

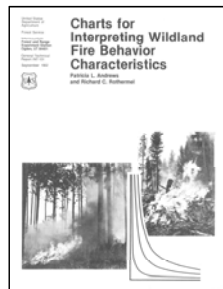
# Fire Characteristics Charts for Fire Behavior and U.S. Fire Danger Rating

Faith Ann Heinsch and Patricia L. Andrews

U.S. Forest Service, Missoula Fire Sciences Lab; faheinsch@fs.fed.us

## Introduction

- ❖ Graphical method for presenting data
  - ❖ U.S. National Fire Danger Rating System (NFDRS)
  - ❖ Surface or Crown Fire Behavior
- ❖ Displays relationships among relevant variables on a single chart
  - ❖ Improvement over the fire characteristics chart in BehavePlus.
    - ❖ Better options for displaying data (change scale, color, label, and legend)
    - ❖ Addition of Fire Danger Rating chart
- ❖ Fire Danger Rating chart can be used for:
  - ❖ Comparing years or months of data at a single station
  - ❖ Comparing weather stations or fuel models
- ❖ Fire Behavior charts can be used for
  - ❖ Examining effect of changes in fuel model or wind speed on fire behavior
  - ❖ Fire documentation, prescribed fire plans, and briefings



Bill Simpson, Florida DACS



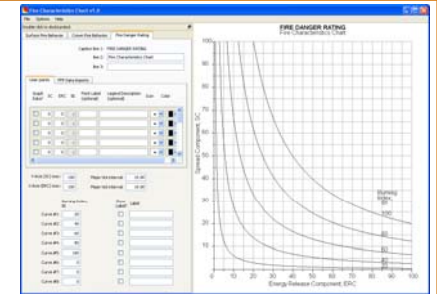
## Obtaining the Program

- ❖ Fire Danger Rating Fire Characteristic Chart available in 2011
  - ❖ Obtain a beta version by contacting the authors.
- ❖ Fire Behavior Fire Characteristics Charts available now; download from the BehavePlus section of [www.FireModels.org](http://www.FireModels.org)
  - ❖ Current version of the program
  - ❖ Documentation
  - ❖ Status
  - ❖ Example applications (Contact the authors to submit an example application.)



## U.S. Fire Danger Rating

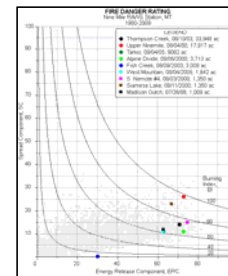
- ❖ Demonstrates relationship among
  - ❖ Spread Component (SC)
  - ❖ Energy Release Component (ERC)
  - ❖ Burning Index (BI)
- ❖ Indices calculated using FireFamilyPlus can be imported.



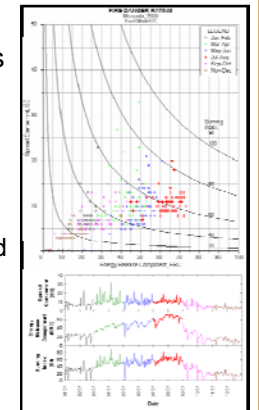
## U.S. Fire Danger Rating Applications

### Fire activity

- ❖ Explore relationships between fire activity and NFDRS indices
- ❖ Compare 30-years of indices with major fires of the same time frame (left).
- ❖ Examine seasonal indices to establish periods of high to extreme fire danger associated with active fires (right).

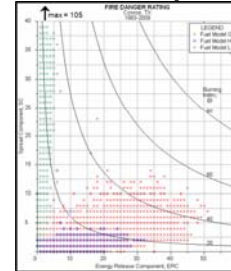


### Seasonal Trends



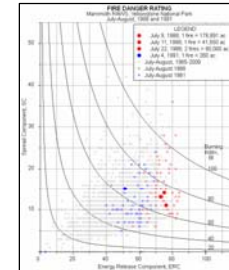
### Fuel model comparison

- ❖ Fuel models (G, H and L, above) can be compared, displaying the information contained in each one.



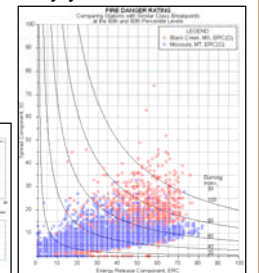
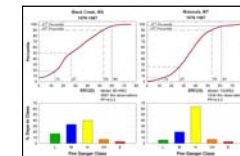
### Interannual Variability

- ❖ Compare indices for July-August during a wet (1991) and a dry (1988) year at Mammoth, WY.
- ❖ Interannual variability may be significant, although fires may occur in both wet and dry years.



### Similar breakpoints, different fire seasons

- ❖ Mississippi (MS) and Montana (MT) have the same class breakpoints, but very different fire seasons.
- ❖ The Fire Characteristics Chart reveals differences hidden in statistical analysis
- ❖ Fire activity should be considered prior to setting threshold values.

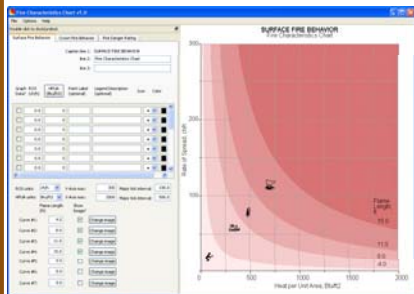


# Surface and Crown Fire Behavior

- ❖ Demonstrates relationship among
  - ❖ Rate of Spread (ROS),
  - ❖ Flame Length (FL)
  - ❖ Heat per Unit Area (HPUA)
- ❖ Fire behavior values can be observed or calculated using BehavePlus or other software.



## Surface Fire Behavior

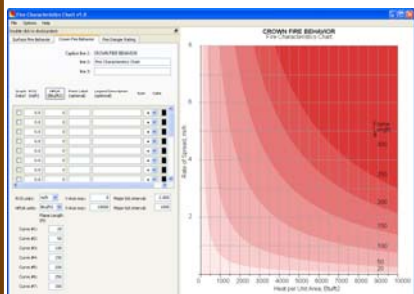


- ❖ Mathematical basis
  - ❖ Rothermel's (1972) surface fire spread model
  - ❖ Byram's (1959) fireline intensity and flame length models
  - ❖ Anderson's (1969) residence time model

Relationship of surface fire flame length and fireline intensity to suppression interpretations (Fireline Handbook, Appendix B 2006)

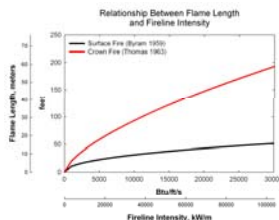
Flame Length		Fireline Intensity		Interpretation
ft	m	Btu/ft/s	kJ/m/s	
< 4	< 1.2	< 100	< 350	<ul style="list-style-type: none"> <li>• Fires can generally be attacked at the head or flanks by persons using hand tools.</li> <li>• Hand line should hold the fire.</li> </ul>
4 - 8	1.2 - 2.4	100 - 500	350 - 1700	<ul style="list-style-type: none"> <li>• Fires are too intense for direct attack on the head by persons using hand tools.</li> <li>• Hand line cannot be relied on to hold the fire.</li> <li>• Equipment such as dozers, pumps, and retardant aircraft can be effective.</li> </ul>
8 - 11	2.4 - 3.4	500 - 1000	1700 - 3500	<ul style="list-style-type: none"> <li>• Fires may present serious control problems -- torching out, crowning, and spotting.</li> <li>• Control efforts at the fire head will probably be ineffective.</li> </ul>
> 11	> 3.4	> 1000	> 3500	<ul style="list-style-type: none"> <li>• Crowning, spotting, and major fire runs are probable.</li> <li>• Control efforts at head of fire are ineffective.</li> </ul>

## Crown Fire Behavior



- ❖ Mathematical basis
  - ❖ Rothermel's (1991) crown fire spread model
  - ❖ Byram's (1959) fireline intensity model
  - ❖ Thomas' (1963) flame length model
  - ❖ Albini's (1976) burnout model

- ❖ Different models used to calculate flame length from fireline intensity for surface and crown fires
- ❖ Difference is significant
  - ❖ FLI = 3000 Btu/ft/s leads to surface fire FL = 18 ft and crown fire FL = 42 ft.
- ❖ Two charts prevent misinterpretation



# Fire Behavior Applications

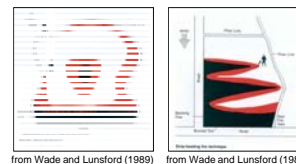
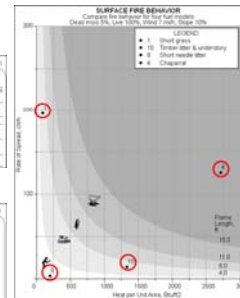
**Fuel model comparison for identical environmental conditions (e.g., fuel models 1, 10)**

- ❖ Similar flame lengths (6.5 ft)
- ❖ Similar fireline intensity
- ❖ Neither controllable using hand tools
- ❖ Very different fire behavior (rate of spread and heat per unit area)

BehavePlus v5.0  
Inputs



Outputs

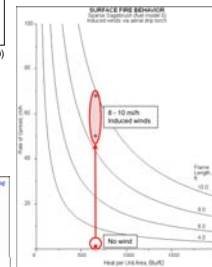
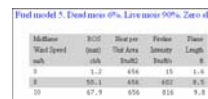


from Wade and Lunsford (1989) from Wade and Lunsford (1989)

## Use in prescribed fire planning

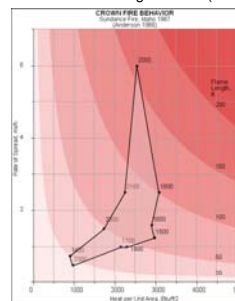
- ❖ BehavePlus calculates steady state fire behavior.
- ❖ But, fire behavior can be controlled by ignition pattern .
- ❖ This behavior can be illustrated on charts.
- ❖ Charts can be included in prescribed fire burn plans.

BehavePlus  
v5.0 Outputs



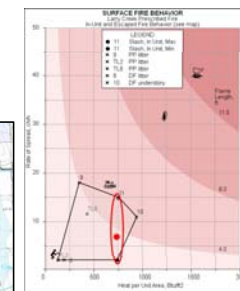
## Sundance Fire, Idaho

1 September 1967  
Observed hourly ROS (Anderson 1968)  
FL calculated using Thomas (1963)



## Range of actual or predicted fire behavior

- ❖ Plots of observed fire behavior (left)
- ❖ Prescribed fire chart (below) with potential fire behavior for
  - ❖ prescribed fire unit
  - ❖ spotting outside burn area



## Additional Information

Andrews, P. L.; Heinsch, F.A.; Schelvan, L. [in review]. Generating and interpreting fire characteristics charts for surface and crown fire behavior  
 Andrew, P.L.; Rothermel, C. 1981. Charts for interpreting wildland fire behavior characteristics. Gen. Tech. Rep. INT-131.  
 Heinsch, F. A.; Andrews, P. L. [in prep]. Fire characteristics charts for U.S. fire danger rating.



# Fire, Fuel, and Smoke Science Program

