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EFFECT OF WEATHERING ON ACCURACY OF FUEL-MOISTURE-INDICATOR STICKS IN THE PACIFIC NORTHWEST

by

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How much does weathering affect accuracy of fuel-moisture-indicator stick readings in different sections of Oregon and Washington? If unpainted lumber is exposed to weather for a few years, its color changes and the grain shows as much erosion as if it were sandblasted. According to the Forest Products Laboratory, [1/] chemical as well as physical changes produce these effects. Repeated, unequal swelling and shrinking--caused by wetting and drying at the surface--distorts surface fibers and raises the grain. Sunlight, air, and water on the surface cause chemical changes that produce first brown then gray color and make lignin and cellulose partly soluble. Similar erosion and leaching of fuel-moisture-indicator sticks would cause a loss of weight and consequent inaccuracy.

In Oregon and Washington, fuel-moisture-indicator sticks used in daily ratings of forest-fire danger for a few months in summer exhibit varying effects of weathering during this time. As frequently observed, weathering erodes wood more rapidly in moist climates than in dry. Sticks in the dry climate east of the Cascade Range

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[1/] U.S. Forest Products Laboratory. Weathering and decay. U.S. Forest Serv. Forest Prod. Lab. Tech. Note 221 (rev.), 2 pp. 1956. (Processed.)

change from the original straw color to tan, or still further to yellowish gray. Those in the more moist climate along the west slope of the Cascades become yellowish gray to dark gray. Those in the still more moist climate of the coastal mountains tend more toward dark gray, and the upper surfaces become rough because the soft springwood in each annual ring weathers away faster than the harder summerwood.

Several years ago we measured loss of weight and noted the consequent errors associated with these signs of weathering. Although at that time most users of fuel-moisture sticks showed little interest in small errors, greater emphasis on use of fire-danger rating has recently increased the demand for such information.

Measurements in Other Regions

Foresters have long recognized that weathering reduces dry weight of fuel-moisture sticks. In 1937 George M. Jemison[2/] described loss of weight from 1/2-inch cylinders of ponderosa pine weathered for 7 years or more at the Priest River Experimental Forest in Idaho. These cylinders were ovendried and weighed at annual or biennial intervals. In 2-1/2 years they lost 9 percent of their original dry weight[3/] in full sunlight and 7 percent in dense shade. He pointed out the lesser weathering when the wood was protected by a tree canopy against full sunlight, high temperatures, great temperature changes, maximum wind, and full impact of rain. Our tests to be described here indicate that protection against dew may have been more important than those factors.

Soon after Jemison's study, fire-danger raters in the East applied similar information to correct at monthly intervals the dry weight of the thin, flat moisture-indicator sticks used there. An adjustment on the weighing scales allowed a correction for expected changes in dry weight. A sample correction schedule[4/] for a given

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[2/] Jemison, George M. Loss of weight of wood due to weathering. Jour. Forestry 35: 460-462. 1937.

[3/] All numerical losses to be discussed are percentages of ovendry weight before exposure to weathering.

[4/] Jemison, George M. The measurement of forest fire danger in the eastern United States and its application in fire control. U. S. Forest Serv. Appalachian Forest Expt. Sta. Tech. Note 35, 43 pp., illus. 1939. (Processed.)

set of sticks showed a loss of 1.2 percent per month for the first 2 months, then 0.9 percent per month for the next 2 months of exposure. Later the manufacturing process included several months of weathering to reduce the original weight by 5 percent. During subsequent field use for 3 months, such sticks normally lost only 0.33 percent per month.[5/]

Measurements in Oregon and Washington

In 1938 each of approximately 100 ranger districts in Oregon and Washington sent us an indicator stick used during that fire season, which we ovendried to determine loss in weight from one season of exposure. We classified them as either weathered to a dark-gray color or not. The dark-gray sticks, in contrast to the light-colored ones, showed loss of springwood in the annual rings, averaged 0.6 percent less in weight, and came almost entirely from districts west of the Cascades. At that time each indicator stick contained three pieces 1/2-inch square and about 2 feet long joined by two small dowels that held the pieces parallel and slightly separated. The complete stick weighed 100 grams when ovendry.

In 1942, after 1/2-inch round material replaced the square pieces in the sticks (fig. 1), we again obtained one or more used sticks from each ranger district. We graded the 111 sticks by three colors (from tan to dark gray) and three surface erosion classes, and weighed them with more precision than before. In general, the more weathered the appearance, the greater the loss in weight. Numerous sticks from west of the Cascades lost 2 percent or more. This meant that a fuel-stick reading of 5 percent near the end of the season should actually be about 7 percent. No sticks from east of the Cascades lost as much as 2 percent, and most of them lost less than 1 percent.

In 1947 each ranger district sent us one or more used sticks, totaling 233 in number. Appearances and losses resembled those recorded for the sticks used in 1942. To facilitate comparison of losses for equal periods of exposure, we converted seasonal total

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[5/] Nelson, Ralph M. Calibration of fuel moisture sticks used in the East and South. U.S. Forest Serv. Fire Control Notes 16(1): 40-42, illus. 1955.

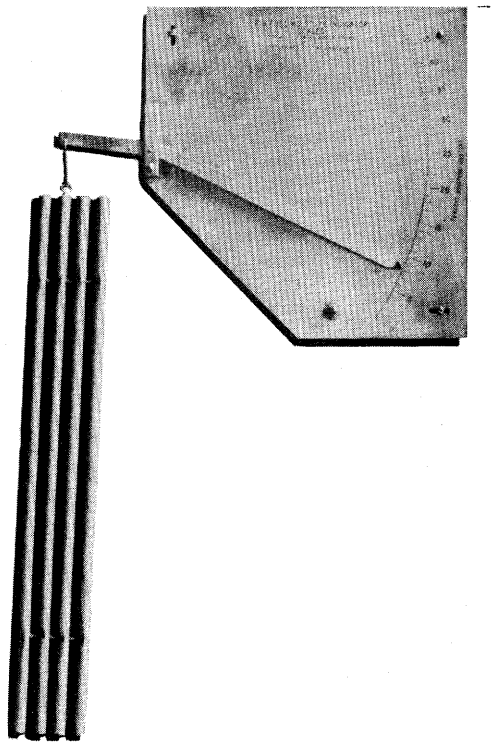

Figure 1.--The fuel-moisture-indicator stick used in the Pacific Northwest consists of four pieces of 1/2-inch round wood joined by two small dowels. Like earlier models, it weighs 100 grams when ovendry.

loss for each stick to loss per 30 days of exposure. Losses in percent per 30 days by subdivisions of the region averaged as follows, in decreasing order: coastal strip (Oregon only), 0.67; west slope of Cascades, 0.45; east slope of Cascades and Fremont National Forest, 0.35; Ochoco Mountains and northeastern Oregon, 0.27. These differences were statistically significant.

To determine the effect of an extra month or two of weathering in early or late season, we exposed pairs of sticks at Wind River Experimental Forest in the Cascades during different parts of the season. This test began in 1943 and continued through 1949. We made similar tests at Cascade Head Experimental Forest on the Oregon coast in the seasons 1947-49 and at Pringle Falls Experimental Forest on the east slope of the Cascades in 1948-49. Sticks whose exposure began at various dates before July 1 and continued until mid-October lost weight in proportion to the length of exposure. Losses per month averaged 0.60 at Cascade Head, 0.52 at Wind River, and 0.37 at Pringle Falls. Other sticks exposed in spring only, summer only, or fall only showed a slightly faster rate of weathering in fall than in summer or spring.

At Wind River we also tested the effects of rain and dew. Rain usually fell about 4 days per month during moderately dry periods and up to 20 days per month in wet periods that occurred in some years. The study showed that differences in frequency of rainy days had little or no effect on losses of weight: for the same length of exposure, sticks lost nearly the same weight, even when two to seven times as many rainy days occurred. Effect of dew was determined by a test repeated for several years during the relatively rainless months of July and August. In this test, a canopy protected one pair of sticks from dew each night while a check pair remained exposed. The canopy was not used in daytime. Heavy dew formed during most nights in these months, and the protected sticks lost only one-half to one-fifth of the weight lost by the normally exposed sticks. These tests indicate that in the summer climate of Wind River, dew and occasional rains supply sufficient moisture for rapid weathering, even in the drier years. Consequently, a relatively great increase in frequency of rains affects weathering loss very little or not at all.

Probably heavy dew, regardless of rain, causes the greater weathering observed west of the Cascades compared to that east of the Cascades. Since dew forms more frequently in valley bottoms than on higher ground, we can also assume that it causes more weathering in bottom lands.

Application

Because of gradual loss of weight with increasing time of exposure to weathering, readings from two sticks in the same locality but weathered for greatly different periods cannot be accurately compared unless the readings are adjusted. Each spring, sticks to be used on a given fire-control area should be first exposed on about the same date. They can be simultaneously exposed at one station and subsequently moved to stations manned several weeks later. Exposure on the same date allows direct comparison between stations on any given date later in the season. If readings from several fire-control areas are to be compared, a uniform beginning exposure date for all areas should be specified. For the national forests in Oregon and Washington, June 25 has been selected as the beginning exposure date. Stations that require early spring readings use an extra stick in early spring and discard it after the common starting date.

If early season readings are to be carefully compared with late-season readings at a given station, they should be adjusted. Averages given in the preceding section show that on the west slope of the Cascades, a reading 3 months after the beginning exposure date compared with another at the same station 1 month after exposure date should be increased by (3-1) x 0.45 = 0.90.

Readings for stations in different sections of the two States should be additionally adjusted by the average loss for the section before they are compared. Thus readings for the coastal strip of Oregon to be compared with those for the east slope of the Cascades 3 months after the beginning exposure date should be increased by 3 x (0.67-0.35) = 0.96.

When adjusting many readings, computations and their errors can be reduced by using graphs or tables of corrections. If actual readings are permanently recorded, they can be adjusted immediately or later as needed. As more complete knowledge of weathering losses becomes available, adjustments can be revised when records from previous years are to be compared.

More studies should be made to determine if weathering differs significantly between certain stations in given localities. If such differences exist, comparisons between those stations should be adjusted accordingly.