

Reference File No. 431.2

SOUTHWEST

FOREST & RANGE EXPERIMENT STATION

Berkeley, California

1964

Moisture Patterns in Douglas-Fir and Tanoak Slash

NORMAN C. SCOTT

ABSTRACT: Moisture content in Douglas-fir cull logs and boles of felled tanoaks was sampled periodically at 2-inch intervals to a depth of 6 inches from October 1960-October 1961. The study area had been clear cut in 1958 and the hardwoods felled in 1959. Analysis of the data showed that the moisture level in tanoak stems decreased at an increasing rate from a 6-inch depth to the surface, whereas Douglas-fir moisture content increased at an increasing rate in this same direction.

smaller fuels is probably the most critical. Even though arrangement and distribution increase in importance as fuel size increases moisture content must be considered in all sizes.

On National Forest lands in California, disposal of Douglas-fir slash is carried out annually by means of prescribed burning. Of all fuel factors directly influencing the success of the burning operation, moisture content of the

In October 1960 we began investigating moisture content of logging residues in clearcut blocks on the Six Rivers National Forest, east of Eureka, California. Douglas-fir cull logs and boles of felled tanoak trees comprise the bulk of heavy fuels left in these man-made forest openings. In many instances these fuels make up a considerable portion of the total material that must be eliminated for forest regeneration and fire protection.

This study was part of a long-term investigation of slash and its environment. It was made to gain some knowledge of the range of moisture contents of Douglas-fir and tanoak, and to recognize any moisture patterns that might show up during the rather limited study period. Such information is desirable for a fuller appreciation of fire control problems in the Douglas-fir type, and in particular for strengthening current slash burning guidelines.

PROCEDURE

Samples were collected from a southeast facing block in the Tish Tang Ranger District. The study area was logged in 1958 and the hardwoods felled in 1959. Logs selected for sampling were those lying apart from each other and had most of their bark intact. All samples were collected through bark.

Using a heavy duty brace and bit (1-1/16-inch diam.), we drilled holes radially through the log to a depth of 6 inches. Wood chips from the drilling were collected from each successive 2-inch increment and sealed in separate polyethylene containers. One drilling operation on each of two logs completed one set of samples for the three levels. The samples were weighed within 1 to 3 hours after the collection period. They were allowed to air-dry for a few days, then sent to the Pacific Southwest Station for determination of their moisture contents by the xylene distillation method.¹

RESULTS

In cull Douglas-fir logs, heart rot was rarely encountered in the 0-to 2-inch level, quite often in the 2-to 4-inch level, and more often than not in the 4-to 6-inch level. Rotted tanoak wood seldom appeared in the samples. On the same day, moisture contents often varied quite widely between logs of the same species for corresponding sample depths. These variations were attributed mainly to: incidence of rot; differences in sapwood thickness; inherent differences within sapwood and heartwood, i. e., those usually ascribed to height and depth within the stem; proximity to areas void of bark; and collection error.

Considering this variation, we decided that our spotty and destructive sampling did not lend itself to establishing rates of water exchange between the logs and the atmosphere, or between levels within the logs. However, the general moisture pattern remained essentially the same throughout the study for both species (table 1).

The two fuel moisture trends as shown by the 2-inch increments were diametrical opposites. Douglas-fir moisture content decreased inwardly, whereas that of tanoak increased with depth.

The Hotelling T^2 -test² was used to test the null hypothesis that the two mean differences between the three sample levels were equal to zero. This hypothesis was rejected at the 1 percent level of significance for each species.

The mean difference in moisture content between the 0-to 2-inch and 2-to 4-inch levels was greater than the mean difference between the 2-to 4-inch and 4-to 6-inch levels for both species. This indicated that the moisture level in the tanoak logs was decreasing at an increasing rate from the innermost level outward; in Douglas-fir cull logs, the moisture level increased at an increasing rate in this same direction.

¹Buck, C. C., and Auges, J. E. The solvent distillation method for determining the moisture content of forest litter. *Jour. Forestry* 37(8):645-651. 1939.

²Anderson, T. W. An introduction to multivariate statistical analysis. 374 pp. New York: John Wiley & Sons.

Table 1.--Three levels of moisture content in the outer 6-inch shell of Douglas-fir and tanoak logs

Sample Number	Douglas-fir			Sample Number	Tanoak		
	Level (inches)				Level (inches)		
	0 to 2	2 to 4	4 to 6		0 to 2	2 to 4	4 to 6
Percent dry weight				Percent dry weight			
1	83.2	77.4	37.9	1	24.0	69.8	77.0
2	118.8	50.5	38.5	2	30.5	51.7	73.5
3	66.7	35.0	33.0	3	53.3	61.0	69.5
4	137.4	46.9	40.5	4	52.7	67.7	80.0
5	90.0	63.9	40.8	5	64.6	73.7	84.9
6	84.0	37.7	30.5	6	63.8	77.6	78.1
7	189.5	47.1	37.1	7	75.7	82.6	75.8
8	60.8	57.0	46.6	8	62.2	82.8	95.7
9	104.9	39.1	36.7	9	57.3	81.4	78.0
10	127.2	53.8	41.4	10	61.1	57.9	67.5
11	78.1	39.2	34.7	11	66.6	73.3	80.4
12	133.2	63.2	43.8	12	57.1	82.1	83.0
13	84.9	52.2	35.4	13	34.9	54.5	74.7
14	75.8	50.2	34.0	14	70.0	74.3	83.3
15	116.9	70.3	52.3	15	52.1	58.5	84.4
16	85.8	60.6	39.0	16	25.4	62.2	77.5
				17	26.1	68.4	78.8
				18	33.6	43.2	72.9
				19	36.1	55.2	32.7
				20	55.0	60.6	67.6
				21	32.4	35.4	91.4

A comparison of the Douglas-fir results with those obtained from live trees by Parker³ and Chalk and Bigg⁴ showed fairly close approximations for similar levels of sampling. For the outermost level the values were 102 percent, 117 percent, and 110 percent, respectively. Parker's value represented that of sapwood only, whereas Chalk's and Bigg's (like ours) was an average of 2-inch samples, but contained a greater proportion of heartwood. Since the samples by Chalk and Bigg were taken from a smaller cross section than ours, their 0-to 3-cm. level probably corresponded more closely to our 0-to 2-inch level. Their average value for this level was about 148 percent, which fell near the upper limit of our range. Our average value for heartwood moisture content (39 percent) corresponded with that of the Rocky Mountain variety (38 percent) and with the fifth centimeter of the tree in Great Britain (33 percent). Closer to home, average moisture contents of 37 percent and 115 percent have been determined for heartwood and sapwood in green timbers of coast-type Douglas-fir.⁵

³Parker, J. Available water in stems of some Rocky Mountain conifers. Bot. Gaz. 115:380-385. 1954.

⁴Chalk, L., and Bigg, J. M. The distribution of moisture in the living stem in Sitka spruce and Douglas-fir. Jour. Forestry 29(1):5-21. 1956.

⁵MacLean, J. D. Effect of moisture changes on the shrinking, swelling, specific gravity, air or void space, weight and similar properties of wood. U.S. Forest Serv. Forest Products Lab. No. 1448, 46 pp., illus.

The shortest span between the time a tree was felled and the time it was sampled was about 4 months. No difference was detected between relatively fresh material and logs that had lain on the ground for 2 to 3 years. This result was attributed partly to the wide variation between logs, and partly to the persistence of Douglas-fir bark.

For the most part, Douglas-fir bark remained attached to the wood throughout the study period; that of tanoak at many locations eventually split and broke away from the woody stem. On two occasions Douglas-fir bark samples were collected along with the wood samples. Table 2 shows the moisture patterns of these sample sets. It is quite obvious that the moisture contents of the bark samples were significantly less than those of the adjacent 0-to 2-inch wood samples.

Table 2.--Moisture content of Douglas-fir bark and wood at three levels

Collection date	Bark	Wood		
	1 inch average	0 to 2 inch	2 to 4 inch	4 to 6 inch
Percent dry weight				
June 22, 1961	26.0	104.9	39.1	36.7
June 22, 1961	30.6	127.2	53.8	41.4
July 7, 1961	35.6	78.1	39.2	34.7
July 7, 1961	28.6	133.2	63.2	43.8
Average	30.2	110.8	48.8	39.2

CONCLUSIONS

The moisture pattern of each species in direction and magnitude, remained much the same throughout the study period. In light of these data, and considering bark properties in general, we decided that Douglas-fir bark quite likely retained much of its effectiveness as a barrier to water movement long after the tree was felled.

On clearcut blocks, cull logs are commonly distributed quite widely, and in some cases rather thickly, down slope from the cull deck. At most, a number of logs will touch, but rarely will any sort of piling result. These logs normally retain most of their bark. Furthermore, these localized areas generally contain relatively light amounts of fine and medium fuels.

Areas characterized by a particular heavy fuel loading of this nature can present problems in slash disposal and regeneration. Where it is evident that this type of pattern is developing, greater cleanup effort should be required during logging.

Further research is needed for a more complete evaluation of the hazard of heavy fuel moisture regimes. Such investigations should be aimed at determining moisture contents and rates of water exchange at the wood-bark, bark-atmosphere, and wood-atmosphere interfaces. Measuring techniques should include repetitive weighing of log cross-

sections representing the above three conditions, and oven drying of increment borings to obtain moisture contents on a more restrictive basis. Such information may be useful in improving techniques for combating wildfire as well as for using fire as a forest tool.

The Author...

NORMAN C. SCOTT was formerly assigned to the Pacific Southwest Station's forest fire laboratory at Riverside, Calif., where he studied problems in fire environment. A forestry graduate (1958) of Utah State University, he is now project forester on the staff of Angeles National Forest at Newhall, California.

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION
POST OFFICE BOX 245
BERKELEY, CALIFORNIA 94701

POSTAGE AND FEES PAID
U. S. DEPARTMENT OF AGRICULTURE

OFFICIAL BUSINESS

ROCKY MT FOR EXP STA 5 01
ARIZONA STATE COLL CAMPUS
FLAGSTAFF ARIZONA 86003