# Wildland Fire Behavior Research at the Northern Forestry Centre

The wildland fire behavior research carried out at the Canadian Forest Service's Northern Forestry Centre has two broad objectives: 1) to conduct fundamental and applied research in order to develop mathematical models and operational guidelines for predicting the characteristics of the various phenomena associated with extreme fire behavior, and 2) to ensure that fire managers and other clients are aware of the current state of knowledge with regard to wildland fire dynamics.

*The Northern Forestry Centre in Edmonton, Alberta, Canada*

Embedded in nearly every fire management decision is the need to accurately appraise potential wildland fire behavior. Fire behavior is the manner in which fuel ignites, flame develops, and fire spreads and exhibits other related phenomena as determined by the interaction of fuels, weather, and topography. Particular emphasis needs to be placed on the prediction of extreme or severe fire behavior because of its adverse effects on the safety of wildland firefighters and the public-at-large and on other values-at-risk.

*Towering convection column developing above a high-intensity wildfire*

*Free-burning fire behavior*

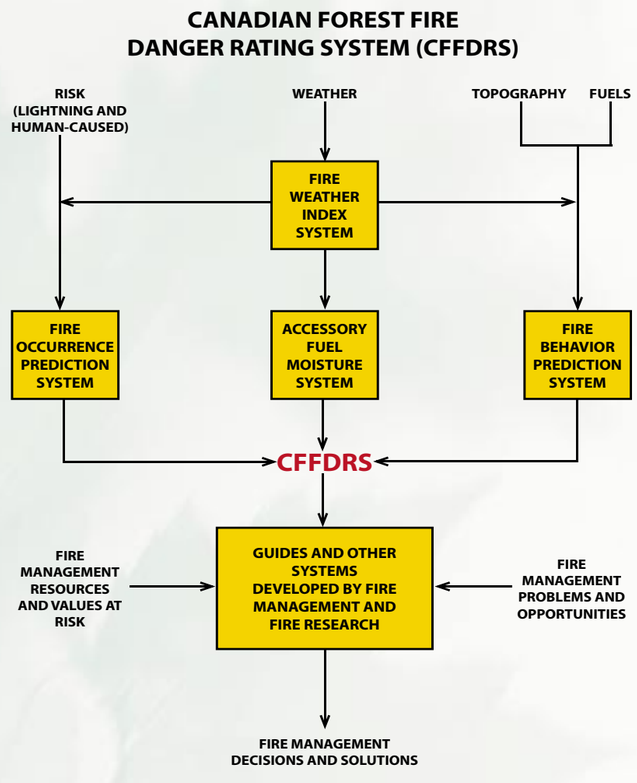
*"... further major advances in combating wildfire are unlikely to be achieved simply by continued application of the traditional methods. What is required is a more fundamental approach that can be applied at the design stage ... Such an approach requires a detailed understanding of fire behavior ...". —D. Drysdale (1985) - An Introduction to Fire Dynamics*

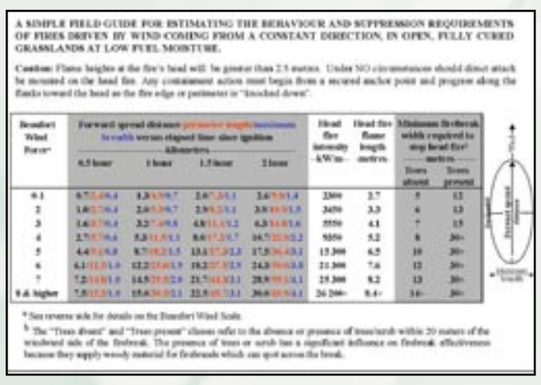
The focus and some of the accomplishments in recent years has been in four main areas:

**1. Applications of fire behavior knowledge and the Canadian Forest Fire Danger Rating System (CFFDRS) to wildland firefighter safety and community fire protection.**

*Above: CFFDRS Logo*

*Right: Simplified CFFDRS structure diagram illustrating the linkages to fire management actions.*



*The emphasis of the Grassland Fire Behavior Pocket Card is on providing basic fire behavior information in simplistic terms to ensure safe wildland firefighting operations.*

*Wildland-urban Interface fire.*

*Fire potential climatological analysis for black spruce forests in Hay River, Northwest Territories (1954-1996), based on the CFFDRS.*

**Hay River, NWT (1954 - 1996)**
**Black Spruce Forests**

| Fire Danger | HFI* Class | Average Number of Days | | | | | |
|---|---|---|---|---|---|---|---|
| | | May | June | July | August | Sept. | Season |
| Low | 1&2 | 14 | 8 | 10 | 10 | 16 | 58 |
| Moderate | 3 | 9 | 9 | 9 | 11 | 8 | 46 |
| High | 4 | 4 | 4 | 5 | 4 | 2 | 19 |
| Extreme | 5&6 | 6 | 9 | 9 | 7 | 3 | 34 |

* HFI = Head Fire Intensity
Classes: 1) <10 kW/m; 2) 10-500 kW/m; 3) 500-2 000 kW/m; 4) 2 000-4 000 kW/m; 5) 4 000-10 000 kW/m; and 6) >10 000 kW/m

**What is Extreme Fire Behavior?**

*A level of fire behavior that often precludes any fire suppression action, and usually involves one or more of the following characteristics: high rate of spread and frontal fire intensity crowning, prolific spotting, presence of large fire whirls, and a well-established convection column. Fires exhibiting such phenomena often behave in an erratic, sometimes dangerous, manner.*

**2. Wildland fire behavior training course delivery and development at the national level, including the Canadian Interagency Forest Fire Centre's (CIFFC) Advanced Wildland Fire Behavior and Wildland Fire Behavior Specialist courses.**

*CD-ROM based courses on wildland fire behavior, fire safety, and fire danger rating.*

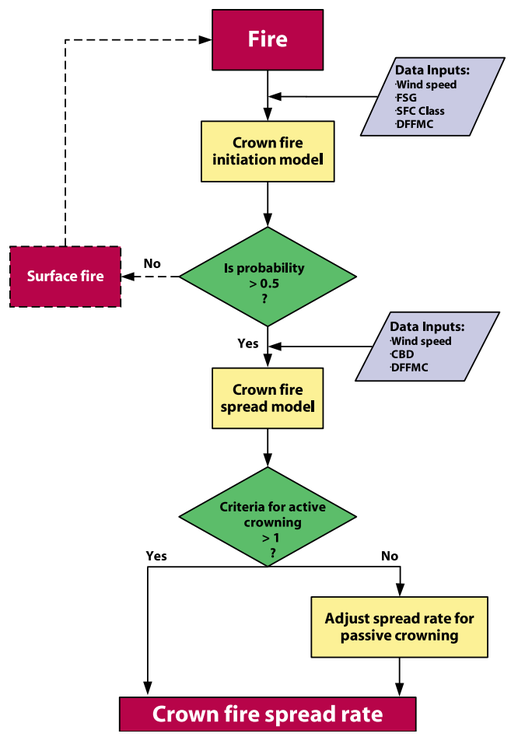
*CD-ROM based wildland fire training session in progress.*

*Actively crowning forest fire.*

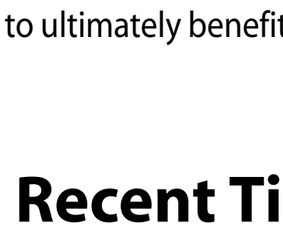
**Crown Fire Behavior Model Inputs**

- Wind speed at a height of 10 m in the open (km/h) – measured, estimated, or forecasted;
- Fuel strata gap (FSG) or crown base height (m) – measured, estimated, or model output;
- Surface fuel consumption (SFC) class – estimated or model output;
- Dead fine fuel moisture content (DFFMC, %) – estimated from Rothermel's (1983. USFS Gen. Tec. Rep. INT-143) tables; and
- Crown or canopy bulk density (CBD, $kg/m^3$) – estimated or model output

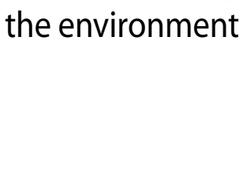
*Diagram of information flow for the prediction of crown fire behavior.*




**3. Development of new, generic models for predicting extreme fire behavior (e.g., initiation and spread of crown fires, including canopy fuel properties).**



*The ICFME study area. The experimental plots averaged 150 x 150 m in size.*



*High intensity flame front associated with ICFME experimental crown fire soon after ignition.*

**4. The International Crown Fire Modelling Experiment (ICFME), which has provided new insights into the nature of crown fires and the opportunity to test/evaluate several fuel management theories.**

All of these activities have been undertaken with the assistance of numerous regional, national, and international partners and with a strong sense of social responsibility in order to ultimately benefit the environment and everyone.

## Major Partners in Recent Times

- Government of the Northwest Territories, Department of Resources, Wildlife and Economic Development
- Alberta Sustainable Resource Development, Hinton Training Centre
- Associação para o Desenvolvimento da Aerodinâmica Industrial (Portugal)
- New Zealand Forest Research
- University of Montana, School of Forestry
- University of New Brunswick, Faculty of Forestry and Environmental Management
- United States Department of Agriculture, Forest Service

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