Introduction

BehavePlus offers a simple switch between English and metric units. The user also has the option of changing the units for individual input and output variables and of setting the number of decimal places displayed for output variables. The number of decimal places for input variables is determined by the entered values. Changed units and decimals are included in saved worksheets and runs. Custom units sets can also be saved for later use.

Because of issues that can arise due to round-off, some basic changes have been made to decimal handling in version 5.0.

Objectives

1. Switch between English and metric default units.
2. Set the decimal display of input variables according to input values.
3. Change units and output variable decimals and save as a custom units set.
4. Apply changes to the worksheet without saving a custom units set.
5. Save a worksheet and run with custom units and decimals set.
6. Use the Units converter Tool to convert individual values.
7. Understand that the number of decimals displayed changes when the units set changes to avoid round-off problems.
8. Use the FuelModeling.bpw or FuelModelingMetric.bpw worksheet for full display of fuel parameter variables.

Where This Lesson Fits In

This is an optional lesson in the operation unit. The only prerequisites are the four lessons in the Introduction Unit.

Lesson Changes: V4.0 to V5.0

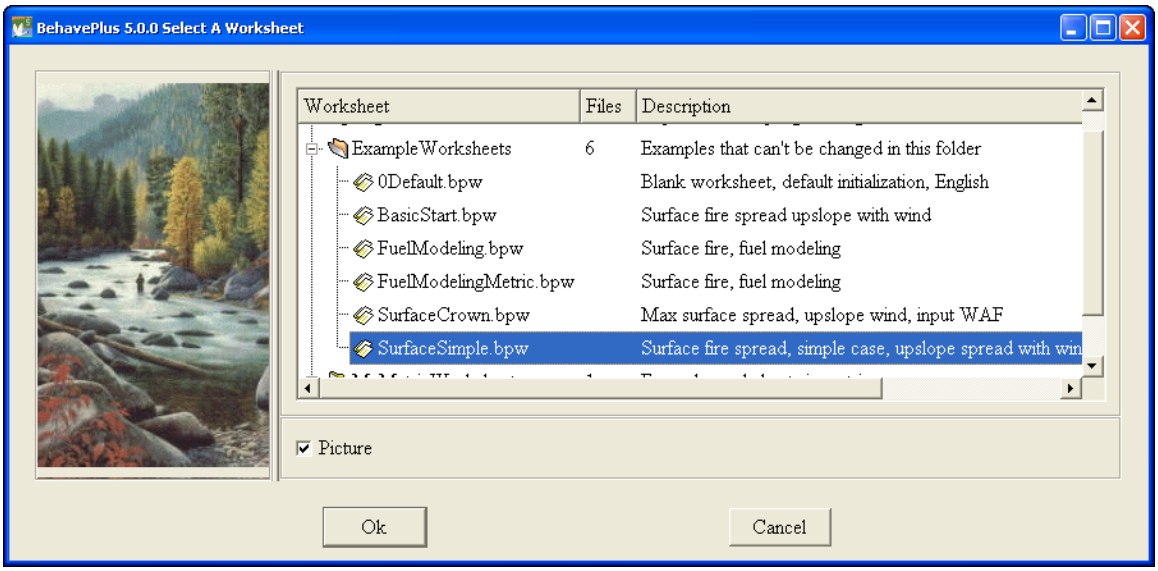
Changes to the BehavePlus program required a major update to this lesson, essentially a total rewrite. There are a few screen captures that still have the 4.0.0 heading.

Decimal Display of Input Variables

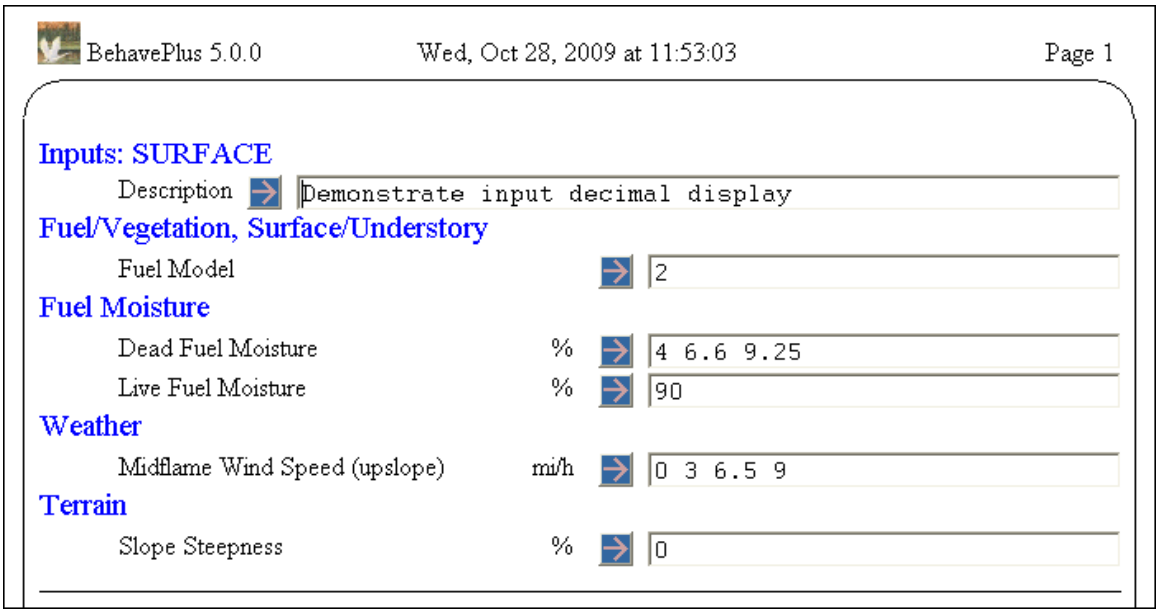
Prior to version 5.0, decimal display of input variables was determined by the setting in the English, Metric, or Custom units set. Because the program uses the value that shows on the worksheet, there were occasional problems with round-off and misinterpretation.

Decimal display of input variables is now determined by the values entered by the user. The greatest number of decimal places entered for a variable are displayed in the output tables for all values for that variable.

- Open the Example Worksheet, **SurfaceSimple.bpw**



- Enter values as follows.



- Calculate the run and look at the first table.

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Demonstrate input decimal display

Surface Rate of Spread (maximum) (ch/h)

Dead Fuel Moisture %	Midflame Wind Speed (upslope) mi/h 0.0	3.0	6.5	9.0
4.00	2.6	17.8	65.2	116.1
6.60	2.3	15.4	56.2	100.1
9.25	2.0	13.6	49.6	88.4

Because one of the values entered for dead fuel moisture was 9.25%, with two decimal places, all of the dead fuel moisture values on the output table. (This is an example to show the way that the program handles decimal display. A moisture value to that precision is not meaningful.)

Similarly, a value of 6.5 mi/h was entered for midflame wind speed, so all of the wind values are shown on the table to one decimal place.

- Entering another dead moisture with ridiculous value of 11.111111 to see the effect on the table.

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Demonstrate input decimal display

Surface Rate of Spread (maximum) (ch/h)

Dead Fuel Moisture %	Midflame Wind Speed (upslope) mi/h 0.0	3.0	6.5	9.0
4.000000	2.6	17.8	65.2	116.1
6.600000	2.3	15.4	56.2	100.1
9.250000	2.0	13.6	49.6	88.4
11.111111	1.7	11.4	41.8	74.5

Decimal Display of Output Variables

The decimal display of output variables can be changed.

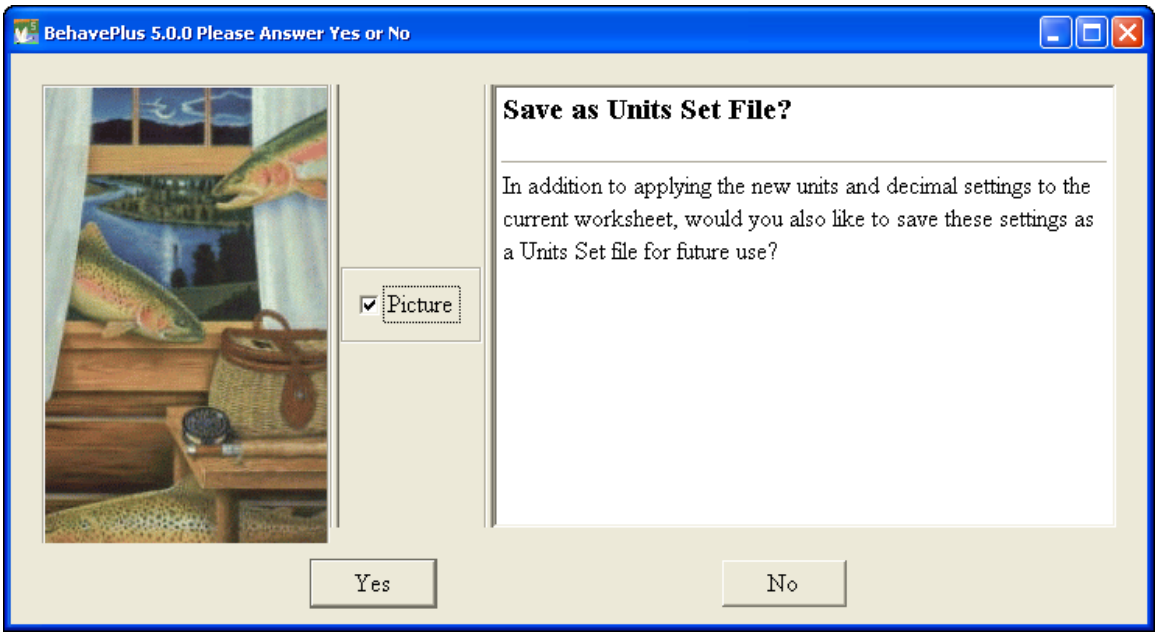
- Click on **Configure > Custom units preferences**.

The **Fuel & Vegetation Units** tab is opened. Note that some of the variables don't have a field for Decimal. Those are variables that are only available as input variables.

- Click on the **Fire & Effects Units** tab.
- Change the number of decimals for Surface rate of spread from 1 to 2.

- Click **Ok.**

You have the option of saving the changes in a custom units set file or of only applying it to the current worksheet. If you save the worksheet or a run that used the worksheet, the changed decimal display (as well as changed units) will be saved with it.



- Click on **No** to apply the change to the current worksheet.
- Calculate the run to see the change in the table.

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Demonstrate input decimal display

Surface Rate of Spread (maximum) (ch/h)

Dead Fuel Moisture %	Midflame Wind Speed (upslope) mi/h 0.0	3.0	6.5	9.0
4.000000	2.64	17.83	65.18	116.11
6.600000	2.28	15.38	56.22	100.14
9.250000	2.01	13.57	49.63	88.40
1.111111	3.67	24.77	90.57	161.33

Decimal Display of a Variable that can be Either Input or Output

Some variables can be either input or output, depending on selected options. One of these is Crown Ratio.

- Click on **Help > Variable Help**
- Click on **Crown Ratio** in the Alphabetical List of Variables

Crown Load		--O--
Crown Ratio	--I--	--O--
Crown ROS		--O--

The description explains how crown ratio can be either input or output. We will do comparison runs and demonstrate how the decimal display can be changed.

Crown Ratio

Crown Ratio is the proportion of the total vertical tree height that is occupied by the vertical length of the tree crown (Figure 16). Crown Ratio and Canopy Height are used to find Canopy Base Height, which is used to calculate Tree Crown Length Scorched in the MORTALITY module. Crown Ratio is also used in the SURFACE module to calculate Wind Adjustment Factor.

See Canopy Height, Figure 7.

I/O	Module	Condition	Notes
Input	MORTALITY		If canopy base height is not entered for CROWN
	SURFACE		If wind adjustment factor is calculated and if canopy base height is not entered for CROWN
Output	SURFACE		If wind adjustment factor is calculated and canopy base height is entered for CROWN.

- Close the Variables PDF document.

- Open the **SurfaceSimple.bpw** worksheet.
- Open the **SURFACE Options… > Wind Speed** tab and select Wind speed is entered as 20-ft wind and Calculated wind adjustment factor.
- Select the **Basic Outputs** tab. Select only Surface rate of spread.
- Select the **Wind Outputs** tab. Select only Midflame wind speed, Wind adjustment factor, and WAF calculation.
- Click **Ok** twice.

- The worksheet should look like this. Enter values as shown.

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Inputs: SURFACE

Description		
Fuel/Vegetation, Surface/Understory		
Fuel Model		2
Fuel/Vegetation, Overstory		
Canopy Cover	%	60
Canopy Height	ft	100
Crown Ratio	fraction	.1 .3 .5
Fuel Moisture		
Dead Fuel Moisture	%	6
Live Fuel Moisture	%	90
Weather		
20-ft Wind Speed (upslope)	mi/h	12
Terrain		
Slope Steepness	%	0

Run Option Notes

Maximum reliable effective wind speed limit IS imposed [SURFACE].

Calculations are only for the direction of maximum spread [SURFACE].

Fireline intensity, flame length, and spread distance are always for the direction of the spread calculations [SURFACE].

Wind is blowing upslope [SURFACE].

Output Variables

Surface Rate of Spread (maximum) (ch/h) [SURFACE]

Midflame Wind Speed (upslope) (mi/h) [SURFACE]

Wind Adjustment Factor [SURFACE]

WAF Calculation [SURFACE]

- Calculate the run to see this table.

Crown Ratio fraction	ROS (max) ch/h	Midflame Wind Speed mi/h	Wind Adj Factor	WAF Calculation
0.1	28.8	4.3	0.36	Unsheltered
0.3	8.0	1.9	0.16	Sheltered
0.5	5.9	1.4	0.12	Sheltered

Crown Ratio is shown to one decimal place because that was the maximum for the three input values (.1, .3, .5).

- Now select the **CROWN** module.
- Open the **CROWN Options… > Spread Outputs** tab and select only Transition to Crown Fire? as an output variable.
- Open the **SURFACE Options… > Wind Outputs** tab and select Crown Ratio as an additional output variable.
- Note that Crown Ratio is not an input variable. It is determined from Canopy Height and Canopy Base Height.
- Enter values on the worksheet as shown.

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Inputs: SURFACE, CROWN

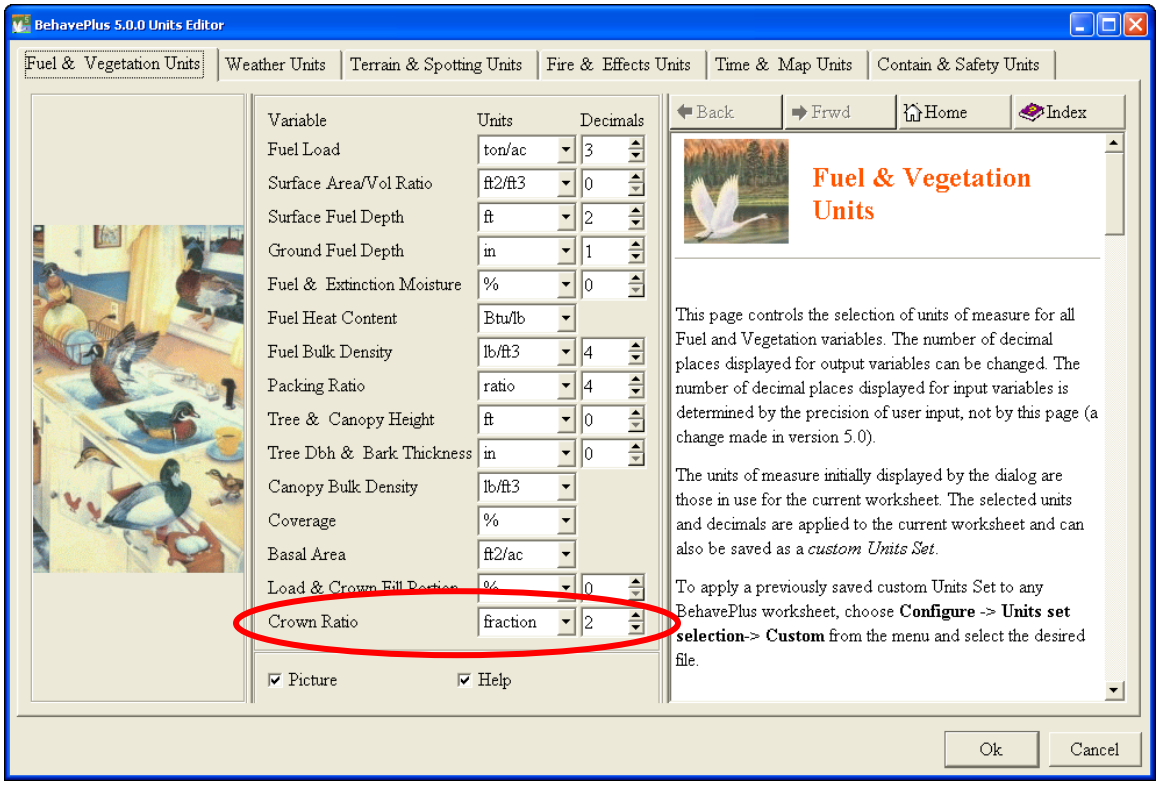
Description		
Fuel/Vegetation, Surface/Understory		
Fuel Model		2
Fuel/Vegetation, Overstory		
Canopy Cover	%	60
Canopy Height	ft	100
Canopy Base Height	ft	10 30 50
Fuel Moisture		
Dead Fuel Moisture	%	6
Live Fuel Moisture	%	90
Foliar Moisture	%	100
Weather		
20-ft Wind Speed (upslope)	mi/h	12
Terrain		
Slope Steepness	%	0

- Calculate the run to see this table.

Canopy Base Ht ft	ROS (max) ch/h	Midflame Wind Speed mi/h	Wind Adj Factor	Crown Ratio fraction	WAF Calculation	Transition to Crown?
10	4.4	1.1	0.09	0.90	Sheltered	No
30	4.9	1.2	0.10	0.70	Sheltered	No
50	5.9	1.4	0.12	0.50	Sheltered	No

Crown ratio is shown to two decimal places because that is the setting in the Units set.

- Click on **Configure > Custom units preferences**
- Click on the **Fuel & Vegetation Units** tab.
- Note that the number of decimals is set to 2. Click **Cancel**.

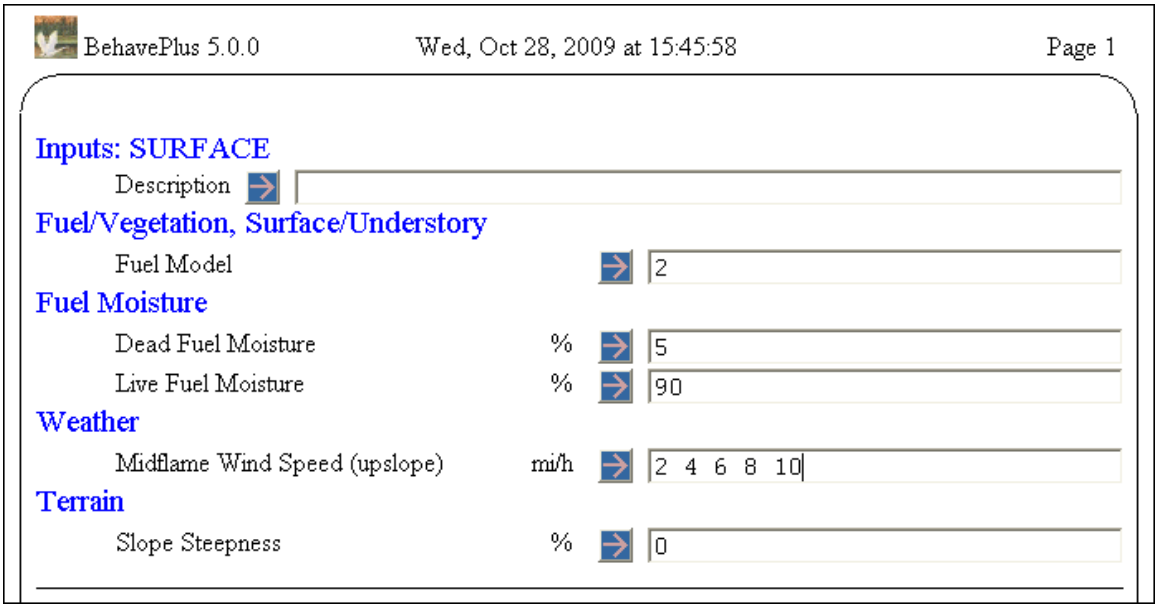


Default English and Metric Units

You can quickly change between the default English and metric units sets (or a custom units set, which you will develop later in the lesson).

If you enter values on the worksheet and then change units set, six decimal places will be displayed for the converted values, although trailing zeros are suppressed. This is a change in version 5.0. It resolves the problem with round-off that occurred in previous versions.

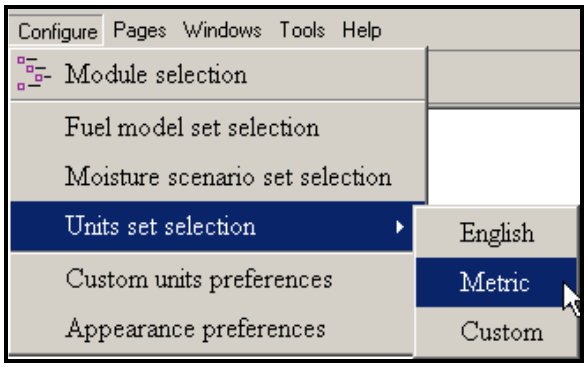
- Open the Example Worksheet, **SurfaceSimple.bpw**
- Enter values as shown.



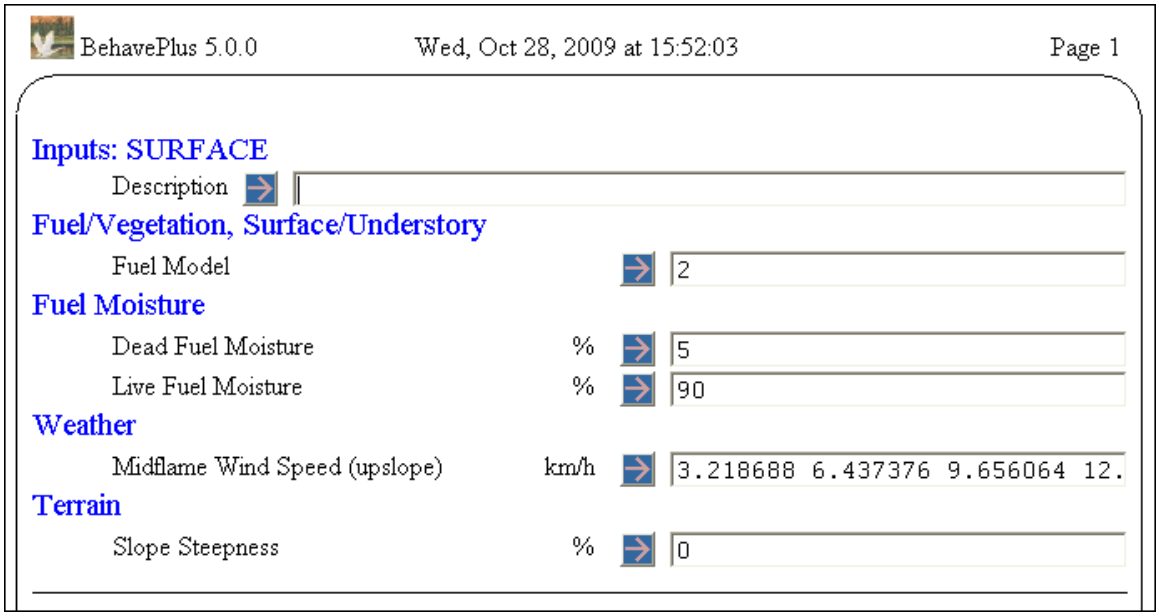
- Calculate the run.

Midflame Wind Speed mi/h	ROS (max) ch/h	Heat per Unit Area Btu/ft2	Fireline Intensity Btu/ft/s	Flame Length ft	Max Wind Exceeded
2	9.2	493	83	3.4	No
4	26.5	493	239	5.6	No
6	52.9	493	478	7.7	No
8	87.8	493	794	9.7	No
10	130.9	493	1183	11.7	No

- Change the units set with **Configure > Units set selection > Metric**



The worksheet is now metric, and all of the values have been converted.



- Calculate the run.

Midflame Wind Speed km/h	ROS (max) m/min	Heat per Unit Area kJ/m2	Fireline Intensity kW/m	Flame Length m	Max Wind Exceeded
3.218688	3.1	5604	288	1.0	No
6.437376	8.9	5604	829	1.7	No
9.656064	17.7	5604	1656	2.3	No
12.874752	29.4	5604	2751	3.0	No
16.093440	43.9	5604	4099	3.6	No

Six decimal places are now given for the midflame wind speed because of the conversion from mi/h to ft/min. All of those decimal places are on the output table. Automatic rounding can cause problems, so we made the decision to add the decimal places. You can change the values. And the most common use of the program will be to set the units and use it without change.

Saving a Worksheet with Metric Units

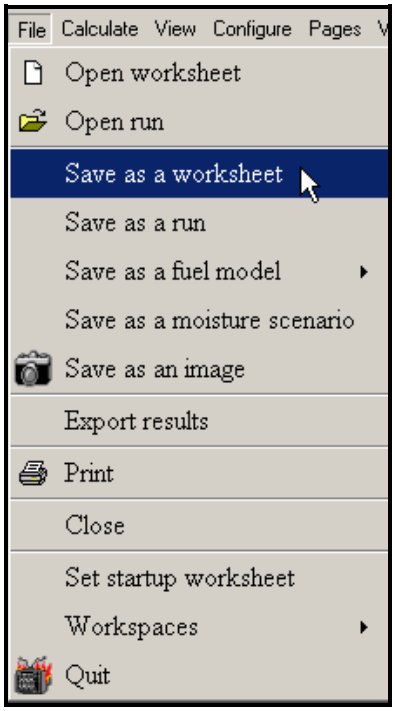
If you would prefer to always use metric rather than English units, you can save worksheets with metric units. (You can change your startup worksheet to one of your metric worksheets, with **File > Set startup worksheet**.)

Recall that when you save a **worksheet**, you save the configuration, not the values entered into the input fields. To save the values you have entered, you must save it as a **run**.

It is important to remember that all of the settings, including units and decimals, are saved with the worksheet or run, not just those that currently show.

Let's save the SurfaceSimple.bpw worksheet with metric units.

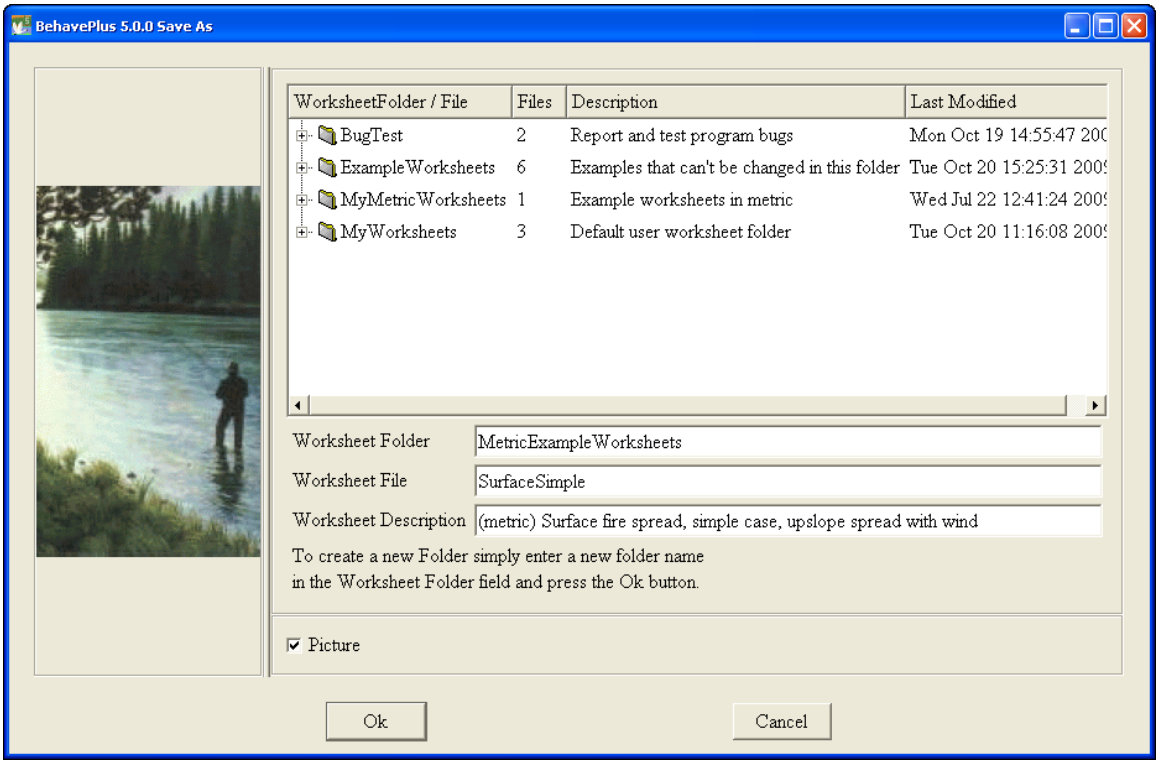
- Click on **File > Save as a worksheet**.



The default Worksheet Folder is **MyWorksheets**. If you try to save a worksheet in the **ExampleWorksheets** folder, you will get an error message. These files are distributed with the program and are write-protected.

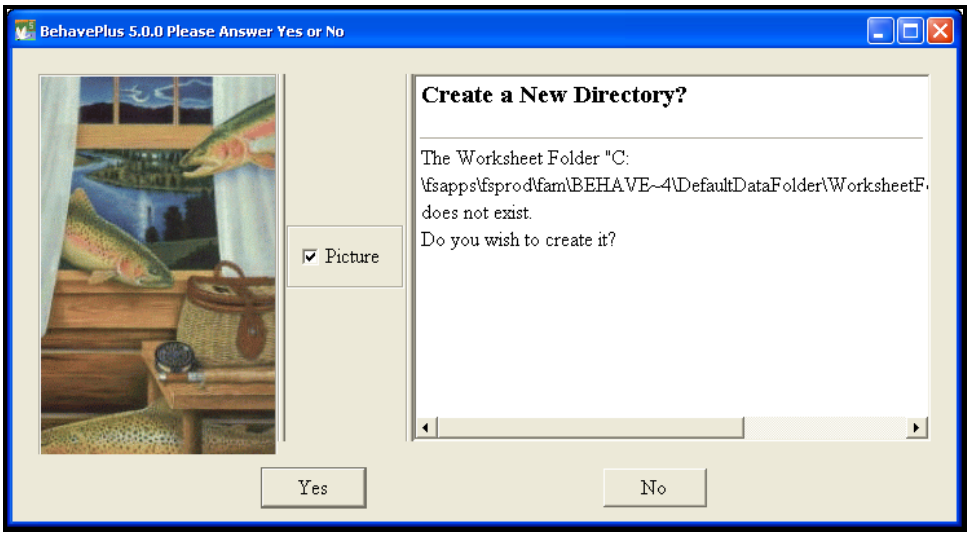
We will create a new folder for metric worksheets that are equivalent in all other ways to the English worksheets found in the **ExampleWorksheets** folder.

- In the **Worksheet Folder** box, change the text to “MetricExampleWorksheets”.
- Call the **Worksheet File** “SurfaceSimple”.
- Change the Worksheet Description. Add “(metric)”



- Click **Ok**.

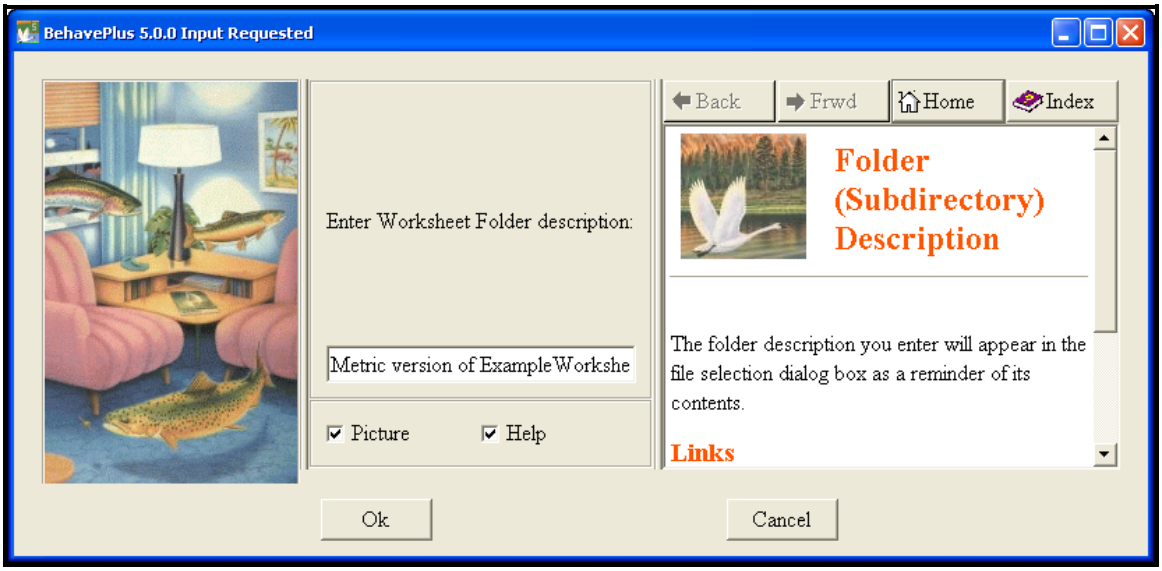
It is perfectly acceptable to use the same file name (SurfaceSimple) in a different folder. The program will ask if you want to **Create a New Directory?**



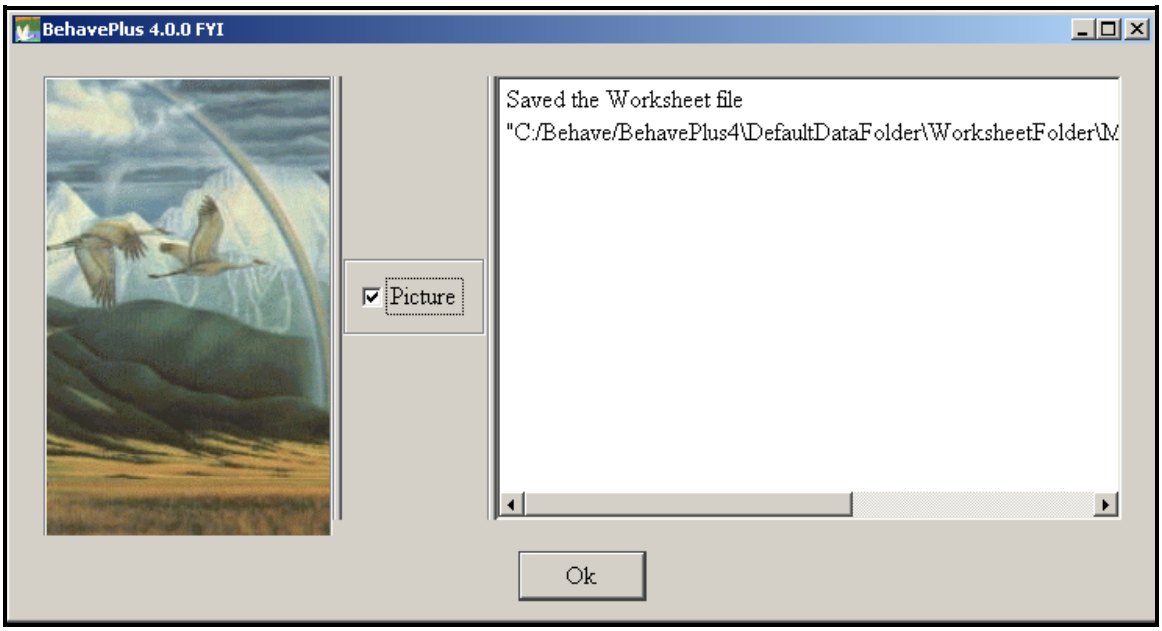
- Click **Yes**.

The program will prompt you to **Enter Worksheet Folder description**.

- Type the following in the box, “Metric version of Example Worksheets”.
- Click **Ok**.

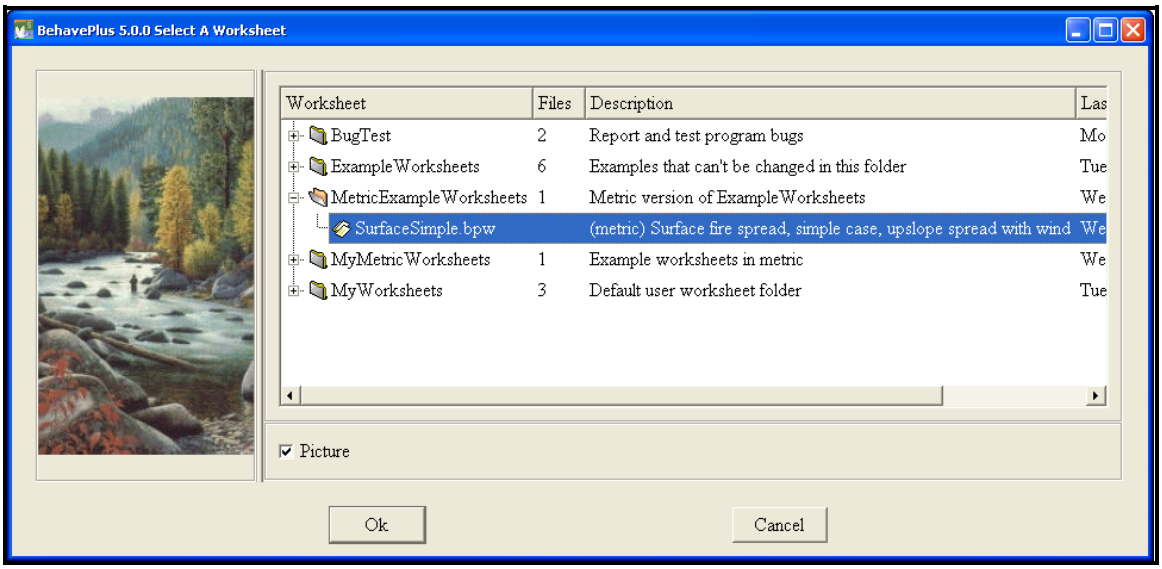


BehavePlus will create the new folder and save the worksheet. An **FYI** box will appear to let you know what was done.



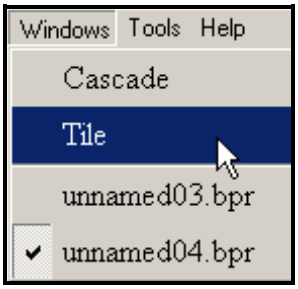
Open Both English and Metric Worksheets.

- Close all open worksheets or exit and restart the program.
- Open the **SurfaceSimple.bpw** worksheet from the **Example Worksheets** folder.
- Open the **SurfaceSimple.bpw** worksheet from the **MetricExampleWorksheets** folder.

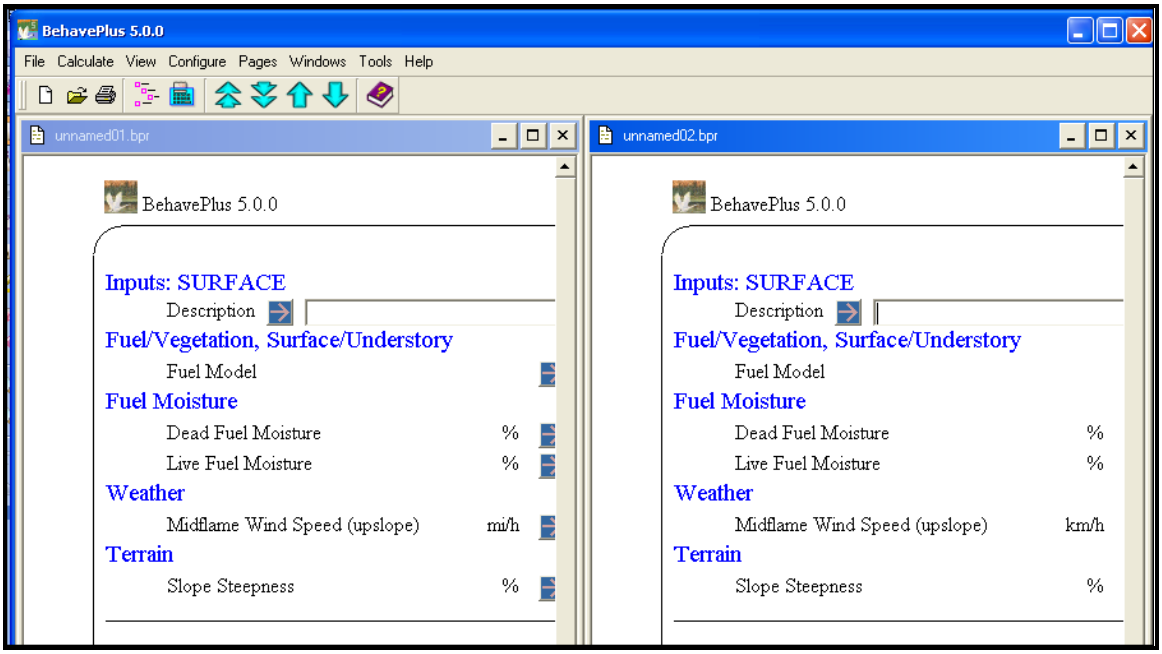


You can view more than one worksheet at a time by going to the Windows button on the main toolbar. Names are assigned only to saved **runs**, so these worksheets will temporarily be named **unnamedXX.bpr**, where xx is the number.

- To view both worksheets simultaneously, click on **Windows > Tile**.



The two worksheets will appear side-by-side in the window.

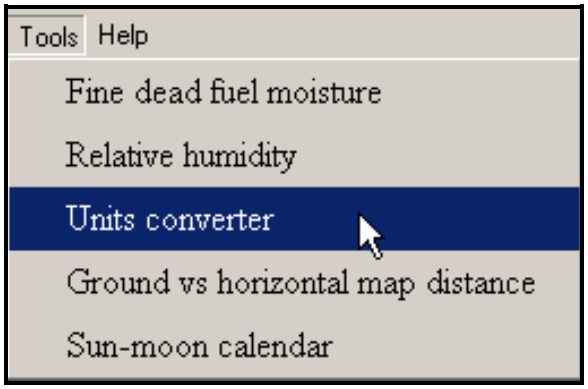


- Close both open worksheets.

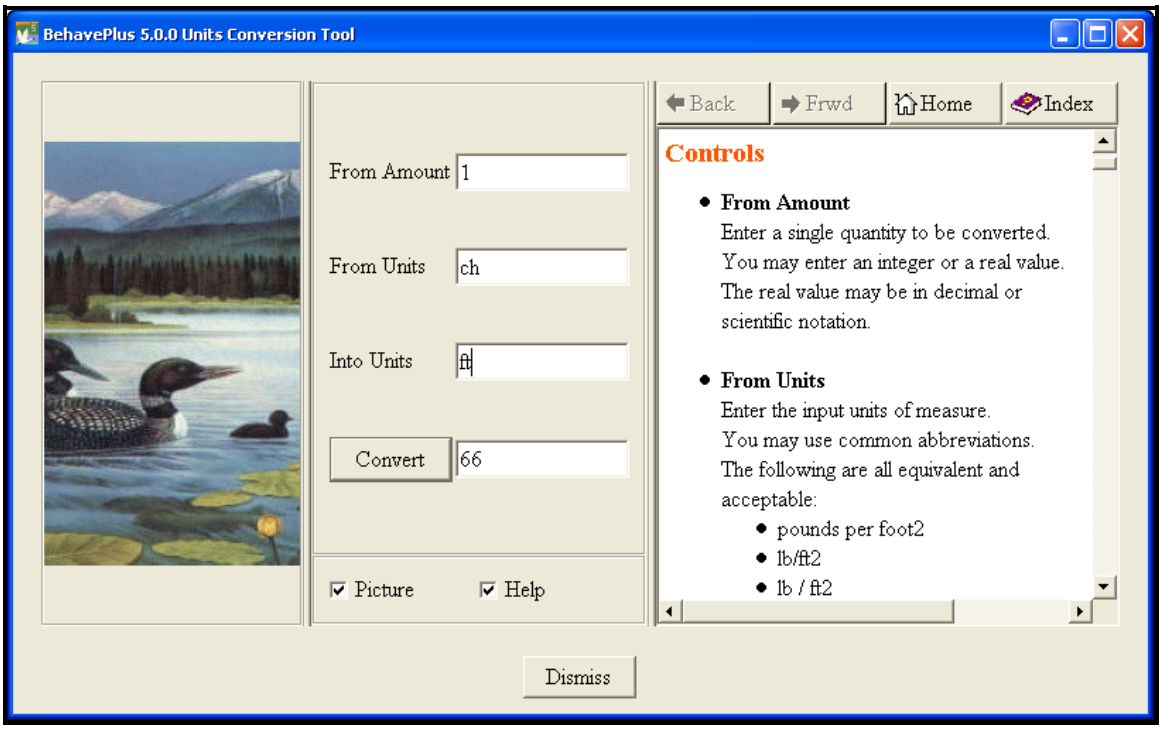
Units Converter Tool

You may not want to use the units that are in the default English and metric sets. For example, you might not want to use chains as the units for rate and distance variables. You may, in fact, be one of those users who ask “What is a chain anyway?”

Let's use **Tools > Units Converter** to see the relationship between chains and feet.



This opens the **Units Conversion Tool**, which converts a quantity between arbitrary units of measure. The help window provides guidance.



One chain is 66 feet.

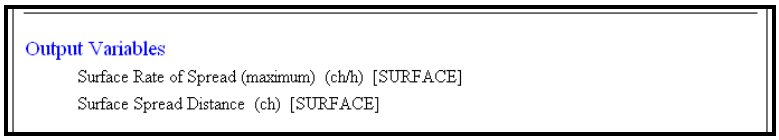
- Click **Dismiss** to exit the **Units Conversion Tool**.

Changing Units

Continuing with the premise that you prefer not to use “chains” as units in your fire modeling efforts, you can build and save a custom units set without “chains”.

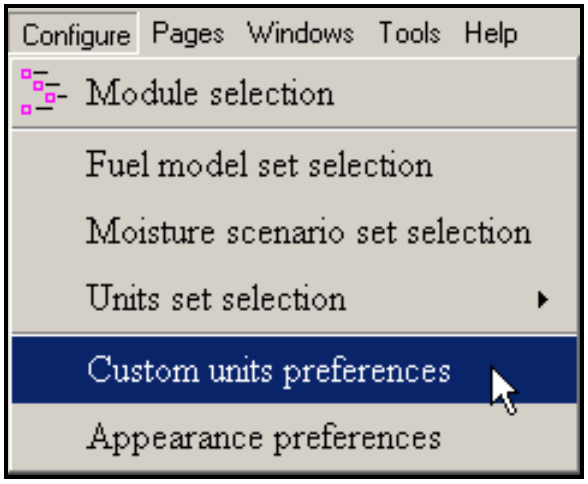
- Exit the program and restart.
- Open the **SurfaceSimple.bpw** worksheet from the **Example Worksheets** folder.
- Change the output variable selection to only Surface Rate of Spread and Surface Spread Distance. Be sure to remove Max Eff Wind Exceeded? from the Wind Outputs tab.
- Click **Ok** twice to close both the **Surface Module Options** and the **Module Selection** windows.
- Look in the **Output Variables** Section of the worksheet.

The Surface Rate of Spread has units of ch/h (chains per hour and Surface Spread Distance has units of chains.



Let’s change the units of these two variables so that they are no longer measured in chains.

- Click on **Configure > Custom units preferences**.



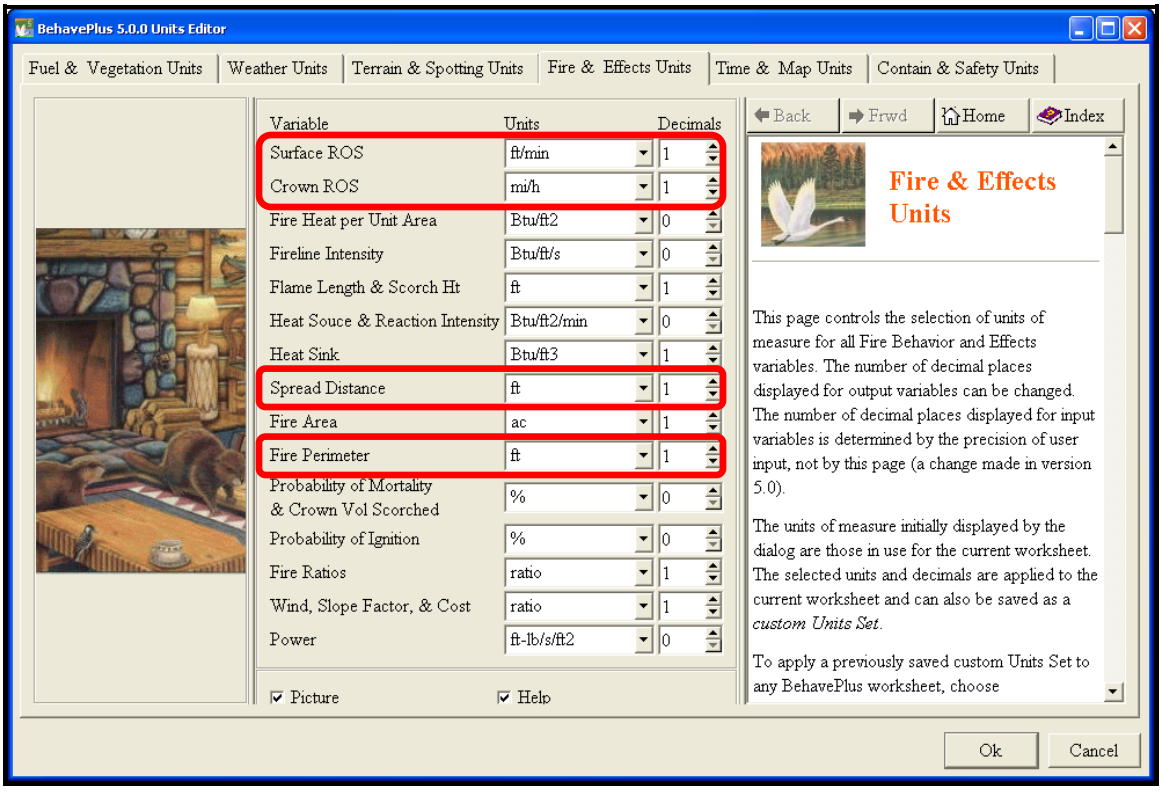
There are over 180 variables in BehavePlus (described in Variables Help). They are divided into groups for the purpose of assigning units and decimal display. The units for each group of variables can be defined independently. However, the units for *all* variables in that group will be changed. More information on the variable groups can be found in the Help pane.

- Click on the **Fire & Effects Units** tab.

Notice that Surface ROS and Crown ROS are listed separately. You may want Surface fire Rate of Spread in units of ft/min and Crown fire Rate of Spread in mi/h (miles per hour).

To change the units for a group, make a selection from the drop-down list associated with each group.

- Change the variables that are in chains to other units as shown below.

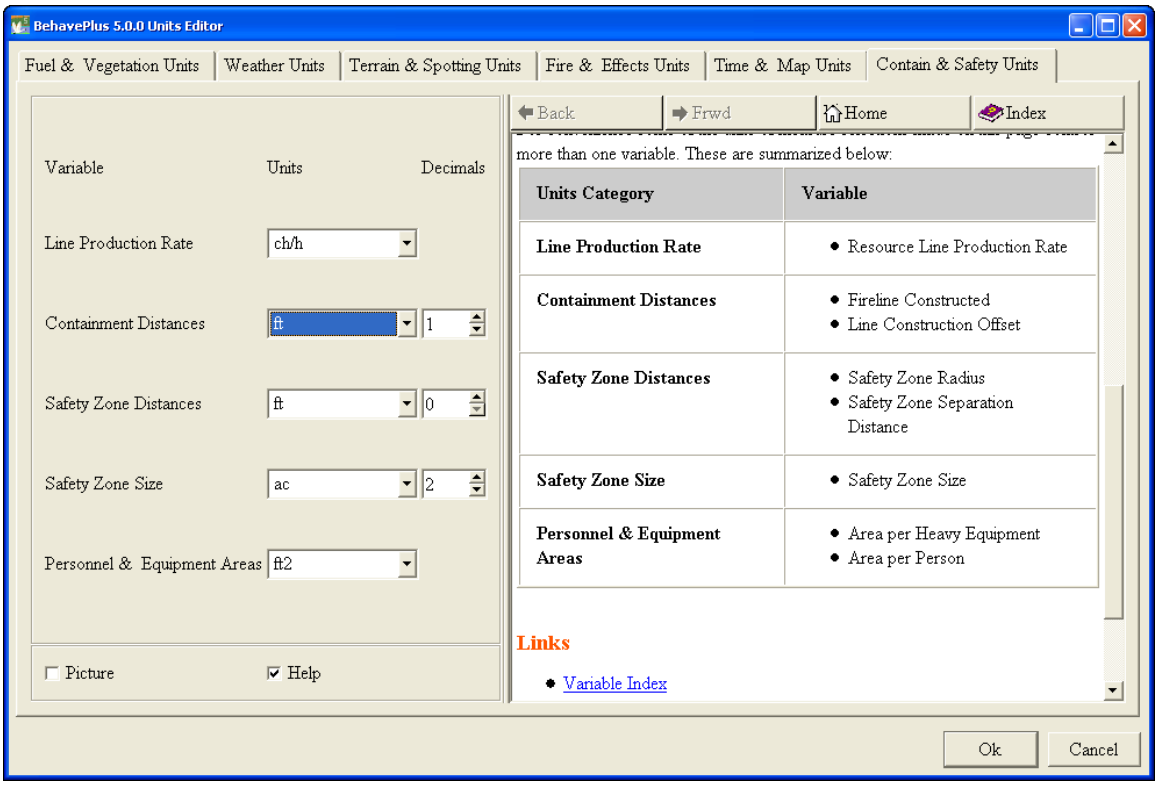


Even though Crown ROS and Fire Perimeter are not currently associated with the worksheet that is currently displayed, the new units will be saved with the worksheet (or run) file. In fact, the entire Custom Units Set is associated with the worksheet. When you save the worksheet, you will save all of the changed units and decimals. At a later time you might add SIZE to the worksheet and would want Fire Perimeter to be in feet rather than chains to obtain consistent results. Therefore, we have changed it now.

- Check the other tabs to see if other variable categories use units of chains.

The only other categories with chains are found on the Contain & Safety Units tab.

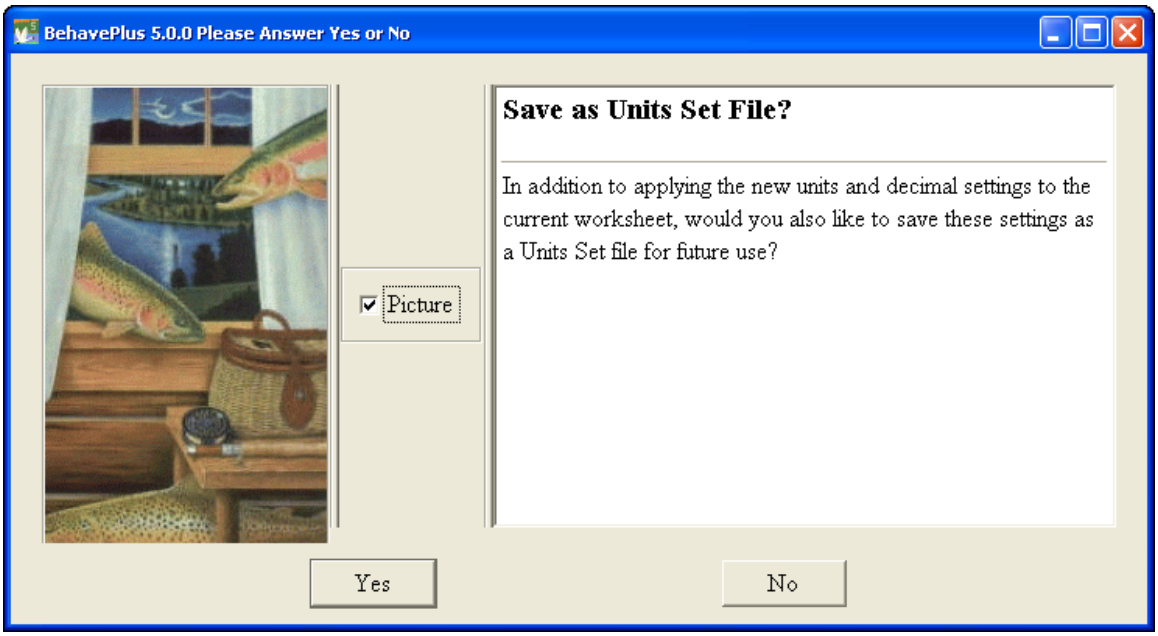
- Change containment distances to ft. Note that the help window lists the variables that fall under that category.



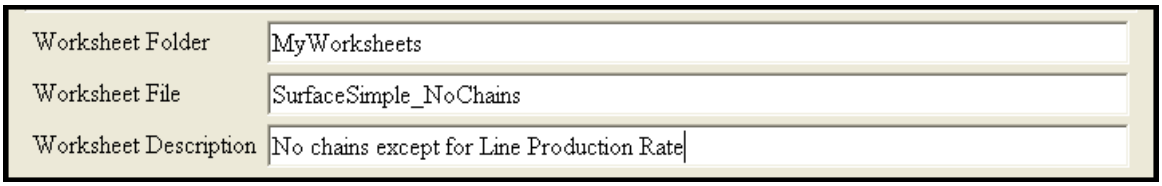
We will leave Resource Line Production Rate in units of ch/h because those are the units found in the *Fireline Handbook* (March 2004). The tables from the *Fireline Handbook* are available in the Help window by looking in the **Variable Index** under Resource Line Production Rate or in the **Table Index** under each specific table name. These links are found at the bottom of every help page.

- Click **Ok** to close the Units Editor.

You are given the option to save this Custom Units Set. If you are going to use this set of units often, you may wish to do that. However, even if you choose not to save the file, the units will be saved with the worksheet.

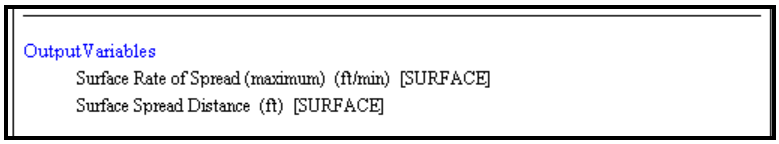


- Click **No** for now, and don't save the Custom Units Set.
- Save the worksheet in the **MyWorksheets** folder with the name and description as shown below. The unit changes will be saved with it (for *all* variables, not just those that show on the worksheet.).



- Click **Ok**.

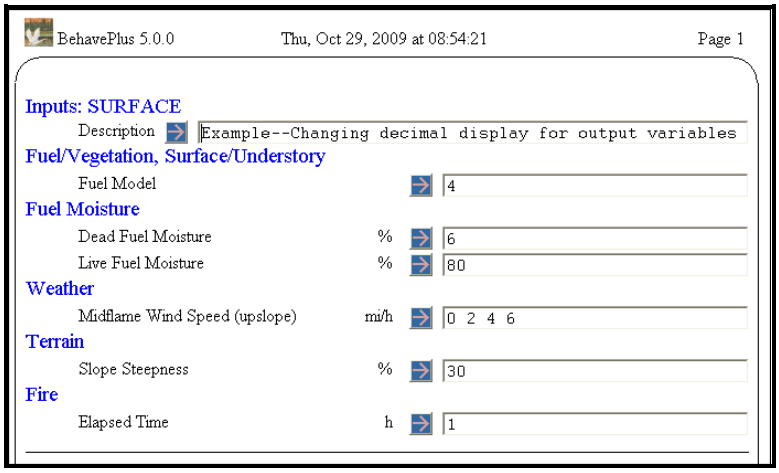
The units of the **Output Variables** have changed on the worksheet.



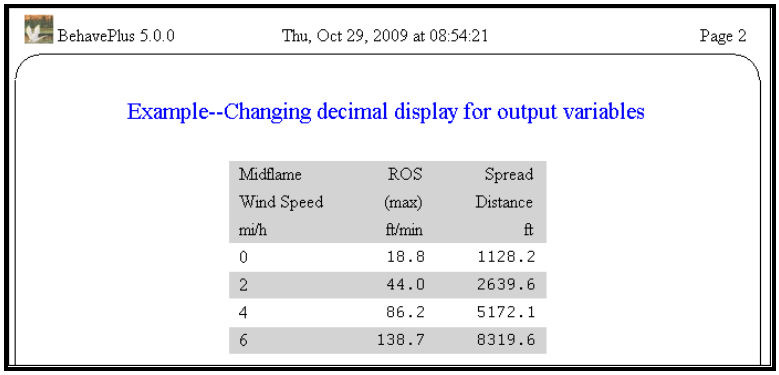
Saving a Run with Changed Output Decimal Display

You can change the decimal display the same way you changed the units.

- In the worksheet you just modified and saved as **SurfaceSimple_NoChains.bpw**, enter values into the worksheet as shown.



- Click the Calculate button to obtain the following results.



Midflame Wind Speed mi/h	ROS (max) ft/min	Spread Distance ft
0	18.8	1128.2
2	44.0	2639.6
4	86.2	5172.1
6	138.7	8319.6

Displaying the results to one decimal place is not necessary for the units of ft/min and ft. We want to change them to zero.

- Click on **Configure > Custom units preferences** and activate the **Fire & Effects Units** tab.
- Change the decimals for Surface ROS, Spread Distance, and Fire Perimeter to zero by using the dial buttons.
- Click **Ok**.
- Click **No** to not save the Custom Units Set.
- Calculate the run again.

The results make more sense for the chosen units.

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Example--Changing decimal display for output variables

Midflame Wind Speed mi/h	ROS (max) ft/min	Spread Distance ft
0	19	1128
2	44	2640
4	86	5172
6	139	8320

It may be preferable to show the Spread Distance in miles with one decimal place. You will try that in the exercises.

- Save the Run in the **MyRuns** folder as "UnitsDecimals". Leave the default description, which is the description from the worksheet.

Run Folder	MyRuns
Run File	UnitsDecimals
Run Description	Example--Changing decimal display for output variables

- Click **Ok**.

Saving a Custom Units Set

When you set up units and decimals the way you want them, you can save a Custom Units Set for later use. Let's save the Custom Units Set.

- Open the **Units Editor** again with **Configure > Custom units preferences**.
- Click **Ok** to close it. This action will prompt you to save the Units Set.
- Click **Yes**.
- Save the file in the **MyUnitsSets** folder as "NoChains". In the description box, type "except ch/h for line production rate".

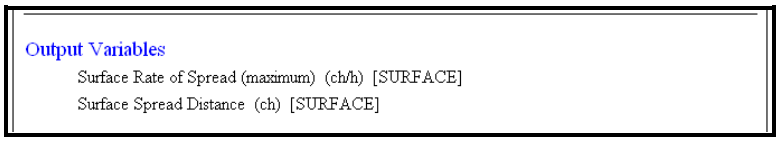
Units Set Folder	MyUnitsSets
Units Set File	NoChains
Units Set Description	except ch/h for line production rate

- Click **Ok** to save the Units Set.

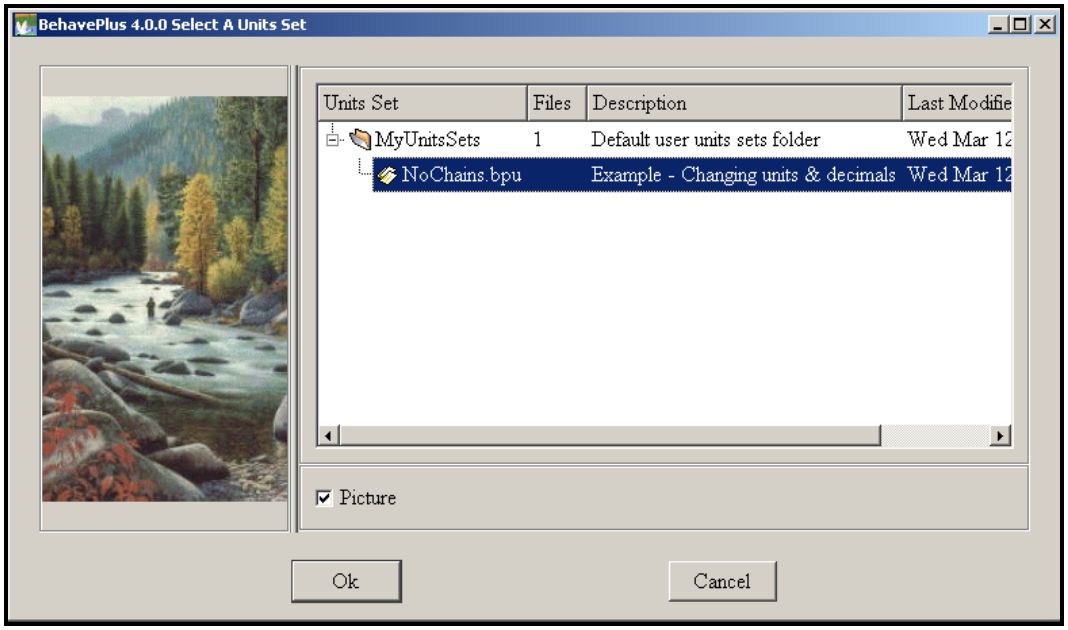
Changing the Units Set Selection

- To convert your worksheet back to default English measurements, click on **Configure > Units set selection > English**

The units for Surface Rate of Spread and Surface Spread Distance are again ch/h and ch, respectively.

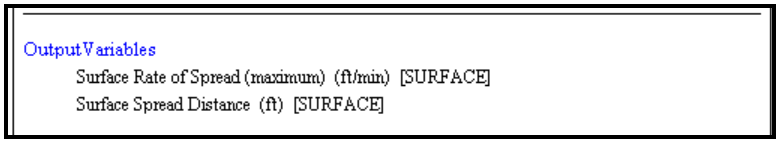


- To change to your Custom Units Set, click on **Configure > Units set selection > Custom**
- Expand **MyUnitsSet** and select the Custom Units Set you just built and saved (**NoChains.bpu**).



- Double click, or click **Ok**.

The units of output variables have changed back to our custom units.

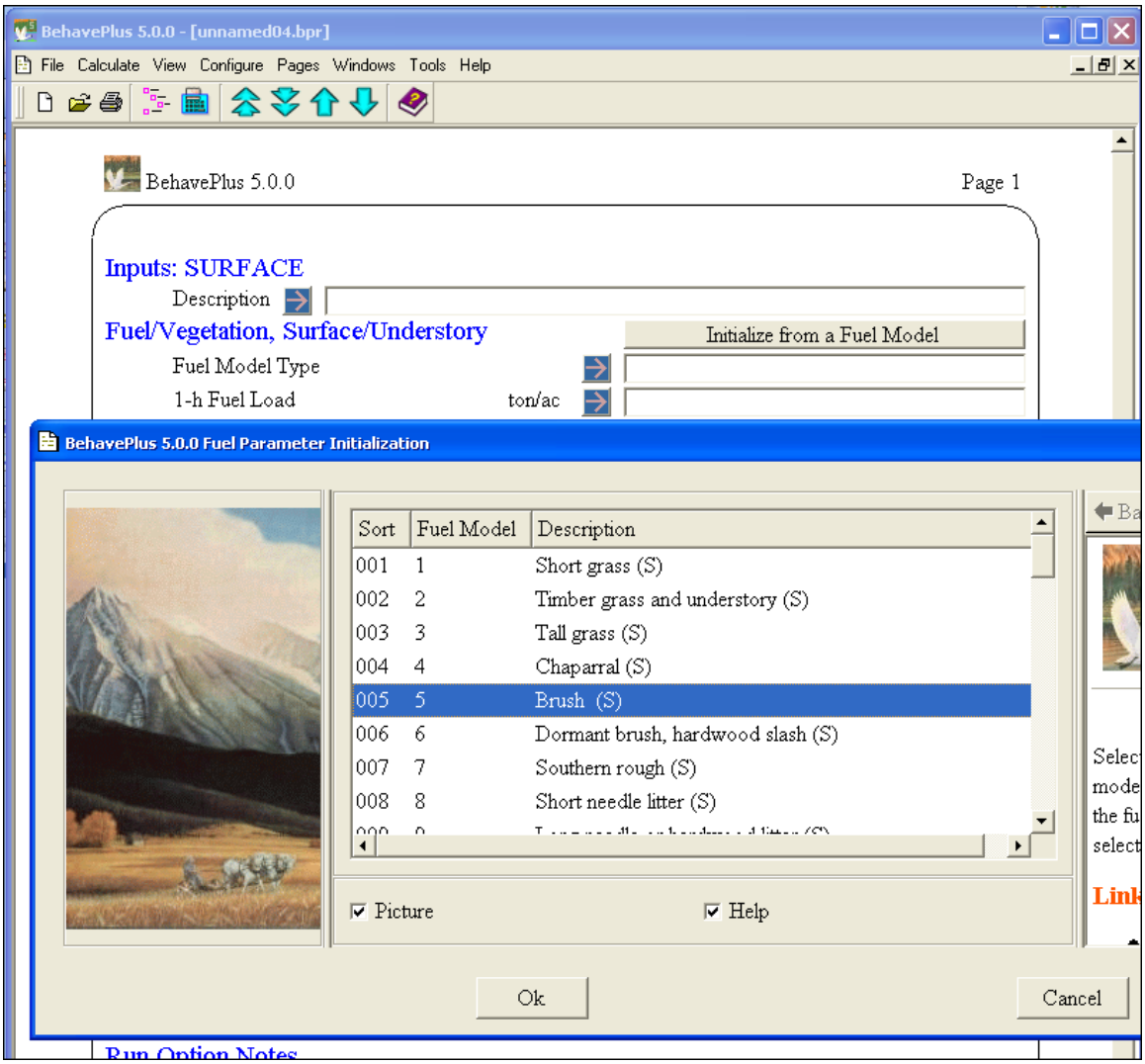


- Select the SIZE and CONTAIN modules.
- Note the changes to units of the output variables.
- Go back to the default English units (**Configure > Units set selection > English**) and view the changes to the worksheet.

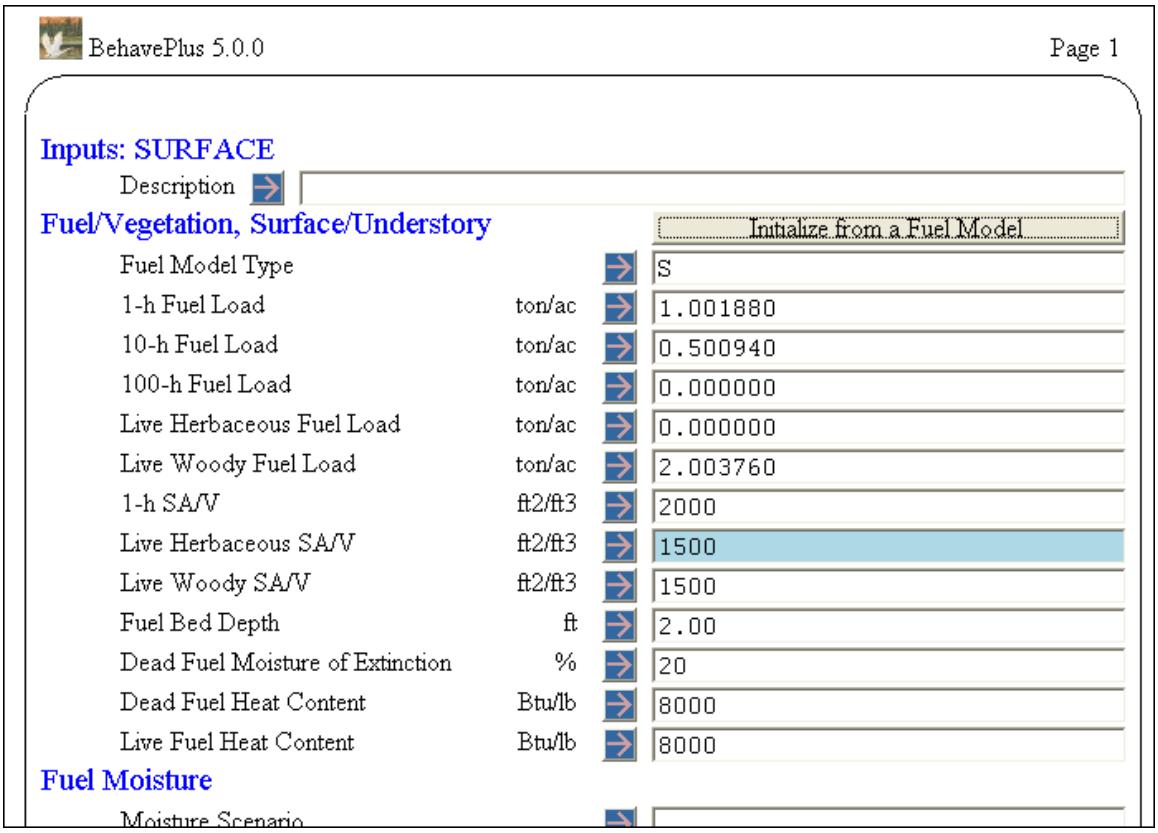
Decimal Display for Fuel Model Parameters

Assigning values for fuel parameters is a special case because of the option "Initialize from a Fuel Model". If you are developing fuel models, it is best to use the worksheets from the **Example Worksheets** folder: **FuelModeling.bpw** or **FuelModelingMetric.bpw**. Six decimal places are displayed to avoid round-off problems.

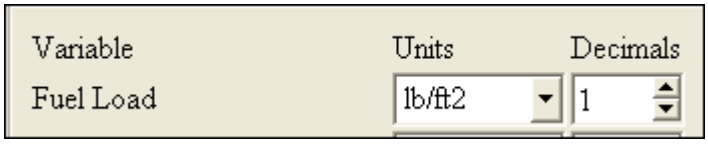
- Open the worksheet **FuelModeling.bpw**
- Click **Initialize from a Fuel Model**
- Select fuel model **5** (Brush).

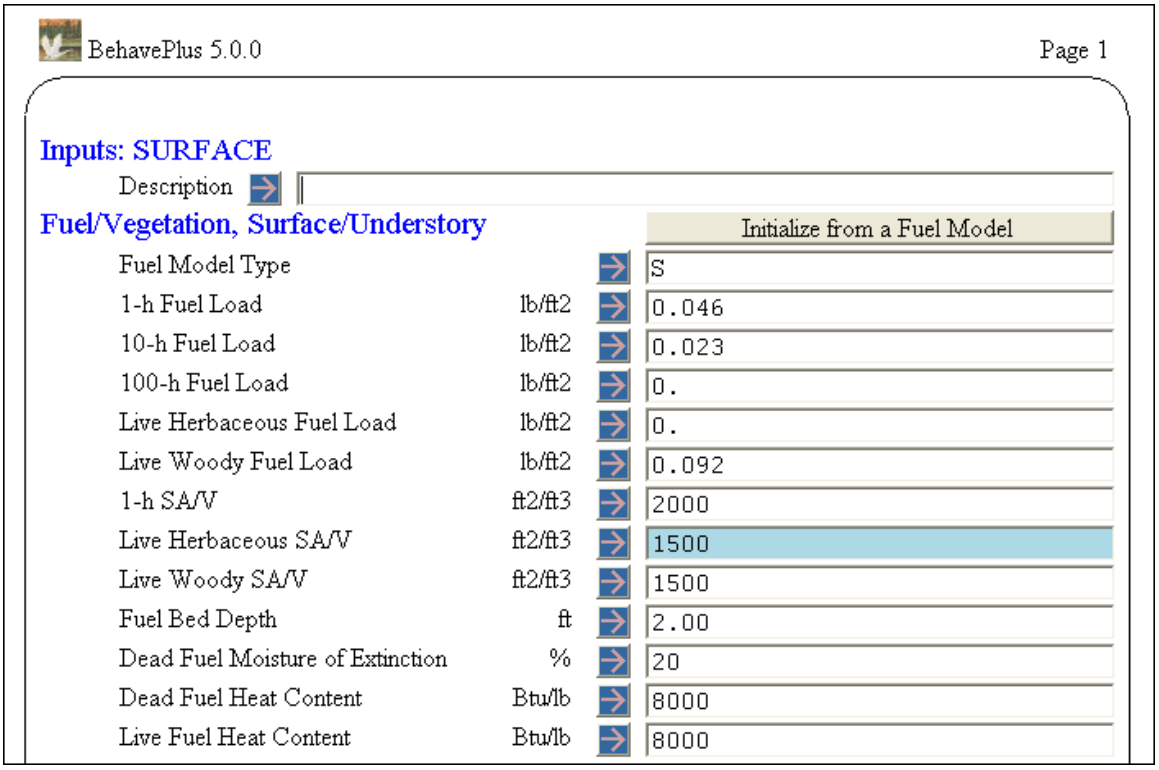


Values are entered into the worksheet. Fuel load values are given to six decimal places. The false precision is a result of the fact that the 'native units' for fuel load are lb/ft^2 and a conversion is done to ton/ac for the worksheet.



- Change the units of fuel load to lb/ft2.
- Change the decimals for fuel load to 1 to confirm that the decimal change does not apply to input variables. (Look at the **SURFACE Options… > Fuel Outputs** tab to see fuel load variables as output.)





The **FuelModeling** worksheets are special cases developed to address the decimal display issue. They should be used as the starting point when developing custom fuel models. They are different from those available prior to version 5.0. Decimal display of load values is different if you load the FuelModeling worksheets than if you start with another worksheet and select **Fuel is entered as fuel parameters**.

Summary

In this lesson, you have seen that

- The decimal display of input variables is determined by the values that are entered.
- You can switch between the default English and metric units using **Configure > Units set selection > English** or **Metric**.
- You can change units and the decimal display of output variables using **Configure > Custom units preferences**.
- You can apply changes to the current worksheet without saving a custom units file.
- Units and output variable decimal display for *all* variables is part of the worksheet, whether those variables are currently shown or not.
- When you save a worksheet or a run, the complete units and decimal set is saved with it.
- You can save a Custom Units Set and apply it at any time using **Configure > Units set selection > Custom.**
- **Initialize from a Fuel Model** for fuel model parameters is a special case for decimal display. For full decimal display, it is best to use the **Example Worksheet FuelModeling.bpw** or **FuelModelingMetric.bpw**.

Exercises

1. Open the run that you saved in the lesson, called "UnitsDecimals".
   - Change the units for Spread Distance to miles (mi) with one decimal place.

The results should look like this.

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Example--Changing decimal display for output variables

Midflame Wind Speed mi/h	ROS (max) ft/min	Spread Distance mi
0	19	0.2
2	44	0.5
4	86	1.0
6	139	1.6

   - Close the worksheet before starting Exercise 2.

2. Open the Example Worksheet **SurfaceSimple.bpw**. Develop a worksheet that looks like this (Crown Ratio ranges from 0.50 to 1.00).

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Inputs: SURFACE

Description: Exercise 2 - Units & Decimals

Fuel/Vegetation, Surface/Understory

Fuel Model: 4

Fuel/Vegetation, Overstory

Canopy Cover (percent): 50

Canopy Height (ft): 100

Crown Ratio: 0.50, 0.60, 0.70, 0.80, 0.90,

Fuel Moisture

Dead Fuel Moisture (percent): 6

Live Fuel Moisture (percent): 80

Weather

20-ft Wind Speed (upslope) (mi/h): 10

Terrain

Slope Steepness (percent): 30

Run Option Notes

Maximum reliable effective wind speed limit is imposed [SURFACE].

Calculations are only for the direction of maximum spread [SURFACE].

Fireline intensity, flame length, and spread distance are always for the direction of the spread calculations [SURFACE].

Wind is blowing upslope [SURFACE].

Output Variables

Surface Rate of Spread (maximum) (ft/min) [SURFACE]

Midflame Wind Speed (upslope) (mi/h) [SURFACE]

Wind Adjustment Factor [SURFACE]