30 Years of Vegetal Change Following Burning of Sagebrush-Grass Range

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Highlight: *A sagebrush-grass range was burned according to plan in 1936. Long-term results show that sagebrush yields have increased while most other important shrub, grass, and forb yields have decreased. Evaluation by subspecies of sagebrush was helpful in interpreting sagebrush behavior. The return of sagebrush shows the need for planning sagebrush control on a continuing basis for maximum forage qualities.*

Fire has been responsible for improving or damaging lands dominated by sagebrush (*Artemisia tridentata*). Haphazard burning and improper grazing practices after burning have resulted in serious deterioration of vegetation and soil; however, planned burning of sagebrush-grass range followed by good grazing practices has resulted in marked improvement of forage yields and availability (Pickford, 1932; Hanson, 1939; Pechanec et al., 1954).

During August 1936, 640 acres of sagebrush-grass range on the Upper Snake River Plains in Clark County near Dubois, Ida., were burned according to plan. Blaisdell (1953) discussed the ecological changes in vegetation and soil on this range 12 years after burning. The purpose of this paper is to report on important vegetation changes that have occurred since 1948. In doing so, it is necessary that we also report on some of the changes that have occurred since data were collected before burning in 1936.

Methods and Procedures

Four hundred permanent 100 ft^2 weight-estimate plots (Pechanec and Pickford, 1937) were located on a grid pattern before the burn in 1936. After the burn, the range was given complete protection for one full year. Since then, sheep have grazed this range in the spring and fall, at a rate of about 2 acres per sheep month, except for 1948 and 1966, when grazing was limited to the fall months only.

The plots were separated into classes—unburned and lightly, moderately, and heavily burned. Weight-estimate data were collected on all species before the burn in 1936, as well as after the burn in 1937, 1939, 1948, and 1966. In addition, big sagebrush plants were counted in 1948 and 1966.

Blaisdell's (1953) analysis was based on differences in yields from the four classes into which the study plots had been grouped. We found that by 1966 the differences among the burned plots were negligible; consequently, we combined yield data from the three burned classes in making our analysis. Moreover, Blaisdell's analysis was based on data taken from 268 plots, but we resampled only 93 plots in our analysis because a portion of the burn had been sprayed with 2,4-D in 1961.

Before treatment the herbage production naturally differs between burned and unburned areas and from year to year. To account for these inherent variations, we used relative instead of absolute values. The relative value was calculated in two steps:

1) A preliminary value (V) was computed for the air-dry production (P) of a species for each year (y):

$$Vy = Py \text{ on burned}/Py \text{ on unburned}$$

2) The final relative value (RV) was then computed for each species each year (1937, 1939, 1948, and 1966):

$$RVy = (Vy/Vy_{1936}) \times 100$$

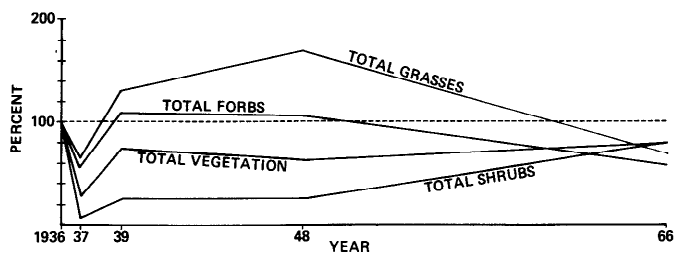

Fig. 1. *Trends of species classes on a planned burn near Dubois, Ida., 1936–1966. Values on burned plots are adjusted for the natural variation between years.*

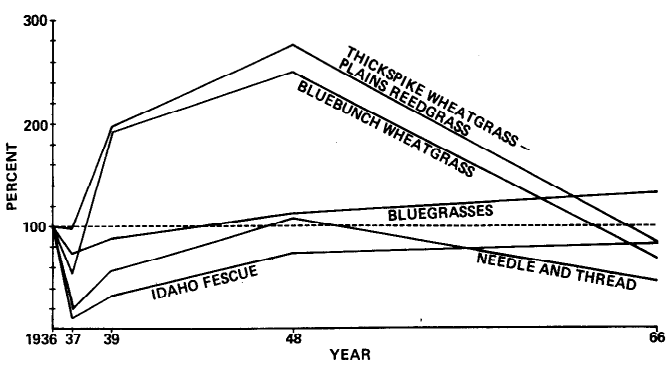

Fig. 2. *Trends of important grass species on a planned burn near Dubois, Ida., 1936–1966. Values are adjusted for the natural variation (a) between burned and unburned plots and (b) between years.*

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Table 1. Comparison of annual herbage production (lb/acre, air-dry) on unburned (UB) and burned (B) areas for 5 selected years following burning during 1936.

Species	1936		1937		1939		1948		1966	
	UB	B	UB	B	UB	B	UB	B	UB	B
Shrubs										
Big sagebrush (*Artemisia tridentata* ssp. *vaseyana*)	187	178	398	2	358	3	611	22	334	286
Rabbitbrush (*Chrysothamnus viscidiflorus*)	14	43	18	26	14	70	11	92	9	10
Horsebrush (*Tetradymia canescens*)	12	33	12	10	8	38	8	70	8	36
Other shrubs	1	2	1	0	0	0	2	1	10	6
Total	214	256	429	38	380	111	632	185	361	338
Grasses										
Thickspike wheatgrass-plains reedgrass (*Agropyron dasystachyum-Calamagrostis montanensis*)	87	63	117	81	175	249	90	179	152	92
Bluebunch wheatgrass (*Agropyron spicatum*)	18	32	30	29	32	106	8	36	13	15
Idaho fescue (*Festuca idahoensis*)	6	6	23	3	51	17	37	29	6	5
Bluegrasses (*Poa secunda* and *P. nevadensis*)	7	10	12	12	33	39	58	88	8	15
Other grasses	13	23	26	14	44	37	19	32	23	17
Total	131	134	208	139	335	448	212	364	202	144
Forbs										
Perennial forbs	9	17	32	35	41	85	70	142	66	72
Annual forbs	19	26	1	1	1	1	26	2	2	1
Total	28	43	33	36	42	86	96	144	68	73
Total vegetation	373	433	670	213	757	645	940	693	631	555

The first step is an attempt to account for the year-to-year fluctuation in vegetation yield by using the unburned-yield data each year as an expression of the variation resulting from different precipitation and temperature patterns. The second step adjusts the data so that species originate from a common base.

Results

The trends shown for the period 1936 to 1948, which are based on our analysis, are similar to those reported by Blaisdell (1953), even though we used only 93 plots (Figs. 1 to 3). These trends show only the general direction of change and do not show peak production years or rates of change.

Many trends reported by Blaisdell following planned burning were reversed during the period 1948 to 1966, as shown in Figures 1 to 3 and Table 1. Yields of "total grasses" and "total forbs" were higher in 1948 on the burned plots than on the unburned plots, but lower in 1966 (Fig. 1). In contrast, the "total shrub" yield was lower in 1948 on the burned plots, but nearly similar on the burned and unburned plots in 1966. In 1966, "total vegetation" yield on the burned plots appeared to be slightly lower than the preburn yield of 1936 when compared to the yield from the unburned plots. Figure 4 shows pictorially some changes that occurred on one of the burned plots from 1936 to 1966.

Yields of the most abundant grasses—thickspike wheatgrass, plains reedgrass, and bluebunch wheatgrass—were lower on the burned plots in 1966 than in 1948, but similar to the yields of these species before the burn in 1936 (Fig. 2).[1] Yields of Idaho fescue and bluegrass were similar in 1966 and 1936.

The number of forb species as well as their yields increased since 1936 on both burned and unburned plots. However, lupine yields were higher on the heavily burned plots, especially in 1948 and 1966. The increase in the number of forb species probably is related to this area's history of use. Before 1936, the area was used as lambing range, which resulted in heavy utilization of forbs, and possibly, a decrease

Table 2. Density of sagebrush in 1948 and 1966 (average number of plants per 100-ft² plot).

Height class	1948		1966	
	Unburned	Burned	Unburned	Burned
Seedling	2.8	.3	5.1	1.2
Under 6 inches	5.5	2.7	13.2	23.9
Mature	17.4	.7	22.7	9.2
Total	25.7	3.7	41.0	34.3

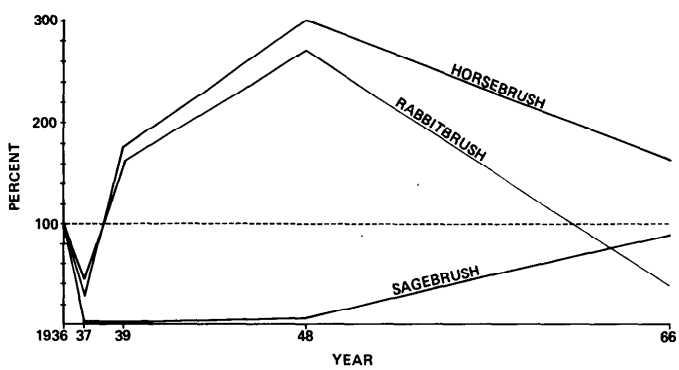

Fig. 3. *Trend of important shrub species on a planned burn area near Dubois, Ida., 1936–1966. Values are adjusted for the natural variation (a) between burned and unburned plots and (b) between years.*

[1] For scientific names, see Table 1. Also, yields of thickspike wheatgrass and plains reedgrass were grouped to allow rapid field identification.

in the number of species. Since 1936, moderate grazing use later in the season probably contributed to the increased numbers and yields of forb species.

In 1966, sagebrush yields were about the same on the burned and unburned plots, although in 1948 these yields were much lower on the burned plots than they were on the unburned plots (Fig. 3). Conversely, in 1948, yields of rabbitbrush and horsebrush were much higher on the burned plots than on the unburned plots; this shows the stimulating effects of burning. However, in 1966, the yield of rabbitbrush was lower than in 1948 on the burned plots. The yield of horsebrush was also lower on the burned plots in 1966 (nearly similar to the preburn yield) than in 1948. In 1936, bitterbrush (*Purshia tridentata*) occurred only on the heavily burned plots; by 1948, small amounts had appeared on the unburned plots as well. However, by 1966 bitterbrush had appeared on plots in the other two classes. This increase might be related to the area's history of use or to weather factors

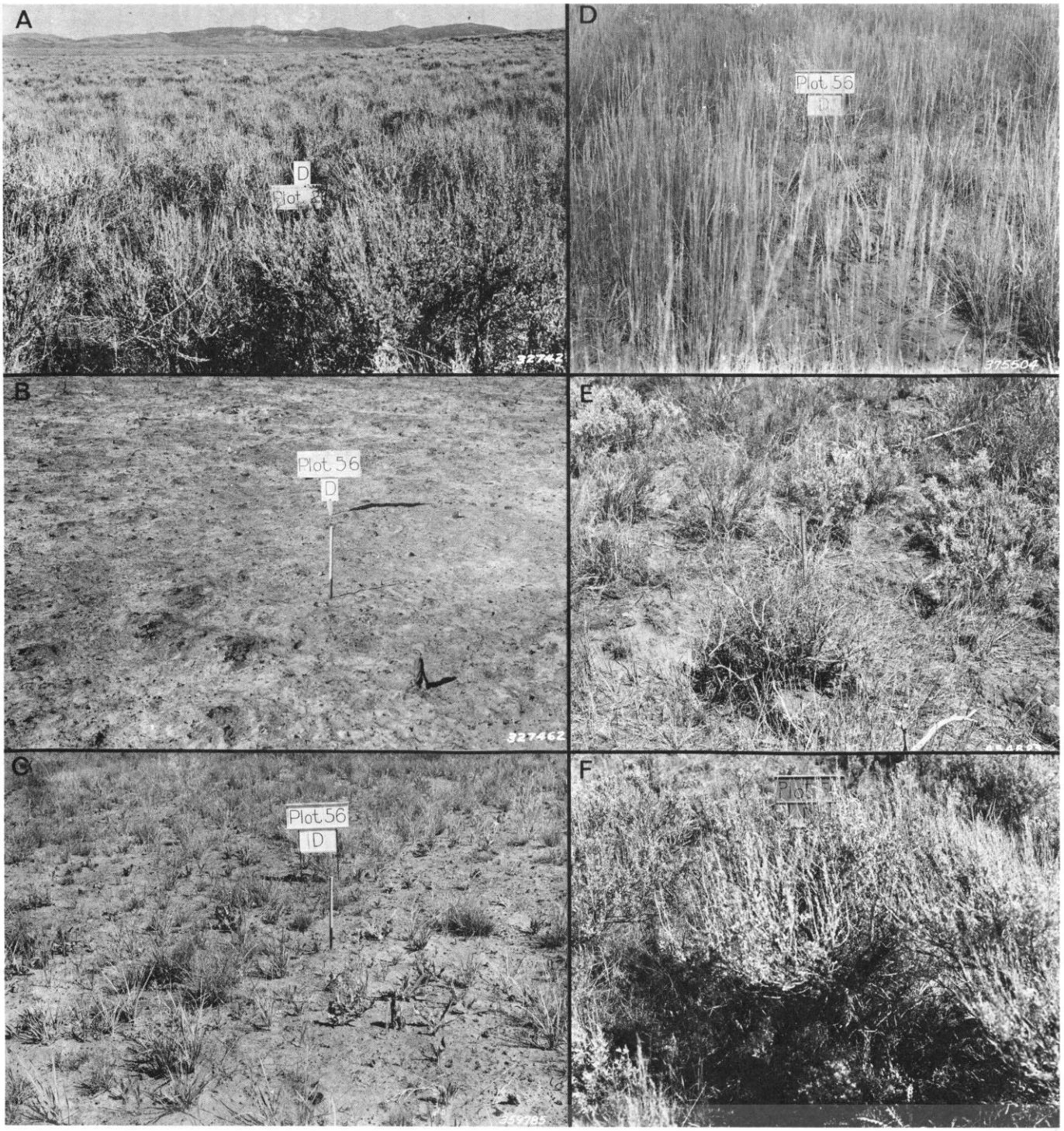

Fig. 4. *Plot depicting vegetation changes in sagebrush-grass range after a planned burn: (a) 1936 (before burning), sagebrush cover extremely dense, grass and forbs unavailable for grazing; (b) 1936 (after burning), complete removal of sagebrush-grass vegetation; (c) 1937, return of forbs and grasses with little brush apparent; (d) 1938, excellent grass and forbs stand with little brush apparent; (e) 1948, grass and forbs readily available to grazing intermixed with a few shrubs; (f) 1966, return of dense sagebrush cover and unavailable understory of grass and forbs.*

that allowed the invasion of a thick sagebrush stand.

The recovery of sagebrush is reflected by the increase in the average number of plants per plot. In 1948, the average number of sagebrush plants on the burned plots (3.7) was only about 14% of the average number of plants on the unburned plots (25.7). By 1966, the average number of plants on the burned plots (34.3) had increased to about 83% of the average number of plants on the unburned plots (41.0).

As shown in Table 2, the unburned plots had the highest number of mature sagebrush plants in both 1948 and 1966. The burned plots had the highest number of plants in the "under 6-inch" class, especially in 1966. These differences indicate that the plant community is not climax on the burned plots.

Discussion

Vegetation trends through 1966 show the overwhelmingly dominant role of big sagebrush on this sagebrush-grass range near Dubois, Ida. Almost all important species of shrubs, grasses, and forbs decreased in yield from 1948 to 1966 as the big sagebrush recovered its dominance after the burn.

The ability of the sagebrush to reinvade the vigorous grass stand that became dominant following the burn was not unexpected; however, the magnitude of the reinvasion was surprising. Frischknecht (1968) indicated that in wet years sagebrush will invade grazed or ungrazed stands of crested wheatgrass (*Agropyron cristatum*). Similarly, Johnsen (1962) reported that one-seed juniper (*Juniperus monosperma*) has invaded dense grass stands. These reports indicate that during wet years the competition for moisture may be reduced enough to allow sagebrush and juniper to become established. However, Beetle (1960) suggested (a) grasses may kill sagebrush seedlings by shading them and (b) drought reduces the grasses, thus permitting sagebrush to become established.

Once established, sagebrush must compete directly for soil moisture and nutrients with most other species in the community. Apparently, sagebrush must also use soil water and nutrients that are not utilized or are not available to these other species, because maximum vegetation yields result when sagebrush is present (Fig. 1, Table 1). Other studies have shown similar results (Blaisdell, 1949, 1953; Mueggler and Blaisdell, 1958). Our observations indicate sagebrush root depths are deeper than grasses' on mature stands; thus, sagebrush would have access to soil water and nutrients unavailable to grasses.

The climax vegetation of the Snake River Plains had been pictured as a grassland by Weaver and Clements (1938). More recently, however, it has been pictured as a vigorous stand of perennial grasses and forbs interspersed with sagebrush and miscellaneous shrubs (Pechanec, 1941; Daubenmire, 1952; Blaisdell, 1953). Tisdale et al. (1969) concluded that the sagebrush type or various successional types cover nearly the same geographic areas that they did before they were extensively grazed by livestock. The recent recognition of sagebrush subspecies (Beetle, 1960; Beetle and Young, 1965) within the *Artemisia tridentata* complex has led to more intensive examination of habitat types that are separated by the subspecies of sagebrush (Tisdale et al., 1969; Winward, 1970; Marchand, 1964).

The sagebrush on the Dubois study site is within the *Artemisia tridentata* subspecies *vaseyana* habitat type. In his study of the taxonomy and ecology of big sagebrush, Winward (1970) found (a) the *vaseyana* subspecies tended to become dense on both sprayed and burned areas, and (b) control of sagebrush is desirable to insure forage production and better animal distribution. He suggested that the need for sagebrush control should be evaluated by subspecies and/or by habitat type.

Our findings support Winward's (1970) views for evaluating sagebrush by subspecies. From observation, sagebrush in the *vaseyana* habitat type sometimes reinvades an area immediately following a burn; so control benefits do not always exist as long as they have on the 1936 burn. The length of time between control measures depends on grazing practices and the undefined weather variables that favor sagebrush seedling survival and establishment. Seed production before control may also be a factor in rate of reinvasion.

Apparently, sagebrush control measures should be applied before the community climax because our findings with regard to plant size showed that the community is not climax on the burned plots.

Although our studies showed that good grazing management will not prevent sagebrush reinvasion, Pechanec et al. (1954) showed that heavy grazing and haphazard burning will accelerate such reinvasion, as well as soil erosion and loss of desirable forage plants. The reestablishment of sagebrush to the detriment of forage and livestock qualities indicates the need for planning sagebrush control measures on a continuing basis, at least in the *Artemisia tridentata* subspecies *vaseyana* habitat type.

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