Effects of Prescribed Burning in Ponderosa Pine[1]

Harold Weaver[2]
Portland, Oregon

PRESCRIBED burning has resulted in significant reduction in fire hazard and in silvicultural benefit in ponderosa pine stands on the Colville Indian Reservation in north-central Washington. It has been applied as part of a management system, in conjunction with slash disposal on logged-over lands. Hazard reduction is proved by comparative records of area burned, damage and cost of control from wild fires that have burned inside of and outside of treated areas over the past eleven years. Silvicultural benefits are evident from observation over the years. Photographic evidence supports such conclusions.

Prescribed burning as a thinning agent in dense ponderosa pine (*Pinus ponderosa*) reproduction stands was first tested on the Colville in October 1942. Fifth acre sample plots established in the treated area at that time, together with similar check plots on adjacent untreated areas, have been studied by the Pacific Northwest Forest and Range Experiment Station. In a preliminary report from 1949 data (*2*), the Station indicated that the burning was effective in reducing number of stems in dense thickets from 2,430 to 690 per acre. Results, however, were not uniform. Some patches were thinned too severely and others not enough. Crop trees within the treated area showed considerable increased diameter growth start when compared with crop trees from adjacent untreated areas. It was concluded that the method needs further systematic test and study of results, since it may afford a cheap, quick, wholesale method of obtaining desirable stand improvement. Studies have been continued on this area and another reproduction area burned in cooperation with the Station in 1952. It is understood that results will soon be reported on in considerable detail.

Prescribed burning techniques were utilized in spot burning of unpiled logging slash and in burning of tractor piled slash subsequent to 1942, during war and post-war years. I have already described in detail these operations that were conducted primarily for hazard reduction (*3-7* inc.). To aid in an understanding of results with which this report is concerned, it is appropriate that stand conditions and burning techniques again be briefly described.

Stand Conditions

The burning was conducted in selectively cut-over stands on extensive slash areas on several widely separated timber sale units. Mature and over-mature age classes predominated before cutting, though merchantable immature and large pole class groups were well represented. Cut per acre averaged 6,000 to 6,500 feet, board measure, with ponderosa pine comprising 75 to 90 percent of the total. Reserve stand volume averaged 3,000 board feet per acre. In Twenty Three Mile Creek Valley in the central portion of the Reservation, however, an extensive even-aged thrifty-mature ponderosa pine reserve stand averaged over 6,000 board feet per acre. Douglas-fir (*Pseudotsuga menziesii*) and western larch (*Larix occidentalis*), the most common associate species, become predominant on steeper north slopes and at elevations above 4,000 feet.

Recurrent fires have swept this forest for many centuries, the most recent extensive burns occurring in 1917, 1920, and 1926. From a fire-scarred stump section, cut on the Omak Lake Ridge in the western portion of the forest, it was found that during the period 1740 to 1920, inclusive, there was an average of one fire every eight years. Similar fire records abound over the forest.

Reproduction, before burning, was almost uniformly abundant, except on some of the areas of heavy pinegrass. Most of the openings were occupied by dense sapling and small pole size reproduction, laced by numerous pitchy, highly inflammable windfalls and snags of beetle killed trees. At lower elevations many of these reproduction groups were so dense that growth was stagnated. Douglas-fir reproduction evidenced a tendency to predominate in seedling and sapling size classes on Omak Lake Ridge, Twenty Three Mile Valley and other areas of higher elevation, between 3,000 and 4,000 feet above sea level. Poles of this species also monopolized many openings.

The Burning Operations

Prescribed burning techniques were applied in logging slash disposal because war time shortage of man-power in the woods rendered impossible hand piling and burning required by Bureau of Indian Affairs regulations. By 1943 growing expanses of unpiled logging slash together with impossibility of providing intensified protection were matters of grave

[1]This article represents the author's views and is not to be regarded as an official expression of the attitude of the Bureau of Indian Affairs on the subject discussed.

[2]The writer is indebted to Fred Rickard, forester in charge of Fire Control on the Colville Reservation and to Mrs. Betty Chin, stenographer, for time consuming and exacting computation of comparative fire data presented in Table 1, and to the Pacific Northwest Forest and Range Experiment Station for testing statistical significance of the data.

FIG. 1.—Fast growing pole stand in center and right background has fully recovered from hot slash fire during the night of October 5-6, 1943, on south slope Omak Lake Ridge. Denser portion of ponderosa pine reproduction is growing on an old logging spur.

concern to foresters responsible for protection of the Colville Indian forest. Success with the 1942 burning encouraged us to attempt reduction of extreme hazard by spot burning, despite the fact that this had always been considered inapplicable to selectively cut ponderosa pine stands.

Twenty Three Mile Valley appeared ideal for the test for ground was almost level or sloped gently and crowns of the reserve stand appeared sufficiently high to escape flames should burning be conducted under favorable conditions. Also it was hoped that burning would encourage future establishment of ponderosa pine reproduction. Successful burning of several hundred acres of slash in late September 1943, encouraged night time burning of 700 acres on the south slope of Omak Lake Ridge later during October. This area had a heavy grass ground cover, without much small advance reproduction. However, there were numerous fine groups of large ponderosa pine poles.

Here the first block of 200 acres was burned at night, just before an anticipated rain. The rain failed to materialize and instead a high wind developed. This, together with our mistake in permitting too many torch men to set fires, caused the fire to become wild and it was feared that severe damage had been caused, particularly to the poles. Daylight disclosed, however, that damage was not nearly as severe as anticipated. Most of the poles survived and now are making excellent growth (Fig. 1). The remaining two blocks were subsequently burned without particular difficulty.

During the summer of 1944 the Biles-Coleman Lumber Company perfected tractor piling of slash and with a Caterpillar D-4 tractor piled between 6 and 7 million board feet of slash on about 1,000 acres on the Omak I ake Ridge. This was burned during a light rain storm in late September. Subsequent to the rain nights were frosty and days sunny, but cool and quiet. Under such ideal conditions spot burning of unpiled slash continued until late October, by which time an additional volume of 33 million board feet had been burned on 5,300 acres.

During subsequent years most of the slash was piled by tractor before burning. Spot burning still continued on rocky areas and steep slopes where tractors could not maneuver. In more recent years, slash on such areas has been hand piled.

In applying prescribed burning techniques in disposal of slash the burning crews as they advanced fired accumulations of dead needles, dry grass, windfalls lacing dense reproduction patches, and dead snags, as well as tractor piles and unpiled slash. This was accomplished during favorable periods following first rain storms of autumn or following melting of snow in springtime. If weather turned drier and hotter following burning, creeping fires usually covered most of the ground surface but seldom caused blowups in reproduction patches because heavy fuel had already been burned. Burning always started on ridge tops from logging spurs, skid trails or bulldozed lines, which were utilized to confine the fire to areas designated, and through firing of successive strips proceeded thence down the slopes. Never were fires intentionally permitted to burn up the slopes.

Besides hazard reduction it was hoped that silvicultural benefit would result, through improved growth following thinning of dense reproduction patches and improved seed bed conditions favoring establishment of ponderosa pine reproduction on heavily grassed areas and on areas being taken over by Douglas-fir. Partial destruction of latter species was also considered desirable. Since fire has been an important ecological factor in the ponderosa pine region it was believed that its application under favorable conditions would not cause excessive soil damage or erosion.

Results and Discussion

Effectiveness of prescribed burning in reducing wildlife acreage burned, damage, and cost of control is indicated by data summarized in Table 1. It will be

TABLE 1.—EFFECT OF PRESCRIBED BURNING ON SUBSEQUENT WILDFIRE CONTROL, COLVILLE INDIAN RESERVATION, WASHINGTON

Year	Area type	Number acres	Number fires	Acres burned	Damage	Cost of control	Average per fire: Acres burned	Damage	Cost control	Average per 10,000 acres protected: No. fires	No. acres burned	Damage	Cost control
					Dollars	*Dollars*		*Dollars*	*Dollars*			*Dollars*	*Dollars*
1945	Untreated	1,028,220	33	1,491	2,862	9,125	45.18	86.73	276.52	.321	14.501	27.83	88.75
	Treated	13,780	0	0	0	0	0	0	0	0	0	0	0
1946	Untreated	1,022,530	17	267	450	5,830	15.71	26.47	342.94	.166	2.611	4.40	57.02
	Treated	19,470	1	2	9	9	2.00	9.00	9.00	.514	1.027	4.62	4.62
1947	Untreated	1,012,790	81	1,923	2,957	20,045	23.74	36.51	247.47	.800	18.987	29.20	197.92
	Treated	29,210	8	23	68	208	2.88	8.50	26.00	2.739	7.874	23.28	71.21
1948	Untreated	1,002,370	8	4	24	234	.50	3.00	29.25	.080	.040	.24	2.33
	Treated	39,630	2	0	0	33	0	0	16.50	.505	0	0	8.33
1949	Untreated	996,030	90	8,725	6,902	38,238	96.94	76.69	424.87	.904	87.598	69.30	383.90
	Treated	45,970	5	62	35	356	12.40	7.00	71.20	1.088	13.487	7.61	77.44
1950	Untreated	985,250	21	71	47	2,228	3.38	2.24	106.10	.213	.721	.48	22.61
	Treated	56,750	1	0	0	6	0	0	6.00	.176	0	0	1.06
1951	Untreated	974,010	31	502	6,238	5,760	16.19	201.23	185.81	.318	5.154	64.04	59.14
	Treated	67,990	5	1	0	93	.20	0	18.60	.735	.147	0	13.68
1952	Untreated	956,510	29	64	7,764	2,855	2.21	267.72	98.45	.303	.669	81.17	29.85
	Treated	85,490	3	0	0	58	0	0	19.33	.351	0	0	6.78
1953	Untreated	945,510	108	1,203	5,947	19,191	11.14	55.06	177.69	1.142	12.723	62.90	202.96
	Treated	96,490	30	111	150	1,851	3.70	5.00	61.70	3.109	11.504	15.55	191.83
1954	Untreated	938,470	14	74	271	1,078	5.29	19.36	77.00	.149	.789	2.89	11.49
	Treated	103,530	2	2	0	133	1.00	0	66.50	.193	.193	0	12.85
1955	Untreated	915,420	50	32	80	3,170	.64	1.60	63.40	.546	.350	.87	34.63
	Treated	126,580	10	1	5	367	.10	.50	36.70	.790	.079	.40	28.99
Totals & Averages													
	Untreated	10,777,110	482	14,352	33,542	107,754	29.78	69.59	223.56	.447	13.321	31.12	99.98
	Treated	684,890	67	202	267	3,114	3.01	3.98	46.48	.978	2.949	3.90	45.47
Percent reduction or increase—Treated compared to Untreated							89.89%	94.28%	79.21%	218.79%	77.86%	87.47%	54.52%

noted that following the fire season of 1945, the first year in which there was available a substantial acreage treated by prescribed burning, the "No. Acres" column is cumulative. For each year there is added number of acres treated during the fall and spring immediately preceding the fire season, with untreated acreage adjusted downward accordingly. Maps showing for each year total areas treated to date were compared with yearly fire occurrence maps. From such comparison and analysis of individual fire reports there are summarized for each fire season, by treated and untreated category, number of fires, number of acres burned, damage in dollars, and cost of control. Non-timbered acreages burned are excluded.

From comparison of data from treated with untreated areas summarized in Table 1 prescribed burning has resulted in the following reductions on an average per fire basis: No. acres burned—89.89 percent; damage—94.28 percent; cost of control—79.21 percent.

On an "Average per 10,000 acres protected" basis over twice as many fires occurred on treated areas in comparison with untreated areas. This difference was not statistically significant. Of the total of 67 fires reported on treated areas 6 were man-caused, while 61 were from lightning strikes, principally on Omak Lake Ridge, Whitmore Mountain, and slopes of Keller Butte. From past experience lightning storms have usually caused a concentration of fires on these particular ridges and mountains. It therefore is apparent that under treated category are included areas where lightning fires are most apt to start. Improved access over logging roads may also be a factor resulting in more man-caused fires. Another factor of significance may be the fact that between 200 and 300 thousand acres of high altitude Douglas-fir —western larch, lodgepole pine, and subalpine types are included under the untreated category. During the past 15 year period ground cover in these types has remained green and damp during most of the fire seasons.

On an "Average per 10,000 acres protected" basis, the number of acres burned has been reduced by 77.86 percent. This reduction was not statistically significant. The treatment reduced damage by 87.47 percent and cost of control by 54.52 percent. These results were statistically significant at the five percent level of fiducial probability.

Treatment of the total 126,580 acres has involved disposal of approximately 700 million board feet of slash at a total estimated cost of $700,000. Cost of slash disposal is properly chargeable to cost of logging and is included as such in Bureau of Indian Affairs stumpage appraisals. It is impossible to segregate the portion of the above total cost that should be charged against the intensified prescribed burning method. Data available from war time operations indicate that its application in conjunction with spot burning of slash resulted in considerable savings in slash disposal cost.

It is impossible to predict what might have happened had no slash disposal or intensive treatment been practiced. The following experience is indicative of what could have happened. On the night of August 15 and 16, 1953, dry lightning storms started 90 fires on the Colville Reservation. One fire in logging slash was extremely difficult to control before it burned over 580 acres. Cost of control was

FIG. 2.—Clump of ponderosa pine reproduction on ash and dirt mound where tractor-piled slash was burned on Omak Lake Ridge in spring of 1946. Most severely burned spots are now stocked with reproduction as depicted in this June 1955 photo.

$6,407 and damage was estimated at $3,805. Because of shortage of man power and urgency of controlling other more dangerous fires, no action was taken until evening of the 16th on two fires burning largely on selectively logged land given intensive prescribed burning and slash disposal during the war. Ground cover consisted of perennial grass, with reproduction patches. These fires were easily controlled at combined cost of $1,527. These two fires accounted for the major portion of the 111 timbered acres burned and $150 damage reported on treated areas for 1953 in Table 1.

Had considerable expanses of slash been available for the August 1953 fires to burn through, my experience leads me to believe that damage and cost of control could conceivably have approached or exceeded the total cost of slash disposal.

During war years when it was considered that the slash situation was threatening, we were always dealing, in burning operations, with slash from one to several years old. Logging spurs and skid trails, though serving as excellent fire lines, also made it necessary in the interior of the various burning blocks to set many fires in order to approximate 100 percent coverage. Prescribed burning in ponderosa pine should be applied one year before logging, preferably during the previous fall. Under favorable conditions, it can be applied by experienced men at a cost of but a few cents per acre. During logging, occasional previously fire scarred trees that have burned down can, of course, be salvaged. As nearly as feasible, in felling green trees, extra care can be exercised to keep felled tops away from reserved trees and pole groups. Following log-skidding, piling-tractors can push slash away from close proximity of any trees that might be damaged by fire. The slash can then be disposed of in whole or in part by spot burning with but minimum effort necessary to prevent fires spreading into adjacent areas. Under such procedure and under conditions similar to Colville conditions effective slash disposal and hazard reduction can be obtained at very reasonable cost.

Though we have no verifying statistics or data for analysis or presentation, in my opinion prescribed burning yields important silvicultural benefits. These are indicated by observation and corroborated by photographic evidence.

Results of thinning dense reproduction are spotty, some patches being thinned too severely and others not enough, as described for the 1942 prescribed burning operation. On the average, however, it may be considered that thinning is conservative. A report on the 1942 operation, soon to be completed by the Pacific Northwest Forest and Range Experiment Station, should be indicative of growth improvement resulting from such thinning.

In discussing possibilities of prescribed burning much ado is sometimes made over "damage to the soil," despite countless centuries of exposure of soils in the ponderosa pine region to periodic burning. In some instances it appears there are anticipated results similar to those attributable to devastating wild fires such as have recently burned in Southern Oregon, in California, and the Southwest. A study by soil chemists of the University of Arizona of effect of burning on certain soils of Northern Arizona seems to indicate that complete destruction of the duff covering the forest floor can be taken as a criterion of damage of soil (*1*). On the Colville, severely burned spots occupy but a small percentage of the total area and are confined principally to spots where slash piles burned and immediately adjacent to windfalls and other pieces of heavy fuel that burned with considerable heat.

There must be compensating benefits for the severely burned spots, particularly at higher elevations, now support vigorous, fast growing clumps of ponderosa pine reproduction (Figs. 2, 5 & 6). This has enabled establishment of ponderosa pine reproduction on heavily grassed areas and on areas formerly dominated by seedlings and saplings of Douglas-fir. Many of the latter were killed by creeping ground fires. Thus prescribed burning has aided greatly in at-

FIG. 3.—Ponderosa pine seedlings are beginning to overtop the heavy pine grass in this July 1947 photo in Twenty Three Mile Valley, where slash was burned in September 1943. Note remnant groups of Douglas-fir reproduction, which would have continued to dominate the understory in absence of fire.

FIG. 4.—June 1955 photo of scene in Figure 3. Note development of ponderosa pine reproduction, which now dominates understory.

taining the result most desired in silvicultural practice, namely perpetuation of the most valuable species.

The grassy broad summit areas of the Omak Lake Ridge, the rolling expanses of Twenty Three Mile Valley and mountains above Hall Creek now support vigorous reproduction stands that are dominated by ponderosa pine (Figs. 3 to 7 inc.). Windfalls, snags and other heavy debris have largely been disposed of and fires are easy to control. These beautiful areas may be compared with slash strewn, windfall laced jungles of Douglas-fir, white fir, or incense cedar reproduction and brush that can now be observed comprising the understory in portions of the untreated ponderosa pine region.

Conclusions

Prescribed burning techniques applied in connection with spot burning and burning of tractor

FIG. 5.—July 1947 photo of ponderosa pine seedlings in severely burned spot resulting from slash fire of September 1943 in Twenty Three Mile Valley.

FIG. 6.—June 1955 photo of scene in Figure 5. Note development of ponderosa pine reproduction over past eight years. This is typical of the areas intensively treated by prescribed burning.

FIG. 7.—Excellent ponderosa pine reproduction on north slope near summit of Omak Lake Ridge, where heavy slash was burned in October 1944. Without treatment it is believed Douglas-fir would now predominate. Photo in June 1955.

piled slash on the Colville Indian forest have resulted in a significant reduction in damage and cost of control. It also has resulted in silvicultural benefit. On an average fire basis, in comparison with surrounding untreated areas, number of acres burned has been reduced by 89.89 percent; damage by 94.28 percent, and cost of control by 79.31 percent. On an average per 10,000 acre protected basis, again comparing with untreated areas, there have been over twice as many fires. This is due largely to the fact that areas of highest lightning fire incidence are included. Despite higher fire incidence number of acres burned have been reduced by 77.86 percent; damage by 87.47 percent, and cost of control by 54. 52 percent.

Dense reproduction thinning has been spotty, though generally on the conservative side, and has resulted from burning of windfalls and snags that formerly laced these thickets.

Complete removal of duff, which apparently may be taken as the criterion of damage to soil, was confined to a small percentage of total area burned, particularly on spots where slash piles, windfalls, snags or other heavy fuel burned with considerable heat. Vigorous groups of ponderosa pine reproduction now occupy those spots. At higher elevations of considerable expanse more favorable seed bed conditions resulting from the burning have enabled ponderosa pine reproduction to largely supplant that of Douglas-fir, which in continued absence of fire had been capturing the ground.

This is a presentation of a management system—not just prescribed burning. This forest type can be logged and with prescribed burning combined with slash disposal, the fire problems can be greatly reduced. At the same time vigorous ponderosa pine reproduction can be encouraged through control of ground cover and preparation of favorable seed beds.

Results on the areas treated by prescribed burning on the Colville Reservation should be studied by research foresters interested in protection and silviculture for similar treatment should benefit other portions of the ponderosa pine region, particularly areas where ground is being captured by reproduction of inferior associate species instead of by ponderosa pine. To enable application of such treatment a methodology of prescribed burning should be developed, for protection, regeneration, and continued development of ponderosa pine is dependent to a considerable extent on use of fire under proper control.

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