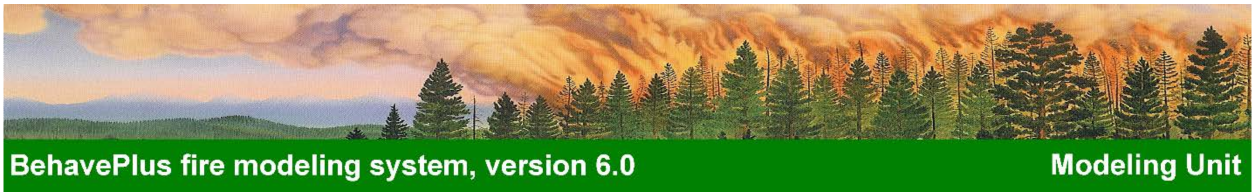


Moisture Scenarios

Introduction
BehavePlus gives you the option of using Moisture Scenarios, which are sets of fuel moisture values used to calculate surface fire spread and intensity. Moisture Scenarios are useful for evaluating several moisture combinations, comparing fire behavior for different Fuel Models, and developing custom fuel models. The Moisture Scenarios used in the analysis of the 40 standard fuel models (Scott and Burgan 2005) are included in BehavePlus as are the original fuel moisture sets defined by Burgan and Rothermel (1984) for developing custom fuel models. You can also define and save custom Moisture Scenarios specific to your needs.

Objectives
At the end of this lesson, the student will be able to:
1. Define a Moisture Scenario.
2. View the fuel moisture parameters of a Moisture Scenario.
3. Describe application of Moisture Scenarios.
4. Describe the Moisture Scenario sets that are available in BehavePlus.
5. Use the Scott and Burgan (2005) Moisture Scenarios to compare standard Fuel Models.
6. Develop and save a custom Moisture Scenario.
7. Load and use a saved Moisture Scenario.

Where This Lesson Fits In
This is a lesson in the **Modeling Unit**, which covers capabilities, limitations, assumptions, and sensitivity of the various models in BehavePlus. It is assumed that the trainee has skill with program operation. Basic operation is covered in the four lessons of the **Introduction Unit**.

This is the last of four lessons that address the influence of fuel moisture on fire behavior model outputs. The *Fuel Moisture Overview Lesson* provided an overview of the role of fuel moisture in fire behavior calculations within BehavePlus. This lesson provides detailed information.
1. Fuel Moisture Overview
2. Dead Fuel Moisture
3. Live Fuel Moisture
4. **Moisture Scenarios**

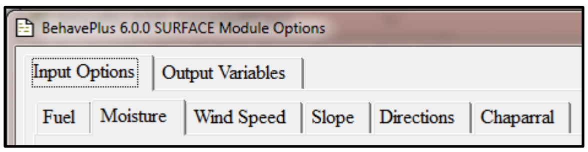
Note: There are questions (in blue) located throughout this lesson. The answers can be found at the end of the lesson starting on page 13.

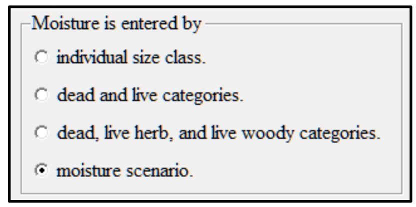
Moisture Scenarios

A Moisture Scenario is a set of fuel moisture values representing moisture conditions of the surface fuel by individual size class: 1-h, 10-h, 100-h, Live Herbaceous, and Live Woody Fuel Moisture. Moisture Scenarios are similar to Fuel Models in that they group a number of parameters into a single set of values – in this case fuel moisture. Since it consists of both dead and live fuel moisture values, a moisture scenario is subject to the same assumptions and limitations as fuel moisture values for each individual size class. As with defining moisture by individual size class, only the moisture values in the scenario that are needed for a given Fuel Model are used in modeling fire behavior.

What Is a Moisture Scenario?

There are several options for entering surface fuel moisture. Selections are made on the **Module selection > SURFACE Options… > Input Options > Moisture** tab.



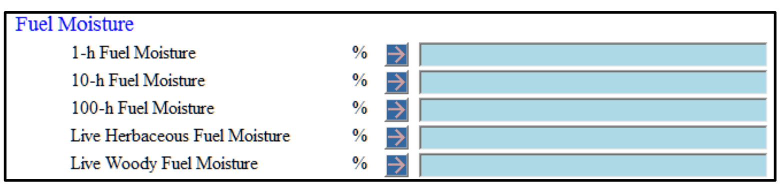


In previous lessons, you learned about the first three options. In this lesson, we focus on the last one: **Moisture is entered by moisture scenario**. Moisture Scenarios are pre-defined sets of the dead and live fuel moisture values required for modeling Surface Fire Rate of Spread. Moisture Scenarios are discrete variables that are analogous to Fuel Models in that a single code represents a complete set of fuel moisture parameters. A number of Moisture Scenarios are provided with BehavePlus, and others can be developed to meet your local needs.

Let's look at a Moisture Scenario in more detail.

- Open the **BasicStart.bpw** Worksheet.

This Worksheet is set up to ask for moisture by individual size class.



- Click on **Model Selection > SURFACE Options… > Input Options > Moisture** and select **Moisture is entered by moisture scenario**.

The Fuel Moisture section of the Worksheet has changed.

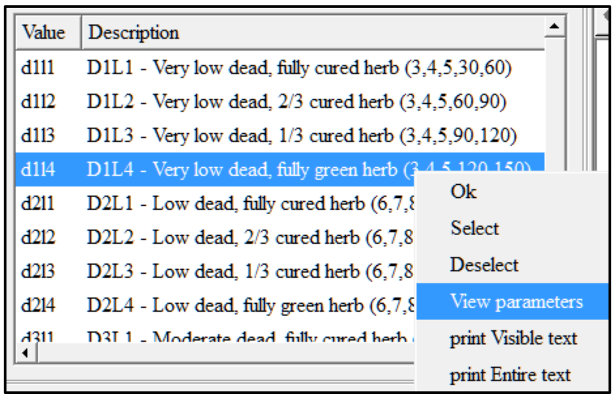
- Click on the **Guide** button next to **Moisture Scenario**.

The Moisture Scenarios that you see in the selection window were defined by Scott and Burgan (2005) to develop the 40 standard fuel models. They selected a range of dead and live fuel moisture values to use in developing all of the models. The range of Live Herbaceous Fuel Moisture allows for fuel load transfer in dynamic fuel models. Each selection includes a code (e.g., D1L4) and a description (e.g., Very low dead, fully green herb) that includes individual moisture values (e.g., 3, 4, 5, 125,150).

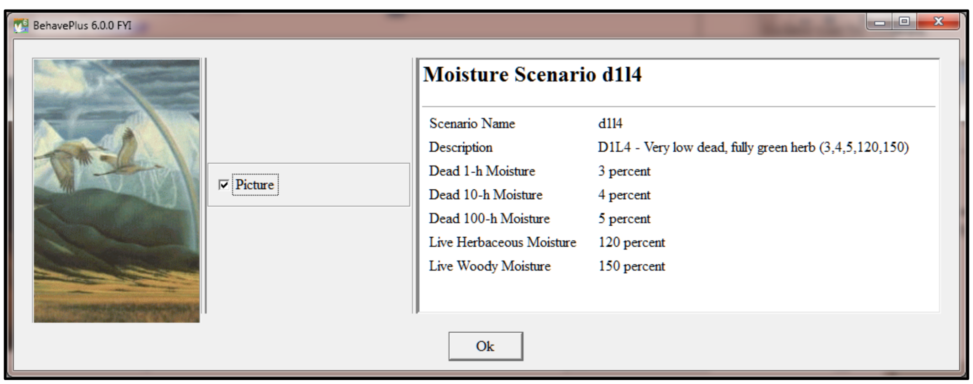
1. *How many Moisture Scenarios are included with BehavePlus?*

Their code is four characters that describe the dead (D) and live (L) fuel moisture characteristics. Dead and live fuel moisture are each divided into four levels – the higher the level, the higher the fuel moisture values. Dead fuel moistures range from very low dead (D1) to high dead (D4). Very low dead, D1, has fuel moisture values as follows: 1-h Dead Fuel Moisture = 3%; 10-h Dead Fuel Moisture = 4%; and 100-h Dead Fuel Moisture = 5%. Live Fuel Moistures range from fully cured herb (L1) to fully green herb (L4). Fully green herb, L4, has fuel moistures of: Live Herbaceous Fuel Moisture = 120% and Live Woody Fuel Moisture = 150%. Therefore, D1L4 assigns values as follows: 1-h Moisture = 3%; 10-h Moisture = 4%; 100-h Moisture = 5%; Live Herbaceous Moisture = 125%; and Live Woody Moisture = 150%.

- In the **Input Guide** window, right-click on **D1L4** and Select **View parameters**.



You can view the defined moisture values for each individual size class.



2. *What are the fuel moisture values associated with Moisture Scenario D2L3?*
3. *Which Moisture Scenario(s) best represent the fuel moisture in your area during the peak of fire season? During a recent prescribed fire?*

The following image is text taken from Scott and Burgan (2005, page 8).

Moisture Scenarios

To facilitate standard comparisons of the new fire behavior fuel models with the original 13 fuel models and with each other, we developed standard dead (table 3) and live (table 4) fuel moisture scenarios. Separate live and dead scenarios were needed so that live and dead fuels could vary independently. There are 16 unique moisture scenario combinations. However, fire behavior predicted with fuel models without a live fuel component is not affected by the live moisture scenario. Live moisture scenarios cover a range of live herbaceous moisture corresponding to fully cured (30 percent) to uncured (fully green; 120 percent).

Table 3—Dead fuel moisture content values (percent) for the dead fuel moisture scenarios.

	D1 **Very low**	D2 **Low**	D3 **Moderate**	D4 **High**
1-hr	3	6	9	12
10-hr	4	7	10	13
100-hr	5	8	11	14

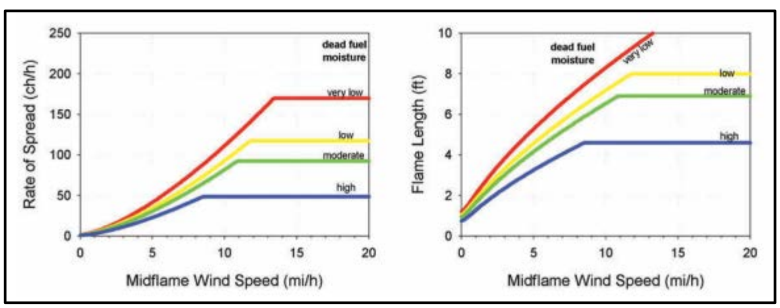
Table 4—Live fuel moisture content values (percent) for the live fuel moisture scenarios.

	L1 **Fully cured** **Very low**	**L2** **Two-thirds cured** **Low**	**L3** **One-third cured** **Moderate**	**L4** **Fully green (uncured)** **High**
Live herbaceous	30	60	90	120
Live woody	60	90	120	150

This publication is listed on the BehavePlus website under the **Publications** tab in the **Fuel** subheading. You can also access this publication through the U.S. Forest Service online publication archive, TreeSearch.

Using a Moisture Scenario to Compare Fuel Models

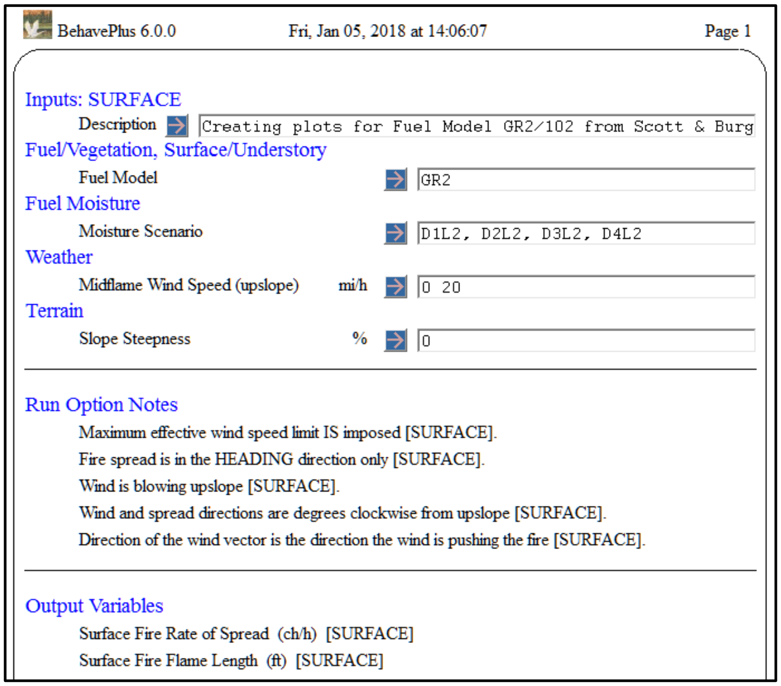
Now that you know what a Moisture Scenario includes, let's create plots for Fuel Model GR2/102, the dynamic Low Load, Dry Climate Grass fuel model. Each description of a fuel model contains two fire behavior graphs: rate of spread and flame length. The graph below is taken from Scott and Burgan (2005).



Each line in the graph represents one of the four dead fuel moisture scenarios (D1, D2, D3, and D4), classified as very low, low, moderate, and high moisture, respectively. All of the graphs in the publication use the L2 live fuel moisture scenario (Live Herbaceous Fuel Moisture of 60% and Live Woody Fuel Moisture of 90%).

4. *What portion of the Live Herbaceous Fuel Load is transferred when the Live Herbaceous Fuel Moisture is 60%?*

- Open a new **BasicStart.bpw** Worksheet.
- Create a Worksheet similar to the following.



- **Calculate** the Run.
- Save the Run (**File > Save as a Run**) to use later in the lesson. We called it **GR2_MoistureScenario.bpr**.

5. *What is the range of Surface Fire Rate of Spread and Flame Length when the Midflame Wind Speed is 4 mi/h? When it is 16 mi/h?*

- Click on the **Last Page** button () to view the **Discrete Variable Codes**.

6. *Which fuel moisture values are used in Moisture Scenario D3L2?*

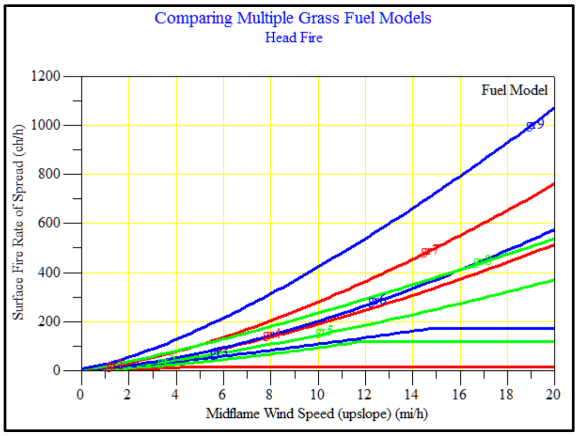
Next, let's calculate Surface Fire Rate of Spread and Flame Length for the Scott and Burgan (2005) grass fuel models (GR1/101 through GR9/109) for a single moisture scenario (D2L2).

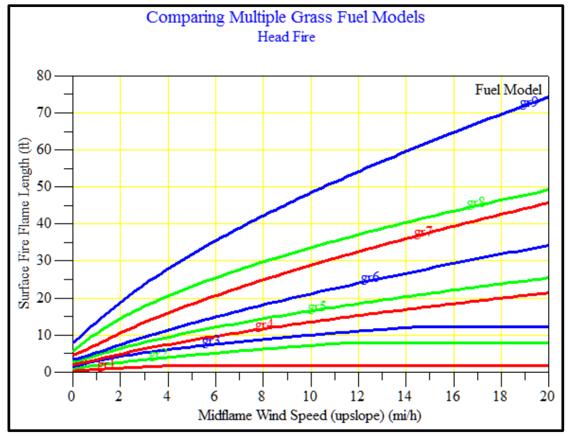
- Enter the following inputs.
  - **Description:** Comparing Multiple Grass Fuel Models
  - **Fuel Model:** GR1, GR2, GR3, GR4, GR5, GR6, GR7, GR8, GR9

    Note: *You can also use the numeric equivalents: 101, 102, 103, etc.*

  - **Moisture Scenario:** D2L2
  - **Midflame Wind Speed:** 0-20, Step 5
  - **Slope Steepness:** 0%
- **Calculate** the Run.

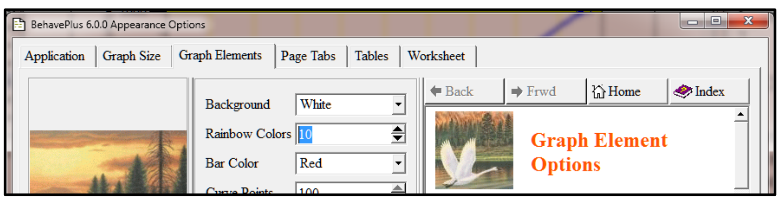
Your outputs should look similar to the following graphs.





As discussed in the **Introduction Unit**, *Calculations Lesson*, you can change the graphs to more easily differentiate between fuel models.

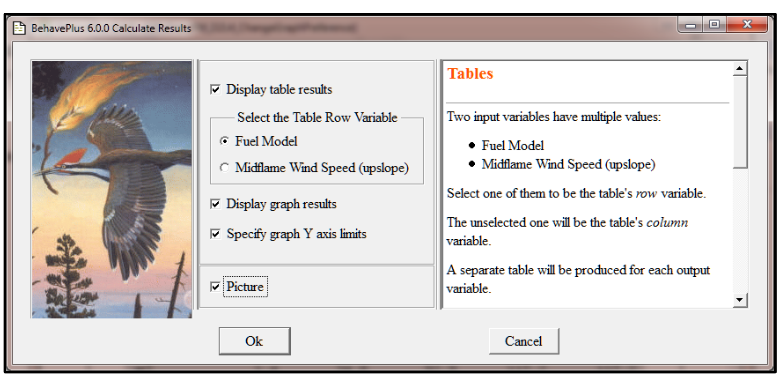
- ➢ Click on **Configure > Appearance preferences > Graph elements.**
- ➢ Change **Rainbow colors** to **10** by using the spinner or typing it in the text box.



- ➢ Click **Ok**.

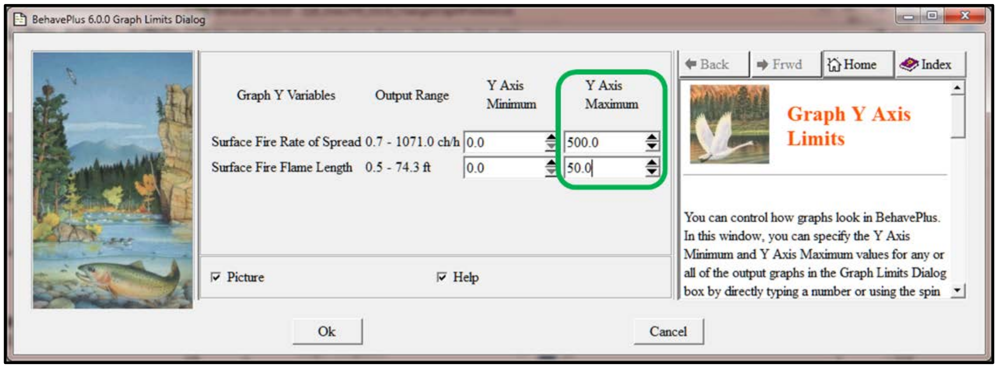
You can further change the scale of the graphs to match those from Scott and Burgan (2005).

- ➢ **Calculate** the Run.
- ➢ In the **Calculate Results** window, check the box next to **Specify graph Y axis limits** and click **Ok**.



A **Graph Limits Dialog** window appears.

- ➢ Change **Surface Fire Rate of Spread (maximum) Y Axis Maximum** to 500 ch/h.
- ➢ Change **Surface Fire Flame Length Y Axis Maximum** to 50 ft.



- ➢ Click **Ok**.

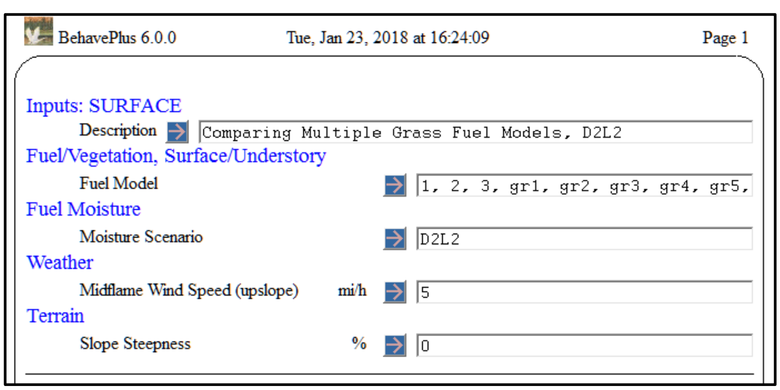
All of these fuel models are dynamic. As you learned in the **Modeling Unit**, *Live Fuel Moisture Lesson*, fuel load transfer plays a large role in modeling fire behavior for dynamic fuel models such as the GR models. As Scott and Burgan (2005) note in their report, “Use the charts to compare the relative behavior of the various models within a fuel type, but be aware that the relative behavior may be different at other moisture contents.” Therefore, when you are looking at fire behavior in an area, you may want to look at values outside those represented by the charts, particularly since they include a single live fuel moisture scenario (L2).

7. *Change the Moisture Scenario to D2L4. How does the fire behavior differ when D2L4 is used as compared to D2L2?*

- ➢ Save the Run (**File > Save as a Run**) to use with Exercise 2.

Now we will compare Surface Fire Rate of Spread and Flame Length for a single Midflame Wind Speed and Moisture Scenario for the nine grass fuel models by Scott and Burgan (2005) *plus* the three grass fuel models from the original 13 standard fire behavior fuel models (Anderson 1982).

- ➢ Return to the Worksheet using the **First Page** ( ) button.
- ➢ Put the cursor before gr1 in the **Fuel Model** line of the Worksheet
- ➢ Enter the additional three grass fuel models: 1, 2, 3.
- ➢ Change the **Midflame Wind Speed** to 5 mi/h.
- ➢ Do not change the Moisture Scenario (D2L2) or Slope Steepness (0%).



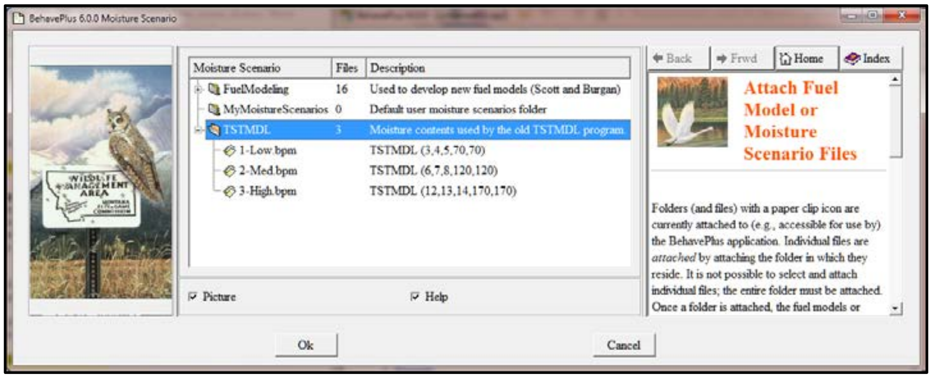
- **Calculate** the Run, letting the program set the scale (uncheck the box by **Specify graph Y axis limits**).

8. *How does the fire behavior compare between the grass models described by Anderson (1982) and those developed by Scott and Burgan (2005)?*

Loading a Saved Moisture Scenario

'Fuel moisture sets' were used by Burgan and Rothermel (1984) for developing custom Fuel Models. The term 'Moisture Scenario' was coined with the development of BehavePlus. The Moisture Scenarios (fuel moisture sets) used in the old BEHAVE TSTMDL (Test Model) program are also available in BehavePlus. They are not standard inputs. To use this Moisture Scenario set, it must be *attached* to the run each time you open BehavePlus. Selections are not stored between sessions.

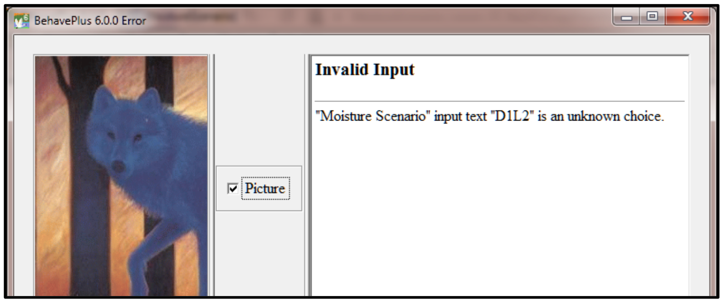
- Click on **Configure > Moisture scenario set selection.**
- Click on the **+** to see the files (i.e., Moisture Scenarios ending in **.bpm**) that are in the **TSTMDL** folder.
- Click on the **TSTMDL** folder.
- Click **Ok** to attach those Moisture Scenarios to BehavePlus.



Individual files (Moisture Scenarios or Fuel Models) are attached by attaching the *folder* in which they reside. It is not possible to select and attach individual files. Once a folder is attached, the Moisture Scenarios appear in the **Input Guide** window.

- Open the first Run you saved, which we called **GR2_MoistureScenario.bpr**.
- **Calculate** the Run.

You will get an error statement from BehavePlus saying that the folder containing the Moisture Scenarios by Scott and Burgan (2005) is no longer attached. Unlike the standard 53 Fuel Models, these Moisture Scenarios are not permanently attached to the program. You must attach the folder containing them.



- ➢ Return to the Worksheet.

The Moisture Scenarios listed on the Worksheet have disappeared. They are no longer recognized as valid inputs since their folder is no longer attached to the session.

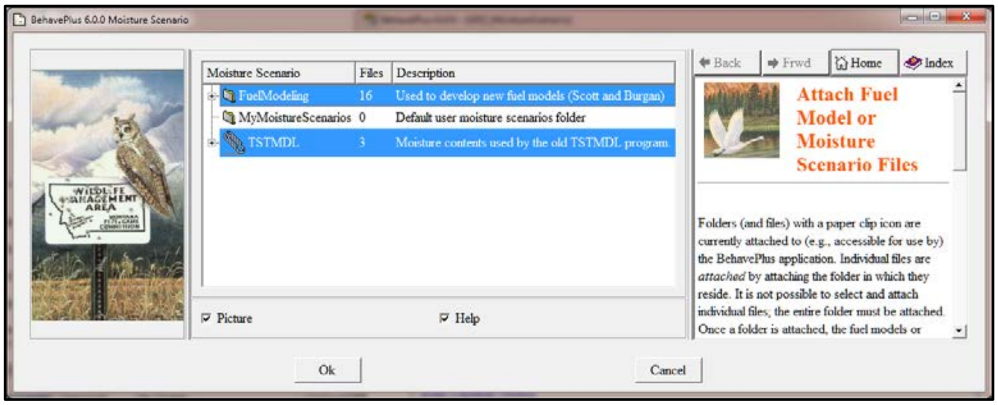
You can attach multiple folders at a time.

- ➢ Click on **Configure > Moisture scenario set selection** again.

The paperclip indicates that the **TSTMDL** folder is currently attached.

- ➢ Highlight both the **FuelModeling** and **TSTMDL** folders.

Folders that are not highlighted will ***not*** have their files attached, even if they are currently marked as attached by the paperclip.



- ➢ Click on the **Guide** button next to **Moisture Scenario**.

9. *How many Moisture Scenarios are included with BehavePlus now?*
10. *How do the two sets of Moisture Scenarios compare?*

- ➢ Select **Moisture Scenarios** 1-Low and D1L2.
- ➢ **Calculate** the Run.

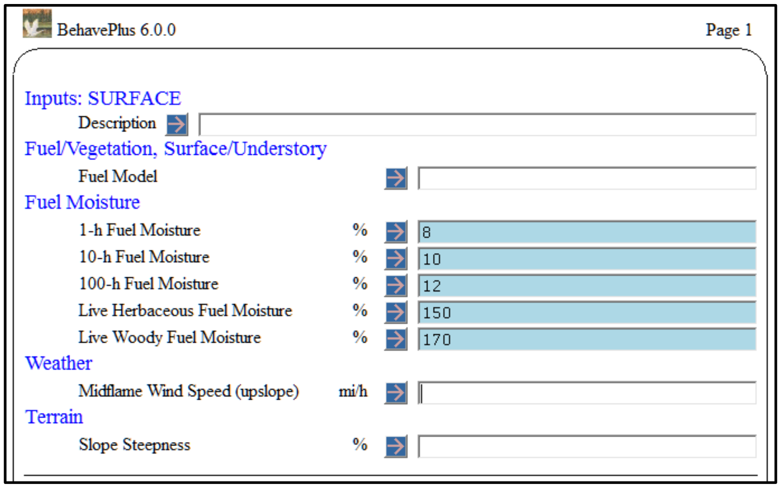
11. *How do the outputs compare for the two Moisture Scenarios? Why do you think that is?*

Developing and Saving Custom Moisture Scenarios

One of the most powerful uses for Moisture Scenarios is to create scenarios that match certain local conditions. When developing burn plans prepared for prescribed fire units, Moisture Scenarios might represent a location's 25th, 50th, and 75th; 80th and 95th; or 90th and 97th percentile fire weather conditions, for example.

- ➢ Close any open Worksheets.
- ➢ Open a new **BasicStart.bpw** Worksheet.

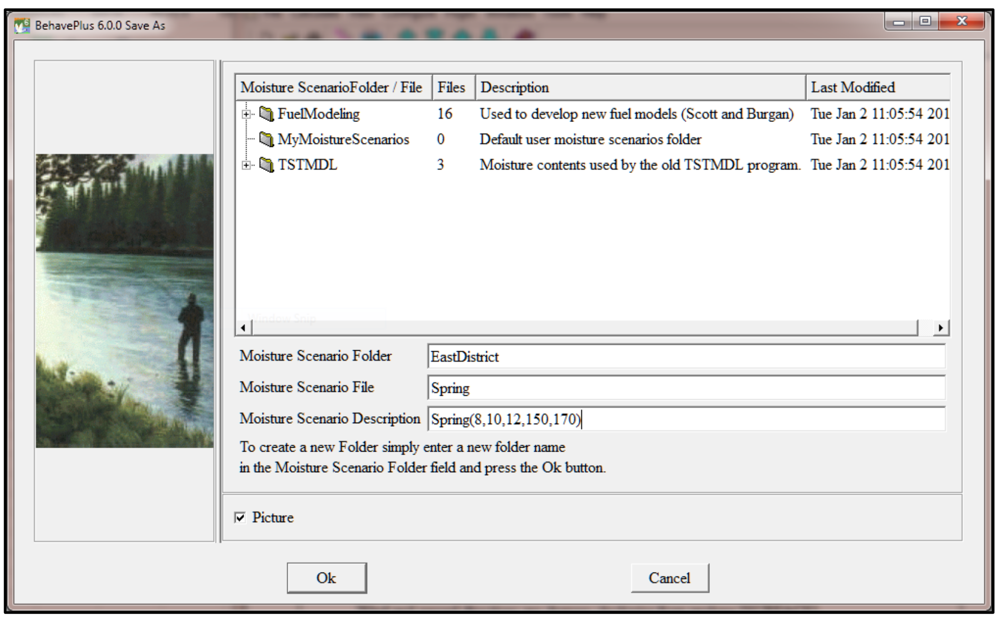
To create a Moisture Scenario, you must start with a Worksheet that contains individual size classes. Because you have not yet entered a Fuel Model, all of the fuel moisture boxes are blue. Enter values for each of the fuel moisture variables as follows. You do not need to enter values for any other variables. You must, however, enter a fuel moisture for *every* individual size class.



- Click on **File > Save as a moisture scenario**.

You can save the Moisture Scenario in the folder called **MyMoistureScenarios**. Or you can create a new folder by entering a new folder name as we will do below.

- Enter inputs as follows.



It is a good practice to include fuel moisture values in the description for easy reference. Recall that the Moisture Scenario names and descriptions are listed with the Discrete Variable Codes on the last page of each Run.

- Click **Ok**.

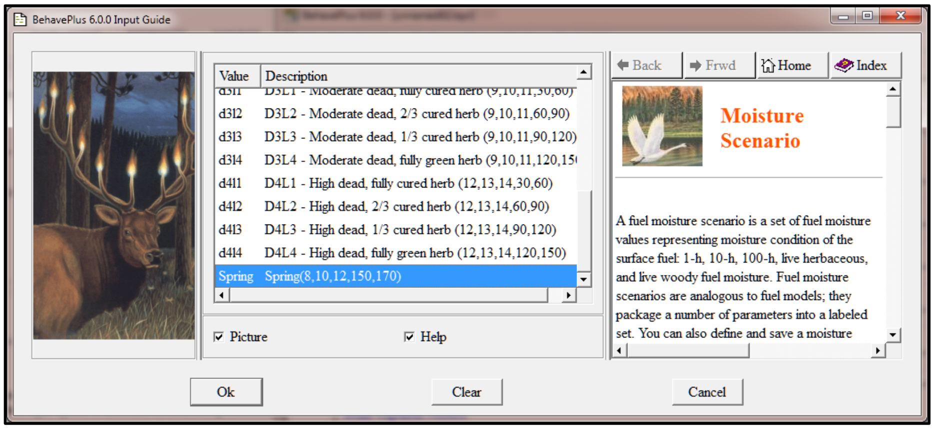
You will be asked to confirm creation of a new folder.

- Click **Yes**.
- When prompted, enter a description such as East District Planning.

- Click **Ok**. You will receive confirmation that the Moisture Scenario was created.
- Change the **Fuel Moisture** input option to **Moisture is entered by moisture scenario**.

- Click the **Guide** button for **Moisture Scenario**.

The previously attached Moisture Scenario folders are still attached because we are in the same BehavePlus session. The newly developed Moisture Scenario has been added to the bottom of the list.



- Select it and click **Ok**.

There should be one Moisture Scenario on the Worksheet named Spring.

- Save this Run. You will use it again in Exercise 4.

Summary

Moisture Scenarios provide a method for examining fire behavior by looking at multiple Fuel Models and a range of fuel moistures, in which all size classes can very. Therefore, they can be used effectively to compare Fuel Models, which is why they were used to create the plots in Scott and Burgan (2005). You can use existing Moisture Scenarios or define those specific to your local conditions.

There are exercises associated with this lesson (page 20), after the answers to the questions in the lesson.

References

Anderson, Hal E. 1982. Aids to determining fuel models for estimating fire behavior. General Technical Report INT-GTR-122. Boise, ID: USDA Forest Service, Intermountain Forest and Range Experimental Station. 22 p. https://www.fs.usda.gov/treesearch/pubs/6447

Andrews, Patricia L.; Cruz, Miguel G.; Rothermel, Richard C. 2013. Examination of the wind speed limit function in the Rothermel surface fire spread model. International Journal of Wildland Fire 22(7):959-969. http://www.publish.csiro.au/wf/WF12122

Burgan, Robert E.; Rothermel, Richard C. 1984. BEHAVE: fire behavior prediction and fuel modeling system – FUEL subsystem. General Technical Report INT-167. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 126 p.

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. https://www.fs.usda.gov/treesearch/pubs/32533

Scott, Joe H.; Burgan, Robert E. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72 p. https://www.fs.usda.gov/treesearch/pubs/9521

Answers to Questions in the Lesson

1. *How many Moisture Scenarios are included with BehavePlus?*
   There are 16 Moisture Scenarios from Scott and Burgan (2005) attached to the session when you open BehavePlus. This scenarios are located in the **FuelModeling** folder.

2. *What are the fuel moisture values associated with Moisture Scenario D2L3?*
   Moisture Scenario D2L3 has the following fuel moisture values.
   - D2: 1-h Fuel Moisture: 6%; 10-h Fuel Moisture: 7%; 100-h Fuel Moisture: 8%
   - L3: Live Herbaceous Fuel Moisture: 90%; Live Woody Fuel Moisture: 120%

3. *Which Moisture Scenario(s) best represent the fuel moisture in your area during the peak of fire season? During a recent prescribed fire?*
   Your answers will vary. If none of them represent the fuel moisture in your area, consider creating some that do.

4. *What portion of the Live Herbaceous Fuel Load is transferred when the Live Herbaceous Fuel Moisture is 60%?*
   There are several ways to find this answer in the BehavePlus Help system. Here is one of them. Click on the **Guide** button next to **Moisture Scenario**. Scroll to the bottom of the Help window and select Live Herbaceous Fuel Moisture. Scroll down to the table, which shows that 2/3, or 66.7%, of the Live Herbaceous Fuel Load is transferred when the Live Herbaceous Fuel Moisture is 60%.

Fuel Load Transfer for Dynamic Fuel Models

Live herbaceous fuel moisture	Curing	Fuel load transfer portion
120%	Uncured	0%
98%	One-quarter cured	25%
90%	One-third cured	33.3%
75%	One-half cured	50%
60%	Two-thirds cured	66.7%

5. *What is the range of Surface Fire Rate of Spread and Flame Length when the Midflame Wind Speed is 4 mi/h? When it is 16 mi/h?*
   At 4 mi/h, Surface Fire Rate of Spread ranges from about 17 to 31 ch/h. Surface Fire Flame Length ranges from 3 to 5 ft. At 16 mi/h, Surface Fire Rate of Spread ranges from about 50 to 170 ch/h. Surface Fire Flame Length ranges from 4.5 to 10 ft.

BehavePlus 6.0.0 Tue, Jan 23, 2018 at 12:58:29 Page 1

Inputs: SURFACE

Description			Creating plots for Fuel Model GR2/102 from Scott & Burg
Fuel/Vegetation, Surface/Understory			
Fuel Model			GR2
Fuel Moisture			
Moisture Scenario			D1L2, D2L2, D3L2, D4L2
Weather			
Midflame Wind Speed (upslope)	mi/h		0, 4, 8, 12, 16, 20
Terrain			
Slope Steepness	%		0

Run Option Notes

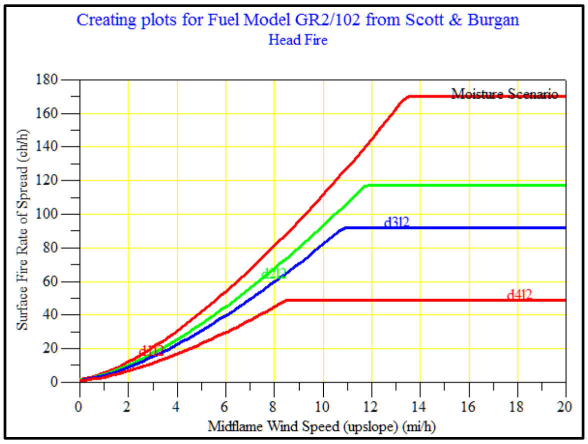
Maximum effective wind speed limit IS imposed [SURFACE].
Fire spread is in the HEADING direction only [SURFACE].
Wind is blowing upslope [SURFACE].
Wind and spread directions are degrees clockwise from upslope [SURFACE].
Direction of the wind vector is the direction the wind is pushing the fire [SURFACE].

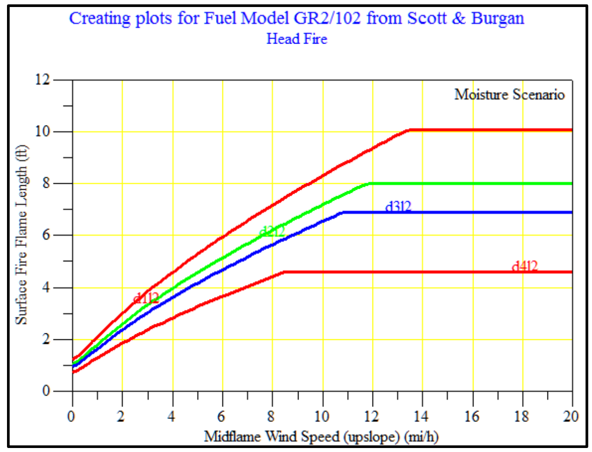
Creating plots for Fuel Model GR2/102 from Scott & Burgan
Head Fire
Surface Fire Rate of Spread (ch/h)

Moisture Scenario	Midflame Wind Speed (upslope) mi/h					
	0	4	8	12	16	20
d1l2	1.7	30.6	80.9	144.7	169.9	169.9
d2l2	1.4	25.5	67.6	117.2	117.2	117.2
d3l2	1.2	22.5	59.6	92.2	92.2	92.2
d4l2	0.9	16.9	44.6	48.6	48.6	48.6

Creating plots for Fuel Model GR2/102 from Scott & Burgan
Head Fire
Surface Fire Flame Length (ft)

Moisture Scenario	Midflame Wind Speed (upslope) mi/h					
	0	4	8	12	16	20
d1l2	1.2	4.6	7.2	9.4	10.1	10.1
d2l2	1.0	4.0	6.2	8.0	8.0	8.0
d3l2	0.9	3.6	5.6	6.9	6.9	6.9
d4l2	0.7	2.8	4.4	4.6	4.6	4.6





6. *Which fuel moisture values are used in Moisture Scenario D3L2?*

Discrete Variable Codes Used
Creating plots for Fuel Model GR2/102 from Scott and Burgan (2005)

Fuel Model		
102	gr2	Low load, dry climate grass (D)
Moisture Scenario		
d1l2		D1L2 - Very low dead, 2/3 cured herb (3,4,5,60,90)
d2l2		D2L2 - Low dead, 2/3 cured herb (6,7,8,60,90)
d3l2		D3L2 - Moderate dead, 2/3 cured herb (9,10,11,60,90)
d4l2		D4L2 - High dead, 2/3 cured herb (12,13,14,60,90)

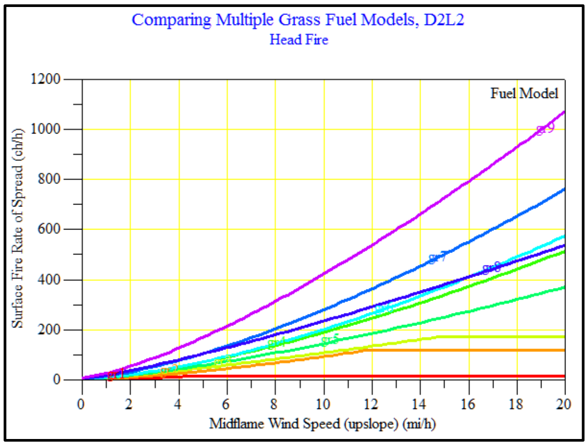
Moisture Scenario D3L2 contains the following fuel moisture values.

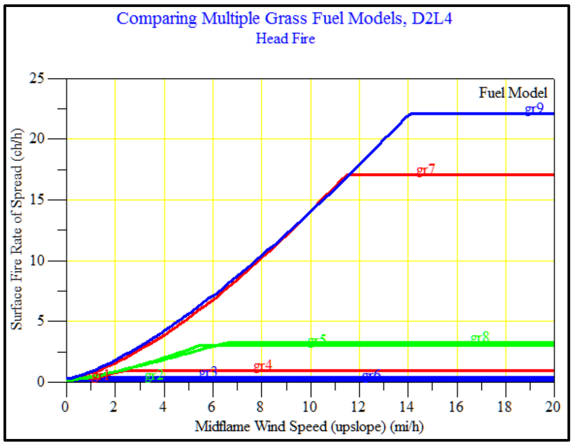
- D3: 1-h Fuel Moisture: 9%; 10-h Fuel Moisture: 10%; 100-h Fuel Moisture: 11%
- L2: Live Herbaceous Fuel Moisture: 60%; Live Woody Fuel Moisture: 90%

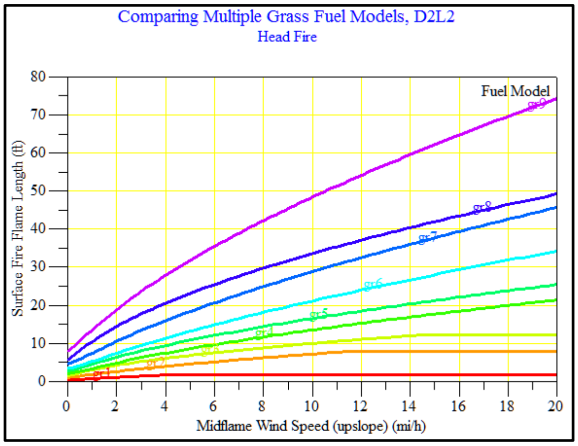
7. *Change the Moisture Scenario to D2L4. How does the fire behavior differ when D2L4 is used as compared to D2L2?*

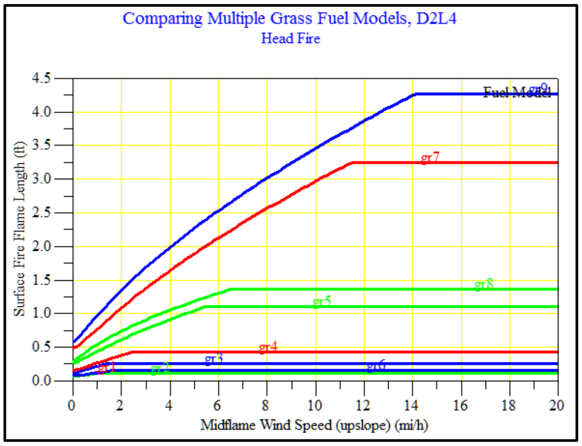
The fire behavior for D2L4 is much lower than that for D2L2. Seven fuel models have Surface Fire Rate of Spread values less than 5 ch/h, and Surface Fire Flame Length is less than 5 ft for all nine Fuel Models. All nine Fuel Models reach the wind limit under the D2L4 scenario. Once the wind limit is reached, the model assumes wind no longer increases the rate of spread or fire intensity.

The lower fire behavior is a result of the change in Live Herbaceous Fuel Moisture from 60% (D2L2) to 120% (D2L4). With D2L2, 2/3 of the herbaceous fuel load was transferred to the dead herbaceous fuel load class, thereby contributing to increased fire behavior. With D2L4, there is no fuel load transfer; the live herbaceous fuel load is maximized, and fire behavior decreases as a result.

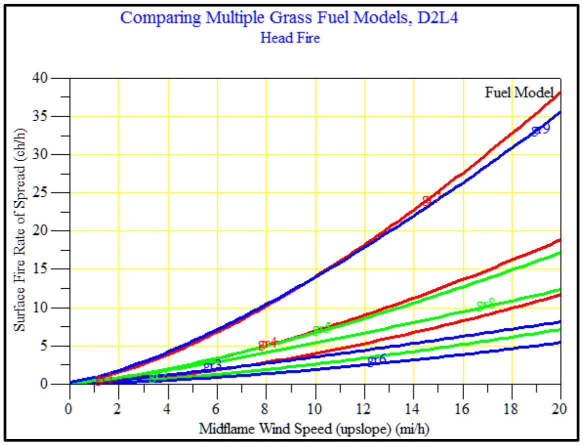


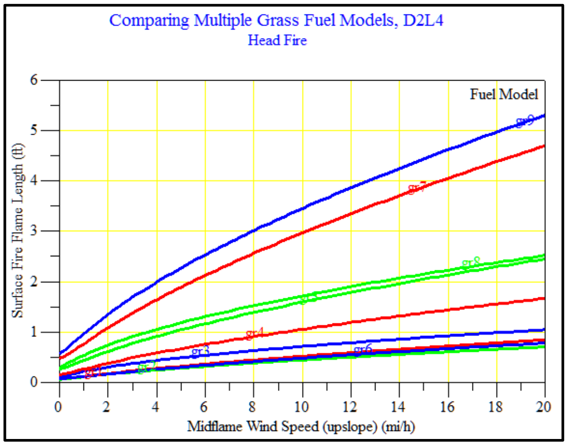




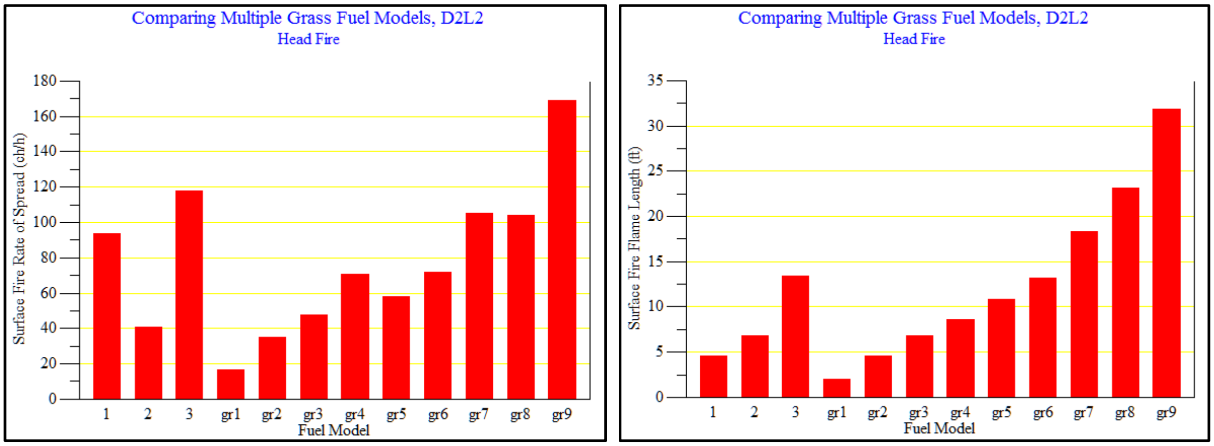


Even if you were to remove the wind limit as recommended by Andrews et al. (2013), the maximum Surface Fire Rate of Spread is less than 40 ch/h, and the Flame Length is less than 6 ft, much less than the fire behavior when D2L2 is used. To test this option, click on **Model Selection > SURFACE Options… > Input Options > Wind Speed**. Under **Impose maximum effective wind speed limit?** select **No**. Remember, however, that the wind speed limit is imposed in the spatial fire behavior modeling systems and cannot be changed.



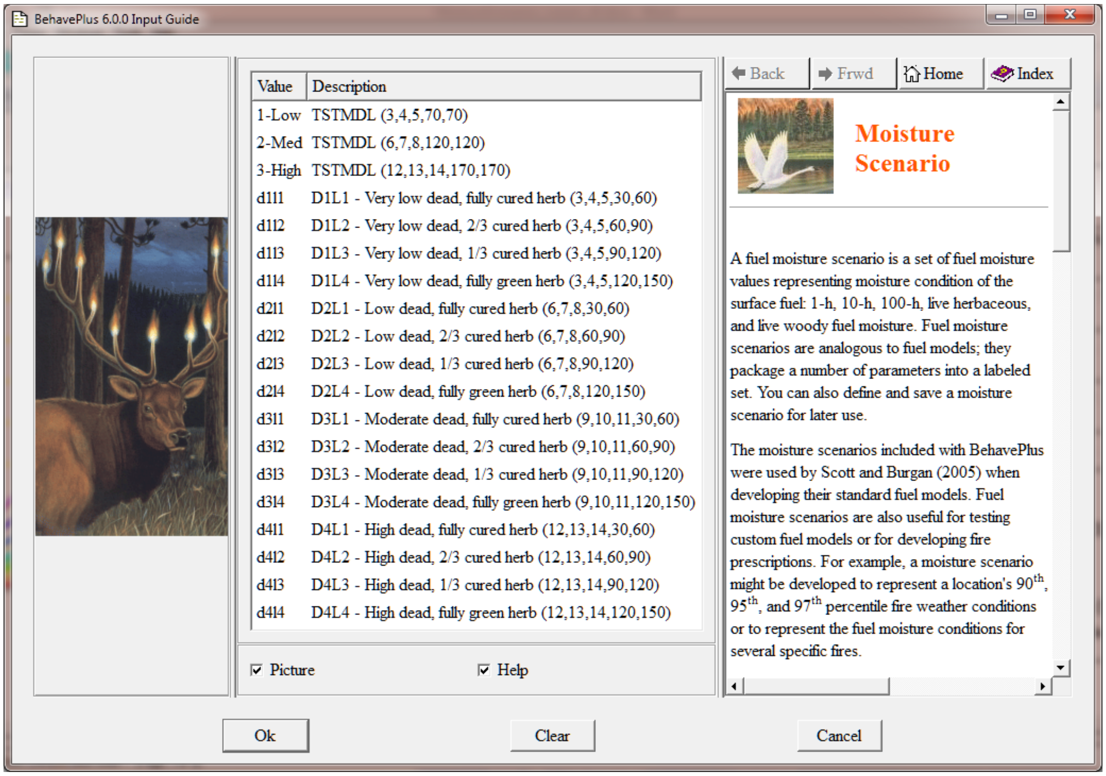


8. *How does the fire behavior compare between the grass models described by Anderson (1982) and those developed by Scott and Burgan (2005)?*
   Under these conditions, the fire behavior for the three original, static fuel models fall in the range calculated for the nine dynamic fuel models. In the exercises, you will see how this relationship may change as the fuel load transfer occurs in the dynamic fuel models.

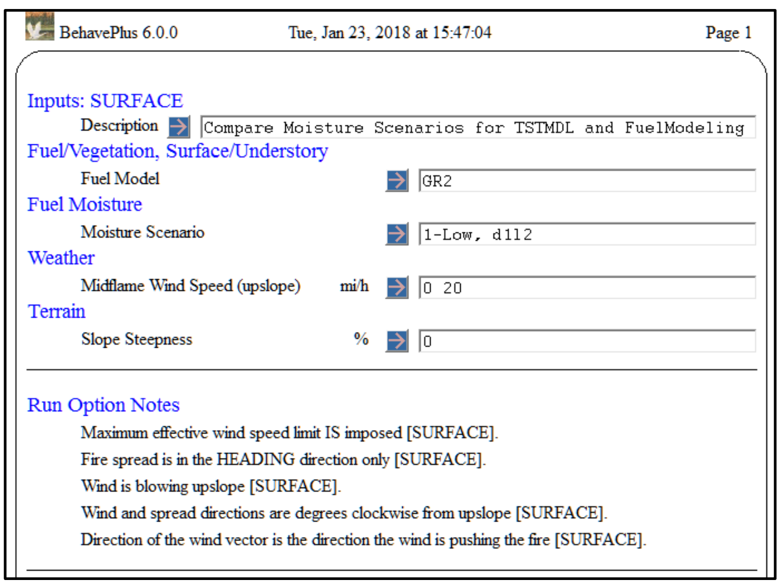


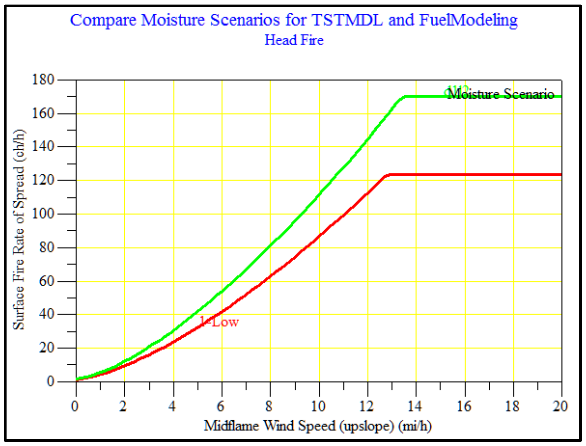
9. *How many Moisture Scenarios are included with BehavePlus now?*
   There are now 19 Moisture Scenarios available for fire behavior modeling – the 16 scenarios from Scott and Burgan, and 3 scenarios from the old BEHAVE TSTMDL program. The Moisture Scenarios in the TSTMDL folder are included with the program, but are not attached to the session when BehavePlus starts.

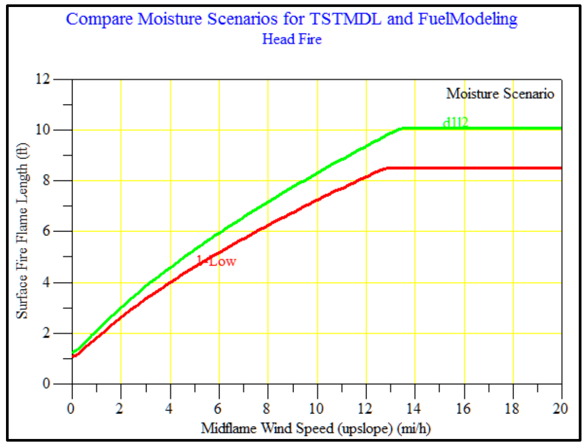
10. *How do the two sets of Moisture Scenarios compare?*
    The image below, obtained by clicking on the **Guide** button next to **Moisture Scenario**, summarizes the results. Scott and Burgan added a new category of dead fuel moistures – moderate dead (9, 10, 11). Live Herbaceous Fuel Moisture starts at a much lower value (30%) and stops at a lower value (120%), which covers the full range of fuel load transfer for the dynamic fuel models. Above a Live Herbaceous Fuel Moisture of 120%, fire behavior is generally quite low for these fuel models. The TSTMDL outputs were developed for static fuel models, and the Live Herbaceous Fuel Moisture ranges from 70-170%.



11. How do the outputs compare for the two Moisture Scenarios? Why do you think that is?







The fire behavior is fairly similar for the two scenarios, especially when the Midflame Wind Speed is less than 13 mi/h. The primary difference results from the difference in Live Herbaceous Fuel Moisture. 1-Low has a Live Herbaceous Fuel Moisture of 70%, and the amount transferred to the Dead Herbaceous Fuel Load category is 56%. D1L2, with a moisture value of 60%, however, transfers about 67% of the fuel to the Dead Herbaceous Fuel Load category. This increase in the amount of dead fuel also increases the fire behavior for the GR2.

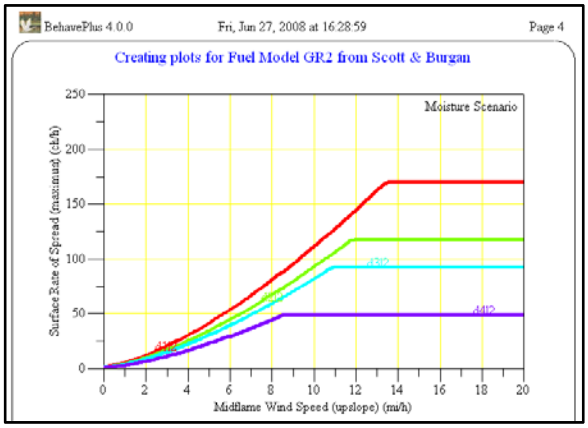
Compare Moisture Scenarios for TSTMDL and FuelModeling

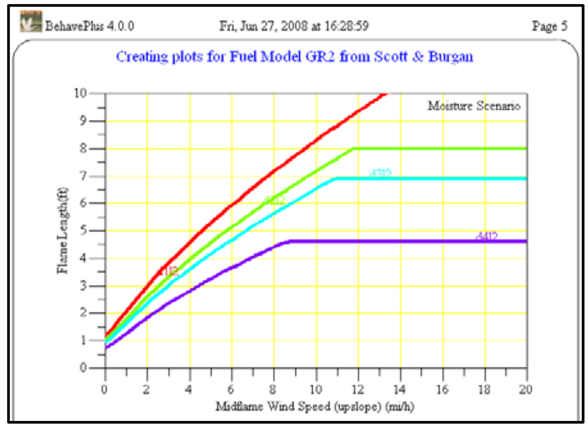
Head Fire

Moisture Scenario	Fuel Load Transferred %	Dead Herb Fuel Load ton/ac	Live Herb Remainder ton/ac	Total Dead Load ton/ac	Total Live Fuel Load ton/ac
1-Low	56	0.56	0.44	0.66	0.44
d1l2	67	0.67	0.33	0.77	0.33

Exercises

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.





Questions

a. What is the purpose for changing the graph scale?

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).

Fuel model	ROS max, ch/h	FL max, ft
GR1		
GR2	250	10
GR3		
GR4		
GR5		
GR6		
GR7		
GR8		
GR9		

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?

2. Twelve grass Fuel Models were compared in the lesson (page 7) 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.

Fuel Moisture, %	D2L1	D2L2	D2L3	D2L4
Live herbaceous				
Live woody				

b. What is the resulting fire behavior?

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

Fuel Moisture, %	Spring	Summer	Fall
1-h	8		
10-h	10		
100-h	12		
Live herbaceous	150		
Live woody	170		

4. Close the BehavePlus program and then restart it. 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 answers will vary depending on the fuel moisture values you selected.

Exercise 4: East District, Projected Fire Behavior

Head Fire

Surface Fire Rate of Spread (ch/h)

Midflame Wind Speed mi/h	Moisture Scenario 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

Questions

a. Can you generate a table like this using individual moisture values rather than Moisture Scenarios?

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.