Natural History and Fire Ecology in the Grasslands of Canada

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Character of Canadian grasslands

Canada's grassland natural region is in the interior plains, bounded by the Rocky Mountains on the west, the boreal forest to the north, the eastern hardwood forest and the transitional forest along the eastern perimeter, and the border of the United States of America to the south.. These native grasslands grow in well developed topsoils, termed chernozemic soils, with surface horizons having substantial organic enrichment. The mixed grass prairie occupies brown and dark brown chernozemic soils (250 to 450 mm of annual precipitation) and is dominated by Stipa comata, Stipa spartea, Agropyron dasystachyum, and Bouteloua gracilis). Productivity ranges from about 200 kg/ha to 1400 kg/ha in the mixed grass prairie (600 to 1100 m ASL). The fescue prairie is found in foothill and parkland (transition zone between prairie grasslands and forest) zones with black chernozem soils and 450 mm to 550 mm of annual precipitation. Fescue grasslands are dominated by Festuca campestris and Festuca halli. Productivity in the fescue prairie and parkland zones, ranges from about 1500 kg/ha up to 2500 kg/ha in our high elevation grasslands (1100 to 2000 m ASL), productivity increasing with altitude.

Since the prairies were settled by non-aboriginal immigrants in the 1800's, most of the black and dark-brown soils have been cultivated for crop production. This is one of the most heavily impacted landscapes in the world with only about 20% of the original prairie remaining. Canada?s commercial ranch lands and government-owned grasslands are the final refuges of grassland biodiversity, with only a tiny fraction of prairie grassland being included in protected areas like parks or ecological reserves.

After the Laurentide ice sheet receded some 12,000 to 14,000 years ago, the character of Canadian prairie was influenced primarily by aridity, by fire, and by the impact of large herbivores, especially the American bison (Bison bison). The plant communities that developed are adapted to the rhythms and processes that defined this pre-colonial landscape (Adams et al 1994). Bison were generally migratory. They spent spring and summer months in the central mixed grass prairie, while in winter bison were drawn back to the shelter and abundant forage of the fescue prairie, foothills, and parkland regions that lie on the western and northern fringes of the open prairie. Today, both types of prairie seem to exhibit a character reflecting their historic use by bison. The mixed grass prairie is remarkably well adapted to moderate summer grazing. In contrast, the fescue prairie and parkland, which were traditional winter grazing areas for bison, thrive under winter use and are intolerant of summer grazing. Festuca campestris, F. halli, and other native grasses maintain a high nutrient value in winter and the grasslands in best condition are those that are winter grazed in the same manner that the bison used them over thousands of years.

It appears that other herbivores relied upon the impacts of fire and bison grazing to maintain a native grassland that provided their forage requirements. In the absence of fire and grazing, both mixed grass and fescue prairies tend to accumulate senescent plant material. Wapiti (Cervus elaphus) and pronghorn (Antilocapra americana) have more specialized grazing habits. Wapiti prefer grasslands with less litter, and pronghorn prefer forb growth.

Fire history in Canadian grasslands

Wildfires caused by lightning or intentionally set by aboriginals had a profound influence on the character and extent of Canada?s grassland natural region. The journals of early European travellers are full of eyewitness accounts of perils of prairie travel and the impacts of fire on landscape. The basic fear of fire by early immigrants set the stage for almost 100 years of government policy that has sought to restrict fire as a natural process in grassland and forest ecosystems. The view put forward by Pascal Podwojewski ("Opinión de un edafologo sobre el efecto del fuego en los paramos") is different than ours. Evidence of man's role in using fire in the immigrant landscape seems to mount by the decade. Anthropologist Johan Goudsblom (1992) has gone so far as to describe the plains and prairies of the Northern Great Plains to be largely the result of the burning practices of native hunters.

These grasslands, with their dense organic layer which resists erosion, have an amazing adaptation to fire. With reasonable management, ground cover remains nearly complete after fire, with little soil surface left vulnerable to water or wind erosion. The highest elevation grasslands are protected by an organic layer termed a ?thatch? layer that is remarkably tough and durable, yielding only to repeated wheel traffic or plowing. Thatch is a thin mat (2 cm) of decomposed root and leaf litter located at the soil surface. Nevertheless, accelerated erosion will occur on all grassland types, especially the higher elevation fescue grassland, when soil exposure exceeds about 10 - 15 %.

Fires impact on plant succession

Although forest cover has moved hundreds of kilometers southward into the prairie region during the past century due to fire control, the evidence of the grassland's former range is still apparent in the soil record and in the place names of many communities that are now in the midst of boreal forest. Village names like Grassland, High Prairie and Grand Prairie were first named for their open, largely treeless prairie landscape. Over time, forest encroachment eventually alters the grassland soils with organically rich topsoil to forest soils with ashy grey soil horizons. Forest leaf litter gives rise to organic acids that eventually leach desirable soil colloids (organic matter and clay) through the surface horizons and slowly begin the shift to a forest soil type. Lutwick et al (1968) measured the early signs of this transformation in the fescue prairie after as little as 40 years of forest encroachment.

Anthropologists Nelson and England (1972), and Lewis (1985) have described many applications of fire by aboriginal man in the central and northern plains. Fire was a tactical tool, tribes would use it to signal, to cover their travel tracks, and to deny grassland to competing tribes. They also used it prior to grass green-up to draw bison and other wildlife into areas of otherwise senescent grassland. Lewis has catalogued many specific prescriptions where fire in more northerly ecosystems was used to rejuvenate wetlands to draw migratory waterfowl or to create new sprouts on willow (Salix spp.) for basket making.

What we know about fire effects on Canadian grasslands

Bailey and his many graduate students have documented the impact of fire in the reduction in cover of woody species in the aspen parkland natural region (Bailey and Wroe 1971) of the central prairies. Fire tends to reduce the cover of deciduous trees like Populus tremuloides and Populus balsamifera), but also shrubs like Symphoricarpos occidentalis, Eleagnus commutata, and Rosa spp.

The next major impact of fire on our grasslands is the reduction of the cover of senescent organic residue termed ?litter." Removal of litter allows more sunlight to strike the crowns of grasses like Festuca campestris, resulting in greater production of basal sprouts. However, litter removal also

has a short term (2 to 5 years) drying effect on plant community and soil surface of moderately grazed grasslands. Less litter means that the site is more subject to moisture loss due to increased soil temperatures and lower moisture retention. Normally, forage yields will decline by 30 to 50 % after burning, not due to plant injury, but to the drying of the site.

The historical role of fire and grazing in recycling nutrients becomes more obvious when our higher elevation grasslands are left ungrazed for a number of years and litter levels begin to build up to 2 or 3 tonnes per ha. Perhaps the most poorly understood aspect of fire effects in the Canadian Prairie is the role of fire in initiating and regenerating grasses and forbs. A recent wildfire in southern Alberta resulted in a strong regenerative response of a variety of leguminous species, especially Astragalus, Oxytropis, and Thermopsis.

The paramos and the Canadian prairie

Our experience with fire effects in grasslands most closely resembles those processes and impacts described in the paper by Lucrecia Aguirre ("Comentario a la reflexión del Dr. Robert Hofstede sobre el uso e impacto del fuego en los ecosistemas de páramo") who observed that most impacts are the reduction of cover of woody species and the removal of senescent material. We experienced none of the undesirable soil impacts described by P. Podwojewski ("Opinión de un edafologo sobre el efecto del fuego en los páramos"), although we are aware that a number of these impacts are common on US rangelands (pronounced release of ions and compounds, some toxic, development of hydrophobic characteristics, often leading to diminished watershed function). A recent accidental fire in grasslands of southern Alberta had catastrophic impacts on a local ranching community. The fire killed several hundred livestock, destroyed rural residences and displaced over 5000 head of cattle for up to 1 to 2 years. Fire behaviour specialists concluded that the fire intensity of this fire was greater than any fire on record in forest or grassland in Canada. Our monitoring program (Bork et al 2000) concluded that little soil erosion resulted, although short term watershed function will be impaired slightly for a few years until grassland canopy cover is restored. The remarkable protective function of the thatch layer was highlighted in by this fire.

Much of what Jorge Zaruma ("Comentario sobre el impacto del fuego en el páramo) describes of the frequent fires in the paramo apply to Canadian grasslands as well. When frequent, brush species will be virtually eliminated and frequent burning can have the same impact on grass species as prolonged heavy grazing.

Bringing fire back to the ranching landscape

Bailey (Bailey et al 1990) and Adams (Adams et al 1995) have demonstrated the cost and benefits of fire, but progress is slow in the adoption of fire as a necessary and desired rangeland treatment. Attitudes are still heavily influenced by the fire control mind set of the past 100 years and from sensational accounts in the media of periodic wildfires that occur under extreme weather conditions where prescribed fires are not normally undertaken. Foothills ranchers are the most supportive of fire, as they are able to see the impact in the short term on forest succession and grassland restoration (see the two rancher accounts in Adams et al 1995). Ranchers in the mixed grass prairie, where forest encroachment is not an issue, see little incentive to use fire. They know that fire will reduce forage yields from their native grasslands. The major ecological benefits of fire may be to restore certain rare and endangered plant species which farmers and ranchers perceive to be of little economic importance to them.

Literature Cited

Adams, B. W. 1995. Fire and grazing to manage willow forest on foothills range. Range Notes 15. 16 pp.

W. Willms, and M. Powell. 1994. Sustainable rangeland management ??aligning livestock with ecosystems. Pages 125-133 In R.C. Wood and J. Dumanski (eds.). Sustainable land management for the 21st century. Vol. 2: Plenary papers. Agricultural Institute of Canada, Ottawa, Ontario. 381pp.

Bailey, A. W., and M. L. Anderson. 1978. Prescribed burning of a Festuca-Stipa grassland. J. Range Manage. 31: 446-449.

B. D. Irving, and R. D. Fitzgerald. 1990. Regeneration of woody species following burning and grazing in aspen parkland: J. Range Manage. 43: 212-215.

and R. A. Wroe. 1974. Aspen invasion in a portion of the Alberta parklands. J. Range Manage. 27: 263-266.

Bork, E. W., B. W. Adams, and W. Willms. 2000. Rough fescue rangeland recovery following the 1997 Granum wildfire. Unpubl. final research report, Alberta Cattle Commission, ILO Project 98-0987. 35 pp

Goudsblom, J. 1995. Fire and civilization. In B. Potyondi. Palliser's triangle - living in the grasslands, 1850 - 1930. Purich Publishing, Saskatoon, Saskatchewan. 143 pp.

Lewis, H.T. 1985. Why Indians burned: specific versus general reasons. In: J.E. Lotan, B.M. Kilgore, W.C. Fischer, and W.R. Mutch (Technical Coordinators). Proceedings of Symposium and Workshop on Wilderness Fire. Intermountain Forest and Range Experiment Station, Forest Service, USDA, Ogden, Utah. pp. 75-80.

Lutwick, L. E., and J. F. Dormaar. 1968. Productivity of a soil biosequence of the fescue prairie - aspen transition. J. Range Manage. 21 :24-27.

Nelson, E.H,. and R.E. England. 1971. Some comments on the causes and effects of fire in the northern grasslands area of Canada and the nearby United States, ca. 1750-1900. Can. Geog. Jour. 15:295-306.