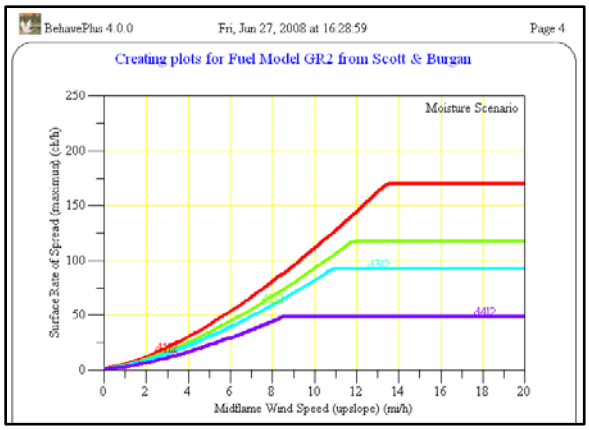
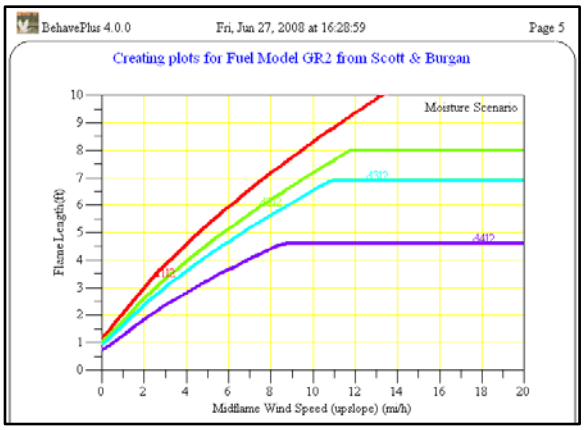
# Moisture Scenarios

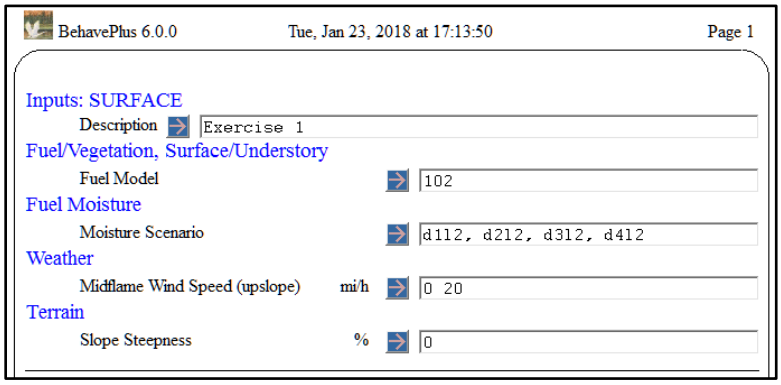
## Exercise Answers

1. **Change the plots created in the lesson to more closely match those in the Scott and Burgan (2005) publication. Change the Curve Colors and Y Axis scale. Use a wider line for the curves. Change your plots for Fuel Model GR2 to look like the ones below.**




From the lesson, the **BasicStart.bpw** Worksheet should look like the following.




To change the graph appearance, we used the following steps.

- Go to the **Configure > Appearance preferences > Graph Elements** tab.
- Set **Rainbow Colors** to 4.
- Set **Curve Width** to 4.
- **Calculate** the Run.
- Check the box next to **Specify graph Y axis limits**.
- Change the **Surface Fire Rate of Spread (maximum) Y Axis Maximum** to **250** ch/h.
- Change the **Surface Fire Flame Length Y Axis Maximum** to **10** ft.

This won't give you the exact colors used in the publication, but there are now four different colors. In addition, the labels on the curves are automatically generated in BehavePlus and can't be changed to match those in the Fuel Model publication. If you wanted to create the graphs exactly, you would need to export the results to a spreadsheet and create graphs there.

**Questions:**

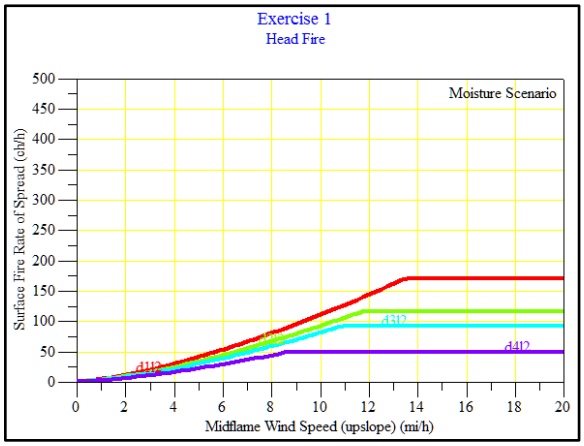
**a. What is the purpose for changing the graph scale?**
It is easier to compare fire behavior for two Fuel Models if the plots have the same scale provided that the outputs are still identifiable.

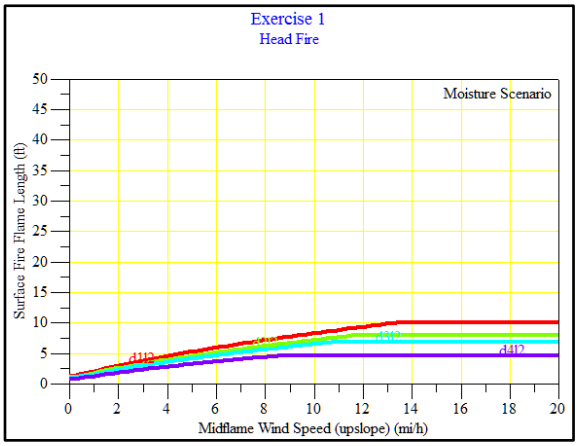
**b. What is the graph scale for the GR Fuel Models in the Scott and Burgan publication? Fill in the numbers in the table below for the Y axis maximum value for Surface Fire Rate of Spread (ROS max) and Surface Fire Flame Length (FL Max).**
Scales are chosen to highlight the dynamics of each individual Fuel Model rather than compare results across all Fuel Models. Therefore, several scales are used.

| Fuel model | ROS max, ch/h | FL Max, ft |
|---|---|---|
| GR1 | 50 | 5 |
| GR2 | 250 | 10 |
| GR3 | 250 | 25 |
| GR4 | 500 | 25 |
| GR5 | 500 | 25 |
| GR6 | 500 | 50 |
| GR7 | 500 | 50 |
| GR8 | 500 | 50 |
| GR9 | 500 | 50 |

**c. Change the plots you did for GR2 so they use the scales used for GR9. Does this change your interpretation of the fire behavior for GR2?**

- **Calculate** the Run again.
- Change the **Surface Fire Rate of Spread (maximum) Y Axis Maximum** to **500** ch/h and **Flame Length Y Axis Maximum** to **50** ft to match those of GR9.



If you do not read the Y-axis scale for Surface Fire Rate of Spread, it would appear that there is little change in ROS between Moisture Scenarios. However, at higher Midflame Wind Speed values the *range* is more than 100 ch/h. There is less effect on Surface Fire Flame Length, which is calculated as 5-10 ft.

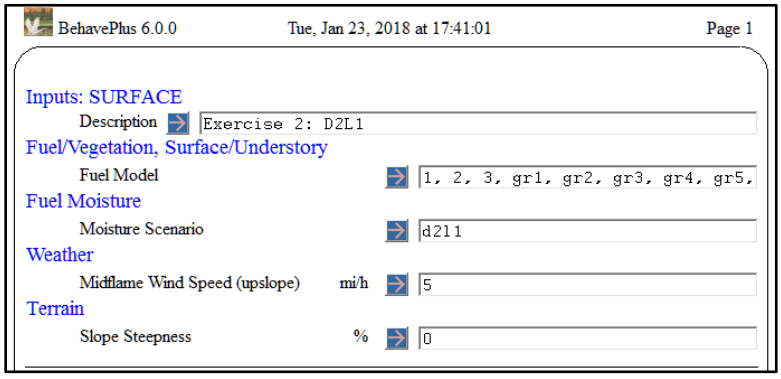
2. **Twelve grass Fuel Models were compared in the lesson using fuel Moisture Scenario D2L2. Do similar comparisons using other Moisture Scenarios. Compare the bar charts for Surface Fire Rate of Spread for D2L1, D2L2, D2L3, and D2L4. Use the same scale (Y Axis Maximum) for each plot.**

**Questions**

a. **What are the live fuel moisture values for each of these Moisture Scenarios? Fill in the numbers in the table below.**
You can get these values from a number of places, for example, go to the Discrete Variable Code Used (last page of Run); click on the **Guide** button, right-click on the scenario and select **View parameters**; or refer to the publication by Scott and Burgan (2005).

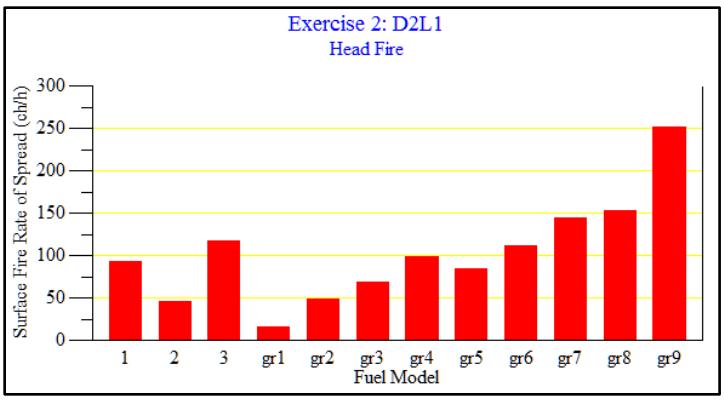
| Fuel Moisture, % | D2L1 | D2L2 | D2L3 | D2L4 |
|---|---|---|---|---|
| Live herbaceous | 30 | 60 | 90 | 120 |
| Live woody | 60 | 90 | 120 | 150 |

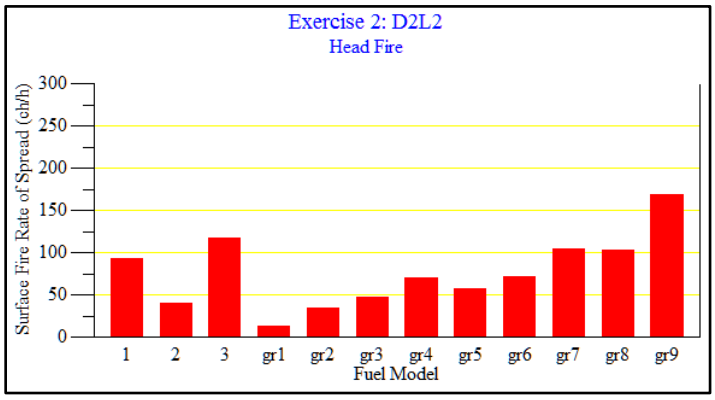
b. **What is the resulting fire behavior?**
As a reminder, the Worksheet should look similar to the following.

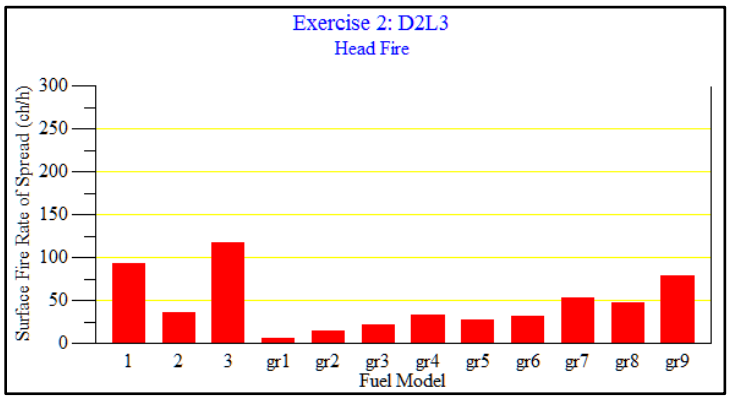


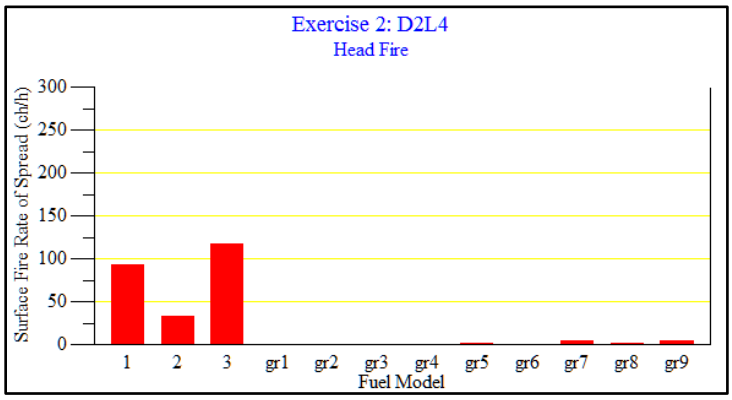

- We decided to change the graph size so that screen captures of the four graphs can better fit on a single page.
- To do this, go to the **Configure > Appearance preferences > Graph Size** tab.
- Change the **Graph Size** to **35**%.
- Do a separate Run for each Moisture Scenario.
- When asked to specify the **Y Axis Maximum**, choose 300 ch/h. We don't need to worry about the **Y Axis Maximum** for Flame Length since we are not examining the effects of Moisture Scenario on this variable.

As expected, the rate of spread decreases as the live fuel moisture increases. For the static fuel models, fuel moisture is the only factor, and there is a slight decrease in Surface Fire Rate of Spread. For the dynamic fuel models, this is a function of both live fuel moisture and fuel load transfer, and Surface Fire Rate of Spread drops dramatically as the live herbaceous fuel greens up and less fuel is transferred to the Dead Herbaceous Fuel Load category.


Exercise 2: D2L1
Head Fire
Surface Fire Rate of Spread (ch/h)
300
250
200
150
100
50
0
1
2
3
gr1
gr2
gr3
gr4
gr5
gr6
gr7
gr8
gr9
Fuel Model


Exercise 2: D2L2
Head Fire
Surface Fire Rate of Spread (ch/h)
300
250
200
150
100
50
0
1
2
3
gr1
gr2
gr3
gr4
gr5
gr6
gr7
gr8
gr9
Fuel Model


Exercise 2: D2L3
Head Fire
Surface Fire Rate of Spread (ch/h)
300
250
200
150
100
50
0
1
2
3
gr1
gr2
gr3
gr4
gr5
gr6
gr7
gr8
gr9
Fuel Model

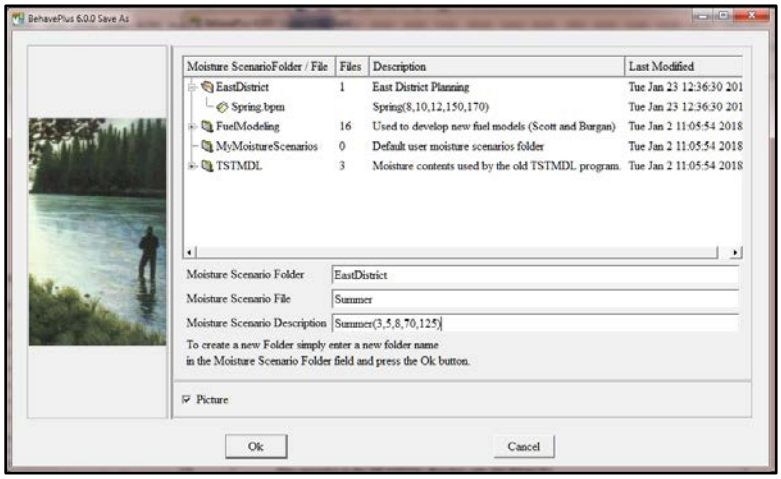

Exercise 2: D2L4
Head Fire
Surface Fire Rate of Spread (ch/h)
300
250
200
150
100
50
0
1
2
3
gr1
gr2
gr3
gr4
gr5
gr6
gr7
gr8
gr9
Fuel Model

**3. Create two more Moisture Scenarios for the EastDistrict folder. Use appropriate values, names and descriptions.**

Our values are below; your answers will vary based on the fuel moisture values you selected. Do your answers make sense based on the inputs that you used and your knowledge of fire behavior?

| Fuel Moisture, % | Spring | Summer | Fall |
|---|---|---|---|
| 1-h | 8 | 3 | 3 |
| 10-h | 10 | 5 | 5 |
| 100-h | 12 | 8 | 8 |
| Live herbaceous | 150 | 70 | 30 |
| Live woody | 170 | 125 | 60 |

- Open the **BasicStart.bpw** Worksheet.
- Enter the appropriate Fuel Moisture values. Ours are 3, 5, 8, 70, 125 for Summer.
- Click on **File > Save as a moisture scenario**.
- Save this in the **EastDistrict** folder as **Summer.bpm** with a Description. Ours was Summer(3,5,8,70,125).




- Repeat these steps for the Fall fuel moisture values.
- Change the Worksheet to input Moisture Scenario.
- Check that the three Moisture Scenarios you created during this lesson are available.

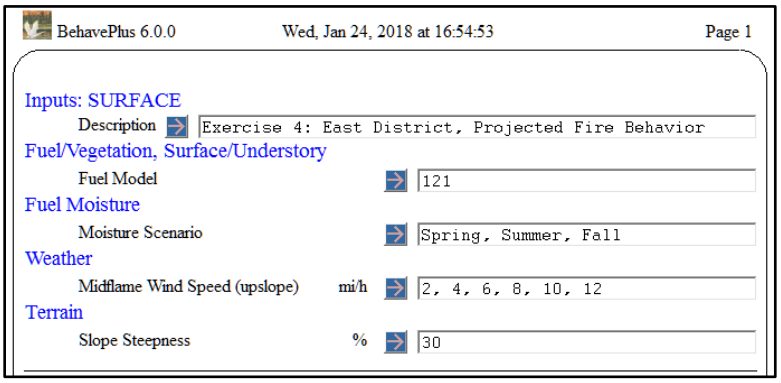
  ***Note:*** *If you closed BehavePlus at any point between creating the Spring scenario during the lesson and creating the Summer and Fall scenarios during this exercise, you will only see the two scenarios you just created as part of this exercise.*

- If you do not see all of the scenarios, attach the **EastDistrict** Moisture Scenario folder by going to **Configure > Moisture scenario set selection** and selecting the folder entitled **EastDistrict**. This ensures that all of the East District Moisture Scenarios are attached.
- Click **Ok.**

**4. Quit the BehavePlus program and restart. Create a Run that produces a table similar to the following using your new Moisture Scenarios. Use Fuel Model GS1/121 and Slope of 30%. Your results will vary depending on the fuel moisture values you selected.**
Since you closed BehavePlus, you will need to reattach the EastDistrict Moisture Scenarios as outlined in Exercise 3.

We set up our Worksheet as follows. When we calculated the Run, we selected Midflame Wind Speed as the Table Row Variable, keeping the tables to a single page each.

***Note:*** *Table rows and columns are organized based on the inputs. To keep the seasons in order, we moved Fall to the end of the Moisture Scenarios.*




Exercise 4: East District, Projected Fire Behavior

Head Fire

Surface Fire Rate of Spread (ch/h)

| Midflame Wind Speed | Moisture Scenario | | |
|---|---|---|---|
| mi/h | Spring | Summer | Fall |
| 2 | 0.3 | 4.8 | 12.1 |
| 4 | 0.3 | 9.7 | 24.5 |
| 6 | 0.3 | 15.9 | 40.2 |
| 8 | 0.3 | 23.1 | 58.5 |
| 10 | 0.3 | 31.2 | 79.1 |
| 12 | 0.3 | 37.8 | 101.7 |

Exercise 4: East District, Projected Fire Behavior

Head Fire

Surface Fire Flame Length (ft)

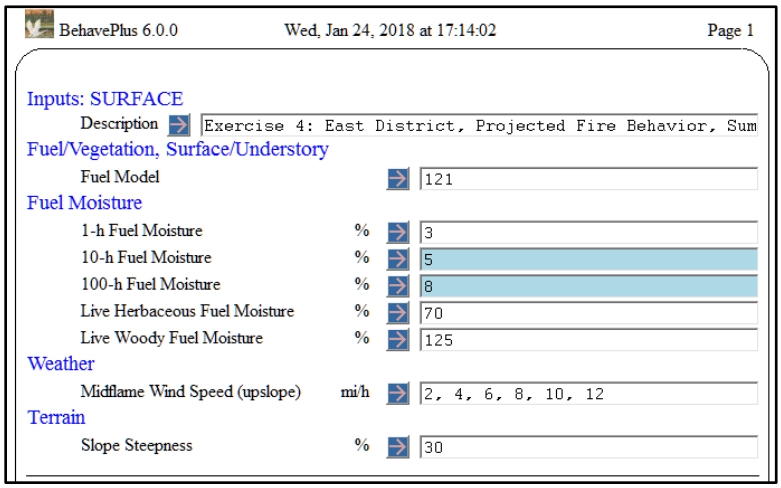
| Midflame Wind Speed | Moisture Scenario | | |
|---|---|---|---|
| mi/h | Spring | Summer | Fall |
| 2 | 0.2 | 1.8 | 3.3 |
| 4 | 0.2 | 2.5 | 4.6 |
| 6 | 0.2 | 3.2 | 5.7 |
| 8 | 0.2 | 3.8 | 6.8 |
| 10 | 0.2 | 4.4 | 7.8 |
| 12 | 0.2 | 4.8 | 8.8 |

**Questions**

**a. Can you generate a table like this using individual moisture values rather than Moisture Scenarios?**
No, you cannot. BehavePlus only allows you to have multiple values for 2 variables at a time. Trying to use individual fuel moisture values does not meet that criteria. This demonstrates a major benefit of using Moisture Scenarios. In fact, if you change to Moisture is entered by individual size class, only the moisture values associated with Fall (the last entry) are entered on the Worksheet. Try to enter moisture values for all of the scenarios and see what happens.

**b. Use the option of Moisture in entered by size class to calculate the fire behavior values shown in the table above for the Summer moisture conditions.**

- Delete Spring and Fall as input values from the Moisture Scenario input line.
- Change the input option to enter moisture as individual size classes. Notice that the values for Summer are automatically inserted into the appropriate lines.




Exercise 4: East District, Projected Fire Behavior, Summer

Head Fire

| Midflame Wind Speed mi/h | Surface Fire Rate of Spread ch/h | Surface Flame Length ft |
|---|---|---|
| 2 | 4.8 | 1.8 |
| 4 | 9.7 | 2.5 |
| 6 | 15.9 | 3.2 |
| 8 | 23.1 | 3.8 |
| 10 | 31.2 | 4.4 |
| 12 | 37.8 | 4.8 |