

**Exercise****1.3**

Predict Potential Fire Behavior in a Stand

OBJECTIVES

- ✓ Create a new, custom fuel model based upon the planar intercept fuel loading data that you collected in Exercise 1.2a or b.
- ✓ Use the BehavePlus fire modeling system to obtain outputs of potential fire behavior.
- ✓ Compare outputs of fire behavior between the custom fuel model that you will develop and the fuel models from the original 13 and new 40 fuel models that you chose in Exercise 1.2a or b. to best describe your site.

INSTRUCTOR SUGGESTIONS

To expand students' ability to determine the wildfire risk to a stand, consider the following supplemental lab assignments:

- Using BehavePlus or FOFEM, quantify potential mortality of specific species and size classes under both normal and extreme weather conditions.
- Using NEXUS, quantify the potential for crown fire initiation and spread under various weather conditions.

MATERIALS

- PC with a Windows operating system and Internet connectivity
- BehavePlus fire modeling program (downloaded free-of-charge at the www.fire.org Web site or from the Student Resources section of the www.wildfirelab.com Web site)
- Fuel loading data calculated in Exercise 1.2a or b

Optional Materials

- FOFEM fire effects modeling program (downloaded free-of-charge at the www.fire.org Web site or from the Student Resources section of the www.wildfirelab.com Web site)
- NEXUS spreadsheet for assessing potential crown fire activity (downloaded free-of-charge at the www.fire.org Web site or from the Student Resources section of the www.wildfirelab.com Web site)

The following exercise will use the BehavePlus fire modeling system to predict potential fire behavior in the stand that you inventoried in Exercise 1.2a. BehavePlus is a free, Windows-based software program that utilizes spread equations (Rothermel 1972) to predict various aspects of fire behavior based on user-input values for fuels, weather, and topography.

This exercise will employ only the most basic aspects of the program. Fortunately, the program has been designed with user-friendly help features that enable you to simulate more advanced calculations such as fire area over time, spotting distances and probability of embers igniting surface fuels, scorch height and potential tree mortality, critical safety zone sizes, potential for crown fire, and many others.

While powerful, you should always remember that BehavePlus, as with any predictive model, is but a tool. The model makes many assumptions, a few of which are listed on the following page.

- **Fine fuels control rate of spread.**
Fire spread is overwhelmingly a function of the finer fuels (1-hr and 10-hr). Thus, you could have an enormous fuel load but have little active spread if the loading is not in the smaller size classes.
- **Fuels are uniform and continuous.**
The model does not account for any changes in fuels that would potentially influence fire behavior, such as patches of fuels that flash readily. Neither does it account for small scale impediments to fire spread such as canopy gaps or rocks. Thus, fire spread is commonly overestimated in BehavePlus.
- **Weather and topography are uniform.**
The program assumes that conditions never change until the user inputs new values. Thus, if a fire spreads up and over a slope, the user must account for it backing down the slope.
- **Fire is predicted at the flaming front.**
Fire behavior is only calculated at the edges of a spreading front. Post-frontal combustion of larger materials is not currently simulated in BehavePlus, although there are plans to simulate this in the future.
- **Fire is free burning.**
Control efforts, such as slurry drops or dozer lines, to impede the fire's spread are not incorporated.
- **The fire is always considered a surface fire.**
Currently, there is no one model that simultaneously predicts surface fire behavior, transition to crown fire, and then crown fire spread. However, crown fire behavior modeling is advancing rapidly. Techniques used in crown fire simulation models such as NEXUS will soon be incorporated into BehavePlus.
- **The model is designed for peak fire season usage.**
Fire spread, particularly in the original 13 fuel models, was often over-predicted because the fuel models were calibrated for use during more severe conditions. Anticipation is strong, however, for the new 40 models to alleviate unrealistic fire behavior predictions outside of the hottest, driest times of the year.

Given these assumptions, good judgment is warranted, both in determining inputs and interpreting outputs. As outputs are nothing more than calculations from a deterministic algorithm, you must remember the old adage, "Garbage in, garbage out" and never assume that the outputs are always realistic.

PROCEDURE

STEP 1 ▶ Download and install the BehavePlus program from www.fire.org.

STEP 2 ▶ Create a custom fuel model.

continued ▶

1.3 Evaluating Forest Stands for Fire Risk

- A Open the Behave-Plus program. By default, a worksheet will open with blanks for various aspects of fuel, weather, and terrain.
- B Open the Fuel-Modeling worksheet.

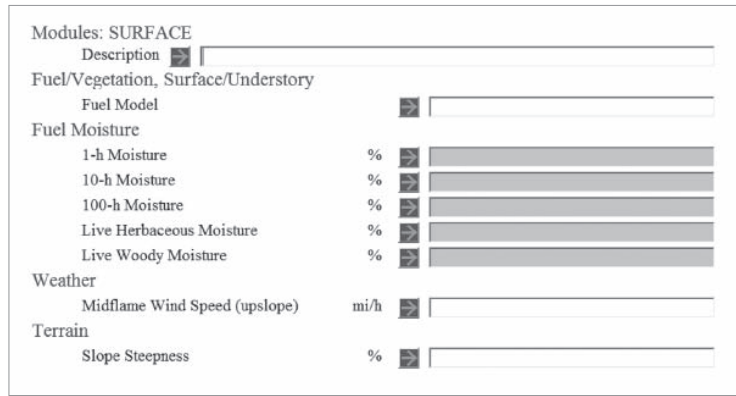


Figure 1.3-1. BehavePlus interface.

Click "File » New

» ExampleWorksheets » FuelModeling.bpw."

- C Input appropriate values into the blanks.

A new worksheet will open with blank cells that must be filled with your inputs. Clicking on any of the arrows next to an input cell opens a text box that defines and discusses the variable of interest. It is highly unlikely that you will know what values to enter for parameters such as the "1-h Surface Area/Vol Ratio." Fortunately, you can adjust the known values of the existing original 13 and new 40 fuel models. To obtain these known values, click on the "Initialize from a Fuel Model" button.

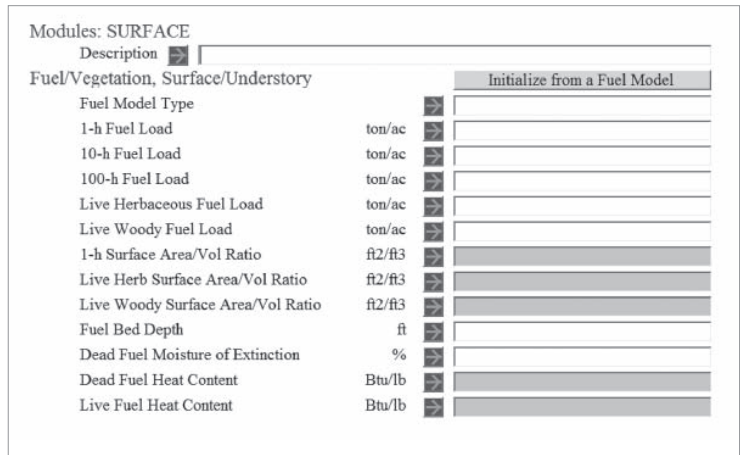


Figure 1.3-2. BehavePlus worksheet.

A text box with each of the original 13 and new 40 fuel models will appear. Choose the fuel model that best described the site that you inventoried in Exercise 1.2a or b.

All of the appropriate values for the fuel model that you chose will now appear. Some of the cells in the worksheet are shaded blue, indicating that these values are not used during a simulation.

Sort	Fuel Model	Description
001	1	Short grass (S)
002	2	Timber with grass and understory (S)
003	3	Tall grass (S)
004	4	Chaparral (S)
005	5	Brush (S)
006	6	Dormant brush, hardwood slash (S)
007	7	Southern rough (S)
008	8	Closed timber litter (S)
009	9	Hardwood litter (S)
010	10	Timber with litter & understory (S)
011	11	Light logging slash (S)
012	12	Medium logging slash (S)
013	13	Heavy logging slash (S)
101	gr1	Short, sparse, dry climate grass (D)
102	gr2	Low load, dry climate grass (D)
103	gr3	Low load, very coarse, humid climate grass (D)
104	gr4	Moderate load, dry climate grass (D)

Figure 1.3-3. BehavePlus fuel model list.



Change the values in each of the input cells for any variable that you calculated in Exercise 1.2a or b. At a minimum, you will change the “1-hr Fuel Load”, “10-hr Fuel Load”, “100-hr Fuel Load”, and “Fuel Bed Depth”. Other potential changes could include “Live Woody Fuel Load”, “Live Herbaceous Fuel Load”, or “Dead Fuel Moisture of Extinction”, if known.

- D** Save your inputs and name your custom fuel model.



Click “File>>saveAs>>Fuel models>>BehavePlus format>>MyFuelModels.”



Save your custom fuel model as a name that appropriately describes the fuels at your site and that you will be able to distinguish from other custom fuel models you might create in the future.

STEP 3

Simulate a surface fire.

- A** Open a simplified input worksheet by clicking “File>>New>>ExampleWorksheets>>SurfaceBasic.bpw.”
- B** You will now see blank cells for “Fuel Model”, “Fuel Moisture”, “Weather”, and “Terrain”. The “Fuel Moisture” cells will remain blue (indicating they are not necessary to fire simulation) until a fuel model is entered.
- C** Click on the arrow beside the “Fuel Model” input cell. The original 13, new 40, and your custom fuel models should appear.



Note: if you saved your custom fuel model, and it does not appear here, click on “Cancel”, then at the top of the page click on “Configure>>Fuel model set selection>>MyFuelModels>>Ok”.

1.3 Evaluating Forest Stands for Fire Risk

Now, if saved it correctly, your custom fuel model will appear in the list when you click the arrow next to the “Fuel Model” input cell.

- D Highlight your custom fuel model, as well as the standard fuel models from the original 13 and the new 40 that you said best describes your site. Click “Ok.” The fuel models that you chose will now appear and some of the cells for “Fuel Moisture” will become white, indicating that a realistic value must be entered into that cell.
- E Input appropriate values for “Fuel Moisture”, “Midflame Windspeed”, and “Slope Steepness”. If fuel moisture is unknown, it can be estimated by various means.

Fuel Moisture Scenarios: Click “Configure>>moisture Scenario set selection>>FuelModeling”, which provides a variety of moisture scenarios developed by Scott & Burgan (2004) for use with the new 40 fuel models.

Moisture Scenario	Files	Description
FuelModeling	16	Used to develop new fuel models (Scott and Burgan)
d111.bpm		D1L1 - Very low dead, fully cured herb (3,4,5,30,60)
d112.bpm		D1L2 - Very low dead, 2/3 cured herb (3,4,5,60,90)
d113.bpm		D1L3 - Very low dead, 1/3 cured herb (3,4,5,90,120)
d114.bpm		D1L4 - Very low dead, fully green herb (3,4,5,120,150)
d211.bpm		D2L1 - Low dead, fully cured herb (6,7,8,30,60)
d212.bpm		D2L2 - Low dead, 2/3 cured herb (6,7,8,60,90)
d213.bpm		D2L3 - Low dead, 1/3 cured herb (6,7,8,90,120)
d214.hnm		D2L4 - Low dead, fully green herb (6,7,8,120,150)

Figure 1.3-4. Fuel moisture scenarios.

Fine Dead Fuel Moisture Tool: Click “Tools>>Fine dead fuel moisture tool.” An input box will open and you will choose appropriate values for each of the variables listed. After all boxes are filled, use the value in the “Fine Dead Fuel Moisture” cell for the “1-h fuel moisture.” For the “10-h” and “100-h fuel moistures”, simply add 1% and 2%, respectively, to the value for fine dead fuel moisture.

Dry Bulb Temperature	70 - 89 oF
Relative Humidity	25 - 29 %
Reference Fuel Moisture	4 %
Month	Feb Mar Apr Aug Sep Oct
Time of Day	12:00 - 13:59
Elevation Difference	Level (within 1000 ft)
Slope	0 - 30%
Aspect	South
Fuel Shading	Exposed (< 50% shading)
Fuel Moisture Correction	1 %
Fine Dead Fuel Moisture	5 %
Description	

Figure 1.3-5. Fine dead fuel moisture tool.



Live fuel moistures can be estimated by following the rules of thumb found after you click the arrow next to either the “Live Herbaceous Moisture” cell or the “Live Woody Moisture” cell.

- F** Calculate the run.



Click “File>>Calculate” (or click the calculator button on the toolbar).



A chart comparing the potential flame length and rate of spread for each of the fuel models will appear:



Graphs comparing the outputs between each of the fuel models can be found by clicking the down arrow button on the toolbar. To go back to the input page, simply click the double-arrow up button on the toolbar.

- G** After learning the basics here, you may want to explore the many other features of BehavePlus. For example, additional outputs (eg, a fire characteristic chart) can be calculated by clicking “Configure>>Module selection>>Surface fire options>>Outputs” and then checking the appropriate box. Additionally, other applications can be explored by clicking “Configure>>Module” selection and checking a module of interest. You are encouraged to explore this powerful, yet user-friendly program.

REPORT



1. Compare the calculated rates of spread and flame lengths between the three fuel models that represented your site in Exercise 1.2a or b, including the following:
 - a. Custom fuel model
 - b. Standard fuel model chosen from the original 13
 - c. Standard fuel model chosen from new 40
2. Explain any differences in the calculated fire behavior between the three fuel models as they relate to differences in fuel loading and depth.
3. How did these results compare to your preconceived ideas of how a fire might behave on your site? If different, to what do you attribute the discrepancy?