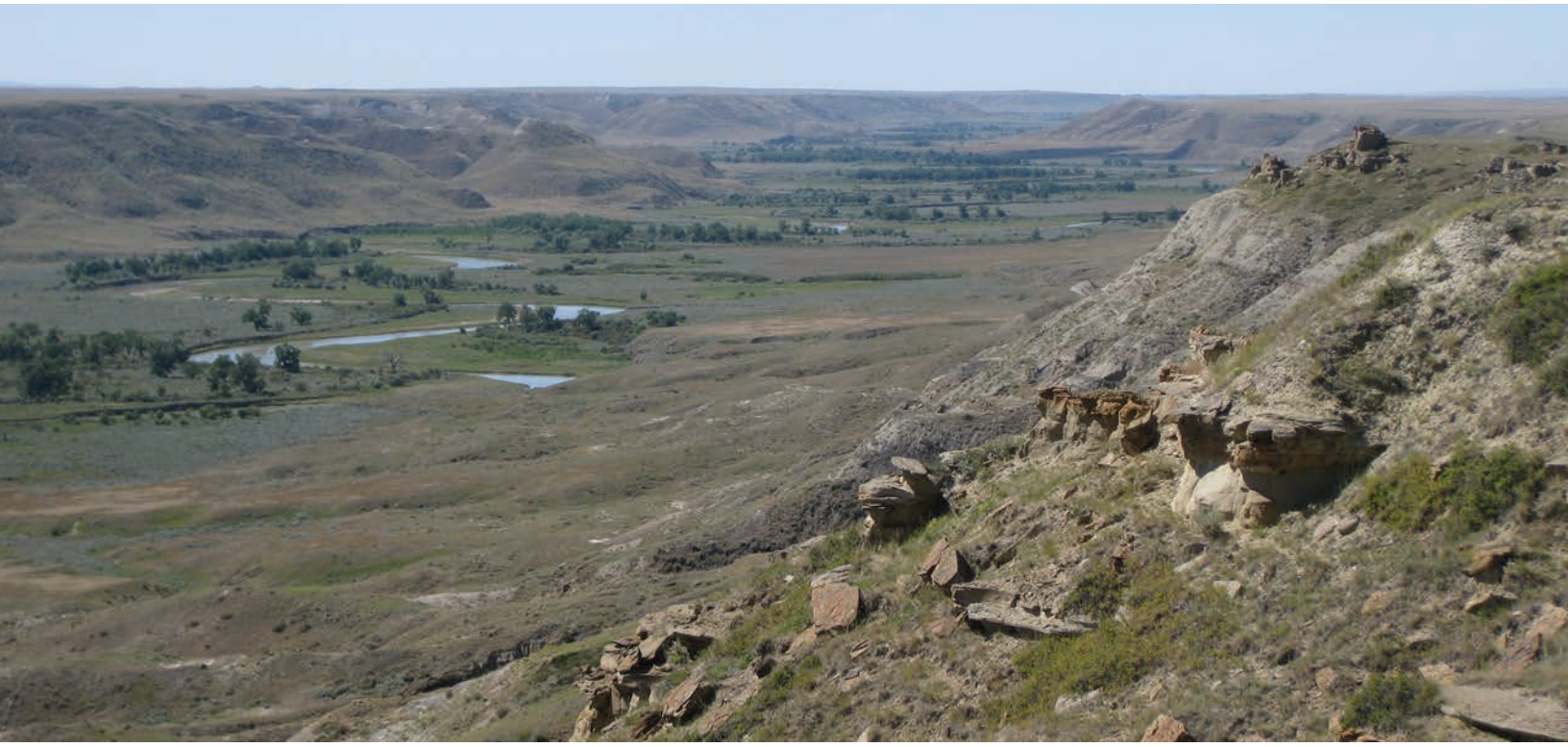
Managing Effects of Livestock on Waterways on Public Land



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Introduction

Alberta's public land grazing dispositions (grazing leases, licenses, and permits) are characterised by low densities of free-ranging livestock. Rangelands like these are considered "extensively managed", relying on natural rangeland ecosystems to provide forage for livestock and employing less infrastructure. In contrast, 'intensively managed' systems describe operations where high densities of livestock are restricted to small areas, such as feedlots, and winter feeding or calving sites that require more infrastructure.

Public land grazing dispositions are not managed solely for livestock production. Biodiversity, healthy watersheds, and wildlife habitat are other priorities for these lands.

To accommodate these values, grazing disposition holders are responsible for stewarding the rangeland resource to promote functional ecosystems. For a grazing disposition holder to ensure range and riparian sustainability, they are expected to apply the four principles of range management, and employ conservative stocking rates. The Government of Alberta regulates and monitors grazing impact to ensure proper stewardship that adheres to the grazing disposition agreement.

The stewardship model used to manage public land grazing extends beyond the scale of Alberta's public lands. Grazing dispositions are interspersed with privately held rangelands that are often managed as a single area. This results in a patchwork of publicly and privately held lands that provide a connected landscape with significant benefits to Alberta's ecology and biodiversity.

In extensively managed systems, drinking water for livestock is often provided by access to streams and wetlands. This has led to increased scrutiny of livestock production, due to concerns over potential negative impacts on water quality, riparian health and fish habitat. This scrutiny is more pronounced in headwaters and watersheds that contain fish species of conservation concern.

Principles of Range Management

1. Balance forage supply and demand
2. Avoid grazing during vulnerable periods
3. Distribute livestock evenly
4. Provide effective rest

It is important to note that Alberta's rangelands developed under periodic disturbance by bison grazing and fire. As a result, disturbance is an important factor for maintaining functional native ecosystems, and well-managed livestock grazing is beneficial to rangelands and compatible with maintaining functional riparian systems.

This review examines potential impacts of extensively managed livestock grazing on surface water quality and fish habitat, and discusses management options to mitigate any potential adverse impacts should they arise. For a more detailed discussion of this subject and a full list of references, please see 'Livestock on Waterways: A Literature Review'.

Potential Impacts on Water Quality

Public land in Alberta is subject to many different types of land uses that can impact water quality. Impacts are cumulative across the landscape, highlighting the importance of managing each to the best of our ability. If not properly managed, livestock have potential to impact water quality and fish habitat through:

1. Alteration of range and riparian function
2. Nutrient loading
3. Contamination with disease-causing organisms
4. Deposition of fine sediment on stream beds

Range and Riparian Function

Maintaining riparian and range function is the most effective way to limit livestock impacts on surface water and aquatic habitat.

Upland and riparian vegetation provide resistance to overland water flow, and filters particulate contaminants such as sediment and micro-organisms. Vegetation absorbs nutrients from runoff and soil water, which reduces surface water contamination. Properly functioning riparian areas generally contain deep-rooted tree, shrub, and sedge species that bind stream bank soils, preventing bank erosion. During flooding, vegetation slows water movement, allowing contaminants to settle, and trapping sediment on floodplains. Deep-rooted plants promote spongy, permeable soils that absorb rainfall quickly, limiting runoff impacts.

Where stocking rates exceed plant productivity for a given site tall perennial grasses and sedges, shrubs and young trees are replaced by shallow-rooted grasses and annual forbs. Mature trees and shrubs that livestock don't browse will persist for some time, but if there is continued heavy grazing new woody growth does not replace the old, and tall woody plants eventually disappear, reducing stream bank stability and shade.

Where grazing pressure is extreme or occurs when soils are saturated, plant cover may disappear completely, and soils can become severely compacted, or pugged and hummocked.

Compacted soil is less permeable, which increases surface runoff during rainstorms. This runoff results in soil erosion, and transportation of sediment, nutrients and fecal microbes. Functioning upland and riparian areas keep manure-based contaminants close to where the animal left them. As these functions are degraded, the likelihood of surface water contamination increases.

Pugging: Animal tracks left in soft soil that leave an uneven surface.

Hummocking: Raised mounds of soil resulting from animal overuse of soft soils.

Nutrients

Though animal manure is rich in nutrients, studies, from Western North America have generally found that streams exposed to extensive grazing have similar nutrient concentrations to streams that do not experience extensive grazing. Despite these studies, the perception is that any livestock or any grazing system results in nutrient loading of surface water.

Cattle manure contains approximately 4.3 per cent nitrogen (N) and 1.4 per cent phosphorus (P). Where large amounts of manure are deposited in or near water bodies there is the potential to fertilize surface water, causing excessive growth of algae and aquatic plants. Decomposition of this excess plant material can reduce dissolved oxygen levels. In severe cases this can create oxygen-free conditions, negatively affecting fish and other aquatic life. However, this only occurs where very large amounts of manure accumulate immediately adjacent to a water body, which does not commonly occur in extensive grazing systems.

Fecal Organisms

Manure from both wild and domestic animals contains large numbers of fecal microbes, many of which can cause illness in humans. Fecal coliform (FC) concentrations are commonly used as a measure of water quality. FC bacteria themselves do not cause illness in humans, but are an indicator of fecal contamination which may indicate the presence of other disease-causing fecal organisms that are more difficult to detect in surface water. It is important to note that livestock are not the sole source of fecal organisms in surface water, and studies of extensively grazed watersheds routinely report wildlife to be a major contributor of fecal organisms. Additionally, high instream concentrations of fecal organisms have been observed in watersheds that do not contain any livestock. For detailed information see 'Livestock on Waterways: A Literature Review' (AEP, 2019).

Cryptosporidium and *Giardia* are of particular concern to human health, but infections in cattle are most common in calves younger than six months of age and less common in mature cattle. Locating calving pastures away from streams and limiting access to surface water for calves less than six months old can reduce *Cryptosporidium* and *Giardia* contamination.

Sediment

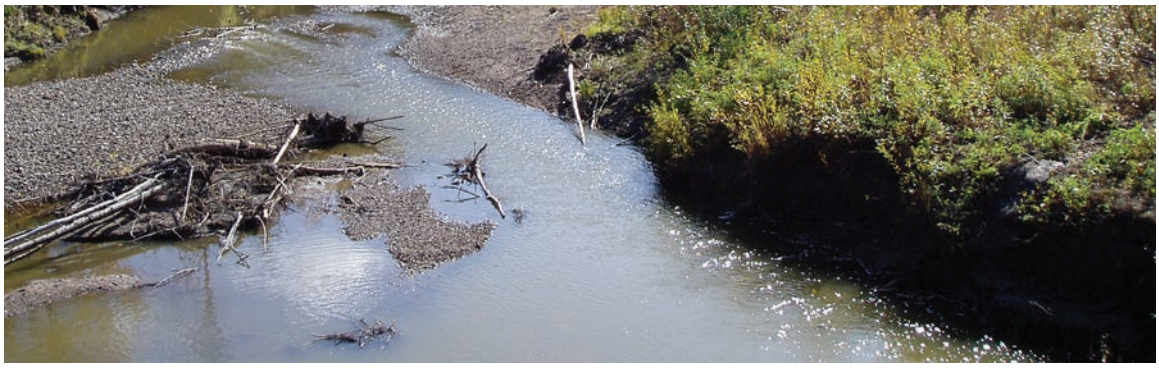
Fine sediment enters streams through erosion of adjacent soils and stream banks. Well managed riparian areas act to filter sediments, but some degree of background erosion and sediment export occurs naturally, even in the absence of human or livestock impact.

Naturally occurring sediment input is necessary to maintain the form and function of streams and rivers. Sedimentation increases when land use leads to loss of vegetation and compaction of soil, causing excessive erosion and sediment transport.

If bare soil cover is limited to less than 25 per cent of an area, erosion and sediment transport are minimized as vegetation provides resistance to overland flow. Where soil exposure exceeds 25 per cent, patches of bare soil merge, creating a vegetation-free path for overland water flow. This lack of resistance to leads to increased runoff speed and soil erosion.

Sediment pollution of gravel-textured streambeds is a major concern because Alberta is host to several fish species of conservation concern, such as Westslope Cutthroat Trout and Bull Trout. These fish require silt-free gravel habitat to reproduce. Fine sediments fill gaps between coarsely-textured materials, binding bed gravels and hardening the stream bed. This prevents fish from excavating nests in gravel and reduces habitat for fish and other aquatic organisms that rely on loose gravel habitat in streambeds. Suspended sediment increases water turbidity and reduces water clarity. High turbidity can damage fish gills, impair oxygen absorption and increase fish mortality.

Overgrazing destabilizes stream banks, leading to soil erosion, sedimentation, and a reduction in overhanging banks which fish rely on for cover. Studies show that livestock grazing has the potential to cause significant sediment pollution of waterbodies but it is important to consider that other land uses, such as industrial and recreational activities, also cause erosion and sedimentation. The impact of each land use is cumulative, making it difficult to determine the relative impact of each on fish habitat.



Management Strategies

Managing for functional upland range and riparian areas by applying the **four principles of range management** benefits surface water quality, fish habitat, and biodiversity values while minimizing any adverse impacts. Tools such as off-stream watering systems and riparian fencing are valuable management options, but the effectiveness of these tools depends on a grazing system rooted in the fundamental four principles of range management.

Range Management Principle 1: Balance Forage Supply with Forage Demand

Stocking rate indicates livestock forage demand, and should be balanced with how much forage the site can sustainably produce. As stocking rate increases and forage demand begins to exceed supply, overgrazing occurs and managers begin to see increased trampling, soil compaction, and total livestock time spent drinking or loitering near streams increases.

A mature cow requires up to 100 litres of water per day, so grazing patterns are significantly influenced by where they can find water. Cattle are also attracted to riparian areas for forage, shade, and protection from wind and insects. For these reasons, livestock often spend more time in riparian areas when they have freedom of movement.

Under low stocking rates, livestock are preferential in where they choose to access water and do not use all lengths of a stream equally. As a result, streams in extensively managed pastures have a mosaic of use along riparian areas. Under higher stocking rates, where forage demand exceeds supply, selectivity decreases, and the amount of affected riparian area increases. In severely overstocked pastures, all riparian areas may become degraded and lose the ability to filter and retain contaminants from runoff. In these cases the risk of surface water contamination by sedimentation, nutrients, and fecal micro-organisms will increase.

Range Management Principles 2 & 3: Avoid Grazing During Vulnerable Periods and Provide Effective Rest

Timing of livestock use is critical to maintaining upland range and riparian functions. Regardless of stocking rate, severe impacts can occur when an area is used during certain vulnerable times of the year. Generally speaking riparian areas are most vulnerable to livestock impact during early spring and late summer/early fall.

Riparian soils are generally saturated from the early spring, when snowmelt begins, until late spring or early summer when flooding of streams and rivers is common. During floods, water spills over stream banks and covers floodplains adjacent to the stream, saturating soils tens to hundreds of metres from the channel. Grazing within riparian areas when soils are saturated creates bare soil and destabilizes stream banks, leading to accelerated erosion and sedimentation. If grazing activities are deferred until soils have had time to dry, the animals will have a reduced impact.

Grasses become dormant in the late summer through early fall and lose palatability and nutritional value. Shrubs are able to access deeper soil moisture and remain green longer into the growing season. Shrubs also store nutrients and protein in the buds, which are available as browse in fall and winter. Once grasses are dormant, livestock may prefer woody vegetation, resulting in heavy browse and damage to riparian trees and shrubs. Browsing pressure can be intense even under low stocking rates if use is concentrated in riparian areas. Effects are cumulative if grazing takes place at the same time year after year.

The timing of vulnerable periods varies between years due to climatic variability, so livestock producers benefit from adaptive management by incorporating flexibility into timing of use. Impacts on riparian areas can be managed effectively through monitoring riparian soils and vegetation for signs of overuse, and avoiding grazing a given area at the same time each year. Rotational grazing allows sites used during vulnerable periods to recover, providing rest and ensuring that grazing does not occur during the same susceptible period each year.

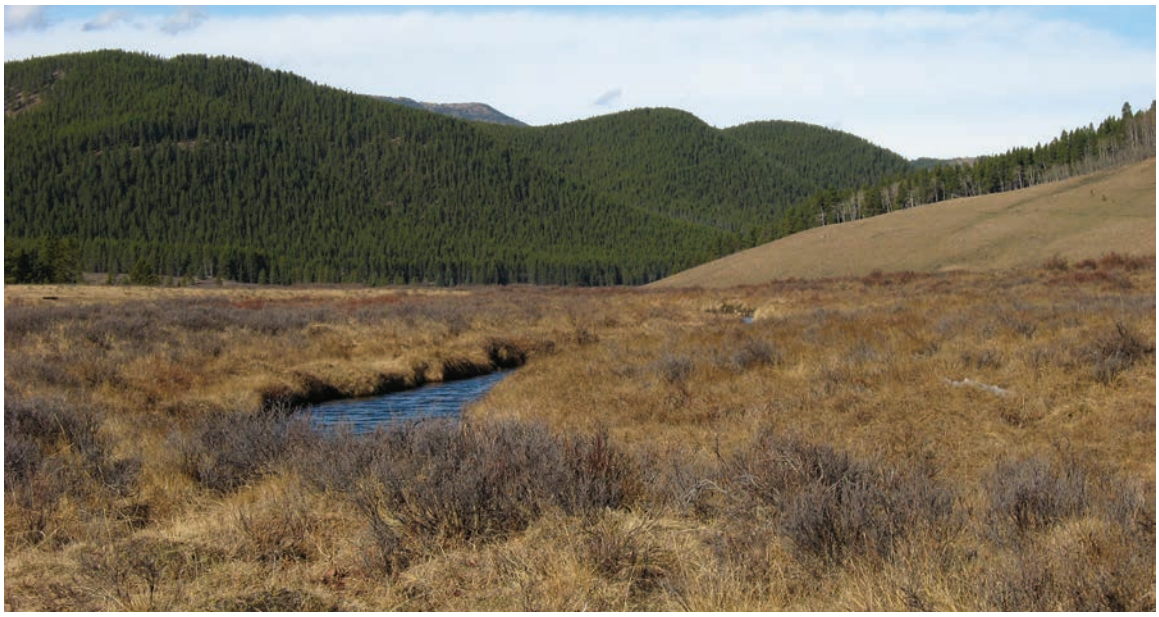
Range Management Principle 4: Distribute Livestock Evenly

Distribution is the assessment of how livestock make use of the landscape. There are a broad suite of factors that influence livestock distribution including, terrain, microclimate, plant community (the types of plants growing on a site), water resources, weather, and time of year as some of the most influential (AEP, 2015).

Several different management tools including alternative water sources, herding, fencing, strategic placement of salt, mineral, and nutritional supplements, and adjustments in the timing of grazing can be used to alter livestock distribution and grazing patterns.

Management strategies that take advantage of the ecological and environmental factors influencing livestock distribution is a developing field (AEP, 2015). The use of GPS collars has enabled managers to gain an understanding of how ecological and environmental variables, such as season of use, distance from water, slope, aspect, and plant community, can impact distribution. A knowledgeable manager with a sound understanding of their rangelands will be able to take advantage of these factors to improve or direct distribution in order to achieve management objectives and maintain ecosystem function.

Providing off-stream water reduces the amount of time livestock spend in or near streams, in some cases by up to 90 per cent, even where livestock have unrestricted access to streams. Off-stream watering troughs have the added benefit of improving livestock health and weight gain, while improving distribution. Providing an alternative water source does not guarantee reduced livestock use of riparian areas, but may be effective when coupled with other tools.



Fencing is perhaps the most commonly used tool for managing livestock distribution. Fencing can be used to completely exclude livestock from streams and riparian areas, or to create riparian pastures that can be managed as a specific unit based on their forage characteristics and periods of vulnerability (GOA, 2011). Studies show that fencing livestock out of overgrazed riparian areas can help to improve water quality and promote recovery of riparian vegetation. However, construction and maintenance of fencing, especially in riparian areas with fluctuating watercourses, is expensive, time consuming, and management intensive. Fences also interfere with wildlife movement and recreational use. Additionally, sites protected from any form of disturbance for long periods of time eventually become decadent, where less active vegetative growth reduces uptake of nutrients which may in some cases lead to increased nutrient loading in surface water. Where livestock are extensively managed, riparian health and water quality issues can be effectively mitigated by managing grazing intensity and timing of use, and monitoring range and riparian areas for signs of overgrazing.

Fencing may be appropriate or even necessary in intensive management settings where large numbers of livestock must be held in small pastures for extended periods of time. Temporary fences are useful for protecting riparian areas from livestock during vulnerable periods, and can be removed when livestock are not present.

Successful implementation of these management tools must be operationally and financially appropriate. Though these tools will aid in improving livestock distribution, none will compensate for excessively high stocking rates.

Summary

Successful stewardship of range and riparian ecosystems depends on awareness and co-operation between livestock producers, government agencies, and all other users.

Employing the principles and tools of range management with a monitoring system to adaptively manage forage use, grazing frequency, livestock distribution, and timing of use enables properly managed grazing to be a key component in achieving and maintaining functional rangeland and riparian areas across large areas of publicly and privately owned land. This ensures that these lands continue to provide important ecological goods and services to all Albertans.

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