Evaluation of Burned Aspen Communities in Jackson Hole, Wyoming

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Abstract—*Aspen has been declining in Jackson Hole for many years, a condition generally attributed to the fact that lightning fires have been aggressively suppressed since the early 1900s. It is also believed that burning will successfully regenerate aspen stands despite high elk numbers. To test this hypothesis, I evaluated 467 burned and 495 adjacent, unburned aspen stands at eight different locations within Jackson Hole. Aspen suckering was stimulated by burning, but most aspen stands still failed to produce new stems greater than 2 m tall where ungulate use was moderate or high. Only when elk use was low were burned aspen stands able to successfully regenerate. At those locations, however, unburned aspen stands also successfully regenerated. Evidence suggests that a combination of fire and continued elk use may eliminate many aspen clones.*

Introduction

The relationship between vegetation and ungulates in Jackson Hole, Wyoming, has long been a subject of conflicting opinions and intense debate (Anderson 1958; Boyce 1989). Until the 1960s, it was thought that (1) Jackson Hole was not historic elk (*Cervus elaphus*) winter range; (2) European settlement forced elk to winter in the valley; and (3) supplemental feeding permitted the growth of an abnormally large elk herd; which (4) caused substantial damage to the winter range and a marked decline of aspen (*Populus tremuloides*) (Preble 1911; Murie 1951; Anderson 1958; Krebill 1972; Beetle 1974, 1979; Basile 1979; DeByle 1979; Weinstein 1979). However, federal and state biologists now believe that (1) large numbers of elk have wintered in Jackson Hole for the last several thousand years; (2) feedlots have only replaced winter range lost to human developments; (3) therefore, today's elk population is not unnaturally high, although the distribution of wintering animals may have changed; (4) serious elk-induced range damage has not occurred (Cole 1969; Gruell 1979; Gruell 1980a,b; Boyce 1989); and (5) the elk herd would "naturally regulate" if sport hunting were terminated (Boyce 1989). Under this interpretation, aspen is thought to be a seral species maintained by fire, and human suppression of lightning fires is believed to be primarily responsible for the observed decline in aspen, not ungulate browsing (Loope and Gruell 1973; Gruell and Loope 1974).

Gruell and Loope (1974:19–20) and Gruell (1980a:2) indicated that aspen stands burned in Jackson Hole were able to successfully regenerate, defined as producing new stems >2 m tall, despite heavy browsing—a claim similar to that made by the Park Service in Yellowstone (Kay 1990). According to Houston (1982:127), "data from [Yellowstone's] northern range and adjacent areas showed that aspen often reproduced successfully when burned in the presence of ungulate populations." While Despain et al. (1986:107) stated that "data from some locations on the northern range have proven that aspen, when

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burned, has actually regenerated despite heavy elk use." However, Basile (1979) and Bartos and Mueggler (1979, 1981) reported that even though an experimental burn in Jackson Hole greatly increased the number of aspen suckers, elk browsing eliminated all incremental height growth after the first summer. The authors cautioned that fire-induced suckering was probably not sufficient to regenerate aspen under current browsing pressures in Jackson Hole.

To determine which of these competing views is correct, and whether burning can, in fact, regenerate aspen despite heavy utilization by elk and other ungulates, I measured burned aspen stands at eight different locations in Jackson Hole (table 1). These sites were prescribe-burned by the Forest Service or U.S. Fish and Wildlife Service to regenerate aspen and to improve range conditions. In addition, the burns have different histories of elk use, making them ideal subjects for this study (Kay 1990).

Methods

I first searched agency files to obtain all existing information for each burn; data on the location, timing, and size of each burn are presented in table 1. Within each burn, I visually evaluated every aspen stand to determine whether it had regenerated. A burned stand was recorded as regenerating if at least one aspen stem had grown taller than 2 m after the fire. Even if only a small portion of the original stand had regenerating stems >2 m tall, those stands were still considered to have regenerated successfully for this study. Thus, visual evaluation of the proportion of aspen stands that regenerated following fire is biased in favor of successful regeneration. I also visually evaluated unburned aspen

Table 1—Location and description of aspen burns in Jackson Hole, Wyoming.

Burn	Area[a]	Location T	Location R	Location S	Date burned	Approx. area burned	Aspect	Elevation
						ha[b]		*(m)*
Burro Hill	BTNF	45N 45N	113W 112W	25 19,30	8/27/1974	178	NE-S-SW	2,100-2,200
Russold Hill	BTNF	42N 43N	114W 114W	1,2 35	5/15/1975	188	NE-S-NW	2,150-2,255
Coal Mine Draw	BTNF	44N	113W	3,4,9	5/18/1976	121	N-E-S-W	2,200-2,270
Lightning Creek[c]	BTNF	42N 42N 42N	112W 113W 113W	7,18,19 10,11,14 15	4/21-23/1977 Spring 1978 Spring 1980	466 26 24	NE-S-NW	2,286-2,560
Breakneck Ridge	BTNF	42N	112W	25,26,35	8/29/1974	366	NE-S-NW	2,377-2,590
Dry Cottonwood[d]	BTNF	42N 42N	112W 111W	23,24,27,30 30	Spring 1978, 1979, 1980	226	NE-S-NW	2,377-2,652
Dry Dallas[e]	BTNF	42N	112W	15,16,17,20, 21,22,23	Spring 1978, 1979, 1980	340	NE-S-NW	2,317-2,621
Elk Refuge	NER	42N	115W	20	8/1973	16	W-N	2,134-2,164

[a]BTNF = Bridger Teton National Forest and NER = National Elk Refuge
[b]Total area burned including sagebrush-grasslands.
[c]Includes the area between Lightning and Dry Dallas Creeks.
[d]Includes the area between Dry Cottonwood and Cottonwood Creeks
[e]Includes the area between Dry Dallas and Dry Cottonwood Creeks

stands immediately adjacent to each burn to determine if they had regenerated. An unburned stand was recorded as having regeneration if and only if the number of aspen stems >2 m tall but ≤5 cm d.b.h. (diameter at breast height) were equal to or greater than the number of trees in the largest d.b.h. size class (Kay 1985).

Next, 20% of the aspen stands within each burn were randomly selected for more detailed measurement, except at Russold Hill and the Elk Refuge where all burned aspen stands were measured (Kay 1990). At Burro Hill, Russold Hill, Coal Mine Draw, and the Elk Refuge, 20% of adjacent, unburned aspen stands were also randomly selected for measurement. At each randomly selected stand, a 2 x 30 m belt transect was used to record aspen stem numbers by various size classes: <2 m tall, >2 m but <5 cm d.b.h., 6-10 cm d.b.h., 11-20 cm d.b.h., and >20 cm d.b.h. Data were also collected on aspect, elevation, slope, and burn intensity. Based on aerial counts and other data, the Wyoming Game and Fish Department provided estimates of long-term winter and summer elk use for all burn areas. Elk use was ranked as none, low, moderate, or high (Kay 1990).

Results

At each burn site in Jackson Hole (table 1), I first visually scanned each aspen stand to estimate whether the stands had successfully regenerated. Visual regeneration estimates were then checked by measuring 111 burned and 28 unburned stands. In all instances, the 139 stands were correctly classified by the visual estimation technique. On Yellowstone's northern range, 268 out of 268 unburned stands (a 20% random sample of 1,342 stands) were correctly classified by the same method (Kay 1990:124). Thus, this technique appears to be accurate for the purposes of this study.

In Jackson Hole, I visually evaluated 467 burned aspen stands and 495 adjacent unburned stands for the presence of regeneration >2 m tall (table 2). The proportion of burned aspen stands with regeneration >2 m tall varied from 0 to 100%, while the rate in unburned stands ranged from 8 to 98% (table 2). In general, the areas with the highest regeneration rates had the lowest levels of elk use, especially winter use. Some burned areas had higher regeneration rates than their unburned counterparts while the reverse was true

Table 2—Proportion of aspen stands with regeneration >2 m tall in burned and adjacent unburned areas, Jackson Hole, Wyoming.

	Stands visually evaluated				Measured stands					
	Number		Percent of stands with regeneration >2 m tall		Number		Percent of stands with regeneration >2 m tall		Level of elk use[a]	
Area	Burned	Unburned	Burned	Unburned	Burned	Unburned	Burned	Unburned	Winter	Summer
Burro Hill	71	50	100	98	14	10	100	100	Low	Low
Russold Hill	19	26	68	38	19	5	68	40	Low-high	None
Coal Mine Draw	51	58	27	38	10	11	40	45	Low-moderate	Moderate
Lightning Creek	98	62	48	16	20	—	50	—	Moderate-high	None
Breakneck	80	48[b]	5	19	16	—	0	—	High	None
Dry Cottonwood	54	48[b]	13	19	10	—	10	—	High	None
Dry Dallas	90	186	17	19	18	—	22	—	High	None
Elk Refuge	4	65	0	8	4	2	0	0	High	Moderate
Totals	467	495			111	28				

[a]Unpublished data in Wyoming Department of Game and Fish files, Jackson, WY, and personal communication, Garvice Roby, Wyoming Game and Fish. A few moose also utilize these areas in winter and summer. Mule deer are rare.
[b]The unburned stands in these two areas are the same because Breakneck Ridge is located between Dry Cottonwood and Cottonwood Creeks.

in other areas (table 2). Only where elk use was low at Burro Hill did all burned aspen srands successfully regenerate, but then, all the adjacent undisturbed stands had also successfully regenerated (table 2).

Variation in regeneration rates was related to aspect. In both burned and unburned areas, aspen stands with a northeast aspect were more likely to have regeneration >2 m rall than stands with other aspects (table 3). The prevailing southwest winds drift snow onto northeast aspects, which apparently limits ungulate use on those sites (Kay 1990). When aspecr is taken into consideration, there was no significant difference between burned and unburned stands in their ability to produce regeneration >2 m tall (table 3).

The aspen burns in Jackson Hole with the lowest levels of elk use also had the highest densities of regenerated stems >2 m tall (table 4). All stands apparently had sufficient initial sucker growth after burning (Bartos and Mueggler 1979, 1981), and many still had large numbers of stems <2 m tall (table 4). Repeated elk browsing, however, prevents those stems from growing >1 m tall. One stand in Coal Mine Draw had initial post-fire sucker densities >100,000 per ha (Bartos and Mueggler 1979, 1981), while 11 years later it still had stem densities >50,000 per ha, but they were all <1 m tall. On Breakneck Ridge, none of the burned aspen stands had been able to produce any stems >2 m tall (table 4). Aspen stands in the Breakneck Ridge burn also had low densities of stems <1 m tall. I was unable to locate live aspen stems in several of those stands. Apparently, burning plus repeated elk use has led to the elimination of some clones.

The Russold Hill burn extends from the Gros Ventre road (USFS 015) upslope to the north. Thus, burned and unburned aspen stands are located at varying distances from the road. This road is not plowed during winter but is open to snow machine use, which in recent years has increased 300-400% (Kay 1990:130). For unburned stands near the road, 90% produced regeneration >2 m tall, while at distances >800 m from the road, no stands successfully regenerated (table 5). This same pattern occurred in burned aspen stands. Those nearest the road had over 11,000 stems per ha >2 m tall, but that dropped to only 595 stems per ha at distances >800 m from the road (table 5). This pattern cannot be attributed to site or climatic differences since the stands

Table 3—The effect of aspect on the ability of burned and unburned aspen stands to produce regeneration >2 m tall in the Gros Ventre Valley, Jackson Hole, Wyoming.

Aspect	Percent of stands with regeneration >2 m[a]	
	Burned	Unburned
	(n = 323)	*(n = 302)*
N	5	0
NE	56	59
E	7	11
SE	14	15
S	4	2
SW	5	2
W	0	0
NW	8	11

χ^2 4.95, *df* 4, *p* > 0.25
[a]Based on visual evaluations of each stand (table 1)

Table 4—Aspen regeneration in burned and adjacent unburned areas in Jackson Hole, Wyoming.

Area	Number of stands	Number of stems <2 m per ha Mean	SEM	Number of stems >2 m but <5 cm d.b.h. per ha Mean	SEM	Level of elk use Winter	Summer
Burro Hill							
Burned	14	1,512	228	13,727	1,115	Low	Low
Unburned	10	2,584	584	4,917	816		
Russold Hill							
Burned	19	4,571	959	5,089	1,822	Low-High	None
Unburned	5	4,101	1,440	3,234	2,142		
Coal Mine Draw							
Burned	10	7,085	2,677	5,201	2,617	Low-moderate	Moderate
Unburned	11	1,515	434	3,758	1,556		
Lightning Creek							
Burned	20	8,335	1,572	3,051	1,030	Moderate-high	None
Breakneck Ridge							
Burned	16	1,125	424	0	0	High	None
Dry Cottonwood							
Burned	10	6,601	2,167	1,317	1,317	High	None
Dry Dallas							
Burned	18	5,066	1,718	2,917	1,587	High	None
Elk Refuge							
Burned	4	3,209	1,667	0	0	High	Moderate
Unburned	2	3,334	2,000	0	0		

farthest from the road are at increasing elevation and if anything, receive more precipitation. Apparently, human disturbance limited elk use close to the road, which allowed nearby aspen stands to produce more stems >2 m tall. This is not unexpected since other studies have shown that elk avoid roads and other areas of human disturbance (Lyon 1979, 1983; Gruell 1980a:7; Edge and Marcum 1985). Gruell and Loope (1974:21) reported a similar pattern of aspen regeneration near roads in Jackson Hole.

Table 5—Aspen regeneration at various distances from the road in the Russold Hill burn, Gros Ventre Valley, Jackson Hole, Wyoming.

Stand condition	Percent of stands regenerating at three distances from road: Stands <400 m	Stands >400 m but <800 m	Stands >800 m
Unburned[a]	90% (n = 10)	25% (n = 25)	0% (n = 11)
Burned	100% (n = 7)	40% (n = 5)	57% (n = 7)
	Mean number of stems >2 m but <5 cm d.b.h. per ha		
Burned[b]	11,086	767	595

[a]Based on visual evaluation of each stand.
[b]All burned stands were measured.

Discussion

Bartos et al. (1991, 1994) reported on several of the aspen burns used in this study and concluded that "the demise of aspen was attributed to heavy ungulate use, primarily elk" (Bartos et al. 1994:79). "Suppression of [aspen] suckers is attributed mainly to heavy elk use. We question the continued use of fire to regenerate aspen stands that are subjected to heavy ungulate use. Such action could speed the elimination of aspen stands under these conditions" (Bartos et al. 1994:83).

Kay et al. (1999:6–18 to 6–22) evaluated Parks Canada's prescribed burn program in Banff National Park. As in Jackson Hole (Bartos and Mueggler 1979, 1981; Bartos et al. 1981, 1994), burning did stimulate aspen suckering, but most aspen stands still failed to produce new stems >2 m tall due to repeated ungulate browsing, again primarily by elk. "Evidence also suggests that combination of fire and continued heavy elk use may actually hasten the demise of the park's aspen communities" (Kay et al. 1999:6-21). White et al. (1998a,b) concluded that because aspen was a key indicator of ecological integrity in the Canadian Rockies, managers should not burn aspen stands if ungulate herbivory was high, unless elk populations were first returned to more natural levels (Kay 1997a,b,c,d, 1998).

It has been suggested, however, that prescribed burns have generally been too small to successfully regenerate aspen. Thus, Gruell (1980b) surmised that it may be necessary to burn large areas in a single event to keep elk and other ungulates from consuming all the fire-stimulated aspen suckers. This experiment, though, was tried in 1988 when wildfires burned approximately one-third of the aspen in Yellowstone National Park, as well as a significant portion of the entire ecosystem (Romme et al. 1995; Kay and Wagner 1996). Despite initial post-fire aspen sucker densities averaging over 120,000 per ha and first-year height growth of 2 m or more, each and every sucker in Yellowstone was repeatedly eaten to within centimeters of the ground by elk and other ungulates (Kay and Wagner 1996). In no instances were burned aspen stands in Yellowstone able to successfully regenerate due to repeated ungulate browsing (Romme et al. 1995). In fact, many burned aspen clones have been eliminated in Yellowstone National Park due to that park's unnatural concentration of wild ungulates (Kay 1998; White et al. 1998b). My other paper in this proceedings ("Long-Term Aspen Exclosures in the Yellowstone Ecosystem," Aboriginal Overkill section) explains how aspen was able to flourish in Yellowstone and throughout the Intermountain West for the last 10,000± years.

Management Implications

When this research (Kay 1990) was initially presented to the Wyoming Fish and Game Department, the agency said, "We are not even going to consider your data because if you are even close to being correct, then everything we are doing is wrong, and we are not ever going to consider that possibility" (Garvice Roby, personal communication 1989). This is similar to what Wright (1984; Kay 1992:316) experienced when he presented his archaeological work in Jackson Hole to the agencies:

> Keep in mind that I have [been] battling wildlife biologists from Grand Teton and Yellowstone Parks for some years. One told me, after a seminar I gave at the Jackson Hole Biological Research Station on the faunal resources of the regions, "Even if you demonstrate that no elk were here, we would still continue to argue for them because our management policies require a herd of at least 10,000 elk by the end of the Pinedale ice (the last deglaciation)."

The U.S. Forest Service has been no more responsive to these data than have the other agencies in Jackson Hole, despite independent confirmation of these findings by Forest Service ecologists from the Intermountain Research Station (Dale Bartos, personal communication 1995). Instead, Wyoming Game and Fish, the Forest Service, the Rocky Mountain Elk Foundation, and others continue to burn aspen in Jackson Hole and aspen repeatedly fails to regenerate (personal observation), which is unfortunate because aspen has the highest biodiversity of any forest type in the West (Kay 1997a). Unless new management philosophies are implemented, aspen will continue to decline in Jackson Hole, and eventually aspen will be eliminated from much of its historic range.

Conclusions

1. Aspen suckering is stimulated by burning.
2. Even when burned, though, most aspen stands in Jackson Hole failed to produce stems >2 m tall when ungulate use was moderate or high. There is no evidence that burned aspen stands in Jackson Hole, or elsewhere, will regenerate successfully despite intense browsing as claimed by some.
3. Evidence also suggests that a combination of fire and continued heavy elk use will eventually eliminate most aspen clones.
4. Fire cannot be used to restore aspen communities unless ungulate herbivory is low.
5. As explained elsewhere (Kay, this proceedings), disturbance is not necessary to regenerate aspen stands. Instead, most aspen stands will regenerate without disturbance if ungulate use is low.
6. Thus, controlling ungulate use is paramount if burned or unburned aspen stands are to successfully regenerate and maintain their presence on the landscape, as aspen clones have done for thousands of years (Kay 1997a).

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Abstract

The current status and trend of aspen is a topic of debate; some studies have claimed dramatic reductions in aspen stands while others have found no major changes. The actual picture of aspen forests across the West is variable, and the presence of conifers and ungulates in aspen may or may not indicate a progressive loss of aspen. These proceedings summarize the state of knowledge about aspen ecology, the condition and trends in aspen ecosystems in the West, and human dimensions and management options for sustaining aspen.

Keywords: ecosystem management, ecosystem research, sustainable forests, quaking aspen, *Populus tremuloides*

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