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M.E. Alexander

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MARTIN E. ALEXANDER

Environment Canada, Canadian Forestry Service, Northern Forest Research Centre, 5320 – 122 Street, Edmonton, Alta., Canada T6H 3S5

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The characteristics and short-term results of experimental prescribed fires in 2-year-old trembling aspen (*Populus tremuloides* Michx.) logging slash in northern Minnesota have been described by D. A. Perala (1974. Can. J. For. Res. 4: 222–228). The associated burning conditions are expressed here in terms of the weather-dependent numerical fuel moisture codes and fire behavior indexes of the Canadian system of forest fire danger rating.

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D. A. Perala (1974. Can. J. For. Res. 4: 222–228) a décrit les caractéristiques et les résultats à court terme de brûlages dirigés expérimentés avec des rémanents de peuplier faux-tremble (*Populus tremuloides* Michx.) de 2 ans dans le nord du Minnesota. Les conditions de brûlage sont ici exprimées en fonction des codes numériques de l'humidité des combustibles, subordonnées à la météo, ainsi que des indices de comportement du feu de la méthode canadienne d'évaluation des dangers de feu de forêt.

Introduction

Perala (1974) reported on the fire behavior and effects of experimental prescribed burning in nine 1-ha trembling aspen (*Populus tremuloides* Michx.) clear-cut blocks. The description of the mean slash fuel complex characteristics was as follows: woody surface fuels weighed 32 t/ha (dry weight basis) and covered 47% of the area at a mean depth of 27 cm with occasional accumulations up to 150 cm; roundwood pieces less than 7.6 cm in diameter comprised 56% of the total dry weight; fuel bed bulk density was 0.025 g/cm^3; preburn organic layer depth following logging was 5.7 cm; and slash age averaged about 23 months. The firing pattern consisted of 15- to 30-m-wide strip head fires after backfiring the downwind sides of each block. The burning was completed between 1330 and 2030 Central Standard Time (CST) on May 17, 1967 (D. A. Perala, personal communication). Forward rate of spread and frontal fire intensity[2] averaged 2.5 m/min and 2970 kW/m, respectively. Nearly all the fine- to medium-sized woody material ($\leq$ 7.6 cm in diameter) was consumed, and surface fire coverage was nearly complete. Depth of burn was minimal, however.

Perala (1974) documented the environmental conditions influencing the fire spread and intensity and the resulting fire impact according to the 1972 version of the United States National Fire-Danger Rating System (NFDRS) described by Deeming *et al.* (1972). The purpose of this note is to redescribe the burning conditions in terms of numerical ratings of the weather-based Fire Weather Index and associated components of the Canadian Forest Fire Danger Rating System (CFFDRS) (Van Wagner 1974; Anonymous 1978; Turner and Lawson 1978), and thus it represents a supplement to Perala's (1974) original paper.

Methods

Daily readings of temperature, relative humidity, wind speed, and 24-h accumulated rainfall measured at 1300 CST leading up to the fires on May 17, 1967, were obtained[3] from the permanent United States Department of Agriculture (USDA) Forest Service fire weather station at Cass Lake in the Chippewa National Forest, Minnesota. The Cass Lake station is located 10.3 km away from the burning site (elevation: 402 m). These records are listed with the USDA Forest Service National Fire Weather Data Library (Furman and Brink 1975) under station number 211604 (R. W. Furman, personal communication). The basic observation time in the CFFDRS is 1200 local standard time. The difference of 1 h is not considered to be of any great significance (Turner and Lawson 1978). The United States NFDRS practice of measuring wind speed at 20 feet (6.1 m) was adjusted to the

[1]Revised manuscript received August 16, 1982.

[2]Recalculated using a low heat of combustion value of 18 700 kJ/kg reduced for fuel moisture content (Alexander 1982).

[3]A copy of the fire weather observations is available, at a nominal charge, from the Depository of Unpublished Data, CISTI, National Research Council of Canada, Ottawa, Ont., Canada K1A 0S2.

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CFFDRS standard of 10 m according to the procedure suggested by Turner and Lawson (1978). April 3 was selected as the spring starting date on which to begin calculations, since the winter snowpack had completely melted on or about March 31 (D. A. Perala, personal communication). The standard spring starting values for the fuel moisture codes following three days of snow-free cover were used (Anonymous 1978; Turner and Lawson 1978). All weather data was converted to metric units and computer processed (Van Wagner and Pickett 1975).

Results

A total of 101.1 mm of rain fell between April 3 and May 17, 1967. Fire weather observations at 1300 CST on the day of the fires were dry-bulb temperature, 20.6°C; relative humidity, 29%; and wind speed,[4] 22 km/h. Six days had elapsed since more than 0.6 mm of rain had fallen. The standard CFFDRS fuel moisture codes representing the moisture content of fine surface litter, loosely compact duff of moderate depth, and deep compact organic matter were Fine Fuel Moisture Code (FFMC), 92.6; Duff Moisture Code (DMC), 23; and Drought Code (DC), 63. The relative fire behavior indexes of the CFFDRS representing rate of spread, fuel available for combustion, and frontal fire intensity were Initial Spread Index (ISI), 18; Buildup Index (BUI), 24; and Fire Weather Index (FWI), 23. An FWI value of 23 or greater is considered to be an *extreme* level of fire danger in Ontario based on the frequency of occurrence (Stocks 1974). In this case, the ISI (combined effect of wind velocity and FFMC on fire spread rate) rather than the BUI (combination of DMC and DC that represents the total fuel available to a spreading fire) has contributed to the extreme FWI (combination of ISI and BUI that represents the energy output rate per unit length of a spreading fire front).

Discussion

Conditions such as those indicated above would result in uncontrollable forest fires in other fuel complexes but in only moderately vigorous fire behavior in aspen-type fuels. Because the FWI and its associated components are based solely on the effect of past and current weather, fire behavior at a given index value will vary with fuel type. For example, according to the ISI and FWI reported above, the expected rate of spread and frontal fire intensity in cured, needle-bearing jack pine (*Pinus banksiana* Lamb.) slash would be 36.6 m/min and 67 920 kW/m, respectively (Stocks and Walker 1972). This is in contrast to 2.5 m/min and 2970 kW/m for the aspen slash where the fuel load was relatively both light in weight and quite discontinuous.

[4]As measured at a height of 10 m in the open on level terrain.

This note illustrates the process that will ultimately provide the means of estimating fire spread rates and intensities in a variety of Canadian fuel complexes based on the Fire Weather Index with its subsidiary indexes and moisture codes. There is a paucity of high-quality, quantitative fire behavior data on operational prescribed burns and wildfires as related to the Fire Weather Index subsystem of the CFFDRS. Van Wagner and Methven (1978) strongly suggest that proper fire weather records should be kept and the relevant codes and indexes of the CFFDRS quoted for all experimental fires. The Canadian Forest Fire Weather Index components make it possible to reconstruct past fire danger conditions if suitable historical weather data are available. In this way, the burning conditions could be duplicated or understood by other workers. However, the weather data must be adequately archived, since fire-danger rating systems are subject to modification, which makes conversion of old to new ratings difficult at best.

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ALEXANDER, M. E. 1982. Calculating and interpreting forest fire intensities. Can. J. Bot. **60**: 349–357.

ANONYMOUS. 1978. Canadian Forest Fire Weather Index tables. 3rd ed. Can. For. Serv. For. Tech. Rep. 25.

DEEMING, J. E., J. W. LANCASTER, M. A. FOSBERG, R. W. FURMAN, and M. J. SCHROEDER. 1972. The national fire-danger rating system. U.S. Dep. Agric. For. Serv. Res. Pap. RM-84.

FURMAN, R. W., and G. E. BRINK. 1975. The national fire weather data library: what it is and how to use it. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. RM-19.

PERALA, D. A. 1974. Prescribed burning in an aspen-mixed hardwood forest. Can. J. For. Res. **4**: 222–228.

STOCKS, B. J. 1974. Wildfires and the Fire Weather Index system in Ontario. Can. For. Serv. Inf. Rep. O-X-213.

STOCKS, B. J., and J. D. WALKER. 1972. Fire behavior and fuel consumption in jack pine slash in Ontario. Can. For. Serv. Inf. Rep. O-X-169.

TURNER, J. A., and B. D. LAWSON. 1978. Weather in the Canadian Forest Fire Danger Rating System: a user guide to national standards and practices. Can. For. Serv. Pac. For. Res. Cent. Inf. Rep. BC-X-177.

VAN WAGNER, C. E. 1974. Structure of the Canadian Forest Fire Weather Index. Can. For. Serv. Publ. No. 1333.

VAN WAGNER, C. E., and I. R. METHVEN. 1978. Discussion: two recent articles on fire ecology. Can. J. For. Res. **8**: 491–492.

VAN WAGNER, C. E., and T. L. PICKETT. 1975. Equations and Fortran IV program for the 1976 metric version of the Forest Fire Weather Index. Can. For. Serv. Inf. Rep. PS-X-58.