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A COMPARISON OF FUEL MOISTURE INFLUENCES UNDER TWO LODGEPOLE PINE STANDS

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CANADIAN FORESTRY SERVICE
VICTORIA, BRITISH COLUMBIA**

INTERNAL REPORT BC-10

DEPARTMENT OF FISHERIES AND FORESTRY

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ABSTRACT

Relative humidity, temperature, precipitation and indicator stick moisture content were measured under adjacent mature and immature stands of lodgepole pine at two locations. Results showed a generally more severe fire climate under the immature stands during the day and dry periods than under the mature stands; the reverse was true at night and immediately following rain. The differences were not considered to be particularly important in view of the more pronounced differences in other fuel characteristics.

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INTRODUCTION

In conjunction with a study of the lodgepole pine, Pinus contorta Dougl. var latifolia Engelm. fuel complex^{1/}, an investigation of the effect of stand type on fuel moisture content was initiated. The objective was to determine if microclimatic differences under two distinctly different lodgepole pine stands were reflected in parameters that are used to estimate the moisture content of forest fuels.

The study was conducted at two locations near Paradise Lake, southeast of Merritt, British Columbia, at latitude 50° 00' North and longitude 120° 00' West.

METHOD

Relative humidity, temperature, precipitation and moisture content were measured at two locations in adjacent mature and immature stands of lodgepole pine, both on level terrain (Table 1). Temperature and relative humidity were recorded by two screened hygrothermographs that were interchanged between stands at weekly intervals to reduce instrument bias, and with an electric psychrometer at hourly intervals when opportunity allowed continuous measurement. Precipitation was determined by two rain gauges in each stand, one located 25 feet north and the other 25 feet west of the hygrothermograph screen. Fuel moisture was determined from the mean weight of two sets of B.C. Forest Service fuel moisture (0.5-inch diameter, Douglas fir) indicator sticks placed adjacent to the

^{1/} Muraro, S.J. The Lodgepole Pine Fuel Complex, manuscript in preparation.

south side of each hygrothermograph screen and at right angles to each other. All instruments were placed at a height of six inches above the forest floor. Weather measured at each of the locations was referenced to a fire weather station situated in a clearing adjacent to location 1 and about 2 miles from location 2 (Fig. 1). Measurements were made on a daily basis for 36 days, June 15 to July 20, 1963, at location 1, and for 35 days, July 22 to August 25, 1963, at location 2. In addition, hourly measurements were obtained in each stand when opportune. At location 1, 73 hourly periods during continuous fair weather were sampled, while at location 2, 65 hours, interrupted by periods of rain, were sampled.

TABLE I - STAND CHARACTERISTICS AT LOCATION OF WEATHER MEASUREMENTS

| | <u>Location 1</u> Elevation 3600' | | <u>Location 2</u> Elevation 4600' | |
|---------------------|--------------------------------------|---------------|--------------------------------------|---------------|
| | <u>Immature</u> | <u>Mature</u> | <u>Immature</u> | <u>Mature</u> |
| Age | 20 years | 66 years | 17 years | 84 years |
| Mean Dbh | 1.1 inch | 5.0 inch | 1.3 inch | 3.5 inch |
| Mean Ht | 20' | 60' | 18' | 57' |
| Stems/Acre | 6130 | 1050 | 3540 | 2030 |
| Ht to Dead Branches | 1.0' | 1.7' | 1.0' | 1.8' |
| Ht to Green Crown | 3.0' | 37' | 3.0' | 32' |

RESULTS AND ANALYSIS

Variations in Temperature

At both locations, maximum daily temperatures on rainless days under immature stands were higher than under mature stands; the reverse was the case immediately after rain. At location 1, for the period June 15 to July 20, maximum temperatures under immature stands on rainless days exceeded those under the mature stands by an average of 5°F (Fig. 2).

At location 2, for rainless days between July 22 and August 25, maximum daily temperatures in the immature stands were an average of 4°F higher than under the mature stands (Fig. 3). Maximum daily temperatures at the fire weather station were less than those in the immature and greater than those in the mature stands at both locations (Fig. 2,3).

Variations in Relative Humidity

Maximum and minimum daily relative humidities reflected the temperature variations mentioned (Fig. 4). Noon relative humidity under the mature stands at location 1 were related to noon R.H. at the fire weather station by: $\text{RH \% in mature} = 2.61 + 1.01 (\text{RH \% at FWS})$ with $r = .996$, and under the immature stands by: $\text{RH \%} = -5.75 + 1.17 (\text{RH \% at FWS})$ with $r = .996$. The difference in slope of the two regressions is due to persistent higher humidities at ground level in the immature stands, immediately following rainfall. At both locations, during periods of fair weather, afternoon humidities were lower under the immature than under the mature stands; at night, the reverse prevailed (Fig. 4).

Variation of Rainfall

On seven occasions that rain occurred during the measurement period at location 1, mean rainfall in both stands averaged 50% of the amount caught at the fire weather station for rains exceeding .30 inches, and 18% for rains less than .16 inches. At location 2, the mean rainfall on 11 occasions was 35% of that measured on the same occasions at the fire weather station. At location 1, the two gauges in the immature received more rain than the two gauges in the mature stands, the reverse was the case at location 2.

Variation in Fuel Moisture

Indicator stick moisture content reacted as expected to the temperature and relative humidity differences previously discussed at both locations (Fig. 4).

Regressions of stick moisture content under the immature stands as a function of stick moisture in the mature stands were similar at both locations (Fig. 5). At location 1, 73 consecutive hourly measurements ranging from 9.2 to 12.9% in the mature stands and 8.6 to 14.1% in the immature stands were compared. At location 2, the 65 measurements ranged from 8.0 to 28.31 and 6.8 to 33.01 in the mature and immature stands respectively. In both cases, moisture content under the immature stands was lower than under the mature stands at the dry end of the range tested, and higher at the wet end (Fig. 4). Although differences of one per cent were experienced for stick values below 12%, sticks exposed at the prescribed level of 12 inches may not show these differences.

The FFM Code (Fine Fuel Moisture Code) of the Forest Fire Behavior System (Anon. 1970) was calculated with noon relative humidity and temperature from the mature and immature stands at location 1 and the fire weather station. In all cases, the lowest (0-3) wind speed class was applied. During dry periods, code values were either the same or one unit higher in the immature stands, dependent on whether the relative humidity to be used in the calculation. During periods immediately following rains, the reverse was true and was further confounded by the difference in rainfall recorded in the two stands.

Stand and fire weather station code values are not truly comparable because of the difference in height of instruments. The

stands had higher code values during rain periods due to lesser rainfall being recorded, and the same or lower code values during dry periods. The maximum code achieved was 95 in the open, 94 in the immature stands, and 91 in the mature stands. Code values in the fire weather station exceeded those in the immature stands twice in a 22-day period; in the mature stands, 7 times in the same period. However, the differences were not considered to be particularly important in view of the pronounced differences in the distribution of fuels in the immature and mature fuel complexes.

CONCLUSIONS

- (1) During dry periods higher temperatures, lower relative humidities and lower fuel moisture occurred during the day at ground level under immature stands than under mature lodgepole pine stands. The reverse was true during night.
- (2) The drier state of fine fuels under immature stands increases the ease of fire ignition and rate of spread compared to fires under mature stands.

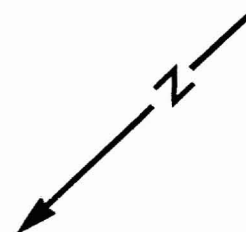
LITERATURE CITED

- Anon. 1970. Canadian forest fire behavior system. Can. Dep. Fisheries and Forest., Can. Forest Service, Ottawa.

- Figure 1 Location of paired mature and immature Lodgepole pine stands in relation to Fire Weather Station.
- Figure 2 Maximum daily temperature on rainless days in mature and immature lodgepole pine stands at location 1, referenced to 4.5 ft maximum daily temperatures in the open.
- Figure 3 Maximum daily temperature on rainless days in mature and immature lodgepole pine stands at location 2, referenced 4.5 ft maximum daily temperature in the open.
- Figure 4 Diurnal variations of temperature, relative humidity and stick moisture content in regeneration and mature stands at location 1.
- Figure 5 Relation of stick moisture content in immature and mature under a 20- and 66-year lodgepole pine stands at location 1 and 2.



LOCATION 2



FIRE WEATHER STATION

LOCATION 1

