Burning in a Bunchgrass/Sagebrush Community: The Southern Interior of B.C. and Northwestern U.S. Compared

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Abstract

Investigations following a wildfire near Kamloops, B.C., indicated that, contrary to reported experiences in the United States, gray rabbitbrush (*Chrysothamnus nauseosus*) is susceptible to fire in this area. Hence caution is necessary when developing burning prescriptions and using extrapolated information.

There is steadily growing recognition and acceptance of fire as a useful tool in management of the 620,000 ha of grassland ranges in the southern interior of British Columbia (B.C. Min. Forests 1980). However, the use of fire to achieve specific objectives requires understanding of the conditions under which burning must be conducted if the desired ecological effects are to be achieved. Unfortunately, we do not yet have the requisite knowledge in B.C. (Wikeem and Strang 1983) and so resource managers often extrapolate research results from northwestern United States when developing prescriptions for prescribed burning here. Although there are strong ecological similarities between the two areas (Tisdale 1947) subtle differences in soils, climates, and, possibly, ecotypes bring into question the validity of these extrapolations.

Because of this, a wildfire in a sagebrush-bluebunch wheatgrass community in B.C.'s southern interior on 26 June, 1979, was used as an opportunity to obtain data on the impact of fire on this community, and to compare observed results with those predicted for current literature.

Study Site and Methods

The study site is at about 500 m on the steep (40-90°) southwest-facing slope of a low hill on the northern outskirts of Kamloops, B.C., at Batchelor Heights in Krajina's (1965) ponderosa pine/bunchgrass biogeoclimatic zone. The vegetation was classified by Watson (1977) as a bunchgrass/sagebrush community dominated by big sagebrush (*Artemisia tridentata* (Nutt.)), gray rabbitbrush (*Chrysothamnus nauseosus* (Pall.) Britt.) and bluebunch wheatgrass (*Agropyron spicatum* (Pursh) Scibn. & Smith). Low-level, large scale aerial photography indicated that shrub and herbaceous cover and density were uniform throughout the locale (Watson 1977). The soil has been classified (Can. Dep. Agr. 1971) as a shallow, lithic, orthic, dark-brown, chernozemic sandy loam.

The fire started early in the afternoon of July 26, 1979, and burned 12.1 ha before being extinguished. Winds during the fire were southwesterly at 30 km/h., and the Canadian Forest fire Weather Indices and codes (Van Wagner 1974) were:—

Fire fuel moisture code	94
Duff moisture code	214
Drought code	527
Initial spread	9
Build-up index	213
Fire weather index	35

The high drought code and build-up index reflect unusually low precipitation during the spring and early summer. (1979 became the driest summer on record.) In the subsequent growing season (1980) late spring precipitation was some 200% of normal and cool damp conditions persisted throughout the summer.

Sampling to assess the fire's effect was conducted in August 1980. Fifteen pairs of plots were established, each a 5m × 5m quadrat with a 1m × 1m sub-quadrat at the centre. Fifteen samples were located randomly outside but near the fire perimeter in unburned vegetation and, within the "brûlé", each quadrat was paired with a second quadrat sited in a topographically identical location.

In each quadrat, shrubs rooted inside the boundary were recorded by species and crown diameter, and percentage crown cover was calculated. Within the sub-quadrats, percentage basal and aerial cover by grass and herb species were estimated.

Differences in species frequency between burned and unburned areas were tested for significance by contingency tables, while density and cover differences were tested by *t*-test (Sokal and Rohlf 1969) (Tables 1 and 2).

Results and Discussion

The fire had a devastating effect on the shrubs present (Table 1). Fourteen months after burning, frequency, density, and cover of both sagebrush and rabbitbrush were significantly lower—approximately 60, 90 and 90% respectively. No regeneration was observed.

The high mortality of sagebrush was not unexpected (Blaisdell 1953, Pechanec et al. 1954, Mueggler and Blaisdell 1958, Frischknecht 1978, and Ralph and Busby 1979). There are no reports of vegetative regeneration of big sagebrush and only 3 (Blaisdell 1953, Pechanec et al. 1954, and Mueggler and Blaisdell 1958) of seedlings in the first year after burning. Even with immediate seedling establishment the species is slow to regain its pre-burn status (Blaisdell 1953, Harniss and Murray 1973).

The literature contains 2 reports of mortality of rabbitbrush similar to ours. Daubenmire (1975) noted that a July fire in eastern Washington caused 97% mortality and that, even in the second year following burning, rabbitbrush was rare on the site. Similar results were noted (Robertson and Cords 1957) for a September burn in California and a November one in Nevada. These are, apparently, atypical results however. Wright (1971), Britton and Ralphs (1979), and Wright et al. (1979) state that all *Chrysothamnus* spp. generally respond to fire injury (mortality of above-ground parts) by vigorous resprouting which rapidly regains the pre-bush dominance. The reasons for observed failures of resprouting are unknown.

In contrast, the fire's effect on the ground vegetation was slight (Table 2). For only one grass, *Koeleria micrantha* (Ledeb.) Schultes, and one forb, *Antennaria microphylla* Rydb., were the frequency, basal and aerial cover significantly different between unburned and burned plots, being significantly higher after the fire. Annual grasses and forbs were not different before or after

Table 1. Frequency, density and crown cover of shrub species in unburned and burned plots.

Species	Frequency %		Density (n/25m ²)		Cover %	
	Unburned	Burned	Unburned	Burned	Unburned	Burned
Big sagebrush	100.00	40.00 ^{xx}	4.6±1.01	1.40±1.1 ^{xxx2}	2.1±6.85	3.8±5.32 ^{xx}
Rabbitbrush	93.3	40.00 ^{xx}	2.0±0.88	0.4 ±0.63 ^{xxx}	6.5±3.21	1.2±2.02 ^{xx}

^{1xx}difference significant at $P \leq 0.005$

^{2xxx}difference significant at $P \leq 0.001$

Table 2. Frequency, basal cover, and aerial cover of grass and forb species on unburned and burned plots.

	Frequency (%)		Basal cover (%)		Aerial cover (%)	
	Unburned	Burned	Unburned	Burned	Unburned	Burned
Perennial grasses						
<i>Agropyron spicatum</i>	100	93.3	19.8±9.93	17.8±9.36	32.2±9.32	30.1±9.83
<i>Aristida longiseta</i>	6.7	6.0	t	0.0	t	0.0
<i>Koeleria micrantha</i>	0.0	46.7 ^x	0.0	0.4±5.76 ^x	0.0	0.6±7.6 ^x
Sub-totals	100.0	93.3	20.4±9.85	22.4±0.06	32.4±9.43	32.5±0.08
Perennial forbs						
<i>Achillea millefolium</i>	0.0	20.0	0.0	t	0.0	t
<i>Agoseris glauca</i>	0.0	6.7	0.0	t	0.0	t
<i>Antennaria microphylla</i>	0.0	46.7 ^x	0.0	0.1±1.08 ^x	0.0	0.8±2.3 ^{xx}
<i>Artemisia ludoviciana</i>	0.0	20.0	0.0	t	0.0	t
<i>Balsamorhiza sagittata</i>	6.7	6.7	t	t	t	t
<i>Erigeron filifolius</i>	33.3	20.0	t	t	t	t
<i>Gaillardia aristata</i>	0.0	6.7	0.0	t	0.0	t
<i>Lithospermum roderale</i>	6.7	20.0	t	t	t	t
Total	46.7	80.0	0.1±1.42	0.3±1.05	0.8±	1.9±8.02
Annual grasses						
<i>Bromus tectorum</i>	0.0	6.7	0.0	t	0.0	t
Sub-totals	0.0	6.7	0.0	t	0.0	t
Annual Forbs						
<i>Lappola echinata</i>	0.0	13.3	0.0	t	0.0	t
<i>Sisymbrium altissimum</i>	0.0	20.0	0.0	t	0.0	0.2±4.80
<i>Taraxacum officinale</i>	0.0	6.7	0.0	t	0.0	t
<i>Tragopogon dubius</i>	0.0	6.7	0.0	t	0.0	t
Total	0.0	26.7	0.0	t	0.0	0.3±5..71

^xdifference significant at $P > 0.05$

^{xx}difference significant at $P \leq 0.01$

burning for all parameters noted. Total frequency, total basal and aerial cover of other perennial and annual grasses and forbs were unaltered except for total aerial cover of perennial forbs, which was significantly greater after burning than before.

Although responses similar to ours have been noted for late summer and fall burns (Blaisdell 1953, Mueggler and Blaisdell 1958, Conrad and Poulton 1966, Uresk et al. 1976, Ralph and Busby 1979), nothing in the literature suggests such responses following an early summer fire. Pechanec et al. (1954), Wright (1974), and Wright et al. (1979) suggest that early summer fires, particularly in drought years, are very damaging to perennials, causing much mortality and reduced size and vigour in survivors. It is not yet known why our results are different.

Similar response by annuals has been reported after early summer fires. Daubenmire (1975) noted that, one year after an early July fire in eastern Washington, there were only slight differences in frequency and aerial cover of *Bromus tectorum* L., *Sisymbrium altissimum* L. and most other annuals between unburned and burned plots.

In a controlled burning trial being carried on a few kilometres to the west, it has been found (Strang and Johnson 1980) that here also gray rabbitbrush is susceptible to burning. The shrub has succumbed whether burned in spring, summer, or early fall and there is virtually no resprouting. Thus the evidence from the wild-fire is confirmed for this location.

Conclusion

The fire's principal impact was virtual elimination of the shrub

components—big sagebrush and gray rabbitbrush. Consequently total biomass production decreased. However, it is to be expected that production of grasses and forbs, the forage species, will increase because of the sharply reduced competition from shrubs (Harniss and Murray 1973).

With the exception of the responses of big sagebrush and the annuals, our results were consistently different from those reported in the literature, for reasons yet to be ascertained. Whatever the reasons, our findings lead to increased doubts about the validity of extrapolation of the results of fire ecology research from north-western U.S. to B.C.

Evidently, further study is needed, but in the interim, U.S. results should be used to develop specific prescriptions for burning the southern interior of B.C. only with extreme caution.

Literature Cited

- B.C. Ministry of Forests. 1980. Forest and range resource analysis technical report. Vol. I. Inform. Serv., Min. Forest., Prov. Brit. Columbia, Victoria, B.C.
- Britton, C.M. and M.W. Ralph 1976. Use of fire as a management tool in rangeland ecosystems. Proc. Sagebrush Symp. Utah State Univ., Logan, Utah.
- Blaisdell, J.P. 1953. Ecological effects of planned burning of sagebrush-grass range on the upper Inaka River Plains. USDA Tech. Bull. 1075.
- Canada Department of Agriculture. 1971. Preliminary soils map covering part of Kamloops Research Station rangeland. Soil Surv. res. Sta., Can. Dep. Agr., Vancouver, B.C.
- Conrad, E.C., and C.E. Poulton. 1966. Effect of a wildfire on Idaho fescue and bluebunch wheatgrass. J. Range Manage. 19:138-141.

- Daubenmire, R. 1975.** Plant succession on abandoned fields and fire influence in a steppe area in southeastern Washington. *Northwest Sci.* 49:36-48.
- Frischknecht, N.C. 1973.** Effects of grazing, climate, fire and other disturbance on a long-term production of sagebrush-grass ranges. *Proc. 1st Int. Grassland Congr.* 633-635.
- Harniss, R.O., and R.B. Murrery. 1973.** 30 years of vegetal change following burning of sagebrush-grass range. *J. Range Manage.* 26:322-323.
- Krajina, V.J. 1965.** Biogeoclimatic zones and classification of British Columbia. *Ecology of N. Amer.* 2:1-146.
- Mueggler, W.F., and J.P. Blaisdell. 1958.** Effects on associated species of burning, rotobearing, spraying and railing sagebrush. *J. Range Manage.* 11:61-66.
- Pechanec, J.F., and A.C. Hull, Jr. 1945.** Spring forage lost through cheat-grass fires. *Nat. Wool-Grower.* 35:13.
- Pechanec, J.F., G. Stewart, and J.P. Blaisdell. 1954.** Sagebrush burning—good and bad. *USDA, Farmer's Bull.* 1948.
- Ralph, M.H., and F.E. Busby. 1979.** Prescribed burning: vegetative change, forage production, costs and returns on six demonstration burns in Utah. *J. Range Manage.* 32:267-270.
- Robertson, J.H., and H.P. Cords. 1957.** Survival of rabbitbrush, *Chrysothamnus* spp., following chemical burning and mechanical treatments. *J. Range Manage.* 10:83-89.
- Sokal, R.R., and F.J. Rohlf. 1969.** *Biometry.* W.H. Freeman & Co., San Francisco.
- Strang, R.M., and A.H. Johnson. 1980.** Preliminary results of a controlled range burning trial near Kamloops, B.C. *Ann. Meet. Pacific N.-W. Sec. Soc. Range Manage., Portland, Ore.*
- Tisdale, E.W. 1947.** The grasslands of the southern interior of British Columbia. *Ecol.* 28:346-382.
- Ureak, W.W., V.P. Kline, and W.H. Rickard. 1976.** Impact of wild fire on three perennial grasses of south-central Washington. *J. Range Manage.* 29:309-310.
- Van Wagner, C.E. 1974.** Structure of the Canadian Forest Fire Weather Index. *Dep. Environ. Can. Forest Serv., Pub.* 1333.
- Watson, K.E. 1977.** A remote sensing-based multilevel rangeland classification for the Lac-du-Bois rangeland, Kamloops, B.C. *M.Sc. Thesis, Univ. Brit. Columbia.*
- Wilkeem, B.H., and R.M. Strang. 1983.** Prescribed burning on the rangelands of southern interior: B.C.:the state of the art. *J. Range Manage.* 36:3-8.
- Wright, H.A. 1971.** Shrub responses to fire. *In: Wildland Shrubs—their biology and utilization.* USDA, Forest Serv. Gen. Tech. Rep. INT-1, Intermountain Forest Range Exp. Sta., Ogden, Utah.
- Wright, H.A. 1974.** Range burning. *J. Range Manage.* 27:5-11.
- Wright, H.A., L.E. Neuenschwander, and C.M. Britton. 1979.** The role and use of fire in sagebrush-grass and pinyon-juniper plant communities. A state-of-the-art review. *USDA, Forest Serv., Gen. Tech. Rep. INT-58, Intermountain Forest Range Exp. Sta., Ogden, Utah.*

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