Early Succession in Aspen Communities Following Fire in Western Wyoming

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Abstract

Aspen clones in varying degrees of deterioration were burned in northwestern Wyoming in an attempt to regenerate the site. Large numbers of aspen suckers are necessary to perpetuate these stands under current heavy ungulate use. Sucker numbers doubled the second year after burning and by the end of the third year had returned to near preburn levels of 15,000–20,000 suckers per hectare. This slight increase in sucker numbers is probably not sufficient to regenerate the stands under current browsing pressures. Total understory production declined the first year following fire and then increased to 3,600 kg/ha the second year—almost double preburn conditions. Production decreased the third year to about one-third greater than before burning. Forb and grass production increased and shrubs decreased as a result of burning. Fireweed *(Epilobium angustifolium)* was the largest post-fire contributor to total understory production.

Fire has long been recognized as a vital natural force in the perpetuation of aspen groves and forests in the Rocky Mountains (Baker 1925). Although the self-maintaining climax status of certain aspen communities is now accepted (Mueggler 1980)[1], most communities require a major disturbance such as burning or clearcutting to alter competitive relationships and stimulate growth of aspen suckers to insure successful regeneration. Aspen *(Populus tremuloides)* is a relatively short-lived tree, reaching maturity in 80 to 120 years. If unable to reproduce, these seral aspen stands deteriorate rapidly (Schier 1975) and may be replaced by communities with lower multiple-use values. Such is the condition of many of the lower elevation aspen groves on the Bridger-Teton National Forest in western Wyoming. Protection from wildfire, compounded by heavy browsing of aspen suckers by wild ungulates, has jeopardized many of these groves (Gruell and Loope 1974). With the demise of the aspen groves, resource managers foresee an accompanying long-term loss in values for wildlife habitat, scenery, and overall community diversity.

The natural role of fire in the development of aspen forests suggests that prescribed burning would rejuvenate decadent aspen groves and perpetuate a desired balance of plant communities and resources. Fire, however, is a drastic tool that should be used with caution. Before beginning an aspen burning program, we should understand the effects of fire not only upon aspen regeneration, but upon the understory components of the community as well. What happens to the herbaceous and shrub understory will have a direct impact on forage values for livestock and wildlife.

In 1972 the Bridger-Teton National Forest and Intermountain Forest and Range Experiment Station began a cooperative study to acquire detailed information on the effects of burning decadent aspen communities. The primary pupose was to so stimulate aspen suckers that enough would escape elk *(Cervas canadensis nelsoni)* browsing to perpetuate the aspen groves. This report describes vegetation changes during the first three post-fire years on lightly, moderately, and heavily burned aspen communities.

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[1]Mueggler, W.F. (In press) Vegetation association in aspen forests. U.S. Dep. Agr. Forest Serv. Res. Pap., Rocky Mt. Forest and Range Exp. Sta., Fort Collins, Colo.

Methods

The study area is located on the upper Gros Ventre drainage approximately 48 km northeast of Jackson, Wyoming. The site, Breakneck Ridge, is a generally west-facing slope at 2,400 m elevation, with a mosaic of aspen, sagebrush, and grassland communities (Fig. 1). The aspen groves variably face southwesterly to northwesterly, with conifers, primarily subalpine fir *(Abies lasiocarpa)* invading the more northerly aspects. This site was selected because of very heavy winter use by elk, the presence of physical barriers which facilitated containment of the fire, and the presence of numerous aspen clones in different condition categories scattered along the same hillside. Some clones were relatively healthy and stable, some were seral and being replaced by conifers, and others were decadent and being replaced by sagebrush-grass communities. Approximately one-fourth of the 200-ha hillside was occupied by aspen groves.

Approximately 14,000 aspen suckers per hectare existed in these communities before burning, which would seem adequate to replace the decadent overstory. These suckers, however, were almost invariably less than 1 meter tall and suppressed primarily by elk and moose *(Alces alces)* browsing. The aspen stands were not regenerating, as evidenced by the lack of intermediate sized trees (Fig. 2).

Permanent sample plots were established in 10 aspen clones prior to burning. Nine of the clones were scattered across that portion of the hillside scheduled for burning; one, a control, was adjacent to the others, but protected by a fire break. Four permanent 10 × 10-m macroplots were selectively placed in each clone.

Aspen suckers were counted on five 4 m^2 permanent subplots located within each of the 40 macroplots. A sucker was defined as an aspen stem less than 2 m high and less than 5 cm d.b.h. Most were small stems less than 1 m high. Sucker counts were converted to numbers per hectare.

Vegetation production was measured at its peak near the end of July or early August before burning in 1974, and in the three post-burn years 1975, 1976, and 1977. Production was determined

Fig. 1. *Decadent aspen groves scattered along the 200-ha Breakneck Ridge study site on the Bridger-Teton National Forest.*

Fig. 2. *A decadent grove of aspen where elk and moose have not only suppressed all reproduction, but also damaged the bark on mature trees.*

by double-sampling 24 microplots, 30.5 × 61 cm in size, systematically distributed within and adjacent to each of the macroplots. Capacitance meter readings (Currie et al. 1973) were obtained on each microplot; one-fourth of these microplots were then clipped by species. Regression equations developed for total production from only those plots both metered and clipped permitted conversion of all meter readings to herbage production. All clipped material was dried (70° C for at least 48 hr). Separation of the clipped material by species permitted determination of species composition in percent. These percentage figures were then applied to total production data to yield production by species and vegetation classes.

The area was burned on August 29, 1974. Weather conditions on this date met those prescribed by fire behavior specialists to achieve good burning conditions for killing the aspen overstory and yet maintain fire control. The following conditions existed at the time of burning: air temperature, 25° C; gusty winds, 13 to 32 kph; relative humdity, 18%; fuel moisture in the aspen groves varied from 10 to 45%. The area, however, did not burn uniformly and a patchwork of burn intensities resulted. This was attributed to differences in the amount of dry fuel on the ground, and differences in the moisture content of duff and understory vegetation caused by slight differences in exposure. Although evaluation of clonal differences was confounded by the irregular burn pattern, this permitted evaluation of the effects of burn intensity on the vegetation.

Each macroplot was assigned to one of four burn intensity categories. The overall burn intensity was derived from the proportion of the macroplot unburned, lightly, moderately, and heavily burned. A point was considered lightly burned if an estimated 0% to 20% of the litter and duff was consumed, moderately burned if 21% to 80% was consumed, and heavily burned if 81% to 100% was consumed. Most of the understory vegetation was scorched or consumed, and up to 90% of the aspen trees were killed on the moderate burn, whereas all of the understory vegetation was consumed and over 90% of the aspen were killed on the heavy burn. Only the four macroplots in the control treatment were without evidence of fire and were classified as unburned. Eleven macroplots were considered lightly burned, 13 were moderately burned, and 12 were heavily burned.

Differences between macroplots in vegetation production prior to burning and natural yearly fluctuations in production attributable to weather, complicate interpretation of burning effects from direct comparisons of the production data. Therefore, the data were adjusted to a common base to account for initial site differences and for weather-induced changes in order to show more clearly the effects of burning on the vegetation.

Adjustment for site differences between macroplots was accomplished by (1) determining for each macroplot the correction factor required to equate before-treatment production across all macroplots, and then (2) applying the macroplot's correction factor to all data for that macroplot regardless of year. Adjustment for yearly weather differences was accomplished by (1) determining for each year the correction factor required to equate production across all years on the control treatment, and then (2) applying the correction factor for a given year to all macroplot data for that year regardless of treatment.

Results and Discussion

As anticipated, burning stimulated production of aspen suckers (Fig. 3). Nearly twice as many occurred the second year after burning. The increase, however, was short-lived; by the third year there were approximately 14,000 to 20,000 suckers per hectare, only slightly more than before burning. The differences in numbers among burn intensities were not statistically significant. Patton and Avant (1970) observed an average density of over 30,000 suckers per hectare the first 5 years following a wildfire in New Mexico. A moderate degree burn is most effective in stimulating suckering according to Horton and Hopkins (1966) and our data (Fig. 3) reflect this with the moderate treatment being consistently but not statistically higher than the other two treatments.

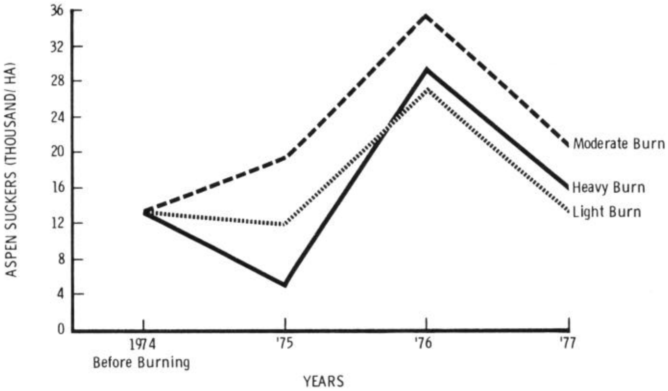

Fig. 3. *Effect of three burn intensities on aspen sucker production for 3 years following burning. (Data have been adjusted for site and yearly weather differences.)*

It is unlikely that such a modest increase in sucker numbers will alone guarantee successful renewal of the aspen groves without a reduction in browsing pressures. These suckers theoretically are no longer suppressed by a tree overstory and should grow more rapidly than those within an unburned aspen grove. We found, however, that on these poor aspen sites suckers protected from browsing for 3 years were approximately the same height (0.5 to 1.0 m) on both the burned and unburned areas. This suggests that a long period of protection from browsing may be all that is necessary to insure replacement of these aspen stands.

Annual production of understory vegetation prior to burning was almost 1,800 kg/ha (Fig. 4). Production decreased about one-third the first year after burning, but then increased substantially. By the second year following burning, understory production averaged two-thirds greater than before the areas were burned. Production then decreased the third year to only about one-third greater than before burning. The heavily burned areas suffered the greatest first year decline, a reduction of two-thirds, but recovered rapidly. Understory production on the lightly burned areas was least harmed initially by burning, but also least benefited later. By the third post-fire year the lightly, moderately, and heavily burned areas were producing 12, 42, and 52%, respectively, more total understory production than before burning.

Both before and after burning, the understory production in these aspen groves consisted primarily of forbs. Before burning, forbs comprised 68%, grasses 15%, and shrubs 17% of the total understory. Following burning, understory composition shifted

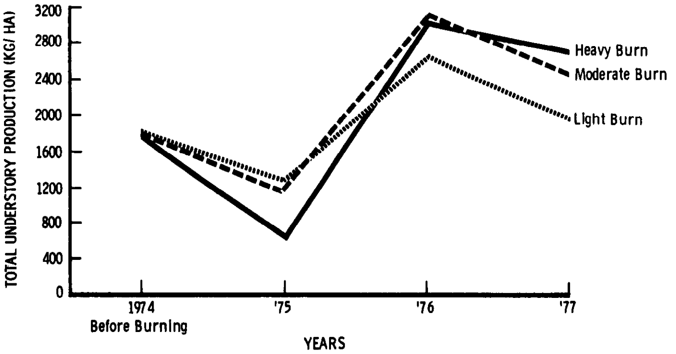

Fig. 4. *Total understory production for 3 years following burning at three intensities. (Data have been adjusted for site and yearly weather differences.)*

even more strongly in favor of the forbs. The general decrease in understory production the first post-fire year affected the forb class least and the shrub class most. As a consequence, composition of the forbs increased to an average 83%, grasses decreased to 11%, and shrubs declined to 6%. Thereafter, the relative proportions of theses classes changed only slightly despite the substantial increase in overall production. By the third post-fire year forbs comprised 80%, grasses 16%, and shrubs 4% of the total understory production.

In the first post-fire year, forb production decreased on the average about one-third. The decrease was greatest on the heavily burned areas and least on the lightly burned areas (Fig. 5a). The forbs then increased greatly and by the second year were almost twice as productive as before burning. They decreased somewhat the third post-fire year, but still produced almost two-thirds more than before burning. Species composition of the forb class was greatly altered by burning. The most dramatic change was the great increase in fireweed *(Epilobium angustifolium)* (Table 1). Prior to burning, this forb comprised only 4% of the total understory production. It increased strikingly the first post-fire year and by the third year averaged 45% of the understory. Fireweed increased most on the heavily burned area where it comprised two-thirds of the total understory the third year. The annual lambsquarter *(Chenopodium fremontii)* also greatly benefited from burning in proportion to burn intensity. Locoweed *(Astragalus miser)*, lupine *(Lupinus* spp.) and Fendler meadowrue *(Thalictrum fendleri)* were apparently harmed by burning.

Table 1. Production (air-dry kg/ha) of major understory species before burning and on the light, moderately, and heavily burned plots the third year following burning. (Data adjusted for initial site differences.)

	Before burning	Light burn	Moderate burn	Heavy burn
	kg/ha			
Achillea lanulosa	14	40	16	14
Agropyron trachycaulum	49	57	136	60
Aquilegia coerulea	56	80	66	12
Astragalus miser	46	14	7	11
Bromus ciliatus	217	267	181	87
Chenopodium fremontii	0	13	16	57
Epilobium angustifolium	68	475	921	1657
Fragaria vesca	108	94	78	51
Frasera speciosa	40	2	103	20
Galium boreale	33	42	31	50
Geranium viscosissimum	297	477	402	255
Lupinus spp.	221	31	23	22
Poa spp.	41	68	107	86
Populus tremuloides	27	25	39	49
Potentilla gracilis	43	41	80	24
Rosa woodsii	53	30	53	16
Symphoricarpos oreophilus	88	9	36	7
Thalictrum fendleri	62	44	13	9
Valeriana occidentalis	3	8	5	13

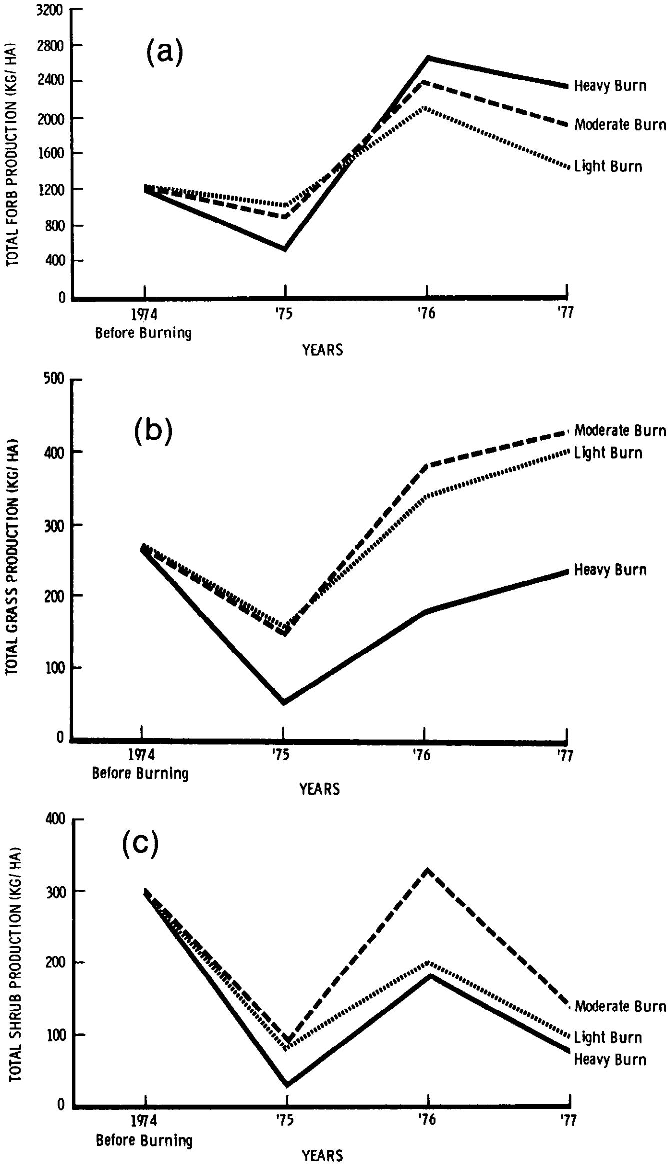

Fig. 5. *Effect of three burn intensities on total forb (a), grass (b), and shrub (c) production for 3 years following burning. (Data have been adjusted for site and weather differences.)*

Initially, the grasses were severely reduced by burning, but quickly recovered on all but the heavily burned areas (Fig. 5b). Grasses produced only half as much the first post-fire year as before burning. The second year, however, they produced approximately one-third more on the light and moderate burns than they did before burning. By the third year, grass production on these areas was almost two-thirds greater than before burning. On heavily burned areas, however, grass production approached pre-burn amounts by the third year. Fringed brome *(Bromus ciliatus)* appeared to be particularly harmed by heavy burning (Table 1).

Before burning, shrubs consisted primarily of wild rose *(Rosa woodsii)* and snowberry *(Symphoricarpos oreophilus)*. Although aspen suckers comprised only about one-seventh of the shrub biomass prior to burning, they formed about one-half in the second and third years. Shrubs were severely harmed by burning. The third post-fire year shrubs averaged only one-third of their before-burning amount (Fig. 5c). An abrupt increase the second year, particularly on the moderately burned areas, was caused by the flush of aspen suckers (Fig. 3). Snowberry appeared to be particularly harmed by burning.

The initial decrease in herbaceous growth the first year following fire and subsequent increase for at least the second and third years is common in a variety of vegetation types. For example, Lyon (1966) found that understory plant cover in the Douglas-fir type of south-central Idaho decreased by at least one-fourth the first year after burning and then increased the second year to almost double that prior to burning. In the sagebrush-grass type of southeastern Idaho, graminoid production the first year after burning was one-third less and forb production one-fourth less than before burning, but by the second and third years production was at least one-third more than before burning (Blaisdell 1953). This increase in herbaceous production in the sagebrush-grass type persisted for at least 12 years (Harniss and Murray 1973) because of the slow reinvasion of the competing overstory of sagebrush which had to reestablish from seed. A prolonged increase in herbaceous production is unlikely in burned aspen communities unless aspen reproduction is suppressed by browsing. Aspen's vegetative mode of reproducing provides for virtually immediate reestablishment. If the suckers are permitted to grow they will compete with and tend to suppress the herbaceous understory.

Understory species composition is expected to gradually revert to pre-burn conditions since fire is a normal, though infrequent, part of the environment of the aspen type. We have yet, however, to determine how long it will be before the pre-burn balance of species is reached. On lightly burned areas where compositional shifts were least, the understory may resemble pre-burn conditions within a decade. Several decades will probably be required for restoration of the understory composition on heavily burned areas.

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