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SNOW BREAKAGE IN A POLE-SIZED PONDEROSA PINE PLANTATION...

more damage at high stand-densities

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ABSTRACT: Damage by snow breakage to pole-sized ponderosa pine *(Pinus ponderosa* Laws.*)* increased as stand density increased. In a plantation on the west slope of California's Sierra Nevada, the tallest trees were most often broken. Thinning in the sapling stage is recommended as a preventative measure in dense plantations subject to heavy snowfall.

OXFORD: 174.7 *Pinus ponderosa:*423.4:228.1 + 174.7 *P. ponderosa*–232.43–423.4: 242.
RETRIEVAL TERMS: Pinus ponderosa; plantation establishment; stand density; snow breakage; pre-commercial thinning.

Snow damage can seriously affect the development of young conifer plantations.[1] Trees of small sapling size usually recover from snow bending,[2,3] but larger saplings often fail to regain their original form.[4] And pole-sized trees are seriously threatened by snow breakage.[5] Many mid-elevation plantations of ponderosa pine *(Pinus ponderosa* Laws.*)* are reaching pole size in California. Will these stands be susceptible to snow damage? What do we know about the problem?

The association of snow damage with high stand density is well documented.[6,7] Recent improvements in nursery stock and planting technique have boosted field survival greatly. Resulting plantations can reach high densities in a short time if precommercial thinning is delayed.

One such plantation is on a highly productive site at 4,100 feet elevation, 11 miles northeast of Forest-hill, Placer County, California, on the west slope of the Sierra Nevada. Planted in 1950 at a 5- by 7-foot spacing, the stand now averages 170 square feet basal area per acre, with some portions exceeding 300 square feet. After an exceptionally heavy snowfall in the winter of 1967-68, we investigated the relation-ship of snow damage to the stand density and structure of this plantation.

METHODS

Stand density.—Damaged and undamaged portions of the plantation were examined by point sampling along a route of random compass bearings and distances. If a damaged tree was found within 30 feet of a located sample point, that tree became the plot center and a basal area count was taken using a 30-factor wedge-prism. If no damage was noted within 30 feet of the sample point, that point became

the plot center for a basal area count. Thirty-five samples each were taken from damaged and undamaged points.

Tree height.—Total heights of broken trees were reconstructed to determine the height classes most susceptible to breakage in unthinned plantations. In addition, we recorded height to the point of breakage and the total heights of the four nearest trees.

RESULTS AND DISCUSSION

Stand density.—Basal area point samples ranged from 60 to 330 square feet per acre. Point samples in damaged areas averaged 193 square feet per acre, while undamaged samples averaged 147 square feet. Differences in stand density between damaged and undamaged point samples were statistically significant by *t*-test at the 1-percent level. Incidence of damage increased as stand density increased *(fig. 1)*. We found no damage at densities of less than 120 square feet per acre.

Tree height.—Total heights of broken trees ranged from 28.9 to 49.3 feet and averaged 35.8 feet. Broken trees averaged 5.0 feet taller than the mean heights of their four nearest neighbors. Differences between paired samples were statistically significant at the 1-percent level. Broken trees were never less than third tallest in each group of five, and in nearly half the samples they were the tallest.

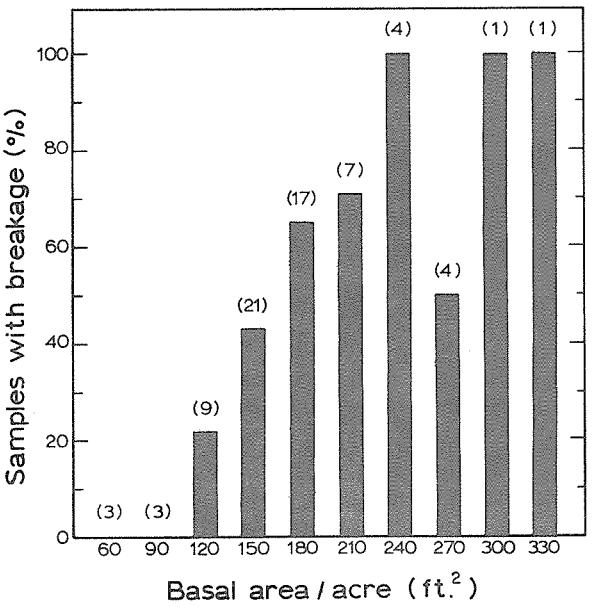

Figure 1—*Proportion of basal area point samples with snow breakage, by stand density class. Number of observations per class are shown above each column.*

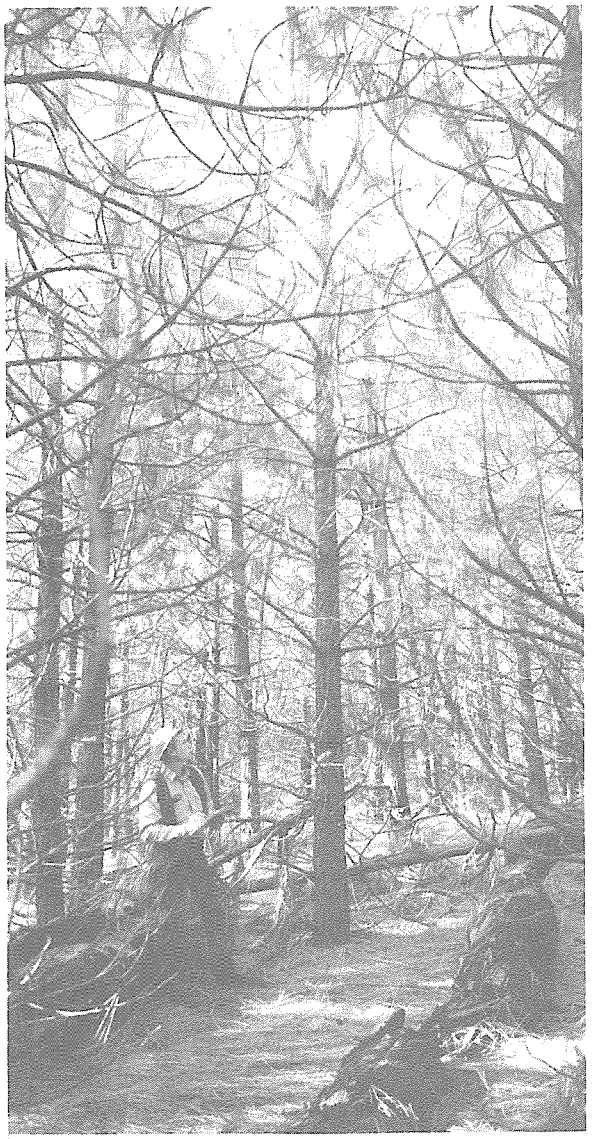

Figure 2—*Living stem of broken ponderosa pine 2 growing seasons after breakage occurred.*

Height to break.—The average breakage point was at 55 percent of the bole length. There was no clear correlation between height to break and either (a) total height or (b) height differences between the broken tree and its nearest neighbors. Often, stems broke within the live crown, leaving an unmerchantable tree still occupying considerable growing space *(fig. 2)*.

Our findings suggest that high stand density and heavy snowfall are not compatible in pole-sized plantations of ponderosa pine. High stand density produces a continuous canopy for snow interception. Adjacent crowns often are interwoven, preventing

branches from bending and releasing their snow loads. Accumulating snow can result in damaging the tallest and potentially most valuable trees. And since heavy snow loads may occur any or every year, we recommend thinning while a stand is still in the sapling stage. Careful thinning should avoid forming openings which favor one-sided crown development.[1]

Released trees may risk snow bend during the first few winters after thinning.[2,8] But by the time they reach pole size, accelerating growth and a more open canopy should create breakage-resistant stems.

NOTES

[1]Curtis, James D. *Snow damage in plantations.* J. Forest. 34(6): 613-619. 1936.

[2]Williams, Carroll B., Jr. *Snow damage to coniferous seedlings and saplings.* U.S. Forest Serv. Res. Note PNW-40, Pacific NW. Forest & Range Exp. Sta., Portland, Ore. 10 p., illus. 1966.

[3]Oliver, William W. *Snow bending of sugar and ponderosa pine seedlings. . . injury not permanent.* (MS. in preparation.)

[4]Fenton, R. H. *Heavy snowfalls damage Virginia pine.* U.S. Forest Serv. NE. Forest Exp. Sta. Sta. Pap. 127, 7 p., illus. 1959.

[5]Watt, R. F. *Snow damage in a pole stand of western white pine.* U.S. Forest Serv. Northern Rocky Mtn. Forest & Range Exp. Sta. Res. Note 92, 4 p., illus. 1951.

[6]Schantz-Hansen, T. *Ten-year observations on thinning of 15-year-old red pine.* J. Forest. 37(12): 963-966. 1939.

[7]Suominen, O. [*Susceptibility of stands to devastation by snow. An investigation into snow devastation in S. Finland in winter 1958-59.*] Silva fenn. 112(5): 1-35. 1963.

[8]Godman, R. M., and Olmstead, R. L. *Snow damage is correlated with stand density in recently thinned jack pine plantations.* U.S. Forest Serv. Lake States Forest Exp.Sta. Tech. Note 625, 2 p. 1962.

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