

Final Report, Joint Fire Science Program

Project Title: BehavePlus and FlamMap Technology Transfer

Project ID: 05-4-1-23

Report Submission Date: March 31, 2008

Project Location: The project did not involve field work. Development of technology transfer material was done in Missoula, Montana.

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Background:

This project was conducted in response to the need identified under Task 1 (RFP 2005-4)—*extension of technology transfer activities beyond the conclusion of successfully completed JFSP funded projects or other applicable wildland fire research.*

Development of the BehavePlus fire modeling system and the FlamMap fire behavior analysis and mapping system and supporting technology transfer material was funded in part under JFSP project #98-1-8-02. After successful completion of that project, development of those systems and supporting material continued under other funding. FlamMap was used in JFSP project #01-1-3-21 “Cumulative effects of fuel management on landscape-scale fire behavior and effects.” A significant amount of technology transfer material has been developed to support these systems. The proposal described the need for additional material to cover expanded capabilities.

Development of technology transfer material for BehavePlus will continue under Forest Service Fire and Aviation Management funding. The structure developed for this JFSP project will facilitate continuing work.

Project Results:

The project was successful. The objectives stated in the proposal were met. Significant advances were made in developing material to support both BehavePlus and FlamMap.

• Website

The www.firemodels.org website was developed for distribution of technology transfer material developed in this project. Previously information on BehavePlus, FlamMap, and other systems was available on www.fire.org. Firemodels.org is a better organized site dedicated to Fire Behavior and Fire Danger Software. Software, publications, and training material are available on FireModels.org. The BehavePlus Training page will include material described in this report.

As an added benefit to JFSP, firemodels.org also serves as a means of sharing information on other JFSP projects (WindWizard, FireStem, and in the future, Safety zone).

A News feature allows people to register for news for systems that they select. Notices will be distributed by email as the training material is expanded and updated. Recognition of JFSP funding of the project will be noted in the News.

There were over 3000 visits by over 2000 users in the last month (Feb. 27 – Mar. 28, 2008). There were 1124 downloads of BehavePlus Version 3 in the last 60 days. We will be able to track the number of downloads of BehavePlus version 4 Beta test program and the new training material developed for this JFSP project. Release will be April 2008.

Attachment A: Firemodels.org download and visit summaries and screen captures.

• **FlamMap Help and Tutorials**

The FlamMap online help system was updated and tutorials were developed. The work was complete in time for the January 2006 release of FlamMap version 3 and has been updated based on user input. The FlamMap27.chm file is available in the program and can be downloaded separately from firemodels.org. Updated and made available on the firemodels.org FlamMap downloads page.

Attachment B: FlamMap Online Help Contents and Index and screen captures.

• **BehavePlus variables paper**

There are 181 input and output variables in BehavePlus version 4. Previously variable descriptions and help information was available only in separate help windows. Variable information is now available as a publication that can be printed as a reference guide. But it is most valuable when viewed by Adobe Reader. It includes many links among variable listings, input and out put tables, and variable descriptions. The pdf document is included with BehavePlus version 4.0 installation along with the User's Guide, and is available from the Help command on the main menu.

Enclosure: Publication review draft.

• **BehavePlus help**

The BehavePlus online help system was updated. Almost every variable description, option selection, and operation help file was improved. Variable help includes information in the paper described above and some additional tables, diagrams, and descriptions. Help information for other aspects of program operation were also updated, including units conversion tables, input option selections, and so on.

Attachment C: BehavePlus online help file listing and screen captures.

• **BehavePlus workshops**

Several short (half-day or less) workshops were presented. The objective of a short workshop is to give an introduction to the BehavePlus fire modeling system. Relationship to other fire behavior systems (FlamMap, FARSITE, FSpro) is explained, BehavePlus fire modeling capabilities is described, and examples operation is demonstrated. The workshop describes where additional information and training material is available. Lessons are available for others to download. Material is designed so that a presenter can adapt the workshop to suit the audience and application at hand.

• **BehavePlus training material**

There is not a single BehavePlus “course”. Lessons were developed to be used singly or in combination to meet specific needs. Individuals and course coordinators can choose lessons to support particular courses. For example,

- A single overview lesson can be used to present an overview of the BehavePlus fire modeling system at a Fire Management Officer meeting
- Several selected lessons can be used for a half-day demonstration and discussion workshop.
- The four basic operation lessons in the Introduction unit can be assigned as pre-work for a course that uses BehavePlus for fire behavior prediction.
- Selected lessons can be used by individuals as review of fire modeling concepts learned elsewhere.
- A course manager can select lessons for pre-work and for instructor-led hands-on training for a course suited to the background of the trainees and the application (e.g. prescribed fire planning).

Example workshop and course agendas are provided on firemodels.org. As course coordinators/instructors develop and teach courses, they are encouraged to provide information that can be posted for others to use.

Lessons are organized according to Units:

- **Overview Unit**—General overview of BehavePlus
- **Introduction Unit**—Four required lessons that give the foundation for program operation
- **Operation Unit**—Optional lessons that cover various aspects of operation
- **Modeling Unit**—Modeling capabilities, limitations and assumptions, sensitivity
- **Application Unit**—Specific application examples

Lessons are designed to be used in either a self-study or instructor-led format. There are lessons suitable for printing, PowerPoint presentations for some, instructor guides, exercises and answers, and handouts.

Lessons were updated, new lessons were added, and a plan was developed for additional lessons. The enclosed BehavePlus Training page gives units, lessons, objectives, status, and associated files. A change log on the web site will keep track of updates. The sample Training page document and training material files are on the CD submitted with this final report.

We used a pre-release version of BehavePlus version 4 to develop the training material. The beta version of BehavePlus version 4.0 will be released April 2008. At that time, the program and supporting material, including the training material developed for this project, will be put on firemodels.org.

Attachment D: BehavePlus training page, which will be on firemodels.org.

Enclosures: Example lesson material: BehavePlus Overview Lesson, PowerPoint presentation with notes, and Basic Start Lesson with Exercises and Instructor Guide.

Deliverable Table from the Proposal:

The first two columns are copied directly from the accepted proposal. The third column indicates that deliverables are complete with notes of explanation. The following table lists specific deliverables.

Deliverable	Description	Accomplishments
BehavePlus		
Improved tutorials	The 14 current tutorials will be reorganized and updated.	Complete. Available on firemodels.org.
Additional tutorials	Additional tutorials for V4 additions	Complete. Several workshops were presented. Material is available on firemodels.org
4-hour workshop package	Lecture and demonstration package available for download and use by anyone as a workshop presentation. Will include the relationship of BehavePlus to FARSITE and FlamMap, application, fire models, and operation.	Complete. The help system was updated and a 'Variables' paper was written.
Fire modeling help information incorporated into the program	The User's Guide describes program operation. A paper focusing on the modeling capabilities will be integrated into the program, version 4.	Complete. Lessons and example agendas are available on firemodels.org.
3-day course material	Hands-on classroom course material based on the tutorials and the fire modeling paper. Operation, model limitations, fire behavior principles, and the need for understanding for proper application. Training material available for download.	Complete. Available in the program and on firemodels.org
FlamMap		
Online help for v3	HTML online help, linked to user interface explaining use of new features. The features include minimum travel time fire growth modeling, and fuel treatment optimization	Complete. Available in the program and on firemodels.org
Tutorials	Application examples with data sets and step-by-step instructions	Complete. Available in the program and on firemodels.org

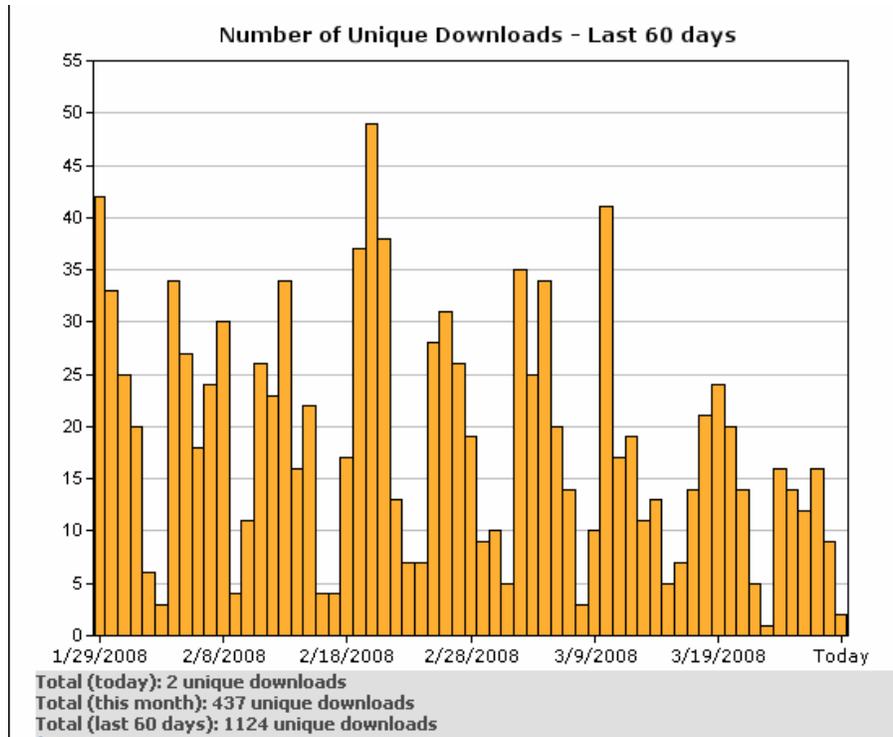
Deliverables Table

Category	Delivered	Status
Website	http://www.firemodels.org	Done.
Help system	FlamMap online help (FlamMap27.chm)	Incorporated into the FlamMap program and available on firemodels.org
Tutorials	FlamMap tutorials (FlamMap27.chm)	Incorporated into the FlamMap program and available on firemodels.org
Help system	BehavePlus online help	Incorporated into BehavePlus, v4. Beta test program will be made available on firemodels.org April 2008.
Publications	Andrews, Patricia L. 2008 (in review). BehavePlus fire modeling system, version 4.0: Variables. Gen. Tech. Rep. RMRS-GTR-xxxWWW. Ogden, UT, Department of Agriculture, Forest Service, Rocky Mountain Research Station, 106 p.	Review draft. Available through the BehavePlus help system and on firemodels.org.
Publications	Andrews, Patricia L. 2007. BehavePlus fire modeling system: past, present, and future. In 'Proceedings of 7th Symposium on Fire and Forest Meteorological Society', 23-25 October 2007, Bar Harbor, Maine, 13 pages.	Available on the BehavePlus publications page of firemodels.org. Included as a handout for the BehavePlus Overview Lesson.
Posters	Andrews, P. L., C.D. Bevins, and R.C. Seli (2007) BehavePlus Fire Modeling System, Version 4.0 Overview. In '2nd Fire Behavior and Fuels Conference: The Fire Environment—Innovations, Management, and Policy'. 26-30 March 2007, Destin, Florida.	Available on the BehavePlus publications page of firemodels.org. Small format included as a handout for the BehavePlus Overview Lesson.
Posters	Andrews, P. L. and T.M. Kelley (2007) Use of the BehavePlus Fire Modeling System for Prescribed Fire Planning. In '2nd Fire Behavior and Fuels Conference: The Fire Environment—Innovations, Management, and Policy'. 26-30 March 2007, Destin, Florida.	Available on the BehavePlus publications page of firemodels.org. Small format included as a handout for for the BehavePlus for Prescribed Fire Lesson.

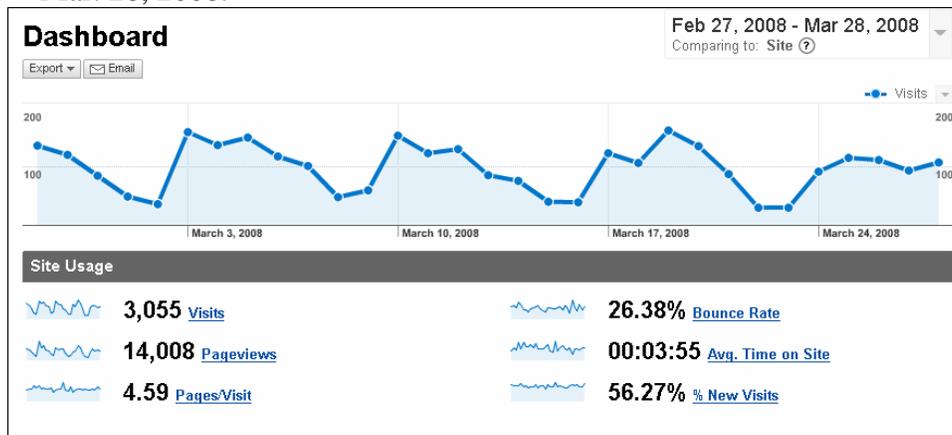
BehavePlus course material	Lessons, instructor guides, handouts, supporting material, which can be used self-study or instructor led. Example agendas for courses and workshops	Will be on firemodels.org when BehavePlus v4 is released April 2008.
Workshops	BehavePlus (3-4 hour) workshops: <ul style="list-style-type: none"> • Feb. 2006. Fuels and Fire Use Burn Boss Workshop, Boulder CO • Jan. 2007. BIA NW Region fuels workshop, Worley ID • Feb. 2007. Northern Rockies Fire Behavior Workshop, Missoula MT • Feb. 2007. Prescribed fire workshop, Rapid City, SD • Feb. 2007. Bitterroot NF fire management meeting, Hamilton MT • Jan. 2008. Bitterroot NF fire management meeting, Hamilton MT • Feb. 2008. Northern Rockies Fire Behavior Workshop, Missoula MT 	

Attachment A: FireModels.org downloads and visits summaries and screen captures

Files downloads from FireModels.org can be tracked. There were 1124 downloads of BehavePlus version 3 in the last 60 days, which is surprising since this version of BehavePlus has been available since 2003. We will release a Beta test version 4.0 in April 2008, along with the training material developed in this JFSP project.



FireModels.org had over 3000 visits by over 2000 visitors in the month of Feb. 27 – Mar. 28, 2008.



FireModels.org is the source for fire behavior and fire danger software.

FireModels.org
Fire Behavior and Fire Danger Software
Missoula Fire Sciences Laboratory

Home

[Print]

The fire behavior and fire danger systems described on **FireModels.org** are a result of a productive cooperative effort on the part of:

- **Forest Service Research, Rocky Mountain Research Station**
 - **Missoula Fire Sciences Laboratory**; Fire, Fuels, and Smoke Program
 - Wildland Fire Management Research, Development, and Application Program, Boise, ID
- **Systems for Environmental Management**
- **Forest Service Fire and Aviation Management**
- **Joint Fire Science Program**

These systems are public domain and most can be downloaded from this site. They are designed to be used by fire and land managers who have training and fire experience. Some require spatial databases. WFAS is an internet-based system that provides fire danger maps that can be viewed by the general public as well as by land managers.

Fire Behavior Systems

The following fire behavior systems are based on essentially the same mathematical fire models, are complementary, and are suited to different fire management needs. Fire behavior systems produce specific elements of a fire (spread rate, perimeter, flame length, scorch height, etc.) whereas fire danger systems produce indices.

- **BehavePlus** fire modeling system
 - PC program
 - Modeling of fire behavior, fire effects, and fire environment
 - Interactive user input
 - Uniform conditions for each calculation
 - Table, graph, and diagram output
 - Used for basic fire modeling understanding, prescribed fire planning, fuel hazard assessment, predicting wildfire behavior, etc.
- **FlamMap** fire mapping and analysis system
 - PC program
 - Potential fire behavior across the landscape
 - Spatial fuel and terrain data needed
 - Weather and fuel moisture constant for a run
 - Minimum travel time and other options available
 - Used for fuel hazard assessment, placement of fuel treatment projects, and more
- **FARSITE** fire area simulator
 - PC program
 - Fire growth simulation
 - Spatial fuel and terrain data needed
 - Weather and fuel moisture change with time
 - Used to project fire growth of ongoing fires and hypothetical fires for planning, and more

The BehavePlus publications page includes publications produced through this JFSO project.

FireModels.org
Fire Behavior and Fire Danger Software
Missoula Fire Sciences Laboratory

Home > BehavePlus > Publications

BehavePlus Publications [Print]

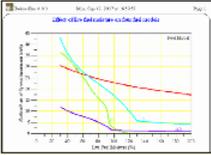
Publications

The publications on this page describe the BehavePlus fire modeling system, related systems, and the fire models that are included in BehavePlus. Additional references and publications will be added.

- [BehavePlus fire modeling system](#)
- [Fire behavior prediction](#)
- [The old BEHAVE fire behavior prediction and fuel modeling system](#)
- [Surface fire spread](#)
- [Fuel](#)
- [Fire shape](#)
- [Midflame wind speed](#)
- [Safety zones](#)
- [Probability of ignition](#)
- [Spatial fire behavior systems](#)
- [Past fire behavior modeling systems](#)

BehavePlus fire modeling system

This paper is an overview of BehavePlus. It includes a description of the relationship of BehavePlus to other fire behavior systems and a table of the mathematical models that form the basis of the system.



Andrews, P. L. (2007) BehavePlus fire modeling system: Past, present, and future. In 'Proceedings of 7th Symposium on Fire and Forest Meteorological Society'. 23-25 October 2007, Bar Harbor, Maine.
<http://ams.confex.com/ams/pdfpapers/126669.pdf> (647 KB; 13 pages) [[PDF](#)]

This poster (PDF reduced to 8.5" x 11") is an overview of BehavePlus. It includes a brief description of each module.



Andrews, P. L., C.D. Bevins, and R.C. Seli (2007) BehavePlus Fire Modeling System, Version 4.0 Overview. In '2nd Fire Behavior and Fuels Conference: The Fire Environment—Innovations, Management, and Policy'. 26-30 March 2007, Destin, Florida. (176 KB) [[PDF](#)]

A larger version can be downloaded for Microsoft PowerPoint (26.5 MB) [[PPT](#)].

This poster (PDF reduced to 8.5" x 11") is an overview of application of BehavePlus to prescribed fire planning.



Andrews, P. L. and T.M. Kelley (2007) Use of the BehavePlus Fire Modeling System for Prescribed Fire Planning. In '2nd Fire Behavior and Fuels Conference: The Fire Environment—Innovations, Management, and Policy'. 26-30 March

The BehavePlus Training page will include the training material developed under this project. A pdf document of the page organization is included with this report. The page will be updated when the Beta test BehavePlus version 4.0 program is released, April, 2008.

FireModels.org
Fire Behavior and Fire Danger Software
Missoula Fire Sciences Laboratory

BehavePlus Training [Print]

We are in the process of updating and expanding documentation and training material. This is possible due to funding from the [Joint Fire Science Program \(JFSP\)](#) and from [Forest Service Fire and Aviation Management](#).

Several 4-hour workshops have been conducted to give participants an overview of BehavePlus. We will package that material so that others can put on similar workshops.

We have developed 14 self-study tutorials. Lessons 1-4 provide a foundation for operation of the program. Others address modeling capabilities (e.g., crown fire) and operation features (e.g., units). We will continue to improve these tutorials.

While there is a place for self-study materials, there are many requests for hands-on classroom training. We will develop materials for a BehavePlus training course. These materials can be used in both self-study and classroom settings. Tutorials

Tutorials
Lesson numbers were assigned as the lessons were developed. The following table groups them into logical categories.

Lessons 1-4 give you a basic foundation for operation of the BehavePlus program. That's where you need to start. Do the first four lessons in order.

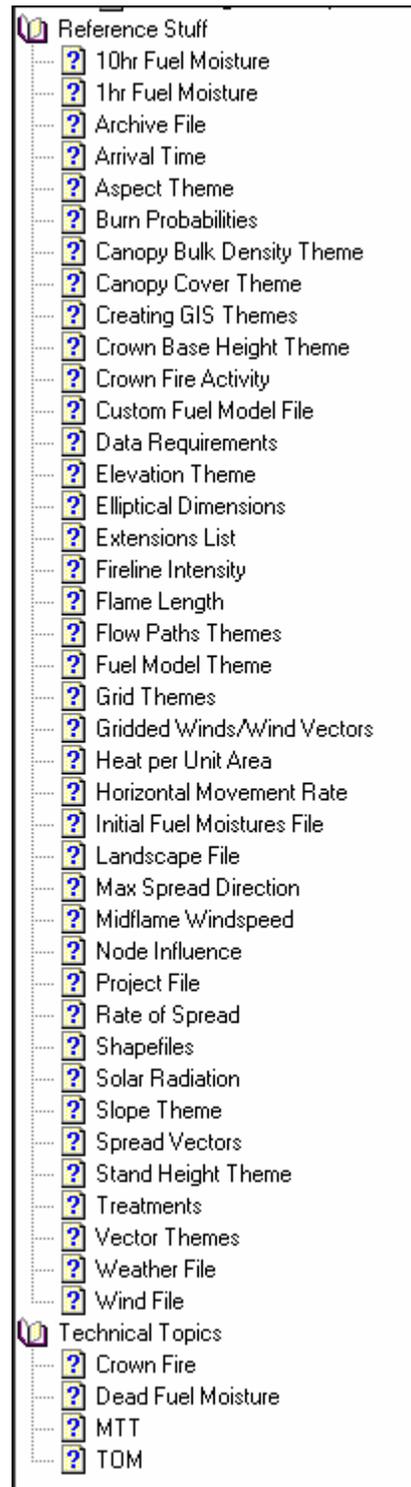
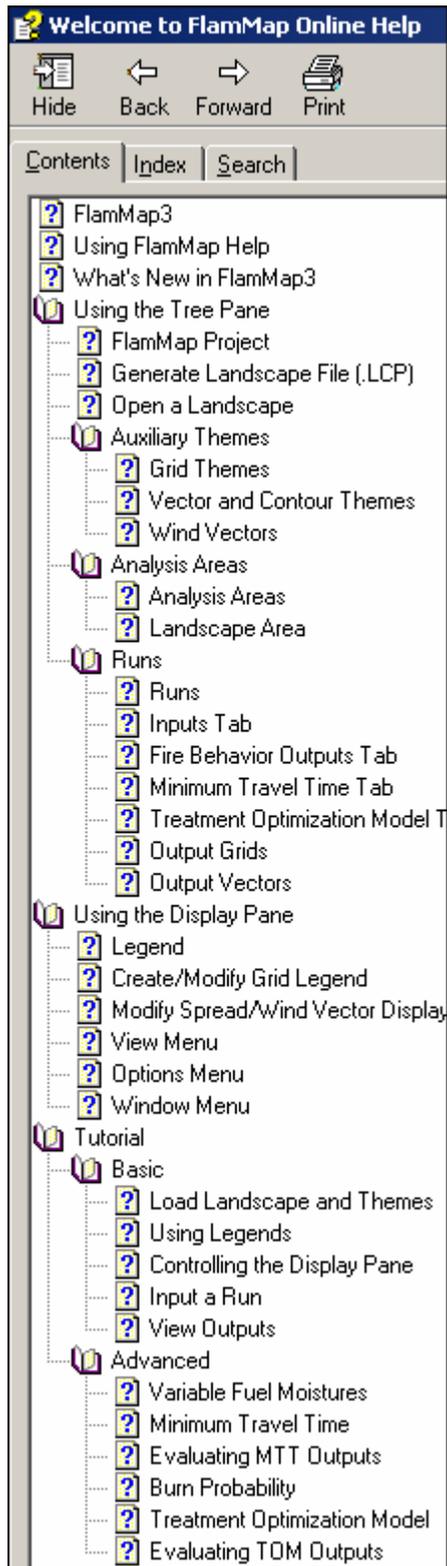
Lessons 8-10 describe some other operation features. You can skip those until you feel like you need them.

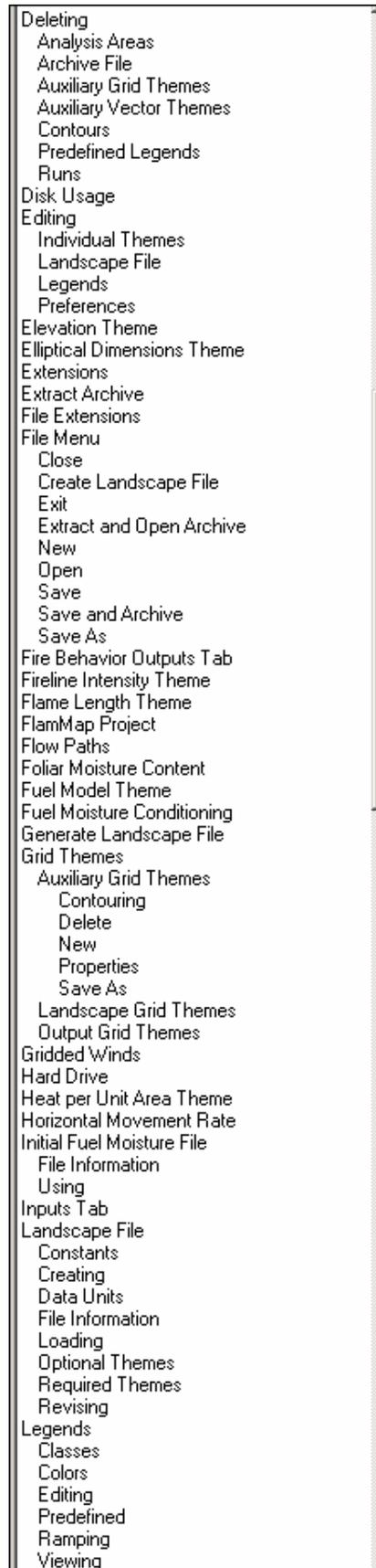
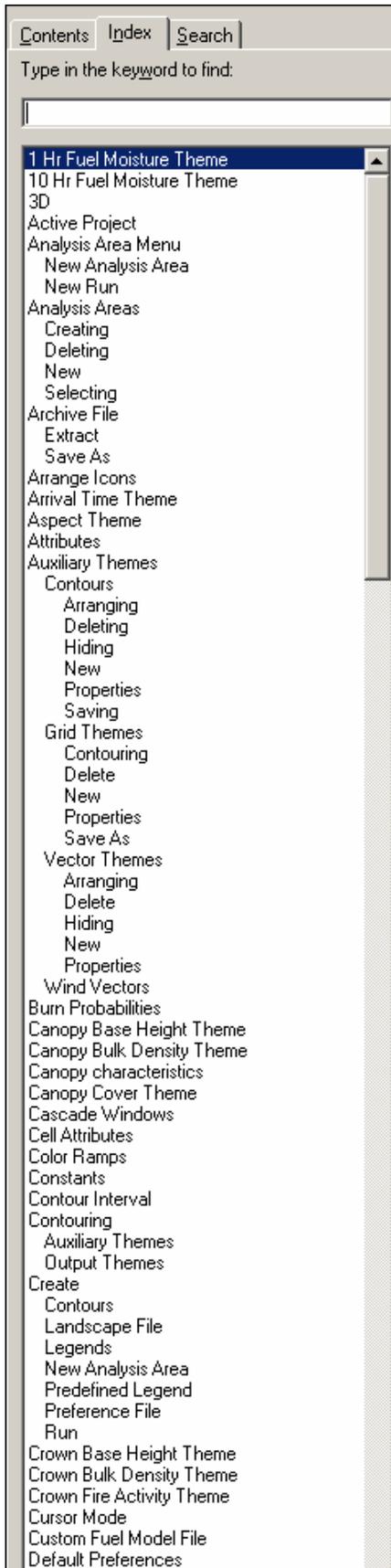
The rest of the lessons address specific modeling features. This is only part of what BehavePlus can do. These lessons can be done in any order. They were developed to describe some of the modeling options that were not available in earlier versions of the program. Select the ones that interest you.

We suggest you download the PDF file for off-line viewing and printing.

Lesson Category	Ref #	Lesson Title	Download PDF Format
Basic Operation	1	Basic Start	0.6 MB
	2	Worksheets	1.1 MB
	3	Input Methods	2.2 MB
	4	Calculation	1.3 MB
Modeling Options	5	Direction Options	2.7 MB
	6	Moisture Scenarios	2.5 MB
	11	Standard Fuel Models	0.6 MB
	7	Custom Fuel Models	2.3 MB
	12	Wind Adjustment Factor	0.5 MB
	13	Crown Fire	0.9 MB
	14	Table Shading for Acceptable Conditions	0.5 MB
Operation Features	8	File Management	0.7 MB

Attachment B: FlamMap Online Help Contents and Index and Screen captures





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 - Auxiliary Vector Theme
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 - Landscape File
 - Preferences
 - Project
- Maximum Spread Direction Theme
- Memory
- Midflame Wind Speed Theme
- Minimum Travel Time Tab
- Modify Legends
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- New
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 - Status Bar
 - Three D
 - Toolbar
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 - Zoom In
 - Zoom Out
- Weather File
 - File Information
 - Using
- Wind File
 - File Information
 - Using
- Wind Grids
 - File Information
 - Using
- Wind Inputs
- Wind Vectors
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 - Arrange Icons
 - Cascade
 - Tiling
- WND File
- WTR File
- Zoom Factor
- Zoom In
- Zoom Out

Welcome to FlamMap Online Help

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 - Using the Tree Pane
 - FlamMap Project
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 - Open a Landscape
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 - Wind Vectors
 - Analysis Areas
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 - Evaluating MTT Outputs
 - Burn Probability
 - Treatment Optimization Model
 - Evaluating TOM Outputs
 - Reference Stuff
 - Technical Topics
 - Crown Fire
 - Dead Fuel Moisture
 - MTT
 - TOM

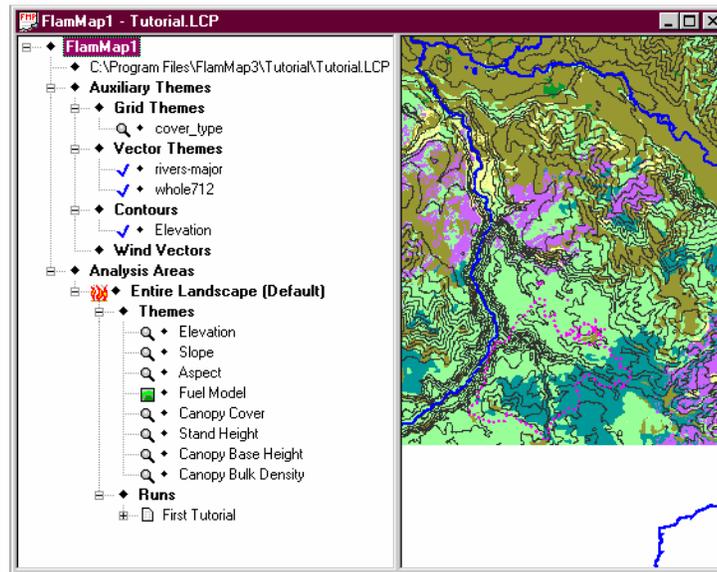
BASIC LESSON 5

VIEW OUTPUTS

This is the part you all have been waiting for, getting some output to look at.

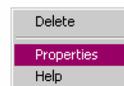
Open your Project

If you have closed your project or shut down FlamMap, you can reopen the project by selecting the **File > Open** command from the menu bar. In the "Open" dialog box select the file Tutorial.fmp and click the **Open** button. Your FlamMap project will display just the way it was when you last saved it as shown below.



Launch Your Run

Right-click on the **First Tutorial** line in the "Tree" pane, it will be the last line in the tree. This shortcut menu is displayed;



Select the **Properties** command from the shortcut menu. The "Run:First Tutorial" dialog box appears, looking just like it did when you finished the [previous lesson](#).

The Status and Button bars at the bottom of the "Run:First Tutorial" dialog box should look like this;



Welcome to FlamMap Online Help

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Contents Index Search

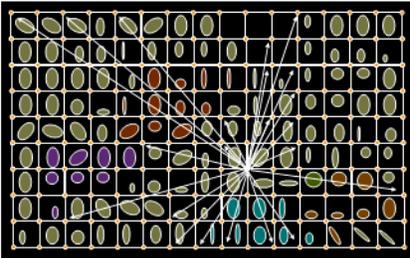
- Basic
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 - Dead Fuel Moisture
 - MTT**
 - TOM

MINIMUM TRAVEL TIME FIRE GROWTH MODEL

Basic Model

The Minimum Travel Time (MTT) feature is a two-dimensional fire growth model. It calculates fire growth and behavior by searching for the set of pathways with minimum fire spread times from point, line or polygon ignition sources. In theory, the results are identical to wave-front expansion used in *FARSITE* with the exception that all weather and fuel moisture conditions are held constant over time with MTT but allowed to vary in time in *FARSITE*.

At a user specified resolution of data cells, the algorithm finds the minimum travel paths by calculating travel times from each node (cell corners) to every other node on the landscape. Travel pathways are straight lines that connect nodes and intersect cells to form segments for which fire behavior is calculated from the input data.



Efficiencies in computation are afforded by stopping the search for a particular node after a specified number of failures occur in the search (in the X- and Y- directions). The algorithm is parallelized to make use of multiple CPUs on a computer system.

Burn Probabilities

In addition to calculating fire growth for a single fire, MTT can be used to compute burn probabilities for a specified number of randomly located ignition points each of a constant duration. Burn probabilities provide one method of evaluating the effectiveness of fuel treatments that removes the uncertainty of ignition sources. A large sample size of ignitions (say 1000's or 10,000's) on the treated and pre-treatment landscape gives an indication of the overall effectiveness of the landscape pattern in retarding the growth of large fires. High burn probabilities are related to the sizes of fires that occur on a given landscape -- for the same conditions, large fires produce higher probabilities than small fires (each burn a larger fraction of the landscape). Since fire size is a function of the gross spread rate and duration of the fire, treatments that reduce the spread rate will lower the burn probability. This feature produces a single output map that contains the fraction of the number of fires that encountered each node (0.0 to 1.0). For further analysis this map can be saved in ASCII grid format to import into a GIS where grid statistics and other procedures can be calculated.

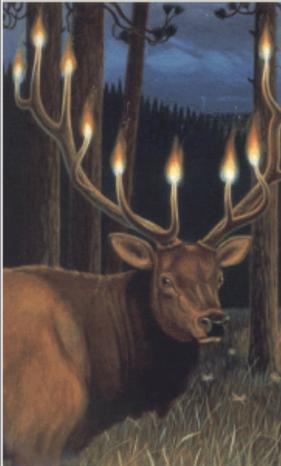
Attachment C: BehavePlus online help file listing and Screen captures

aboutBehavePlus.html	slopeOptions.html	vIgnitionLightningFuelType.html
aboutHelp.html	sunDialogContents.html	vIgnitionLightningProb.html
applicationAppearance.html	sunDialogLocation.html	vMapContourCount.html
attachFiles.html	tablesAppearance.html	vMapContourInterval.html
CBD_Dougfir_Lodgepole.html	tablesIndex.html	vMapDist.html
CBD_Lodgepole.html	terrainSpottingUnits.html	vMapFraction.html
CBD_Ppine.html	timeMapUnits.html	vSafetyZoneEquipmentArea.html
CBD_Ppine_Dougfir.html	TwoFuelOptions.html	vSafetyZoneEquipmentNumber.html
CBD_SierraNevadaMixedConifer.html	unitsConverter.html	vSafetyZonePersonnelArea.html
conflict1.html	variableIndex.html	vSafetyZonePersonnelNumber.html
conflict2.html	vContainAttackDist.html	vSafetyZoneRadius.html
containOptions.html	vContainAttackPerimeter.html	vSafetyZoneSepDist.html
containUnits.html	vContainAttackSize.html	vSafetyZoneSize.html
crownOptions.html	vContainAttackTactic.html	vSiteAspectDirFromNorth.html
directionOptions.html	vContainCost.html	vSiteRidgeToValleyDist.html
fdmcDialog.html	vContainDiagram.html	vSiteRidgeToValleyElev.html
figureIndex.html	vContainLimitDist.html	vSiteSlope.html
fileSelector.html	vContainLine.html	vSiteSlopeReach.html
fireUnits.html	vContainResourceArrival.html	vSiteSlopeRise.html
folderDescription.html	vContainResourceBaseCost.html	vSiteSunShading.html
fuelExportDialog.html	vContainResourceDuration.html	vSpotCoverHtBurningPile.html
fuelInit.html	vContainResourceHourCost.html	vSpotCoverHtSurfaceFire.html
fuelModel01.html	vContainResourceName.html	vSpotCoverHtTorchingTrees.html
fuelModel02.html	vContainResourceProd.html	vSpotDistBurningPile.html
fuelModel03.html	vContainResourceUsed.html	vSpotDistSurfaceFire.html
fuelModel04.html	vContainSize.html	vSpotDistTorchingTrees.html
fuelModel05.html	vContainStatus.html	vSpotFirebrandDriftSurfaceFire.html
fuelModel06.html	vContainTime.html	vSpotFirebrandHtBurningPile.html
fuelModel07.html	vCrownFireActiveCrown.html	vSpotFirebrandHtSurfaceFire.html
fuelModel08.html	vCrownFireActiveRatio.html	vSpotFirebrandHtTorchingTrees.html
fuelModel09.html	vCrownFireArea.html	vSpotFireSource.html
fuelModel10.html	vCrownFireCritCrownSpreadRate.html	vSpotFlameDurTorchingTrees.html
fuelModel11.html	vCrownFireCritSurfFireInt.html	vSpotFlameHtTorchingTrees.html
fuelModel12.html	vCrownFireCritSurfFlameLeng.html	vSpotFlameRatioTorchingTrees.html
fuelModel13.html	vCrownFireLengthToWidth.html	vSpotFlatDistBurningPile.html
fuelModelKey.html	vCrownFirePerimeter.html	vSpotFlatDistSurfaceFire.html
fuelMoisOptions.html	vCrownFireSpreadDist.html	vSpotFlatDistTorchingTrees.html
fuelVegetationUnits.html	vCrownFireSpreadRate.html	vSpotTorchingTrees.html
geoCatalog.html	vCrownFireTransRatio.html	vSurfaceFireArea.html
geoPlace.html	vCrownFireTransToCrown.html	vSurfaceFireCharacteristicsDiagram.html
graphElements.html	vCrownFireType.html	vSurfaceFireDistAtBack.html
graphLimitsDialog.html	vDocDescription.html	vSurfaceFireDistAtHead.html
graphSize.html	vDocFireAnalyst.html	vSurfaceFireDistAtVector.html
guideIndex.html	vDocFireName.html	vSurfaceFireEffWind.html
horizontalDistance.html	vDocFirePeriod.html	vSurfaceFireElapsedTime.html
index.html	vDocRxAdminUnit.html	vSurfaceFireFlameHtPile.html
moduleSelection.html	vDocRxName.html	vSurfaceFireFlameLeng.html
mortalityOptions.html	vDocRxPreparedBy.html	vSurfaceFireHeatPerUnitArea.html
pageTabs.html	vDocTrainingCourse.html	vSurfaceFireHeatSource.html
PalmettoGallberryDetails.html	vDocTrainingExercise.html	vSurfaceFireLengDist.html
relativeHumidity.html	vDocTrainingTrainee.html	vSurfaceFireLengthToWidth.html
scorchOptions.html	vIgnitionFirebrandProb.html	vSurfaceFireLineInt.html
selectOutput.html	vIgnitionLightningDuffDepth.html	vSurfaceFireMaxDir.html
slopeOptions.html	vIgnitionLightningFuelType.html	vSurfaceFireMaxDirDiagram.html
	vIgnitionLightningProb.html	vSurfaceFirePerimeter.html
		vSurfaceFireReactionInt.html

vSurfaceFireReactionIntDead.html	vSurfaceFuelPalmettoLoadDead1.html	
vSurfaceFireReactionIntLive.html	vSurfaceFuelPalmettoLoadDead10.html	
vSurfaceFireResidenceTime.html	vSurfaceFuelPalmettoLoadDeadFoliage.html	
vSurfaceFireScorchHt.html	vSurfaceFuelPalmettoLoadLitter.html	
vSurfaceFireSeverityAspen.html	vSurfaceFuelPalmettoLoadLive1.html	
vSurfaceFireShapeDiagram.html	vSurfaceFuelPalmettoLoadLive10.html	
vSurfaceFireSlopeFactor.html	vSurfaceFuelPalmettoLoadLiveFoliage.html	
vSurfaceFireSpread.html	vSurfaceFuelPalmettoOverstoryBasalArea.html	
vSurfaceFireSpreadDir.html	vSurfaceFuelSavrDead1.html	
vSurfaceFireVectorDir.html	vSurfaceFuelSavrLiveHerb.html	
vSurfaceFireWidthDist.html	vSurfaceFuelSavrLiveWood.html	
vSurfaceFireWindFactor.html	vTreeAspenMortalityRate.html	
vSurfaceFireWindSpeedFlag.html	vTreeBarkThickness.html	
vSurfaceFireWindSpeedLimit.html	vTreeCanopyBulkDens.html	
vSurfaceFuelAspenCuring.html	vTreeCanopyCover.html	
vSurfaceFuelAspenType.html	vTreeCanopyCrownFraction.html	
vSurfaceFuelBedBetaRatio.html	vTreeCoverHt.html	
vSurfaceFuelBedBulkDensity.html	vTreeCrownBaseHt.html	
vSurfaceFuelBedCoverage1.html	vTreeCrownLengScorched.html	
vSurfaceFuelBedDeadFraction.html	vTreeCrownRatio.html	
vSurfaceFuelBedDepth.html	vTreeCrownWolScorched.html	
vSurfaceFuelBedHeatSink.html	vTreeDbh.html	
vSurfaceFuelBedMextDead.html	vTreeFoliarMois.html	
vSurfaceFuelBedMextLive.html	vTreeHt.html	
vSurfaceFuelBedModel.html	vTreeMortalityRate.html	
vSurfaceFuelBedModel1.html	vTreeSpecies.html	
vSurfaceFuelBedModel2.html	vTreeSpeciesMortality.html	
vSurfaceFuelBedMoisDead.html	vTreeSpeciesMortalityTable.html	
vSurfaceFuelBedMoisLive.html	vTreeSpeciesSpot.html	
vSurfaceFuelBedPackingRatio.html	vWindAdjFactor.html	
vSurfaceFuelBedSigma.html	vWindAdjMethod.html	
vSurfaceFuelHeatDead.html	vWindDirSource.html	
vSurfaceFuelHeatLive.html	vWindDirVector.html	
vSurfaceFuelLoadDead.html	vWindSpeedAt10M.html	
vSurfaceFuelLoadDead1.html	vWindSpeedAt20Ft.html	
vSurfaceFuelLoadDead10.html	vWindSpeedAtMidflame.html	
vSurfaceFuelLoadDead100.html	vWthrAirTemp.html	
vSurfaceFuelLoadDeadHerb.html	vWthrLightningStrikeType.html	
vSurfaceFuelLoadLive.html	weatherUnits.html	
vSurfaceFuelLoadLiveHerb.html	WesternAspenDetails.html	
vSurfaceFuelLoadLiveWood.html	windOptions.html	
vSurfaceFuelLoadTransferEq.html	worksheetAppearance.html	
vSurfaceFuelLoadTransferFraction.html		
vSurfaceFuelLoadUndeadHerb.html		
vSurfaceFuelMoisDead1.html		
vSurfaceFuelMoisDead10.html		
vSurfaceFuelMoisDead100.html		
vSurfaceFuelMoisLifeDead.html		
vSurfaceFuelMoisLifeLive.html		
vSurfaceFuelMoisLiveHerb.html		
vSurfaceFuelMoisLiveWood.html		
vSurfaceFuelMoisScenario.html		
vSurfaceFuelPalmettoAge.html		
vSurfaceFuelPalmettoCover.html		
vSurfaceFuelPalmettoHeight.html		

BehavePlus 4.0.0 Input Guide

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(0.1 - 100.0 ft)

From

Thru

Step

Picture Help

Ok Clear Cancel

Canopy Base Height

The canopy base height for an individual tree is the height at which sufficient fuel density exists for sustained canopy ignition.

For a stand of trees, canopy base height considers both the main canopy layer and ladder fuels in the understory.

Canopy base height and foliar moisture content are used to calculate critical fireline intensity for transition to crown fire.

I/O	Module	If
Input	CROWN	
Output	None	

BehavePlus 4.0.0 Input Guide

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Canopy Bulk Density -- Ponderosa pine / Douglas-fir

The following table was developed from information in Scott and Reinhardt (2005). Please consult that publication for a complete description.

Scott, Joe H.; Reinhardt, Elizabeth D. 2005. Stereo photo guide for estimating canopy fuel characteristics in conifer stands. Gen. Tech. Rep. RMRS-GTR-145. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 49 p. plus stereoscope.

Canopy fuel characteristics for a Ponderosa pine / Douglas-fir forest under different canopy conditions.

		Ponderosa pine / Douglas-fir				
		Initial Condition	Understory Removed (≤ 5 cm)	75% of initial basal area	50% of initial basal area	25% of initial basal area
						
Canopy Cover	%	59	9	50	30	19
Stand Height	m	23	23	23	23	23
	ft	75	75	75	75	75
Canopy Base Height	m	0	1	5	11	12
	ft	0	3	16	36	39
Canopy Bulk Density	kg / m ³	0.089	0.086	0.055	0.037	0.022
	lb / ft ³	0.0056	0.0054	0.0034	.0023	.0014

(0.001 - 0.062 lb/ft³)

From
 Thru
 Step

Picture Help

Ok Clear Choices Cancel

BehavePlus 4.0.0 Input Guide

Sort	Value	Description
001	1	Short grass (S)
002	2	Timber grass and understory (S)
003	3	Tall grass (S)
004	4	Chaparral (S)
005	5	Brush (S)
006	6	Dormant brush, hardwood slash (S)
007	7	Southern rough (S)
008	8	Short needle litter (S)
009	9	Long needle or hardwood litter (S)
010	10	Timber litter and understory (S)
011	11	Light logging slash (S)
012	12	Medium logging slash (S)
013	13	Heavy logging slash (S)
101	gr1	Short, sparse, dry climate grass (D) (101)
102	gr2	Low load, dry climate grass (D) (102)
103	gr3	Low load, very coarse, humid climate grass (D) (103)
104	gr4	Moderate load, dry climate grass (D) (104)
105	gr5	Low load, humid climate grass (D) (105)
106	gr6	Moderate load, humid climate grass (D) (106)
107	gr7	High load, dry climate grass (D) (107)
108	gr8	High load, very coarse, humid climate grass (D) (108)
109	gr9	Very high load, humid climate grass (D) (109)
121	gs1	Low load, dry climate grass-shrub (D) (121)
122	gs2	Moderate load, dry climate grass-shrub (D) (122)
123	gs3	Moderate load, humid climate grass-shrub (D) (123)
124	gs4	High load, humid climate grass-shrub (D) (124)

Picture Help

Ok Clear Cancel

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Fuel Model



A fuel model is a set of numerical values that describe the fuel inputs for Rothermel's mathematical model that predicts surface fire spread.

There are 53 standard fire behavior fuel models including the original 13 described by Anderson (1982), plus the forty defined by Scott and Burgan (2004). Custom fuel models can be developed and saved for later use. Standard and custom fuel models can be used with one of the three options for calculating a weighted rate of spread through two fuel models. And there are special case fuel models that require different input: palmetto-gallberry (Hough and Albini 1978) and western aspen (Brown and Simmerman 1986).

I/O	Module	If	Notes
Input	SURFACE	If <i>Fuel is entered as fuel models or two fuel models</i> is selected as an input option.	If <i>Fuel is entered as fuel parameters</i> is selected as the input option, the assigned parameters can be saved as a custom fuel model.
Output	None		

Publications describing the standard fuel models with photographs are available on the BehavePlus publications page of www.firemodels.org.

- Anderson, H.E. (1982) Aids to determining fuel models for estimating fire behavior.
- Scott, J.H.; Burgan, R.E. (2005) Standard fire behavior fuel models: A comprehensive set for use with Rothermel's surface fire spread model.

A [fuel model key](#) for the 13 standard fuel models is taken from Rothermel, R.C. (1983) "How to Predict the Spread and Intensity of Forest and Range Fires."

BehavePlus 4.0.0 SURFACE Module Options

Fuel & Moisture | **Wind Speed** | Directions | Slope | Basic Outputs | Intermediates | Fuel Outputs | P-G Outputs | Aspen Outputs

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SURFACE Wind Speed Input Options

This page controls the SURFACE Module's wind speed options.

Options

Wind speed is entered as

midflame height.

20-ft wind and Input wind adj factor.

20-ft wind and Calculated wind adj factor.

10-m wind and Input wind adj factor.

10-m wind and Calculated wind adj factor.

Impose maximum reliable effective wind speed limit?

Yes

No

Picture Help

Wind speed is entered as....	
<i>midflame height.</i>	Wind speed at midflame height is entered on the worksheet.
<i>20-ft wind and Input wind adjustment factor.</i>	Wind speed at 20 feet above the vegetation and wind adjustment factor (WAF) are entered on the worksheet. WAF depends on sheltering of surface fuels from the wind, location on the terrain, and fuel model for exposed fuel. 20-ft wind * WAF = midflame wind.
<i>20-ft wind and Calculated wind adjustment factor.</i>	Wind speed at 20 feet above the vegetation is entered on the worksheet and the wind adjustment factor is calculated from overstory description and fuel model for exposed fuel. The calculations do not take location in the terrain or surrounding vegetation into account.
<i>10-m wind and Input wind adjustment factor.</i>	Wind speed at 10 meters above the vegetation and wind adjustment factor are entered on the worksheet. 10-m wind is reduced to 20-ft wind. The wind adjustment factor is applied to 20-ft wind to get midflame wind.
<i>10-m wind and</i>	Wind speed at 10 meters above the vegetation is entered on the worksheet

Ok Cancel

Attachment D: BehavePlus training material... will be on firemodels.org.

BehavePlus Training

BehavePlus training material has been updated and expanded as part of JFSP project 05-4-1-23. Work will continue with the support of Forest Service Fire and Aviation Management.

There is not a single BehavePlus “course”. The current lessons (and those under development) can be used singly or in combination to meet specific needs. Individuals and course coordinators can pick and choose lessons to support particular courses. For example,

- A single overview lesson can be used to present an overview of the BehavePlus fire modeling system at a Fire Management Officer meeting
- Several selected lessons can be used for a half-day demonstration and discussion workshop.
- The four basic operation lessons in the Introduction unit can be assigned as pre-work for a course that uses BehavePlus for fire behavior prediction.
- Selected lessons can be used by individuals as review of fire modeling concepts learned elsewhere.
- A course manager can select lessons for pre-work and for instructor-led hands-on training for a course suited to the background of the trainees and the application (e.g. prescribed fire planning).

Example course agendas are provided on this site. As course coordinators/instructors develop and teach courses, it would be helpful to have feedback on what did and did not work. Suggestions on courses can be posted on this web site and shared.

Contact: BehavePlus@firemodels.org

- [Table 1](#)— BehavePlus Training Material: Unit, Lesson, Status, Date of last change, and Download (zip file of lesson material)
- [Table 2](#)— BehavePlus Training Material: Unit (with description), Lesson, Objectives, Notes, and Download (files of each element of lesson material)
- [Table 3](#)— Supporting material (example course outlines, etc.)
- [Table 4](#)— Change log for BehavePlus training material and supporting material.

Lessons are organized according to Units:

- [Overview Unit](#)—General overview of BehavePlus
- [Introduction Unit](#)—Four required lessons that give the foundation for program operation
- [Operation Unit](#)—Optional lessons that cover various aspects of operation
- [Modeling Unit](#)—Modeling capabilities, limitations and assumptions, sensitivity
- [Application Unit](#)—Specific application examples

Tables 1 and 2 include lessons that are available, under development, and planned.

Training material will be added to this page as it becomes available. When there are significant updates, a notice will be sent out through the News system. Be sure to subscribe to receive these updates.

Table 1. BehavePlus training material

See [Table 2](#) for Unit descriptions, Lessons, Objectives, and specific material available for download.

See [Table 3](#) for a change log.

Unit	Lesson	Status	Date of last change	Download
Overview	1—BehavePlus Overview	Available	31-Mar-2008	zip
	2—BehavePlus Update	Under development	April 2008	
	3—Application of BehavePlus	Under development		
	4—Before You Start with Fire Modeling	Under development	April 2008	
	5—Modeling Capabilities	Available	31-Mar-2008	zip
	6—BehavePlus for Prescribed Fire	Available	31-Mar-2008	zip
Unit	Lesson	Status	Date of last change	Download
Introduction	1—Basic Start	Available	31-Mar-2008	zip
	2—Worksheets	Available	31-Mar-2008	zip
	3—Input Methods	Available	31-Mar-2008	zip
	4—Calculations	Available	31-Mar-2008	zip
Unit	Lesson	Status	Date of last change	Download
Operation	1—Help, more help and desperate for help	Available	31-Mar-2008	zip

	2—Features	Under development		
	3—Worksheets (advanced)	Under development		
	4—Independent vs. linked modules	Planned		
	5—BehavePlus results in written reports	Available	31-Mar-2008	zip
	6—File Management	Update in progress	2003 2007	zip
	7—Units and Decimals	Available	31-Mar-2008	zip
	8—Table Shading	Available	31-Mar-2008	zip
	9—Export to Spreadsheet	Planned		
Unit	Lesson	Status	Date of last change	Download
Modeling	1—Modeling Concepts	Planned		
	2—Surface Fire Spread and Intensity	Planned		
	3—Surface fuel	Under development		
	4—Fuel Models, Standard	Additional v4 updates in progress	2007	pdf
	5—Fuel Models, Custom	Additional v4 updates in progress	2007	pdf
	6—Fuel models, Custom (advanced)	Planned		
	5—Fuel Models, Dynamic	Planned		
	8—Two fuel models	Planned		
	9—Fuel Models, special case—Palmetto-Gallberry	Planned		

10—Fuel Models, special case—Aspen	Planned		
11—Dead Fuel Moisture	Planned		
12—Live Fuel Moisture	Planned		
13—Moisture Scenarios	Additional v4 updates in progress	2007	pdf
14—Slope	Planned		
15—Wind	Planned		
16—Wind adjustment factor	Additional v4 updates in progress	2007	pdf
17—Directions	Additional v4 updates in progress	2007	pdf
18—Overstory vegetation	Planned		
19—Crown Fire	Additional v4 updates in progress	2007	pdf
20—Safety zone size	Planned		
21—Scorch and Mortality	Planned		
22—Spotting and Ignition	Planned		
23—Size and Contain	Planned		
24—Map applications	Planned		

Table 2. BehavePlus training material.

(See [Table 1](#) for date of last change by Lesson and [Table 3](#) for change log.)

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Overview		Unit Description: ➤ Lessons in the Overview Unit address questions such as What is BehavePlus? What can it do? Does it suit your needs? Is there a need for you to continue with training to learn more? ➤ Some Overview lessons are optional. ➤ The course manager can select lessons to suit specific needs.		
Overview	1—BehavePlus Overview	1. Understand the relationship of BehavePlus to other fire behavior systems: FlamMap, FARSITE, and FSPro. 2. Understand the relationship of BEHAVE to BehavePlus. 3. See an overview of the fire modeling capabilities of BehavePlus 4. See brief thoughts on the future of BehavePlus		Lesson (ppt) Lesson (pps) Instructor guide (pdf) Handout: Andrews (2007) (pdf)

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Overview	2—BehavePlus Update	<ol style="list-style-type: none"> 1. Summary of changes from version 3 to version 4 2. Information available on www.firemodels.org 3. Register for News 		Handout: Version comparison (pdf)
Overview	3—Application of BehavePlus	<ol style="list-style-type: none"> 1. Examples of application of BehavePlus to various fire and land management activities 		
Overview	4—Before You Start with Fire Modeling	<ol style="list-style-type: none"> 1. What kind of information you should know 2. Where you find it 3. The relative role of models and user experience and judgment. 		
Overview	5—Modeling Capabilities	<ol style="list-style-type: none"> 1. Explore the nine different modules of BehavePlus. 2. Examine input options for each module. 3. Identify the outputs available from each module. 4. View the five stand-alone tools available in BehavePlus. 		Lesson (pdf) Instructor guide (doc)

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Overview	6—BehavePlus for Prescribed Fire	<ol style="list-style-type: none"> 1. Know the modeling capabilities of BehavePlus that can be applied to prescribed fire. 2. Be aware of the role of models and of experience. 3. Recognize that the user is responsible for proper application of models with all of their limitations. 4. See examples of the table shading option of BehavePlus which can be used to examine tradeoffs that lead to acceptable fire conditions. 		Lesson (ppt) Lesson (pps) Instructor guide (pdf)

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Introduction		Unit Description: <ul style="list-style-type: none"> ➤ The four lessons must be completed in order to develop basic skills in program operation. ➤ The lessons in the Introduction Unit are required. They are prerequisite lessons for the Operation, Modeling, and Applications Units. ➤ The focus of this unit is on program operation and not on modeling concepts. ➤ The lessons address button pushing, which is a small part of the BehavePlus skill set. ➤ These four lessons can be used as pre-work for an instructor led course 	Required lessons. Can be used as pre-work.	Self-study lessons 1-4 with exercises (zip)

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Introduction	1—Basic Start	<ol style="list-style-type: none"> 1. Enter values in a Worksheet. 2. View the information available in the help window. 3. Calculate a Run to produce tables and graphs. 4. Change inputs and produce new tables and graphs. 5. Use BehavePlus to examine the effect of fuel model, fuel moisture, wind, and slope on rate of spread and flame length. 		Lesson (pdf) Exercise Answers (pdf) Instructor guide (doc)
Introduction	2—Worksheets	<ol style="list-style-type: none"> 1. Know the program options that change the worksheet 2. Develop a new worksheet 3. Save a worksheet 4. Load a worksheet 		Lesson (pdf) Exercise Answers (pdf) Instructor guide (doc)
Introduction	3—Input Methods	<ol style="list-style-type: none"> 1. Learn the various ways to enter inputs on a worksheet. 2. Save a Worksheet with inputs as a Run. 		Lesson (pdf) Exercise Answers (pdf) Instructor guide (doc)

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Introduction	4—Calculations	<ol style="list-style-type: none"> 1. Produce results for single and multiple values for input variables 2. Understand differences in tables and graphs for continuous and discrete variables. 3. Learn to modify table and graph appearances through selection of row, column, and x-axis variables. 4. Be able to change graph and table appearance 		Lesson (pdf) Instructor guide (doc)

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Operation		Unit Description: <ul style="list-style-type: none"> ➤ The lessons in the Operations Unit go beyond those in the Introduction Unit and cover additional features offered by the program. ➤ Prerequisites are identified in each lesson. ➤ Many lessons are optional. ➤ A course manager or user can select from Operation lessons to meet specific needs. 		
Operation	1—Help, more help and desperate for help	1. Find help in BehavePlus: User’s Guide, Variables paper, and help windows.		Handout: Adobe Reader Settings (pdf)
Operation	2—Features	1. Demonstration of some of the useful features of the program	This could be used as an Overview lesson.	

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Operation	3—Worksheets (advanced)	<ol style="list-style-type: none"> 1. Develop and save worksheets with changes in modules, options, units, decimal display, and appearance options. 2. Define a worksheet as the startup worksheet 3. Open example worksheets that come with the program 	Prerequisite: Units and Decimals lesson.	
Operation	4—Independent vs. linked modules	<ol style="list-style-type: none"> 1. Demonstrate linked modules. 2. Compare linked and unlinked runs. 		
Operation	5—BehavePlus results in written reports	<ol style="list-style-type: none"> 1. Capture and paste 2. Good practices—include headings, input with output, etc. 		Lesson (pdf) Exercise Answers (pdf) Instructor guide (doc) Handout: B+ in reports (pdf)
Operation	6—File Management	<ol style="list-style-type: none"> 1. Understand file structure 2. Download run files from the web, where to put them 3. Workspaces 4. Documentation 		Lesson (pdf) Handout (pdf)

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Operation	7—Units and Decimals	<ol style="list-style-type: none"> 1. Switch between English and metric default units. 2. Change units and decimals and save as a custom units set. 3. Save a worksheet with custom units set. 4. Use the Units converter Tool to convert individual values. 		Lesson (pdf) Exercise Answers (pdf) Instructor guide (doc)
Operation	8—Table Shading	<ol style="list-style-type: none"> 1. Practice implementation of the table shading option in BehavePlus. 2. Define acceptable fire conditions within the program. 3. Produce and interpret tables with crossed out and blank values. 		Lesson (pdf) Exercise Answers (pdf) Instructor guide (doc)
Operation	9—Export to Spreadsheet	<ol style="list-style-type: none"> 1. Export results as an html file 2. Open the html file as a spreadsheet for further analysis 3. Save the file as a spreadsheet 		

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Modeling		<ul style="list-style-type: none"> ➤ Lessons in the Modeling Unit address various modeling capabilities of BehavePlus. ➤ Limitations and assumptions of the models are given. ➤ Relationships of input values to results are shown. ➤ These lessons assume that the trainee has skills with program operation. 		
Modeling	1—Modeling Concepts	<ol style="list-style-type: none"> 1. Review of the mathematical models that form the basis of BehavePlus 2. See how models are combined to form a system 3. Relationship of mathematical models to BehavePlus modules 		
Modeling	2—Surface Fire Spread and Intensity	<ol style="list-style-type: none"> 1. Assumptions and limitations of Rothermel’s surface fire spread model 2. Calculations using the SURFACE module 3. Overview of the inputs of fuel, fuel moisture, wind speed, and slope. 		

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Modeling	3—Surface fuel	1. Overview of methods of describing surface fuel—53 standard fuel models (13 + 40), custom fuel models, dynamic fuel models, two fuel model weighting options, and two special case fuel models.	Introduction to the following seven surface fuel lessons	
Modeling	4—Fuel Models, Standard	1. Definition of a fuel model 2. Review of the original 13 fuel models 3. Reason for development of the 40 fuel models 4. Use BehavePlus to compare fuel models		Lesson (pdf)
Modeling	5—Fuel Models, Custom	1. Development of custom fuel models 2. Examine ranges of fuel model parameters 3. Discuss reasons for developing custom fuel models		Lesson (pdf)
Modeling	6—Fuel models, Custom (advanced)	1. Make use of the intermediate output variables in SURFACE to develop and test custom fuel models		
Modeling	7—Fuel Models, Dynamic	1. Definition of ‘dynamic’ fuel models 2. Load transfer function 3. Direct entry of curing level		

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Modeling	8—Two fuel models	<ol style="list-style-type: none"> 1. Proper application of weighting of two fuel models 2. Three methods of two fuel model weighting 		
Modeling	9—Fuel Models, special case—Palmetto-Gallberry	<ol style="list-style-type: none"> 1. Understand the difference between a ‘special case’ fuel model and standard and custom fuel models. 2. Input values for the P-G fuel model 3. Output variables for the P-G model 		
Modeling	10—Fuel Models, special case—Aspen	<ol style="list-style-type: none"> 1. Understand the difference between a ‘special case’ fuel model and standard and custom fuel models. 2. Input values for the western Aspen fuel model 3. Output variables for the western Aspen model 4. Calculation of aspen mortality 5. Aspen curing level compared to curing level for dynamic fuel models 		
Modeling	11—Dead Fuel Moisture	<ol style="list-style-type: none"> 1. Relative influence of 1-h, 10-h, and 100-h dead fuel moisture 2. Characteristic dead fuel moisture 3. Using the live and dead fuel moisture input option 4. Fine dead fuel moisture table 		

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Modeling	12—Live Fuel Moisture	<ol style="list-style-type: none"> 1. Role of live fuel moisture in the surface fire spread model 2. Effect of live herbaceous fuel moisture in dynamic fuel models 3. Guidelines for live fuel moisture according to Rothermel (1983) compared to curing level guidelines 4. Foliar moisture for crown fire modeling 		
Modeling	13—Moisture Scenarios	<ol style="list-style-type: none"> 1. Definition and application of a moisture scenario 2. Developing and saving moisture scenarios in BehavePlus 3. Moisture scenarios used to develop the 40 standard fuel models 		Lesson (pdf)
Modeling	14—Slope	<ol style="list-style-type: none"> 1. Effect of slope on surface fire spread 2. Why slope steepness is not used in the calculation of crown fire spread rate 3. Calculation of slope steepness from map measurements 4. Calculation of horizontal map distance from ground map distance and direction with respect to upslope 		

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Modeling	15--Wind	<ol style="list-style-type: none"> 1. Effect of wind on surface rate of spread 2. 20-ft wind, 10-m wind, and midflame wind 3. Maximum reliable wind speed 4. Variation of wind speed and gusts 		
Modeling	16—Wind adjustment factor	<ol style="list-style-type: none"> 1. Assignment of wind adjustment factor 2. Calculation of wind adjustment factor 3. Value of estimation vs. calculation 		Lesson (pdf)
Modeling	17—Directions	<ol style="list-style-type: none"> 1. Options on specifying wind/slope/spread directions 2. Application of direction with respect to upslope and direction of the wind vector 3. Application of direction with respect to North and wind direction as the direction from which the wind is blowing 		Lesson (pdf)
Modeling	18—Overstory vegetation	<ol style="list-style-type: none"> 1. Variables that describe the overstory in BehavePlus 2. Review of the role of overstory variables in various modules 3. Stand vs. tree descriptions 4. Reality vs. models 		

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Modeling	19—Crown Fire	<ol style="list-style-type: none"> 1. Transition from surface to crown fire 2. Crown fire spread, area, perimeter 3. Active crown fire 4. Fire type 		Lesson (pdf)
Modeling	20—Safety zone size	<ol style="list-style-type: none"> 1. Definition of safety zone size 2. Calculation for surface fire and for crown fire 		
Modeling	21—Scorch and Mortality	<ol style="list-style-type: none"> 1. Scorch height from surface fire 2. Role of wind in flame length calculation and in flame tilt 3. Tree mortality from crown scorch 4. Mortality calculations 5. Bark thickness estimation 		
Modeling	22—Spotting and Ignition	<ol style="list-style-type: none"> 1. Spotting distance from torching trees, burning piles, or wind-driven surface fire 2. Probability of ignition from a firebrand 3. Probability of ignition from lightning 		
Modeling	23—Size and Contain	<ol style="list-style-type: none"> 1. Size and shape of a point source fire 2. How the containment model works, using diagrams for understanding 3. Appropriate application 		

Unit	Lesson	Unit Description & Lesson Objective	Notes	Download
Modeling	24—Map applications	<ol style="list-style-type: none"> 1. Converting distance to map distances 2. Calculating slope from map measurements 3. Wind direction 4. Aspect 		

Table 3. Supporting material

Document	Notes	Date of last change	Download
How to set Acrobat Reader	How to set your reader to show the previous and next view buttons, which is very important for effective use of the User's Guide and the Variables paper.		pdf
Example pre-work instructions	Example guidance to trainee who is asked to do pre-work for a course. To be edited by the course coordinator.		doc
Example workshop introduction	Example introduction of workshop topics, presentation and Instructor Guide To be edited by the presenter.		ppt pdf
Example course agendas	These are examples that include some lessons that are still under development. Check back for updates.		doc
Certificate of completion	There is not a formal standard for acceptable completion of BehavePlus training. This certificate can be used at the discretion of a course manager. (Or a self-study person can present it to her or himself.)		doc pdf

Table 4. Change Log for BehavePlus Training Material

(See [Table 1](#) for date of last change by Lesson and [Table 3](#) for date of last change for Supporting material.)

[Example entries to demonstrate use of the table]

Date	Category	Change	Changed by
15-May-2008	Introduction Lesson 4—Calculations	Exercises added.	PA
15-May-2008	Overview Lesson 2—BehavePlus Update	All lesson material added	PA
10-May-2008	Operation Lesson 7—Units and Decimals	Minor correction to a screen capture in the lesson and instructor guide	TK
10-May-2008	Supporting material	Another example workshop agenda added	TK