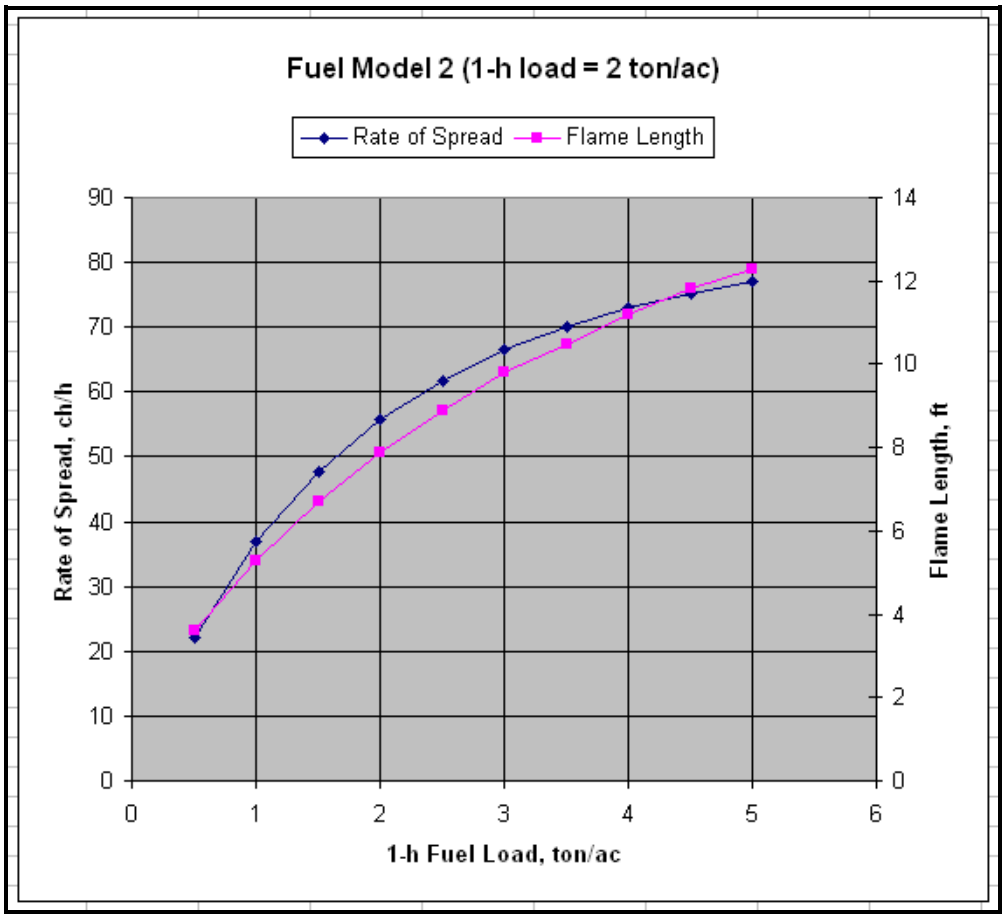
Exercise Answers

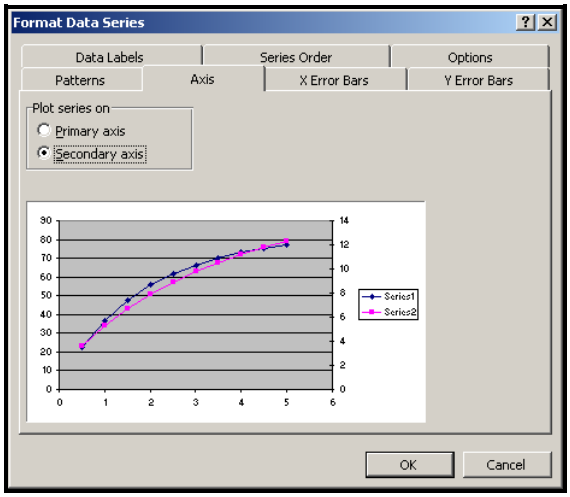
1. **Continuing with the example at the end of this lesson, change the graph of Surface Rate of Spread and Flame Length to look like the following graph.**



Start by putting Flame Length on a secondary axis.

- Right-click on the Flame Length line (**Series2**) and select **Format Data Series…**.
- Click on the **Axis** tab.

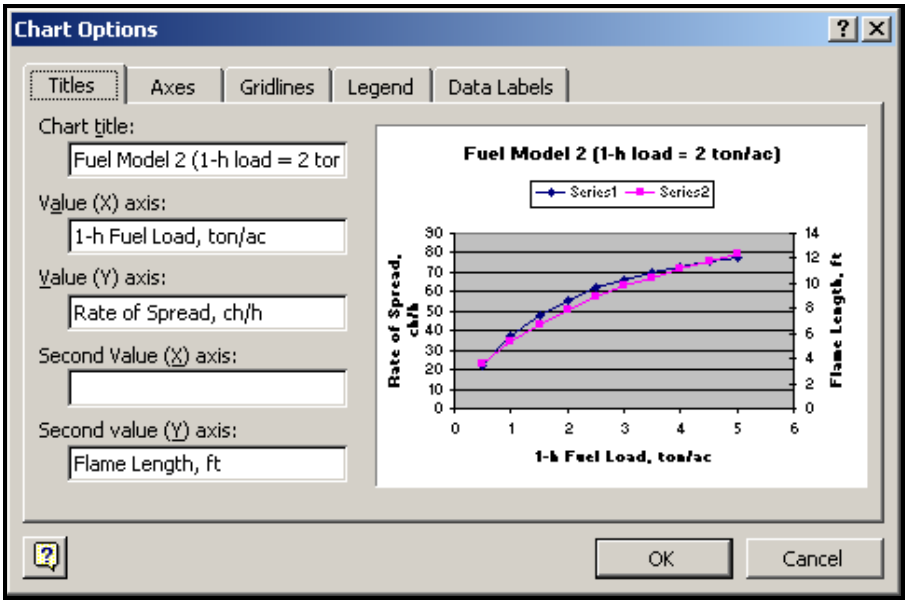
- Change **Plot series on** to **Secondary axis**.



- Click **OK**.

Next, modify the graph.

- Right-click in the white area of the plot.
- Click on **Chart Options**.
- Click on the **Titles** tab.
- Fill out the **Chart title**, **Value (X) axis**, **Value (Y) axis**, and **Second Value (Y) axis** as follows.
- Leave the **Second Value (X) axis** blank as both Surface Rate of Spread and Flame Length use the same independent variable (x-axis).
- Click on the **Legend** tab. Change the **Placement** from **Right** to **Top**.



- Click on the **Gridlines** tab. Add a check by **Major gridlines** for **Value (X) axis**.
- Click **OK**.

Changing the primary y-axis:

- Right-click on the primary y-axis (on the left-hand side of the graph). A pop-up window should appear.
- Select **Format Axis**.
- Click on the **Scale** tab. Change the **Maximum** from 100 to 90. Change the **Major unit** from 20 to 10.
- Click **OK**.

You shouldn't need to change either the x-axis or the secondary y-axis (right-hand side of the graph). If you do, follow the instructions for changing the primary y-axis above.

Changing the Legend entries:

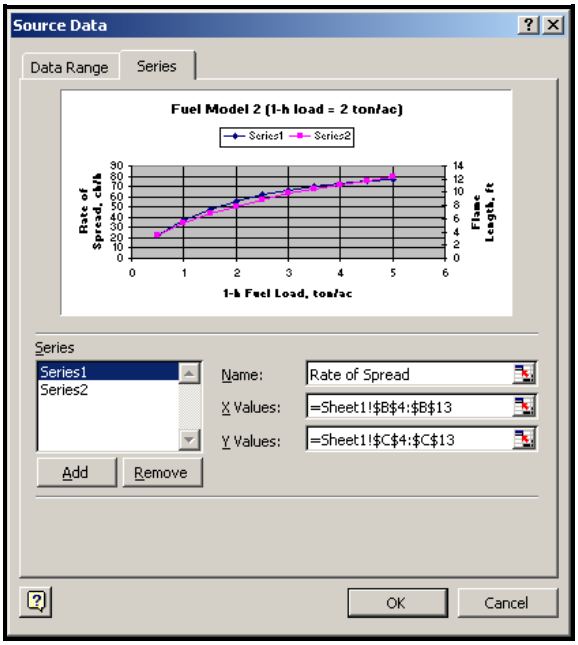
- Right-click in the white area of the graph, and click on **Source Data…**.

On the **Series** tab, there are two important items:

- two **Series**, and
- the **Name** is blank for each one.

Change between **Series** by clicking on the series you want to view.

- Make sure **Series1** is highlighted.
- In the **Name** field, type 'Rate of Spread'.

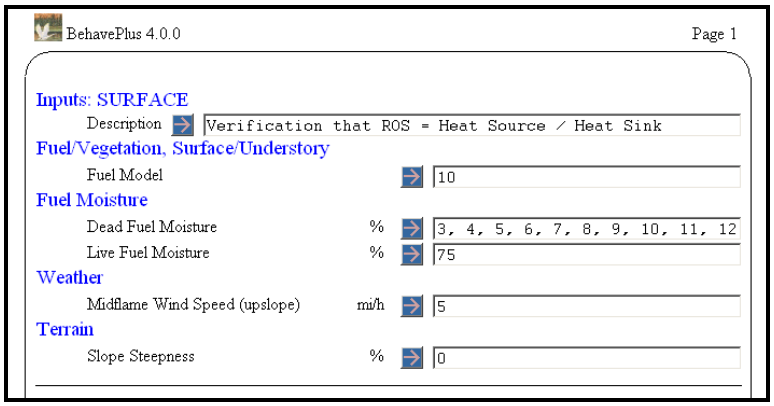


- Highlight **Series2**.
- In the **Name** field, type ‘Flame Length’.
- Click **OK**.

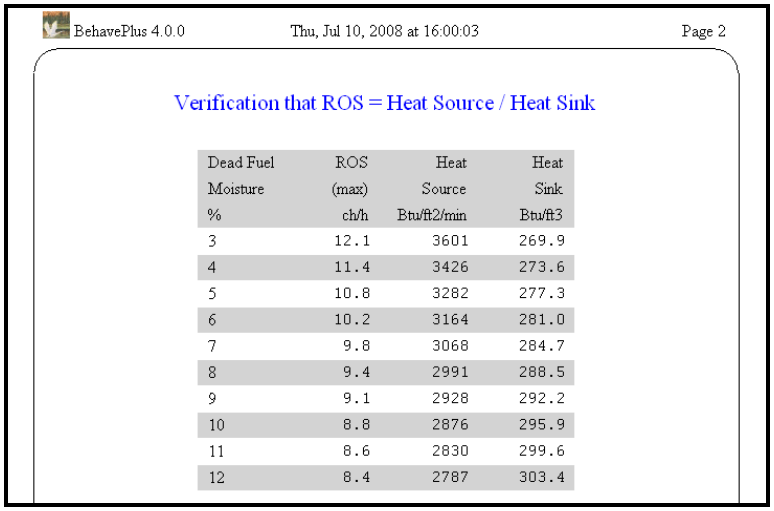
If you forget which series corresponds to which variable, you can look at the Y values and compare them with the corresponding column in the Excel® worksheet.

- Click on the chart. Grab the corner and resize the chart. The graph is now complete.

2. Confirm that the Heat Source / Heat Sink = Surface Fire Rate of Spread. Use the following inputs:



- Open **SurfaceSimple.bpw**.
- Open the **Module Selection > SURFACE Options > Basic Outputs** tab. Change the outputs so that only Surface Rate of Spread is output.
- Click on the tab for **Intermediates**. Add checks by **Heat Source** and **Heat Sink**.
- Click **Ok** twice.
- Calculate the run.



Dead Fuel Moisture %	ROS (max) ch/h	Heat Source Btu/ft2/min	Heat Sink Btu/ft3
3	12.1	3601	269.9
4	11.4	3426	273.6
5	10.8	3282	277.3
6	10.2	3164	281.0
7	9.8	3068	284.7
8	9.4	2991	288.5
9	9.1	2928	292.2
10	8.8	2876	295.9
11	8.6	2830	299.6
12	8.4	2787	303.4

- Export the results to the **ExportLesson** folder as 'Exercise1'
- Open the file with Microsoft Excel®.
- Save the file in .xls format.
- As before, copy the outputs into a new worksheet.
- Add a column titled 'heat source / heat sink, ft/min'.

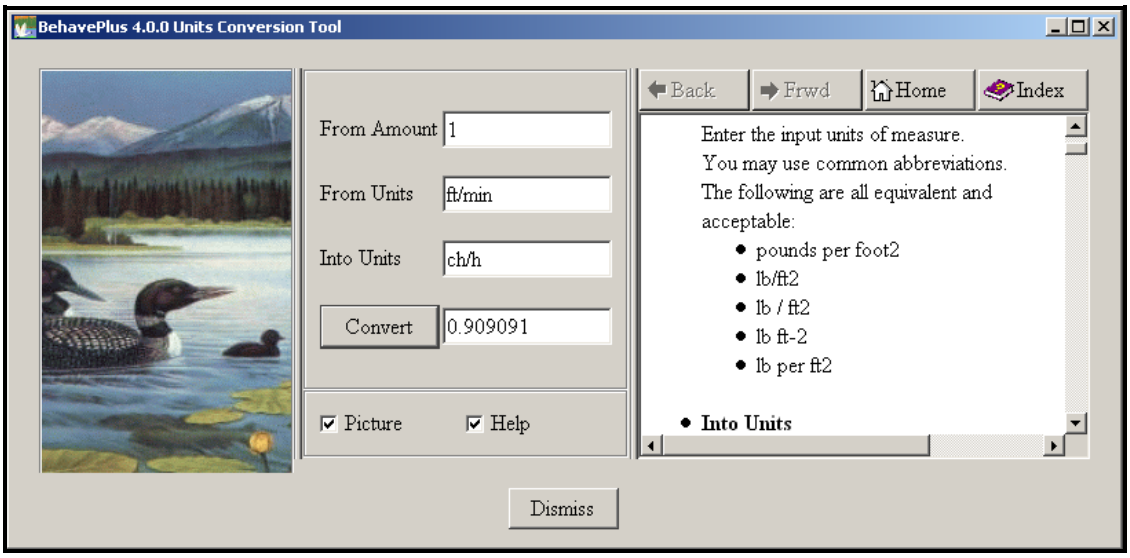
Calculate the values for this column.

- Click on the cell associated with **Dead Fuel Moisture = 3%** in the column you just created for **heat source / heat sink**.
- Type '='.
- Click on the **Heat Source** value for that row.
- Type '/'.
- Click on the **Heat Sink** value for that row.
- Click **Enter**.
- A value should appear.
- Click on the resulting value.
- Double-click on the **Dot** in the lower right-hand corner of the cell.
- Values will be automatically calculated for the entire column.

Question: Why are the results not equal to the Surface Rate of Spread calculated by BehavePlus?

Hint: Look at the units. The Surface Rate of Spread is in ch/h, but the ratio of Heat Source to Heat Sink is in ft/min. You need to convert this ratio into units of ch/h to compare your answer with the Surface Rate of Spread. You can use the **Converter Tool** to find the conversion factor you need.

- In BehavePlus, click on **Tools > Units converter**.
- Fill out the **Units Conversion Tool** window as follows. Acceptable units are found in the **Help Pane**. Clicking **Dismiss** will close the **Units Conversion Tool**.



- Based on the results from the **Units Conversion Tool**, multiply the values in the **Heat Source / Heat Sink** column by 0.91.
- Type '='.
- Click on the **Heat Source / Heat Sink** value for that row.
- Type '*'.
- Type '0.91'.

B	C	D	E	F	G
Dead Fuel Moisture	ROS (max)	Heat Source Btu/ft2/min	Heat Sink	Heat Source / Heat Sink	ROS
%	ch/h		Btu/ft3	ft/min	ch/h
3	12.1	3601	269.9	13.34197851	=F4*0.91
4	11.4	3426	273.6	12.52192982	
5	10.8	3282	277.3	11.83555716	
6	10.2	3164	281	11.25978648	
7	9.8	3068	284.7	10.77625571	
8	9.4	2991	288.5	10.36741768	
9	9.1	2928	292.2	10.02053388	
10	8.8	2876	295.9	9.719499831	
11	8.6	2830	299.6	9.445927904	
12	8.4	2787	303.4	9.18589321	

- Click **Enter**.
- Click on the resulting value.
- Double-click on the **Dot** in the lower right-hand corner of the cell to calculate values for the entire column.

To match the ROS output from BehavePlus, we need to change the number of significant figures in the column of data.

- Highlight the cells you just calculated.
- Go to **Format > Cells…**.
- In the **Number** tab, change the **Category** to **Number** and the **Decimal Places** to **1**.
- Go to the **Alignment** tab.
- Change the **Horizontal Text alignment** to **Center**.
- Click **OK**.

Conversely, you can

- Highlight the cells you just calculated.
- Click on the **Increase Decimal** or **Decrease Decimal** toolbar buttons ( ) until you have the desired number of decimal places.
- Center your results using the **Center** toolbar button ( ).

Now the results agree, confirming that Heat Source / Heat Sink = Surface Fire Rate of Spread.

B	C	D	E	F	G
Dead Fuel Moisture	ROS (max)	Heat Source Btu/ft2/min	Heat Sink	Heat Source / Heat Sink	ROS
%	ch/h		Btu/ft3	ft/min	ch/h
3	12.1	3601	269.9	13.34197851	12.1
4	11.4	3426	273.6	12.52192982	11.4
5	10.8	3282	277.3	11.83555716	10.8
6	10.2	3164	281	11.25978648	10.2
7	9.8	3068	284.7	10.77625571	9.8
8	9.4	2991	288.5	10.36741768	9.4
9	9.1	2928	292.2	10.02053388	9.1
10	8.8	2876	295.9	9.719499831	8.8
11	8.6	2830	299.6	9.445927904	8.6
12	8.4	2787	303.4	9.18589321	8.4