Geology and Soils of Grassland Ranges, Kamloops, British Columbia

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The Kamloops-Merritt area has been the hub of the ranching industry in south central British Columbia, Canada, since European settlements were established in the mid-1800's. The first ranchers were attracted by the ready source of feed during all seasons on the open grasslands that lie in the rain shadow of the Coast Mountains and on the Interior Plateau.

In many instances, this first use of the grassland ranges by domestic livestock led to their rapid deterioration. To develop recommendations for rehabilitation and management of these ranges, it is necessary to consider the roles that geology and soils play in the character of range vegetation and in forage management.

The Interior Plateau lies between the western Coast Mountains and the eastern mountain system that includes the Purcell, Selkirk, and Rocky Mountains. The rolling plateau upland, at elevations between about 4,000 and 5,000 feet, is deeply dissected by valleys of the major rivers which flow at about 1,000 feet. The grasslands extend from the valley bottoms up to 3,000 feet at Kamloops and to 4,000 feet near Merritt.

Rocks of the plateau include the youngest basalt lava and the older sedimentary shale, sandstone and limestone as well as igneous granites. These rocks provided a wide variety of minerals and materials that were distributed over the landscape during the glacial periods to form the soil parent materials.

The last glacial period began about 19,000 years ago when the climate became cooler and wetter allowing annual snow accumulation in the Coast and eastern mountains. This accumulation eventually formed ice (glaciers) that flowed down the mountain valleys to coalesce on the plateau creating the Cordilleran ice sheet attaining a thickness of about one mile over the major valleys. At its maximum, the ice sheet flowed to a point just south of Spokane, Washington. It eroded and ground the rocks on the high parts of the landscape and deposited the resulting mixture on the lower parts as a dense compact layer called basal till.

About 15,000 years ago the climate warmed and the ice melted faster than it accumulated. The ice sheet retreated and became thinner, exposing the highest hills first. During this period of deglaciation, most of the soil-forming materials were deposited on the surface. Rock material that had been carried within the ice was deposited on top of the basal till forming a thin loose layer of mixed debris.

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The great volumes of spring melt-water eroded and redistributed much of the rock material deposited by the ice sheet. Tongues of remnant ice often blocked outlets of the Thompson and Nicola valleys, creating temporary glacial lakes. Layers of sands and gravels, several tens of feet thick, were deposited as deltas where the glacial streams entered the lakes. Silts and clays were carried further into the lakes, settling out during summer and winter as annual layers to form deposits one hundred or more feet thick.

The last remnant of ice had melted by about 10,000 years ago in the Kamloops-Merritt area. Streams and rivers assumed their present pattern and have since formed the recent fine- and medium-textured deposits on their valley bottoms.

When the landscape was first exposed from the ice and before vegetation established, drying winds picked up fine sands and silts. These were redeposited over the surface in a layer a few inches thick on the hills and up to one or two feet thick in the low parts of the landscape.

Grassland vegetation that had existed in southeastern Washington State migrated northward as the ice front retreated. The British Columbia grasslands therefore represent the northern extension of those in Washington.

During the last 10,000 years the climate has fluctuated. The extent of grassland increased during a prolonged dry period and then decreased during subsequent wetter periods as the adjacent forest encroached upon it. During this time, soils developed on the new deposits of the glacial period.

Summer drought is a regular feature of the climate of these grasslands due to the rain shadow effect of the Coast Mountains. However, precipitation increases and temperature decreases with elevation, resulting in greater moisture effectiveness at higher elevations. Annual climatic moisture deficits (estimated evapotranspiration minus precipitation) range from 16 inches for the lower grasslands to 8 inches for the upper grasslands and occur during late spring and summer. Annual precipitation ranges from 10 to 12 inches. Thus drought tolerant grasses and shrubs dominate the grasslands. The dominant species found in good to excellent condition stands of the lower grasslands are bluebunch wheatgrass and big sagebrush; that of the middle grassland is bluebunch wheatgrass; and those of the upper grassland are bluebunch wheatgrass and rough fescue. Several other herbaceous species and clumps of aspen occur consistently in the upper grassland to provide a rich floral mixture. The

Looking west, Kamloops lies in the middle ground adjacent to the confluence of the South and North Thompson Rivers. The flowing Cordilleran ice sheet formed the U-shape of the Thompson Valley. The valley was filled with the "white" silts at the glacial lake stage. They were eroded and redeposited by the river in recent times. Grasslands extend from the valley bottom to merge with the Douglas fir forest on the glaciated plateau upland.

open Douglas fir forest borders the upper grassland.

The medium-textured layer of wind-blown deposits provided an excellent medium for the grasses. Chernozemic soils (Mollisols) developed under the grass. They are characterized by surface horizons with accumulations of organic matter derived from the annual production of grass roots. Organic matter content of the surface horizons varies from about 1% for the Brown Chernozems (Aridic Haploboroll) on the lower grasslands to 4% for Dark Brown Chernozems (Typic Haploboroll) and up to 10% for Black Chernozems (Udic Haploboroll) on the upper grasslands. The rich flora of the upper grasslands are responsible for the high organic matter content of the Black Chernozems. Variations from the general soil and vegetation patterns occur because of differences in texture, water holding capacity, compaction and depth of the material deposited during the glacial period.

Yellow pine will establish on deep sandy gravelly deposits. The low water holding capacity of these materials will allow precipitation to penetrate deeper than in medium-textured materials. The long taproots of the pine enables it to utilize the moisture in the deeper soil layers and to coexist with bluebunch wheatgrass. Brunisolic (Inceptisol) soils have developed under the yellow pine-bluebunch wheatgrass vegetation.

At the forest-grassland boundary, the roots of Douglas fir have difficulty penetrating the compact basil till where it occurs near the surface, usually on high parts of the landscape. Fescue and bluebunch wheatgrass, with shallower root systems, are well suited to establish on the thin wind-blown surface deposits. Douglas fir, however, can establish where deep, loose medium-textured materials occur in ravines and at the base of steep slopes. The differences among the deposited materials has created a mosaic of forest and grassland vegetation associated with respective Brunisolic and Chernozemic soils.

The low growing needle-and-thread grass is the dominant grass on sites where gravelly sandy stream deposits occur. Sites with very shallow deposits over bedrock support mainly the small Sandberg's bluegrass. These sites have low water holding capacity so support only species that can complete their growth cycle before soil moisture is depleted and therefore have a low forage production potential. Adjacent sites that have deep, medium-textured wind-blown or glacial lake deposits will support productive stands of bluebunch wheatgrass because they have a higher water-holding capacity.

Certain forage management practices can be related to the different geologic materials and the soils developed on them. Grazing bluebunch wheatgrass during its critical boot to flowering period has been responsible for its depletion. This has allowed an increase of needle-and-thread grass, which has a lower forage productivity. Recovery of bluebunch wheatgrass may take decades, even when grazing pressure is reduced. Seeding these ranges to crested wheatgrass would be an alternative to reducing livestock usage. However, improved forage production could be expected only on the deeper medium-textured deposits with higher water-holding capacity.

Rough fescue on the upper grasslands deteriorates rapidly when subjected to grazing at critical periods. However, it also recovers in a few years when grazing pressure is reduced. Grazing management is a feasible alternative to seeding for improving forage production on these grasslands.

Increases in forage production from applications of nitrogen fertilizer are greatest on the middle and upper grasslands where moisture effectiveness is greatest. Increased production is also greatest on good condition stands well stocked with dominant native bluebunch wheatgrass and rough fescue or with introduced crested wheatgrass. Stands dominated by low-growing grasses, either because of depletion by grazing or because of coarse-textured or shallow soil material, show small forage increases to fertilizer application.

A wide variety of geologic materials were deposited in the Kamloops-Merritt area during the glacial period. Some of the preceding examples have illustrated how these materials, and the soils developed on them, are related to the grassland vegetation of the area and to certain forage management practices.

Suggested Reading

British Columbia Ministry of Environment. 1978. The Soil Landscapes of British Columbia. K.W.G. Valentine, P.N. Sprout, T.E. Baker and L.M. Lavkulich (eds.), B.C. Ministry of Environment, Resource Analysis Branch, Victoria, B.C. 197 pp.

British Columbia Ministry of Forests. 1982. Grassland Ecology and Classification. In Symposium proceedings June 1982, Kamloops, B.C., A.C. Nicholson, A. McLean and T.E. Baker (eds.), B.C. Ministry of Forests, Information Services Branch, Victoria, B.C. 353 pp.

Recognizing Range Readiness

Alfred H. Bawtree

During the early years of the range industry, in the intermountain region of the Pacific Northwest, horses and cattle grazed the grasslands year-long. After some severe winters in the late eighteen hundreds, it was accepted that hay was required for feeding of cattle during some winters. In the southern interior of British Columbia, turnout of cattle occurred when the snow melted or hay supplies ran out. Horses continued to graze year-round and cattle continued to graze the grasslands season-long until about the middle of this century. British Columbia is fortunate to have both grassland and forest range in most of the ranching country with very different growing periods. Bunch grasses may start growth early in March on the lower grasslands, whereas at higher elevations in the forest, the pinegrass doesn't start growth until May or June.

The science of range management has been developing through the twentieth century. Initially the objective was to develop management guidelines which would stop range deterioration and restore the range to its former productivity. **Two highly significant guidelines were developed: range utilization and range readiness.**

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Rules-of-thumb were provided for the application of those two guidelines. **The rule-of-thumb for range utilization was take half and leave half.** The rule-of-thumb for range readiness was to allow six to eight inches of new growth on bunch grasses before grazing. By applying these rules, a gradual improvement in range condition took place. By 1960, most of the range deterioration in British Columbia had been stopped and since that time, considerable improvement has taken place. **Much of that improvement can be attributed to the rules-of-thumb regarding range readiness and utilization.**

Range readiness is a term frequently used by range managers. The SRM Range Term Glossary Committee (1974) has defined range readiness as the defined stage of plant growth at which grazing may begin under a specific management plan without permanent damage to vegetation or soil. This definition says range readiness takes into account the stage of plant growth, the management plan to be used, and the possibility of permanent damage to vegetation and soil. It does not consider economics, nutritive value of the forage or animal requirements.

Should we continue to manage for range improvement? How much more range improvement can we