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Rating fire danger in Alaska ecosystems:

CFFDRS provides an invaluable guide to systematically evaluating burning conditions

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The Canadian Forest Fire Danger Rating System (CFFDRS) has officially been used in Alaska since 1992. The CFFDRS comprises chiefly two major subsystems. (Fig. 1a): the Canadian Forest Fire Weather Index (FWI) System (Fig. 1b) and the Canadian Forest Fire Behavior Prediction (FBP) System (Fig. 1c).

The FWI System really constitutes the "spine" of the CFFDRS. The six standard components of the FWI System provide relative numerical ratings of wildland fire potential for a standard fuel type on level terrain based on four weather inputs. These are defined in Figure 1d.

The first three components are fuel moisture codes that follow daily changes in the moisture contents of three classes of forest fuel with different drying rates (Table 1). For each, there are two phases – one for wetting by rain and one for drying – arranged so that the higher values represent lower moisture contents and hence greater flammability. The Fine Fuel Moisture Code has a maximum value of 101, but the other two codes are "open ended," although significant differences in fire potential eventually become inconsequential.

The final three components are fire behavior indexes, representing rate of spread, amount of available fuel, and fire intensity; their values increase as fire weather severity worsens (all three indexes are also "open ended," but there are practical limits). The system is dependent on weather only and does not consider differences in ignition risk, fuel types or topography. It provides a uniform method of rating fire danger.

Calculation of the FWI System components can be accomplished with the use of manual tables or by a computer program. Because calculation of the components depends solely on weather readings, they can just as easily be calculated from forecast weather to yield a fire danger forecast.

Each component of the FWI System conveys direct information about certain aspects of wildland fire potential. Because the FWI System is dependent solely on weather, the actual fire behavior can in turn be expected to vary from one fuel type to another at the same code or index value. Thus, the following "quick and dirty" guidelines, recently formulated for inclusion in the 2001-2002 edition of the "Handy-Dandy" Alaska Fire Suppression Field Handbook, are *general* interpretations based on fire research information and operational experience with the system over many years in conifer stands in the boreal forest.

- **Fine Fuel Moisture Code (FFMC):** There is little chance of ignition, and surface fire spread with an open flame is unlikely at 74 or less. Continuous surface fire spread begins to occur when 80 is exceeded. Spot fire ignition potential approaches certainty at 90, and the onset of extreme fire behavior generally occurs at 92, depending on the wind and BUI level.
- **Duff Moisture Code (DMC):** The duff layer doesn't generally become involved in the combustion process until about 20 is reached, which coincidentally represents the threshold for lighting fire ignitions. At 40, the influence of the duff layer on surface fire behavior noticeably increases. The onset of extreme fire behavior often occurs at 60, depending on the wind and FFMC. Very little decrease in duff moisture content occurs when a level of around 150 is attained.
- **Drought Code (DC):** The potential for significant ground or sub-surface fire activity is relatively minimal at levels less than 300. However, the tendency for persistent smouldering increases as values of around 500 are approached in which case mop-up and extinguishment gradually becomes increasingly more difficult as the DC continues to rise.
- **Initial Spread Index (ISI):** Fires tend to spread on the ground surface until values of about 10 are exceeded at which time the onset of crowning can be expected, especially in the spring, in fuel types that will support crown fires. Extreme fire behavior is generally associated with values in excess of 20, depending on the BUI. Severe fires or major conflagrations occur when 70 is approached, a level of fire danger severity that is rarely exceeded.
- **Buildup Index (BUI):** Low-intensity surface fires are commonly associated with values less than 30. A fire's behavior or vigor noticeably increases once the BUI climbs above this level as the additional fuel for combustion becomes available. A BUI of 60-80 is commonly viewed as the transition threshold for extreme fire behavior, although this does depend on the ISI. A value of 90 is regarded as representing severe fire behavior potential.
- **Fire Weather Index (FWI):** An FWI of 3 constitutes a threshold for sustained flaming combustion and fire growth. The onset of crowning and other characteristics associated with extreme fire behavior occur at values of 25-30. Most wildfire disasters have occurred when the FWI exceeds 50.

More specific interpretations of potential fire behavior should be sought through the use of the FBP System and other CFFDRS based guides (e.g., Lawson and Dalrymple 1996; Lawson et al. 1997).

In contrast to the FWI System, the FBP System provides for actual quantitative estimates of various fire behavior parameters for 16 distinct fuel types (Table 2) and topographic situations based in part on inputs from the FWI System (principally the ISI and BUI). For example, head fire rate of spread is outputted in metres/minute or chains/hour. For further information, fire personnel are encouraged to consult the FBP System "Red Book" field guide (Taylor et al. 1997).

As an aid to fostering a greater appreciation of the CFFDRS amongst Alaskan fire managers, readers are reminded that a head fire intensity class graph and interpretive table for FBP System Fuel Type C-2 (Boreal Spruce) has been produced (Alexander and Cole 1995), and a color wall poster version also made available (Cole and Alexander 1995).

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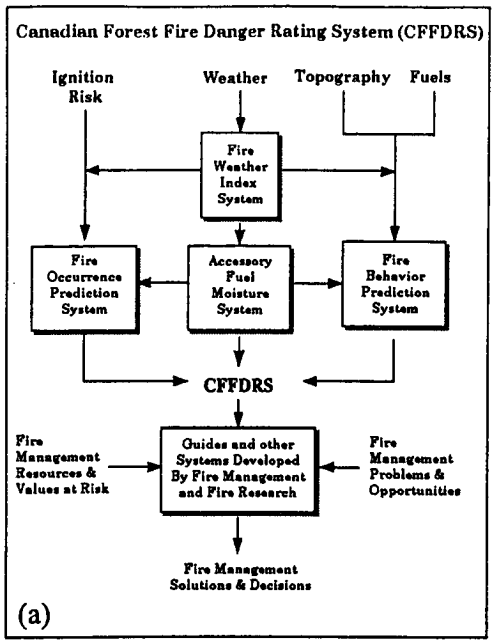
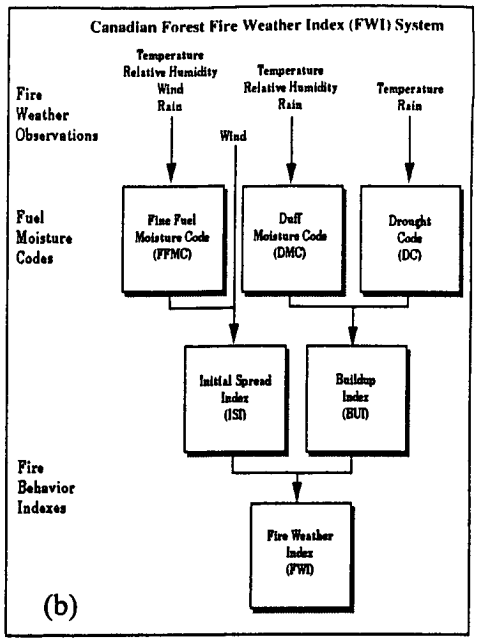
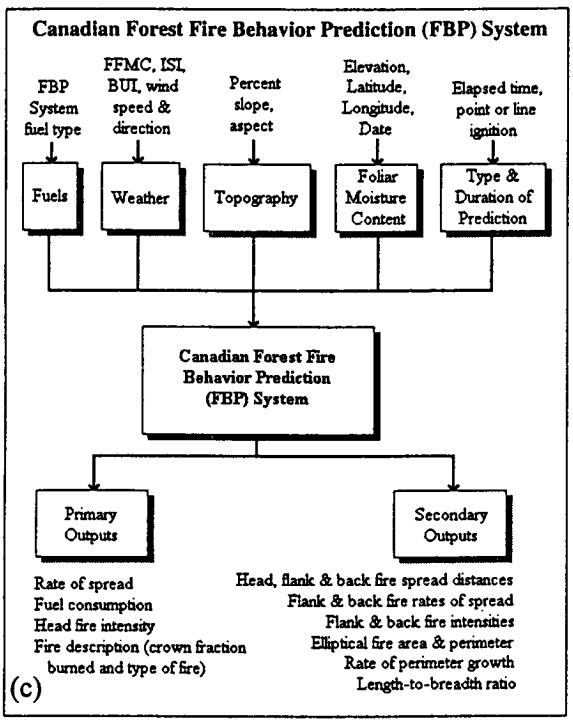
Figure 1. Simplified structure diagrams for (a) the Canadian Forest Fire Danger Rating System illustrating the linkages to fire management actions, (b) the Canadian Forest Fire Weather Index (FWI) System, (c) the Canadian Forest Fire Behavior Prediction (FBP) System, and (d) the definitions of the six standard components of the FWI System.







Canadian Forest Fire Weather Index (FWI) System
Codes and Indexes

FFMC – A numerical rating of the moisture content of litter and other cured fine fuels. This code is an indicator of the relative ease of ignition and flammability of fine fuel.

DMC – A numerical rating of the average moisture content of loosely compacted organic layers of moderate depth. This code gives an indication of fuel consumption in moderate duff layers and medium-size woody material.

DC – A numerical rating of average moisture content of deep, compact, organic layers. This code is a useful indicator of seasonal drought effects on forest fuels, and amount of smoldering in deep duff layers and large logs.

ISI – A numerical rating of the expected rate of fire spread. It combines the effects of wind and FFMC on rate of spread without the influence of variable quantities of fuel.

BUI – A numerical rating of the total amount of fuel available for combustion that combines DMC and DC. The BUI was constructed so that when the DMC is near zero the DC would not affect daily fire danger (except for smouldering potential) no matter what the level of DC (i.e., when the DMC is near zero, so is the BUI, no matter what the DC value).

FWI – A numerical rating of fire intensity that combines ISI and BUI. It is suitable as a general index of fire danger in forested areas.

(d)

Table 1. Selected Properties of the FWI System Fuel Moisture Codes

FWI System Fuel Moisture Code	Fuel Moisture Timelag (days)	Rainfall Threshold* (mm)	(in.)	Nominal Fuel Depth (cm)	(in.)	Nominal Fuel Load (t/ha)	(T/ac)
FFMC	2/3	0.6	~0.02	1.2	~0.5	2.5	~1.1
DMC	15	1.5	~0.06	7	~2.8	50	~22
DC	53	2.9	~0.11	18	~7.1	250	~112

*The 24-hour rainfall total must reach these amounts before it is considered to have any effect on the respective code.

Table 2. List of FBP System Fuel Types*

Group / Identifier	Descriptive name
Coniferous	
C-1	Spruce-lichen woodland
C-2	Boreal spruce
C-3	Mature jack or lodgepole pine
C-4	Immature jack or lodgepole pine
C-5	Red and white pine
C-6	Conifer plantation
C-7	Ponderosa pine/Douglas-fir
Deciduous	
D-1	Leafless aspen
Mixedwood	
M-1	Boreal mixedwood -- leafless
M-2	Boreal mixedwood -- green
M-3	Dead balsam fir mixedwood -- leafless
M-4	Dead balsam fir mixedwood -- green
Slash	
S-1	Jack or lodgepole pine slash
S-2	White spruce-balsam slash
S-3	Coastal cedar/hemlock/Douglas-fir slash
Open	
O-1a	Standing grass
O-1b	Matted grass

*See De Groot (1993) or Taylor et al. (1997) for photographic examples.

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