

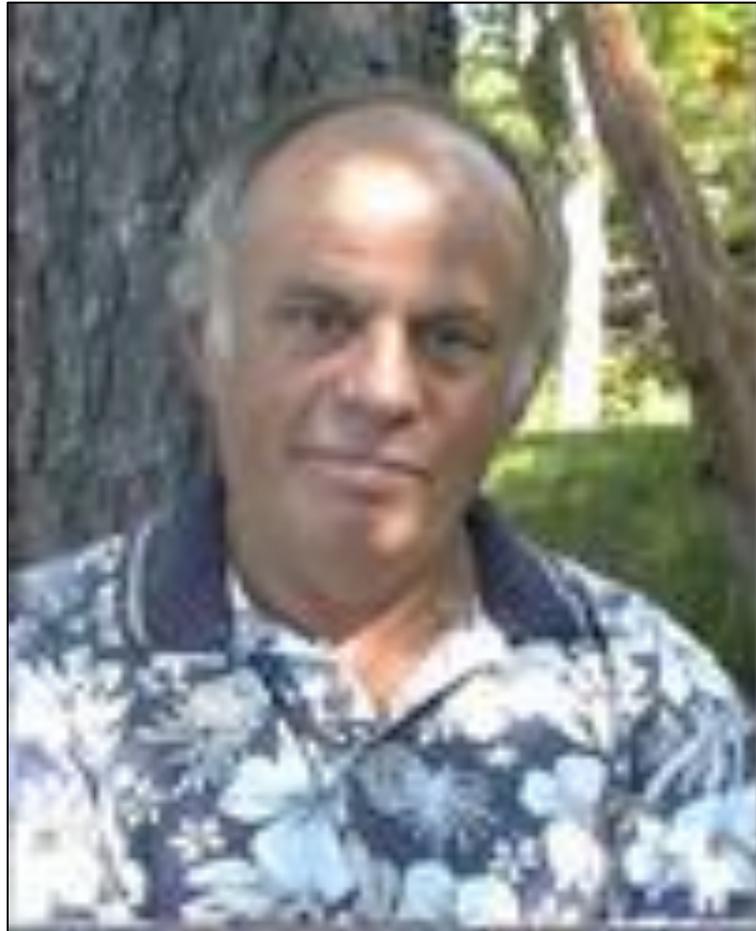
# Reflecting on the 1992 Canadian Forest Fire Behavior Prediction (FBP) System

Martin E. Alexander & Brian J. Stocks  
Canadian Forest Service (retired)



November 18-21, 2019 – Ottawa, Ontario

## Co-author: BJ Stocks



Present Day

**Co-author: BJ Stocks**



1973

# Other 1992 FBP System Architects



Charlie Van Wagner



Bruce Lawson



Rob McAlpine



Tim Lynham

# Post-1992 Contributors



Mike Wotton



Steve Taylor

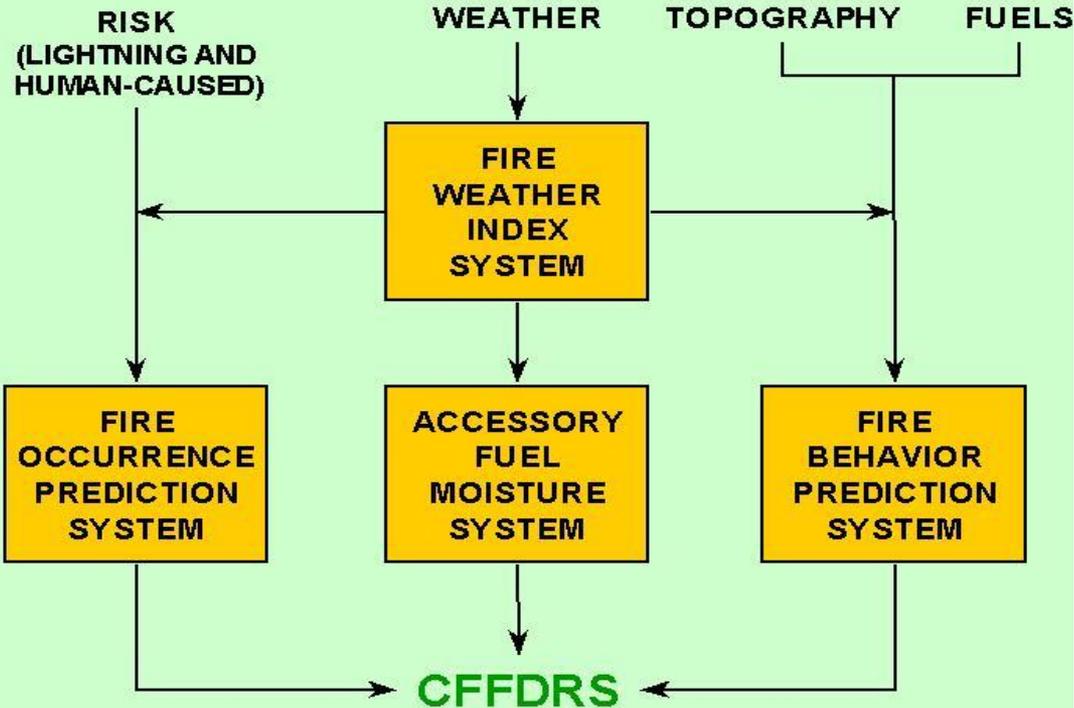
## **Purpose of Presentation**

**A number of issues surrounding the FBP System have arisen amongst both fire management personnel and fire researchers alike since the completion of the first edition of the system in 1992.**

**Here we offer some commentary in regards to these issues and related matters based on our perspective of having been involved in the development of the system.**

# CANADIAN FOREST FIRE DANGER RATING SYSTEM (CFFDRS)

Alexander, Stocks, Lawson (1996)



FIRE MANAGEMENT RESOURCES AND VALUES AT RISK

GUIDES AND OTHER SYSTEM DEVELOPED BY FIRE MANAGEMENT AND FIRE RESREACH

FIRE MANAGEMENT PROBLEMS AND OPPORTUNITIES

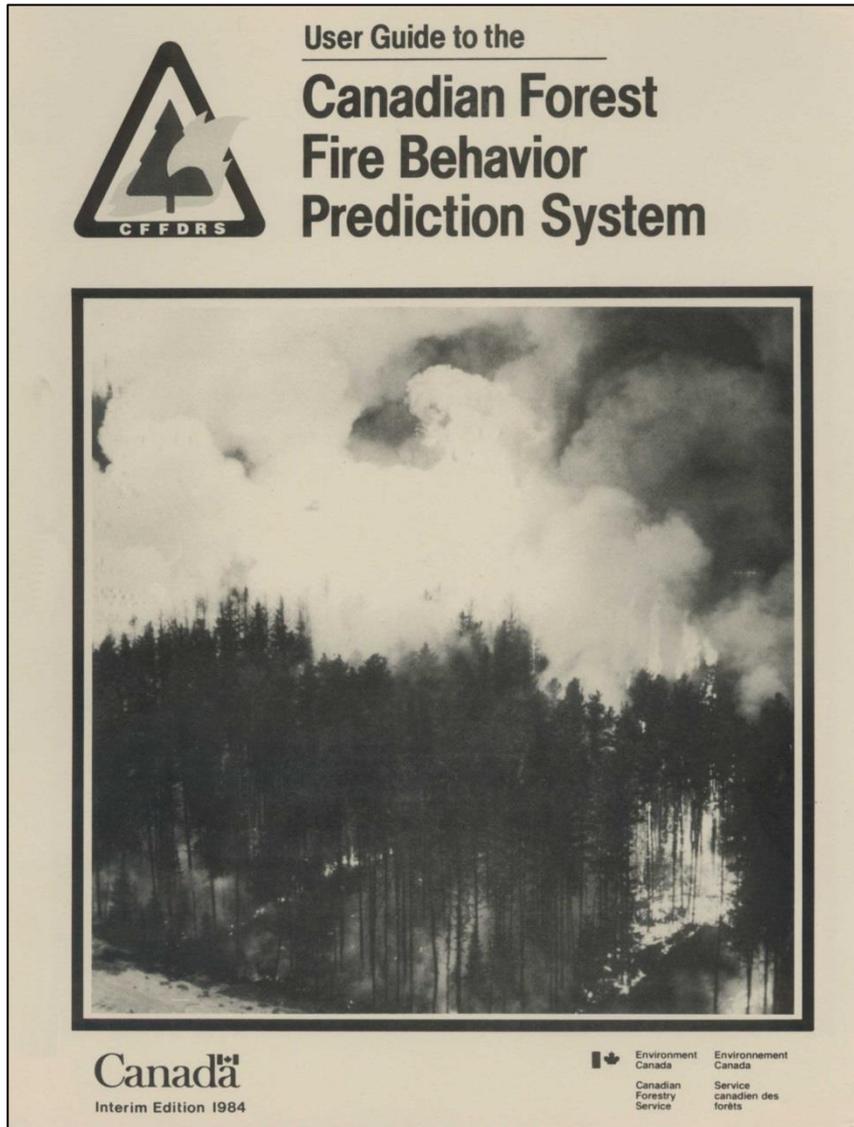
FIRE MANAGEMENT DECISION(S) AND SOLUTION(S)



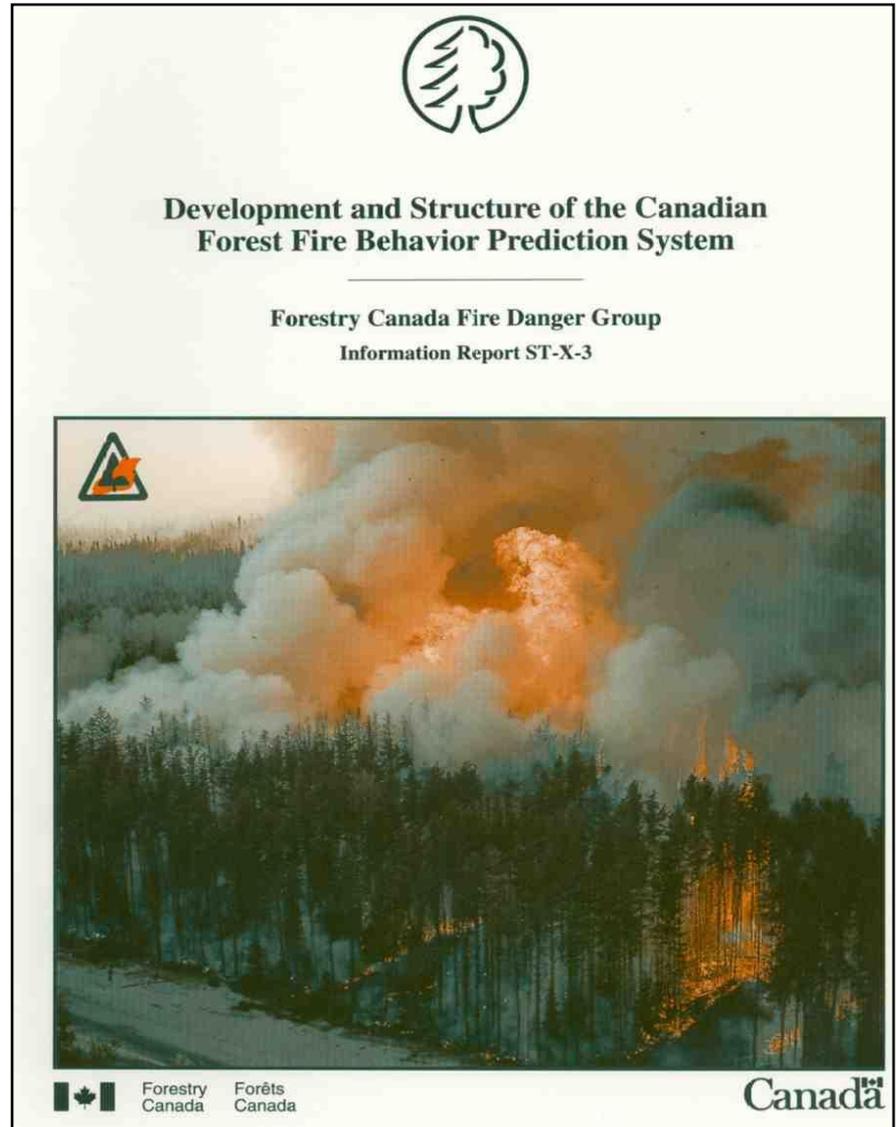
# Examples of Applications of the FBP System

- Canadian Wildland Fire Information System
- Prometheus wildland fire growth model
- Burn-P3
- CanFIRE
- Prescribed Fire Analysis System
- RedAPP
- ON Modifying Industrial Operations Protocol
- BC Operational Safe Work Standard #5
- Advanced Wildland Fire Behaviour & Wildland Fire Behaviour Specialist Training Courses
- Fire Behaviour Forecasts & Fire Safety Briefings
- Fire Research Studies (e.g., climate change)

# FBP System Technical Documentation – part 1

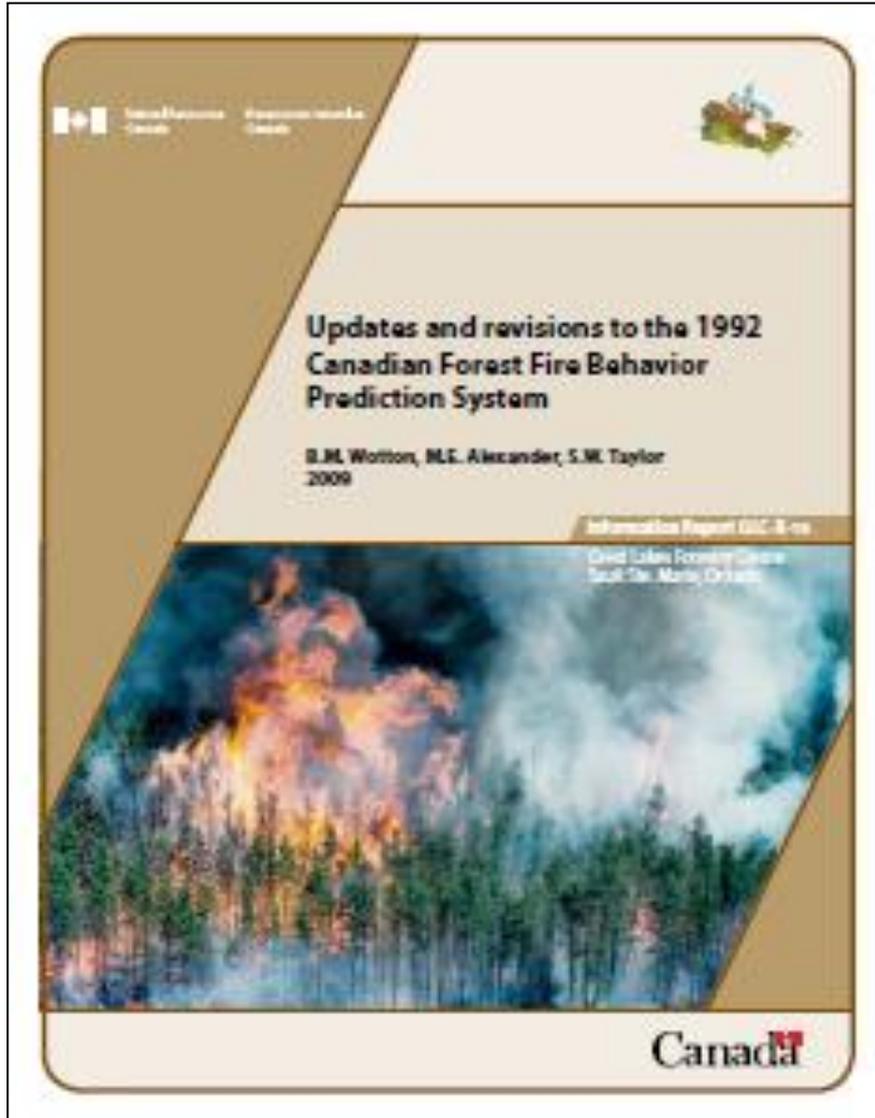


Alexander, Lawson, Stocks, Van Wagner (1984)

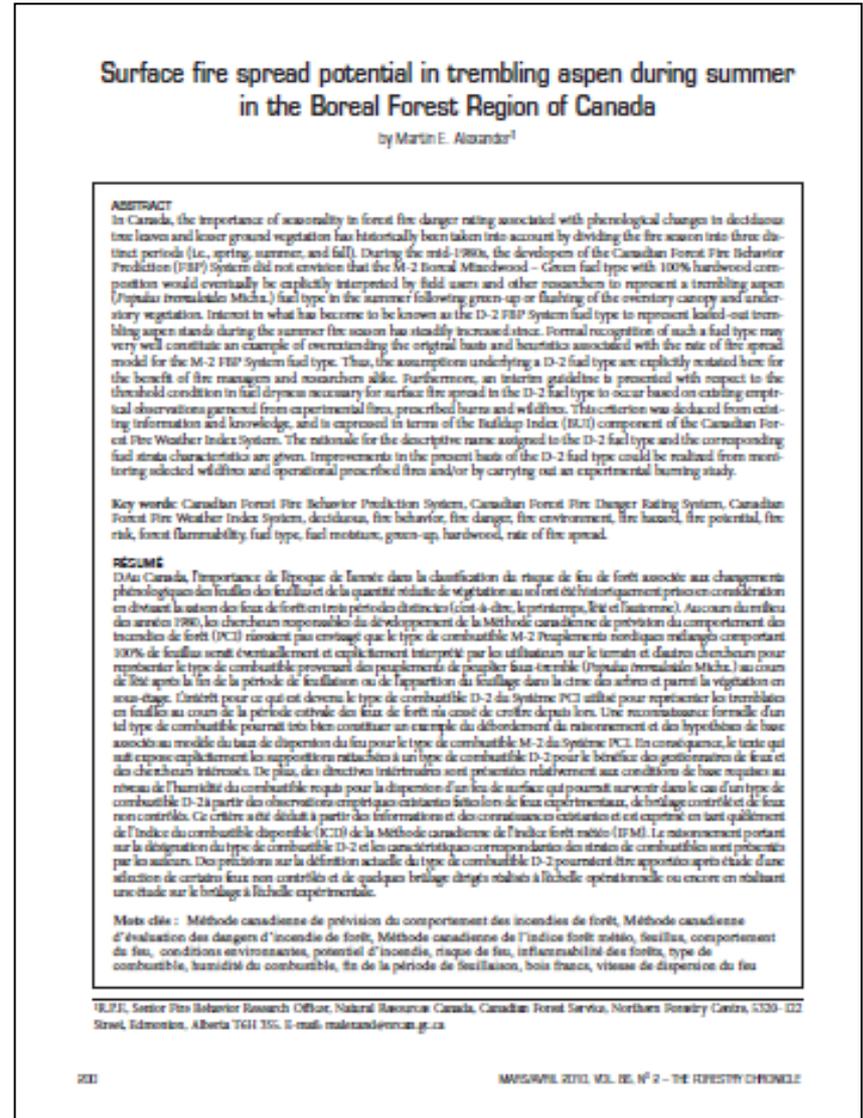


Forestry Canada Fire Danger Group (1992)

# FBP System Technical Documentation – part 2



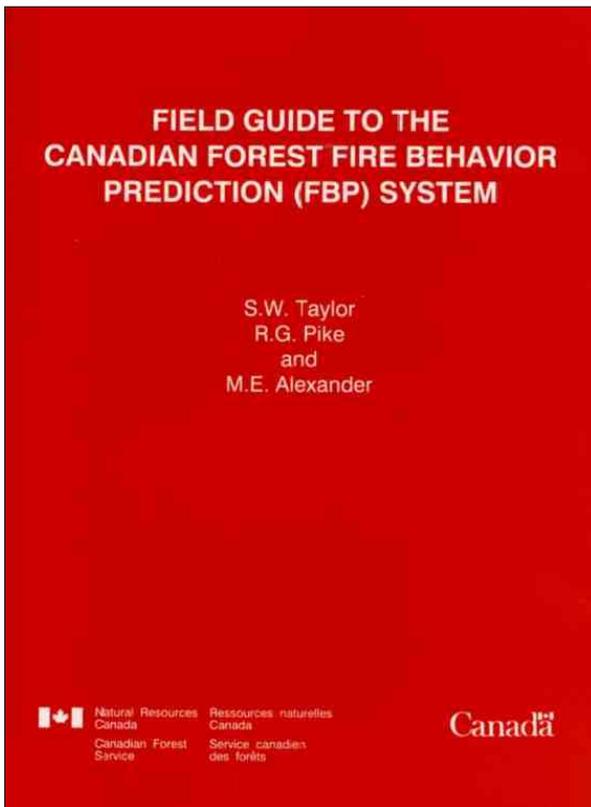
Wotton, Alexander, Taylor (2009)



Alexander (2010)

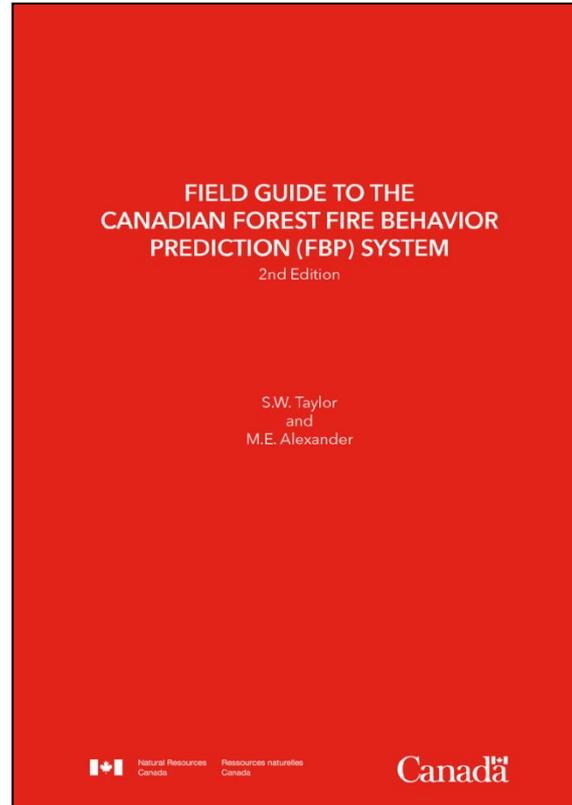
# FBP System Field Guide or “Red Book”

**1<sup>st</sup> Edition - 1997**



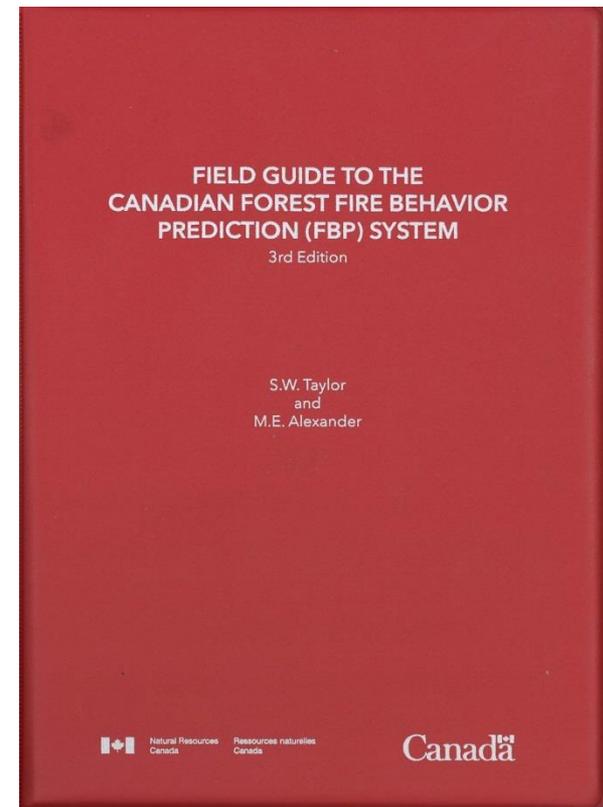
Taylor, Pike, Alexander (1997)  
(~14K copies sold)

**2<sup>nd</sup> Edition - 2016**



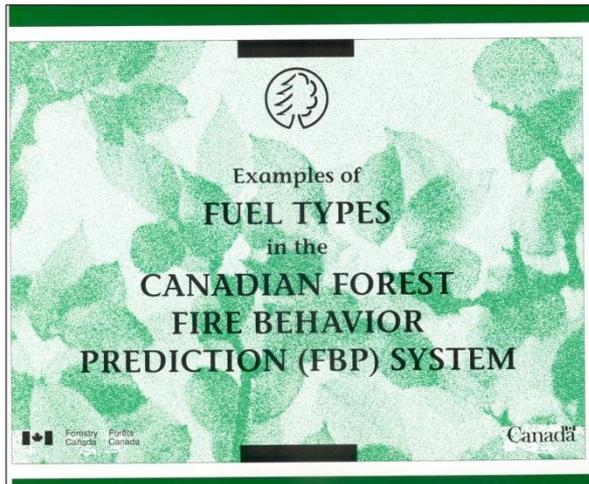
Taylor & Alexander (2016)

**3<sup>rd</sup> Edition - 2018**

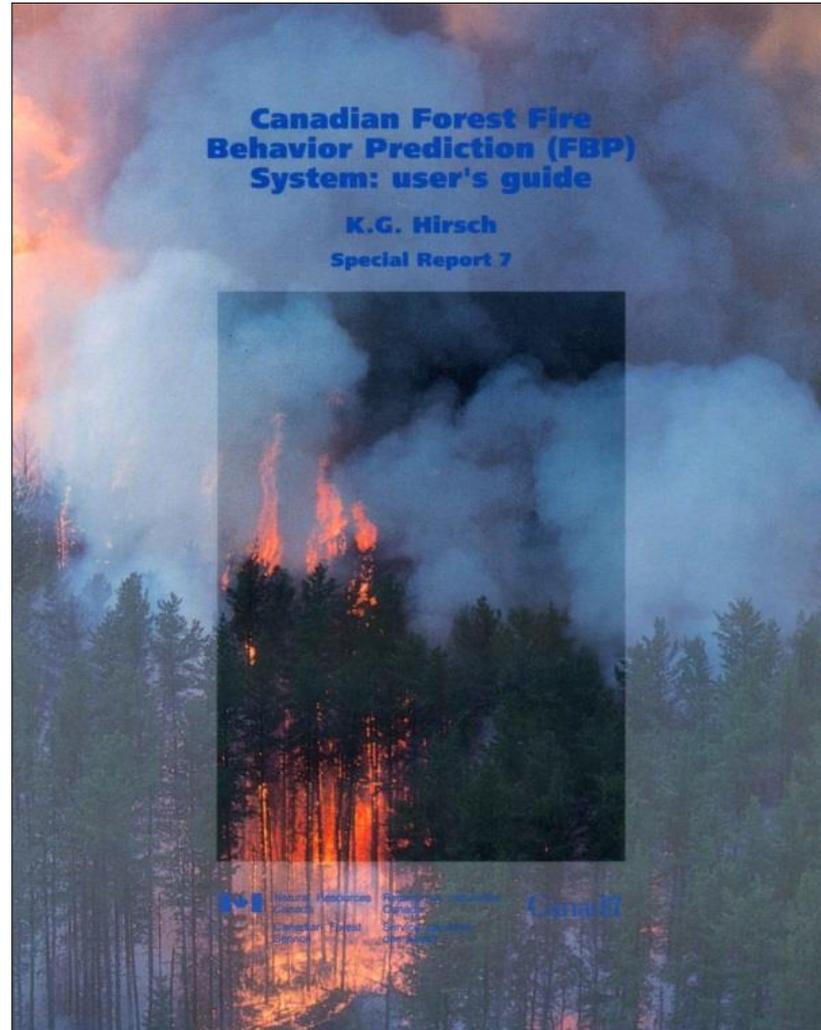


Taylor & Alexander (2018)

# FBP System Technology Transfer Materials



De Groot (1993)

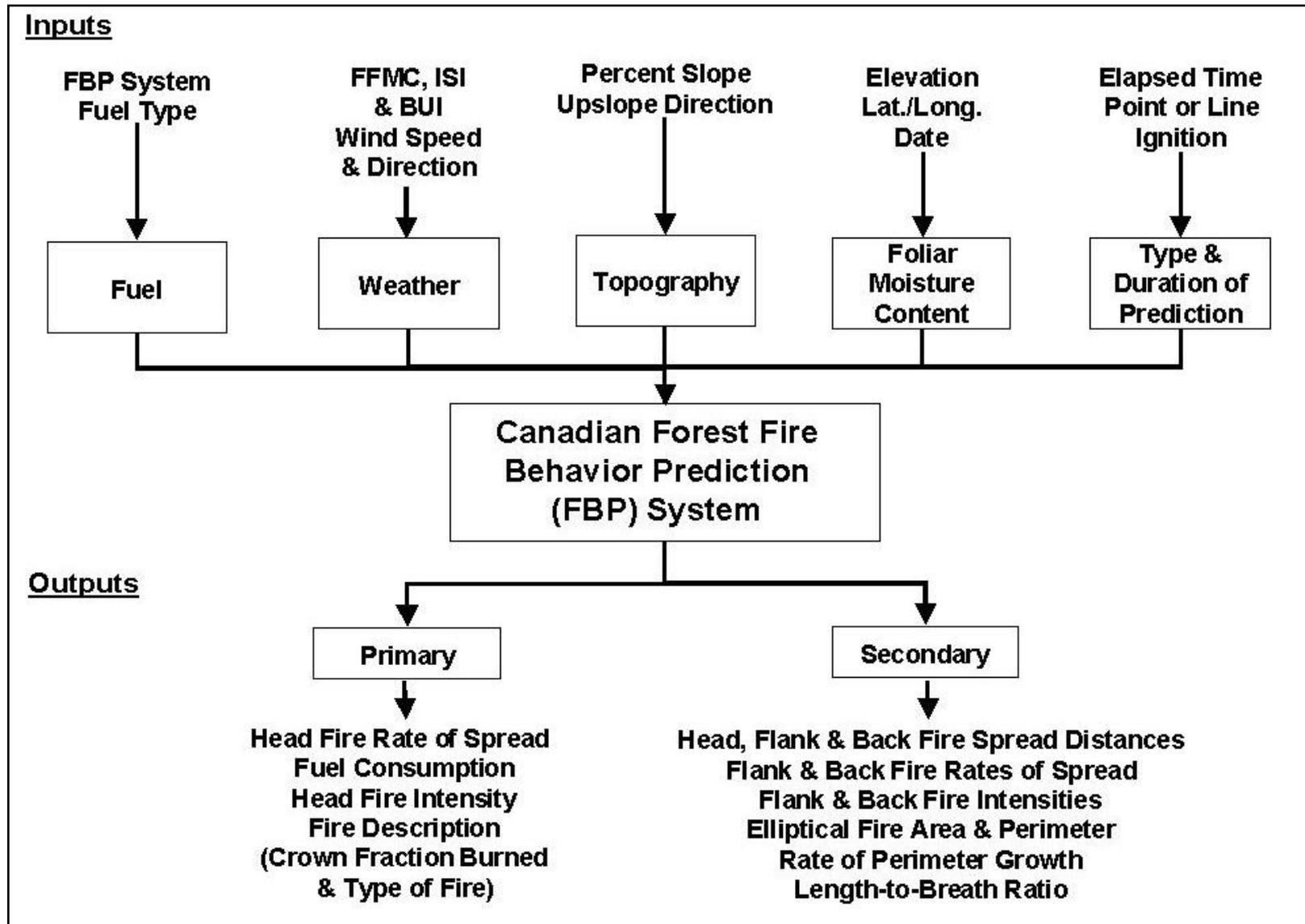


Hirsch (1996)



Hirsch (1998)  
(now web-based)

# Structure of the FBP System



# Three Basic Approaches to Wildland Fire Behavior Model Development

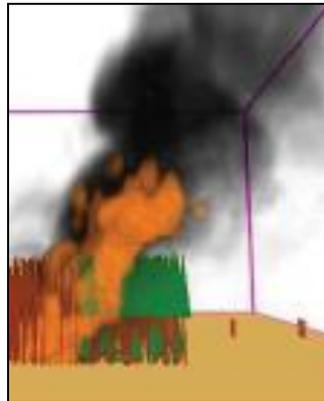
- Outdoor fires



- Laboratory fires



- Physics-based modelling



**Experimental Fires**



**The FBP System database is comprised of three basic types of empirical fire behavior information**



**Operational Prescribed Fires**



**Wildfires**

From Hirsch (1996)

Alaska



US Lake States

Note: more than 1 fire may have occurred at any given location.

# Experimental burning is at the core of the FBP System



**Experimental  
fire C6, May 31,  
1967**

**Red pine  
plantation  
plot**

Note person (BJ Stocks) just left of centre.

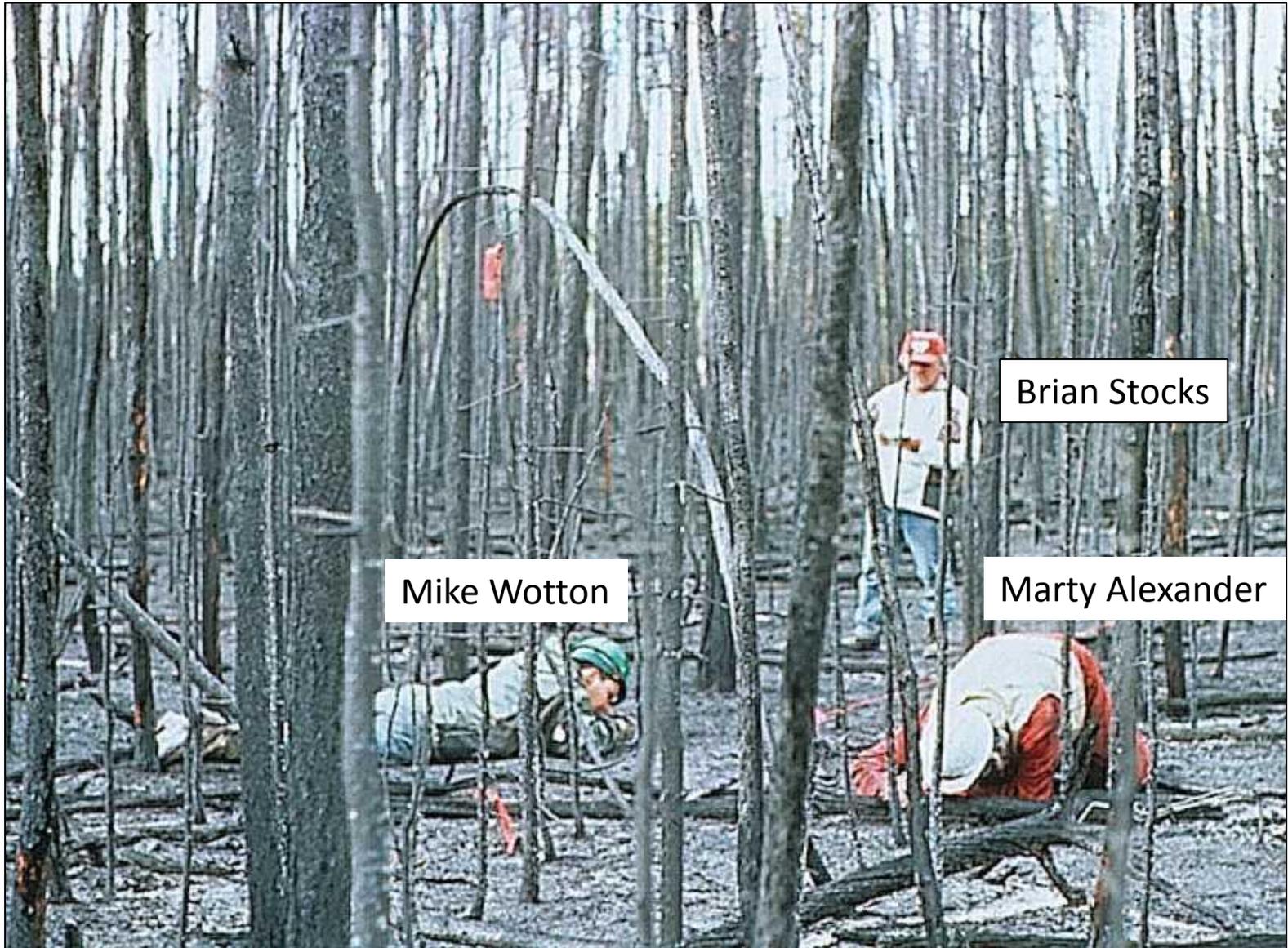
**Petawawa Forest Experiment Station, Chalk River, ON**

# Experimental burning can be a dirty business



Chris Stefner – CFS: after a day of post-burn crown weight sampling

# There are a variety of ways to get dirty!



Depth of Burn Measurements

**Kenshoe L.ake, Ontario (C-3)**



**Sharpsand Creek, Ontario (C-4)**



**Aubinadong River, Ontario (M-3/M-4)**



**Big Fish Lake, Alberta (C-2)**

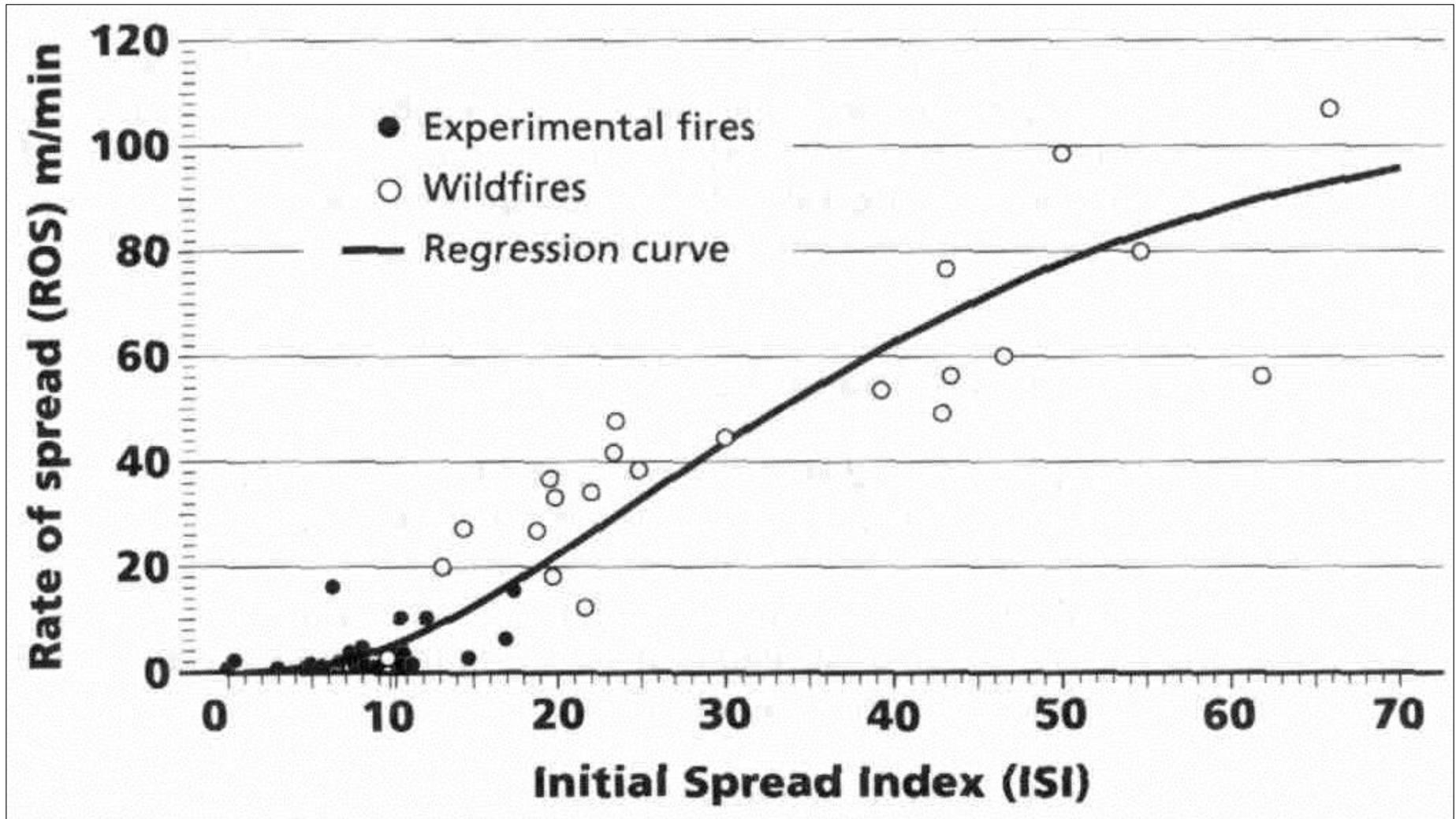


# Outdoor Experimental Burning

- Basic approach was to burn over as broad a range of Initial Spread Index (ISI) values as possible (i.e., up to about 18 – e.g., FFMC 93, wind 20 km/h). **Predictability ultimately comes about from burning over a range of conditions.**
- Typically not possible to burn at very high BUI levels (>80) due to wildfire situations.
- As a result of restrictions on conducting experimental fires, it becomes necessary to rely upon wildfire observations to obtain “upper end” data.

**Requires a great deal of perseverance!**

# Basic rate of spread curve for FBP System Fuel Type C-3 (Mature Jack or Lodgepole Pine)



# List of Current FBP System Fuel Types

| Group     | Identifier | Descriptive Name                        | Modifier   |
|-----------|------------|---|--|
| Conifer   | 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                      | Crown base height can vary                           |
|           | C-7        | Ponderosa pine/Douglas-fir              | -  |
| Deciduous | D-1        | Leafless aspen                          | -  |
|           | D-2        | Green aspen                             | -  |
| Mixedwood | M-1        | Boreal mixedwood – leafless             | Must specify % conifer/hardwood                      |
|           | M-2        | Boreal mixedwood – green                | Must specify % conifer/hardwood                      |
|           | M-3        | Dead balsam fir mixedwood – leafless    | Must specify % dead fir                              |
|           | M-4        | Dead balsam fir mixedwood – green       | Must specify % dead fir                              |
| 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       | Matted grass                            | Must specify degree of curing and fuel load can vary |
|           | O-1b       | Standing grass                          |  |

**C-1**



**C-2**



**C-3**



**C-4**



**C-5**



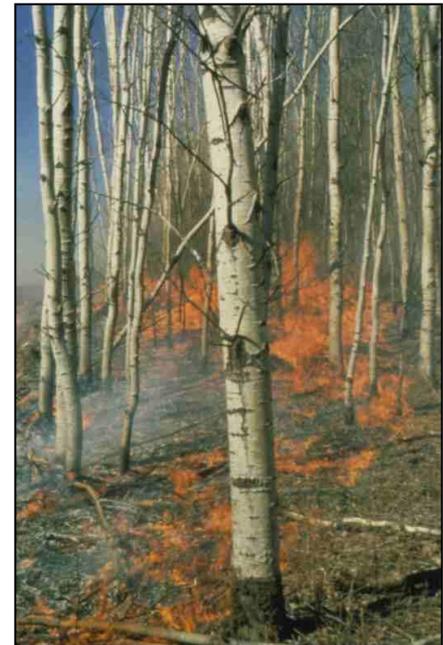
**C-6**



**C-7**



**D-1**



# D-2





**M-1 & M-2**



# ON Experimental Fires in Boreal Mixedwood\*

| Fire behavior                  | Plot 1 | Plot 2 | Plot 3 |
|--------------------------------|--------|--------|--------|
| <b>Observed</b>                |        |        |        |
| ROS (m/min)                    | 8.84   | 12.86  | 3.72   |
| HFI (kW/m)                     | 2236   | 3420   | 789    |
| Area Burned (ha)               | 1      | 1      | 1      |
| <b>FBP System Predictions</b>  |        |        |        |
| ROS (m/min)                    | 8.51   | 11.65  | 7.17   |
| HFI (kW/m)                     | 3538   | 7522   | 1939   |
| Area Burned (ha)               | 1.04   | 0.99   | 4.94   |
| <b>U.S. BEHAVE Predictions</b> |        |        |        |
| ROS (m/min)                    | 1      | <0.1   | <0.1   |
| HFI (kW/m)                     | 121    | 15     | 12     |
| Area Burned (ha)               | <0.01  | <0.01  | <0.01  |

\*from Hely, Flannigan, Bergeron and McRae (2001)

**M-3**



**M-4**



**S-1**

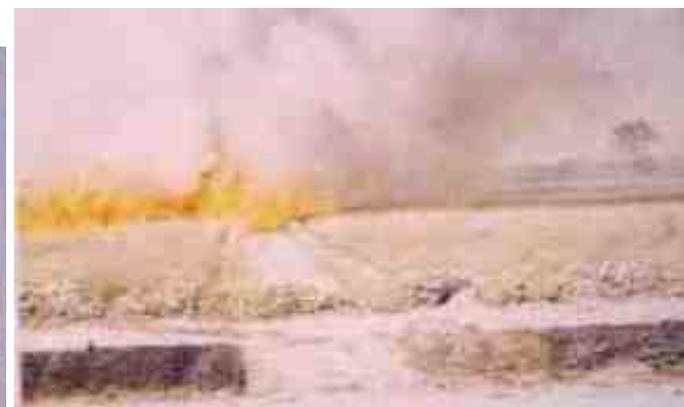


**S-2**



**S-3**





**O-1a & O1-b**

# Experimental Fire Escapes

(a few have happened)



Wildfire CR-06-82: "Porter Lake"

# The Importance of Agency Cooperation and Inter-personal Relationships

**Required extensive commitment and collaboration from fire management agencies, with considerable risk involved.**



Rick Lanoville – Northwest Territories



Dale Huberdeau - Alberta

# Development of the FBP System required numerous people working together over many years towards a common goal



Darwin Lake, AB: 1974



Porter Lake, NWT: 1982



Bigfish Lake, AB: 1984-1989



ICFME, NWT: 1995-2001

## **ISSUE #1:**

**“There aren’t enough  
fuel types”**

**or “none fit my  
particular situation”**

:

**The existing list of FBP System fuel types “... represents as broad a range of conditions in Canadian fuel types as allowed by the existing fire behavior database ...”**

***“The list of fuel types is not intended to be comprehensive or fixed for the future; additions and refinements will be made as data become available.”***

**From page 3 of ST-X-3**

**Have always stressed fuel structure  
and not descriptive names**



# **Other Related Developments in Fire Behaviour Research Since 1992**

- International Crown Fire Modelling Experiment**
- FERIC/FP Innovations Fuel Treatments & Simulated Mountain Pine Beetle (MPB) Attack**
- MBP Attacked Lodgepole Pine, BC**
- Blowdown Fuel Type, northern Ontario**
- Tall Grass Prairie Fuel Type, southern Ontario**
- Shrub Fuel Type (“Nova Scotia Special”)**

# International Crown Fire Modelling Experiment (ICFME): 1995-2001

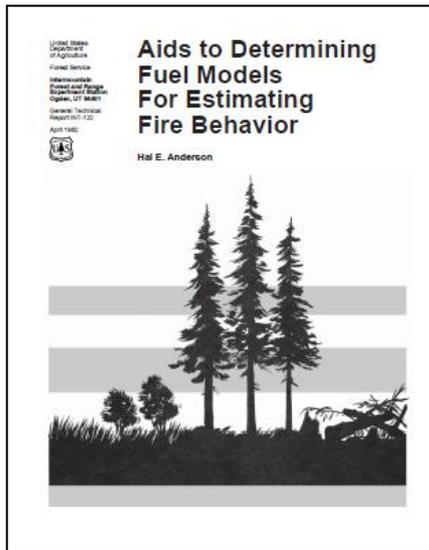


**ISSUE #2:**  
**“The FBP System is  
inflexible”**

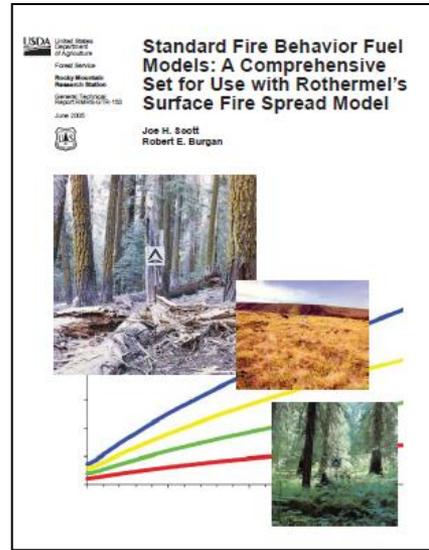
## **This is not necessarily true. Consider for a moment the fact that you currently:**

- Can vary the crown base height in the conifer plantation fuel type.
- Can account for the seasonality in the aspen, boreal mixedwood, dead balsam fir mixedwood and grass fuel types.
- Can vary the % conifer/hardwood composition in the boreal mixedwood fuel types.
- Can vary the % dead fir in the balsam fir mixedwood fuel types.
- Can vary the fuel load in grass fuel types.

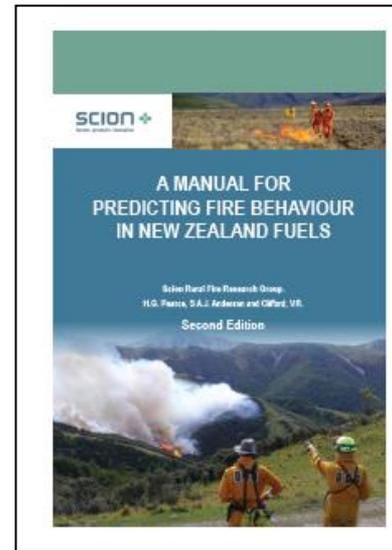
# Static or stylized fire behaviour – fuel model classifications are commonly inflexible



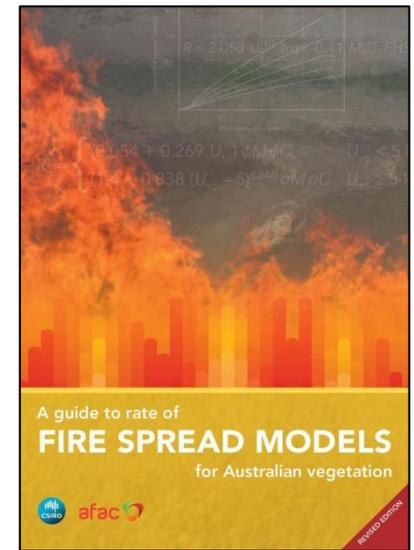
US



US



NZ



OZ

**ISSUE #3:**  
**The FBP System lacks  
quantification**

# Maximum Surface Fuel Loads of FBP System Fuel Types

| Group     | Identifier | Descriptive Name                        | Maximum Surface Fuel Load<br>(t/ha) |
|-----------|------------|---|-------------------------------------|
| Conifer   | C-1        | Spruce-lichen woodland                  | 15.0                                |
|           | C-2        | Boreal spruce                           | 50.0                                |
|           | C-3        | Mature jack or lodgepole pine           | 50.0                                |
|           | C-4        | Immature jack or lodgepole pine         | 50.0                                |
|           | C-5        | Red and white pine                      | 50.0                                |
|           | C-6        | Conifer plantation                      | 50.0                                |
|           | C-7        | Ponderosa pine/Douglas-fir              | 35.0                                |
| Deciduous | D-1        | Leafless aspen                          | 15.0                                |
|           | D-2        | Green aspen                             | 15.0                                |
| Mixedwood | M-1        | Boreal mixedwood – leafless             | 50.0                                |
|           | M-2        | Boreal mixedwood – green                | 50.0                                |
|           | M-3        | Dead balsam fir mixedwood – leafless    | 50.0                                |
|           | M-4        | Dead balsam fir mixedwood – green       | 50.0                                |
| Slash     | S-1        | Jack or lodgepole pine slash            | 80.0                                |
|           | S-2        | White spruce/balsam slash               | 160.0                               |
|           | S-3        | Coastal cedar/hemlock/Douglas-fir slash | 320.0                               |
| Open      | O-1a       | Matted grass                            | 3.5                                 |
|           | O-1b       | Standing grass                          | 3.5                                 |

## **End-user Expectations**

***“Consider that nearly every move and decision in fire control management depends on decent estimates of ignition potential and fire behavior.***

***It seems as though the better these estimates become, the greater is the pressure for better ones still.”***

C.E. Van Wagner (1985)

# **The Silver Bullet Syndrome in Fire Behavior Prediction**

**This occurs when end-users expect fire behavior researchers to come up with a new system to solve their latest problems.**

**Unfortunately there are no quick fixes or “silver bullets”.**

**The ability to predict or forecast fire behavior must be learned.**



## **Second Thoughts**

- **Should we have thought more about paired plot setups where fuel treatments could have been studied had we recognized that the WUI would become such a major issue?**
- **Should we have thought more about having multiple burning sites across the country where we could have moved to as burning conditions dictated?**
- **Should we have thought more about novel or new fuel types?**

## **Alternatives to the FBP System**

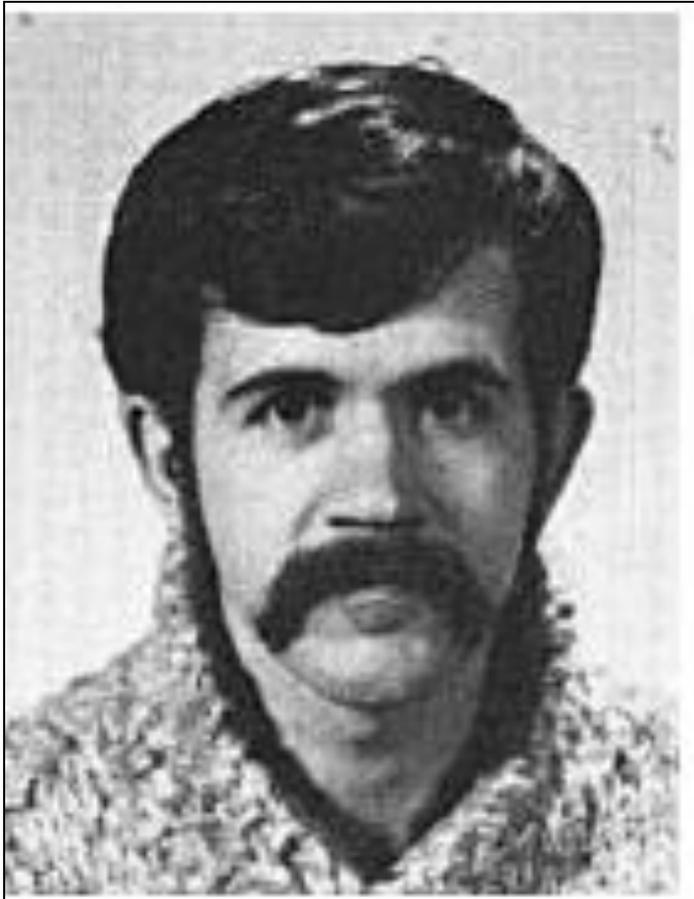
- **A universally-accepted system for predicting fire behavior in any fuel complex does not presently exist and is unlikely to appear in the near future.**
- **How about the Rothermel surface & crown fire models? Known to under-predict ROS in slash and conifer forest cover types by a factor of 2-3.**
- **Many unknowns exist with respect to the validity of physics-based models (e.g. WFDS, FIRETEC).**
- **What about the CCP system?**

# Future Challenges

- **Are fire management agencies still willing to support experimental burning and if so what kind (e.g., ignition test fires, surface fires, crown fires)?**
- **Is there an appetite by senior research managers to support the commitment required in terms of staff time and \$ to undertake experimental burning?**

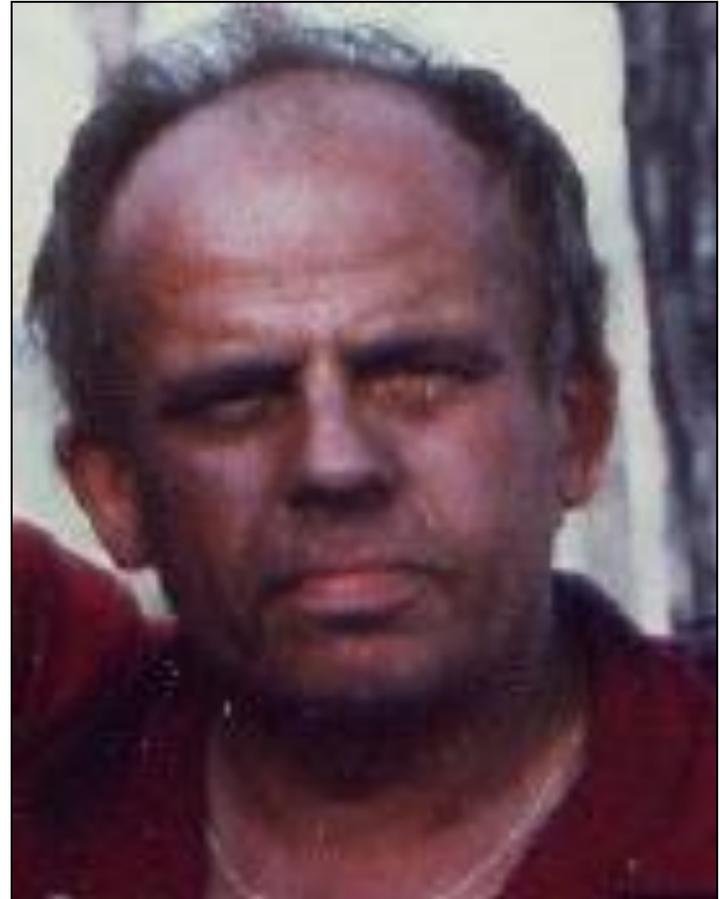
# Thank you for your attention!

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1993