RE-ESTABLISHING LIVESTOCK USE ON MINED LANDSCAPES IN THE SOUTHERN INTERIOR OF BC

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ABSTRACT

Ranching is a signficant land use in the Southern Interior of BC. In recent decades, acreages of both grassland and forest land have been disturbed by mining and, as reclamation proceeds, returned to forage production for the purpose of livestock use. Numerous issues surround the capability and suitability of waste rock and tailings sites for grazing. Despite a large amount of research being done on the revegetation of mined land, grazing as a post-mining land use has received limited study. Research is still needed to determine proper stocking rates, season and intensity of grazing for optimum livestock management systems. This paper presents the issues of site capability and suitability for livestock use, potential conflicts with other proposed end land uses and post-mining land management requirements.

INTRODUCTION

BC's cattle industry has a past tightly bound with the mining industry. Between the gold mining rush in the 1860s to the start of hard-rock gold and copper mining in the 1890s, the cattle market bloomed and ranches sprang up throughout the Southern Interior (Bawtree et al. 1998). With the reclamation of more current mining activities, the ranching industry has the potential to benefit from the large acreages of forages being established.

Disturbance in the Thompson and Similkameen Valleys that occurs on the lower elevation bunchgrass (BG) and ponderosa pine (PP) biogeoclimatic zones temporarily displaces spring range. Reclamation back to forage for grazing use on these sites is expected. Mining disturbances at higher elevations in the Douglas Fir (IDF) and Montane Spruce (MS) zones, however, open up previously inaccessible timbered areas. As mining operations cease, significant portions of these mid-elevation lands are being destignated for grazing use with the potential to provide substantial summer forage to the ranching industry.

Within the IDF or MS zone, 2000 kg/ha (Highland Valley Copper 2002, Gizikoff 1994) legume and grass forage can be produced on a reclaimed site, increasing the landscape's carrying capacity from roughly 0.8 to over 2 animal unit months (AUMs – one cow/calf pair for one month) per hectare. A 200 ha reclaimed site would provide a ranch operator 2 months of summer grazing for his/her 200 head of cattle, compared to a 3 week period that may have been feasible prior to mining. This simplistic scenario, however,

overlooks the numerous challenges and unknowns with regards to returning land to grazing use. Not all waste rock dump and tailings sites with established forage cover are capable of supporting livestock, or suitable for grazing use.

CAPABILITY AND SUITABILITY FOR GRAZING USE

Post-mining grazing use was not likely a factor considered during the mine planning and operational stage at most Southern Interior minesites. Seeding and maintaining forages for soil development purposes seemed to match livestock use goals. As the mining properties enter a phase of evaluating reclamation success for release, and neighbouring ranchers become anxious for grazing opportunties, the capability and suitability of the mined sites for grazing use is starting to be considered.

Grazing Capability

A rangeland capability analysis would typically assess a site's physical characteristics for supporting livestock grazing. Generally, a site must produce adequate forage and be accessible to livestock. Capability can be affected by the following factors:

Topography – Cattle use is limited by steepness of terrain (Gillen et al. 1984). Table 1 illustrates the relative grazing use of varying slope gradients. Slopes greater than 30% generally receive little grazing; however, cattle can traverse sites and lightly use up to 45% slopes where the extent of slopes is relatively small and slopes are short. Regraded waste dump slopes and tailings dams are generally greater than 45% and of significant length and height to be of minimal value for livestock grazing. Forage could only be utilized on these slopes with extensive fencing to contain cattle, forcing them to use the area.

Table 1. Percent Slope and Relative Proporations of Grazing Use to be Expected

Slope Gradient (%)	Relative Use Expected (%)
5 or less	100
6 to 10	75
11 to 15	50
16 to 20	25
21 to 30	13
31 to 45	8
>45	3

adapted from Gillen et al. 1984

Water Availability - The distance to water influences the distribution of cattle and the utilization of forage more than any other single factor. Most cattle will travel up to 1.6 kilometers over flat terrain to access water; however, in sloping or rough terrain, distances to water need may need to be 0.5 kilometers or less (Holecheck et al. 1995). Vegetation near water sources can be severely impacted by grazing if watering sites are limited and livestock needs should be considered during the re-establishment of watercourses following mining.

Forage Productivity – Large areas producing less than an average of 200 kg of forage per hectare are generally considered unusable rangelands (USDA 2002). Grazing on these sites is inefficient as excessive energy is expended in travelling.

Roughness of Terrain – Coarse surfaces and rough terrain impact the distance cattle will travel for forage or water (Holecheck et al. 1995). This is a particular concern on coarse, waste rock dumps where cattle can easily become sore-footed. Site scarification and ripping increases the coarseness of the site surface, but overburden capping, and possibly biosolids incorporation, can improve the site for cattle traffic.

Grazing Suitability

The determination of rangeland capability is not, on its own, an evaluation of a site's suitability for grazing. Suitability assessments further consider economic, social and management factors. A few factors for determining grazing suitability are as follows:

Market - As identified in Horton and Freberg (2002), the market for grazing needs to be present. In the Southern Interior of BC, one of the most common limitations for existing ranch operations is the availability of spring grass, which can be supplemented with forage from lower elevation mine sites in the Thompson and Similkameen Valleys. New summer range opportunites for Crown licencees on timbered areas are limited and existing operators' rely on agronomic vegetation on roadsides, cutblocks and reclaimed disturbances.

Surface Stability and Erosion Resistance – A site's ability to resist impacts from hoof action is a key consideration in assessing a reclaimed area's suitability for grazing. Tailings sites, particularly dam slopes built from coarse, cycloned sands, are particularly fragile and susceptible to sod disturbance and erosion from mis-managed grazing and trailing. Prior to opening a reclaimed site to grazing use, ground cover of vegetation, litter, and rock (ie. greater than 2 cm) should be sufficient to protect soil from disturbance (USDA 2002).

Season of Grazing – There are numerous reasons for grazing on a reclaimed site being limited to specific seasons. Plant species selected for reclamation can result in seasonal limitations: bloat may be a concern on legume dominated areas until at least mid-summer flowering stage; legumes, in general, are not particularly resistent to grazing pressure and fall use may be preferred in effort to preserve them in the forage stand; and, wheatgrasses, which are common reclamation species in the Southern Interior, are not highly palatable after mid-summer months, limiting reclaimed sites to spring use.

Water availability is a concern in arid climates. On natural, low elevation grasslands, grazing use is frequently restricted to spring months due to lack of water later in the season. Similarly, the grazing period on mine sites may be limited due to water availability. Springs and seeps occasionally occur on droughty waste dumps and tailings areas and their presence may dictate the most appropriate period for grazing use. During reclamation efforts, these water sources need preservation.

Suitable grazing season must consider potential impacts with other end land uses. Most Southern Interior mines designate end land use goals as wildlife as well as livestock use. In fall months, grazing use can conflict with wildlife management objectives as the cattle more actively browse shrubs. Fall grazing is sometimes best for riparian areas because soils are drier, plants have set seed and built up carbohydrate reserves, and less impacts on nesting waterfowl.

Metal Uptake – Substantial foliar monitoring for metal concentrations has been conducted on the Southern Interior mines to ensure that metal levels are safe for plant and animal life. Elevated metals in vegetation, however, do not necessarily mean a site is unsuitable for cattle use. Instead, special management options, such as limiting the season of use, modifing the seed mix for forage quality rather than productivity, or even modifying fertilization program can be employed. Table 2 provides examples of management options for improving a reclaimed site's suitability for grazing where mineral toxicity, deficiency, or imbalance is a concern.

Livestock Conflicts with Wildlife - Conflicts with ungulates, birds, and small mammals can occur as cattle compete for forage, or modify the habitat removing cover required for nesting and escape hiding. In arid and semi-arid landscapes, livestock concentrate around sources of water. In general, cattle make heavy use of riparian areas because of more palatable forage, proximity to water, and cool, lush environment (Powell et al. 2000). If grazing use is not limited, cattle can cause damage by trampling banks and increasing sedimentation, removing vegetation which stabilizes soil, filters sediment and debris, and excessively browsing young shrubs. The use of riparian areas on a mined landscape would be influenced by topography. On steeper terrain, such as on waste dumps, cattle use and impacts on riparian areas established for wildlife travel corridors and browse are not likely to be impacted. On lower gradient

areas, such as tailings, cattle preference for shrub areas may be high. To meet wildlife end land use objectives, cattle distribution, grazing intensity and timing need to be controlled. In some cases, shrub islands established for wildlife browse and escape/hiding cover may need to be fenced to prevent cattle access.

Table 2. Management Options for Grazing Sites With Elevated or Imbalanced Minerals in Forage

Option	Objective
Limit season of use	Graze site with a larger number of cattle over a shorter period of time rather than expose cattle to mineral toxicity (deficiency) over a long period.
Select breed or class of cattle most suitable	If mineral problem creates a conception concern, graze yearlings rather than cows with calves. Some cattle breeds are more tolerant of mineral toxicities/deficiencies than others.
Graze sites with lower (higher) mineral levels before and after minesite use.	Avoid exposing animals to high (or low) mineralized sites before and after reclamation site use.
Mineral supplementation	Build up mineral levels during winter months when cattle are at home during winter feeding period and spring months when on breeding pastures. Supplement cattle when on minesite.
Avoid during breeding season	For sites with mineral concerns that affect estrous cycles and conceptions rates, graze later in season.
Select grazing season for forage quality	Mineral levels are frequently higher, earlier in growing season.
Manage fertilization program	Fertilize with micronutrients where deficiencies occur. Be aware of fertilization effects on plant uptake of mineral of concern. Consider alternate fertilizer options (biosolids).
Species Selection	Legumes accumulate more minerals than grasses. Mineral uptake of grass species varies. Select species for forage quality, rather than productivity.
Provide offsite water	Offsite water lower in minerals may be beneficial.

ASSESSING RECLAMATION SUCCESS FOR GRAZING END LAND USE

The Health, Safety and Reclamation Code for Mines in British Columbia (BC Ministry of Energy and Mines 2003) sets out general Reclamation Standards for achieving end land use goals:

- use appropriate plant species,
- productivity/capability shall not be less than that which existed prior to mining, and
- revegetate to a self-sustaining state.

The results-based system is assumed to work well for assessing reclamation success for grazing use since results are clearly defined: “for an end land use such as grazing land, it is relatively easy to establish forage and measure productivity” (Errington, 2002).

Species Appropriateness

Some debate will likely be generated regarding appropriate species for reclamation on grazing sites. Forages for reclamation purposes may not necessarily be the appropriate forages for grazing use. Reclamation species commonly used in the Southern Interior are generally agronomics that are tolerant of low nutrient and droughty conditions, that maximize productivity during years of fertilization, and build organic matter, fix nitrogen and hasten soil development. They are not necessarily palatable throughout the growing season, adapted to withstand grazing pressure, nor amiable to encroaching native species.

Productivity

Productivity is generally a value of above ground biomass, but in terms of site stability, below ground is probably more important (Munshower, 2000). Above ground biomass varies significantly from year to year due to weather. On its own, it is not an indication of suitability for grazing in terms of quality or resilience to defoliation.

Above ground biomass criteria for livestock use have not been established. Table 3 summarizes generalized pre-mining forage yields for Southern Interior rangelands. Forage production of agronomics can be substantially greater on seeded areas in the same biogeoclimatic zone and approximate yields are provided for comparison.

Table 3. Average Forage Yield

Zone	Native Forage	kg/ha	Agronomic Forage	kg/ha
Bunchgrass (BG)/ Ponderosa Pine (PP)	Open Grassland*	500-1000	Crested Wheatgrass	1000-1500
Interior Douglas-fir (IDF)	Under Canopy	450-900		
	Grassland Phases *	900-1200	Bromegrass Hay	1500-2000
Montane Spruce (MS) and Englemann Spruce/Subalpine Fir (ESSF)	Under Canopy	300-400	Seeded Clearcuts and Roadsides	900-2000
	Unseeded Clearcuts	500-900		
	Grassland Phases/ Meadows*	1000-1800		

* Good to Excellent Range Condition. Production on Poor to Fair Rangelands Substantially Lower.
Adapted from a variety of sources as summarized in Wikeem and Wikeem 1998.

Sustainability of Vegetation

Mined areas differ from undisturbed areas with respect to physical and chemical soil characteristics, hydrological properties and soil microorganisms. Before an area is deemed sustainable, it must have a productive vegetation cover that can withstand a grazing program. It is not well documented how

reclaimed areas respond to grazing the dry interior of BC. Research on the effects of intensity, frequency and season of defoliation and how these influence plant vigour and production on reclaimed areas in the Southern Interior is limited. Understanding the plant community response to grazing will allow for developing guidelines for proper grazing management programs, including stocking rates, and season and frequency of use.

Assessing Ecosystem Health on Grazing Lands

In addition to appropriate species and productivity, there are other indicators of ecosystem health commonly used in rangeland assessments. Indicators of rangeland health (Pellant et al. 2000, Wikeem 2003) provide an evaluation of soil/site stability, hydrological function, and integrity of the biotic community to help land managers identify areas that are potentially at risk of degradation, or sustainable. The rangeland health or ecological condition assessment is an attempt to look at how the ecological processes on a site are functioning as evidenced through three attributes: *Soil/ site stability* is the capacity of the site to limit loss of soil resources (including nutrients and organic matter) by wind and water. *Hydrologic function* is the capacity of the site to capture, store and safely release water from rainfall, run-on, and snowmelt, to resist a reduction in this capacity, and to recover this capacity following degradation. The *Integrity of the biotic community* is the capacity of the site to support characteristic function and structural communities in the context of normal variability, to resist loss of this function and structure due to disturbance, and to recover following disturbance.

Building upon the reclamation criteria identified by Horton and Freberg (2002) by incorporating ecosystem health indicators (Pellant et al. 2000) plus indicators specific to primary successional sites, an approach for assessing the sustainability of lands reclaimed with forages for grazing use can be developed (Table 4). Table 4 provides a cross-reference of common reclamation activities with the attributes and indicators that these activities ultimately influence.

POST-MINING LAND MANAGEMENT ISSUES

Once reclamation release is obtained, management input is still required to govern cattle use and monitor the impacts on plant communities.

Grazing Management

Without proper grazing management programs, reclaimed lands will be subjected to grazing practices that may destroy costly reclamation. A few head of domestic livestock can and have eliminated reclamation efforts in a short time (Packer and Aldon 1978). Proper management of fragile reclaimed land following vegetation establishment and reclamation release is as important as other steps in the reclamation process

prior to vegetation establishment. Further research and monitoring is needed to determine proper stocking rates, season and intensity of grazing for optimum livestock management systems on reclaimed lands. It is unlikely that the existing Ministry of Forests' Range Section will have the resources to research, monitor, or police grazing use on reclaimed mine landscapes in the Southern Interior of BC. It was suggested at last year's conference that a Government authority, a Crown corporation, commission, agency or a private entity may need to be established to take on the responsibility for closed mines (Errington, 2002).

Weed Management

Weed species, particularly exotic or introduced weed species, reduce forage yield and quality, wildlife habitat values and aesthetic land values. Livestock tend to spread weed seeds and plant parts throughout grazed rangelands and forested lands. Weed burs (e.g. common hound's tongue – *Cynoglossum officinale*) can adhere to cattle and cause infections and injuries while being transported to other potential infestation sites. Typically, weeds are observed and spread via cattle trails and high use areas. Once weed infestations are established they can spread rapidly and become a range management priority and concern. Weed management is a post-mining cost to be incurred due to the high susceptibility of waste dump and tailings sites to infestation.

GRAZING AS A RECLAMATION TOOL

Reclaimed sites' limitations for grazing use and potential negative impacts from cattle have been presented above. Livestock grazing, however, can be advantageous to the revegetation and soil development process through proper management. Action by cattle hooves, stimulation of vegetation growth, trampling weeds, eating weed flowers, and the addition of manure can be beneficial aspects of grazing use on reclaimed lands. On challenging sites, grazing can be investigated as a tool for improving productivity, ground cover, and ecosystem health. Rather than managing cattle away from congregating areas to disperse grazing use, cattle can be drawn to or fed in areas of poor growth to concentrate manure to increase microorganism populations and soil fertility. Programs to assess the potential positive and negative impacts from cattle grazing on reclaimed tailings and waste dumps in the Southern Interior have yet to be thoroughly explored.

Table 4. Modification of Rangeland Health Indicators for Use in Assessing Reclamation Success to Grazing Land

Attribute	Indicator	Influencing Reclamation Activities				
		Site Design	Soil Material Selection	Species Selection	Fertilization	Other Soil Amendments
Biotic	***Rangeland Health Indicators*:***					
	Presence of Functional/ Structural Groups		**X**	**X**	**X**	
	Plant Mortality/ Decadence		**X**	**X**	**X**	
	Annual Production			**X**	**X**	
	Presence of Invasive Plants			**X**	**X**	
	Reproductive Capabiltiy of Perennial Plants			**X**	**X**	
	Additional Indicators for Primary Successional Sites:					
	Evidence of Encroaching Native Plants			**X**	**X**	
	Soil Biological Activity		**X**		**X**	**X**
Soils/ Site Stability	***Rangeland Health Indicators*:***					
	Evidence of Erosion**	**X**	**X**	**X**		**X**
	Bare Ground			**X**	**X**	**X**
	Soil Surface Resistance to Disturbance		**X**	**X**		**X**
	Soil Surface Loss or Degradation	**X**	**X**			**X**
Hydrology	***Rangeland Health Indicators*:***					
	Litter Amount			**X**	**X**	
	Litter Movement	**X**	**X**	**X**		
	Surface Compaction		**X**			**X**
	Total Cover		**X**	**X**	**X**	**X**
	Additional Indicators for Primary Successional Sites:					
	Organic Matter Build-up			**X**	**X**	**X**

* Adapted from Pellant et al. 2000.

** presence of rills, water flow patterns, pedestals, wind-scoured blow-outs or depositional areas.

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