Advanced Wildland Fire Behavior Calculations, S-490

Pre-Course Study Material

Part 3: Fire Behavior Inputs

Materials Needed:

6 or 12 inch Ruler with 1/10 inch markings
Calculator (recommended)
Pencil or pen
360 degree clear protractor

Introduction:

At its most basic level, Rothermel's spread formula is:

$$\frac{\text{Heat Received By Fuel Ahead of Fire}}{\text{Heat Required To Ignite the Fuel}} = \text{Rate of Fire Spread}$$

To solve the equation we will need to know the inputs.

What variables influence fire behavior? (Source: http://www.physics.ucsb.edu/~complex/research/hfire/fbehave/fbehave_variables.html)

These are variables summarized in the wildland fire behavior triangle: fuels, topography, and weather. Of course, many other variables fall into these headings such as slope, aspect, moisture, vegetation, etc. The influence of each variable on fire behavior is complex due to nonlinear interactions between variables. Yet, the gathering of these is basic to the use of the FBPS models.

Directions:
Part 3 is about inputs into the spread equation and other equations. Lesson 3 among the BehavePlus tutorials can be read for this section. "Basic Land Navigation" and Rothermel's "How to Predict the Spread and Intensity of Forest and Range Fires" are on the Student CD. Other references may also be used (S-290 and S-390 student workbooks).

The key concepts this part is concerned with are:

I. Fuel

A. Fuel Model

B. Fuel Moisture - live (herbaceous and woody) and dead

- 1 hour
  - Estimated from tables or from BehavePlus, may be measured.

- 10 hour
  - May be measured from 10 hour fuel sticks.

  - For BehavePlus modeling purpose this may be calculated by adding 1% to the 1-hr moisture (Mediterranean type climate) or 2% to the 1-hr fine fuel moisture (in the eastern U.S.).

  - Obtained from the nearest NFDRS RAWS station.

- 100 hour
  - For BehavePlus modeling purpose this may be calculated by adding 1% to the 10-hr moisture (Mediterranean type climate) or 2% to the 10-hr fine fuel moisture (in the eastern U.S.)

  - Obtained from the nearest NFDRS RAWS station

C. Fuel Characteristics

- Height, bark thickness, crown ratio, diameter at breast height (DBH), species, density, shading , mean cover height

D. Fire brand sources

- Piles
- Surface
- Trees
  - Number of torching trees

II. Weather

A. Windspeed
- 20 ft
- Mid-flame windspeed
- Effective windspeed

B. Wind Adjustment Factor

C. Wind direction
- In relation to slope
- Azimuth reading

III. Terrain

A. Slope steepness

B. Elevation

C. Aspect
- Effect on fuel shading

D. Characteristics (lay of the land)
- Ridge to valley distance
  - Vertical and horizontal

E. Location of spotting fuel
- Midslope, windward
- Valley bottom
- Midslope, leeward
- Ridgetop

IV. Other

A. Projection time
B. Representative Fraction
C. Contour interval
D. Surface flame length
E. Flame height

You will need to know each of the listed topics and how to obtain all of the above inputs before taking the pre-qualifying test. A practice test and answers are provided on the following pages.

Practice Test

Scenario A:

This fire is at Point A on Figure 1 (see page 7).
It is 1600 on August 12.
The RAWS is used to obtain the temperature and wind variables.

Dry bulb: 82°F.
RH: 27%
Dew point: 46°F.
20-foot windspeed: 10 mi/h.
It is a southeast wind.

1. The most appropriate fuel model is:

    a. 1
    b. 2
    c. 8
    d. 12

2. The 1-hour fine fuel moisture is:

    a. 4%
    b. 5%
    c. 6%
    d. 7%

3. The slope is:

    a. 12%
    b. 24%
    c. 6%
    d. 18%

4. In order for BehavePlus to calculate the fire behavior the direction of the wind and slope is required. It may be entered as an azimuth in relation to north or in relation to directly uphill. Draw the wind and slope lines on Figure 1 at point "A." What is the azimuth of the wind and slope lines in relation to north?

	Wind Azimuth	Slope Azimuth
a.	270°	0°
b.	315°	45°
c.	135°	225°
d.	90°	0°

5. How would you characterize the stand for determining dead fine fuel moisture and windspeed?

   a. Unshaded, partially sheltered
   b. Shaded, fully sheltered
   c. Unshaded, unsheltered
   d. Unshaded, fully sheltered

Scenario B:

This fire is at point "D" on Figure 1 (see page 7). The firefighter in the lower left corner is standing with a drip torch in heavy slash. The flames in the right are from 1 foot to 8 feet tall. The slash is the result of a timber harvest. It is about three feet deep and not compacted. All the needles are red and attached. There are no live fuels affecting the fire spread.

It is 1600 hours on August 12. The RAWS is used to obtain the temperature and wind variables. The dry bulb is 82°F. The relative humidity is 27%. The dew point is 46°F. The 20-foot windspeed is 10 mi/h. It is a north wind. The weather tonight is predicted to be clear; minimum temperature...55-65 midslopes, 45-55 elsewhere; maximum humidity...40-50% and isolated 23-29% over ridges; 20 ft wind downslope/downcanyon 3-5 mph, ridges...northeast to southeast 5-10 mph.

6. The most appropriate fuel model is:

    a. 1
    b. 4
    c. 8
    d. 11

7. The 1-hour fine fuel moisture for 2300 hours is:

    a. 4-5%
    b. 8-9%
    c. 9-10%
    d. 10-11%

8. The aspect is:

    a. E
    b. W
    c. NW
    d. SW

9. In order for BehavePlus to calculate the fire behavior the direction of the wind and slope is required. It may be entered as an azimuth in relation to north or in relation to directly uphill. Draw the wind and slope lines on Figure 1 at point "D." The predicted weather says that there will be downslope winds tonight. What is the input value for the wind and slope lines in relation to directly uphill?

	Wind input	Slope input
a.	180°	0°
b.	270°	68°
c.	90°	292°
d.	180°	180°

10. What wind reduction factor would you use for determining mid-flame windspeed?

    a. .3 - .4
    b. .4 - .5
    c. .5 - .6
    d. none

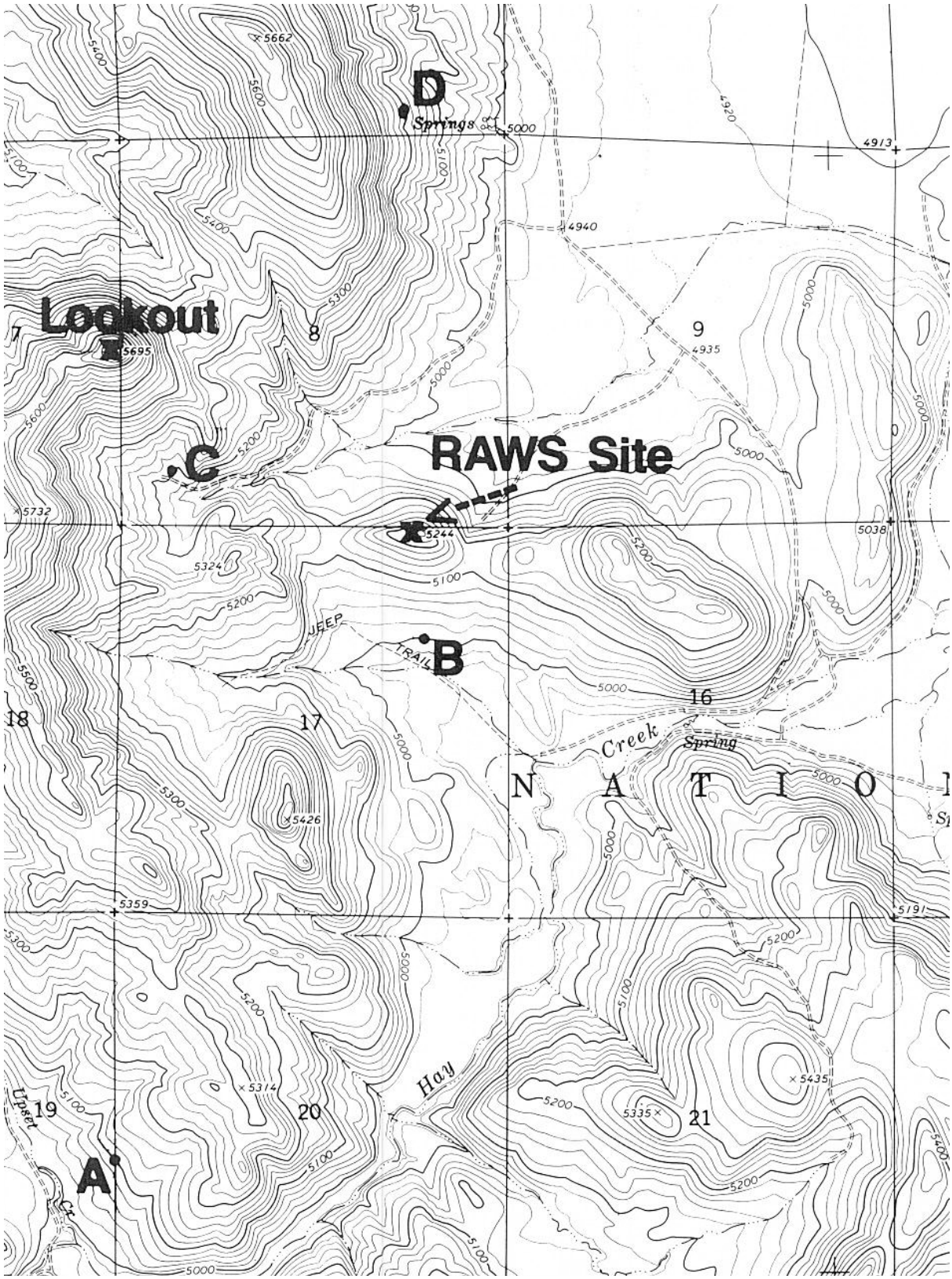
D
Springs
5000
4913
4940
4920
Lookout
5695
7
8
9
4935
C
RAWS Site
5244
5732
5038
5324
5100
5200
5000
JEEP
TRAIL
B
16
18
17
Creek
Spring
N A T I O
5426
5359
5191
5300
5500
5600
5400
5314
20
Hay
5435
5335
21
19
Upper
A
Cr

Figure 1

FINE DEAD FUEL MOISTURE & PROBABILITY OF IGNITION WORKSHEET

INPUT

0. Projection Point						
1. Day Time Calculations						
2. Dry Bulb Temperature, º F						
3. Wet Bulb Temperature, º F						
4. Dew Point, º F						
5. Relative Humidity, %						
6. Reference Fuel Moisture, % (from table 2)						
7. Month						
8. Unshaded(U) or Shaded(S)						
9. Time						
10. Elevation Change **B = 1000'-2000' below site** **L = within 1000' of site location** **A = 1000'-2000' above site**						
11. Aspect						
12. Slope						
13. Fuel Moisture Correction, % (from table 3, 4, or 5)						

OUTPUT

1. Fine Dead Fuel Moisture, % (Line 6 + Line 13)						
2. Probability of Ignition, % (Table 12)						

Practice Test Answers

1. b
2. c
3. a
4. c
5. a
6. b
7. b
8. a
9. a
10. b