

Predicting Fire Behavior in Canada's Aspen Forests¹

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Quantitative System Now Available

The development of the Canadian Forest Fire Behavior Prediction (FBP) System represents the latest achievement by Forestry Canada's Fire Danger Group in practically applying fire behavior knowledge and research experience for the general improvement of forest fire management in Canada (Alexander et al. 1984; Lawson et al. 1985; Stocks et al. 1989; Forestry Canada Fire Danger Group 1992).

The technical derivation of the FBP System rests on a sound scientific basis, developed from real-world observations of numerous experimental fires conducted under field conditions and several selected wildfires documented by Forestry Canada fire researchers and others (e.g., Alexander 1982; Alexander and Sando 1989; Quintilio et al. 1991).

Fuel Type Considerations

Currently there are 16 major Canadian fuel types recognized in the FBP System. Fuel type D-1 (leafless aspen) is described in this way (fig. 1):

... characterized by pure, semi-mature trembling aspen stands prior to "green-up" in the spring or following leaf fall and curing of lesser vegetation in the autumn. A conifer understory is noticeably absent but a well-developed medium to tall shrub layer is typically present. Dead and down roundwood fuels are a minor component of the fuel complex. The principal fire-carrying surface fuel consists chiefly of deciduous leaf litter and cured herbaceous material which are directly exposed to wind and solar radiation. In the

spring, the duff mantle (F and H horizons) seldom contributes to the available fuel for combustion due to its generally high moisture content.

Four boreal mixedwood fuel types, which can contain varying amounts of aspen, are also recognized in the FBP System.

System Structure

The FBP System allows users to get a quantitative prediction of spread rate, fuel consumption, and frontal intensity for fires that are still accelerating or have in fact reached an equilibrium



Figure 1—An example of Canadian Forest Fire Behavior Prediction System Fuel Type D-1 (leafless aspen). This trembling aspen stand is located near Hondo, Alberta, Canada, and was photographed in May 1988. The perception marker shown here is composed of a 30 x 30 cm (12 x 12 in) sign and a pole with markings at 30 cm (12 in) intervals.



Figure 2—Fire spreading through a leafless aspen stand in central Alberta during the spring of the year. Free-burning fires in the trembling aspen fuel type are typically low to moderately vigorous surface fires, even under relatively severe burning conditions.

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Table 1—Illustration of estimating potential fire behavior using the Canadian Forest Fire Behavior Prediction (FBP) System for four contrasting situations involving a trembling aspen stand during the spring fire season (FBP System Fuel Type D-1)

Calendar date: May 1		Time of day: 1600 MDT			
Geographical location: 53 °37'N, 112 °58'W		(Elk Island National Park, Alberta, Canada)			
Item	Case A	Case B	Case C	Case D	
Inputs					
FBP System fuel type	D-1	D-1	D-1	D-1	
Slope (%)	0	0	+20	+20	
Elevation (m MSL)	717	717	717	717	
(ft MSL)	(2,352)	(2,352)	(2,352)	(2,352)	
Aspect	level	level	south	south	
Fine Fuel Moisture Code (FFMC)*	94	94	94	94	
10-m open wind speed (km/h)	10	10	20	20	
(mi/h)	(6)	(6)	(12)	(12)	
Buildup Index (BUI)*	37	35	70	70	
Elapsed time since ignition (hr)	1.0	1.0	1.0	1.0	
Type of projection (point- or line-source)	point	line	point	line	
Outputs					
Initial Spread Index (ISI)*	12.5	12.5	29.5	29.5	
Head fire rate of spread (m/min)	3.3	3.3	10.7	10.7	
(ft/min)	(10.8)	(10.8)	(35.1)	(35.1)	
Fuel consumption (t/ha)	7.1	7.1	10.8	10.8	
(T/acre)	(3.2)	(3.2)	(4.8)	(4.8)	
Head fire intensity (kW/m)	711	711	3,469	3,469	
(Btu/sec-ft)	(206)	(206)	(1,003)	(1,003)	
Type of fire	surface	surface	surface	surface	
Head fire spread distance (m)	170	200	550	640	
(ft)	(558)	(656)	(1,804)	(2,100)	
Total flank fire spread distance (m)	140	N/A**	160	N/A	
(ft)	(459)	(N/A)	(525)	(N/A)	
Backfire spread distance (m)	40	50	10	10	
(ft)	(131)	(164)	(33)	(33)	
Elliptical length-to-breadth ratio (L/B)	1.5	N/A	3.5	N/A	
Elliptical fire area (ha)	2	N/A	7	N/A	
(acre)	(5)	(N/A)	(17)	(N/A)	
Elliptical fire perimeter length (m)	560	N/A	1,220	N/A	
(ft)	(1,837)	(N/A)	(4,003)	(N/A)	
Rate of perimeter growth (m/min)	10.9	N/A	23.7	N/A	
(ft/min)	(35.8)	(N/A)	(77.8)	(N/A)	
Backfire rate of spread (m/min)	0.8	0.8	0.2	0.2	
(ft/min)	(2.6)	(2.6)	(0.7)	(0.7)	
Flank fire intensity (kW/m)	296	N/A	511	N/A	
(Btu/sec-ft)	(86)	(N/A)	(148)	(N/A)	
Backfire intensity (kW/m)	164	164	71	71	
(Btu/sec-ft)	(47)	(47)	(21)	(21)	

*Components of the Canadian Forest Fire Weather Index (FWI) System (see Van Wagner 1987).

**N/A = not applicable because of the type of projection (ie., line source versus point source).

steady-state with their environment (table 1). A general description of the type of fire (fig. 2) is also given (for instance, surface fire, intermittent crowning, or continuous crowning).

A simple elliptical fire growth model (fig. 3) is used in estimating the size and shape of fires originating from a single ignition source as opposed to an established "line of

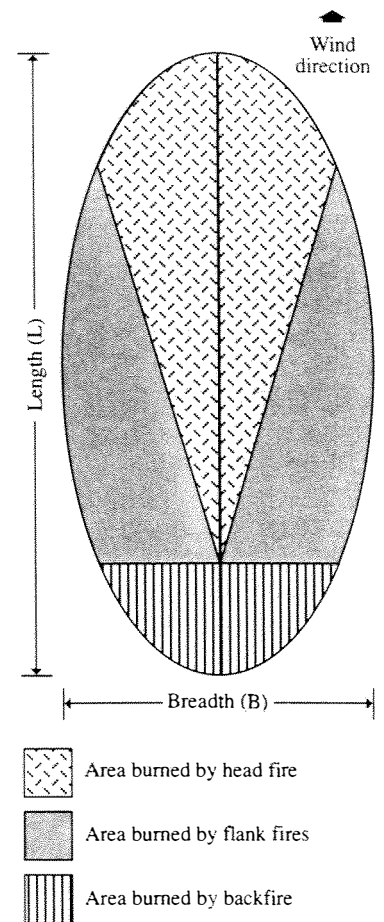


Figure 3—Schematic diagram of a simple elliptical fire growth model (after Alexander 1985). The point of ignition is judged to be at the junction of the four area growth zones, (i.e., head, left and right flanks, and back).



Figure 4—A head fire ignition pattern is used during a prescribed burning operation in Elk Island National Park, central Alberta, Canada.



Figure 5—Tree hole charring in a leafless aspen stand soon after a fire. Direct, fire-induced mortality among trembling aspen is related to stem diameter and a fire's frontal intensity. Determining the number of aspen suckers following a fire is considerably less predictable.

fire" (fig. 4). The FBP System's operation is based on a small number of readily available inputs, as table 1 shows.

Implications for Fire Managers

The FBP System incorporates the best available information on forest fire behavior in Canada (McAlpine et al. 1990). Canadian fire managers are therefore in a good position to predict fire behavior with reasonable assurance for a wide range of burning conditions.

In managing Canada's aspen forests, the FBP System can be applied to both fire protection concerns and fire use considerations. However, additional studies such as those conducted by Alexander and Sando (1989), Weber (1990, 1991), and Quintilio et al. (1991) are needed to strengthen the link between the physical characteristics of fire behavior and the biological or ecological effects of fire (fig. 5). This

The Canadian Forest Fire Behavior Prediction (FBP) System can be applied to both fire protection concerns and fire use considerations in managing Canada's aspen forests.

information is required in order to develop more refined prescriptions for prescribed burning than existing guides provide (Sando and Alexander 1990). ■

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**“REMEMBER . . . SMOKEY HAS FOR FIFTY YEARS” —
Smokey Bear’s 50th Anniversary Slogan**

Smokey Bear has reminded Americans for nearly 50 years to protect our Nation’s forests from carelessly caused fire. To celebrate the Smokey Bear golden anniversary year, the USDA Forest Service and the National Association of State Foresters announced a 50th year anniversary slogan and logo for the famous bear. The slogan, “REMEMBER... SMOKEY HAS FOR FIFTY YEARS,” will be used throughout the golden anniversary campaign.

The Ohio Division of Forestry submitted the new slogan, chosen from among 3,400 entries in a nationwide contest sponsored by the National Association of State Foresters. Working through The Advertising Council, Foote, Cone & Belding, the Smokey Bear volunteer advertising agency for 50 years, designed the anniversary logo.

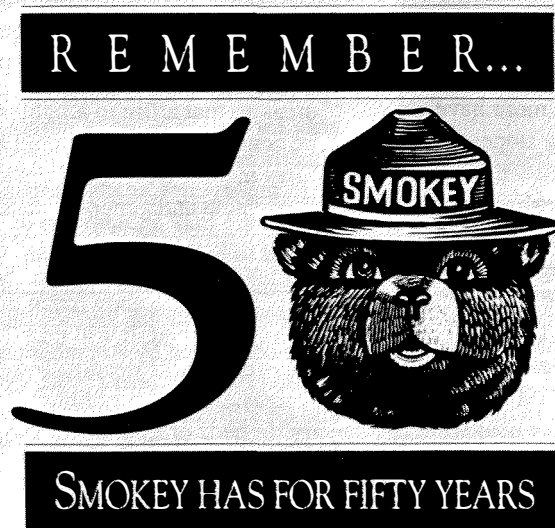
Beginning in October 1993 until August 1994, foresters and fire officials

throughout the United States will participate in local and statewide events celebrating Smokey’s golden anniversary. The anniversary will wind up with a celebration in Washington, D.C., on August 9, 1994. ■

Enid Hodess, editor, USDA Forest Service, Public Affairs Office, Washington, DC

“This anniversary slogan reinforces Smokey’s classic wildfire prevention message, ‘Remember, only YOU can prevent forest fires.’ For the past half century, generations of Americans have grown up with Smokey. Our anniversary celebration will bring back a lot of memories and drive home Smokey’s message of fire prevention to a new generation.”

—Chief F. Dale Robertson



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Front Cover: *Smoldering combustion in a trembling aspen stand immediately following passage of the active flame front associated with an experimental fire in Elk Island National Park, central Alberta, Canada, April 29, 1983. See the article by Alexander and Maffey, pages 10-13.*