Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

1.9622
I2R312

Research Note

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION

OGDEN UTAH

No. 66

May 1959

EFFECTS OF A WILDFIRE ON MORTALITY AND GROWTH OF YOUNG PONDEROSA PINE TREES^{1/}

Donald W. Lynch^{2/}
Division of Forest Management Research

Despite the present significant accomplishments in fire prevention, wild-fires do occasionally burn through valuable young stands of ponderosa pine timber. Prescribed burning, too, is sometimes practiced in order to reduce fire hazards, to eliminate logging slash, or to thin young stands. Whether the fire is accidental or planned, foresters should be able to appraise its effects on future mortality and growth. Few fires, even those that burn out of control, kill every tree in the stand. Damage ranges from a mild scorching of the lower branches on some trees to a complete crown burning and severe bole injury on others.

Ponderosa pine usually is classed as a relatively fire-resistant species. Flint (1) as early as 1925 evaluated fire resistance of northern Rocky Mountain conifers on the basis of bark thickness, root habit, resin content of bark, branching habit, stand habit, and relative inflammability of foliage. He classed ponderosa pine second only to western larch in fire resistance on the basis of all these characteristics. Starker (4) listed ponderosa pine third on his list of fire-resistant trees of the Pacific Northwest; he ranked western larch and Douglas-fir first and second, respectively.

A study of fire damage in a ponderosa pine forest in Arizona (2) showed close correlation between mortality and length of live crown destroyed in poles and mature timber. No trees that had 50 percent or less of their crown burned were dead 16 months after the fire. Where more than 60 percent of the crown was killed, 64 percent of the trees were dead; and where 80 percent and more of the crown was killed by the fire, 80 percent of the trees died. Other

^{1/} Grateful acknowledgment is made to Henry Wershing, formerly Forest Supervisor, Colville Indian Agency, for helping in the establishment, photographing, and subsequent observation of the study plot.

^{2/} Forester, Intermountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Research Center at Boise, Idaho.

factors correlated with tree mortality were turpentine beetle attacks following the fire and intensity of the fire itself as measured by surface conditions around individual trees.

Wegener's (6) extensive studies of mortality following fire in mature ponderosa and Jeffrey pines showed several definite conclusions. He found that trees were most vulnerable to fire injury during the active spring growth period when terminal shoots and buds are tender. He determined that mortality of ponderosa and Jeffrey pines is more closely correlated with bud kill than with foliage kill. Fires that occur late in the season, after buds have formed and hardened, often kill foliage but do not kill buds. If 50 percent of the buds are uninjured, the tree is likely to survive. Wegener further concluded that vigor of individual trees was an important factor in determining survival following fire as well as determining disposition to insect attack.

All the four studies cited above were made on large trees--principally sawlog material--with the view of aiding in salvage cutting operations. The same important questions apply to young stands. Just how much fire can a young ponderosa pine tree withstand and still live? How much increment will be lost from scorched trees? How soon will they recover?

Answers to some of these questions were sought on an area on the Colville Indian Reservation, Washington, that supported a 30- to 40-year-old stand of ponderosa pine that was burned by a wildfire in July 1949. In September following the fire 200 trees were selected for observation and study; they ranged in diameter from 2 to 12 inches (only a few of the trees were larger than 7 inches d.b.h.); the variation in burning damage was from "little" to 100 percent crown scorching. Diameter, heights, and crown classes were recorded, and the trees were tagged. Injury was evaluated on the basis of the percentage of crown killed, and the 200 trees were grouped into eight damage classes by percentages, as follows: 0-24, 25-49, 50-59, 60-69, 70-79, 80-89, 90-94, and 95-100. At the time of the first observations the scorched needles, dried to a bright yellow color, were still retained on the trees. The extent of crown injury was readily apparent (fig. 1).

Tree mortality was observed and recorded in the fall of 1950 and 1951, 1 and 2 years after the fire. In 1957, 8 years following the fire, a final check was made on mortality, and diameters and heights were remeasured.^{3/}

^{3/} Raymond J. Boyd and Albert R. Stage, foresters, Intermountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Research Center, Spokane, Wash., made final measurements for this study.

Figure 1.--Crown injury in a 30- to 40-year-old stand of ponderosa pine 2 months after a fire.

RESULTS

Mortality

First-year mortality was closely correlated with crown injury. Considering all size classes together, every tree died that had been burned 95 to 100 percent, but only 73 percent of the trees died in the 90 to 94 percent class. Only 32 percent of the 80 to 89 percent class died; and of those trees burned 79 percent or less, only zero to 17 percent died (fig. 2).

For nearly every given degree of crown injury more small trees died than large trees; but when injury was very severe (greater than 95 percent) all died. Fifty percent of the 2-inch trees died when crown injury was only 50 percent, yet no 3-inch trees having less than 70 percent crown injury died during the first year after the fire. Few trees 4 inches d.b.h. or larger died unless crown damage was greater than 80 percent. Exceptions to this were trees believed killed by subsequent beetle attacks.

Mortality was not related to crown classes (dominant, codominant, etc.) except as crown classes were correlated with tree size.

Figure 2.--Ponderosa pine mortality by diameter classes and crown injury classes.

Most of the first-year mortality was assumed to be caused by crown burning. Bole burning, even when severe, did not appear to cause death the first year. A small infestation of turpentine beetles was noted the first year (on only six trees out of the 200 observed), but no particular correlation of beetle attack with injury could be detected.

Second-year mortality, although correlated with crown damage and tree size, was more erratic than first-year mortality. Severe bole burning that injured the cambium probably caused most of the second-year mortality. Smaller trees, having thinner bark, probably were more susceptible to cambium injury from fire than larger trees. Several trees in the 3- to 5-inch classes died the second year even though their crowns were damaged less than 70 percent. On the other hand, no trees 6 inches and larger died the second year except those that had crown injury greater than 80 percent.

Total mortality 2 years after the fire is tabulated below (see also fig. 2). The erratic behavior of the 0-24 percent class may be due to the small number of trees observed in this category:

<u>Crown burned</u> <u>Percent</u>	<u>Mortality</u> <u>Percent</u>
0 - 24	14
25 - 49	6
50 - 59	20
60 - 69	24
70 - 79	20
80 - 89	63
90 - 94	100
95 - 100	100

Only one additional tree died on this plot between the second and eighth year following the fire.

Growth

Diameter growth for the 8-year period following the fire is plotted in figure 3 over d.b.h. for three broad damage classes: 70 to 89 percent crown damage; 50 to 69 percent; and less than 50 percent. This graph also shows two curves of normal 8-year diameter growth for ages 30 and 40 (3). Individual ages for all the trees in this study were not measured, but most of the smaller trees were about 30 years old, and the larger ones about 40, at the time of the fire.

Trees whose crowns were damaged less than 50 percent followed the expected growth curve very closely. Trees more severely burned, however, showed reduced growth especially in the 6- to 9-inch diameter classes (there were no larger trees in the severely damaged classes). Although this study had insufficient trees to give reliable growth figures, the results suggest that reductions in

Figure 3.--Comparison of 8-year diameter growth of fire-injured and normal trees by diameter classes.

diameter growth of 30 to 50 percent can be expected in larger trees when crowns are damaged more than 50 percent.

The smaller trees, which were generally in the intermediate and suppressed crown classes, showed average or even better growth following the fire. The thinning effect of the fire had released these trees more than the larger trees.

The reduced diameter growth following a fire cannot be considered of major importance because it is only a temporary reduction that probably will be offset by the releasing effect of the thinning.

Height growth was similarly studied, but no correlation with fire damage was found. Height growth followed closely the expected height growth read from site curves.

CONCLUSIONS AND SUMMARY

Young ponderosa pine trees can withstand considerable fire damage without serious mortality. Their resistance appears to be superior to that of older trees of the same species for a given amount of crown injury. Fire is somewhat selective in its killing effect: it kills the smaller, weaker trees in greater proportion than the larger, more vigorous components of a stand. This characteristic has been cited as evidence in support of prescribed burning as a tool for thinning in dense, young stands (5).

Results of this study on 200 trees burned in 1949 can be summarized as follows:

1. Virtually all mortality occurred during the first 2 years following the fire.

2. Mortality was directly related to crown injury: (a) all trees died whose crowns were 90 percent or more burned, and (b) mortality was only 6 to 24 percent when less than 80 percent of the crown was burned.

3. Small trees suffered greater mortality than large trees having the same degree of burn.

4. Second-year mortality was restricted to trees smaller than 6 inches d.b.h. except where crown injury had been 80 percent or greater. Second-year mortality probably was related more closely to bole injury than to crown injury.

5. Crown injury of 50 percent or more appeared to have reduced diameter growth in trees 6 to 9 inches d.b.h.

6. Height growth was not affected by burning.

LITERATURE CITED

1. Flint, Howard R.
1925. Fire resistance of northern Rocky Mountain conifers. Idaho Forester 7: 7-10, 41-43, illus.
2. Herman, F. R.
1950. Survival of fire-damaged ponderosa pine...a progress report. U. S. Forest Serv., Southwest. Forest and Range Expt. Sta., Res. Note 119, 3 pp. (Processed.)
3. Lynch, Donald W.
1954. Growth of young ponderosa pine stands in the Inland Empire. U. S. Forest Serv., Intermtn. Forest and Range Expt. Sta., Res. Paper 36, 16 pp., illus. (Processed.)
4. Starker, J. J.
1934. Fire resistance in the forest. Jour. Forestry 32: 462-467.
5. Weaver, Harold
1947. Thinning pine stands by prescribed burning. West Coast Lumberman 74: 111-114, illus.
6. Wegener, Willis W.
1955. Preliminary guidelines for estimating the survival of fire-damaged trees. U. S. Forest Serv., Calif. Forest and Range Expt. Sta., Forest Res. Note 98, 9 pp. (Processed.)