sunlight energy, carbon, hydrogen, and oxygen are combined to form carbohydrates.

The chemical pathway is very complex but the end result is a usable form of energy or “food”: simple sugars which form the building blocks for all compounds.

Energy Storage and Use in Range Plants

Simple sugars are used to create other compounds that can store energy in plants. Carbohydrates, both structural (incorporated in the fibre strengthening material of plant cells) and nonstructural (starch, complex sugars and proteins), can all store energy captured by photosynthesis. These compounds provide the energy required for the growth and maintenance of tissues within the plant, and can be stored anywhere in the plant, including the roots, crowns, rhizomes, and stems.

During the mid 20th century, early range scientists and plant physiologists developed a model to explain carbohydrate level fluctuations in range plants throughout the season (Figure 21). Initial studies linked decreases in plant carbohydrate levels to events such as grazing, over-wintering, spring growth and seed set, and deduced that recovery from these events were primarily at the expense of stored energy within the plant in the form of carbohydrates. These reserves were suggested to be “withdrawn” after grazing to redevelop leaf area. The amount of carbohydrates available in storage was thought to largely predict the ability and rate of recovery from grazing. The main assumptions of the model were:

- carbohydrates produced in excess of plant needs were stored and used to regenerate leaf area after grazing;

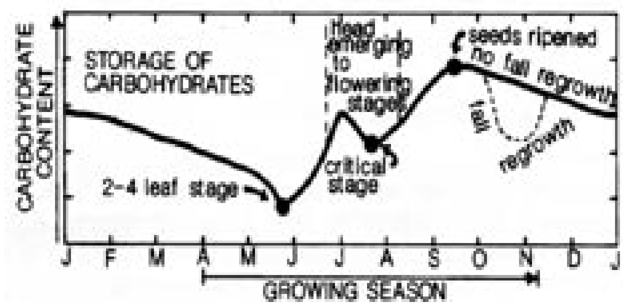


Figure 21: An early interpretation of the carbohydrate storage cycle

- carbohydrates were the primary form of stored energy;
- carbohydrates were stored mostly in the roots and crowns, and were remobilized upwards after grazing to assist in formation of new leaves;
- rest was required after grazing to allow for the plant to develop new leaves. These leaves would produce additional energy to restore carbohydrate levels – in effect, re-depositing into the bank to recover from grazing.

Updated range management research has provided new insights into the role of stored energy and plant recovery after grazing. This research has demonstrated that plants store relatively little energy in readily available forms, such as carbohydrates. The energy produced may be as little as a few day’s worth of photosynthesis. It has also been determined that carbohydrates do not move around in the plant as readily as earlier assumed. For example, energy stored in the roots is used for maintenance and growth of the root system, and it is not readily moved elsewhere. Reductions in carbohydrate concentrations in roots after grazing

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Green plants convert solar energy into chemical energy

sunlight

$$\textbf{Carbon Dioxide } (CO_2) + \textbf{Water } (H_2O) \xrightarrow[\text{green plant material}]{\text{sunlight}} \textbf{Carbohydrate (food)} + \textbf{Oxygen } (O_2)$$

green plant material

Figure 20: Photosynthesis

are due to continued root respiration with reduced supplies of carbohydrates being directed to the roots because of the loss of leaf area, rather than root reserves being moved elsewhere. Observations of total energy in plants and the rate of plant recovery are not always consistent. Some species, with relatively high carbohydrate concentrations, recover more slowly than species with relatively low concentrations. These new findings indicate that:

- stored energy in the form of carbohydrates plays a small role in the ability of a plant to recover after grazing;
- energy reserves do not move around the plant as much as previously thought;
- plants hold a relatively small amount of carbohydrates in reserve – only as much as can be produced in a few days of photosynthesis;
- there is considerable difference in how energy is allocated among species;
- estimating carbohydrate reserves levels is not a reliable indicator of ability of a plant to recover from grazing, as there are many energy storage compounds present in a plant;
- photosynthesis in remaining green tissue after grazing is the major contributor to the energy needed to develop new leaves after grazing;
- recovery of plants after grazing is thus related to their opportunity or ability to photosynthesize.

It appears previous interpretations of energy dynamics and the role of carbohydrates in plant recovery from grazing were oversimplified. Stored carbohydrates have a significant role in providing energy to the plant during times of low photosynthetic capacity (winter dormancy). Environmental limitations or removal of excessive leaf material will slow recovery.

Most often, grazing on rangelands occurs when production and forage quality are optimal. This period also usually coincides with favorable growing conditions. The favourable growing conditions will vary with the forage species being grazed. Grazing during this period will allow for high rates of photosynthesis in plant material remaining after grazing and will assist the plant in recovering rapidly from defoliation. Ensuring that plants can maintain energy levels and recover quickly from grazing can be accomplished by:

- grazing during the optimal growth period for the species being grazed;
- leaving more leaf area remaining after grazing allows the plant to recover more quickly because there is more residual tissue to provide energy to develop new leaves;
- maintaining litter - an indicator of appropriate levels of use.

Grass Morphology

Morphological changes occur in the grass plant throughout its development. These changes are easy to see and coincide with certain physiological changes that are impossible to detect visually. Morphological characteristics can be very useful when making grazing management decisions.

Grass Tillers

Vegetative reproduction of perennial grasses takes place through production of new shoots or tillers. Each grass tiller arises from a growing point and has the potential to mature as an individual plant.

The growing point is where new cells develop. (Trees, shrubs and some forbs have growing points at the outer tips of their branches).

Growing points on grasses are present just above the last completed joint or node of each stem. In young grasses and in new growth of perennial grasses, the joints are compressed together near the soil surface. A leaf extends from each of these joints. There may be 10 to 15 joints in the first inch of the stem.

All grass tillers begin growth with a growing point developing from a dormant bud. Provided tillers are vegetative, they have the potential to produce new leaves. A tiller that has become reproductive can no longer develop new leaves.

Internode Elongation

As the growing season progresses, hormonal changes in the tiller cause the stem to extend upward. The first growth of tillers is vegetative because no seed head is evident. As the stem grows the distance between the joints (nodes) increases. The area between the nodes is called the internode. Elongation is often a transitional stage between the vegetative and reproductive stages of plant growth. In some grasses, tillers remain in the elongated vegetative stage because the seedhead either never develops or aborts at a very young stage.

Continued Growth

Seed production does not mean the grass plant stops growing. Each tiller has dormant (inactive) buds located at the base of the tiller (basal buds), on the stem (aerial buds), and at the nodes on the stolons or rhizomes. Dormant buds can produce a new tiller with a new growing point.

Basal, rhizome, and stolon buds are generally the fastest source of regrowth. While active on some grasses such as reed canary grass, aerial buds are usually the least productive of the new buds.

Removing an elongated tiller's growing point breaks the dormancy of the dormant buds associated with the tiller. Growth of new leaves from an activated growing point can then occur, if environmental conditions are conducive to growth. New tillers may not be formed until the next growing season.

Buds that remain dormant must survive the winter and produce tillers the next year. A tiller developing from a dormant bud in the spring can be compared to an annual plant developing from seed.

Perennial grasses must be allowed to manufacture and store sufficient energy to develop buds that are vigorous enough to survive the winter and begin spring growth. Buds for next year's tillers develop later in the growing season. Consequently, severe grazing near the end of the growing season may cause a decline in forage output the following year.

Grazing And Tiller Growth

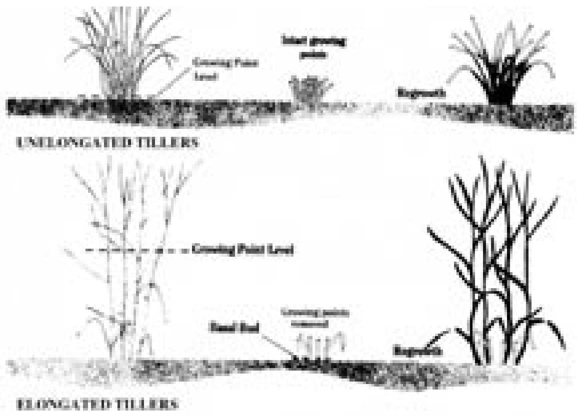
Early in the growing season all grass growing points are close to the soil surface. Because livestock cannot physically graze any closer than about an inch from the ground, there is no danger of removing the growing point at this time. Although plants are grazed, each grazed tiller continues to produce new leaf material. However, reproductive tillers that will eventually have internode elongation, may have the growing point removed during grazing. If the growing point is removed, new leaf material must come from tillers that develop from dormant buds (Figure 22), which may not happen until the next growing season.

Because a bud developing into a new tiller has no leaves, it must depend on recently captured energy provided by remaining leaves.

If grazing is not severe and sufficient leaf material remains, new tiller growth receives energy manufactured by the remaining leaves.

Elongation Timing

The timing of internode elongation is important because the amount of vegetative material plants produce is dependent on when internode elongation occurs. Once internode elongation has occurred, the plant may be in a transitional stage from vegetative into reproductive development. Once this transition has occurred, no new leaf initiation will occur. A reproductive tiller that is defoliated will not produce new leaves. New growth must then develop from dormant buds. Delaying grazing on reproductive



Source: Waller, S.S. et. al. 1985.

Figure 22: Regrowth from intact growing points versus regrowth from basal buds

plants until internode elongation occurs will maximize vegetative growth.

Kentucky bluegrass, June grass, red top, and many other grasses do not raise growing points until just before entering the reproductive phase. Growing points are maintained close to or below ground level for most of the growing season and are difficult to remove by grazing animals. These grasses are more resistant to close grazing.

Grasses such as smooth bromegrass, western wheatgrass and Canada wildrye elevate growing points early in their development. Smooth bromegrass, reed canary grass and western wheatgrass may have elevated growing points without seed head development at certain times of the year. These species are more productive, but are less resistant to grazing.

Proper Defoliation

Defoliation factors such as time, intensity, frequency, and duration can influence the impact on plant production. Studies indicate that most native grass seed production is typically low and often erratic. Thus, vegetative reproduction (tillering) plays a major role in native grass survival. New tillers receive support from the original plant until their own root systems develop, minimizing adverse environmental effects on reproductive success. However, plants may die because of drought and other stresses, and in the long-term, seeds play a role in producing new plants.

Root Growth

Roots and underground stems account for more than half of a grass plant's total mass. Roots anchor plants in the soil, absorb water and nutrients, and allow plants to compete with others. Underground stems, or rhizomes, enable plants to reproduce vegetatively.

Healthy root systems are vital for healthy plants. Grazing management, therefore, involves managing root systems in pastures and rangeland.

Root Replacement

Studies show that grass roots have relatively short lives. Because root replacement occurs rapidly, organic matter is constantly added to the soil.

Canada wildrye roots, for example, live no longer than three years. Only 45 percent of blue grama roots survive over three years.

Thus, except for large shrub roots, roots are not permanent structures and must be replaced regularly. Replacement rate varies with species, but ranges from 20 to 50 percent of the total root system each year.

Leaf Removal and Root Growth

Grazing intensity and frequency directly affects root development of all grasses.

Plants respond to defoliation by first stopping root and rhizome elongation. If grazing continues, plants react by reducing root numbers and diameter, branching and depth. The amount of reduction directly relates to defoliation severity and frequency. Root growth is diminished because less energy is available due to a reduction in plants ability to photosynthesize efficiently.

A plant that has lost a majority of its root system is very susceptible to environmental factors such as drought. It can be replaced by less desirable, lower producing species.

One study showed root growth stopping within 24 hours after removing at least 40 percent of the leaf area. Another study showed that clipping 80 percent of the leaf area stopped root growth for 12 days, while removing 90 percent halted growth for 18 days. These roots did not resume growth until the leaves grew again.

Removing 60 percent of leaves stopped growth of half of the roots. At 50 percent removal, almost all roots continued to grow.

This study was conducted under good growing conditions. Unfavourable soil moisture conditions after defoliation may interrupt root growth until the following year.

The amount of defoliation is usually more harmful to root growth than grazing frequency. Taking a little of the plant more often is a better management strategy than taking all of the plant only once.

Because perennial plants are most common in Saskatchewan, the consequences of overgrazing are carried over from season-to-season. Similarly good management is beneficial in the following years.

Source: Johnston, A. 1961.

Rough fescue sod clipped in the greenhouse at various heights every four weeks for five months. Left to right: not clipped, clipped to 12.5, 7.5 and 3.8 cm. Decrease in root volume is evident

Continued overgrazing reduces the number, size and extent of underground plant parts and it causes changes in species composition that ultimately lead to poor pasture productivity.

References

Holechek, J.L., R.D. Pieper, and C.H.Herbel. 1989. Range Management Principles and Practices. Department of Animal and Range Sciences, New Mexico State University. Las Cruces, NM. 501p.

Johnston, A. 1961. Comparison of lightly grazed and ungrazed range in the fescue grassland of southwestern Alberta. Canadian Journal of Plant Science 41: 615-622.

Looman, J. 1982. Prairie Grasses Identified and Described by Vegetative Characteristics. Agriculture Canada. Ottawa, ON. 244p.

Stubbendieck, J., S.L. Hatch, and K.J. Kjar. 1982. North American Range Plants. University of Nebraska. Lincoln, NE. 464p.

Vavra, M., W.A. Laycock, and R.D. Pieper (eds.). 1994. Ecological Implications of Livestock Herbivory in the West. Society for Range Management Press. Denver, CO. 297p.

Waller, S.S., L.E. Moser, P.E. Reece, and G.A. Gates. 1985. Understanding Grass Growth: The Key to Profitable Livestock Production. Kansas City, MO. 20p.

White, L. 1973. Carbohydrate reserves of grasses: A review. Journal of Range Management. 26:13-18.

Saskatchewan Range Plants
GRASSES

Northern Wheatgrass or Thickspike Wheatgrass

Agropyron dasystachum (Hook.) Scribn.,
Elymus lanceolatus (Scrin. and Smith) Gould

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	2 mm long, often claw-like, clasping the stem, light green coloured
Ligule:	inconspicuous
Leaf blade:	6 mm wide to 20 mm long, flat to rolled, ridged, slightly rough above and smooth below, light green collar divided and light green
Sheath:	round, split, smooth or slightly rough to the touch, margins overlapping

Northern wheatgrass is an erect rhizomatous plant reaching heights of 40-70 cm. It is a major component of the Mixed Grass Prairie and Parkland region of the prairie provinces of Canada, and is one of the most common wheatgrasss on the prairies. This grass grows with western wheatgrass and needle-and-thread on clay and loam soils and occasionally in nearly pure stands on sandy sites. Northern wheatgrass grows with western porcupine grass in xeric communities on mid- to upper slopes on coarse-textured soils. It is best adapted to clay, sandy loam and loamy soils. This grass produces few seed heads and is drought resistant. A very dense, shallow root system penetrating depths of about 25 cm takes advantage of surface moisture, while a few deeper feeding roots reach depths of about 50 cm. Tufted basal leaves (persistent old leaf sheaths), lighter green color and pubescent lemmas distinguish it from western wheatgrass. Palatable forage for all livestock classes, the protein content of northern wheatgrass decreases from 16 percent in early May to about 4 percent by October. Digestible energy remains high at 45 percent from emergence to maturity.

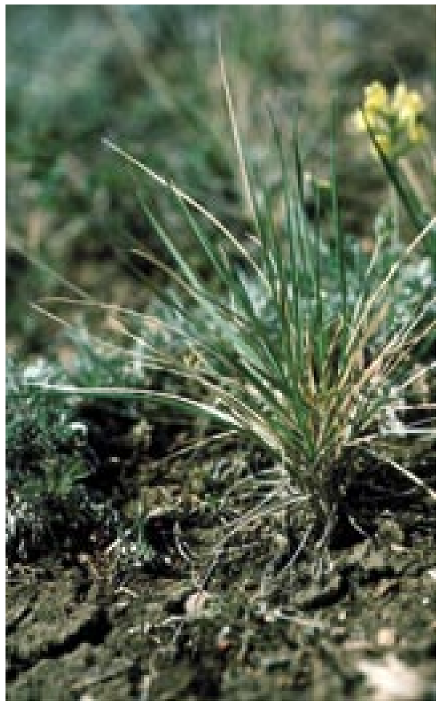


Photo Credit: Jim Romo

Northern Wheatgrass

Western Wheatgrass or Blue Joint

Agropyron smithii Rydb.,
Pascopyrum smithii Rydb. (Love),

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	often claw-shaped, usually clasping the stem, purplish colour
Ligule:	inconspicuous
Leaf Blade:	flat, prominently veined, very rough on upper surface, blue green colored, leaves grow at 45 degree angles from the stem. Collar light green and not well defined
Sheath:	Split, strongly veined, often brownish or purplish at base

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Western Wheatgrass

Western wheatgrass is erect and sod-forming with long slender rhizomes. A drought tolerant perennial, it grows in fairly dense stands on clay soils in association with green needlegrass, on saline soils with salt tolerant grasses and greasewood, and in sparse stands among blue grama and needle-and-thread on upland sites. Rarely producing seeds, it spreads by rhizomes. Western wheatgrass is fair yielding, palatable, nutritious, digestible and cures well on stem. Protein content averages 18 percent in the spring, dropping to 3-4 percent in the fall.

Photo Credit: Jim Romo

Western Wheatgrass

Slough Grass

Beckmannia syzigachne (Steud) Fern.

Life Span:	annual or biennial
Origin:	native
Season:	cool
Auricles:	absent
Ligule:	10 mm long, pointed, maybe split when mature, membranous
Leaf Blade:	12 mm wide, 20 cm long, wide, flat, light green, rough above smooth below. Collar inconspicuous
Sheath:	cross-veined, hairless, split, margins overlapping and translucent

Slough grass is an erect, tufted grass forming large bunches from shallow fibrous roots. It is common in shallow sloughs and marshes, preferring clay soils covered with a shallow layer of organic matter. A stout plant with shallow roots supporting a leafy stem, it can reach 1 m in height. The branched head is a closed panicle with seeds that are sickle-shaped and hard-coated. This plant is palatable to cattle and horses from early growth until seed is nearly ripe. Nutrients are well balanced, with seasonal protein concentrations constant, but slightly lower than upland grasses. Hay is light but of good quality.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Slough Grass

Blue Grama

Bouteloua gracilis (H.B.K.) Lag. Ex Steud.

Life Span:	perennial
Origin:	native
Season:	warm
Auricles:	absent
Ligule:	fringe of hairs
Leaf Blade:	flat to loosely inrolled, sparsely hairy on upper surface, short and curly
Sheath:	round, split, margins, without hairs or if hairs present, very sparse

Blue grama is low growing and densely tufted, often forming mats. It is most abundant in the southern regions of the province. Flower stalks reach 50 cm and usually carry two dark brown, sickle-shaped spikes with all flowers clustered along one side. It starts growth late in the season (early May in southwestern Saskatchewan) and nearly two weeks later further north. Blue grama is highly digestible, producing good forage for all livestock classes, but has low forage productivity. Drought tolerant and resistant to grazing, it increases under heavy grazing and drought.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Blue Grama

Marsh Reed Grass

Calamagrostis canadensis (Michx.) Beauv.

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	absent
Ligule:	prominent, pointed, often irregular or split
Blade:	wide (6-10 mm), flat, lax, with a prominent mid rib
Sheath:	rounded and split with pale margins, usually without hairs, yellowish at the base

Marsh reed grass is tall, erect, tufted and is the most widespread of the reed grasses. It is a moisture-loving plant that grows in marshes, along streams, and in moist, shaded draws. Nearly pure stands are occasionally found in shallow, northern sloughs. Creeping rootstocks give rise to many coarse stems that may reach 1.5 m. Stems produce rough, lax leaves that may be 30-60 cm long. It develops nodding seed heads with upright branches close to the central column that contains numerous small seeds surrounded by a dense ring of hairs growing from the base of the seed. Palatability varies, however it makes good hay if cut early in July.

Photo Credit: Jim Romo

Marsh Reed Grass

Sand Grass or Prairie Sandreed

Calamovilfa longifolia (Hook.) Scribn. ***var. longifolia***

Life Span:	perennial
Origin:	native
Season:	warm
Auricles:	absent
Ligule:	fringe of hairs
Blade:	coarse, flat, without hairs, light green, wide at base tapering to long fine point
Sheath:	round, pillose (hairs 2-3 mm long) at the throat and collar

Sand grass is a tall, erect grass with sharp, long, scaly rhizomes that grows on sandy prairie, sand dunes, along lakeshores, and in open forests. One of the most important species in the Great Sand Hills, it is common in association with Indian rice grass and sand dropseed. Roots extend to 1.5 m, but most found within 50 cm of surface. Surface roots dense, wiry and well adapted to hold sandy soil. Harsh basal leafage surrounds coarse, leafy stems which may reach 2 m. Palatable during first month of growth and after curing. Seeds are eaten in autumn, while stems are rarely eaten. Despite heavy roots, sand grass is susceptible to trampling and it disappears where livestock congregate. Protein drops from 12 percent in May to about 4 percent in November, but available carbohydrates increase from 45 percent in May to 55 percent in October. This plant provides good winter pasture for maintenance of livestock.

Photo Credit: Jim Romo

Sand Grass

Timber Oatgrass

Danthonia intermedia Vasey ***var. cusickii*** Williams

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	absent
Ligule:	fringe of hairs
Blade:	flat or inrolled, often pubescent on lower surface
Sheath:	round, split, with thin, transparent margins prominently veined, very pubescent

Timber oatgrass is a short, tufted grass with fibrous roots. Most common of the five *Danthonia* species, it occurs in the prairies growing in meadows and the upland prairie close to the tree line and favorable sites within the spruce and pine zones. It is common in the Wood Mountain, Cypress Hills, and southernmost Parkland areas. A related species, Parry's Oatgrass *(Danthonia parryi)*, is found only in the Cypress Hills. Timber oatgrass produces an abundance of basal leaves and short, numerous stems. It has 4 to 12 purplish spikelets that form a closed panicle which clusters to one side. Flowering occurs in August with seed shatter in early September. It is grazed by domestic livestock, deer and elk during spring growth. In overused Fescue Prairie it may form a solid stand after rough fescue has been grazed out, indicating that livestock prefer other grasses more than timber oatgrass.

Photo Credit: Jim Romo

Timber Oatgrass

Tufted Hair Grass

Deschampsia caespitosa (L.) P. Beauv.

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	absent
Ligule:	very prominent, sharp pointed
Blade:	to 5 mm wide, contracted at collar
Sheath:	compressed, keeled, margins transparent and overlapping, prominently veined

Tufted hair grass is an erect, densely tufted bunchgrass with fibrous roots. It is widespread and abundant throughout Canada and grows sparsely in marshes or around shallow sloughs in drier prairie areas. This is an important species in permanently moist sites in the Cypress Hills and seldom grows under trees. Dense, shallow roots support a mass of deep-green leaves. Folded leaves swell where sheath and blade join. The seed head is a feathery panicle with branches growing in whorls and usually contains 2 seeds per spikelet. Tufted hair grass has good to excellent forage value for all livestock classes and fair to good value for wildlife. The protein content is as high as 18 percent in May decreasing to 7 percent by August. It is generally considered a valuable range grass. Plants may be short-lived and may reproduce only from seed so it is important to allow the plants to set seed.

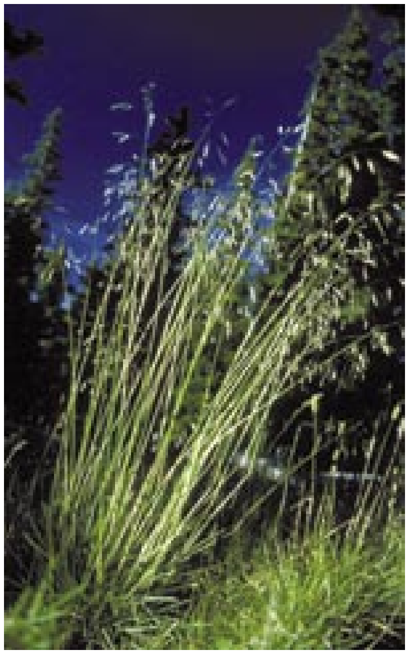


Photo Credit: Jim Romo

Tufted Hair Grass

Salt Grass or Desert Salt Grass

Distichlis stricta (Torr.) Rydb.

Life Span:	perennial
Origin:	native
Season:	warm
Auricles:	absent
Ligule:	fringe of hairs, fused at base
Blade:	stiff, rather short, somewhat awl-shaped, leaf collars bunched along stem and appear opposite
Sheath:	round, split, usually without hairs, basal sheaths usually yellowish

Salt grass is an erect, short, sod-forming grass with extensive scaly rhizomes. Habitat includes moderately saline or alkaline soils, particularly around wetlands and saline flats. Male and female flower heads are on different plants, but both usually occur in the same clump. Palatability is low, with plants grazed only when more palatable grasses are not available. Well-balanced nutrient composition supports fair to good livestock gains. This is an important grass for the prevention and control of saline soil erosion in Saskatchewan.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Salt Grass

Canada Wildrye

Elymus canadensis L.

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	to 2 mm, claw-like, and often clasping the stem
Ligule:	short, not conspicuous
Blade:	very wide (1-2 cm), flat, rough on upper surface
Sheath:	round, split, prominently veined, green or bluish green, purplish at the base, margins overlapping, inner margin thin transparent, outer margin has fringe of hairs

Photo Credit: Jim Romo

Canada Wildrye

Canada wildrye, a tall, erect bunchgrass with short rhizomes, grows in sparse stands on sandy soils, in woods, along river banks, roadsides, and other disturbed ground in the prairies. Considerable basal leafage and tall stems leaf out from base to spike. Nodding spikes, about 15 cm long, have two spikelets at each node, a characteristic of wildryes. It is usually eaten in spring but is not very palatable. Forage value decreases sharply when mature.

Plains Rough Fescue

Festuca hallii (Vasey) Piper

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	absent
Ligule:	membranous, short fringed
Blade:	narrow, rough, flat to tightly rolled
Sheath:	round, ridged, split, rough to the touch, thin margins

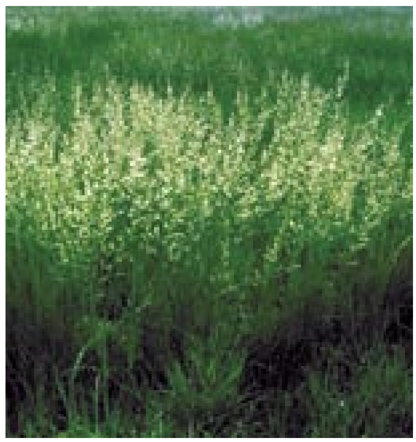


Photo Credit: Jim Romo

Plains Rough Fescue

Plains rough fescue, an erect grass with short rhizomes, grows on deep sandy loam soils in the Dark Brown and Black soil zones. Dense, gray-green, rough and basal leaves provide most of the forage. Individual plants spread from tufts growing at the edge of the crown. It is very palatable and it is readily grazed out, particularly with repeated heavy spring usage. Plants are replaced by northern porcupine grass, needle-and-thread, or weedy species. Protein concentrations in spring are approximately 12 percent. It cures well with digestiblity remaining high at all times; however, it is best used as summer and winter range.

Hooker's Oatgrass

Helictotrichon hookeri (Scribn.) Henr.

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	absent
Ligule:	conspicuous, large, pointed
Blade:	somewhat short, firm, to 5 mm wide, keeled with a boat-shaped tip
Sheath:	compressed, keeled, split, prominently veined, thin transparent margins

Hooker's oatgrass, a densely tufted, smooth-leaved grass with fibrous roots, grows east of the Rockies from Alberta to Manitoba. It grows only where moisture is plentiful in open grasslands occurring in the Cypress Hills and Parkland areas. This species seldom occurs in solid stands, rather, single plants are scattered among associated species and rarely accounts for more than 5 percent of a stand. It is densely bunched with a shallow root system and flat leaves. The awned seed head is a panicle with erect branches clinging closely to central column containing glumes that appear shiny. Hooker's oatgrass provides palatable forage.

Photo Credit: Jim Romo

Hooker's Oatgrass

June Grass

Koeleria cristata Pers.
Koeleria macrantha (Ledeb.) Schult.

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	absent
Ligule:	1 mm, truncate and ragged
Blade:	flat or inrolled, soft, sometimes pubescent
Sheath:	round, split, rough to the touch, often pubescent, prominently veined

June grass, a long-lived bunchgrass grows throughout open prairie and Parkland regions but less common in open bush areas. It often grows as single plants in mixed communities rather than dense stands. The shallow, densely rooted plants rely on surface moisture and die back when subsurface moisture disappears. The leaves are short, flat, dark green and distinctly veined, sometimes with a few fine hairs near the stem. Almost leafless, the flower stalks usually reach 20-30 cm. Its closed-panicle seed head resembles a small wheat or barley spike and produces abundant seed. June grass is palatable in spring, declining in the summer; however, it is preferred in late fall after curing. The protein content is 20 percent during early spring decreasing rapidly to a low of 4 percent by November. This native grass is common, but contributes little to total forage production. June grass increases in fair condition range, but declines as condition becomes poor.

Photo Credit: Jim Romo

June Grass

Indian Rice Grass

Oryzopsis hymenoides (Roemer & J.A. Schultes) Ricker ex Piper,
Achnatherum hymenoides (Roemer & J.A. Schultes) Barkworth

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	absent
Ligule:	conspicuous, long, tapered to a point
Blade:	long, slender, inrolled, smooth
Sheath:	round split, very prominently veined, smooth or slightly rough, margins overlapping, outer margin often with a fringe of hairs

Indian rice grass is a tall, tufted, wiry grass with fibrous roots, common on sandy soils and abundant in the Great Sand Hills. Old leaf sheaths located at base help protect numerous, long, deep green, folded basal leaves. Its open, feathery panicle is white due to light colored chaff. The panicle always splits in two. Mature seed is black and surrounded with white silky hair. The awns readily break away from the tips. This is one of the most palatable native grasses. It cures well, providing nutritious forage.

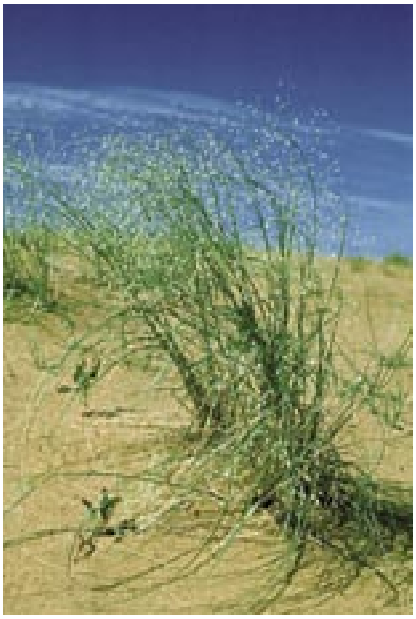


Photo Credit: Jim Romo

Indian Rice Grass

Kentucky Bluegrass

Poa pratensis L

Life Span:	perennial
Origin:	introduced from Europe
Season:	cool
Auricles:	absent
Ligule:	membranous, to 1 mm long, truncate, entire
Blade:	leaf tips are boat shaped, somewhat keeled, and narrow
Sheath:	compressed but not sharply keeled, split, distinctly veined, transparent margins

Kentucky bluegrass grows abundantly in moist northern and eastern parts of Saskatchewan. It has invaded many grasslands and is a common lawn species. With boat-shaped tips, the leaves are mostly basal deep blue-green, folded or flat and slightly keeled. The mid-vein appears as a double line or railroad track. Seeds are numerous with cobweb-like hairs at the base of the florets. Palatable and nutritious in early spring, the protein content drops after seed heads form. A rhizomatous growth form and good seed production make it a strong competitor. Under poor pasture management it tends to invade. Unless irrigated, it is not high yielding in Saskatchewan. Pastures become less productive as Kentucky bluegrass increases in abundance.

Photo Credit: Jim Romo

Kentucky Bluegrass

Sandberg's Bluegrass

Poa sandbergii Vasey.
Poa secunda J. Presl

Life Span:	perennial
Origin:	native
Season:	cool
Ligule:	prominent, pointed
Blade:	4 to 12 mm long, flat or folded with boat-shaped tips
Sheath:	compressed, pale to purplish at base, margins overlapping

Sandberg's bluegrass, a small, erect bunchgrass with shallow fibrous roots, grows throughout the prairies but it is rarely abundant. The leaves are numerous, fine, folded and mostly basal. Its seed head is a closed panicle that is straw coloured and shiny when mature. One of the first grasses to grow in spring, it usually matures by early July with leaves withering into white clumps. Because of its drought resistance, it may spread during dry years as other less tolerant species die. Livestock avoid this species after mid-June as it is not very palatable. Sandberg's bluegrass is easily pulled from the soil by cattle.

Photo Credit: Jim Romo

Sandberg's Bluegrass

Little Bluestem

Andropogon scoparius Michx.
Schizachyrium scoparium (Michx.) Nash

Life Span:	perennial
Origin:	native
Season:	warm
Auricles:	absent
Ligule:	membranous (1-3 mm), truncate, ciliate
Blade:	3-8 mm wide, short leaves along the stem, rough on upper surface, smooth below
Sheath:	compressed, keeled, open in older leaves, purplish at base

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Little Bluestem

Little bluestem is a bunchgrass producing many pith-filled stems. This perennial grows up to 60 cm tall in dense stands from the Interlake area of Manitoba to Saskatchewan. Small, sparse stands occur throughout the balance of the prairies on sandy and gravelly soils with shallow water tables or where snow accumulates. Plants are fairly common in most localities in the Great Sand Hills, throughout the Missouri Coteau, along the South Saskatchewan and Frenchmen Rivers, and Swift Current Creek. It is palatable to all livestock classes. After seed heads shatter, the plants provide fair to good forage for cattle and horses. Plants often look ungrazed because livestock pull tender leaves out from around the bunch edge. A single, branched panicle tops each stem and produces the characteristic fluffy hair-covered awned seed. Plants develop a distinctive red tinge after frost.

Photo Credit: Jim Romo

Little Bluestem

Sand Dropseed

Sporobolus cryptandrus (Torr.) Gray

Life Span:	perennial
Origin:	native
Season:	warm
Sheath:	conspicuous tufts of long white hairs at cut throat and collar
Ligule:	dense fringe of fine hairs
Blade:	to 5 mm wide, fine-pointed, stiff
Sheath:	round, split, prominently veined, often purplish at the base, margins thin transparent with fringe of hairs

Sand dropseed is an erect or reclining, tufted, bunchgrass with fibrous roots. Found in sparse stands in all sandy soil areas, the plant has a solid stem that reaches 1 m high from a very coarse base. It is moderately palatable when starting growth in mid-May but becomes unpalatable when cured. This plant's seed matures before the end of July. The protein content is 10-11 percent in early summer, dropping to 5 percent by fall. Sand dropseed provides higher fibre content than most other prairie grasses. Buried seeds are viable for more than 20 years.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Sand Dropseed

Needle-And-Thread or Speargrass

Stipa comata Trin. And Rupr.

Note:	*This is Saskatchewan's Provincial grass*
Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	absent
Ligule:	to 4 mm long, very conspicuous, pointed with a split top
Blade:	narrow, flat or inrolled, slightly rough
Sheath:	round or slightly compressed, split, margins thin and transparent

Needle-and-thread is an erect, densely tufted bunchgrass and one of the more important native grasses on the Canadian prairies. The most common of the speargrasses or needlegrasses, its seed heads grow from a stem that has a broad papery leaf called the "flag leaf". Panicles are loosely spreading and branched. The cylindrical, straw-colored seed is up to 12 mm long; and contains an awn that is 20-25 mm long with one bend and a fine, long curly segment. Awns may cause mechanical injury to livestock. Seeds have a sharp, needle-like tip at the lower end. Growth starts in late April and proceeds rapidly until mid-June. Flowering begins in early July with seeds maturing by August. Forage value is good before awns develop and after the seeds drop. Palatable and drought resistant, it can be eliminated with continual heavy use.

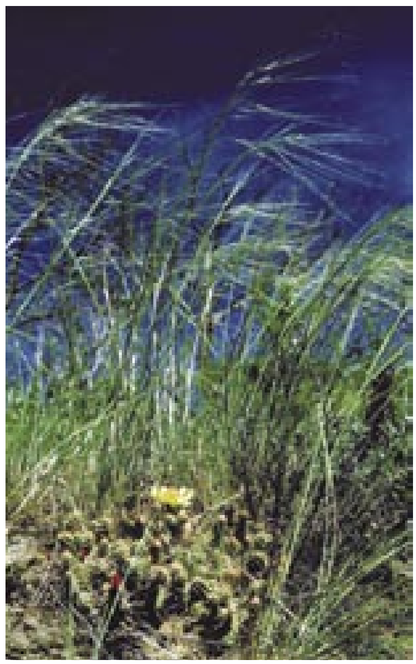


Photo Credit: Jim Romo

Needle-And-Thread

Western Porcupine Grass

Stipa spartea Trin. Var. ***curtiseta*** Hitch,
Stipa curtiseta Hitch
Hesperostipa curtiseta (Hitchc.) Barkworth

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	to 10 cm, bent twice when mature, coarse
Ligule:	to 3 mm, with a depression in centre
Blade:	to 5 mm, flat
Sheath:	round, split, often purplish at base, margins thin, transparent, outer margin with a fringe of hairs

Western porcupine grass is an erect bunchgrass and usually the dominant species on loam soils in the Dark Brown soil zone. A related species, porcupine grass (*Stipa spartea*), grows in southeast Saskatchewan and in Manitoba. Roots of western porcupine grass extend to depths of 1 m. Flowering stems are tall (40-60 cm), producing up to 30 sharp-pointed seeds in a feathery panicle. Mature seeds (12-15 mm long) have a 5-9 cm coarse awn which is bent twice. It is palatable except between seed production and dropping. Nutritive and curing properties are lower then needle-and-thread, but higher than porcupine grass. Under similar conditions, western porcupine grass is more palatable than needle-and-thread.


Photo Credit: Jim Romo

Western Porcupine Grass

Green Needlegrass

Stipa viridula Trin.
Nassella viridula (Trin.) Barkworth

Life Span:	perennial
Origin:	native
Season:	cool
Auricles:	absent
Ligule:	2 mm membranous, hairs on outside margins
Blade:	up to 5 mm wide, flat, shiny on underside
Sheath:	round, prominently veined, long hairs at the throat, margins overlapping

Green needlegrass is a tall, erect bunchgrass with a dense root system extending to depths of 2-3 m. It grows throughout the prairies, but seldom occurs in dense stands and grows best on heavy clay soils with western wheatgrass. The leaves are long, green and mostly basal. Seed stalks can reach 1.25 m tall producing an abundance of small, black, hairy seeds that lack the sharp-pointed callus of other needlegrasses. The weak awn is 2-3 cm long. The most palatable of the needlegrasses, it is sought by livestock all season long. Spring protein content exceeds 20 percent, while protein content in fall is about 8 percent. Tolerant to drought, it is moderately resistant to grazing.


Photo Credit: Jim Romo

Green Needlegrass

SEDGES AND RUSHES

All species listed are perennial, native and cool season plants

Awned Sedge

Carex atherodes Spreng.

Awned sedge is one of the most important plants growing in fresh to brackish marshes and shallow sloughs across most of North America. Strong rootstalks give rise to numerous three-angled leafy stems. Dense masses of short hairs cover underside of soft, three-ranked leaves. Male flower heads grow at stem tips; female spike develops among upper leaves. Stands yield up to 4 tonnes per hectare of palatable, nutritious hay if protected from grazing and flooded until early July. Awned sedge provides good quality forage for cattle and sheep, but does not tolerate heavy grazing. Often occurring with non-palatable water sedge *(Cares aquatilis)*, awned sedge is preferred by grazing animals.

Photo Credit: Gary Larson @ USDA-NRCS PLANTS Database / USDA SCS

Awned Sedge

Thread-Leaved Sedge

Carex filifolia Nutt.

Thread-leaved sedge is a common grass-like plant growing in the Mixed Grass Prairie. While dominant in a few areas, it is usually subdominant with blue grama, needle-and-thread and June grass. It grows 8 to 25 cm high, producing leaves that are 3 to 15 cm long. Densest stands occur on sandy flats and exposed gravelly ridges, or on shallow or infertile soil. Leaves are fine, thread-like, upright, deep-green, rolled and glossy. Chestnut-brown, dead sheaths and female flowers are on the same spike. Often more palatable than surrounding grasses, thread-leaved sedge may contain higher protein and phosphorus concentrations and lower crude fibre. It withstands grazing and trampling better than associated grasses.

Photo Credit: Jim Romo

Thread-Leaved Sedge

Beaked Sedge

Carex rostrata Stokes

Beaked sedge is an important species of marshes and wetlands in the Saskatchewan Parkland and further north. Soft, hair-free leaves grow in whorls of three. Male flowers grow near stem tips; female spikes develop among leaves. The seed ends in a distinctive curved beak. It provides similar yield, protein content, and tolerance to haying as awned sedge. Beaked sedge maintains 18 percent crude protein until mid-summer and is readily grazed by cattle. It produces low quality hay because cutting rarely occurs at optimum time and it often grows with other vegetation of poor forage quality.

Photo Credit: USDA-NRCS PLANTS Database

Beaked Sedge

Low Sedge

Carex stenophylla Wahlenb. ssp. ***eleocharis***

Low sedge is one of the most common dryland plants of the interior plains. It grows throughout the prairies, with dense stands occurring on overgrazed or eroded rangelands. It is the smallest of the dryland sedges having shallow rootstalks that send up single plants 3 to 10 cm apart. Plants have a central three-edged (or triangular shaped) seed stalk and either 3 or 6 leaves, which grow up to 2 mm wide and 3 to 10 cm long. Seed matures in early June, with brown heads and drying leaves that are distinctive when grasses are green (not to be confused with grass carry-over). Heavy stands indicate overgrazed pasture. Two other dryland sedges are palatable but neither produces much forage. Sun-loving sedge *(Carex pensylvanica)* has wider, glossier and more numerous leaves, and more than one flower cluster on its seed-bearing stem. Blunt sedge *(Carex obtusata)* produces seeds which are nearly black when mature.

Photo Credit: Jim Romo

Low Sedge

Baltic Rush

Juncus balticus Willd.

Baltic rush is a species found on a wide variety of sites, but prefers rich soils with high water tables. A well-developed, horizontal rootstock combines with extensive and deep fibrous roots. Stems arise at intervals from the rootstalk. Leaves are basal and scaly. Brown flower clusters develop below stem tips. The crude protein is 16 percent in spring, dropping to 9 percent by late summer. It is grazed readily while green and growing, but palatability declines as plants age. If cut at the right time, it provides suitable hay.

Photo Credit: Jim Romo

Baltic Rush

FORBS

Common Yarrow

Achillea millefolium (ssp. ***lanulosa***) L.

Life span: perennial
Origin: native
Season: cool

Common yarrow is an erect forb growing up to 70 cm tall, from extensive rhizomes. It grows throughout the prairies in moist meadows, woods and open grasslands on various soils. The leaves are hairy, aromatic, deeply divided and fern-like. Numerous, small white (rarely pinkish) flowers form compact, flat-topped clusters. The forage value is poor, with only flower heads usually grazed. An abundance of yarrow indicates a heavily grazed pasture.

Photo Credit: Jim Romo

Common Yarrow

Everlasting or Pussy Toes

Antennaria ssp.

Life span: perennial
Origin: native
Season: cool

Everlasting is a woolly, mat-forming, often stoloniferous forb. There are over 10 species common on the prairies. Leaves are mostly in basal rosettes and usually woolly or hairy. White or rose flowers in compact heads resemble the toes of a cat's paws. It propagates by seed, rhizomes and stolons. Everlasting increases to form ground cover on overgrazed ranges, but it is not normally abundant. Everlasting offers little forage value although flowers are sometimes grazed.

Photo Credit: Jim Romo

Everlasting

Fireweed

Epilobium angustifolium (L.) Holub

Life span: perennial
Origin: native
Season: cool

Fireweed, an erect and stout plant with alternate, very short-stalked, entire leaves, is very common in woodlands, forest edges and burned-over forest, and occasionally along roadsides and moist places in the Prairie region. It grows from long creeping root stalks to heights of 1.2 m. Flowers are pink to purple and appear in July and August. Forage value is good for sheep, fair for cattle, and sometimes used by horses, deer, and elk. It is a good source of honey nectar.

Photo Credit: L. Tremblay

Fireweed

Gumweed

Grindelia squarrosa (Pursh) Dunal

Life span: biennial or perennial
Origin: native
Season: cool

Gumweed is a coarse, erect, branched forb that grows from a taproot throughout the prairies on roadsides, moist, saline sites and heavily impacted sites. Leaves are thick, sticky and hairless with toothed margins. A sticky resin covers numerous, showy yellow flowers. It is unpalatable to livestock or big game, but upland game birds utilize its fruits. Gumweed increases in abundance on heavily grazed pastures.

Photo Credit: Jim Romo

Gumweed

Hairy Golden Aster

Heterotheca villosa (Pursh) Shinners
Chrysopsis villosa (Pursh) Nutt. ex DC.

Life span: perennial
Origin: native
Season: warm

Hairy golden aster, a many branched, tap-rooted and, hardy plant is common on dry sandy prairie and hillsides. It is less common in the Parkland. Leaves are numerous, gray-green, alternative and covered with short stiff hairs. Hairy stems grow 15 to 60 cm high. Bright yellow flowers are usually solitary on the stem. The deep taproot penetrates to 2.4 m. It reproduces from seed. The growth form varies greatly and this forb generally has low palatability for livestock and wildlife. Cattle will selectively graze the flowers. An abundance of hairy golden aster indicates range deterioration.

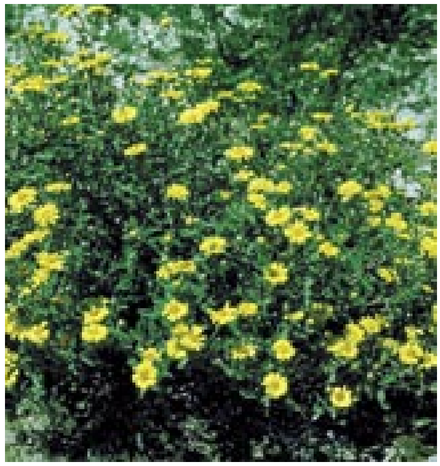


Photo Credit: Jim Romo

Hairy Golden Aster

Purple Vetchling or Peavine

Lathyrus venosus Muhl. Ex Willd White

Life span: perennial
Origin: native
Season: cool

Purple vetchling has a climbing, four-angled stem that extends from a woody root. This palatable forbs grows in forested areas. Leaves have 4 to 6 pairs of smooth, oval leaflets with tendrils at the tips. This plant produces a purple flower. Young leaves can reach as high as 30 percent crude protein, however, it does not cure well and frost greatly reduces nutritive quality. Often selected by livestock, it is a decreaser plant. The roots persist for many years and under proper grazing management and fire, it will grow back.

Photo Credit: Jim Romo

Purple Vetchling

Moss Phlox

Phlox hoodii Richards

Life span:	perennial
Origin:	native
Season:	cool

Photo Credit: Jim Romo

Moss Phlox

Moss phlox, a low, cushion-like, mat-forming plant with coarse woody roots is common on open prairie and less common in parklands. The leaves are numerous, small and needle-like. This plant produces white-blue flowers that are showy, small, and fragrant. It is a conspicuous and very early flowering plant, forming large masses of white on overgrazed areas and eroded hillsides. It is generally avoided by livestock because of its prickly foliage and low growth form. The matted nature of the plant helps protects the soil from erosion. Moss phlox increases as range deteriorates.

Dense Clubmoss

Selaginella densa Rydb

Life span:	perennial
Origin:	native

Photo Credit: Jim Romo

Dense Clubmoss

Dense clubmoss, a compact, low-growing, densely matted plant, is common on drier and open prairies; however, it also grows in the Aspen Parkland of the province. Usually it occupies medium-textured soils, but is plentiful on drier, light, and eroded soils. The leaves are lance-shaped, tiny, and arranged in four ranks to form square, rod-like branches. Plants are usually less than 1.5 cm tall, with stems rooting along entire length helping stop erosion. The plant has a shallow (less than 8 cm deep) and extensive root system. Clubmoss provides no forage value and increases with overgrazing.

Golden Bean

Thermopsis rhombifolia (Nutt. Ex. Pursh) Nutt. Ex Richards

Life span:	perennial
Origin:	native
Season:	cool

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Golden Bean

Golden bean, an erect, branched forb, usually grows in large patches from rhizomes throughout the grasslands and in sandy Aspen Parkland areas. Leaves are alternate and are numerous with three leaflets. Large stipules develop at the junction of stem. The conspicuous flowers bloom early, producing a bright golden yellow that develops a seed pod that is curved in a semi-circle. It provides little forage value. The fruit may cause severe sickness in children.

American Vetch

Vicia americana Muhl. Ex Willd

Life span: perennial
Origin: native
Season: cool

Two varieties of this legume are common: a low-growing variety occurs in moist grassland and another variety growing as a forest understorey climber. The four-angled stems are easily broken. Leaves are compound with 6 to 12 pairs of leaflets. One or more tendrils grow at leaflet tips. Blue-purple flowers grow in leaf axils and produce flat seed pods that break open easily. Plant roots have nodules containing rhizobia that fix nitrogen. The plant contains about 20 percent protein in summer, and is low in crude fibre. American vetch disappears with heavy grazing.

Photo Credit: M. Tremblay, Saskatchewan Ministry of Agriculture

American Vetch

Photo Credit: Jim Romo

American Vetch

SHRUBS

Silver Sagebrush or Hoary Sage

Artemisia cana Pursh

Life span: perennial
Origin: native
Season: cool

Silver sagebrush, a many-branched shrub with gnarled, twisted stems, and shredded bark is very common on lighter soils, but rare in Parkland areas. The largest stands occur in the Great Sand Hills. These shrubs have a deep taproot and the shrub can form extensive colonies by rhizomes. Silver leaves (up to 40 mm long) have hairs on both sides and are occasionally toothed at the end. It is not classified as palatable, but is often browsed. Protein is approximately 20 percent in summer, dropping to 10 percent in fall. Silver sagebrush increases in abundance under cattle grazing, but decreases with sheep browsing. This plant is an important winter browse for pronghorn antelope and is critical for sage grouse habitat.

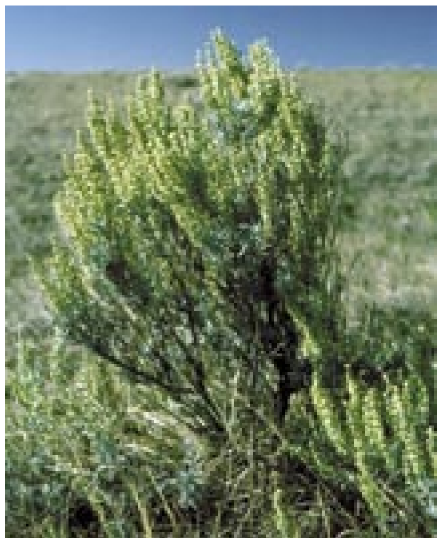


Photo Credit: Jim Romo

Silver Sagebrush

Pasture Sage or Fringed Sagebrush

Artemisia frigida Willd.

Life span:	perennial
Origin:	native
Season:	cool

Pasture sage is a very hairy, silver-gray half-shrub growing from a woody base. The plant dies back to ground level every year bur resprouts from the crown the following year. The leaves divide 2 or 3 times into linear segments. Small yellow flowers bloom from July to early September. Handling leaves releases a distinct, camphor-like odour. The nutritive value of this plant is high, however it is unpalatable for cattle. This plant decreases under sheep grazing. Heavy stands indicate overgrazing. Numerous viable seeds, drought tolerance, and low palatability allow this plant to thrive on heavily used rangelands.

Photo Credit: M. Tremblay, Saskatchewan Ministry of Agriculture

Pasture Sage

Nuttall's Saltbush

Atriplex nuttallii S. Watson
Atriplex gardneri (Moq.) D. Dietr.

Life span:	perennial
Origin:	native
Season:	warm

Nuttall's saltbush, a low-growing, gray-green, many branched shrub with a woody base, grows in southern Saskatchewan on moderately saline soils in association with western wheatgrass, and on shallow soils with blue grama. Its branches may be prostrate, reaching 70 cm long and producing leaves that are alternate, long-oval, short-stalked or stalkless, grayish-green and fine-scaly. Male and female flowers are on separate plants. Deep roots enhance drought tolerance, but new stems grow slowly after being grazed. It is palatable to all livestock classes and is preferred during autumn and winter (providing over 10 percent protein in late autumn), but can be grazed anytime. It contains low crude fibre and high ash. Nuttall's saltbush requires careful management to maintain productivity.

Photo Credit: Jim Romo

Nuttall's Saltbush

Winterfat

Eurotia lanata (Pursh) Moq.
Ceratoides lanata (Pursh) J.T. Howell
Krascheninnikovia lanata (Pursh) A. Meeuse & Smit

Life span:	perennial
Origin:	native
Season:	cool

Winterfat, a silver-gray, tap-rooted shrub, grows up to 50 cm tall on well-drained soils, but may also occur on shallow, eroded sites and saline soils. Fine star-like white hairs cover plants and redden with age. Male and female flowers are separate on the same plant. The long, silky, white hairs that cover the female seed heads make plants very conspicuous. This plant is extremely palatable with good nutritive balance and contains high protein and phosphorous concentrations into late fall. Winterfat is grazed out on many ranges. Maintaining plants is possible when associated grass management produces an average carryover of about 50 percent and if grazing is delayed until fall or winter.


Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Winterfat

Wolfwillow or Silverberry

Elaeagnus commutata Bernh. Ex Rydb.

Life span:	perennial
Origin:	native
Season:	cool

Wolfwillow, a shrub, grows 2 to 5 m high with brown, scaly twigs and is present throughout the Aspen Parkland and prairie areas on lighter soils where moisture is plentiful. Silvery, oblong, alternate leaves are scurfy on both sides. Dense clusters of yellow flowers in leaf axils produce silver berries. Flowering period produces a distinctive fragrant smell. The root nodules on this plant fix nitrogen. It is a valuable plant in well-managed pastures, but can spread and create a grazing barrier for livestock in overgrazed pastures.


Photo Credit: M. Tremblay, Saskatchewan Ministry of Agriculture

Wolfwillow

Broomweed or Broom Snakeweed

Gutierrezia sarothrae (Pursh) Britt. & Rusby
Xanthocephalum sarothrae (Pursh) Shinners

Life span:	perennial
Origin:	native
Season:	cool

Broomweed, a bushy, many-branched half-shrub grows from a deep, woody taproot in dry areas and hillsides throughout the prairie and Aspen Parkland regions. The plant produces numerous clusters of yellow heads at its branch ends. It is unpalatable and poisonous to sheep and cattle, causing death and abortions. Broomweed is extremely drought-tolerant with deep roots and narrow leaves. It increases on poorly managed rangelands.


Photo Credit: Jim Romo

Broomweed

Greasewood

Sarcobatus vermiculatus (Hook.) Torr.

Life span:	perennial
Origin:	native
Season:	cool

Greesewood is a thorny, free-branching shrub that grows around saline sloughs and flats throughout the Brown soil zone. The smooth stems are covered with white, easily shredded bark that turns gray with maturity. Thorns and branches grow at 90 degree angles to the stem. Leaves are linear, fleshy and yellow-green. It is a valuable winter browse for livestock and is important food for wildlife such as porcupines, jack-rabbits and prairie dogs. Greasewood is poisonous to sheep if eaten in large amounts, especially during spring and summer; however cattle are rarely poisoned. It contains high sodium and potassium concentrations, particularly in dry years.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Greasewood

Western Snowberry or Buckbrush

Symphoricarpos occidentalis Hook.

Life span:	perennial
Origin:	native
Season:	cool

Western snowberry is an erect, broad-leaved shrub with a creeping root system and is one of the most widespread and common shrubs. It can form dense stands in open prairies, ravines, coulees and woodland. Snowberry traps snow well. Old growth has shredded brown bark. Pink flowers open in late June, eventually forming white, waxy berries by late August. This plant spreads by creeping roots and it can increase on overgrazed pastures. Plants can also expand into vigorous grasslands. Palatability varies with locality, but plants are usually left ungrazed. An important browse species for mule deer.

Photo Credit: Jim Romo

Western Snowberry

POISONOUS PLANTS

All species listed are native, cool season perennials.

Milkvetch

Astragalus ssp.

Photo Credit: Jim Romo

Narrow-Leaved Milkvetch

Milkvetches are legumes that grow from woody taproots, have pinnate leaves with 3 to many leaflets and are common across the prairies on native grasslands and woodlands. Two species are potentially poisonous due to selenium accumulation: Narrow-leaved milkvetch *(A. pectinatus)* grows in dry prairie on light and medium-textured soils, while two-grooved milkvetch *(A. bisulcatus)* grows on heavier textured soils in moist habitats. Poisonings are rare, occurring most often in late summer or fall on overgrazed ranges that have little palatable forage available. These plants have a strong odour arising from the selenium they accumulate.

Photo Credit: Jim Romo

Two-Grooved Milkvetch

Western Water Hemlock

Cicuta douglasii (DC.) Coult. & Rose

Warning: *Contact with this plant's root can cause death in humans.*

Western water hemlock is the most toxic plant of the North Temperate zone. It grows in wetlands, meadows, wet draws and stream banks in grasslands and forests. A tall (up to 2 m) erect forb with a hollow stem produces leaves that are twice-divided and leaflets of 5 to 8 cm long with toothed margins. Flowers are small and white in an umbrella-shaped head. Hollow chambers divide horizontal cross sections of the thick stem base. Short, tuberous rootstalks emit a yellow, aromatic, extremely poisonous oil. Oil is concentrated in roots, but young shoots contain troublesome amounts. A single root can kill a cow. Less can kill a human. Symptoms include frothing at the mouth, uneasiness, pain and then violent convulsions. Treatment is not usually possible. Plants are easily pulled out of wet ground by grazing livestock. Avoid confusing plants with the non-poisonous cow parsnip *(Heracleum lanatum),* which has once-divided leaves with large leaflets.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Western Water Hemlock

Low Larkspur

Delphinium bicolour Nutt.

Low larkspur occurs in the Wood Mountain and Cypress Hills regions of southern Saskatchewan, growing in sheltered open places, in coulees, lower slopes of hills, and particularly on heavier soils. Blue flowers bloom in May-June, are spurred and resemble domestic Delphinium plants, but this plant only grows 20-50 cm tall. Leaves are mostly basal, clefted and dissected and are covered with fine hairs which give them a grayish appearance. The plant is very poisonous to cattle in spring, but is not known to be poisonous to sheep. Avoid poisonings by delaying grazing until the mature plants dry in early July.

Photo Credit: Jim Romo

Low Larkspur

Early Yellow Locoweed

Oxytropis ssp.

Early yellow locoweed is a legume that grows from a taproot with no apparent stem. Early yellow locoweed *(O. sericea)* and late yellow locoweed *(O. campestris)* are common in dry and moist prairie, respectively. Two other species, *O. lanmbertii* and *O. splendens* with purple flowers are less common. Pinnately compound leaves produce odd-numbered, silky or short-haired leaflets. The exact nature of the toxic substance (locoine) is not known. Locoweed has low palatability, but it is grazed if other forage is scarce, especially in spring. While poisonings rarely occur, extensive grazing induces chronic and addictive illness and prolonged consumption can cause death. If plants are numerous, exclude already addicted animals from ranges.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Early Yellow Locoweed

Seaside Arrowgrass

Triglochin maritima L.

Seaside arrowgrass is a grass-like plant with solid, leafless stems growing from deep rhizomes. It grows in salt marshes and saline sloughs throughout western Canada. Leaves are basal, spongy and crescent-shaped in cross section. Hydrocyanic acid (prussic acid) is produced in the plant's fresh or dried leaves by mixing two usually separate non-poisonous substances. Drought, frost, grazing, and trampling cause the poison to develop. Foliage is readily eaten if livestock are hungry, thirsty, or if they need salt. Consumption of as little as 5 percent of animal body weight can be fatal. Asphyxia or respiratory paralysis causes death. Symptoms usually progress too rapidly for treatment. Avoid infested areas. Herbicides for selective control are not available. Non-selective herbicides are not effective.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Seaside Arrowgrass

Death Camas

Zygadenus gramineus Rydb.

Death camas grows in early spring in draws, low-lying areas, and lower coulee slopes. The plant grows from south central Saskatchewan west throughout southern Alberta. The foliage and flowers of death camas arise from a bulb about 10 cm deep in the ground. The leaves are grasslike, but are thicker and V-shaped, growing up to 15 cm long. A single flowering stem grows up to 50 cm tall and bears an elongated raceme with many small, yellowish-white flowers. All parts of death camas are poisonous, especially the bulb. The bulb can be easily pulled out in wet conditions in spring. Most dangerous to sheep, but cattle can be affected also, particularly when stands are thick and other forage is not readily available.

Photo Credit: Jim Romo

Death Camas

References and Suggested Readings

Bedunah, D.J., and R.E. Sosebee (eds.). 1995. Wildland Plants: Physiological Ecology and Developmental Morphology. Society for Range Management. Denver, CO.

Dietz, H. E. 1989. Grass: The Stockman's Crop: How To Harvest More Of It. Sunshine Unlimited Inc. Lindsborg, KS. 16p.

Gates, George A. (ed). 1985. Understanding Grass Growth: The Key To Profitable Livestock Production. Trabon Printing Co. Kansas City, MO. 20p.

Looman, J., and D. F. Best. 1987. Budd's Flora of the Canadian Prairie Provinces. Agriculture Canada. Ottawa, ON. 863p.

Looman, J., W. Majak, and S. Smoliak. 1983. Stock Poisoning Plants of Western Canada. Agriculture Canada. Ottawa, ON. 36p.

Looman, J. 1982. Prairie Grasses Identified and Described by Vegetative Characteristics. Agriculture Canada. Ottawa, ON. 244p.

Looman, J. 1983. 111 Range and Forage Plants of the Canadian Prairies. Agriculture Canada. Ottawa, ON. 255p.

Moss, E. H. 1983. Flora of Alberta. Revised by J. G. Packer. University of Toronto Press. Toronto, ON. 687p.

Saskatchewan Forage Council. 2007. Field Guide: Identification of Common Range Plants of Northern Saskatchewan, Compiled by Alicia N. Hargrave. Saskatoon, SK. 63p.

Saskatchewan Forage Council. 2007. Field Guide: Identification of Common Riparian Plants of Saskatchewan, Compiled by Alicia N. Hargrave. Saskatoon, SK. 59p.

Saskatchewan Forage Council. 2007. Field Guide: Identification of Common Range Plants of Southern Saskatchewan, Compiled by Alicia N. Hargrave. Saskatoon, SK. 59p.

Schuster, J. L. 1964. Root development of native plants under three grazing intensities. Ecology 45: 63-70.

Sindelar, B. W. 1988. Opportunities for Improving Grass Reproductive Efficiency on Rangelands. In: Achieving Efficient Use of Rangeland Resources. R. S. White and R. E. Short (eds). Montana Agriculture Experiment Station. Bozeman, MT. 132p.

Sosebee, R. E. (ed). 1977. Rangeland Plant Physiology. Range Science. Series No. 4. Society for Range Management. Denver, CO. 290p.

Stoddart, L. A., A. D. Smith, and T. W. Box. 1975. Range Management. Third Edition. McGraw-Hill. New York, NY. 532p.

Stubbendieck, J., S.L. Hatch, and L.M. Landholt. 2003. North American Wildland Plants: A Field Guide. Sixth Edition. University of Nebraska Press. Lincoln, NE. 506p.

The Great Plains Flora Association. 1986. Flora at the Great Plains, University of Kansas Press. Lawrence, KS. 1392p.

University of Saskatchewan. 2000. Plant Ecology 434.3: Rangeland Ecosystems and Plants. http://www.usask.ca/agriculture/plantsci/classes/range/

Vance, F. R., J. R. Jowsey, and J. S. McLean. 1984. Wildflowers Across the Prairies. Western Producer Prairie Books. Saskatoon, SK. 337p.

Planned Grazing Management: Using Grazing Systems

To meet management goals and maintain the condition of range, managers must evaluate the strengths and weaknesses of many grazing systems. It is useful to understand and apply the principles of grazing management when developing a customized grazing system. Grazing management must be tailored to match available resources, maximize energy capture and flow, balance forage production and consumption by animals, optimize forage yield and livestock performance, prevent overgrazing, optimize ecosystem functions, and be economically and ecologically sustainable.

Photo Credit: T. Lennox, Saskatchewan Ministry of Agriculture

Photo Credit: T. Lennox, Saskatchewan Ministry of Agriculture

A well designed grazing system allows the range to improve while it is being used

Developing Grazing Systems

Grazing systems are intended to allow use of forages by grazing animals while improving or maintaining soil and plant resources. Grazing systems are customized for the local climatic conditions, soils, landscape, vegetation, kind of animals or class of stock grazing, and the objectives, interest, abilities and knowledge of managers.

Sustainable grazing systems maximize energy capture and flow, maintain or improve the chemical and physical properties of soils, maintain or enhance nutrient cycling, optimize the hydrologic cycle, control which plants grow on the range, and meet the physiological needs of animals. These goals are achieved by alternating periods of grazing with periods of rest or non-use.

Photo Credit: Jim Romo

Cattle grazing Fescue Prairie

Photo Credit: Jim Romo

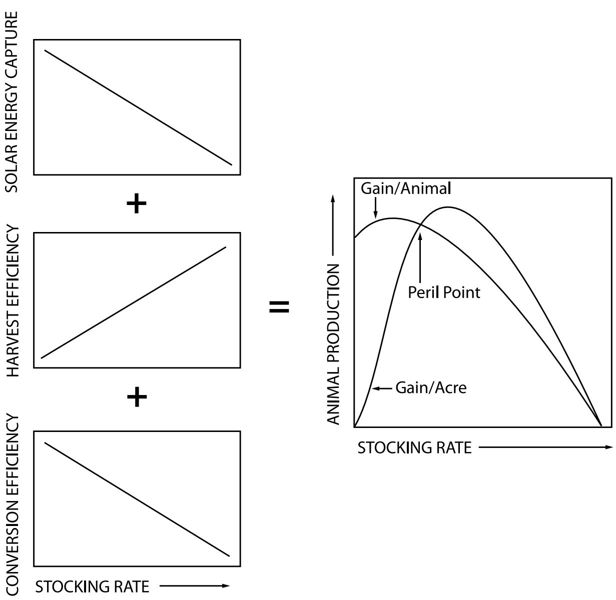
Clipping to determine forage supply

All sustainable grazing systems recognize that forage supply must exceed or equal the amount of forage required to meet the needs of animals. Potential forage supply varies with range ecosites and range health. Forage supply is determined by inventorying the ecosites and the relative amounts of different plants on each ecosite. After determining range condition, stocking rates for each ecosite and the total amount of forage supply can be determined. As a rule it is recommended that range be stocked at about 80 percent of the forage supply or carrying capacity to provide a buffer for drought. This buffering is extremely important in Saskatchewan as precipitation is less than average on rangelands more than 50 percent of the time.

The amount of forage each animal is expected to consume during the grazing season is the demand. The size of animals must be taken into account as different classes of animals need different amounts of forage. A balanced monthly and yearly budget must be developed after the animal and forage inventory is completed.

Producing Forage

The amount of animal production that can be produced from range is closely linked to the amount of forage produced by plants and efficiency of converting forages into animal products by grazing animals (Figure 23). Stable and optimum production of animal products cannot be expected if forage production is limiting. If the goal is to sustain and optimize forage and animal production then plants must capture maximum amounts of solar energy (Figure 24), or energy must be supplied from another source (Figure 25), and forage must be converted efficiently to animal products.



Source: Heitschmidt and Stuth 1991.

Figure 23: Livestock production per individual animal and per unit area originate from the combined effects of efficient solar energy capture, forage harvest efficiency, and conversion efficiency in response to grazing intensity

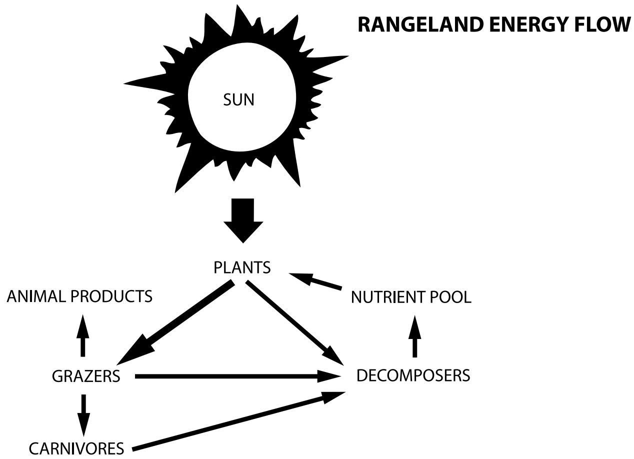


Figure 24: Rangeland energy flow

If managerial goals include maximizing forage yield on an acre-by-acre basis, it is necessary to maximize energy capture through photosynthesis by forage plants. Therefore, when considering grazing systems evaluating the effectiveness of plant energy capture and conversion into forage is essential.

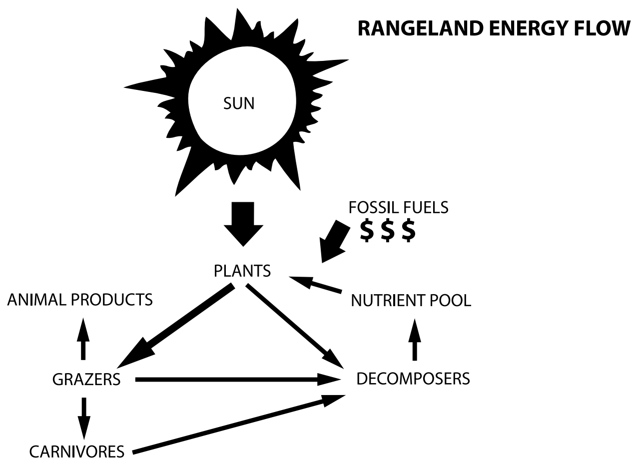


Figure 25: Rangeland energy flow with external inputs to the system

All rangelands have environmentally controlled upper limits on energy capture and flow. The proximity to the upper limit of energy capture is regulated primarily by managerial decisions. **The key to achieving maximum energy capture is providing plants with periods of high quality rest of adequate duration after grazing.**

Photo Credit: Jim Romo

Plant material remaining after grazing has many benefits

Plant Recovery After Grazing

Plant grazing creates an energy deficit for the plant. In addition, their ability to capture additional solar energy through photosynthesis is reduced after grazing. However, if plants are rested and allowed to re-grow, they will regain their potential to capture energy through photosynthesis (Figure 26).

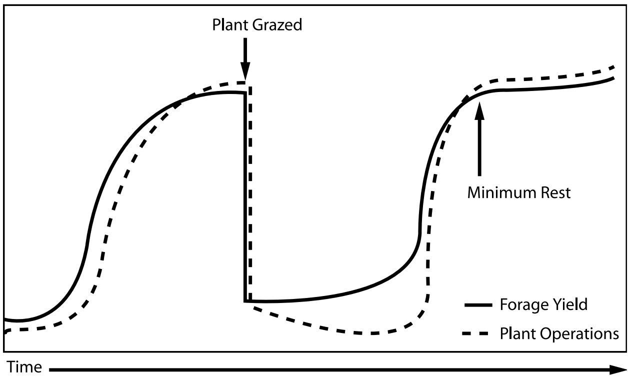


Figure 26: Plants NOT Under Rested and NOT Overgrazed

Grazing accentuates environmental stresses, which affects photosynthesis in plants. For example, in southern Alberta, removal of dead plant material reduces forage production by more than 50 percent, presumably because soil water deficits are created. Therefore, it is critical to leave live and dead plant material after grazing in water-limited environments such as on rangelands in Saskatchewan.

Plant functions impaired by grazing is likely the most important consideration when developing grazing systems. Fortunately, the impacts of grazing are eliminated when plants are given ample rest and time to repair the consequences of grazing. Recovery from grazing takes time - time with favourable conditions for plant growth - and time in which plants are not further affected by grazing.

Overgrazing is simply caused by not providing plants with enough rest after grazing (Figure 27). The lack of rest after grazing causes many effects on range.

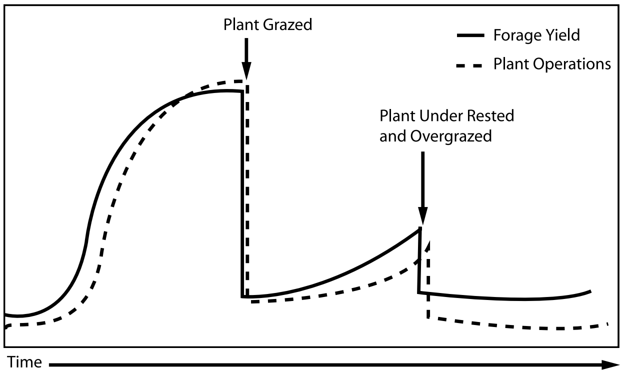


Figure 27: Under Resting - Overgrazing of Plants

Rest periods must be provided during the growing season. Most forage production takes place in about a 60 day period of early- to mid-summer in Saskatchewan. Therefore, plants must be rested during this time or they will not completely regain their vigour. It may be necessary to rest plants the year after grazing if they cannot grow after the grazing period.

Animal Production

Managers have the option of maximizing animal production per acre or maximizing gain per animal. In some cases managers may wish to optimize both. At low stocking rates, gain per animal will be greatest; however, animal production per acre will be low (Figure 23). As stocking rates are increased, gains per animal decline slightly, but animal production per acre increases. Further increases in stocking rate will reduce gain per animal and gain per acre. Under high stocking rates neither gain per acre nor gain per animal will be near the long term potential. Between these extremes in stocking rates, it is possible to achieve a sustainable balance in gain per animal and gain per acre. Stocking rates that allow the best of gain per animal and gain per acre vary with soil zone, ecosite, and ecological condition of the range.

Sustainable Grazing

The key to making grazing sustainable is to identify sustainability as a management goal and to develop grazing systems within the constraints of the biological and physical resources of the range. Providing plants with periods of high quality rest of adequate duration after grazing will go a long way toward reaching this goal.

Understanding and applying grazing principles dictate the success of grazing systems. Applying the basic principles of grazing systems allows managers to develop grazing systems that are user friendly, simple, and practical. In the end, each grazing system must be customized for sustainable use of natural resources upon which we all depend.

All grazing systems are based on a similar set of principles. Some grazing systems are more effective than others at allowing use of forage resources while maintaining or improving condition of rangeland resources. Each manager must apply set principles of grazing management to meet the unique needs of the soils, environment, conditions of the range, plants, and management.

The following checklist can be used to help evaluate whether a sustainable grazing management system has been developed.

- Planning and implementation of the grazing system fits the soil and plant resources;
- Energy capture and flow are maximized;
- Nutrient cycling is not impaired;
- The water cycle is functioning properly;
- Rangeland health is improving or being maintained in a high state;
- Overgrazing is not occurring--periods of grazing and rest are alternated, and rest is provided during the growing season;
- Livestock are uniformly distributed in paddocks, and selective grazing has been reduced;
- Livestock demands are balanced with forage supply, and physiological needs of animals are met;
- Livestock production per acre, gain per animal, or both are being optimized in the long term, and;
- The grazing system is user friendly, practical, simple, and flexible.

Photo Credit: Jim Romo

Animal production should be based upon sustainable grazing management strategies

It is likely that a sustainable grazing system has been developed when all of these principles have been incorporated and are being met. If one or more of these conditions are not being met, it is likely that the grazing system can be improved. Understanding the principles of grazing systems allows one to evaluate the strengths and opportunities for improvement in a livestock operation.

Grazing System 'Tools'

Land managers have various 'tools' that can be used to accomplish specific goals. To improve animal distribution, some of the tools that can be employed are cross-fencing, water development, herding, and salt/mineral placement. More management by the producer can significantly improve the degree of success.

Misconceptions

Two common misconceptions about grazing systems include:

1. *A universal best grazing system exists.*

   Grazing systems must be developed for each situation. Grazing systems must be tailored for unique resources and goals. Managers can combine traits from more than one grazing system to develop one that suits particular needs and goals.

2. *Specialized systems allow managers to ignore other range management principles.*

   Successful grazing systems rely on range management principles such as proper stocking, incorporating short periods of grazing, promoting plant rest during the growing season, grazing during the proper season, and improving livestock distribution.

Grazing systems each have distinct characteristics, advantages, and disadvantages. Some grazing systems are not universally applicable and are only successful in certain environments. For example, grazing systems which strive for multiple periods of grazing during the year may not be suited to areas with short growing seasons, harsh environments, and slow growing plants. Grazing systems that make use of different areas of a pasture at different times of the year may complement or compete with

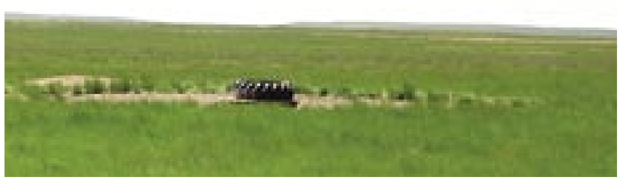


Photo Credit: T. Lennox, Saskatchewan Ministry of Agriculture

Salt and mineral placement help improve livestock distribution various wildlife species. For example, sharp-tailed grouse and dabbling ducks nest in taller grasses. Deer prefer the cover of the dense undergrowth in aspen groves or wetland margins for birth and resting of fawns in early summer.

Common Grazing Management Systems

Continuous (season long)

Livestock are turned onto a grazing allotment at the beginning of the grazing season and remain there until the season ends. This system is popular because it does not require a high level of management skill and it requires fewer improvements and less monitoring than other systems. Stocking rates should be moderate and based on a proper use factor of 50 percent. Continuous systems do little to control livestock distribution or eliminate localized overgrazing. Many well-documented cases of range deterioration can be attributed to overstocking and continuous grazing. However, if a range is in good condition and it continues to be grazed moderately, this system can work.

Deferred Grazing

A deferred grazing system delays grazing on specified pastures until the key forage species produce seeds. This deferment reduces the length of the grazing period for deferred pastures and may lead to reduced palatability of forage plants. On the positive side, deferment provides rest for valuable decreaser species, and leads to higher forage quality in the remaining forage, and allows plants opportunity to reproduce and sustain production. Stocking rates are usually based on a predetermined proper use factor.

Two-Paddock Switchback

The range is divided into two paddocks by construction of a single crossfence. Fencing allows the manager to concentrate use on one paddock, while resting the other. Livestock may be grazed on the unit for a predetermined length of time or according to growing conditions.

For example, livestock may graze paddock A for the first half of the grazing season, then A is rested until the following year. Pasture B would be grazed during the latter part of the grazing season during year one, as well as the early part of the season during year two (Figure 28).

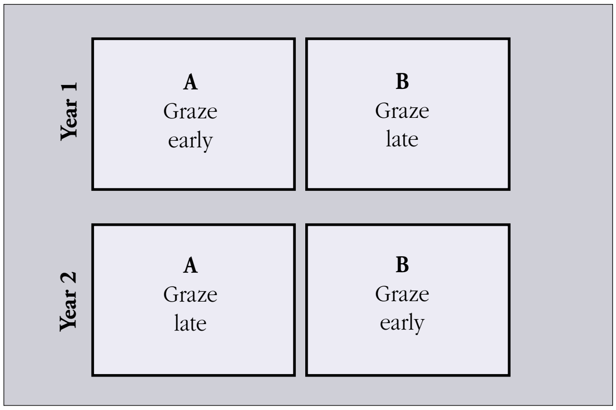


Figure 28: Two-paddock switchback grazing system

Deferred-Rotation Grazing

This grazing system defers grazing on several pasture units in a planned rotation. A minimum of three paddocks are required, making additional fencing and water development necessary. Producers must also spend more time monitoring and moving livestock.

In year one a paddock is grazed early until a predetermined proper use factor is reached. During year two grazing is deferred until seed ripens to allow trampling of seed into the ground. In year three grazing is deferred to allow new seedlings to establish (Figure 29).

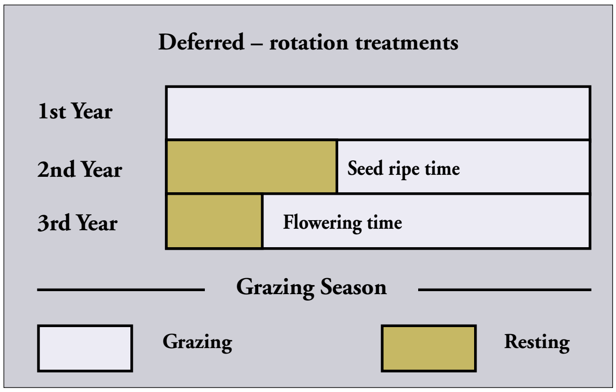


Figure 29: Deferred-rotation grazing system

Reduced selective grazing and less selective overgrazing is achieved by concentrating more livestock on a smaller area and encouraging consistent utilization. Range condition often improves over time with this system, but individual animals may gain less than with other systems but overall gain/acre is greater.

Rest-Rotation

Rest-rotation grazing is similar to deferred-rotation grazing, but it has the addition of a yearlong rest period for at least one pasture during a grazing cycle. This yearly rest period allows the opportunity for establishment of new grass seedlings and allows for plants to recover from previous grazing

(Figure 30). A minimum of four paddocks is required for rest-rotation, thus this grazing system requires more development than deferred-rotation grazing. Rest-rotation grazing has the same advantages and disadvantages as deferred-rotation grazing. In cases of severe over utilization, one year of rest may not be sufficient to allow plant recovery.

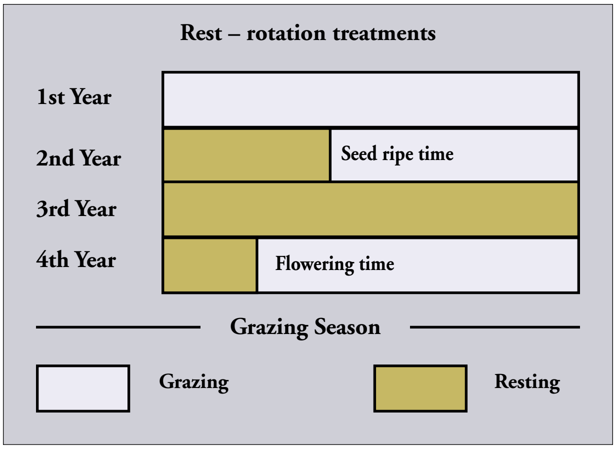


Figure 30: Rest-rotation grazing systems

Complementary

Complementary grazing is one of the most common grazing systems in western Canada. Nearly all producers utilize complementary grazing systems. Complementary grazing systems, which manage and use different forages in a complementary manner, have been successful in Canada. For example, crested wheatgrass provides early, highly nutritious forage at a time when native range is most vulnerable to grazing. Crested wheatgrass can be grazed from late April to about mid-June. Livestock then graze native range until mid-September. Russian wildrye can be grazed from mid-September until freeze-up, and Altai wildrye is grazed through early winter.

Photo Credit: T. Lennox, Saskatchewan Ministry of Agriculture

Meadow bromegrass is commonly used for grazing

In areas with greater available moisture, meadow bromegrass is used rather than crested wheatgrass or Russian wildrye. Meadow bromegrass is easy to establish, is competitive, and provides excellent early spring and fall grazing. It is more versatile than crested wheatgrass because it has a wider season of appropriate use than does crested wheatgrass.

Intensive Grazing Systems

'Intensive Grazing' refers to systems that focus on high management inputs and increased stock control. Intensive grazing generally involves many pastures (Figure 31). The basic premise of intensive grazing is that livestock are grazed at relatively high stock density, but not necessarily a high overall stocking rate. Livestock are rotated through paddocks based on plant growth and recovery time after grazing. The goal is to distribute livestock use evenly over the pasture, reduce re-grazing of individual plants through short grazing periods, and provide long rest periods after grazing.

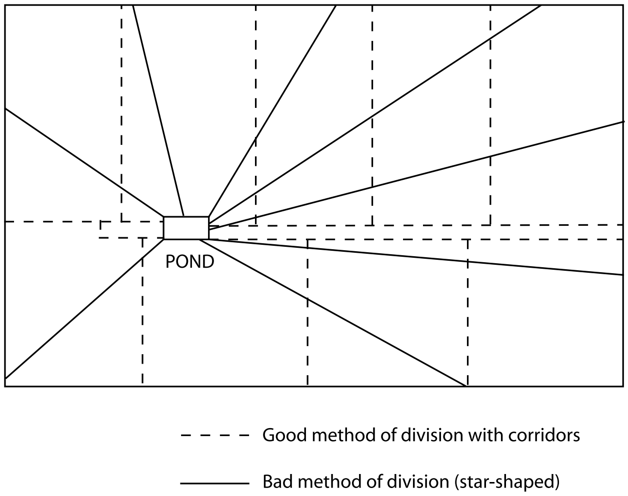


Figure 31: An example of intensive grazing divisions from Voisin (1959)

Following grazing, plant growth is slow. Plants then grow rapidly, and growth slows again as leaves die. Timely rainfall speeds growth or regrowth, reducing the required recovery time. Grazing intervals and rest periods must be altered according to the growth rate of plants.

Livestock should return to paddocks only after plants have adequately recovered from previous grazing. Determining how much forage to remove from a paddock is important, as residual plant material is important for regrowth of plants. A good goal to aim for would be to leave between four and six inches of standing residue behind.

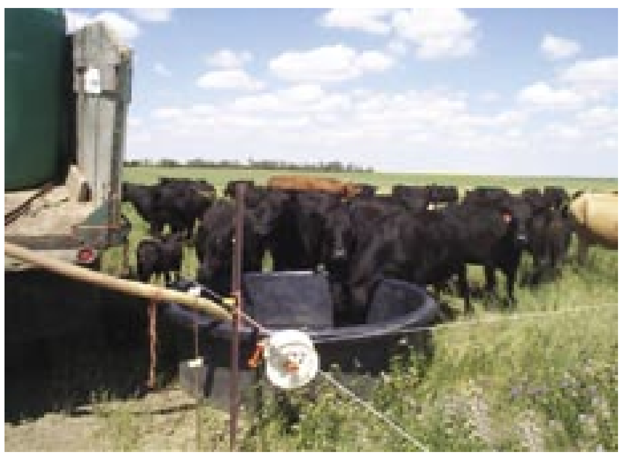


Photo Credit: T. Lennox, Saskatchewan Ministry of Agriculture

Electric fencing and water development are important tools for intensive grazing

Table 2. Comparison of selected grazing systems

A. Grazing System Requirements				
Grazing System	**Minimum Number of Pastures**	**Relative Level of Investment**	**New Water Needs**	**Labour & Skills**
Continuous	1	low	none	low
Deferred	1	moderate	none	low
Light	1	low	none	low
Complementary	2	moderate	moderate-high	low
Deferred-rotation	2	moderate	moderate	moderate
Switchback	2	moderate	moderate	high
Repeated seasonal	3	moderate-high	moderate-high	moderate
Rest-rotation	4	high	high	high
H.I.L.F.*	8	very high	very high	very high
SD/TC*	8	very high	very high	very high

B. Management Considerations			
Grazing System	**Animal Handling Requirements**	**Suitability for Improvement Practices**	**Potential for Improving Range Condition**
Continuous	low	low	low
Deferred	low	low	moderate
Light	low	low	moderate
Complementary	low-moderate	low-moderate	moderate
Deferred-rotation	low-moderate	low-moderate	moderate
Switchback	low	low-moderate	low
Repeated seasonal	moderate	low-moderate	low-moderate
Rest-rotation	high	high	very high
H.I.L.F.*	very high	very high	low
SD/TC*	very high	very high	low

C. Potential Gain/Risk			
Grazing Strategies	**Relative Gain Per Animal**	**Relative Gain Per Acre**	**Risk of Plant & Animal Soil Impact**
Continuous	high	low-moderate	low
Deferred	moderate	moderate	low
Light	very high	low-moderate	very low
Complementary	moderate-high	very high	low
Deferred-rotation	low-moderate	moderate-high	low
Switchback	nd*	nd	nd
Repeated seasonal	moderate	moderate	low-moderate
Rest-rotation	low-moderate	moderate	low
H.I.L.F.*	very low	high	very high
Short duration	low	high	very-high
Time Controlled	low	high	high

* H.I.L.F.: high-intensity low-frequency grazing
SD: short-duration grazing
TC: time-controlled grazing
nd: limited data

Intensive grazing systems have been referred to as Savory grazing, cell grazing, etc. Often these grazing systems are grouped under three main types: high-intensity low frequency grazing, short-duration grazing and time-controlled grazing. These grazing systems, by definition, have varying paddock numbers, stock densities, length of grazing and rest periods. It is somewhat difficult to differentiate between these grazing systems because they differ only by degrees - there is a continuous gradation from one type to another. Intensive grazing systems require greater management skills than other grazing systems. Strong time and financial commitment from the producer is required for successful implementation of intensive grazing systems.

One of the cornerstones of successful grazing systems is flexibility. All grazing systems should be flexible enough to allow for adjustments to grazing periods, rest periods, stocking rates and densities, to match the current growing conditions. Simply adding crossfences does not necessarily make a good grazing system. Concentrating livestock into smaller pastures may be detrimental to both plant and animal growth if the principles of grazing management are ignored.

A land manager must work within the productivity limitations for a specific tract of land. No matter what grazing system is used, stocking rate has a large impact upon plant health and overall range condition. There is an upper limit on the potential productivity for a site and productivity will not increase by putting in additional water sources and fences.

Management of Special Areas

Riparian Areas

Riparian areas are the transition zones between upland and aquatic environments, and form narrow strips along rivers, streams, lakes and other bodies of water.

Domestic livestock are generally attracted to riparian areas, which provide them with water, feed and shelter. Proper distribution of livestock can reduce or prevent overuse of riparian areas and reduce deposition of animal excrement in or near water bodies. Possible management options for drawing cattle away from riparian areas include:

1) clean water and shade made available away from riparian areas; rubbing posts, feed, and supplements placed away from the riparian zone;

2) riding and herding; (research conducted by Bailey (2003) indicates that herding has great promise for protecting riparian areas);

3) seeding complementary pastures;

4) fencing;

5) restricted or reinforced access points;

6) strategic change in location and timing;

7) season of grazing.

Uneven grazing distribution can occur in riparian areas because most cattle prefer to spend time near the water and do not graze upland areas intensively.

Range managers use grazing systems for maintaining and improving the condition and functioning of riparian ecosystems. The value of grazing systems for improving a degraded riparian zone is ranked based on observation of several operations using each system:

- high value (setting aside a specific riparian pasture, corridor fencing),
- good value (deferred, deferred rotational, rest-rotation, seasonal), or
- low value (continuous season-long, short duration).

Timing, duration and intensity of grazing are particularly important in riparian areas (Table 3).

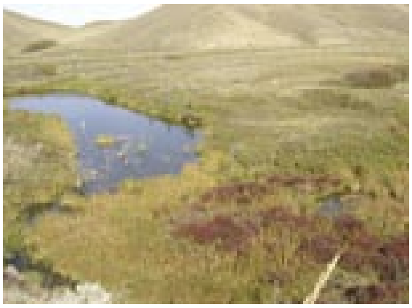


Photo Credit: T. Lennox, Saskatchewan Ministry of Agriculture

Some examples of riparian areas

Table 3. Relative success of some grazing management strategies in riparian ecosystems (Adapted from Kinch. 1989.)

	Relative Success of Management	
Grazing Management Strategy	**Successful**	**Unsuccessful**
Rest period following grazing	long	short
Duration of use	short	long
Duration of use in fall	short	long
Years with fall use	few	many
Maintenance of plant cover through rest and regrowth periods	many	few

Conclusions

- Long rest periods least damaging
- Short grazing periods least damaging
- Short periods of fall grazing least damaging to ecosystem
- Infrequent fall grazing least damaging
- Maintaining residual cover is critical

Forested Areas

Saskatchewan's forested areas support many uses such as grazing, wildlife habitat, logging, tourism, and recreation. Grazing management can have direct or indirect impacts on other land uses due to changes in vegetation and soils caused by livestock. Reaching a balance between livestock grazing and ecological sustainability is of prime importance and is realistically attainable. Grazing management priorities should be:

- maintaining litter;
- minimizing soil compaction; and
- maintaining a healthy and desirable composition of understorey plants.

Stocking rates and season of use are key tools for managing grazing forested areas. Many of the forage species in forest range do not have the regrowth potential that prairie grasses possess. It is best to delay grazing in forests at least until early June when plants have made significant growth and are growing quickly.

Overstocking and overgrazing forests compacts soils, reduces the humus layer, and changes species composition. Overgrazed forest range will have less structure or variety in understorey plants. Various plant layers such as tall and low shrubs and forbs are reduced with overstocking and overgrazing. Continued overgrazing eliminates the various plant layers and causes a shift to a simple ground layer of low producing weeds and grasses such as bluegrasses. At this stage, ecological functioning of the forest is severely impeded and recovery to healthy condition is slow.

Photo Credit: T. Lennox, Saskatchewan Ministry of Agriculture

Photo Credit: T. Lennox, Saskatchewan Ministry of Agriculture

Whitebeech community pasture in northeast Saskatchewan

References

Abouguendia, Z. 1991. Livestock Grazing and Riparian Areas: A Literature Review. Grazing and Pasture Technology Program. Regina, SK.

Abouguendia, Z. 1990. Range Plan Development - A Practical Guide to Planning for Management and Improvement of Saskatchewan Rangeland. New Pasture and Grazing Technologies Project. Regina, SK. 52p.

Abouguendia, Z.M., and T.O. Dill. 1993. Grazing Systems for Rangelands of Southern Saskatchewan. Saskatchewan Stock Growers Association and Agriculture Development Fund. Grazing and Pasture Technology Program. Regina, SK.

Abouguendia, Z., and T. Dill. 1995. Planning Aids For Balancing Forage Supply And Demand. Saskatchewan Stock Growers Association. Grazing and Pasture Technology Program. Regina, SK. 10p.

Archer, S., and D.A. Pyke. 1991. Plant-animal interactions affecting plant establishment and persistence on revegetated rangeland. Journal of Range Management 44:558-565.

Bailey, D. W. 2003. Integrating Management Practices to Improve the Uniformity and Sustainabiltiy of Grazing. Proceedings of the Nashville Grazing & Livestock Conservation Initiative. Nashville, TN.

Bailey, D. W., D. D. Kress, D. C. Anderson, D. L. Boss, and E. T. Miller. 2001. Relationship between terrain use and performance of beef cows grazing foothill rangeland. Canadian Journal of Animal Science 79:1883-1891.

Dusch, G.L. 1975. Range relations of mule deer and cattle in prairie habitat. Journal of Wildlife Management. 39:605-616

Ehrhart, R.C., and P.L. Hansen. 1997. Effective cattle management in riparian zones: a field survey and literature review. United States Department of Interior, Bureau of Land Management, Montana State Office. Missoula, Montana. Riparian Technical Bulletin No. 3. Missoula, MT. 92p.

Grazing Systems for Alberta. Alberta Agriculture Agdex 134/14. Edmonton, AB.

Heitschmidt, R.K., and J.W. Stuth. (eds.). 1991. Grazing Management – An Ecological Perspective. Timber Press. Portland, OR.

Kinch, G. 1989. Riparian area management: Grazing management in riparian areas. U.S. Dept. Of Interior Bureau of Land Manage. Technical Reference 1737-4. 44 pp.

McCartney, D.H. 1993. History of grazing research in the Aspen Parkland. Canadian Journal of Animal Science 73: 749-763.

Romo, J.T. 1989. Ecological Effects of Grazing. pp. 35-41. In: Reid Communications (compilers and eds.) Proc. Grazing Management, It's More Than Grass! New Grazing and Pasture Technology Program. Saskatoon, SK.

Romo, J.T. 2006. Resting Forage Plants - A Beneficial Grazing Management Practice On Native Rangeland. Agriculture and Agri-Food Canada's Greencover Canada Program. 12 pp.

Saskatchewan Ministry of Agriculture. 1990. Intensive Management of Livestock Grazing. Regina, SK.

Sindelar, B.W. 1989. Myths in Grazing Management. pp. 1-23. In: Reid Communications (compilers and eds.) Proc. Grazing Management, It's More Than Grass! New Grazing and Pasture Technology Program. Saskatoon, SK.

Vallentine, J.F. 1990. Grazing Management, Academic Press. San Diego, CA.

Voisin, A. 1959. Grass Productivity. Reprinted in 1988 by Island Press. Covelo, CA.

Wambolt, C.L. 1979. Range Grazing Systems. Cooperative Extension Service, Montana State University. Bozeman, MT. 13p.

Willms, W.D., S. Smoliak, and A.W. Bailey. 1986. Herbage production following litter removal on Alberta native grasslands. Journal of Range Management 39:536-540.

Willms, W. 1995. Grazing Management – A Balancing Act? pp. 39-42. In: Z. Abouguendia (ed.). Proc. Total Ranch Management in the Northern Great Plains. Grazing and Pasture Technology Program. Swift Current, SK.

Evaluation and Monitoring

Range Ecosite Concept

Effective evaluation of the health or condition of Saskatchewan's rangelands begins with an understanding of the range ecosite concept. Range ecosites divide rangeland into basic ecological units for study, evaluation, and management. Several range ecosites exist within an ecoregion. Saskatchewan's ecoregions are described in the Natural Vegetation Zones section of this publication.

A range ecosite is a distinctive area of rangeland differing from others by its ability to produce a characteristic plant community. It is the product of all environmental factors responsible for its development. The major factors that interact to produce a distinctive climax plant community are climate, soil and topography.

The climax community is a relatively stable balance of plant species having evolved in the absence of abnormal disturbance. These species are adapted to their surroundings and survive within the environmental limitations of the area. Generally one or two species dominate and this does not vary from year to year.

Mineral recycling in a climax community is at maximum level and dominant plant species reproduce forever. Production may fluctuate yearly with climatic differences, but species composition changes very little.

Range ecosites are distinguished by significant differences in the kinds or proportions of plants making up the climax community, significant differences in productivity, or both. Significant differences refer to requirement in changes in individual management factors such as stocking rate.

Boundaries between range ecosites may be distinct where changes in soil, topography, or moisture are abrupt, but generally are less distinct along boarders of environmental gradients.

Detailed information regarding the classification of range ecosites in Saskatchewan is available in the publication titled, *Saskatchewan Rangeland Ecosystems, Publication 1: Ecoregions and Ecosites* (Thorpe, 2007).

Range Ecosite Versus Management Unit

Range ecosites should not be confused with management units. A management unit is created by fencing a field or pasture. Management decisions concerning that particular parcel of land can be made regardless of what is happening across the fence.

Several range ecosites may exist within one management unit. Or depending on fence line placement, a range ecosite may be divided between two management units - part on one side of the fence, part on the other side.

Range Condition

Range condition indicates the status or composition of the present plant community in relation to the potential, or climax and expresses changes in vegetation composition, productivity, and land stability. Condition is divided into four classes: Excellent, Good, Fair, and Poor, depending on how far the present plant community status or composition of is from its potential. These ratings are not the same as forage values and do not necessarily indicate the yield, nutritive value or palatability of species present on a range site.

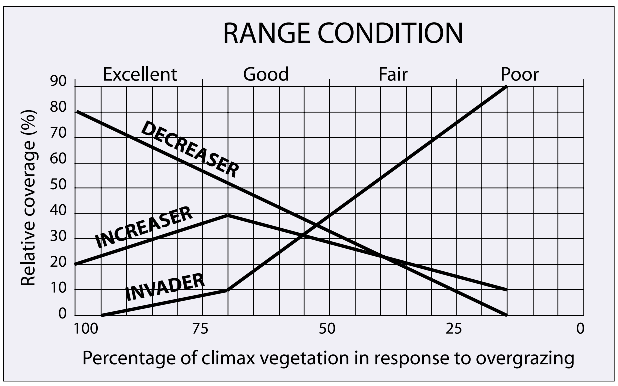


Figure 32: Relation of decreasers, increasers and invaders on rangelands

The relative contribution of each of the three plant categories (decreasers/increasers/invaders) to the composition of the range ecosite determines its present condition rating (Figure 32).

Many influences can modify or temporarily destroy vegetation, but do not necessarily eliminate recovery of the potential plant community. Unless the disturbance is particularly severe or prolonged, the site potential is not permanently affected and the site itself remains capable of supporting the climax community.

Range in Saskatchewan is often considered in poor condition due to drought. This is an inaccurate assessment because range does not decline in condition quickly. Forage production may be temporarily less due to drought, but the range condition is not changed and the plant community composition is likely not altered.

Range condition is a component of rangeland health, not its annual production. Annual production can be estimated through conducting a range inventory.

Deterioration Signs of Native Range

Plant vigour decline and loss of surface litter are the first warning signs of range deterioration. This is followed by a shift in species composition, the change most easily measured and the main contributing factor to other changes in the site.

Deterioration of the plant community causes loss of organic matter, soil fertility, ability of the soil to absorb and retain water, as well as exposure of surface stones. This deterioration reduces the opportunities for establishing the original plant community and productive capacity of the site. Severe deterioration may significantly alter the potential productivity and plant community.

Photo Credit: Jim Romo

Monitoring helps determine changes in the plant community

Tame Pastures

In tame pastures where the native vegetation has been removed, traditional rangeland assessment cannot be used to rate condition. However, there are signs that indicate deterioration of tame grass stands.

The natural tendency in any plant community is to move towards a higher successional stage. Nature attempts to replace tame forages with either weedy or native species adapted to the site.

Reduced productivity, increased bare ground or the formation of dense sod are the first visual signs of tame stand deterioration. Replacement and encroachment by increaser and invader species soon follow. Crested wheatgrass may be replaced by an increaser such as pasture sage or an invader like Russian thistle.

Eventually other site characteristics deteriorate. Erosion becomes evident, the soil absorbs and retains less water, and site fertility drops.

Range Health

The concept of range health builds on the traditional range condition approach, but adds new indicators of important natural processes and functions – things that producers can observe and that are easier to measure than plant community alone. Range health refers to the ability of rangelands to perform certain natural functions like:

- produce plant biomass including forage for livestock and wildlife;
- maintain and protect the soil from erosion;
- beneficial capture and release of water;
- cycle nutrients and energy;
- maintain biological diversity.

A range health assessment will provide a more detailed snapshot in time of management impacts on a given site. A guide to Saskatchewan grassland and forest range health assessment methodologies is available (Saskatchewan PCAP Greencover Committee, 2008).

Using Range Ecosite and Condition Information

Range ecosite and condition information are useful when developing an inventory for range management purposes.

The inventory of available resources is a simple, but often overlooked aspect of the planning process. Whether on public or private land, this inventory is the basis for developing and applying management decisions.

Decisions to maintain, improve or, in rare cases, degrade the present range condition are based on overall objectives. Areas to reseed, rest, burn, or fertilize are mapped out. Stocking rates, season of use, and kind and class of grazing animals are tools used to achieve objectives based on the site and condition inventory.

Range trend information is also useful. While range condition reflects the plant composition of the range at any point in time, trend measures change in range condition over time and is measured through periodic determination of range condition on the same area. Range condition trend is referred to as improving, declining or stable.

Range condition trend provides a basis for management adjustment. If range condition is not moving in the desired direction, management needs to be altered. Continued evaluations of range condition trend are used to measure the effectiveness of applied management.

Use of air photos facilitates the planning process greatly

The Inventory

Taking stock of the land base and determining its potential as compared to actual production is the first step in developing an inventory on which to base management decisions.

An inventory of the forage resource base should include:

1. A pasture map showing vegetation boundaries and soil types;
2. Range condition and forage production of native units;
3. Species, age, and production of native units;
4. Topographic features;
5. A record of past use including season of use and stocking rates;
6. Potential problem areas (weedy and poisonous plants);
7. Areas requiring special treatment because of wildlife or watershed concerns;
8. Hay production;
9. Crop aftermath.

Tally livestock numbers, classes and forage requirements to determine forage demand for each year. Compare them to actual amounts of forage produced through the year, this should include carry-over hay, to help determine where shortages are. In many cases, livestock production is severely restricted by shortages during critical periods, while apparent forage surpluses occur at other times.

List physical improvements such as fences, handling facilities, dugouts, wells and equipment. Mark fences, salting areas and water sites on a map or aerial photo.

List all equipment including age, condition and replacement value.

List manpower availability and identify training needs.

The following three tables provide important information for completing an inventory of forage resources and animal demand. Reductions in carrying capacity must be taken into account for slope and distance to water (Tables 4 and 5) and forage demand must allow for species, weight and age differences using Animal Unit Equivalencies (Table 6).

Table 4. Suggested reduction in cattle carrying capacity according to percentage slope

% Slope	% Reduction in Carrying Capacity
0 – 10	No Reduction
11 – 30	30
31 – 60	60
over 60	100 (ungrazable)

Table 5. Suggested reduction in carrying capacity according to distance from water

Distance from % Water (km)	Reduction In Carrying Capacity
0 - 1.5	None
1.5 – 3	50
3	100 (ungrazable)

Table 6. Animal Unit Equivalences for species on a body weight basis

Animal Species	Weight (lbs)	AUM Equiv.	Forage Dry Matter (daily lbs)	No. Per AUM
Cow	1000	1.0	26.0	1.0
Cow	1500	1.5	39.0	0.7
Heifer	700	0.7	18.0	1.4
Bull	1500	1.5	39.0	0.7
Horse	1400	2.0	52.0	0.5
Sheep	120	0.2	5.2	5.0
Antelope	120	0.2	5.2	5.0
Deer	160	0.25	6.5	4.0
Bison	1500	1.5	39.0	0.70
Elk	600	0.7	18.0	1.4
Gopher	1	0.0006	0.16	177.0
Jack rabbit	7	0.024	0.6	42.0

References

Abouguendia, Z., and T. Dill. 1995. Planning Aids for Balancing Forage Supply and Demand. Saskatchewan Stock Growers Association. Grazing and Pasture Technology Program. Regina, SK. 10p.

Abouguendia, Z.M., J.P. Thorpe, and R.C. Godwin. 1990. An Assessment Procedure for Saskatchewan Rangeland. Saskatchewan Research Council Publication No. E-2520-2-E-90. Saskatoon, SK.

Adams, B.W., W.D. Willms, S. Smoliak, and R.A. Wroe. 1986. Range, Its Nature and Use. Alberta Forestry, Lands and Wildlife, Public Lands Division. Edmonton, AB.

Daubenmire, R. 1968. Plant Communities: A Textbook of Plant Synecology. Harper and Row, Publishers. New York, NY. 300p.

Lacey, J., and C. Marlow. Forage Planning Guide. Montana State University. Bozeman, MT.

Public Lands, Alberta Sustainable Resource Development. Range Health Assessment Field Worksheet for Grasslands. Edmonton, AB.

Saskatchewan PCAP Greencover Committee. 2008. Rangeland Health Assessment: Native Grassland and Forest. Prairie Conservation Action Plan. Regina, SK.

Shiflet, T.N. 1973. Range Sites and Soils in the United States. In Hyder, D.N. (ed), Arid Shrublands. Proceedings of the 3rd Workshop of the US/Australia Rangelands Panel. Society for Range Management. Denver, CO. pp. 26-32.

Society for Range Management. 1986. Range Research: Basic Problems and Techniques. C. Wayne Cook and James Stubbendieck (eds.). Denver, CO. 317p.

Thorpe, J. 2007. Saskatchewan Rangeland Ecosystems, Publication 1: Ecoregions and Ecosites. Saskatchewan Prairie Conservation Action Plan. Saskatchewan Research Council Pub. No. 11881-1E07. Saskatoon, SK.

Wilm, H.G., D.F. Costello, and G.E. Klipple. 1944. Estimating forage yield by the double-sampling method. Journal of American Society of Agronomy 36:194-203.

Workman, J.P. 1979. Range Economics. Department. Of Range Science, Utah State University. Logan UT.

Wroe, R.A., S. Smoliak, B.W. Adams, W.D. Willms, and M.L. Anderson. 1988. Guide to Range Conditions and Stocking Rates for Alberta Grasslands. Alberta Forestry, Lands and Wildlife. Edmonton, AB.

Livestock Behaviour

Grazing Patterns

Free-ranging livestock exhibit behaviour that differs with each season, each individual, and type of animal. Understanding these differences is important to developing and implementing a managed grazing plan.

Most activities that occur on pastures influence grazing animal behaviour. Fencing, water, mineral placement, industrial activity such as oil and gas, topography, vegetation, animal density, and animal handling all play a role in animal behaviour.

Range improvements and grazing systems attempt to influence livestock behaviour. Fencing, salting, herding, and water development can lead to more uniform livestock distribution. Systems can be designed to control timing, intensity, and frequency of grazing on individual plants, avoid sensitive areas, and enhance wildlife habitat.

Photo Credit: J. Bruynooghe

Location of watering sites influences livestock behaviour and distribution patterns

Grazing Animal Type and Grazing Patterns

All grazing animals are not created equal. Cattle, horses, sheep, goats, bison, elk, antelope, and deer all exhibit different grazing patterns. Species, age, prior exposure to different foods, breed-type, and physiology may influence grazing behaviour. Understanding grazing animal reaction to management is essential in evaluating management success.

There are distinct differences in forage selection among the various herbivore species. Generally cattle, horses, and elk prefer grass. Sheep and antelope find forbs more palatable, whereas goats and deer prefer shrubs. Animals which have larger mouths select larger bites of food. By comparison, species with smaller mouths such as sheep, antelope, and deer, are more selective in what they eat.

Often, domestic livestock will not travel far from water or graze rugged terrain. This lack of movement can be remedied by selecting animals that will readily graze rugged areas while meeting production goals. Selection for these traits can occur within herds, between breeds, within age classes (cows vs. yearlings) and between species (cattle vs. sheep).

Cattle reluctantly graze slopes exceeding 15 percent and they rarely feed at elevations greater than 70 metres (230 feet) above water. They are also limited by horizontal distance from water, rarely grazing more than 2.5 kilometres (1.5 miles) from it. Greater travel distances cause an increase in energy expenditure.

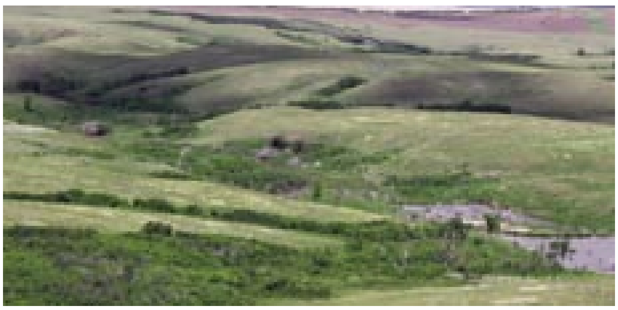


Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Topography and distance to water affects grazing behaviour

Sheep utilize rugged terrain better than cattle but show more reluctance to graze areas having natural predator cover, such as bush or topographic relief. They will walk from three to five kilometres (1.8 to 3 miles) for water, but as with cattle, travel distance has a significant influence on production.

Livestock seek shade during hot summer periods, resulting in excessive usage of forest and riparian areas. Livestock usually overuse dry southern exposures early in spring and then use riparian and shaded areas during hotter periods of the year. North facing slopes are usually grazed less or may even remain entirely ungrazed on larger pastures.

Younger animals travel more often and further than older animals and those with a calf, colt, or lamb at side.

Palatability and Forage Selection

Livestock select foods which have the most pleasing texture and are familiar. Green material is preferred over dry material, and leaves over stems. Palatability is affected by fibre content, bitterness or sweetness, water content, and plant abundance. Diet selection can be modified by the presence of secondary compounds (phenols, volatile oils), plant morphology, (thorns, thick cuticles), and past grazing experience.

Forage selection is a function of past experience and grazing selectivity, and is an acquired ability which occurs at an early age. Dietary training is possible. Recently, cattle have been trained to eat leafy spurge, Canada thistle, and spotted knapweed.

Diet composition changes seasonally as grasses, forbs, and shrubs change in palatability and nutritional status. Range management techniques can be used to improve the palatability of forages. For example, burning usually increases short-term forage palatability. Controlled burning and rotational grazing may allow the manager to provide grazing animals with more palatable forages during key production stages such as lactation.

Grazing Duration

Several factors affect foraging time of grazing animals. Cows that are pregnant or lactating require more energy than animals which are not. They must therefore spend more time grazing to meet their nutritional needs. To meet their requirements, calves spend more time grazing as their dam's milk supply declines.

Preferred food location and volume also affect time spent grazing.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Forage selection differs with age and experience of animals

Cattle use their tongues to gather forage before biting the plants. As forages get shorter, cattle must work harder to gather a mouthful. Horses can bite closer to ground level.

Photo Credit: Jim Romo

Forage height affects the grazing efficiency

Cattle experience peak grazing efficiency when forage is about 15 centimetres (6 inches) high, eating three percent of their body weight on a dry weight basis. An animal on poor range with short and widely spaced forage plants must take more bites, travel farther, and graze longer to meet its daily requirements. In doing so, it uses more energy to acquire food. If forage is only five centimetres high, daily intake can be reduced by 75 percent. A cow takes between 30 and 90 bites per minute, and by moving her head from side to side in an arc, can bite continuously for up to 30 minutes.

Cattle rarely graze for more than nine hours in a 24 hour period. Depending on the fibre content of the forage, cattle ruminate from five to nine hours per day. Rumination evolution has been attributed to predator evasion. Animals could lie and ruminate when they felt safe from predators. Rumination is believed to create a sense of well-being in cattle.

Grazing Periods

Livestock exhibit distinct periods of grazing, ruminating, resting, standing, and watering. If one becomes familiar with these periods, livestock moves can often be planned to minimize disturbance of their feeding cycle.

Livestock also adjust their grazing periods according to day length and weather conditions. Most grazing occurs around dawn and dusk.

Spells of extreme cold or heat may cause animals to alter their activities. They may seek shelter or shade to maintain their body temperatures, with the least possible stress.

Cattle may graze through the night during full moon periods. At higher, cooler latitudes grazing may continue all day as daylight hours shorten. On the other hand, livestock in warmer climates may feed at night to avoid midday heat.

Changes from normal grazing behaviour can alert the producer that something is wrong.

Livestock that crop grass very closely and graze during midday probably lack adequate forage in terms of quantity or quality, or both.

Livestock often change their behaviour when placed in large herds or onto new range. They tend to disperse and move through a new pasture rapidly as they investigate all of the available food choices. They are also competing for forage with other animals in the herd which can lead to better overall utilization. Experience by AAFC-PFRA Community Pasture staff indicates that it may take up to two years for livestock originating from open rangelands to become habituated to forested range.

If livestock are disturbed by dogs, predators or unfamiliar people, normal activity patterns may be disrupted.

Taking the Time

Examine the behaviour of grazing animals and consider the effects that management changes will have.

Key Questions:

Which species and type of animal will best fit rangeland management goals?

What types of grazing experiences have these livestock had in the past?

What tools are available to influence animal behaviour?

Are there individuals that require culling because of their undesirable foraging behaviour, realizing that this behaviour will be passed on to their calves?

What impact will the fencing, topography, water, salt, fire, herding, movement routines, shelter, season of use, forage availability, grazing intensity, or my own behavior have on grazing animal behaviour?

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

References and Suggested Readings

Bailey, D.W. 2005. Identification and creation of optimum habitat conditions for livestock. Rangeland Ecology and Management 58: 109-118.

Blaxter, K.L. 1977. Environmental factors and their influence on the nutrition of farm livestock. In: W. Hearesign, M.H. Swan, and D. Lewis, (e.d.), Nutrition and the Climatic Environment. Butterworth, London.

Collier, R.J., and D.K. Beede. 1985. Thermal stress as a factor associated with nutrient requirements and interrelationships. p. 59. In: McDowell, L.R., (e.d.), Nutrition of Grazing Ruminants in Warm Climates, Academy Press. New York, NY.

Clapperton, J.L. 1961. The energy expenditure of sheep in walking on the level and on gradients. Proceedings of the Nutrition Society 20:31-32.

Graham, N.M. 1962. Energy costs of feeding activities and energy expenditure of grazing sheep. Australian Journal of Agricultural Research 15: 969-973.

Launchbaugh, K.L., J.C. Mosley, and K.D. Sanders. 1999. Grazing Behaviour of Wildlife and Livestock; Pacific Northwest short course. Idaho Forest, Wildlife and Range Exp. Stn Bltn 70. Moscow, ID.

Launchbaugh, K.L., and L.D. Howery. 2005. Understanding landscape use patterns of livestock as a consequence of foraging behaviour. Rangeland Ecology and Management. 58: 99-108.

Moen, A.N. 1968. Wildlife Ecology, An Analytical Approach, W.H. Freeman and Co. San Francisco, CA. 458p.

Osuji, P.O. 1974. The physiology of eating and the energy expenditure of the ruminant at pasture. Journal of Range Management 27:437-443.

Vavra, M. 2005. Livestock grazing and wildlife: developing compatibilities. Rangeland Ecology and Management. 58: 128-134.

Voisin, A. 1988. Grass productivity. Island Press Edition. Washington, D.C. 353p.

Voth, K. 2007. Livestock for Landscapes. http://www.livestockforlandscapes.com

Voth, K. 2007. Principles for Using Livestock Behaviour on Your Operation (DVD). Department of Forestry, Range and Wildlife, Utah State University. Logan, UT.

Webster, A.J.F. 1974. Heat loss from cattle with particular emphasis on the effects of cold. p. 205. In: Monteith, J.L. and L.E. Mounts (eds.), Heat Loss from Animals and Man. Butterworth, London.

Webster, A.J.F. 1976. Principles of Cattle Production. p. 103. In: Swan, H. and W.H. Broster, (eds.). Butterworth, London.

Watering Livestock on Pasture

Livestock watering methods on pasture change and evolve. The benefits of a reliable, good quality water source are being increasingly realized. Remote watering reduces stress on pastured animals, reduces physical damage to sensitive areas and increases the life span of the water source. A good stock water source can also benefit wildlife habitat and production. Agriculture is an industry, and as such is expected to be environmentally proactive.

Water Requirements for Livestock on Pasture

Daily water consumption will depend on many physiological and environmental factors. Some of these are:

- Size and type of animal;
- Amount and type of feed consumed. Dry diets induce more water consumption than moist diets such as silage or lush pasture. Generally, animals require 2-3 litres (0.4-0.7 gallons) of water per kilogram (2.2 pounds) of dry feed consumed;
- Physiological state (i.e. pregnant, lactating, growing). For every kilogram (2.2 pounds) of milk produced, 0.87 kilogram (1.9 pounds) of water is required. During the last four months of pregnancy water use increases 30-50 percent above maintenance;
- Activity level (more active animals require more water);
- Climatic conditions (approximately 1 litre/ day (0.2 gallons/day) for each degree above $0^{o}C$);
- Water quality and temperature (palatability, salt, and warm water will affect consumption);
- Trough space (total water trough space should allow at least ten percent of the herd to drink at one time).

The range of daily water requirements for common livestock species are given in Table 7.

Table 7. Ranges of daily water requirements for livestock

Species	Litres/Head/Day	Imperial Gallons/ Head/Day
Beef Cattle	25-75	6-17
Dairy Cattle	35-150	8-33
Horses	30-45	7-10
Sheep & Goats	5-12	1-3

Adapted from: The Merck Veterinary Manual, 1998.

Many factors affect water consumption, including, temperature, body weight, stage of production, activity, and wool/hair covering. The following table outlines water requirements for cattle as influenced by temperature.

Table 8: Water requirements for cattle as influenced by temperature

Air temperature	Water Requirements (L water/kg dry matter feed intake)
> 35°C	8 - 15
25-35°C	4-10
15-25°C	3-5
-5-15°C	2-4
<-5°C	2-3

Source: National Research Council, 1981.

Water Quality

Water accounts for 50-80 percent of an animal's weight and is involved in every physiological process. Feed intake is directly related to water intake. Many factors affect water intake and many compounds in surface and well water can affect livestock performance and health.

Cattle can tolerate poor water quality better than humans, but if concentrations of specific compounds in water are high enough, cattle can be affected. Most factors affecting water quality are not fatal to cattle. Cattle may not show clinical signs of illness, but growth, lactation and reproduction may be affected.

Table 9 summarizes the most common water quality concerns on the prairies, however, the values for reduced performance for the various water constituents must consider the additive effect from minerals and nutrients in the feed.

Table 9: Water constituents affecting beef cattle performance

Constituent	Reduced Performance	Unsuitable
Sulphates (ppm)	500 - 3300	>3300
Total dissolved solids/salinity (ppm)	3000 - 7000	>7000
Nitrates (ppm)	450 - 1300	>1300
Iron (ppm)	4 - 12	>12
Bacteria, Viruses and Parasites	Varies	Varies
Blue-Green Algae (Cyanobacteria)	Unknown	Unknown

Sulphates affect trace mineral metabolism resulting in copper, zinc, iron, and manganese deficiency. High sulphate levels are usually related to high salinity groundwater, however, during droughts, high sulphate levels may also occur in dugouts.

Total dissolved solids (TDS), or salinity refers to the mineral content of the water. If it is great enough, cattle will refuse to drink the water. The type of minerals in the water determines the level of effect on the cattle.

Nitrates affect the oxygen carrying capacity of the blood. They are found in groundwater contaminated by manure or fertilizer, however, rarely found at significant levels in dugouts. Feed can contain high levels of nitrates and the contribution from both feed and water must be considered.

Water with high **iron** levels reduces water consumption by cattle. Only groundwater has iron levels high enough to affect water consumption. Iron in the water also precipitates in pipelines and can cause blockages.

Pathogens such as bacteria, viruses, and parasites can cause a variety of different symptoms and production loss. Introduction of uncommon pathogens is usually more of a concern than the actual number of pathogens. Preventing inflow of manure and restricting entry of cattle into water bodies is the easiest way to minimize pathogens in the water.

Blue-green algae (cyanobacteria) blooms are common in nutrient-rich dugouts. Toxins produced by the *Microcystis* species causes liver damage in cattle. Prevention measures include limiting the inflow of nutrients and using a remote watering system.

Several studies have shown that improving drinking water quality may improve animal productivity up to 30 percent. Aeration and restricting cattle access to the water source will provide up to 20 percent increase in cattle weight gain.

Pasture Watering Techniques

Traditional methods of supplying water to livestock on pasture enable livestock free access to whatever water supply is available. With increased livestock numbers, a growing concern about environmental damage and new knowledge about animal health and water quality, producers have developed many ways to supply water to livestock, while protecting the water source. “Remote” watering strategies have been developed to reduce direct livestock contact with the water supply, implement beneficial management practices for the environment, and promote livestock herd health. Livestock access to a surface water body can be reduced 75 to 90 percent, by providing properly located alternative water sources. Legislative restrictions regarding direct access to water supplies apply in many cases and being aware of the requirements ahead of time may save money and time.

Cattle Watering Points

Producers can provide healthy, economical, and efficient water supplies for their herd in many ways. These methods may also provide benefits to riparian areas around the water supply and to the environment in general. While exclusion of the animal from the water supply is key to this management practice, there are some cases where it may not be practical, and this possibility may be dealt with through the use of access ramps.

Access Ramps

While access ramps allow some direct contact with the water supply, good management and restricting access to the rest of the water supply may be a viable option for producers who are not able to regularly monitor a “mechanical” system. The construction of ramps is fairly straight forward. The main criteria are to provide firm footing, either by using solid materials at the site or by installation of Geotextile webbing for stability, and keeping the slope of the ramp at about 6:1 or less, to allow easy access and departure from the watering point. By using fencing to restrict access around the rest

Photo Credit: AAFC-PFRA

Access ramps may provide some environmental benefits of the water supply, some environmental benefit is provided. Maintenance of the ramp and barrier fencing, combined with regular manure removal will improve the function of this system.

Livestock Powered Systems

"Nose pumps" are operated by the actions of the animal. Animals use their nose to operate a lever which provides about a quart (1.1 litres) of water for each push of the lever. The water is delivered to a bowl under the lever and the animal will continue to push the lever until its requirements are met. Power is not required, the cost is relatively low, and the unit can be moved easily from place to place (although they must be securely anchored when in use). However, only one animal can water at a time, requiring a pump every 20-25 animal units. It is important to note that lift from the source can not exceed six metres (20 feet).

Young calves are not able to use the pump and some cattle are unable to learn how to operate the system. Livestock species that do not use their heads to push, such as sheep, cannot use the pump at all. It is also important to ensure that during hot weather or periods of increased water demand, all livestock are able to access adequate water supply when using a nose pump system.

Photo Credit: AAFC-PFRA

Nose pumps are operated by the actions of the animal

Solar and Wind Powered Systems

A solar or wind powered system can be used instead of electric or gas pumps to move the water from the source to trough. It is important to select a system that is suited to the application and is sized to meet the requirements of the herd. Reservoir storage is recommended, with the system being designed to pump to a larger reservoir, then gravity fed to the trough system and equipped with a shut-off device. By utilizing a reservoir, some extra water capacity is guaranteed in the event of equipment failure or high water demands during heavy watering periods.

Solar Pumps

A solar system can be used anywhere that a water supply system is required. Several factors should be considered when choosing a system. The main concern is that the system be sized to suit the requirements of the herd. Use of secondary storage, such as a reservoir, is also highly recommended. A solar panel converts sunlight to DC power, which drives a DC pump for water supply, as well as to charge batteries which provide power storage for times of peak demand, panel malfunctions or low sunlight conditions.

Photo Credit: AAFC-PFRA

Solar systems provide another option when pumping water at a remote location

Major improvements have been made in this technology and these systems are now considered very reliable and can be sized to meet the requirements of virtually any herd. Initial capital costs rise as the size of the herd increases or as the lift required to move water from the source to a trough becomes greater. Regular maintenance is recommended as with any other mechanical water supply system.

Wind Powered Pumps

These systems have been used for centuries to pump water from wells and dugouts. While some of the older systems may no longer be as efficient, recent developments have improved the technology. There are now pumps that use compressed air generated by a diaphragm on an elevated windmill to pump water from a floating pump to smaller herds. These units are able to supply about 540 litres (120 gallons) an hour with a wind speed of 16 kilometres per hour (10 miles per hour). Bigger windmills are also available and these can supply water to larger herds. Several important factors must be considered when choosing wind powered systems, the most critical being the water requirements of the herd and the need for additional storage in the form of a reservoir. The windmill must be placed far from and higher than trees or buildings if possible. The efficiency of the system decreases with the lift, so placement of the system is important. As most of the smaller windmills are not fitted with a shutoff and will pump continuously when the wind is blowing, troughs should be fitted with some type of a return pipe that will allow excess water to go back into the source once the trough is full.


Photo Credit: AAFC-PFRA

Various forms of wind powered systems are available for use in remote locations

Pasture Pipelines

Shallow buried, or “pasture” pipelines, have become a popular method of supplying water to livestock. The benefits of these systems are many, as the source supply is usually the home yard or somewhere that the supply is reliable, sufficient and of good quality. The pipelines can literally be run anywhere, and many are over three kilometres (two miles) in length. Points of delivery can be chosen with the best grazing plan in mind. These pipelines are generally 26 millimetres (1 inch) or larger, usually High Density Polyethylene (HDPE) and buried 0.3 to 0.5 metres (12 to 18 inches) deep. At the delivery point, troughs or watering bowls can be used and there are many storage designs to choose from. The cost benefits of this type of system are a major selling point, as it is nearly always cheaper to install a pipeline from a known source than it is to develop a new source when the cost of power installation and a second supply system is factored in. Some care must be taken with this system, as the period of use is from late spring to late fall and they are not designed for winter use. Evacuation of the water in the troughs, including fittings and parts that may be damaged by frost, is required each fall. The HDPE line is resistant to frost damage, however many producers evacuate the water in the lines with a large compressor because this will allow earlier use the next spring. Caution must be taken to bury the lines at a depth that will ensure that what ice has formed melts as early as possible, but deep enough to prevent damage by vehicle or equipment crossings.


Photo Credit: AAFC-PFRA

Shallow buried pipelines can be used to supply reliable, sufficient and good quality water

References and Suggested Readings

Braul, L., and B. Kirychuk. 2001. Water Quality and Cattle. Agriculture and Agri-Food Canada. Ottawa, ON.

Ducks Unlimited Canada. 2007. Livestock Watering Systems in Saskatchewan: Producer Experiences. Agriculture and Agri-Food Canada’s Greencover Canada Program. Regina, SK. 46p.

Looper, M.L., and D.N. Waldner. 2002. Water for Dairy Cattle. New Mexico State University, Cooperative Extension Service. Las Crusces, NM.

Merck & Co., Inc. 1998. The Merck Veterinary Manual. Eighth Edition. Duluth, GA. ISBN Number 0-911910-50-6

National Research Council, Subcommittee on Environmental Stress. 1981. Effect of Environment on Nutrient Requirements of Domestic Animals. National Academies Press. 168p.

Prairie Agricultural Machinery Institute. 1997. The Stockman’s Guide to Range Livestock Watering from Surface Water Sources. Canada-Manitoba Agreement on Agricultural Sustainability (CMAAS), Saskatchewan Ministry of Agriculture. Humboldt, SK. 36p.

Fencing
Applications

Fencing is an important range management tool, facilitating the regulation of grazing use, rest, stocking rates, stocking density, and animal husbandry. Fences control livestock movement and distribution.

Boundary fences prevent livestock from trespassing on neighbouring properties. Drift fences keep livestock from moving off or onto a range, or confine herds to specific elevations. Crossfences are used to subdivide rangelands into smaller management units, and can provide enclosures or exclosures for special uses.

The ideal fence combines low capital cost, ease of construction, and a long lifespan. It also must be livestock proof. Although fences simplify livestock containment, they can also lead to less effective management of grazing resources. Fences, along with water development, can allow the establishment of permanent confines.

Unless proper range management principles are applied, grazing resources may deteriorate.

Photo Credit: R. Macdonald

Fencing plays a vital role in the range planning process

Using Fences Effectively

A properly located fence is a powerful tool when used in a well-planned grazing system.

Livestock will graze selectively if areas of differing slope, soil and forage type are fenced together. Selective grazing may lead to over-utilization and under-utilization in the same pasture. This can be remedied by creating pastures that are as uniform in vegetation type and ecosite as possible.

Some areas are best fenced out of the grazing system altogether. For example, weigh the potential for erosion on fragile soils against any economic gains or the use of areas which make livestock handling difficult.

Primary fence lines should follow land contours and boundaries of ecosites to separate unique management units. Fence hillsides separately from valley bottoms, and bush apart from grasslands. Fence native grasslands separately from tame pastures, and different tame species apart from each other. Paddocks need not be square and fences need not be permanent. Temporary fencing can be used to subdivide fields on a short-term basis. Animals can be temporarily confined to achieve brush control. Confining livestock at night is also possible with temporary barriers. Part of a pasture may be reserved for hay production using temporary fencing.

It is also extremely important to consider animal movement within the fenced area. Considering topography and animal behaviour when choosing a location for fences increases their effectiveness. These considerations may allow easier animal movement and reduce possible fence damage.

There is no universally ideal fencing design.

Available resources and management goals determine pasture size and shape. Different sized pastures accommodate a variation in grazing period.

Fencelines do not need to be straight provided that changes in direction are properly braced according to the force placed on the materials. Although a straight fence is shorter, it is more efficient in the long-term to follow the contours of landforms and vegetation types.

Existing Fences

Although many existing fences can be used in a grazing plan, always consider best use of the land resources first. Do not let existing fencing limit planning.

The repair of existing fences is an important consideration. If major repairs or replacement are necessary, evaluate the current location and construction. A change in placement and technology may lead to improved management.

Conventional Wire Fences

Built for durability, the lifespan of a well-constructed barbed wire fence is 25 to 40 years. Choice of materials and design are important considerations for fenceline longevity.

Posts

Wood posts are used extensively due to availability, ease of handling and low cost.

Steel posts can be easier to work with, but are more costly than wooden posts. Concrete posts can be formed on the ranch or farm, but must be adequately reinforced with steel. They are heavy and difficult to handle.

To minimize maintenance costs, treat wooden posts. Untreated wood in contact with the soil decays in three to twelve years. Pressure-treated wooden posts are usually better than those treated with a non-pressure process as the preservative is forced into the wood to a greater depth. Pressure treating can add up to 25 percent to the fence cost but it extends post life by 20 years.

Barb Wire Fences

Barbed wire is available in two types - double strand and single strand. Single strand is lighter and stronger, has more barbs per metre and is less costly. Double strand must be stretched, while single strand needs only to be pulled taut. However, repairing single strand barb-wire can be more difficult.

Photo Credit: R. Macdonald

Barbed wire remains the most common type of range fence

Staples

The recommended staple is galvanized, 1 3/4 inches x 9 gauge with slash-cut points.

Wire Stays

Stays are used to keep wires properly spaced when posts are located at a distance greater than 5 to 7 metres (16 to 22 feet). Two types are available. One-piece stays consist of a wire formed into a double spiral one metre (40 inches) long. It is installed by twisting the stay on to the barbed wires starting at the top wire continuing down over the remaining wires, maintaining the spacing between the wires.

Two-piece stays have a single spiral and a straight wire one metre (40 inches) long. They are installed by placing the spiral wire on one side of the barbed wire and inserting the straight wire through the spiral wire, locking the barbed wire into place.

Construction

Brace and corner assemblies are the foundation of a conventional fence. Braces determine structural soundness and longevity. Corners are braces located where fence direction changes. If any brace or post fails, there is a loss of wire tension and fence effectiveness.

The horizontal brace is widely accepted as the standard fence brace. It is structurally sound and appropriate for most fences (Figure 33).

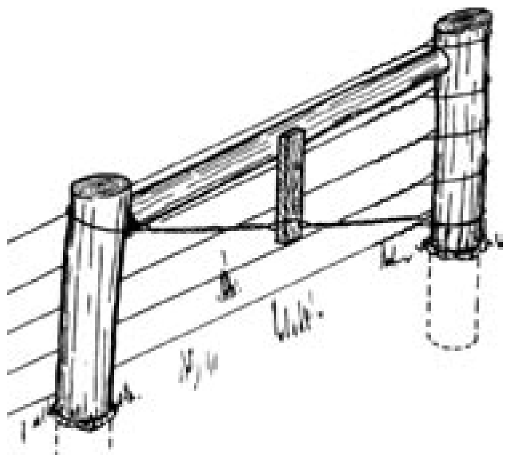


Figure 33: Horizontal gate or fence end strainer

Appropriate sizes of pressure treated posts

Post Use	Length (ft)	Length (m)	Top Diameter (in)	Top Diameter (cm)	Approximate Burial Depth (ft)	Approximate Burial Depth (m)
Corner, end, and draw posts	8	2.4	5-6	13-15	4	1.2
Corner, end, and draw braces	7	2.1	4-5	10-13	3	0.9
Line posts	7	2.1	3-4	8-10	3	0.9
	6	1.8	3-4	8-10	2	0.6
	6	1.8	2-3	5-8	2	0.6

The diagonal brace is structurally equal to the horizontal brace, and is eight percent more resistant to overturn and 25 percent less expensive to buy and install (Figure 34). Be sure the end of the diagonal brace which contacts the ground is free to move forward, and that it is not blocked by a stake or post. The diagonal brace should be as long as possible.

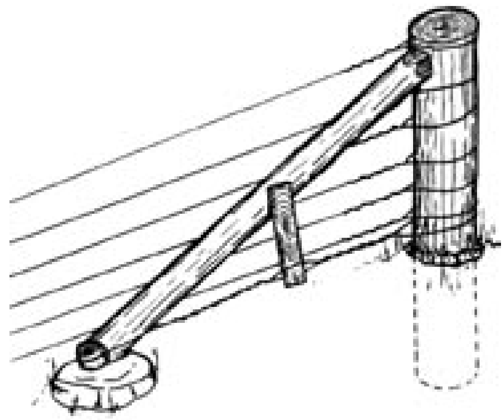


Figure 34: Diagonal gate or fence end strainer

Horizontal and diagonal braces can be used together to hold in soft soils. (Figure 35).

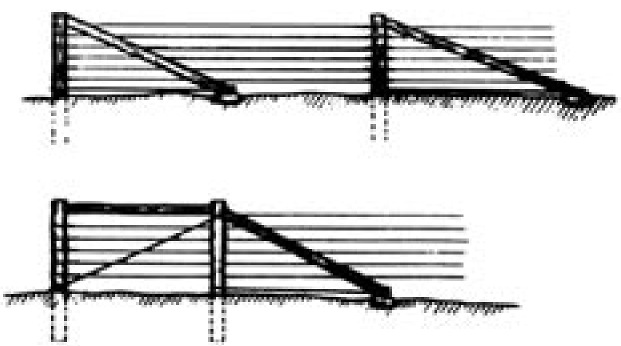


Figure 35: Use of strainers for holding in soft soil. Top: two diagonal strainers. Above: one horizontal and one diagonal strainer

Line posts are used to suspend the fence wire. Posts can be 6 to 10 centimetres (2.5 to 4 inches) in diameter and 1.8 to 2.1 metres (6 to 7 feet) long. They are usually set 0.6 to 0.8 metres (2 to 2.5 feet) into the ground at spacing of 5 to 7 metres (16 to 22 feet). Shorter posts are used for low fences and deeper-set posts for soft ground.

Reduce post spacing where terrain is uneven or a particularly strong fence is needed. Increase post spacing on flat terrain or where livestock crowding is not a factor.

The intended use of the fence determines wire spacings (Figure 36). To install barbed wire, unroll, stretch and fasten one line at a time starting with the top strand.

To counteract the forces acting on wires, drive staples at an upward angle into posts on rises. Do not use the staple to pull the wire to the post. Hold the wire against the post when stapling.

Unroll the wire on the livestock side of the posts. Tension wires up to 45 kilograms (100 pounds) before stapling line posts.

Never drive staples all the way 'home' on line posts. Leave a space of approximately 3 millimetres (1/8 inches) between the post and wire to allow movement of the wire through the staples. Otherwise, fence impacts are absorbed between the two line posts rather than being distributed evenly between brace assemblies.

If a barb is located within 2.5 centimetres (1 inch) of the staple, clip off the barb.

To prevent pull-out, use the recommended staples and drive them properly. Straddling the wood grain of the post prevents splitting which reduces the staple's holding capacity (Figure 37 and 38).

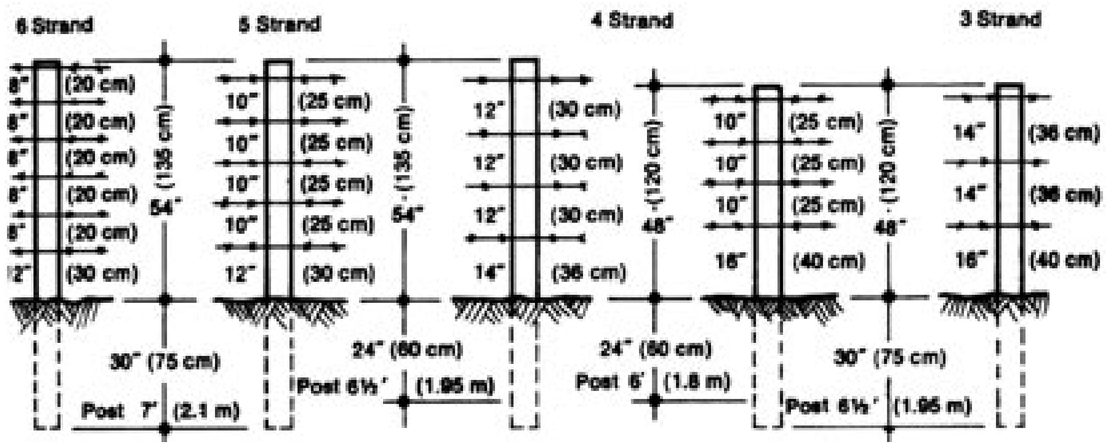


Figure 36: Wire spacing and line post sizes

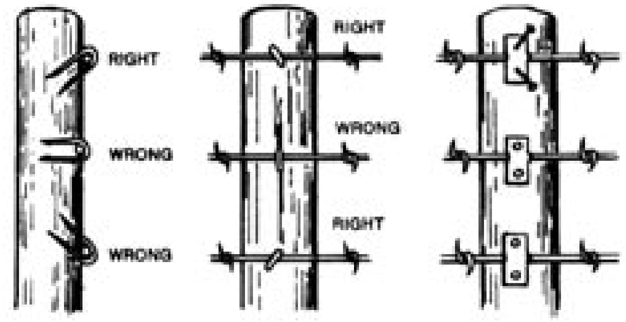


Figure 37: Staple fastening methods

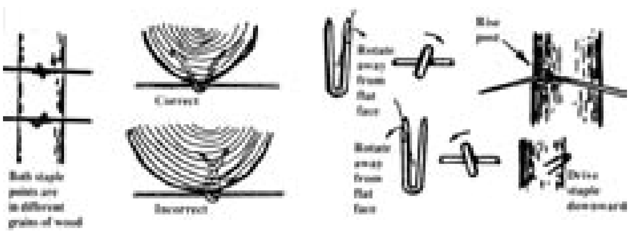


Figure 38: Correct staple driving method

Slash-cut points act as wedges to force the staple legs to curve away from the flat surfaces of the point as the staples are driven into the wood. To achieve outward curvature, rotate the staple slightly (15 to 30 degrees off vertical) away from the flat surface of the point on the upper leg.

Suspension Fences

Suspension fences were originally developed in Texas as interior or cross-fences. They are not suited to hilly or steeply rolling land.

In contrast to conventional fences which use the barricade principle to stop livestock, the suspension fence functions as a series of panels with resilience and a whip-like action. When pressure is exerted on the top wire, the bottom wire moves in the opposite direction. A cow attempting to reach over the top wire is struck on the leg by the bottom wire. This type of fence tends to sway in the wind, discouraging livestock from attempting to break through.
Fewer posts are used compared to conventional construction, lowering costs. The quality and setting of corner and brace posts is particularly important with the suspension fence.

Vertical wire spacing is similar to standard barbed wire fences. The fence loses its effectiveness if the bottom wire or the ends of the wire stays drag on the ground or brush. Wires are fastened to line posts with staples or metal clips. Heavy line posts are spaced from 15 to 50 metres (50 to 160 feet) apart depending upon land contour. Wire stays at intervals of 3 to 6 metres (10 to 20 feet) are used to maintain wire spacing. Wires should not have more than 7.5 centimetres (3 inches) sag per 30 metres (100 feet) span.

Semi-Suspension Fence

This construction is an adaptation of the suspension fence. It is used where terrain is gently rolling.

The semi-suspension fence does not have the live action of a true suspension barricade. It has posts spaced 6 to 14 metres (20 to 45 feet) apart.

Electric Fencing

Electric or "Power" fencing as it is commonly referred to, took years to catch on in western Canada. However, in recent years has progressed to one of the cattleman's greatest management tools.

Developed and perfected in New Zealand, power-fencing products are now used and produced world-wide. This management tool can reduce yardage and wintering costs and make such use of previously ungrazed areas.

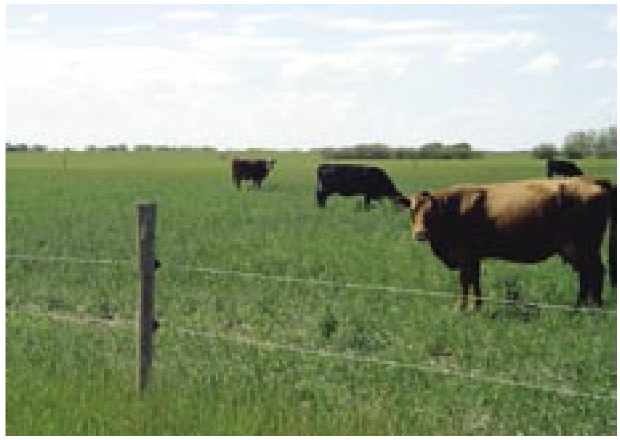


Photo Credit: Jason Williams

Electric fence

Theory

Power fencing is used as a "mental barrier" to keep livestock inside a specific area, and often to keep predators out. Animal perception that the fence will hurt enables control of stock distribution.

The "shock" that an animal feels from the fence is a sharp pinching sensation, lasting approximately 1/3 of a second. Animals quickly associate these feelings with the fence, and will learn to avoid pushing-on or touching fences in the future. That being said, if the initial "shock" is not strong enough, or not felt often enough, animals will continue to push the boundaries of their confinement. Fencers should not be turned off for long periods and no section of the fence should be without power.

Physical barriers definitely have their place. Steel panels, wooden rails, and barbed wire are still needed in the management of livestock. They too are designed to confine or separate animals and are perfect materials for working pens and corrals.

The major downfalls with using these products for perimeter and cross fencing are the higher costs and the time and work involved in construction.

Components

The three major components to any successful power fence system are – grounding, energizer, and the physical structure.

Grounding

The grounding portion of any fencing system is the most important. Western Canada is a very difficult area to achieve a ground for any energizer, so care must be taken to build this portion properly.

An energizer needs to be well grounded so that the maximum voltage available can be put onto the fence. Electricity will always take the path of least resistance. If there is insufficient grounding, the pulse goes to the ground rods not down the fence. Adding more ground rods makes it easier to push power to the fence where it flows until an animal makes contact.

When an animal touches the wire, the pulse traveling down the wire goes through the animal into the soil. From the soil under the animal, the pulse then runs through the earth back to the ground rods. This completes the electrical circuit and causes the animal to back off the fence.

Ground rods should be positioned at least 18 metres (60 feet) from other ground fields, well casings, hydrants etc. If too close, electrical interference may occur or stray voltage may affect animals in barns or at watering bowls.

One ground rod should be used for every 3 joules of stored power in the energizer with a minimum of three rods recommended to achieve proper ground. One continuous piece of insulated underground cable should run from the negative terminal on the fencer to all ground rods. Galvanized ground rods can be round or T-shaped and from six to ten feet long and ten feet apart in a location that will not harm the animals. Rebar is a poor product for a ground rod as it is made of mixed metals. Rebar rusts very quickly, reducing electrical conductivity.

Energizers

The heart of a fence system is the energizer – this is the source for the shock or pulse that is produced and pushed onto the fence. This is also where the signals are sent to from a remote control to turn on and off the unit for servicing or repairing the fence. Some energizers may not have a remote control capability.

Energizers are available in both 110V plug-in (mains) and 12V (battery) styles. Mains are less expensive and always more reliable because of the constant power source. The largest 110V energizers will use an amount of power similar to a 5W light bulb. Battery energizers allow for electrified fences in remote areas where 110V power is not an option or in small paddocks.

A minimum of 3000 volts on the fence should be acceptable for cattle, with sheep requiring around 5000 volts. Five thousand volts are required for proper predator control.

All high quality energizers are rated in joules of available power as a measure of the strength behind the pulse. Energizers are tested in volts or KV, but it is the joule that makes the voltage emerge further down the fence. Some of the smallest energizers have a high voltage reading near the source but they quickly lose power on long fences or those that are grown over with plant material. Higher joules ensure that the shock will be felt at the end of fences.

A joule is the amount of energy required to produce 1 watt for 1 second. (Watts x Seconds = Joules)

A watt is a flow of 1 amp at a pressure of 1 volt. (Amps x Volts = Watts)

Avoid costly down time by making sure a local dealer can repair a chosen energizer. Also, compare warranties for coverage of lightning damage and product malfunctions.

Fence Structure

Fence structure includes the posts, wire, insulators, and all other accessories.

Because animals are not pushing on or through an electrified fence, it is possible to space perimeter line posts further apart than with a traditional barbed wire fence. Distances of 11-15 metres (35-50 feet) are becoming more common, allowing the high tensile wire to flex if wildlife run through it or the wire needs to be lifted, while also providing cost savings over barbed wire fences. If the topography allows – expand the distance between posts.

Fewer posts and the lighter weight of 12.5 gauge high tensile wire, make it very easy to construct cross-fence. Cross-fencing can be done with one strand of wire and with posts spaced 18-24 metres (60-80 feet) apart for convenience. To allow maximum movement without breaking, allow 15 to 20 centimetres (six to eight inches) of wire sag between posts.

Eight foot (2.5 metres) posts are recommended for corners and braces should be adequate to bear the load of the fence. Brace posts should be twice as wide as the height of posts out of the ground (i.e., posts that are four feet deep need a brace post 2.5 metres (eight feet) out from the corner).

Twelve and a half (12.5) gauge wire is recommended for permanent perimeter fencing and permanent cross fencing. High tensile wire is extremely strong yet flexible enough not to break if anything pushes through it. The larger the diameter of the wire, the easier it is to push power along. Sixteen gauge wire is less costly but does not stand up over time, is hard to see, and is less conductive than 12.5 gauge.

Designed to prevent a voltage leak through posts and to hold wire off the ground, insulators are needed to ensure enough power stays on the fence. Proper corner insulators are made from glass filled polyester to ensure the pulse will not trickle through to corner posts. This material is also extremely strong and will not crack or break under the strain from high tensile wire.

Photo Credit: Kane Veterinary Supplies

High strain insulator

Post insulators are available in an assortment of styles to accommodate a wide variety of posts. Many companies manufacture insulators from various types and qualities of plastic. Products made from virgin polymers, containing high amounts of UV stabilizers are the best choice. These products last the longest and are not affected by weather, such as extreme cold or bleaching by the sun. Insulators must provide ample distance between the wire and posts. This will eliminate the chance of power leaking through to the post and draining voltage.

Electrified spring gates (available up to 24 feet long) and poly-tape gates allow for gate construction to any width, usually within a few minutes; and these options are very cost efficient. If using a traditional steel or barbed wire gate, keep in mind to route the power under the gateway via underground insulated cable. This will ensure power is maintained on both sides of the gateway even as vehicles or stock pass through.

Photo Credit: Kane Veterinary Supplies

Wood post insulator

Wire can be joined together by tying the ends in a figure eight knot, a simple square knot or by the use of crimping sleeves. Crimping sleeves work well as long as adequate numbers are used to ensure that they do not become loose under strain (Figure 39). Proper wire knots ensure adequate contact points, without putting a kink in the wire (Figure 40). Twisting wires together as you would with barbed wire causes kinks in 12.5 gauge high tensile wire and will likely break at that spot when tension is applied.

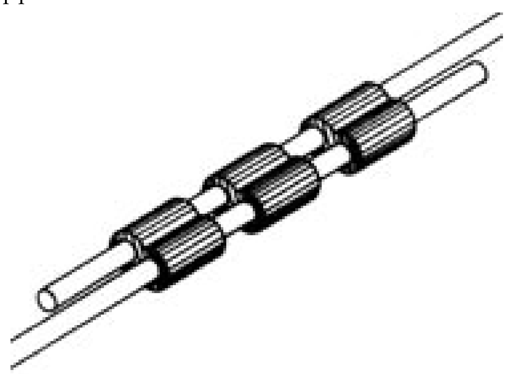


Figure 39: Crimping sleeves

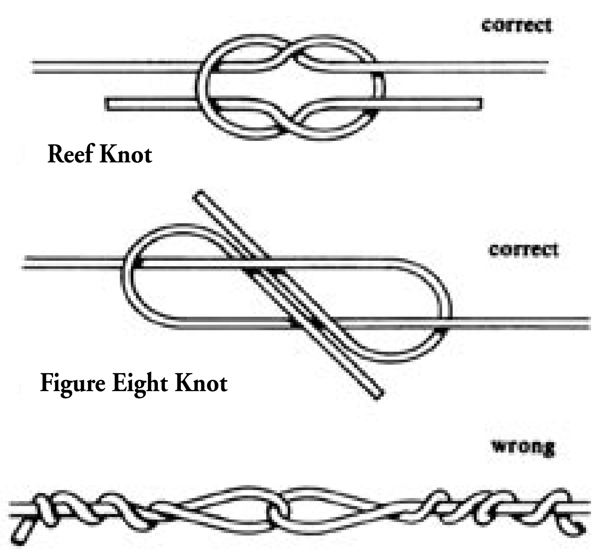


Figure 40: Knots

Construction

When constructing fence, aerial photos, topographical maps, or even a hand drawn layout can assist in the planning process. Answering the following questions will help ensure that a successful fencing project is completed:

- What will the power source be?
- Where are watering sites located?
- How many gates are needed?
- How will cross-fencing be integrated?

- Is any adjoining land a future consideration for fencing?
- What type or class of animal will be managed?
- Will the land be cultivated and farmed in the future?
- Is there an adequate supply of components to electrify what is currently being constructed?
- Will the power supply need to cross a road or other barriers?
- Is this new construction or integrating with existing fence?

Be sure to only string as much wire as what can be easily hung and electrified that day; wildlife will play havoc with wire that is not energized. It is also recommended to release tension from wires before winter to absorb shrinkage due to cold weather and reduce potential wildlife damage.

Maintenance

Power fences require regular attention to most of the components. Each portion should be monitored before animal turn-out and regularly after that.

A good digital voltmeter or a fault finder with built in voltmeter is a necessity for any type of fence maintenance. Initial voltage should be measured at least 30 metres (100 feet) from the energizer and then at various points down the fence. By utilizing cut-out switches sections of the fence can be isolated, making it easier to find any trouble spots. Common causes of power losses include poor grounding, lush growth on low wires, branches or tree limbs, submersion under water or an under-powered energizer.

Photo Credit: Kane Veterinary Supply

Safety

Keep in mind that fencers are a powerful tool and if not handled properly can become dangerous.

- Never connect power to barbed wire;
- Install energizers inside a building;
- Do not use household or shop ground rods;
- Avoid running wires parallel to overhead power;
- Never hook two energizers to the same wire;
- Affix warning signs to electrified fences.

Photo Credit: Kane Veterinary Supplies

Seek out suppliers who can provide training sessions for working with power fencing products and high tensile wire. Fence training days provide opportunities to discuss management techniques and ideas.

References and Suggested Readings

Canada Plan Service, Barbed Wire Field Fencing. Plan M-8366.

Karsky, R. (project leader). 1988. Fences. USDA Forest Service Technology and Development Program. Missoula Technology and Development Center. Missoula, MT. 210p.

McKenzie, D.W., and W.F. Currier. 1984. Low-cost Diagonal Fence Strainer. American Society of Agricultural Engineer. St. Joseph, MI. Paper 84-1624.

Porter, G. 1983. High-Tensile Smooth Wire Fencing. British Columbia Ministry of Agriculture and Food. Victoria, BC.

Porter, G. 1983. Electric Fencing Manual. British Columbia, Ministry of Agriculture and Food. 83-2. Victoria, BC.

Quinton, D.A. 1983. High-Tension High Tensile Fencing. Agriculture Canada. Kamloops, BC. Publication 1983-22E.

Skinner, J., R. Rae, and R. Kapty. 1980. Farm Pasture Fencing. Canada Department of Agriculture. Ottawa, ON. Publication 1568.

Vallentine, J.F. 1971. Range Development and Improvements. Brigham Young University Press. Provo, UT. 516p.

van Dalfsen, K.B., L. Brown, and J.W. Aahradnik. 1982. Improved Rangeland Fencing Methods. Province of British Columbia Engineering Notes. Victoria, BC. Agdex 724.

Wasylik, L. 1985. Electric Fencing Manual for Alberta. Engineering Branch, Alberta Agriculture. Edmonton, AB. Agdex 724-4.

Options for Managing Undesirable Plant Species

A growing problem on Saskatchewan rangeland is the invasion and spread of undesirable plants. These plants contribute to unhealthy ranges and animals, and can interfere with planned land use.

Undesirable plants can be native or introduced grasses, trees, shrubs, or forbs. Some are poisonous. All compete with desirable species for water, nutrients and sunlight, potentially decreasing production of desired forage plants.

A weed can be defined as any plant growing out of place. Many plants considered undesirable are part of the natural ecosystem, but their presence or abundance can be changed by inappropriate management. They are not weeds, but should be considered indicators of overuse.

"True" range weeds are not a natural part of the ecosystem and they invade rangelands. Many of these species are designated noxious and their control is legislated by the Noxious Weeds Act.

Determine the names and characteristics of undesirable plants and watch for new species. It is less costly and easier to manage small infestations early than treating large ones later.

Evaluate the nature and background of the undesirable plant problem before undertaking any control measures. Is the presence of this plant a symptom of inappropriate land management? The control method and results will be affected by the biology of the plant and past land use.

Collect samples of unknown plants and have them identified. The Saskatchewan Ministry of Agriculture Crop Protection Lab, Agriculture and Agri-Food Canada Centres and universities can provide assistance with plant identification.

Native Undesirable Species

With the advent of ranching and other agriculture, livestock foraging habits combined with fire suppression, and their interactions, are believed to favour increases in woody plants.

Western snowberry and **trembling aspen** are two of the most widely distributed woody plants on Saskatchewan rangelends. Western snowberry can be an increaser on many productive range sites, yet it can be a decreaser on other ecosites. Trembling aspen is the climax species of the Aspen Parkland, and eventually forms forests in the absence of fire and/or grazing.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Trembling aspen

Photo Credit: Jim Romo

Western snowberry

At limited levels neither plant poses a serious problem because each provides food and cover for wildlife and aids many ecosystem processes such as snow trapping and nutrient cycling. However, control may be necessary when pastures and rangeland become dominated by these species.

Aspen expands at a slow, but ever increasing pace. Existing clones expand their area based on climate and insect populations. Clones expand by sending out new shoots or suckers. Drought and heavy insect infestations kill aspen while favourable growing conditions facilitate rapid expansion. Management practices that increase competition for the suckers or increase browsing will limit expansion.

Activities that remove or damage the existing top growth will cause a flush of suckers. It is common to see several new suckers establish at the base of a killed aspen. In the year following treatment of an aspen stand there will be a much greater density of stems than before treatment. This suckering necessitates follow up management after any treatments.

Aspen trees grow in separate groups of genetically identical clones connected through a root system. They regenerate by seed and by shoots or root suckers. Seedlings need very precise growing conditions and little competition to survive, and thus they do not account for a significant amount of aspen expansion. Suckers are supported by established trees and have good survival if not stressed significantly in early years.

Apical dominance can inhibit suckering when the plant hormone auxin is translocated to the roots from growing shoots and leaves. Disturbances that damage, cut or kill stems will reduce the flow of auxin into the roots and allow aspen regeneration.

The optimal time to manage aspen is when suckers are one to two years old. Keeping brush short is the key to controlling woody plants because many methods can be applied.

There are different strategies when it comes to brush management. Complete removal of trees reduces wildlife habitat, aesthetics, biodiversity and greenhouse gas sequestration. But the loss of grazing capacity as trees expand onto open grassland must be considered. An approach to manage for all of these objectives is to keep tree cover comparable to that which existed before settlement.

Many techniques are available for managing aspen, including:

- intensive livestock grazing;
- fire;
- mechanical (ie. scraping, mowers, or roller choppers/drum rollers);
- herbicides.

To be successful, these options must be used in combination because no single treatment is successful in the long term. Choices should be made based on a combination of cost, equipment availability, skills, safety, impact on brush, and impacts on non-target species.

Pasture sage, a native half-shrub grows throughout Saskatchewan grasslands and the Parkland. This plant is the most abundant broadleaf plant in the Northern Mixed Grass Prairie. It is present at low levels in rangeland in excellent condition. It is a problem when it begins to dominate a range. The reason for it's abundance should be evaluated before control occurs.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Pasture sage

Improper grazing management and drought promote the increase of pasture sage. An unpalatable plant for cattle, it has a competitive growth advantage over grazed species. Pasture sage is reduced with sheep grazing.

Foxtail barley, a native grass, will quickly move in to occupy gaps in a plant community. Because it is salt tolerant, it increases on saline soils during wet years. Poor drainage, above normal moisture, cool temperatures, and poor grazing management contributes to it increase.

The forage quality of foxtail barley approaches 20 percent crude protein before it produces seed heads. Thus, it can provide valuable grazing if livestock grazing can be concentrated onto the affected area. Palatability of foxtail barley declines once its stiff awns are produced. Adjacent forbs and grasses are then consumed, giving a competitive advantage to foxtail barley.

Eventually measures may be required to reduce amounts of pasture sage and foxtail barley. Addressing the original problem of improper grazing management must accompany any control measures.

Introduced Undesirable Species

Non-native, alien, or exotic plants are plants introduced into Saskatchewan from foreign countries. Some non-native plants are considered Invasive Alien Species (IAS) when they are well-adapted to our conditions and spread throughout the province. Canada thistle, Russian knapweed, leafy spurge, absinthe, baby's breath and toadflax are persistent perennials that were introduced to Saskatchewan. Annual or biennial invasive alien species include downy brome, burdock and bull thistle. Other plants in neighbouring provinces and states that may also invade Saskatchewan include spotted knapweed, yellow star-thistle, common crupina and hound's-tongue.

Photo Credit: D. Fontaine, Saskatchewan Ministry of Agriculture

Leafy spurge on range

In native rangeland, certain tame forages such as crested wheatgrass, smooth bromegrass, and sweet clover were also introduced from foreign countries, and may be considered invasive alien species by those trying to preserve the natural landscape and native plant diversity.

All plant species in a natural ecosystem are continually impacted by animals, insects or diseases that have evolved to utilize them as a food source. These impacts keep an ecosystem in a balanced state. Many invasive alien species have a competitive advantage over desirable native plants because they have been introduced in an ecosystem in which there are no natural predators to reduce their relative vigour. This lack of natural predators can allow these plants to dominate permanent pasture and rangeland, thereby excluding desirable grasses and forbs. Although large tracts of land can be infested with these weeds, they are usually found in localized areas. They will continue to spread if not controlled.

Early detection and control are necessary to avoid the establishment of unwanted weeds. Once unwanted plants become established, measures must be taken to prevent their spread. It is important to define a boundary, outside of which new plants will be eradicated, while taking integrated control measures within the boundary. Keep a record of when and what measures were taken in response to invasive plants. Visit the site every year to evaluate the treatment and retreat any areas when necessary.

Control Measure Definitions

Eradication is the complete kill or removal of undesirable plants, including the elimination of sexual and vegetative reproductive structures. It is difficult and nearly impossible to eradicate plants on a large scale. Small-scale infestations may be eradicated at early stages, provided that the sites are visited yearly, and any additional growth is treated as it appears.

Control is manipulation and management designed to achieve a reduction in the number and the overall impact of undesirable plants. The degree of reduction can vary from slight to nearly complete, and involves keeping undesirable plant numbers at a level that minimizes loss of desirable forage. Control is the most common treatment and is often the only practical management for widespread and well-established native and introduced undesirable plants.

Prevention refers to preventing an initial infestation by keeping undesirable plants out of an area. Purchase only clean forage seed and hay from areas that are known to be free from undesirable plants. Ensure that preventative approaches are taken to prevent seed and hay that may contain undesirable species from escaping during transport. Tarping open topped trucks is the most common form of containment during transport, but other methods such as self contained panel trucks, and use of poly bale wrapping are other good methods to use. Cleaning equipment thoroughly before leaving fields, avoiding driving vehicles through infested areas, and watching for 'hitch hikers' on clothing and livestock are good prevention methods. Also be aware of prevailing winds and waterways that can transport seeds. A percentage of foxtail barley, common tansy and scentless chamomile seed remain in the inflorescence through the winter and as the wind buffets the dead stalks, seeds are shed and moved in or on snow. Leafy spurge propels its seeds up to five metres (15 feet) from the parent plant after it sets seed, while it and scentless chamomile seeds travel easily in water. When prevention is neglected, control and eradication costs are high.

Control Methods

Control of undesirable plants on rangeland requires good vegetation management. Success is based on two principles: competition and succession.

The competitive ability of an undesirable plant must be reduced for plant community succession to proceed in a desired direction. These goals can be achieved by choosing the most appropriate mix of control methods for each situation. The control methods should not conflict with each other.

Several methods are available for controlling undesirable plants. To determine which method or combination of methods may fit a specific situation, contact your local Rangeland Agrologist.

Manual Control

Manual control involves pulling, digging, and cutting individual plants. These techniques are highly selective but slow, costly, and in the case of deep-rooted perennial plants, ineffective, therefore manual controls are usually limited to small areas. Manual control is most useful for removing invading plants in the initial stages of infestation and cleaning up after other methods have been used. It can be used to remove undesirable plants from around corrals, small pastures and along fencelines. Do not give plants an opportunity to set seed.

Grazing

Control by grazing may involve use of a combination of animal species that each has different dietary preferences. Control can sometimes be achieved by changing the time a particular field is grazed. For example, sheep or goats may be used to effectively control leafy spurge while goats can also be utilized to keep brush in check.

Some recent and promising work undertaken at Utah State University involves training young cattle to eat weeds such as Canada thistle, leafy spurge and spotted knapweed. Key considerations include proper use of supplements to reduce the toxic effects of these plants, and creating a taste for the plant through careful training of the animals.

Delaying grazing on native range will allow desirable plants to increase in vigour and this will give them a competitive advantage over undesirable plants. Through early use of tame pastures containing species such as crested wheatgrass, and deferred rotational grazing strategies, native pastures can be used later in the season.

Seeding competitive tame species such as crested wheatgrass or smooth bromegrass on weedy cultivated land can provide good weed control. Care should be taken not to seed them too close to existing native rangelands because they may invade. Good grazing management can be an effective way to keep smooth bromegrass out of native rangeland because smooth bromegrass is palatable to livestock in early spring and summer.

Controlled grazing is one of the cheapest ways to control aspen suckers because the producer already has access to cattle and there is an economic return. Current year's growth of poplar stems are readily grazed by livestock, whereas older aged stems may be too tough to break. However, with intensive grazing cattle trample and rub on older suckers, causing some damage. Target areas for brush management should be grazed by livestock every year. Twice over systems that allow browsing and livestock impacts in the early and late summer can be most effective. Late summer grazing limits the amount of root reserves in plants, thus enhancing winterkill of the suckers. Grazing must occur during the growing season to reduce suckers.

Photo Credit: T. Jorgenson, Saskatchewan Ministry of Agriculture

Grazed aspen rose complex

Young poplar is palatable and nutritious for cattle. In early July, the protein content is about 22 percent, declining to about 13 percent by early September - greater than most grasses. Given the choice, conditioned cattle will readily browse brush as the grazing season progresses into August and September. Browse species can compose up to 30 percent of cattle diets. Unconditioned animals that are not familiar with browsing woody species may require up to two years of grazing experience to become habituated to it.

The key to using livestock to manage woody suckers is to maintain a high stocking density on the target area for a short period of time. Livestock must be monitored closely to ensure that the desired outcome is being achieved. Using electric fence and stock water to concentrate cattle in specific areas will improve success.

Grazing management of forested pastures should consider where capital developments are being made in relation to the capability of livestock to graze areas. Water developments and strategic salt placement can be used to increase the amount of browsing on brush. A rotational grazing plan which includes the entire land base, and allows for high density grazing in brush control areas is critical.

Biological Control

Biological control is the control of species by their natural enemies (predators, parasites and pathogens). Undesirable native plants have an array of organisms that have evolved in the same habitat and attack on a continual basis. When used appropriately, these natural enemies will only target a single species, avoiding damage to the associated plant community. This selectivity is particularly beneficial on rangeland where a mixture of grasses and forbs occur and when herbicides are not selective enough.

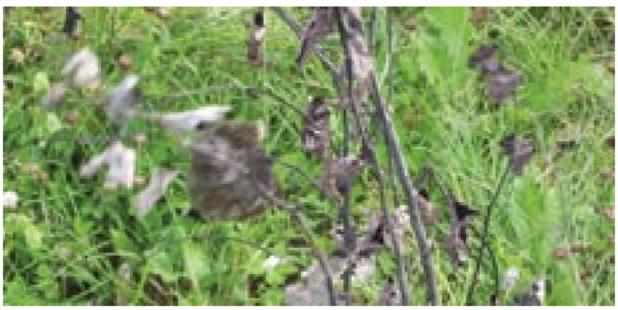
Chemical Control

Chemical control uses herbicides to disrupt the biological processes of undesirable plants so that they are killed or their competitive ability is reduced. Herbicides have several advantages as a control method. They require a minimum amount of labour, they can be effectively used on steep slopes and stony terrain where mechanical equipment cannot operate, and they can be easily targeted to small specific areas if need be. The costs of these applications are usually less than mechanical control treatments.

Non-selective herbicides have negative impacts on all plants. They control a broader range of target weeds, but will also damage desirable forage species if indiscriminately applied. To minimize damage to desirable species, non-selective herbicides should only be used:

- as an alternative to complete stand replacement;
- as a spot treatment to a small area where other management practices are not effective;
- in a situation where the desirable plants may be protected from the non-selective herbicide, such as with wick type applications on tall weedy plants, or when cover of the undesirable species is complete.

Photo Credit: AAFC-PFRA



Aspen sucker control with a wiper – note undamaged herbaceous plants in background

Selective herbicides have a narrower range of plants that they control. Regardless of options, selective herbicides are preferred over non-selective herbicides as total elimination of vegetation may result in soil erosion. After treatment with selective herbicides, vegetation and litter covers the soil, reducing the risk of water and wind erosion. Using a selective herbicide to remove undesirable plants can increase production of desirable plants.

There are some disadvantages to using herbicides:

- some undesirable plants cannot be effectively controlled with the selective herbicides available;
- some desirable forbs and shrubs may be temporarily injured or killed in the process of removing the undesirable broadleaf weed;
- depending on the herbicide used, the cost of control may exceed the value of expected forage increase;
- improper use can damage non-target vegetation and/or contaminate the environment.

Before applying herbicides, check product labels for precautions, grazing and feeding restrictions, general use information and specific application instructions. This information will determine the appropriate herbicide to use in each situation. Recommendations for specific problem plants and herbicide selection can be found in the Saskatchewan Ministry of Agriculture publication 'Guide to Crop Protection' published annually.

Fire

Prescribed fire has been used to manipulate vegetation on the Canadian prairies for thousands of years. It is low cost and effective provided that proper precautions are taken. Burning is an effective tool for removing brush from large areas provided there is enough fuel to carry the fire. A minimum of 1000 kg/ha (lbs/ac) of fine fuel (dry grass, forbs and leaves) must be present to carry a fire. Larger trees and more mature stands are difficult to burn because fine fuels are usually inadequate.

Early spring and late fall burning when grasses are dormant are the best times to control brush while maintaining forage productivity. Burns should be conducted while forage species are dormant so forage productivity is not reduced.

Planning for a burn is critical. Planning should begin a year in advance to have enough fuel. In most areas of the Black soil zone pastures must be rested from grazing for at least half of the growing season. Resting pastures to accumulate fine fuels may take longer in degraded pastures, during dry years, or on light-textured soils. When it comes time to conduct the burn ensure that enough personnel to ignite, patrol and fight the fire are present. Desired equipment includes ATV and truck mounted fire fighting tanks and pumps, back pack sprayers, possibly foamers, radios for communicating with the crew, and drip torches.

The first step is to ensure that the perimeter is protected and that the fire cannot escape. A fireguard must be made if the field is not protected from other land by cultivated land or a road. One of the most effective ways to make a wide fireguard is to backfire (burn into the wind) a safe width and then put the fire out on both sides. At least a 30 metre (100 foot) fireguard is required, but safety is increased with wider fireguards.

The fire must be ignited so it builds enough momentum to kill the trees but still remains under control. An effective method is the strip headfire technique. This technique requires that a narrow headfire immediately adjacent to the down wind fireguard (with the wind) be ignited. Headfires are lit to follow this one up. Generally three to four headfires is an acceptable target depending on the size of the area being burned. This way the fireguard is effectively becoming wider, and the momentum of the fire is also kept at a manageable rate.

Weather requirements are the most important factors to consider for a successful and safe burn. Higher temperatures, lower humidity, and greater wind speed are better for burning brush but the danger of escape also becomes greater. The following table illustrates the optimum combination of weather factors for both control and safety.

Fuel Type	Minimum Temp °C	Wind Speed km/hr	Maximum RH %	Drying Days after Snow
grassland	7	3 – 20	62	1 – 3
deciduous shrubland	13	3 – 20	50	3 – 5
deciduous forest	18	6 – 20	30	8 – 10

Source: Adapted from Bailey, A.W. 1988.

Do not consider burning any areas unless follow up brush management will occur. The use of fire requires a long term commitment to brush management because burning will promote vigorous sprouting of aspen, snowberry and many other brush species. Resultant sprouting can promote an effective follow-up control of brush in the long term, whether repeated fire or other methods used in combination. The new growth after a fire is also very palatable to livestock and this tool can be used to attract livestock to access previously ungrazed areas of a pasture.

Photo Credit: AAFC-PFRA

Fire crew burning a "backline" fireguard before the actual prescribed fire takes place

Photo Credit: AAFC-PFRA

Aspen suckering after a hot prescribed burn

Photo Credit: AAFC-PFRA

Prescribed burn to control aspen – note the backfire and headfire

Photo Credit: AAFC-PFRA

Successful burn

Proper training on the use of fire for controlling brush is important to achieve success at minimal risk.

Mechanical Renovation or Reseeding

Mechanical control measures can be implemented to control undesirable plant species on rangelands. Mechanical methods need to be carefully planned prior to implementation.

Determine whether the returns will pay for the costs incurred. Comparison of all alternatives allows for a decision on the most efficient method. Consider all alternatives before renovating any existing pasture as well as seeding new pasture. For example, if an existing pasture contains adequate grass cover and some legumes are present, the use of improved grazing management with extended rest periods can return the forage stand to adequate production. Fertilizer use enhances this process in many cases, but tame pasture species may be more responsive to fertility management than native species.

The following variables have a major impact on conversion costs and returns on renovating existing tame pasture and new seedings:

- Landform, including amount of stones. Stones may break or wear machinery rapidly;
- Soil characteristics, including salinity. Cultivation may bring shallow salt deposits to the surface or may dilute surface deposits through the tillage layer enough to allow cover to establish. Tillage can also leave soils prone to wind and water erosion or allow invasive species an opportunity to increase;
- Amount and quality of water, for livestock and vegetation;
- Type and amount of both woody and herbaceous vegetation. Existing vegetation may be difficult to kill and will reestablish quickly from seed and roots stored in the soil. Land which has been growing annual crops for many years does not usually cause major difficulties when converting to forage crops;
- Current custom breaking costs. Tree and brush removal is expensive.

Mechanical control of aspen stands and encroachment is often practiced in the transition zones of the province.

Bark scrapers are effective for managing aspen when tree diameter is small and the stem density low. The method is relatively simple to implement, however the following drawbacks should be noted:

- a repeat treatment is required because plants will sucker, but likely not to the extent of other treatments;
- the remaining trees will be at a 30 to 60 degree angle to the surface, which can be "spear like" to cattle and horses.

Photo Credit: AAFC-PFRA

Roller chopper in use

Roller choppers or drum rollers can be used in aspen that is either too tall or large to use a herbicide wiper or bark scraper. This equipment knocks trees to the ground where they can be burned or left to decay. The subsequent even-aged suckers can then be dealt with more easily, through either intensive livestock grazing or with a herbicide wiper, or ideally both. The new suckers are palatable to livestock if they are the current year's growth. A drawback to this method is greater expense especially if used with herbicides. This dual approach is very effective in controlling aspen.

Costs Versus Returns

Fertilizer application can be used instead of breaking and re-seeding on some pastures. If brush regrowth is extensive, fertilizer application may not be appropriate. Other alternatives include change in the timing or intensity of grazing, change in the species of animals grazing the area, bark scraping, herbicides, and fire. The criteria used to determine which methods should be used include cost and what the expected return on investment will be.

Nitrogen is often the limiting factor in forage production, especially if no legumes are in the sward. Fertilizing tame forage with nitrogen almost always increases production even in dry years. A soil test is recommended to determine fertilizer requirements. The increased grass and undesirable plant production usually does not equal fertilizer and application costs. Consider the cost of alternative pasture and expected beef production before applying fertilizer.

References and Suggested Readings

Abouguendia, Z. 1998. Nutrient content and digestibility of Saskatchewan range plants. Agriculture Development Fund Technical Report 94000114. Regina, SK.

Bailey, A.W. 1988. Understanding fire ecology for range management. p. 527-557. In: Tueller, P.T. (ed.). Vegetation science applications for rangeland analysis and management. Kluwer, Dordrecht.

Bowes, G. 1996. Aspen Sucker Control with Herbicides. Summary Report. Saskatoon Research Centre. Agriculture and Agri-Food Canada. Saskatoon, SK.

Bowes, G. 1996. Bark Scrape to Manage Aspen. Final Report. Saskatoon Research Centre. Agriculture and Agri-Food Canada. Saskatoon, SK.

Bowes, G. 1994. Western Snowberry Control. Saskatoon Research Centre. Agriculture and Agri-Food Canada. Saskatoon, SK.

Bowes, G. 1996. Wiper Applied Herbicides to Manage Brush. Final Report. Saskatoon Research Centre. Agriculture and Agri-Food Canada. Saskatoon, SK.

Looman J., W. Majak, and S. Smoliak. 1983. Stock-poisoning Plants of Western Canada. Agriculture Canada Publication 1982-7E. Ottawa, ON.

Manitoba Forage Council. 2008. An Integrated Guide to Brush Management on the Western Canadian Plains. Agriculture and Agri-Food Canada's Greencover Canada Program. ISBN 978-00980961-0-8.

Saskatchewan Ministry of Agriculture. (Annual). Saskatchewan Forage Crop Production Guide. Crop Development Branch. Regina, SK.

Saskatchewan Ministry of Agriculture. (Annual). Guide to Crop Protection. Crop Development Branch. Regina, SK.

Stearman, W.A. 1988. Controlling Brush in Alberta. Alberta Agriculture. Edmonton, AB. Agdex 643-2.

Vallentine, J. 1989. Range Development and Improvements. Third Edition. Brigham Young University Press. Provo, UT.

Rangeland Restoration

The fundamental definition of rangeland restoration is to return disturbed rangeland or sites to pre-disturbance conditions.

Photo Credit: T. Jorgenson, Saskatchewan Ministry of Agriculture

Developments such as gas lines require restoration

Site specific restoration is often required because of man-made disturbances. Developments such as oil and gas, sand and gravel, pipelines, roads and utilities often involve the complete removal of vegetation and associated soil profile. These disturbed sites often require reseeding as a component of restoration depending on the level of disturbance. It is unrealistic to expect a restoration effort to immediately replace lost native species and ecological functions. It is, however, an attempt to help speed up natural regenerative processes inherent in native rangeland. Seeding native plants is not sufficient to recreate pre-disturbance conditions. The seeded plant community does, however, provide the structural environment for succession to occur and allow for many species to colonize the site on their own.

Photo Credit: T. Jorgenson, Saskatchewan Ministry of Agriculture

Well site

Succession is the process by which species in a community change over time. Following disturbance, an ecosystem generally progresses from a simple level of organization with a few dominant species to a more complex community or "climax" community. Every ecosite has the potential to support a different climax plant community. Most rangelands in Saskatchewan have the ability to recover following mild natural disturbances. An ecosite that has experienced more severe disturbance, such as soil stripping for an oil well, requires more extensive efforts to promote natural succession.

Ecosystem function describes the basic processes of a natural system such as energy flow (ultimately from the sun), the hydrologic cycle, and nutrient cycling. These are the main, essential components of an ecosystem. In late successional or "climax" communities these functions are generally stable and limited by the biophysical characteristics of the ecosite. A functional ecosystem that is self-perpetuating should be the end result of restoration efforts. Succession occurs over time so monitoring and ongoing management are needed for the long-term stability of a disturbed ecosite.

Fragmentation of Saskatchewan's rangeland is an ongoing concern. Land-use changes have dissected many larger tracts of rangeland into smaller parts. These smaller parts then support smaller species populations rendering them more vulnerable to environmental stresses and ultimately extirpation or local extinction. Habitat along the edge of a fragment typically has different environmental conditions and supports different species. Non-native species can invade from road allowances into adjacent rangelands. Restoration projects can increase the effective size and stability of rangeland by establishing corridors that link isolated fragments together. The use of designated corridors for utilities and pipelines will minimize the effects of fragmentation. Designated corridors are based on the premise that one larger disturbance or corridor is better than dissecting the rangeland with many smaller corridors. The use of designated corridors requires extensive planning and consultation with stakeholders before any development occurs. Mitigating the effects of fragmentation is a primary goal of restoration ecology.

In Saskatchewan, an array of environmental legislation regulates developers such as the oil and gas industry. Typically these requirements apply to

Developments such as gas lines require restoration

Crown Land, but also may include private lands. Most major projects occurring on Saskatchewan's rangeland require an Environmental Protection Plan (EPP) or an Environmental Impact Assessment (EIA).

An EPP will outline all potential development sites, provide a pre-site assessment of the rangeland and outline any mitigation measures that may be needed. An EIA is required where there is a high degree of stakeholder concerns and/or the proposed development is within an ecologically sensitive or unique area. An EIA involves public and/or stakeholder consultation and issue resolution while an EPP does not. Developers work with government staff from various departments through the EIA and EPP process to ensure all environmental as well as socio-economic concerns are addressed. Both requirements place emphasis on thorough planning prior to any actual development. There may be additional requirements placed on developers that specifically address restoration requirements. One example is the requirement for a restoration plan on all agricultural Crown rangeland. This requirement applies to seismic operations, oil or gas well sites and associated facilities, sand and gravel removal, coal or oilsands development, pipeline development, utility development, and roads.

The restoration plan must include all proposed development and site restoration methods such as native seed mixtures or other re-vegetation techniques, topsoil stripping and stockpiling, minimum surface disturbance methods, weed control, rare or endangered species mitigation measures, and a monitoring plan. The developer is responsible for ensuring proper restoration techniques are used. A site will not be released from a developer by the government agency until it meets standard criteria for native vegetation, soils, and landscape. The main measure for these restoration criteria are the pre-development site conditions, i.e., a comparison of restoration efforts to the natural ecosystem before development.

Site restoration methods may include seeding with native seed mixtures

Restoration criteria are based on pre-development site conditions

It should be noted that owners of private rangeland can request that developers take the same planning and restoration measures as on Crown rangeland.

References and Suggested Readings

Prairie Conservation Action Plan (PCAP). 2005. Oil and Gas Exploration and Development on Saskatchewan Agricultural Crown Lands. Regina, SK.

Saskatchewan Environment. 2007. Environmental Impact Assessment (EIA) Process. Regina, SK.

Saskatchewan Environment. 2007. Environmental Protection Plan (EPP) Process. Regina, SK.

Saskatchewan Ministry of Agriculture. 2005. Crown Land Conditions: Seismic Exploration. Regina, SK.

Saskatchewan Ministry of Agriculture. 2005. Restoration of Saskatchewan's Agricultural Crown Rangelands. Guidelines and Procedures for Developers. Regina, SK.

Saskatchewan Petroleum Industry / Government Environmental Committee. 1999. Restoration of Spill Sites on Saskatchewan Ministry of Agriculture and Pasture Lands. Regina, SK.

Appendix A
Common & Latin* Names of Saskatchewan Range Plants

Common Name	Latin Name
GRASSES	
Alkali Cord Grass	*Spartina gracilis*
Awned/Bearded Wheatgrass	*Agropyron subsecundum*
Big Bluestem	*Andropogon gerardii*
Blue Grama	*Bouteloua gracilis*
Buffalo Grass	*Bouteloua dactyloides*
Canada Bluegrass	*Poa compressa*
Canada Wildrye	*Elymus canadensis*
Canadian Rice Grass	*Oryzopsis canadensis*
Canby Bluegrass	*Poa canbyi*
Crested Wheatgrass	*Agropyron cristatum*
Salt Grass	*Distichlis stricta*
Fowl Bluegrass	*Poa palustris*
Fowl Manna Grass	*Glyceria striata*
Foxtail/Wild Barley	*Hordeum jubatum*
Fringed Bromegrass	*Bromus ciliatus*
Green Foxtail	*Setaria viridis*
Green Needlegrass	*Stipa viridula*
Hairy Wildrye	*Elymus innovatus*
Hooker's Oat Grass	*Helictotrichon hookeri*
Indian Rice Grass	*Oryzopsis hymenoides*
June Grass	*Koeleria macrantha*
Kentucky Bluegrass	*Poa pratensis*
Little Bluestem	*Andropogon scoparius*
Marsh Reed Grass	*Calamagrostis canadensis*
Mat Muhly	*Muhlenbergia richardsonis*
Meadow Bromegrass	*Bromus biebersteinii*
Narrow Reed Grass	*Calamagrostis neglecta*
Needle-and-Thread	*Stipa comata*
Northern Awnless Bromegrass	*Bromus pumpellianus*
Northern Reed Grass	*Calamagrostis inexpansa*
Northern Rice Grass	*Oryzopsis pungens*
Northern Wheatgrass	*Agropyron dasystachyum*
Nutall's Alkali Grass	*Puccinella nuttalliana*
Parry Oat Grass	*Danthonia parryi*
Pine Grass	*Calamagrostis rubescens*
Prairie Muhly	*Muhlenbergia cuspidata*
Plains Reed Grass	*Calamagrostis montanensis*
Plains Rough Fescue	*Festuca hallii*
Porcupine Grass	*Stipa spartea*
Prairie Cord Grass	*Spartina pectinata*
Prairie Drop Seed	*Spartina heterolepis*
Purple Oat Grass	*Schizachne purpurascens*
Quackgrass	*Agropyron repens*
Reed Canary Grass	*Phalaris arundinacea*
Richardson's Needlegrass	*Stipa richardsonii*
Rough Fescue	*Festuca scabrella*
Rough Hair Grass	*Agrostis scabra*
Sand Dropseed	*Sporobolus cryptandrus*
Sand Reed Grass	*Calamovilfa longifolia*
Sandberg's Bluegrass	*Poa sandbergii*
Sheep Fescue	*Festuca saximontana*
Side-Oats Grama	*Bouteloua curtipendula*
Slender Wheatgrass	*Agropyron trachycaulum*
Slender Wood Grass	*Cinna latifolia*
Slough Grass	*Beckmannia syzigachne*
Smooth Bromegrass	*Bromus inermis*
Sweet Grass	*Hierochloe odorata*
Switch Grass	*Panicum virgatum*
Timber/Intermediate Oat Grass	*Danthonia intermedia*
Tall Manna Grass	*Glyceria grandis*
Tufted Hair Grass	*Deschampsia caespitosa*
Western Porcupine Grass	*Stipa curtiseta*
Western Wheatgrass/Blue Joint	*Agropyron smithii*
White-Grained Rice Grass	*Oryzopsis asperifolia*
Whitetop Spangletop	*Scolochloa festucacea*
Grasslike Plants	
Awned Sedge	*Carex atherodes*
Baltic Rush	*Juncus balticus*
Beaked Sedge	*Carex rostrata*
Cotton Grass	*Eriphorum spp.*
Graceful Sedge	*Carex praegracilis*
Hay Sedge	*Carex siccata*
Low Sedge	*Carex stenophylla var eleocharis*

Common Name	Latin Name
Northern Bog Sedge	*Carex gynocrates*
Sprengel's Sedge	*Carex sprengelli*
Sun-loving Sedge	*Carex pensylvanica*
Thread-leaved Sedge	*Carex filifolia*
FORBS	
Absinth	*Artemisia absinthium*
American Hedysarum	*Hedysarum alpinum var. americanum*
American Vetch	*Vicia americana*
Arrow-Leaved Colt's Foot	*Petasites sagittatus*
Baneberry	*Actaea rubra*
Biennial Wormwood	*Artemisia biennis*
Blue-eyed Grass	*Sisyrinchium montanum*
Broomweed (Broom Snakeweed)	*Gutierrezia sarthrae*
Bunchberry	*Cornus canadensis*
Cactus	*Optuntia spp.*
Canada Thistle	*Cirsium arvense*
Canada Anemone	*Anemone canadensis*
Colorado Rubberweed	*Hymenoxys richardsonii*
Cow Parsnip	*Heraceleum lanatum*
Cream-Coloured Vetchling	*Lathyrus ochroleucus*
Crocus	*Anemone patens*
Curled Dock	*Rumex crispus*
Dandelion	*Taraxacum officinale*
Diffuse Knapweed	*Centaurea diffusa*
Dotted Blazing Star	*Liatris punctata*
Early Yellow Locoweed	*Oxytropis sericea*
Fairybells	*Disporum trachycarpum*
Field Bindweed	*Convolvulus arvensis*
Field Chickweed	*Cerastium arvense*
Fireweed	*Epilobium angustifolium*
Gaillardia	*Gaillardia aristata*
Goatsbeard	*Tragopogon dubius*
Golden Bean	*Thermopsis rhombifolia*
Gumweed	*Grindelia squarrosa*
Hairy Golden Aster	*Chrysopsis villosa*
Harebell	*Campanula rotundifolia*
Hoary Cress	*Cardaria spp.*
Indian Breadroot	*Psoralea esculenta*
Indian Paintbrush	*Castilleja spp.*
Kochia	*Kochia scoparia*
Leafy Spurge	*Euphorbia esula*
Lindley's Aster	*Aster ciliolatus*
Little Clubmoss	*Selaginella densa*

Common Name	Latin Name
Low Everlasting/Pussy Toes	*Antennaria aprica*
Low Goldenrod	*Solidago missouriensis*
Many-Flowered Aster	*Aster ericoides*
Meadow Rue	*Thalictrum spp.*
Milkweed	*Asclepias spp.*
Moss Phlox	*Phlox hoodii*
Narrow-Leaved Milkvetch	*Astragalus pectinatus*
Northern Bedstraw	*Galium boreale*
Northern Bog Violet	*Viola cucullata*
Pale Comandra/ Bastard Toad Flax	*Comandra umbellata*
Pasture Sage/Fringed Sagebrush	*Artemisia frigida*
Perennial Sow Thistle	*Sonchus arvensis*
Philadelphia Fleabane	*Erigeron philadelphicus*
Poverty Weed	*Iva axillaris*
Prairie Cinquefoil	*Potentilla pensylvanica*
Prairie Coneflower	*Ratibida columnifera*
Prairie Sage	*Artemisia ludoviciana*
Purple Prairie Clover	*Petalostemon purpureum*
Purple Vetchling/Peavine	*Lathyrus venosus*
Red Samphire	*Salicornia rubra*
Rough Cinquefoil	*Potentilla norvegica*
Russian Knapweed	*Centaurea repens*
Scarlet Gaura	*Gaura coccinea*
Scarlet Mallow	*Malvastrum coccineum*
Scentless Chamomile	*Matricaria maritima*
Silverleaf Psoralea	*Psoralea argophylla*
Skeletonweed	*Lygodesmia juncea*
Smooth Aster	*Aster laevis*
Smooth Sweet Cicely	*Osmorhiza aristata*
Snakeroot	*Sanicula marilandica*
Spiny Ironplant	*Haplopappus spinulosus*
Spreading Dogbane	*Apocynum androaemifolium*
Star-Flowered Solomon's Seal	*Hedysarum spp.*
Sweet Broom	*Smilacina stellata*
Tansy	*Tanacetum vulgare*
Tall Lungwort/Bluebell	*Mertensia paniculata*
Tall Meadow Rue	*Thalictrum dasycarpum*
Three-Flowered Avens	*Geum triflorum*
Three-Toothed Cinquefoil	*Potentilla tridentata*
Toadflax	*Linaria vulgaris*
Tufted Fleabane	*Erigeron caespitosus*
Two-Grooved Milkvetch	*Astragalus bisulcatus*
Two-Leaved Solomon's Seal	*Maianthemum canadense*
Western Canada Violet	*Viola rugulosa*

Common Name	Latin Name
White Prairie Aster	*Aster falcatus*
Wild Licorice	*Glycyrrhiza lepidota*
Wild Peavine	*Lathyrus venosus*
Wild Sarsaparilla	*Aralia nudicalis*
Wild Strawberry	*Fragaria virginiana*
Yarrow	*Achillea millefolium*
Yellow Avens	*Geum aleppicum*

Shrubs and Trees

Common Name	Latin Name
Alder	*Alnus spp.*
Balsam Fir	*Abies balsamea*
Balsam Poplar	*Populus balsamifera*
Beaked Hazelnut	*Corylus cornuta*
Bearberry	*Arctostaphylos uva-ursi*
Black Spruce	*Picea mariana*
Bog/Dwarf Birch	*Betula glandulosa*
Canada Blueberry	*Vaccinium myrtilloides*
Canada Buffaloberry	*Shepherdia canadesis*
Chokecherry	*Prunus virginiana*
Creeping Juniper	*Juniperus horizontalis*
Dewberry	*Rubus pubescens*
Dry Ground Cranberry	*Vaccinium vitis-idaea*
Gooseberry	*Ribes spp.*
Greasewood	*Sarcobatus vermiculatus*
Green Alder	*Alnus crispa*
Green Ash	*Fraxinus pennsylvanica*
Hawthorn	*Crataegus spp.*
High-Bush Cranberry	*Viburnum opulus*
Jack Pine	*Pinus banksiana*
Labrador Tea	*Ledum groenlandicum*
Lodgepole Pine	*Pinus contorta*
Low-Bush Cranberry	*Viburnum edule*
Nutall's Saltbush	*Atriplex nuttallii*
Northern Gooseberry	*Ribes oxyacanthoides*
Pincherry	*Prunus pensylvanica*
Prickly Rose	*Rosa acicularis*
Rabbitbrush	*Crysothamnus nauseousus*
Red Osier Dogwood	*Cornus stolonifera*
Saskatoon	*Amelanchier alnifolia*
Shrubby Cinquefoil	*Potentilla fruticosa*
Silver Sage	*Artemisia cana*
Skunkbush	*Rhus trilobata*
Tamarack	*Larix laricina*
Thorny Buffaloberry	*Shepherdia argentea*
Trembling Aspen	*Populus tremuloides*
Twinflower	*Linnaea borealis*
Twining Honeysuckle	*Lonicera glaucescens*
Western Snowberry/Buckbrush	*Symphoricarpos occidentalis*
White Spruce	*Picea glauca*
Wild Black Currant	*Ribes americanum*
Wild Red Raspberry	*Rubus idaeus*
Willow	*Salix spp.*
Winterfat	*Eurotia lanata*
Wolfwillow/Silverberry	*Eleaegnus commutata*
Wood's Rose	*Rosa woodsii*

Poisonous

Common Name	Latin Name
Seaside Arrowgrass	*Triglochin maritima*
Death Camas	*Zygadenus gramineus*
Horsetail	*Equisteum spp.*
Leafy Spurge	*Euphorbia esula*
Locoweed	*Oxytropis spp.*
Narrow-Leaved Milkvetch	*Astragalus pectinatus*
Silvery Lupine	*Lupinus argenteus*
Two-Grooved Milkvetch	*Astragalus bisulcatus*
Water Hemlock	*Cicuta virosa*

* The grouping of plants is continually changing with ongoing taxonomy research. Re-grouping often requires a scientific/Latin name change. The names listed in this publication match those in the Saskatchewan Field Identification Guides (Saskatchewan Forage Council, 2007). For updated Latin/scientific names, the following internet links may be helpful:

Tropicos Nomenclatural database:
http://biodiversity.uno.edu/delta/grass/index.htm

World grasses database:
http://www.rbgkew.org.uk/herbarium/gramineae/wrldgr.htm

Grass genera of the world:
http://biodiversity.uno.edu/delta/grass/index.htm

United States Department of Agriculture, National Resources Conservation Service, Plants Database:
http://plants.usda.gov

Appendix B
Conversion Factors for Metric System

Imperial units	Approximate conversion factor	Results in:
LINEAR		
inch	x 25	millimetre (mm)
foot	x 30	centimetre (cm)
yard	x 0.9	meter (m)
mile	x 1.6	kilometre (km)
AREA		
square inch	x 6.5	square centimetre (cm^2)
square foot	x 0.09	square metre (m^2)
acre	x 0.40	hectare (ha)
VOLUME		
cubic inch	x 16	cubic centimetre (cm^3)
cubic foot	x 28	cubic decimetre (dm^3)
cubic yard	x 0.8	cubic metre (m^3)
fluid ounce	x 28	millilitre (ml)
pint	x 0.57	litre (L)
quart	x 1.1	litre (L)
gallon	x 4.5	litre (L)
bushel	x 0.36	hectolitre (hl)
WEIGHT		
ounce	x 28	gram (g)
pound	x 0.45	kilogram (kg)
short ton (2000 lb)	x 0.9	tonne (t)
TEMPERATURE		
degrees Fahrenheit	(^{o}F -32) x 0.56 or (^{o}F -32) x 5/9	degrees Celsius (^{o}C)
PRESSURE		
pounds per square inch	x 6.9	kilopascal (kPa)
POWER		
horsepower	x 746	watt (W)
	x 0.75	kilowatt (kW)
SPEED		
feet per second	x 0.30	metres per second (m/s)
miles per hour	x 0.75	kilometres per hour (km/h)
AGRICULTURE		
gallons per acre	x 11.23	litres per hectare (L/ha)
quarts per acre	x 2.8	litres per hectare (L/ha)
pints per acre	x 1.4	litres per hectare (L/ha)
fluid ounces per acre	x 70	millilitres per hectare (ml/ha)
tons per acre	x 2.24	kilograms per hectare (kg/ha)
ounces per acre	x 70	grams per hectare (g/ha)
plants per acre	x 2.47	plants per hectare (plants/ha)

Glossary

These definitions are compiled from the Society for Range Management publication *Glossary of Terms Used in Range Management*. Fourth Edition 1998, *Society for Range Management Policy Statements 2008* and *North American Range Plants*. Third Edition. 1986.

Abbreviations

cf. – confer, compare this definition with the definition of words that follow

n. – Noun

v. – Verb

adj. – Adjective

Abiotic. Non-living components of an ecosystem.

Acute. A grass blade or ligule which is abruptly sharp pointed.

Animal-Unit (AU). Considered to be one mature cow of about 1,000 pounds (450 kg), either dry or with calf up to 6 months of age, or their equivalent, consuming about 26 pounds (12 kg) of forage on an oven-dry basis.

Animal-Unit-Equivalent (AUE). A number relating the forage dry matter intake of a particular kind or class of animal relative to one A.U.

Animal Unit Month (AUM). The amount of dry forage required by one animal unit for one month based on a forage allowance of 22 pounds per day. Not synonymous with animal-month.

The term AUM is commonly used in three ways: (a) Stocking rate, as in "X acres per AUM"; (b) forage allocations, as in "X AUMs taken from unit B"; (c) utilization, as in "X AUMs taken from total units available".

Auricle. An ear-like lobe or claw-like appendage at the base of the leaf blade of certain grasses.

Awl-shaped. Narrow and sharp pointed.

Browse. The parts of shrubs, woody vines and trees available for animal consumption.

Bunchgrass. A graminoid growth habit forming a bunch or a clump.

Carrying Capacity. A measure of an ecological site's sustained forage yield. Carrying capacity is based on a safe utilization level based on mean annual forage production and the plant community's tolerance of grazing pressure. Carrying capacity does not fluctuate yearly in response to forage production and stocking rates, but does fluctuate with weather conditions.

Ciliate. Fringed with hairs on margin.

Climax. (1) the final or stable biotic community in a successional series which is self-perpetuating and in dynamic equilibrium with the physical habitat; (2) the assumed end point in succession.

Decreaser. Plant species of the original or climax vegetation that will decrease in relative amount with continued disturbance.

Defoliation. The removal of plant leaves by grazing or browsing, cutting, or natural phenomena such as hail, fire or frost.

Degree of Use. The proportion of a current year's forage production that is consumed and /or destroyed by grazing animals.

Ecology. The study of the interrelationships of organisms with their environment.

Ecological Site (Ecosite). A kind of land with a specific potential natural community and specific physical site characteristics, differing from other kinds of land in its ability to produce vegetation and to respond to management.

Ecoregion. Broad classes that are determined mainly by climate. Within these ecological regions, rangeland is divided into ecological sites or ecosites, which are defined by more local factors.

Ecosystem. Organisms together with their abiotic environment, forming an interacting system, inhabiting an identifiable space.

Ecotone. A transition area of vegetation between two communities, having characteristics of both kinds of neighbouring vegetation as well as characteristics of its own. Varies in width depending on site and climatic factors.

Ecotype. A locally adapted population within a species which has certain genetically determined characteristics.

Edaphic. Refers to the soil.

Environment. The sum of all external conditions that affect an organism or community to influence its development or existence.

Extensive Grazing Management. Grazing management that utilizes relatively large land areas per animal and a relatively low level of labour, resources, or capital. cf. intensive grazing management.

Forage. (n.) Browse and herbage which is available and may provide food for grazing animals or be harvested for feeding. (v.) to search for or consume forage.

Forage Inventory. An estimate of available forage in each pasture and for the operating unit as a whole; used to project stocking rates and feed requirements for specific time periods.

Grazing Capacity. The maximum stocking rate that will achieve a target level of animal performance in a specified grazing method, based on total nutrient resources available, that can be applied over a defined period without deterioration of the ecosystem. A description of grazing capacity should include stocking rate, grazing method, targeted animal performance and non-grazed nutrient resources.

Grazing Cell. An area of land planned for grazing management purposes.

Grazing Management. The manipulation of animal grazing in pursuit of a defined objective.

Grazing System. A specialization of grazing management which defines the periods of grazing and non-grazing or rest.

Herbivore. An animal which feeds on plants

Increaser. Plant species of the original vegetation that increase in relative amount, at least for a time, under overuse.

Intensive Grazing Management. Grazing management that attempts to increase production or utilization per unit area or production per animal through a relative increase in stocking rates, stocking density, forage utilization, labour, resources, or capital. cf. extensive grazing management.

Introduced Species. A species not part of the original fauna or flora of the area in question. cf. native species.

Invader. Plant species that are absent in undisturbed portions of the original vegetation of a specific range site and will invade or increase following disturbance or continued overuse.

Ligule. The appendage, membrane or ring of hairs at the junction of the leaf sheath and blade.

Membranous. Thin, opaque, not green; like a membrane.

Native Species. A species which is part of the original fauna or flora of the area in question. cf. introduced species.

Obtuse. Blunt or rounded at the end.

Overgrazing. Occurs when a plant is grazed before it has completely recovered from a previous defoliation event; continued grazing which exceeds the recovery capacity of the plants causes range deterioration.

Paddock. A division of land within a grazing cell.

Palatability. The relish with which a particular species or plant is consumed by an animal.

Pasture. (1) A grazing area separated from other areas by fencing or other barriers; the management unit for grazing land. (2) Forage plants used as food for grazing animals. (3) Any area devoted to the production of forage, native or introduced, and harvested by grazing.

Pastureland. Grazing lands, planted primarily to introduced or domesticated native forage species

Phenology. The study of periodic biological phenomenon such as flowering and seed-set, especially relating to climate.

Phenotype. The physical appearance of an individual as contrasted with genetic makeup or genotype.

Preference. Selection of certain plants, or plant parts, over others by grazing animals.

Proper Use Factors (PUFs). The percentage of utilization (for a forage species or range type) deemed as acceptable to improve or maintain range condition.

Pubescent. Covered with short, soft hairs.

Quadrat. In strict terms, a square sample unit or plot. In practical terms, quadrats vary in size and shape according to the plant community being sampled.

Range. (n.) Land supporting native vegetation that either is grazed or that has the potential to be grazed, and is managed as a natural ecosystem, including grassland, forests, and shrubland. Range is not a use. (adj.) Modifies resources, products, activities, practices and phenomena pertaining to rangeland. cf. rangeland.

Rangeland. Rangelands, a broad category of land comprising more than 40 percent of the earth's land area, are characterized by native plant communities, which are often associated with grazing, and are managed by ecological, rather than agronomic methods. The term "range" can also include forestlands that have grazing resources, or seeded lands that are managed like rangeland. Range resources are not limited to the grazable forage, but may include wildlife, water and many other benefits.

Range Condition. The composition of range plant communities relative to the kinds and relative amounts of plants that range is naturally capable of supporting.

Range Health. A term used to describe net primary productivity, maintenance of soil/site stability, capture and beneficial release of water, nutrient cycling and energy flow, and functional diversity of plant species on rangeland.

Range Improvement. Any activity or program designed to improve production of forage, change vegetation composition, control patterns of use, provide water, stabilize soil and water conditions, or provide habitat for livestock and wildlife.

Range Inventory. A list of resources of a management area, including ecosites, range condition and trend, degree of use, stocking rates, physical improvements and natural features.

Range Management. A distinct discipline founded on ecological principles and dealing with the use of rangelands and range resources for a variety of purposes. These purposes include use as watersheds, wildlife habitat, grazing by livestock, recreation, and aesthetics, as well as other associated uses.

Range Readiness. The defined stage of plant growth at which grazing may begin under a specific management plan without permanent damage to vegetation and or soils.

Range Site. Synonymous with ecological site. A kind of land with specific physical characteristics which differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation and in its response to management. Range sites can support a characteristic plant community under its particular combination of environmental factors, particularly climate, soils, topography and associated native biota.

Range Trend. The direction of change in range condition, whether improving, deteriorating or remaining stable.

Reclamation. Restoration of a site or resource to a desired condition to achieve management objectives or stated goals.

Rhizome. An underground stem with nodes, scale-like leaves and internodes.

Riparian Zone or Riparian Area. Referring to or relating to areas adjacent to water or influenced by free water associated with streams or rivers.

Ruminant. A hoofed mammal that chews a cud and has a four-chambered stomach.

Sod Grass. Stoloniferous or rhizomatous grass which forms a sod or turf.

Stipules. Leaf-like appendages occurring in pairs on each side of the leaf base in forbs and shrubs.

Stocking Density. The number of animals on a given area of land at any moment in time. For example, an acre of land grazing 50 cows for one day each year would have a stock density of 50 head per acre.

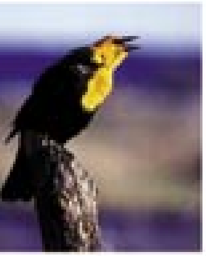
Stocking Rate. The number of animal units on a unit area of land for a specified time period. This is usually expressed in AUMs/acre or acres/AUM. For example, 160 acres of rangeland on which 10 cows graze for four months has a stocking rate of 0.25 AUMs/acre or 4 acres/AUM.

Succession. The progressive replacement of plant communities on a site which leads to the potential natural community.

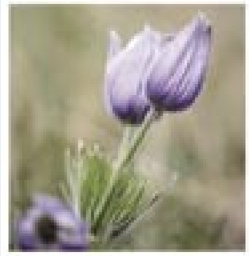
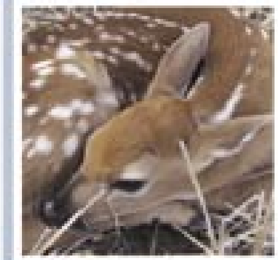
Transect. A line across and area used as a sample for recording, mapping or studying vegetation.

Truncate. Ending abruptly; appearing to be cut off at the end.

Watershed. A total area of land above a given point on a waterway that contributes run-off to the water flow at that point. A major subdivision of a drainage basin.






Project Partners

Ducks Unlimited Canada
Conserving Canada's Wetlands

Sask Forage Council

Saskatchewan Ministry of Agriculture

University of Saskatchewan

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Funding for this publication provided by
Agriculture and Agri-Food Canada's Greencover Canada Program.

Canada

Government of Saskatchewan