Help, More Help, and Desperate for Help Lesson

Exercise Answers

You can use any of the resources in the Help Lesson to answer the questions in the following exercises. In many cases, the answer can be found in multiple places. We provide at least one example for each one.

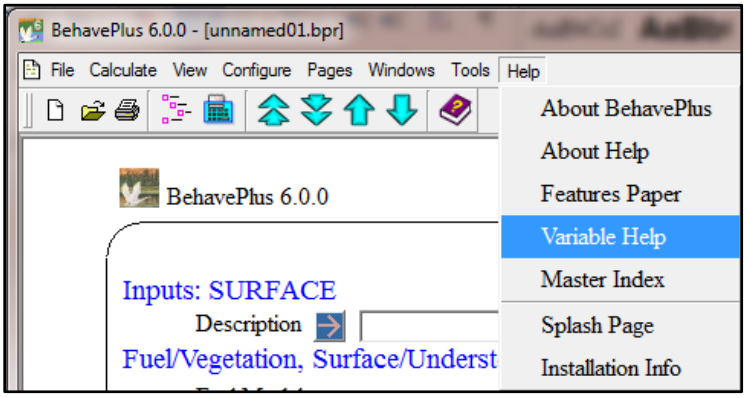
1. What is the relationship between 10-m and 20-ft Wind Speed?

There are at least three places to find the answer to this exercise.

a. Variables Paper
b. BehavePlus Help System
c. A Worksheet when you choose to enter 10-m Wind Speed.

a. Variables Paper

- Open BehavePlus.
- Click on **Help > Variable Help**. The Variables Paper will open in a new window.



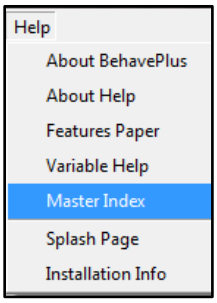
- In the **Table of Contents, Wind** section, click on **10-Meter Wind Speed**.

> **10-Meter Wind Speed**
> **10-Meter Wind Speed** is the wind 10 meters above the vegetation. The 10-m Wind Speed is reduced to 20-Ft Wind Speed by dividing by 1.15. For fire spread and intensity calculations in SURFACE, the 20-Ft Wind Speed is further reduced to Midflame Wind Speed according to the Wind Adjustment Factor.

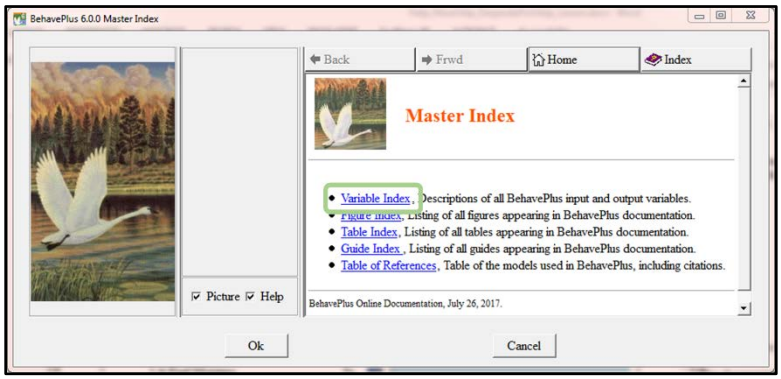
- Click on **20-Ft Wind Speed** to read the definition.

b. BehavePlus Help system

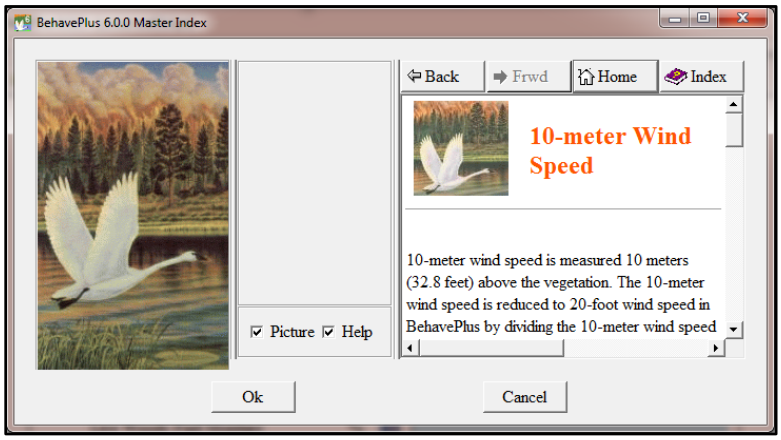
- Open BehavePlus.
- Click on **Help > Master Index**.



- Click on **Variable Index**.



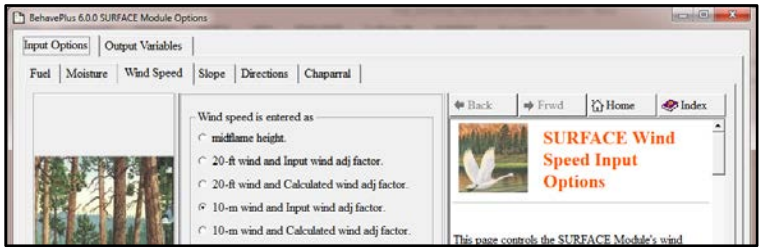
- Scroll down and click on **10-Meter Wind Speed**. The same definition as in the Variables Paper will appear.



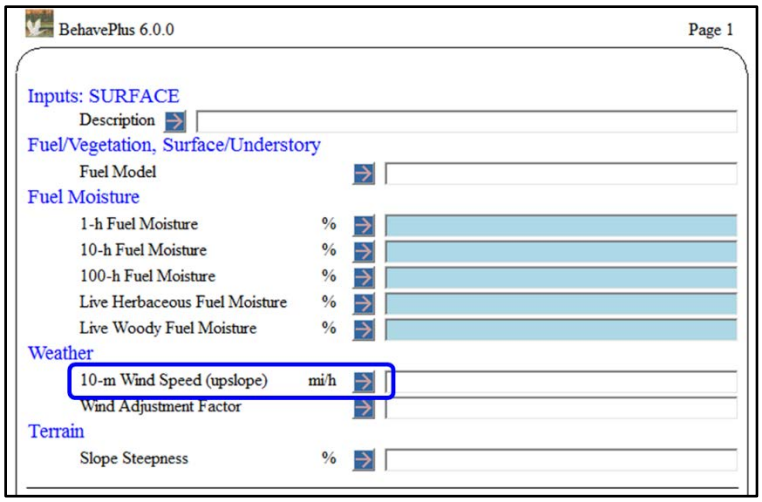
- If you scroll down in this window, you can click on **20-Foot Wind Speed** under **See Also**.

c. From a Worksheet

- Open BehavePlus.
- Open the **Worksheet BasicStart.bpw**.
- Click on the **Module Selection** button.
- Click on **SURFACE Options…**.
- Click on the **Input Options > Wind Speed** tab.
- Select **Wind speed is entered as 10-m wind and Input wind adj factor**.

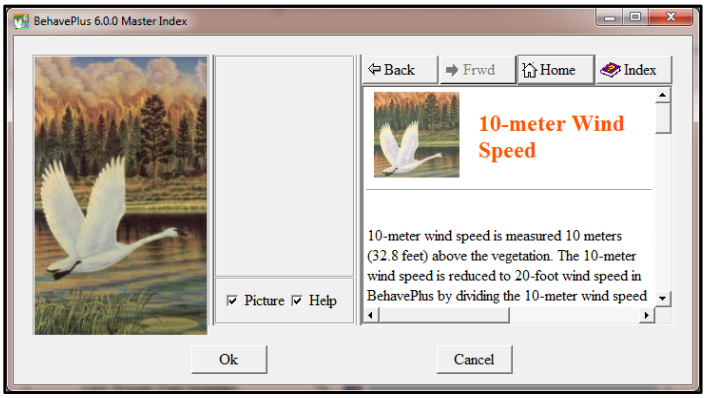


- Click **Ok** twice.



- Click the **Guide** button ( ) next to **10-m Wind Speed (upslope)**.

The definition for 10-meter Wind Speed is the same definition found in (1b) above.



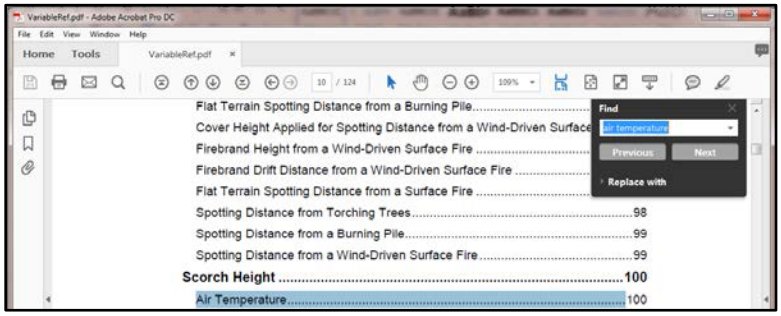
2. In which calculations is Air Temperature used in BehavePlus?

There are at least two places to find the answer to this exercise.

a. Variables Paper
b. BehavePlus Help System

a. Variables Paper

- Open the Variables Paper.
- Scroll down until you find Air Temperature in the **Contents** or look for it in the **Alphabetical List of Variables**.
- Alternatively, you can search for **Air Temperature** using the search tool. It should take you to the first appearance, which is in the **Contents**.



- Click on the highlighted **Air Temperature** to go to the description of the variable.

Air Temperature

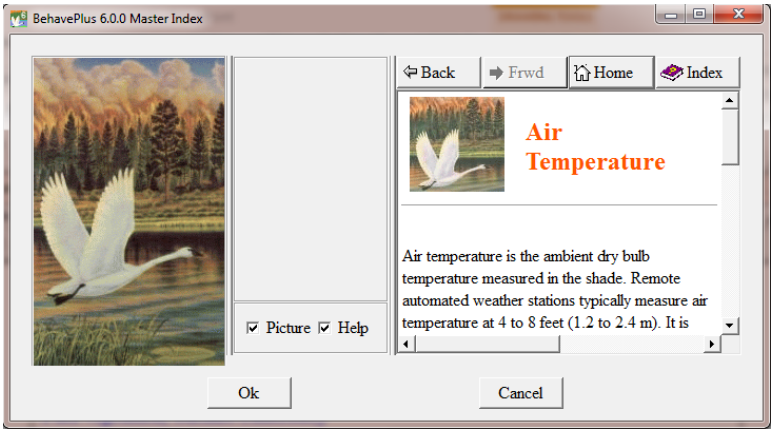
Air Temperature is the ambient dry bulb temperature measured in the shade. It is used to calculate Scorch Height and Probability of Ignition from a Firebrand. Note that Air Temperature is not included in the SURFACE Surface Rate of Spread and Fireline Intensity calculations.

I/O	Module	Condition	Notes
Input	SCORCH		
	IGNITE	If "*Probability of ignition from a firebrand*" is calculated.	
Output	none		

Air Temperature is used in SCORCH and IGNITE, but it is not used in the spread rate and intensity calculations in SURFACE.

b. BehavePlus Help System

As in Question 1, you can look up Air Temperature through the **Variable Index** (see 1b for instructions).



Air Temperature is used in SCORCH to calculate Scorch Height and in IGNITE to calculate Probability of Ignition from a Firebrand.

Note: *Air Temperature is also used in the Fine Dead Fuel Moisture Tool. This is a stand-alone implementation of the tables found in the Fire Behavior Field Reference Guide. Only variables in the calculation modules are described in the Variables Paper and in the Help system.*

3. Find the Canopy Bulk Density, Stand Height and Canopy Cover for Lodgepole pine at the initial condition.

There are at least two sources for this information.

a. Report by Scott and Reinhardt (2005)
b. BehavePlus Help system

a. Report by Scott and Reinhardt (2005)

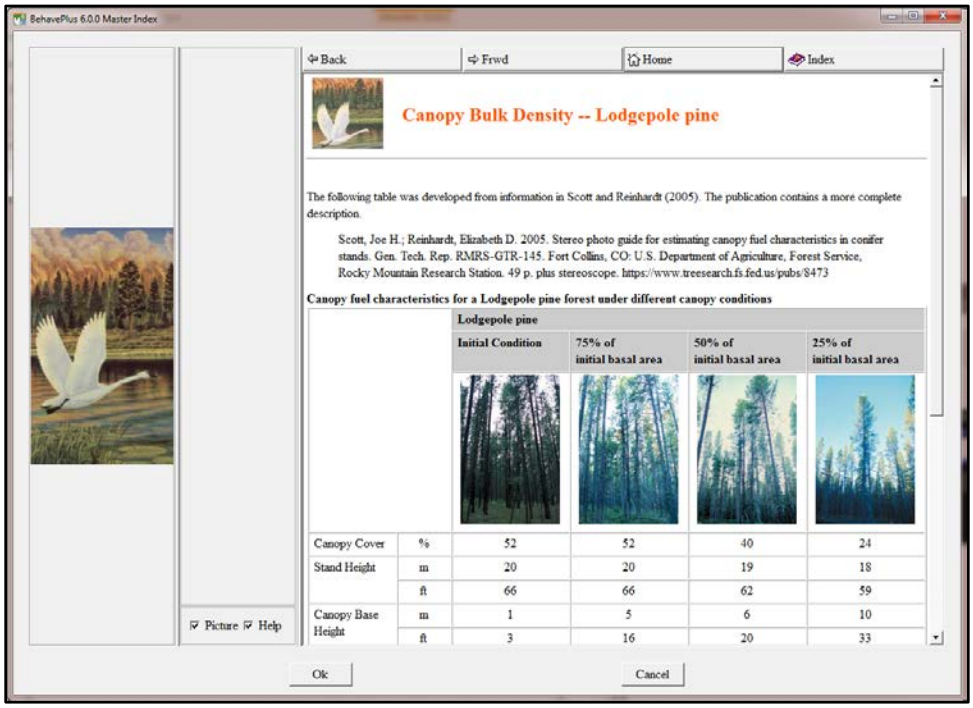
Complete information on estimating fuel characteristics for Lodgepole pine, including canopy bulk density, stand height, and canopy cover is covered in General Technical Report number RMRS-GTR-145 *Stereo Photo Guide for Estimating Fuel Characteristics in Conifer Stands* written by Scott and Reinhardt (2005).

b. BehavePlus Help System

This information is also contained in the BehavePlus system in a simplified form.

- In BehavePlus, click on **Help > Master Index**.
- Click on the **Guide Index**.

- Scroll down and click on **Canopy Bulk Density -- Lodgepole pine**.
- Expand the help window. Values for Canopy Bulk Density, Stand Height and Canopy Cover are listed. To answer this question, look in the column for the initial condition.



The answer to the exercise is highlighted in the table below.

		Lodgepole Pine Initial Condition
Canopy Cover	**%**	**52**
Stand Height	**m**	**20**
	ft	**66**
Canopy Base Height	m	1
	ft	3
Canopy Bulk Density	**kg / m^3**	**0.112**
	lb / ft^3	**0.0070**

4. What input values are used in the special case Western Aspen fuel model?

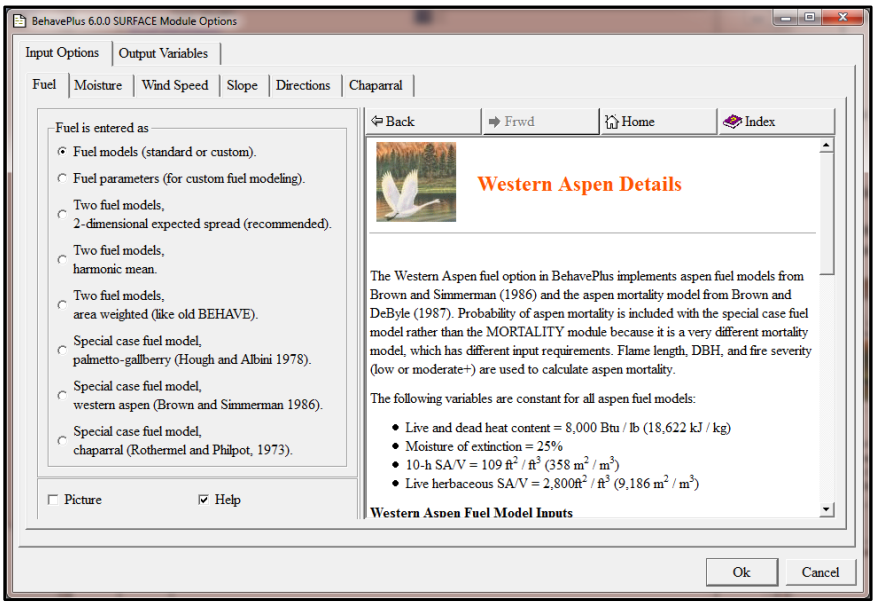
The primary source of information is found in the BehavePlus Help system in two ways.

a. Guide Index
b. Worksheet

Details on the Western Aspen Fuel Model are accessed via the **Guide Index**. Details on accessing the **Guide Index** are covered in Question 3b.

- Go to **Help > Master Index > Guide Index**.
- Scroll down and click on **Western Aspen Details**, which is in the **Fuel** section.

This file also provides information on the paper used to obtain the fuel model for Western Aspen. You can reference that paper for complete details on the model.



- Scroll down in the window. A list and table describe inputs used in the Western Aspen fuel special case fuel model.

The following variables are constant for all aspen fuel models:

- Live and dead heat content = 8,000 Btu / lb (18,622 kJ / kg)
- Moisture of extinction = 25%
- 10-h SA/V = 109 ft^2 / ft^3 (358 m^2 / m^3)
- Live herbaceous SA/V = 2,800ft^2 / ft^3 (9,186 m^2 / m^3)

Western Aspen Fuel Model Inputs

Aspen Fuel Model	Fuel Bed Depth		10-h Fuel Load	
	ft	m	tons / ac	tonnes / ha
Aspen/shrub	0.65	0.20	0.975	0.297
Aspen/tall forb	0.30	0.09	0.475	0.145
Aspen/low forb	0.18	0.05	1.035	0.315
Mixed/shrub	0.50	0.15	1.340	0.408
Mixed forb	0.18	0.05	1.115	0.340

5. **How does one calculate Surface Fire Rate of Spread? Surface Fire Rate of Spread is an input to which module(s)?**

- In **Module Selection** window, ( ) click on **SURFACE Options… > Output Variables > Basic**.
- Hover over **Surface Fire Rate of Spread** for a definition.

You can also access this information from Appendix A of the Variables Paper.

Appendix A—Mathematical models in BehavePlus

Table A1—Models that are included in each of the BehavePlus modules with citations and notes.

BehavePlus Module	Model	Reference and notes
SURFACE	Surface head fire rate of spread, reaction intensity, heat per unit area, characteristic dead fuel moisture, live fuel moisture of extinction, etc.	(Rothermel 1972) (Albini 1976a) minor adjustments
	Fireline intensity Flame length	(Byram 1959) with adjustments to work with Rothermel's surface fire spread model by (Albini 1976b)
	Surface fire flame residence time (used to calculate fireline intensity)	(Anderson 1969)
	Direction of maximum spread	(Rothermel 1983) using manual vectoring (Rothermel 1983) (Finney 1998) calculations based on Rothermel's wind and slope factors

As you can see, the SURFACE module includes much more than a calculation of the Surface Fire Rate of Spread, although Rothermel's surface fire spread model is the foundation of surface fire behavior calculations in BehavePlus. The full model is described in the classic paper by Rothermel (1972) entitled *A Mathematical Foundation for Predicting Fire Spread in Wildland Fuels*. This paper

can be downloaded from the website. Minor adjustments to the model are described in *Estimating wildfire behavior and effects* by Albini (1976), also available on the website.

Rothermel's 1972 surface fire spread model is the foundation of BehavePlus and many other systems used in the U.S.

Rothermel, Richard C. 1972. A mathematical model for predicting fire spread in wildland fuels. Research Paper INT-RP-115. Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station. 40 p.

Original publication of the nomographs (nomograms).

Albini, Frank A. 1976. Estimating wildfire behavior and effects. General Technical Report INT-GTR-30. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 92 p.

As with previous variables, Surface Fire Rate of Spread is described in the following resources.

a. Variables Paper
b. BehavePlus Help system

a. Variables Paper:

- Open the Variables Paper.
- Find Surface Rate of Spread.

Surface Rate of Spread

Surface Rate of Spread is the "speed" the fire travels through the surface fuels. Surface fuels include the litter, grass, brush and other dead and live vegetation within about six feet of the ground.

A SURFACE module input option determines whether rate of spread calculations are done for the heading fire spread or for any other direction as specified on the worksheet.

The maximum rate of spread is the spread rate of the head fire. This value is used along with elapsed time to determine the size of an elliptically shaped fire in SIZE. The maximum spread rate is also used by CONTAIN to model fire growth as suppression action is occurring.

The rate of spread prediction uses the Rothermel (1972) surface fire spread model, which assumes the weather, topography and fuel are constant and uniform for the elapsed time. The basic model is for a head fire spreading upslope with the wind. Adaptations have been made to allow calculations for other direction options.

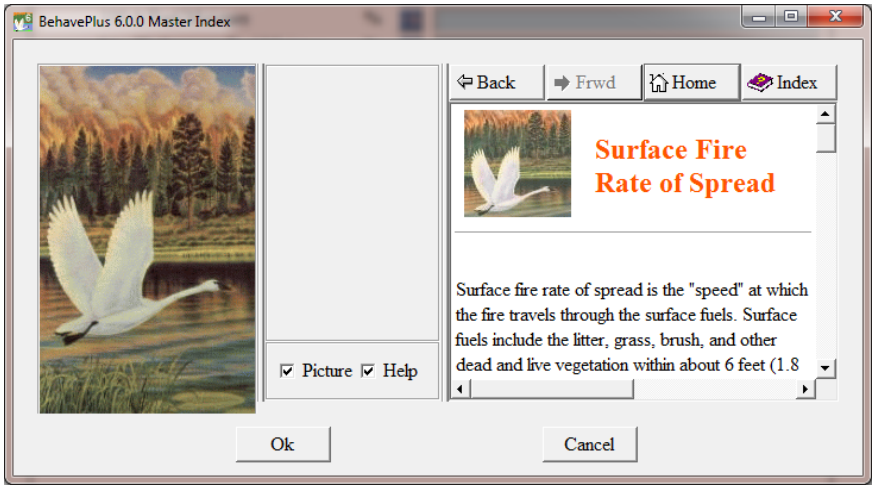
Spread Distance = Rate of Spread × Elapsed Time.

See Fire Characteristics Chart.

I/O	Module	If	Notes
Input	SIZE	if SURFACE is not selected	The maximum (head fire) spread rate is used in SIZE. If both SURFACE and SIZE are selected, the calculated maximum rate of spread is used in SIZE, even if it is not displayed as an output in SURFACE.
	CONTAIN	if SURFACE is not selected	If both SURFACE and CONTAIN are selected, the calculated maximum (head fire) rate of spread is used in CONTAIN, even if it is not displayed as an output in SURFACE.
Output	SURFACE		

The table shows that Surface Rate of Spread is calculated in SURFACE and is an input to SIZE and CONTAIN.

b. BehavePlus Help System.
As in Question 1, you can look up Surface Fire Rate of Spread via the **Variable Index** (see 1b for instructions).



The SURFACE Module is used to calculate the Surface Fire Rate of Spread. Surface Fire Rate of Spread is also an input to both SIZE and CONTAIN. You can enter it directly or it can be calculated by selecting both SURFACE and either SIZE or CONTAIN.

6. Which models are included in the CONTAIN module?
All of the models used in the various modules are described in Appendix A of the Variables Paper.

- Open the Variables Paper.
- Go to Appendix A at the end of the paper.
- Look for the CONTAIN module in the table.

CONTAIN	Fire containment	(Albini and others 1978) in the old BEHAVE (Fried and Fried 1996) in BehavePlus

The model used in CONTAIN is the fire containment model used in the old BEHAVE program (Albini and others 1978) and updated with equations from Fried and Fried (1996), which are listed in the references of the Variables Paper.

- Albini, F. A.; Korovin, G. N.; Gorovaya, E. H. 1978. Mathematical analysis of forest fire suppression. Res. Pap. INT-207. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 19 p.
- Fried, Jeremy S.; Fried, Burton D. 1996. Simulating wildfire containment with realistic tactics. Forest Science. 42(3): 267-281.

You can also find them in the **Help** system by clicking on Table of References in any help window.

7. What is Fuel Shading from the Sun used for? In which module(s) is it used? Is it an input or an output?

So far, we have used the Variables Paper Table of Content to answer many of the questions. In this question, we can continue to use the Table of Contents. However, we can also answer the third part of the question by looking at the Alphabetical List of Variables.

- Open the Variables Paper.
- Click on **Alphabetical List of Variables** in the **Bookmarks** or in the **Table of Contents**.
- Scroll down to **Fuel Shading from the Sun**.
- Click on the **--I--** to go to the Input Table.
- See the checkmark under the IGNITE column.
- Then, click on **Fuel Shading from the Sun** in this table to go to the description.

Fuel Shading from the Sun is an input to the IGNITE module. It is the portion of fuel that is not receiving direct sunlight due to **both** cloud cover and the overstory. Less than 50% shading is often referred to as being in an *unshaded* condition; 50% or more shading is referred to as *shaded* condition.

These same answers are found in the BehavePlus Variable Index or in the Worksheet when the IGNITE module is selected.

8. What are the range and units for 1-h Fuel Load?

1-h Fuel Load is both an input and an output to the SURFACE Module. Both the Variables Paper and BehavePlus contain the answers to this question.

a. Variables Paper:

The Alphabetical List of Variables table tells us that 1-h Fuel Load is both an input and an output. To find the acceptable range of units for input, we need to look at the Input Variable Table.

- In the **Alphabetical List of Variables** table, click on the **--I--** next to **1-h Fuel Load**.
- Scroll down to **1-h Fuel Load**.

In English, the range and units for 1-h Fuel Load are 0.0-31 ton/ac. In metric units, it is 0.0-69.5 tonne/ha. Units of tonnes indicates that these are metric tons (1 tonne = 1,000 kg) instead of English tons (1 ton = 2,000 lbs)

- Click the button to return to the **Alphabetical List of Variables**.
- In the **Alphabetical List of Variables** table, click on the **--O--** next to **1-h Fuel Load**.

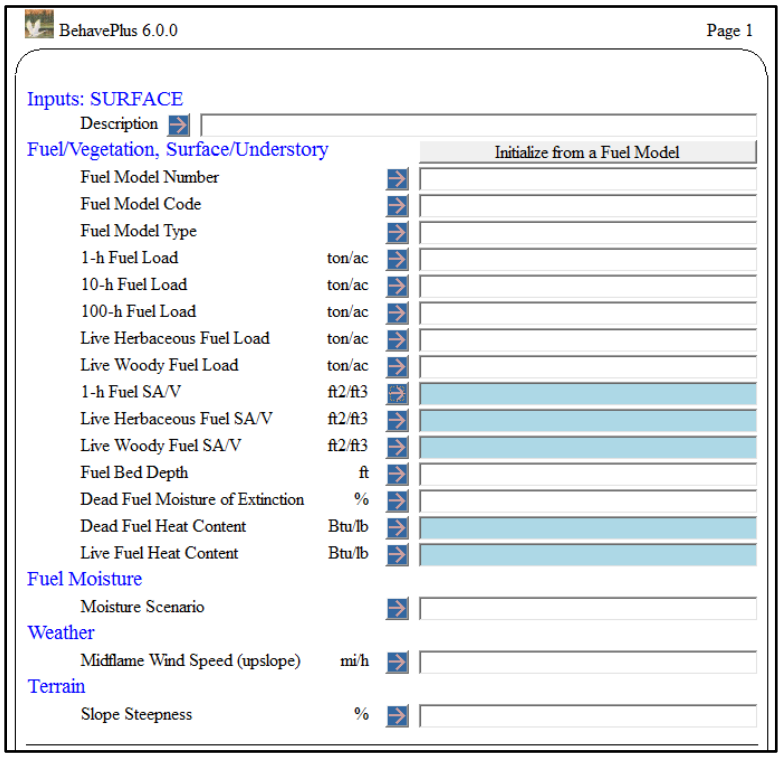
Units are defined for the output. You do not need to worry about valid ranges for outputs; they are determined as part of the calculations.

b. BehavePlus fire modeling system

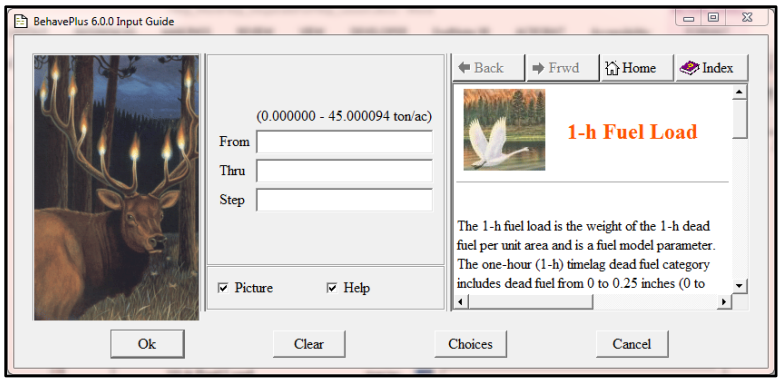
The same information is found in BehavePlus, but it is in a slightly different format.

- Open BehavePlus.
- Open the Worksheet **FuelModeling.bpw**.

This Worksheet allows you to enter your own fuel parameters.

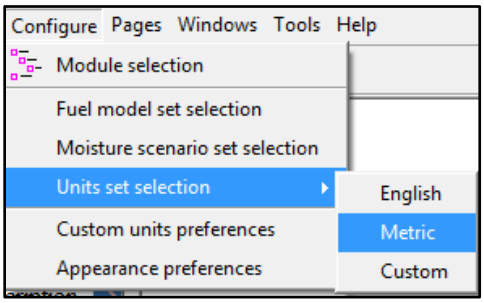


- Click on the **Guide** button next to **1-h Fuel Load**.



Since **FuelModeling.bpw** uses English units, the central window of the **Input Guide** shows that the acceptable range for 1-h Fuel Load is 0-45 tons/ac, which is an update from the Variables Paper. The acceptable range is shown to six decimal places to allow for precision in internal calculations in BehavePlus. The **help window** provides a definition of 1-h Fuel Load.

- To see metric units, click **Ok**.
- Go to **Configure > Units set selection > Metric**.



All units in the Worksheet have been converted to metric units.

- Click on the **Guide** button next to **1-h Fuel Load** again.

The units are now 0.00-100.88 tonne/ha, which is again an update to the value in the Variables Paper. You could also open the **FuelModelingMetric.bpw** Worksheet to get the same answer to six decimal places.

9. Is Critical Surface Intensity a default output? Is it a table shading variable?

Unlike the answers to many other questions in this exercise, there is only one place to find the answer to this question – the Variables Paper. Outputs are listed in the Output Variable Table which is organized by Module.

- Find **Critical Surface Intensity** in the **Alphabetical List of Variables** table.
- Click on the associated **--O--** to go to the **Output Variable Table**.

An **X** denotes if the variable is a Default output variable, a Table shading variable, and/or Available as map distance. Critical Surface Intensity is a default output variable for CROWN, but it is not a Table shading variable.

10. What are the units for Cost of Resources Used? Why?

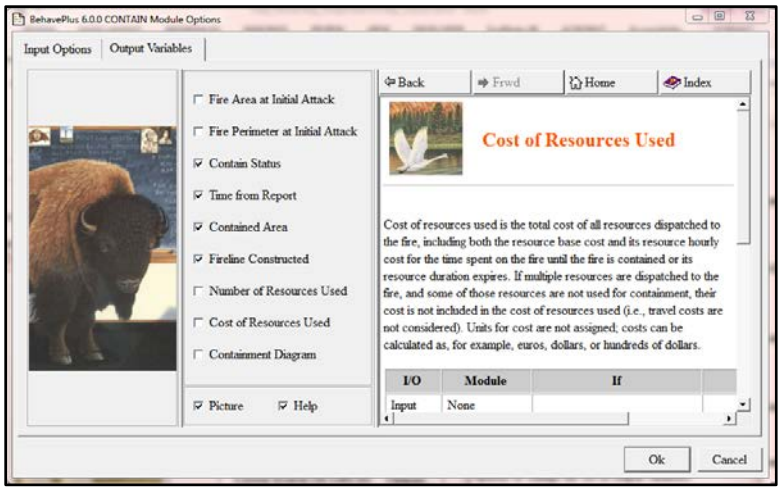
Question 7 describes the method that using the Variables Paper to answer to this question.

a. Variables Paper

- In the **Alphabetical List of Variables** table, find **Cost of Resources Used**.
- Click on the **--O--**.
- Click on the variable name **Cost of Resources Used** and read the description for an explanation.

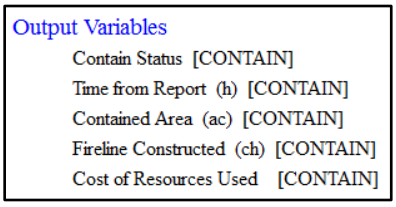
b. BehavePlus

- Click on **Module Selection**.
- Click on **CONTAIN Options…**.
- In the **Output Variables** tab, check the box by **Cost of Resources Used**.
- Hover over **Cost of Resources Used** so the description appears in the **help window**.



There are no units assigned to Cost of Resources Used.

- Click **Ok** twice.
- Look at the Output Variables list on the Worksheet.

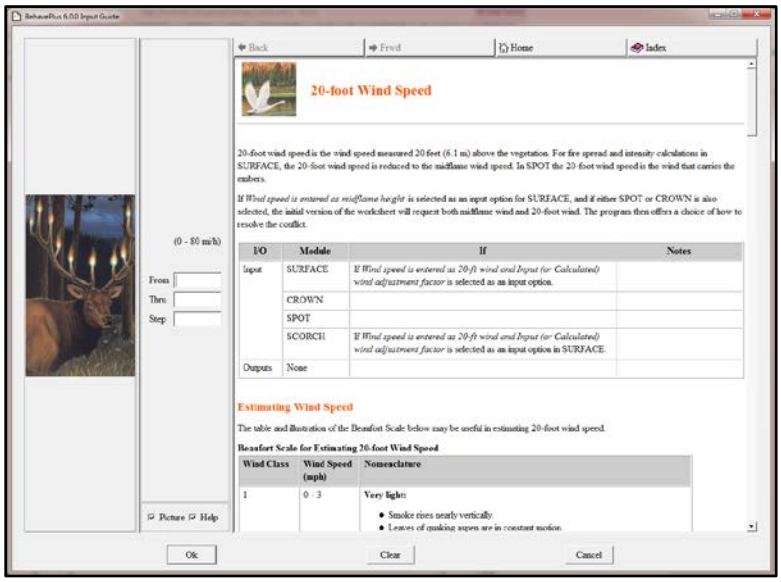


While many of the outputs from CONTAIN have units (in parenthesis), Cost of Resources Used has no units. Because there are many ways to enter costs, BehavePlus does not consider units. You know the units you used (e.g., U.S. Dollars, Euros, thousands of dollars), and you can assign units once costs are calculated.

11. How can you estimate 20-ft wind speed using the Beaufort Scale? How many wind classes are there?

The BehavePlus Help system often contains more information than the Variables Paper. This is one such example.

- Open the **BasicStart.bpw** Worksheet.
- Click on the **Module Selection > SURFACE Options…. > Input Options > Wind Speed**.
- Select **Wind speed is entered as 20-ft wind and Input wind adj factor**.
- Click **Ok** twice.
- Click the **Guide** button by **20-ft Wind Speed (upslope)**.
- Uncheck the **Picture** box and expand the **Input Guide** window.

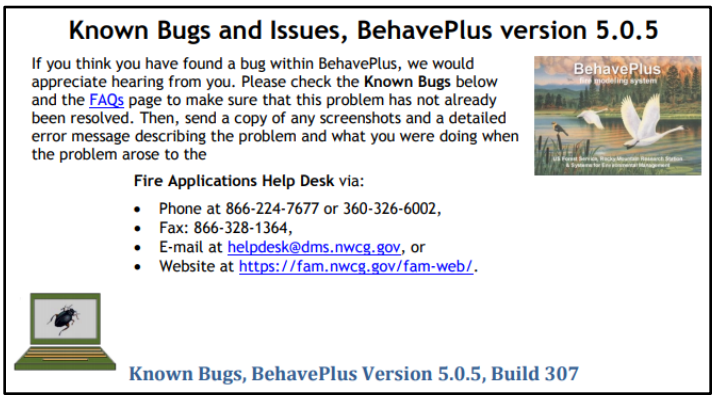


- When you scroll down, you will see both a table and a graph of the Beaufort Scale for Estimating 20-Foot Wind Speed.

The Beaufort Scale allows the user to estimate wind speed from a series of visual clues on the landscape. The table and pictures are both helpful. There are eight wind classes in the scale.

12. Where can you find information about Known Bugs in BehavePlus?

To find the Known Bugs for BehavePlus, visit www.frames.gov/behaveplus and go to the **Software/Manuals** page and find the link to the Known Bugs PDF file. All Known Bugs and their associated fixes are listed. This document is updated as often as necessary. Please check this document before submitting a potential bug to the Help Desk.



13. What are the possible sources of help for using BehavePlus?

There are several sources of help for using BehavePlus, including the following.

- BehavePlus Help system
  - Worksheet **Guide** buttons
  - Hover over output variables in module **Options…** windows.
  - Master Index
- Features Paper
- Variables Paper
- BehavePlus website
- Numerous publications about BehavePlus and the models included in the program
- The BehavePlus Installation Information available in the Help menu in the program.