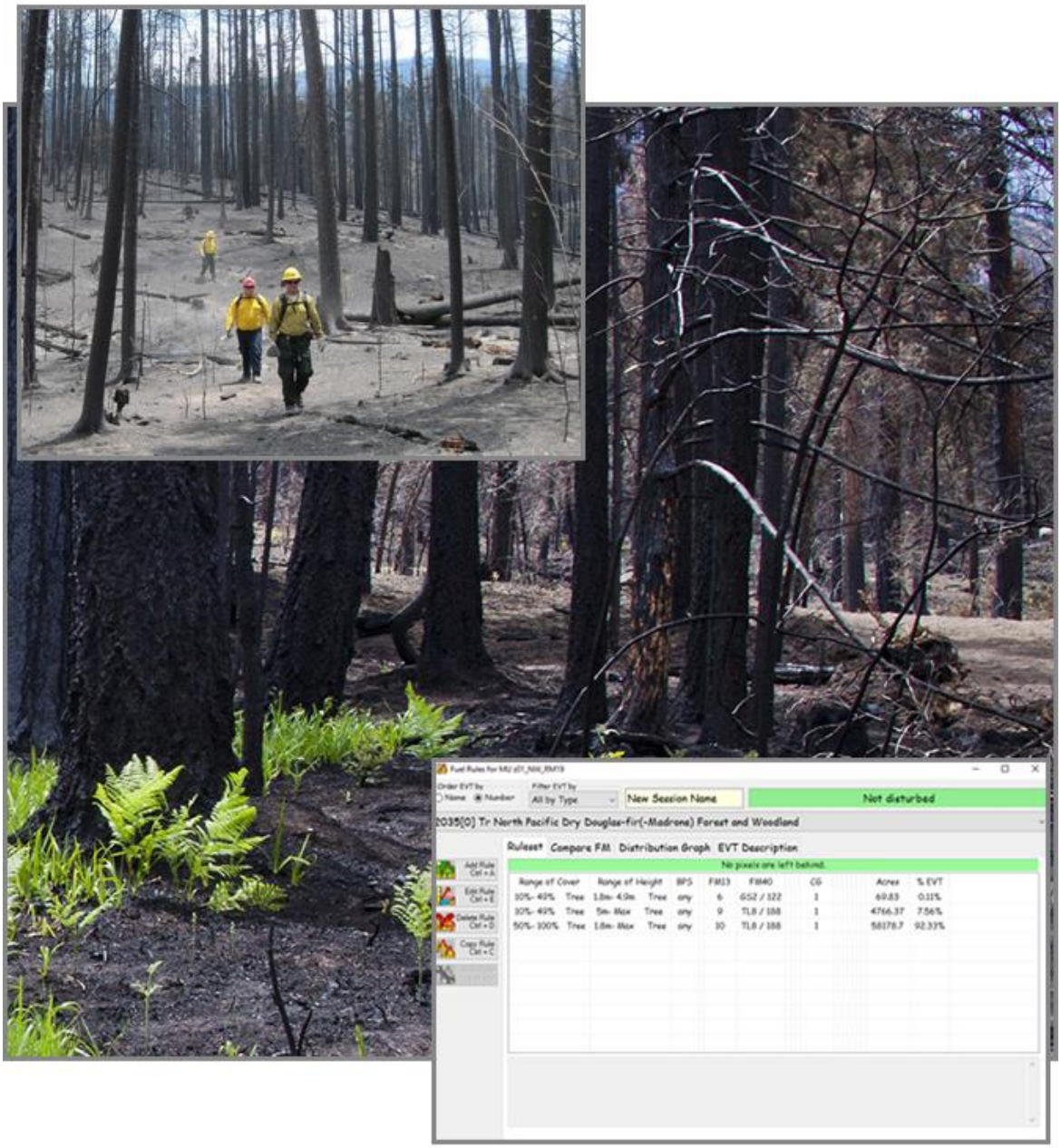
The LANDFIRE Total Fuel Change Tool (LFTFC) User Guide

Version 3.19, for ArcMap 10.2 to 10.7

June 2020



Preface

Landscape Fire and Resource Management Planning Tools (LANDFIRE) fuel data were originally developed from coarse-scale existing vegetation type, existing vegetation cover, existing vegetation height, and biophysical setting layers. Fire and fuel specialists from across the country provided input to the original LANDFIRE (LF) National (LF_1.0.0) fuel layers to help calibrate fuel characteristics on a more localized scale. The LF Total Fuel Change Tool (LFTFC) was developed from this calibration process.

Vegetation is subject to constant change and fuels are therefore also dynamic, necessitating a systematic method for reflecting changes spatially so that fire behavior can be accurately accessed. LFTFC allows local experts to quickly produce maps that spatially display any proposed fuel characteristics changes.

Just as fuel beds are dynamic across time and space, the process for developing the fuels layers for the LF Program has gone through significant changes since the LF National fuels layers were developed. This processing change has affected the way the required input data and processing format of the LFTFC Toolbar has evolved. The LFTFC Toolbar works through a Microsoft Access database to produce spatial results in ArcMap based on rulesets devised by the user. With the development of LF Remap, the users now construct fuel rulesets based on Fuel Vegetation Type (FVT), Fuel Vegetation Cover (FVC), Fuel Vegetation Height (FVH), Disturbance (Dist), and Biophysical Settings (BpS) from LF grid data. There are also options within LFTFC to add discrete variables in grid format through use of the wildcard option and for subdividing specific areas for different fuel characteristic assignments through the BpS grid.

The LFTFC user determines the size of the area for assessment by defining a Management Unit, or "MU." User-defined rulesets made up of FVT, FVC, FVH, Dist, and BpS layers, as well as any wildcard selections, are used to change or refine fuel characteristics within the MU. Once these changes have been made to the fuel characteristics, new grids are created for fire behavior analysis or planning. These grids represent the most common LFTFC output.

LFTFC is currently under development and will continue to be updated in the future.

Prerequisites

LFTFC is compatible with ArcGIS 10.2 to 10.7. When installed, the software will create a toolbar within ArcMap to access the spatial features of the program. Users need to be familiar with ArcGIS. More importantly, users must have a good understanding of fire behavior and effects, as well as knowledge pertaining to fuels (such as fuel loading models and fire behavior fuel models), weather, topography, and wildland fire situations. Users should also understand the relationships between disturbance,

vegetation attributes, and fuel characteristics. This knowledge should be accompanied by the ability to use non-spatial fire behavior and effects prediction systems such as BehavePlus, NEXUS, and FOFEM.

Specific computer requirements are described in detail in Chapter 1: About the LFTFC User Guide.

Obtaining copies

To obtain the latest version of LFTFC, additional copies of the LFTFC User Guide, and the LFTFC Tutorial, go to the LF website at https://www.landfire.gov/download_lfdat.php#lftfct

Credits

The beta version of LFTFC was developed and is maintained by the LF Fuels Team: Tobin Smail[1], developer/programmer, Charley Martin[1], and Jim Napoli[1], user interface and function testing.[2, 3]

- *[1]KBR, Inc., contractor to the United States Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center, Sioux Falls, SD. Work performed under contract G10PC00012.*
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Your input

We value your input. Please forward any questions, comments, reports of bugs or ideas to the LF Help Desk at helpdesk@landfire.gov

Helpful links

LANDFIRE Website: https://www.landfire.gov

Data Distribution Site: https//www.landfire.gov/viewer

LANDFIRE Data Access Tool Download: https://www.landfire.gov/datatool.php

LANDFIRE Total Fuel Change Tool Download: https://landfire.gov/download_lfdat.php#lftfct

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Chapter 1: About the LFTFC User Guide

1.1 Before you begin
1.2 How to use this guide
1.3 Computer requirements

1.1 Before you begin

This user guide describes the basic operation of the LANDFIRE (LF) Total Fuel Change Tool (LFTFC), which is used to edit surface and canopy fuel characteristics on a specific site or on large landscapes to support fire and fuels analysis.

Prior to using the tool, LFTFC users must be familiar with Microsoft Windows and basic ArcGIS functions.

1.2 How to use this guide

It is not necessary to read the entire guide to carry out a specific task. Once you are familiar with the basic concepts associated with LFTFC, you can quickly locate commonly performed tasks by reviewing the headings in the Table of Contents. You can then refer to the specific section pertaining to your needs. Whenever possible, screen captures are used to illustrate steps required to complete a task.

The LFTFC User Guide is not intended to provide step-by-step guidance on the tool's operation; rather, its intention is to serve as a reference guide. The LFTFC Tutorial provides basic step-by-step instructions using a specific management scenario as an example.

1.3 Computer requirements

Ensure the following programs are installed and functioning properly on your computer: This has been tested with 10.1 - 10.7 Arc Map, and presumably more recent versions.

- Spatial Analyst extension
- Microsoft Access

  Note: *Ensure that you have enough space and adequate permissions for storing LFTFC outputs on your computer.*

  Note*: Although not required, ArcCatalog is a highly valuable tool for managing and organizing ArcMap data layers and should be used for all data manipulation such as copying, pasting, renaming, and deleting.*

Chapter 2: LFTFC Function

2.1 How LFTFC operates
2.2 Applications

2.1 How LFTFC operates

LFTFC works through a Microsoft Access database to produce spatial results in ArcMap based on rulesets devised by the user. These rulesets principally take into account the FVT, FVC, FVH, fuel disturbance, and biophysical setting (BpS) from the LF grid data. There are also options within the fuel change tool to add discrete variables in grid format through use of the wildcard option or by subdividing specific areas for different fuel characteristic assignments through the BpS grid.

LFTFC adheres to landscape data file standards for use with FARSITE, FlamMap, WFDSS, FSPRO, and other fire behavior / fire effects programs.

2.2 Applications

LFTFC has numerous and diverse potential management applications. Fire and fuels managers can use LFTFC for planning purposes, fire behavior analysts can use the tool on actual incidents, and GIS analysts can use it to update national data sets. It can be used to edit surface and canopy fuel characteristics on a specific site at a local scale or across large landscapes used in fire and fuels analysis at a national scale. Specifically, LFTFC can be used to:

- Create Canopy Base Height, Canopy Bulk Density, Canadian Fire Behavior Prediction System Fuel Models, 13 Fire Behavior Fuel Model (Anderson 1982), 40 Fire Behavior Fuel Model (Scott and Burgan 2005), and GIS GRID layers
- Analyze and validate GIS fire behavior outputs
- Help perform routine and recurring database management operations to allow for progressive manipulation of fuels data during planning efforts, fire incidents, and LF fuel calibration
- Display and describe vegetation, ecological processes, and how the data are incorporated into final spatial products
- Capture local expertise from a wide range of specialists on fire behavior and fire effects and distribute these data spatially

Chapter 3: Inputs

3.1 Required input data
- 3.1.1 Biophysical Settings Models and Descriptions (BpS) layer
- 3.1.2 Fuel Vegetation Type (FVT) layer
- 3.1.3 Fuel Vegetation Cover (FVC) layer
- 3.1.4 Fuel Vegetation Height (FVH) layer
- 3.1.5 Fuel Disturbance (FDist)

3.2 Optional input data
- 3.2.1 Wildcard
- 3.2.2 Elevation
- 3.2.3 Slope
- 3.2.4 Aspect

3.3 Other data
- 3.3.1 Fire Behavior Fuel Models (FBFM)
- 3.3.2 Canopy Base Height (CBH)
- 3.3.3 Canopy Bulk Density (CBD)
- 3.3.4 Canopy Cover (CC)
- 3.3.5 Canopy Height (CH)

3.4 Concepts of ruleset development for fuel characteristics
- 3.4.1 Fire Behavior Fuel Model assignments in LF National data
- 3.4.2 Canopy guide toggle
- 3.4.3 Assigning canopy characteristics

3.1 Required input data

The Management Unit (MU) serves as the basic building block for changing fuel characteristics in a particular area. The extent of the MU is defined by the user and can be designated by using coordinates or the intersection of the input grid layers. Five separate LF data sets are required to build a MU and run LFTFC: FVT, FVC, FVH, Fuel Disturbance (FDist) and BpS.

For development and processing within the LF Program, map zones were used as the standard area for analysis. The default data set was processed by LF map zones and consequently, rulesets for fuels characteristics that are within the default are set at that extent. The grid layers of FVT FVC, FVH, FDist and BpS (all set to the extent of each LF map zone) were combined for processing.

The five required grids FVT, FVC, FVH, FDist and BpS must be downloaded from the LF Data Distribution Site (DDS). For additional information on accessing and downloading data, see Chapter 4: Obtaining Input Data from the LF Data Distribution Site.

> ***Note:*** *Because LFTFC was developed to process LF data, the classifications of FVT, FVC, FVH, FDist, BpS, and FDist are embedded in the tool's nomenclature; therefore, other data sets with different classification systems cannot be used.*

These layers are described briefly below. For additional information on these required input items, consult the LF website.

3.1.1 Biophysical Settings Models and Descriptions (BpS) layer

The Biophysical Settings (BPS) spatial product represents vegetation that may have been dominant on the landscape prior to Euro-American settlement. It is based on both the current biophysical environment and an approximation of the historical disturbance regime. Biophysical Settings Models and Descriptions (BpS) models are a refinement of the Environmental Site Potential (ESP) product in that current scientific knowledge regarding the functioning of ecological processes (such as fire) in the centuries preceding non-indigenous human influence is leveraged. Map units are based on NatureServe's Ecological Systems classification, which is a nationally consistent set of mid-scale ecological units (Comer and others 2003). Because LF BPS map units represent the natural plant communities that may have been present during the reference period they should not be treated as units of existing vegetation. Each BPS map unit is matched with a model of vegetation succession, and both serve as key inputs to the LANDSUM landscape succession model (Keane and others 2002). The LF BPS product is similar in concept to potential natural vegetation group layers produced in conjunction with fire regime condition class (Schmidt and others 2002) during LF National. The BPS spatial product is used in LF to spatially depict reference conditions of vegetation across landscapes. The actual period for this data set is a composite of both the historical context provided by the fire regime and vegetation dynamics models and the more recent field and geospatial inputs used to create it. The weather data used in DAYMET were compiled from 1980 to 1997. BPS is unchanged from LF Nationals BPS except for updates made to water, barren, and snow classes (additions or removal), so that not vegetated cover types within the spatial BPS product matches LF existing vegetation and fuel products. An example value attribute table for a BpS layer is shown below (Figure 3-1).

Attributes of bps

Rowid	VALUE *	COUNT	BPS_CODE	ZONE	BPS_MODEL	BPS_NAME
0	11	8464	0			Water
1	12	12	0			Snow/Ice
2	31	207982	0			Barren
3	101	40	10010	16	1610010	Inter-Mountain Basins Sparsely Vegetated Systems
4	102	1026	10060	16	1610060	Rocky Mountain Alpine/Montane Sparsely Vegetated Systems
5	103	229191	10110	16	1610110	Rocky Mountain Aspen Forest and Woodland
6	104	9773	10120	16	1610120	Rocky Mountain Bigtooth Maple Ravine Woodland
7	105	1231503	10160	16	1610160	Colorado Plateau Pinyon-Juniper Woodland
8	106	501643	10190	16	1610190	Great Basin Pinyon-Juniper Woodland
9	107	302	10200	16	1610200	Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland
10	108	2750	10500	16	1610500	Rocky Mountain Lodgepole Pine Forest

Record: 1 Show: All Selected Records (0 out of 42 Selected) Options

Figure 3.1. *The attribute BpS_model in the Value Attribute Table from a BpS layer.*

Tip: To view an example attribute table, open ArcMap and right click on any desired layer in the Table of Contents. Select Open Attribute Table from the menu options

3.1.2 Fuel Vegetation Type (FVT) layer

LF fuels vegetation products describe the elements of fuels vegetation for each LF vegetation production unit. FVT represents a modified version of Existing Vegetation Type (EVT) and more accurately leverages fuel transition assignments related to disturbed areas by re-establishing pre-disturbance vegetation. Linking disturbed areas to pre-disturbance EVTs allows fuel model transition

assignments to properly align with logic developed from Fuels Calibration Workshops, giving more accurate representations during fire behavior analysis.

FVT was developed using the full suite of LF vegetation releases and the most recent 10 years of Annual Disturbance products. The FVT product was then evaluated through a series of QA/QC measures ensuring lifeform of the vegetation type assignment matches the lifeform of associated FVT layers.

A significant refinement to the LF Remap process for FVT and other fuel products was adopted to more accurately represent vegetation within disturbed areas for fuels use, allowing LF Remap to provide "capable fuels" products. What this means is that the Time Since Disturbance (TSD) assignments for disturbed areas have been calculated using an effective year. Year 2019 fuels, for example, may be calculated for the year 2019. This new process considers all the existing disturbances included in LF Remap and adjusts the TSD for these to the effective year (2019 in this example), making the products "2019 capable fuels."

By synchronizing TSDs for surface and canopy fuels, these refinements improve performance of fire behavior modeling and reduce the need for local LF users to update the vegetation and fuel conditions to represent current conditions when using the data operationally. LF Remap fuel products in areas mapped as disturbed within the past 10 years are delivered with this "capable fuels" functionality. LF uses FVT in the development of fuel products.

3.1.3 Fuel Vegetation Cover (FVC) layer

LF fuels vegetation products describe the elements of fuels vegetation for each LF vegetation production unit. FVC represents a modified version of Existing Vegetation Cover (EVC). LF Remap EVC is mapped as continuous estimates of canopy cover for tree, shrub, and herbaceous lifeforms with a potential range from 0-100 percent. To translate continuous EVC values into fuel model assignments, EVC values were binned to correspond with the bins for previous LF versions.

FVC was developed using the full suite of LF vegetation releases and the most recent 10 years of disturbance data. FVC more accurately leverages fuel transition assignments related to disturbed areas to properly align with logic developed from Fuels Calibration Workshops.

A significant refinement to the LF Remap process for FVC and other fuel products was adopted to more accurately represent vegetation within disturbed areas for fuels use, allowing LF Remap to provide "capable fuels" products. This means that the TSD assignments for disturbed areas have been calculated using an effective year. For example, year 2019 fuels may be calculated for the year 2019. This new process considers all the existing disturbances included in LF Remap and adjusts the TSD for these to the effective year (2019 in this example), making the products "2019 capable fuels."

By synchronizing TSDs for surface and canopy fuels, these refinements improve performance of fire behavior modeling and reduce the need for local LF users to update the vegetation and fuel conditions to represent current conditions when using the data operationally. LF Remap fuel products in areas mapped as disturbed within the past 10 years are delivered with this "capable fuels" functionality. LF uses FVC in the development of fuel products. See Appendix B: LF Canopy Cover and Height Classification for additional information.

3.1.4 Fuel Vegetation Height (FVH) layer

LF fuels vegetation products describe the elements of fuels vegetation for each LF vegetation production unit. FVH represents a modified version of Existing Vegetation Height (EVH) and is mapped as continuous estimates of canopy height for tree, shrub, and herbaceous lifeforms. To translate continuous EVH values into fuel model assignments, EVH values were binned to correspond with the bins for previous LF versions.

FVH was developed using the full suite of LF vegetation releases and the most recent 10 years of disturbance data. FVH more accurately leverages fuel transition assignments related to disturbed areas to properly align with logic developed from Fuels Calibration Workshops.

A significant refinement to the LF Remap process for FVH and other fuel products was adopted to more accurately represent vegetation within disturbed areas for fuels use, allowing LF Remap to provide "capable fuels" products. This means that the TSD assignments for disturbed areas have been calculated using an effective year. For example, year 2019 fuels may be calculated for the year 2019. This new process considers all the existing disturbances included in LF Remap and adjusts the TSD for these to the effective year (2019 in this example), making the products "2019 capable fuels."

By synchronizing TSDs for surface and canopy fuels, these refinements improve performance of fire behavior modeling and reduce the need for local LF users to update the vegetation and fuel conditions to represent current conditions when using the data operationally. LF Remap fuel products in areas mapped as disturbed within the past 10 years are delivered with this "capable fuels" functionality. LF uses FVH in the development of fuel products. See Appendix B: LF Canopy Cover and Height Classification for additional information.

3.1.5 Fuel Disturbance (FDist) layer

LF disturbance products are developed to provide temporal and spatial information related to landscape change. Fuel Disturbance (FDist) uses the latest 10 years of Annual Disturbance products representing disturbance year and original disturbance code. FDist was a refinement of Vegetation Disturbance (VDist) in LF 1.x products and is a refinement of Historical Disturbance (HDist) in LF Remap to more accurately represent disturbance scenarios within the fuels' environment. FDist development involves a comprehensive review of disturbance attributes.

A significant refinement to the LF Remap process that more accurately represents vegetation within disturbed areas for fuels use was adopted, allowing LF Remap to provide "capable fuels" products. This means that the TSD assignments for disturbed areas have been calculated using an effective year. For example, year 2019 fuels may be calculated for the year 2019. This new process considers all the existing disturbances included in LF Remap and adjusts the TSD for these to the effective year (2019 in this example), making the products "2019 capable fuels."

By synchronizing TSDs for surface and canopy fuels, these refinements improve performance of fire behavior modeling and reduce the need for local LF users to update the vegetation and fuel conditions to represent current conditions when using the data operationally. LF Remap fuel products in areas mapped as disturbed within the past 10 years are delivered with this "capable fuels" functionality.

Disturbances older than 10 years follow the existing LF protocol for removal from FDist and are represented by more recent non-disturbed LF Remap vegetation c2016. All non-disturbed fuel is based

on LF Remap, which is the newest fuel vegetation available. LF uses FDist in the development of Fuels products.

3.2 Optional input data

3.2.1 Wildcard

Wildcard inputs to LFTFC can include prepared fuel raster data such as fuel model or canopy attributes. Often, grids built and processed through the tool are brought into a combine with FVT, FVC, FVH, FDist, and BpS after changes have been made to those layers in order to set the fuel data. Any other grid data that may influence the fuel type within an EVT may also be used. For example, elevation may be used to differentiate lowland fuel models as opposed to upland areas in the same EVT. Aspect and slope can be included as wildcard data.

3.2.2 Elevation

The elevation layer represents meters or feet above sea level, and zero values are used for those areas that are at or below sea level (Figure 3-2).

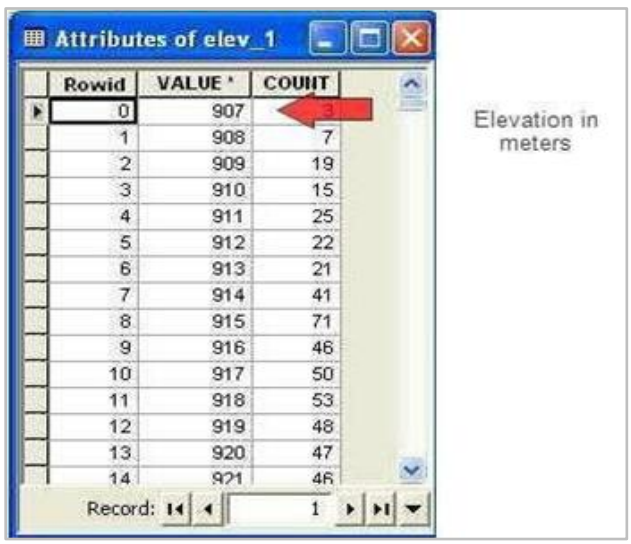


Figure 3-2. *Example of a value attribute table of an elevation layer. The Value field must depict elevation in meters or feet above sea level.*

3.2.3 Slope

The slope layer has cell values represented by integers, and the units may be expressed in either degrees or percent (Figure 3-3).

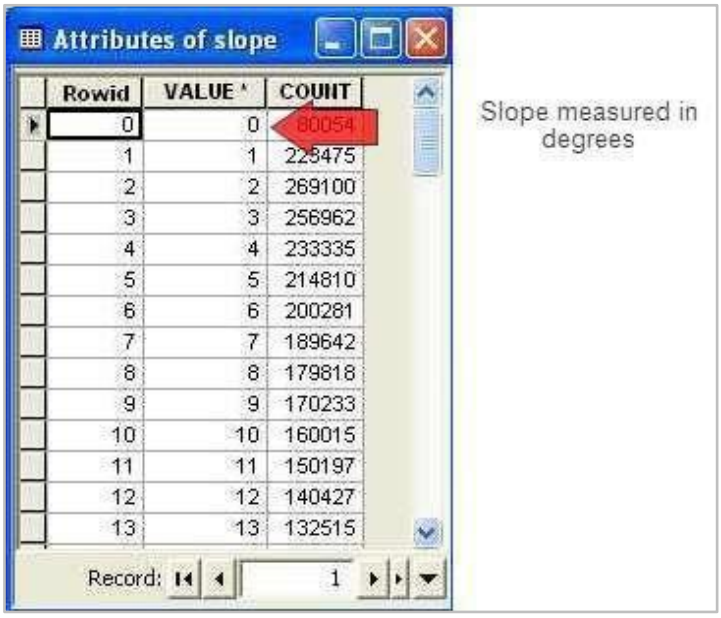


Figure 3-3. *Example of a value attribute table of a slope layer. The Value field must show slope in degrees.*

3.2.4 Aspect

The aspect layer must denote slope azimuth in degrees clockwise from the north. Cell values are represented by integers. Flat areas that lack an aspect are identified by a value of -1 (Figure 3-4).

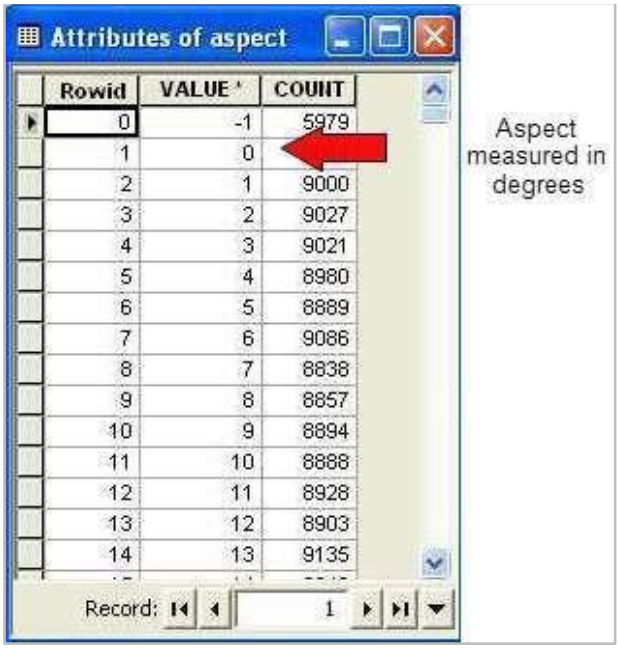


Figure 3-4. *Example of a value attribute table of an aspect layer. The Value field must depict aspect in degrees. (A value of -1 denotes flat areas that have no aspect.)*

> ***Note****: Integers are used for memory and processing efficiency in LF data, rather than floating point grids.*

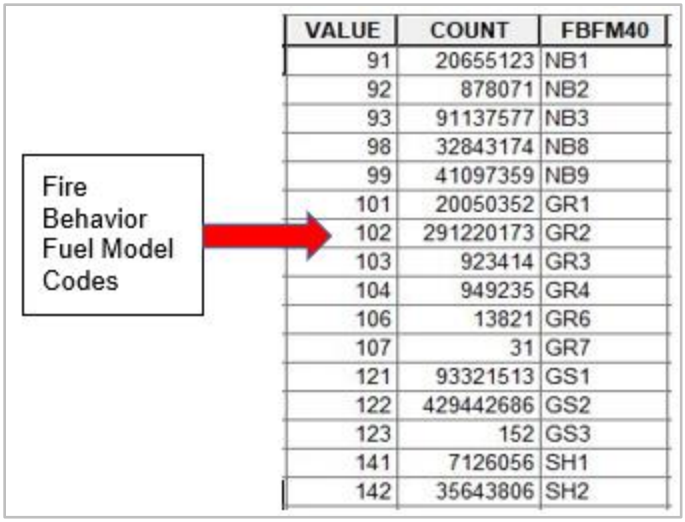
3.3 3 Other data

LF calibration data are in the default Microsoft Access database (.mdb) within the program. Copying (or creating a grid and using "auto rule") will give the user the starting rulesets developed for the FVTs within their desired map zone. This provides a starting point for any further editing or adding any additional rules. More specifically, it provides the means for addressing rules through biophysical settings.

Note: *Users should be familiar with the LF zone numbers for their selected map areas.*

3.3.1 Fire Behavior Fuel Models (FBFM)

LFTFC uses either the FBFM13 characterized by Anderson (1982) or the FBFM40 characterized by Scott and Burgan (2005). Cells must contain integers denoting the numeric codes of Anderson's (1982) models (values: 1 to 13) or the Scott and Burgan (2005) models (values: 91 to 204). Non-burnable fuels must be denoted by values 91, 92, 93, 98, and 99, which characterize urban/developed, snow/ice, agriculture, water, and bare ground, respectively (Figure 3-5).



VALUE	COUNT	FBFM40
91	20655123	NB1
92	878071	NB2
93	91137577	NB3
98	32843174	NB8
99	41097359	NB9
101	20050352	GR1
102	291220173	GR2
103	923414	GR3
104	949235	GR4
106	13821	GR6
107	31	GR7
121	93321513	GS1
122	429442686	GS2
123	152	GS3
141	7126056	SH1
142	35643806	SH2

Figure 3-5. *Example of a value attribute table for a FBFM40 layer (Scott and Burgan 2005). The Value field (FBFM codes) must correspond to the numeric FBFM codes of Anderson (1982) or Scott and Burgan (2005).*

3.3.2 Canopy Base Height (CBH)

CBH is a stand attribute that denotes the lowest height above the ground that has enough canopy fuel to propagate fire vertically. The CBH layer is necessary for determining the transition from a surface fire to a crown fire. Typically, lower canopy base heights increase the likelihood of torching (in other words, lower heights increase the likelihood of passive crown fires). The tool requires the CBH layer units to be in meters*10 (Figure 3-6), meters, feet*10, or feet. A cell value of 0 characterizes a non-forested setting. Integers are used in LF data due to memory and processing efficiency. The operations, meters * 100, and meters * 10 are used to keep numbers expressed as integers. CBH is continuous data in 1/10 of meter increments to 10 meters. All values above 10 meters are grouped into >10 class (value for 10 meters is 100).

Canopy Base Height measured as meters *10

VALUE	COUNT	CBH_M_X_10
0	33602786	Non-Forested
3	9365706	
4	1353434	
5	2765218	
6	2002450	
7	3033408	
8	2972077	
9	3282696	
10	1800547	
11	1421932	
12	2255477	

Figure 3-6. *Example of a value attribute table for a CBH layer. In this example, the Value field depicts heights expressed in meters*10. Thus, a cell value of 12 corresponds to a 1.2-meter canopy base height. This coding structure is the LF Remap standard.*

3.3.3 Canopy Bulk Density (CBD)

CBD is a stand attribute that refers to the weight (mass) of "available" canopy fuel, both dead and live, per unit volume of canopy. Available canopy fuel is of a size and type that would be consumed in the flaming front. FARSITE and FlamMap use CBD to determine the transition between passive and active crown fire. (See Scott and Reinhardt [2001] for a discussion on the derivation of crown fire activity.) The tool requires the units of the CBD layer to be expressed in kg/m^3 *100 (Figure 3-7), kg/m^3, lb/ft^3*1,000, or lb/ft^3. Cell values are represented by integers.

Canopy Bulk Density in kg/m^3*100

VALUE	COUNT	CBD_KGM3_X
0	33602786	Non-Forested
1	7594293	
2	35361	
3	346669	
4	827934	
5	695853	
6	7237461	
8	6512306	
9	2579106	
11	6630742	
12	2993944	
16	17142536	
17	755519	
22	18211583	
24	556252	
30	4019214	
31	352	
34	827964	
42	531	
45	460427	CBD > =45

Figure 3-7. *Example value attribute table for a CBD layer. In this example, the Value field depicts canopy bulk density in kg/m^3 *100. Thus, a cell value of 22 corresponds to a 0.22 kgm^3 canopy bulk density. A value of 0 identifies a non-forested area.*

3.3.4 Canopy Cover (CC)

CC is a stand attribute that corresponds to the proportion of the ground that is covered directly overhead by the overstory canopy (that is, the vertical projection of the canopy to the ground). The CC

layer is used to compute the wind reduction factor attributable to the canopy and the subsequent wind speed at the mid-flame height. The CC layer is also used to modify solar radiance with the fuel conditioning function of FlamMap and FARSITE. The tool requires that the CC layer be expressed in percent (Figure 3- 8). A cell value of 0 indicates a non-forested setting. The cell values are denoted by integers.

Canopy Cover measured in percent

VALUE	COUNT	CC_PERCENT
0	33602786	Non-Forested
15	602080	Tree Cover >= 10 and < 20%
25	2233571	Tree Cover >= 20 and < 30%
35	8016033	Tree Cover >= 30 and < 40%
45	11212487	Tree Cover >= 40 and < 50%
55	9846972	Tree Cover >= 50 and < 60%
65	15168023	Tree Cover >= 60 and < 70%
75	24674085	Tree Cover >= 70 and < 80%
85	5673897	Tree Cover >= 80 and < 90%
95	899	Tree Cover >= 90 and <= 100%

Figure 3-8. *Example Value Attribute Table for a CC layer. The value field denotes CC in percent. A value of 0 indicates a non- forested setting. In this example, CC has been grouped into 10 classes in which the cell value corresponds to the class mid-point. Thus, a cell value of 15 represents a CC class with values ranging from 10 to 20 percent.*

3.3.5 Canopy Height (CH)

CH is a stand attribute that reflects the average height of the overstory dominant and co-dominant in a stand. The CH layer along with the CC layer is used to compute the wind reduction factor attributable to the canopy and the subsequent wind speed at the mid-flame height. In FARSITE, the CH layer is also used for estimating spotting distances from torching trees. The tool requires the CH layer units to be in meters*10 (Figure 3-9). A cell value of 0 indicates a non-forested setting. The cell values can be denoted by either floating point numbers (decimals) or integers.

Canopy height measured as meters *10

VALUE	COUNT	CH_M_X_10
0	33602786	Non-Forested
30	1292135	Forest Height 1.8 to 5 meters
70	2690215	Forest Height 5 to 9 meters
110	3746909	Forest Height 9 to 13 meters
150	8361967	Forest Height 13 to 17 meters
190	17457970	Forest Height 17 to 21 meters
230	17197939	Forest Height 21 to 25 meters
270	12654527	Forest Height 25 to 29 meters
310	6638906	Forest Height 29 to 33 meters
350	3465332	Forest Height 33 to 37 meers
390	3909813	Forest Height 37 to 41 meters
430	2133	Forest Height 41 to 45 meters
470	2923	Forest Height 45 to 49 meters
510	7278	Forest Height > 50 meters

Figure 3-9. *Example Value Attribute Table for a CH layer. The value field must depict CH in meters*10. In this example, the canopy heights have been grouped into thirteen classes in which the cell value corresponds to the approximate mid-point of the class in meter * 10. For example, a value of 430 relates to a CH class that ranges between 41 and 45 meters.*

3.4 Concepts of ruleset development for fuel characteristics

3.4.1 Fire Behavior Fuel Model assignments in LF National data

The LF data are imagery-driven with plot data used to "train" the imagery interpretation. EVT, EVC, and EVH derived from this process are the layers primarily used to develop FVT, FVC, FVH, the layers used to create the primary fuel attributes. This new process for LF 2016 Remap is described in the technical document *Changing the mapping approach for fuels in disturbed areas-LANDFIRE introduces "Capable"Fuels*.

This triplet of data is further segregated by life form categories: tree, shrub, or herbaceous. Pixels with less than 10% tree cover are designated as "shrub," and those with less than 10% shrub cover are designated "herbaceous."

From these layers, fuel specialists can determine life form, species, vegetation density, and height above ground on a pixel-by-pixel basis. Managers can then use this information to specify a surface fuel model from the original set of 13 (Anderson 1982) or the 40 Fire Behavior Fuel Models developed by Scott and Burgan (2005).

3.4.2 Canopy guide toggle

Modeled fire behavior is influenced by many vegetation attributes, but in forested areas, canopy is a particularly important factor affecting fire behavior outputs. A user-defined switch has been incorporated in LFTFC to describe the effects of canopy. The switch has the following three numeric settings.

- **0:** This setting indicates no canopy on the site. Canopy Base Height (CBH) and Canopy Bulk Density (CBD) calculations from the LF data sets would be used to indicate the likelihood of crown fire on the site.
- **1:** This setting would be used on a tree life form site where torching and crowning in the upper strata vegetation is common during times of fire activity.
- **2:** This setting would be used on tree life form sites where torching and crowning are not likely to occur, such as in some hardwood communities. The mapping tool in this setting artificially raises CBH to 10 meters and lowers CBD to 0.012 kg/m^3. Torching and crowning will not occur but the stand attributes (CH and CC) will be used in the calculations of surface fire behavior characteristics. The reason for keeping the canopy attributes in place is to adjust wind speed, shading, and sheltering for surface fire calculations.
- **3:** This setting would be used on tree life form sites where torching would occur, but active crowning is not likely, such as in mixed hardwood and conifer communities. The mapping tool in this setting artificially lowers CBD to 0.03 kg/m^3, but leaves CBH, CH, and CC as predicted.

3.4.3 Assigning canopy characteristics

In fire behavior modeling, surface fire spread, and intensity combine with the vegetation attributes CBH and CBD to add torching and active crowning to projected fire behavior. In the LF data sets, these

attributes are calculated by plot data. Several methods for assigning numeric values to these attributes have been investigated. The current preferred approach is to use a general linear model (GLM) from plot data to describe the CBD and linear regression equations derived from Forest Vegetation Simulator (FVS) scenario outputs for CBH. (See the LF website for additional information on metadata).

LFTFC allows users to input expert opinion values for CBH and CBD for their desired forested areas instead of the prediction.

***Note**: The GLM method is described in Reeves and others 2009.*

Chapter 4: Obtaining Input Data from the LF Data Distribution Site

4.1 Acquiring input data

4.2 Downloading data directly from the LF Data Distribution site

4.1 Acquiring input data

The LF Program has developed nationally consistent data – across ownerships – of the spatial themes necessary for running LFTFC as well as those used in FARSITE and FlamMap. The LF website provides links that allow the user to download any of the separate spatial data themes (elevation, slope, aspect, canopy cover, fire behavior fuel model, canopy bulk density, canopy base height, and canopy height). The five grids required to run LFTFC are: FVT, FVC, FVH, FDist, and BpS. All these grids can be downloaded from the LF website.

4.2 Downloading data directly from the LF Data Distribution Site (DDS)

On the LF website, select "Get Data," then Data Distribution Site (DDS), and download the desired input layers. Explore the site for additional information on resources offered.

Once you are familiar with the DDS, acquiring LF data using the LF Data Access Tool (LFDAT) is the most efficient method for both downloading and processing LF data directly within ArcMap. See Appendix C: Downloading data using the LF Data Access Tool (LFDAT) for details on how to use LFDAT to download data.

Chapter 5: Installing LFTFC Toolbar Add-in

5.1 LFTFC installation
5.1.1 Downloading LFTFC
5.1.2 Beginning the installation process
5.2 Uninstalling LFTFC

5.1 LFTFC installation

5.1.1 Downloading LFTFC

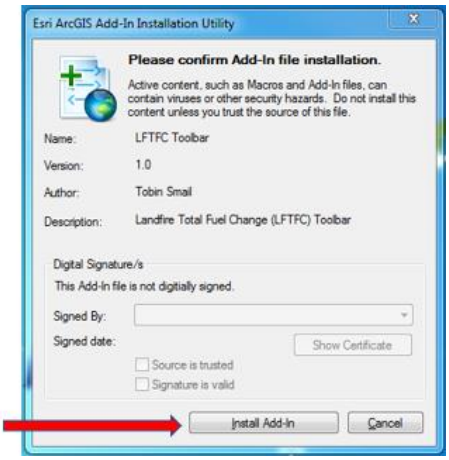
***Note**: If you have an earlier version of LFTFC installed on your computer, you will first need to uninstall it before proceeding with installation of the current version. Refer to section 5.2 LFTFC uninstalling for more information on this subject.*

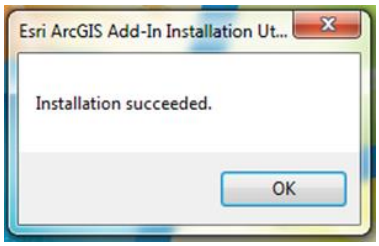
Download LFTFC from the LF website at https://landfire.gov/download_lfdat.php#lftfct.

5.1.2 Installing

This has been tested with 10.1 - 10.7 ArcMap, and presumably more recent versions

1. Uninstall any previously installed LFTFC toolbars
    a. All LFTFC toolbars prior to version 0.153 must be uninstalled through the "Control panel", "Programs", "Uninstall a program"
    b. All other versions refer to section 5.2 LFTFC uninstalling.
2. Installing - Run Setup_LFTFC_####.bat
    a. Make sure ArcMap is closed
    b. Double left-click to run "Setup_LFTFC_####.bat"
    c. This copies required files to "C:\Landfire\LFTFC"
    d. The black command window will automatically close (approx. 2 minutes)
3. ArcGIS Add-in window will open, select "Install Add-in"



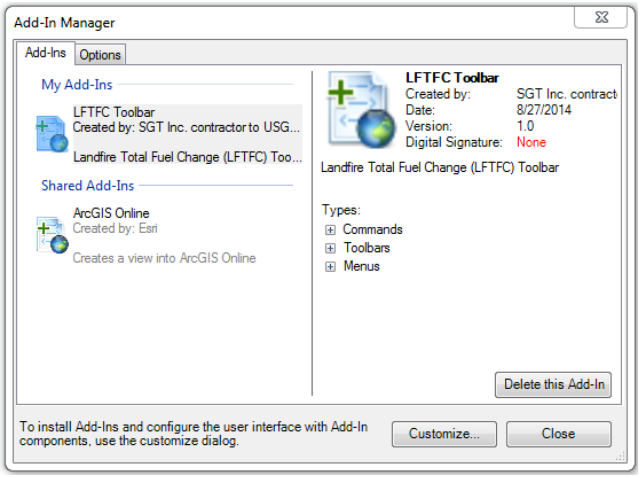


1. Select "OK"
2. Start ArcMap. LFTFC should be visible

3. If LFTFC is not visible, right click in the toolbars and select "LFTFC"

5.2 LFTFC uninstalling

1. Start ArcMap
    a. Select "Customize" at the top of the screen in the menu bar.
    b. In the "Customize" menu bar select "Add-in Manager"



    c. Select "LFTFC Toolbar" located under "My Add-Ins"
    d. Click "Delete this Add-In"
    e. Click "Close"
    f. Close ArcMap
2. Open "Windows Explorer"
    a. Navigate to the "(C:)" directory
    b. Delete the folder named "Landfire"
3. Start ArcMap (This next part seems unnecessary, but some versions of ArcMap have a problem with letting go of add-ins.)
    a. "LFTFC" toolbar should be gone.
    b. Close ArcMap

Chapter 6: A quick start guide to running LFTFC

6.1 Setting up the working directory
6.2 Creating a Management Unit (MU)
6.3 Working with fuel rules
6.4 Evaluating surface and canopy fuel assignments
6.5 Creating the grid menu
6.6 Selecting canopy options
6.7 Applying changes to specified areas
6.8 Creating grids
6.9 Adjusting rulesets
6.10 Evaluating outputs

This chapter will provide a brief overview of the basic steps required to run LFTFC. To learn more about all tool options, proceed to Chapter 7: Using LFTFC. Advanced users seeking detailed information on all available options, or users looking for help on a specific topic may find the next chapter to be more useful. This chapter does not discuss every option for each step of the process.

The following flowchart shows the basic steps required to run LFTFC (Figure 6-1). Click on the flowchart's links for information describing each stage of the process.

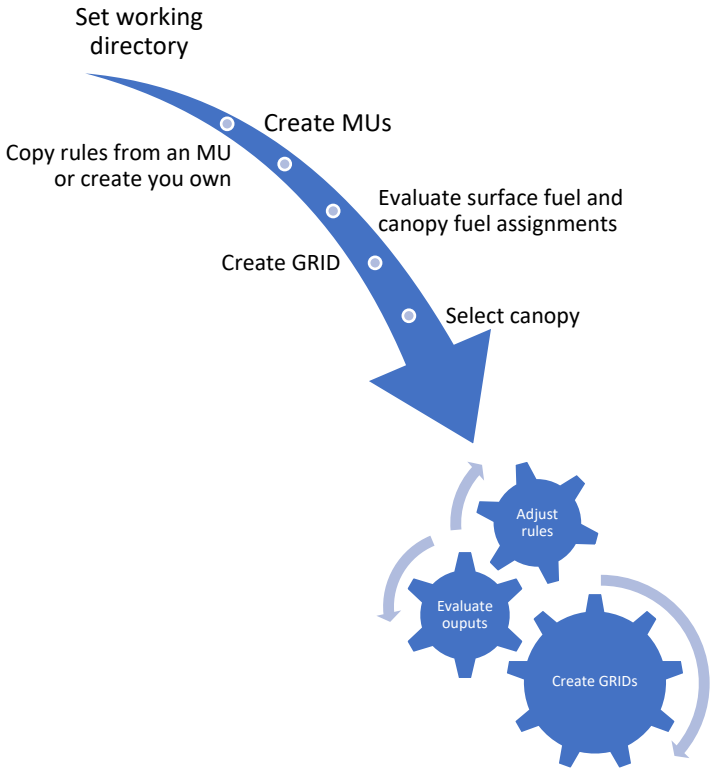


Figure 6-1. *Steps required for running LFTFC.*

6.1 Setting up the working directory

- First, use the LFTFC toolbar to set your working directory by clicking on **Set the project path** as shown below (Figure 6-2).

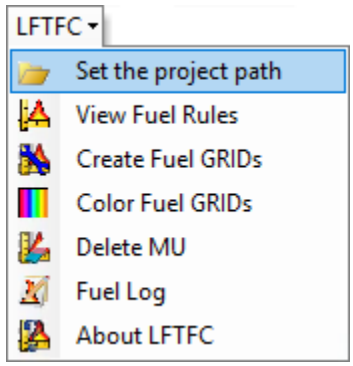


Figure 6-2. *Set project directory by using the drop-down menu and selecting* ***Set the project path****.*

- The following **Browse for Folder** dialog box will open. Use this dialog box to select the project folder (Figure 6-3).

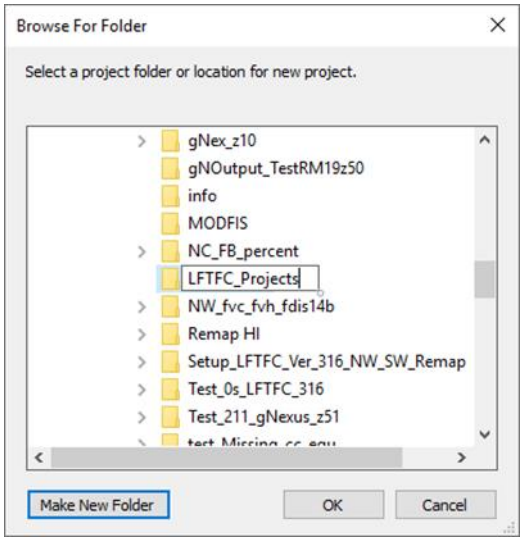


Figure 6-3. *Use dialog box to create a project folder.*

- Click **OK** after you have specified a location for your project.
- Once the project folder has been created, the **Create Project** dialog box will open (Figure 6-4).
- Use the **Create Project** dialog box to specify a name in the Enter New Project Name box (Figure 6-4).

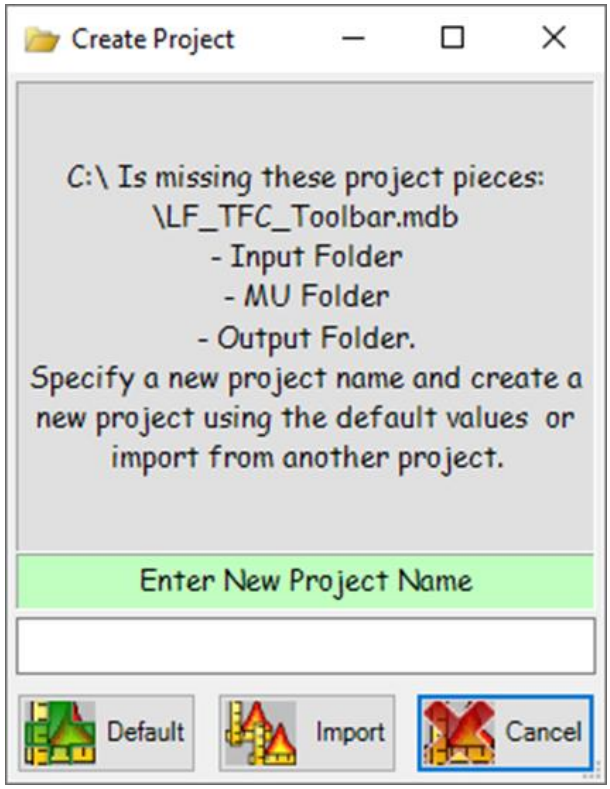


Figure 6-4. *Specify a project name.*

- Click the **Default** button when finished to load the database and necessary folders.

For additional information on default folders, naming conventions, and suggested filing systems, see section 7.3 Workspace settings.

6.2 Creating a Management Unit

- Click the **Add Management Unit** icon on the LFTFC toolbar (Figure 6-5) to define a Management Unit.

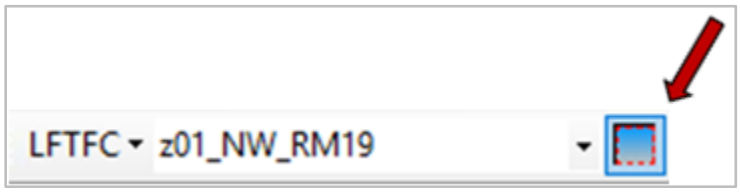


Figure 6-5. *Use the* ***Add Management*** *Icon to create a MU.*

The **Add Management Unit** dialog box opens as shown (Figure 6-6).

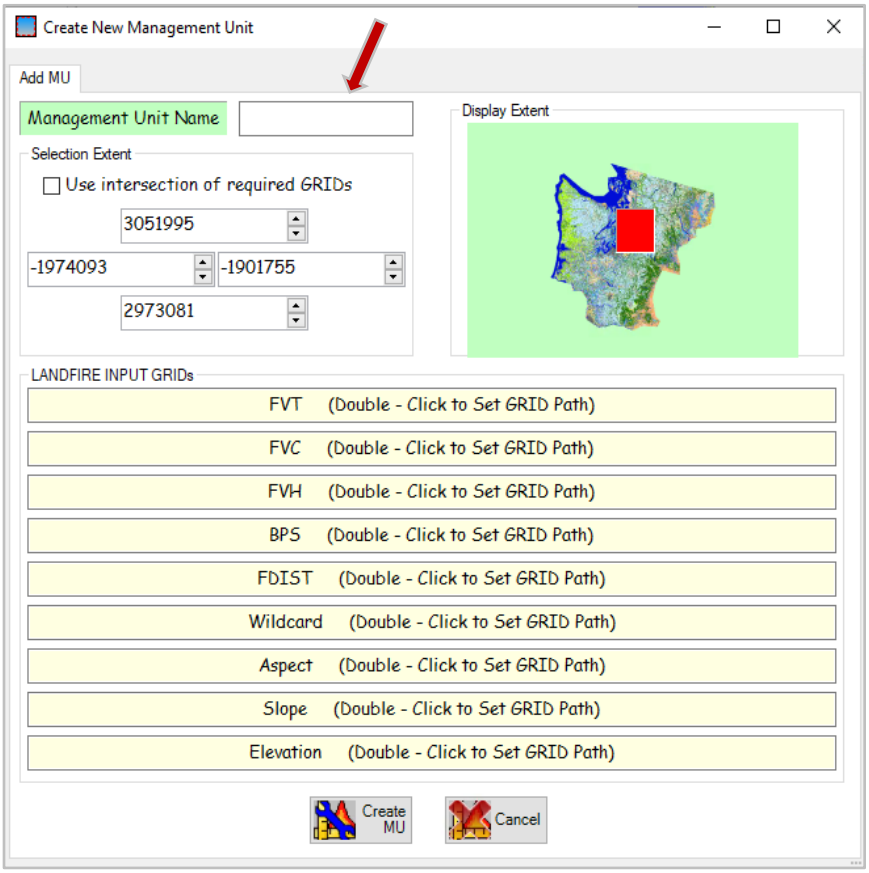


Figure 6-6. *Select the Management Unit Name (**ADD MU** screen visible).*

A MU can be defined by specifying coordinates or by using the drawing rectangle.

Note: *For detailed information on specifying the extent of your MU, see* section *7.5 Fuel rules*

- To use the drawing rectangle, drag your cursor to draw an extent rectangle in the "Display Extent" window of the dialog box (Figure 6-6).
- With the **Add MU** tab selected, type a **Management Unit Name** in the box provided (Figure 6-6).

Note: *The naming convention follows the rules of ArcMap, which means a grid name can be no longer than 13 characters.*

- Input the required data layers (FVT, FVC, FVH, FDist, and BpS) by double-clicking in the adjacent boxes to set a grid path.

Tip: You do not have to load grids first in ArcMap; you can simply double-click in the **Add Management Unit** dialog box to load grids.

Note: *All five grids (FVT, FVC, FVH, FDist and BpS) must be in the same projection.*

The Wildcard selection is optional but may be useful in some situations. A soils or other GRID can be used in the wildcard to help define fuel rules for a special condition. See 7.4 Management Units for more information.

- Enter other optional data layers if desired (Wildcard, Aspect, Slope, and Elevation). See 7.4 Management Units for additional information on using the Wildcard option.

  ***Note**: All grids must be in the same projection.*

- When you have completed filling out the **Add Management Unit** dialog box, click the **Create MU** button at the bottom of the **Add MU** page (Figure 6-6).

For additional information on creating a Management Unit, see 7.4 Management Units.

6.3 Working with fuel rules

The **Fuel Rules** window is where the bulk of the modifications will be made to spatial data to prepare them for creation of new fuels layers for fire and fuels analysis. The **Fuel Rules** dialog box has many functions and display items. For additional information on other available options, refer to 7.5 Fuel rules.

The following description will progress from general to more specific steps and in the order a typical LFTFC user would follow. This explanation includes, in order, the main **Fuel Rules** page tabs **Ruleset**, **Compare FM**, **Distribution Graph**, and **EVT Description**) as well as several of the more commonly used Rule input icons located in the **Fuel Rules** window (**Copy Rule** and **Add Rule**).

Each FVT has a set of zone-based fuel rules. New rules can be added, edited, deleted, or copied (see 7.5 Fuel rules for more detailed information).

- To continue, you will need to copy rules from another existing MU or create your own rules.
- To begin, select **View Fuel Rules** from the drop-down menu on the left-hand icon of the toolbar (Figure 6-7).

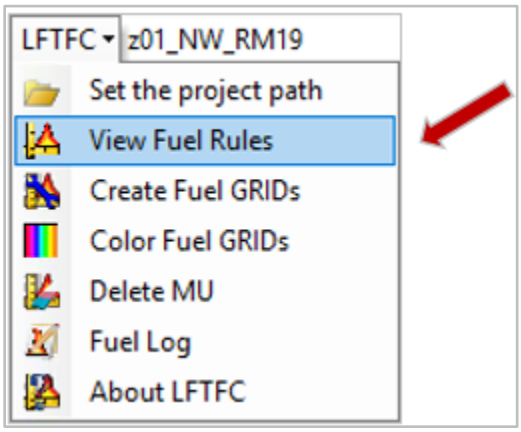


***Figure 6-7.** Select **View Fuel Rules** option from the drop-down menu.*

- Select the MU you created from the list displayed in the drop-down menu (Figure 6-8).

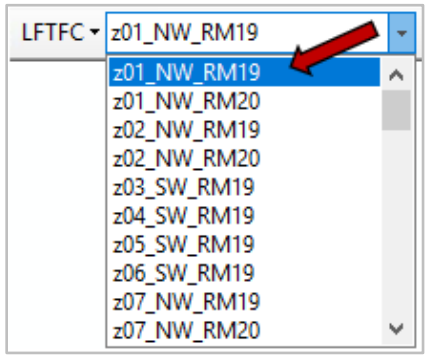


Figure 6-8. *Select **MU** option from the drop-down menu.*

***Note**: Management Units appear in alphabetical order in the drop-down menu. You may have to scroll down to view the MU of interest.*

The **Fuel Rules** dialog box with the **Ruleset** page displayed will open (Figure 6-9).

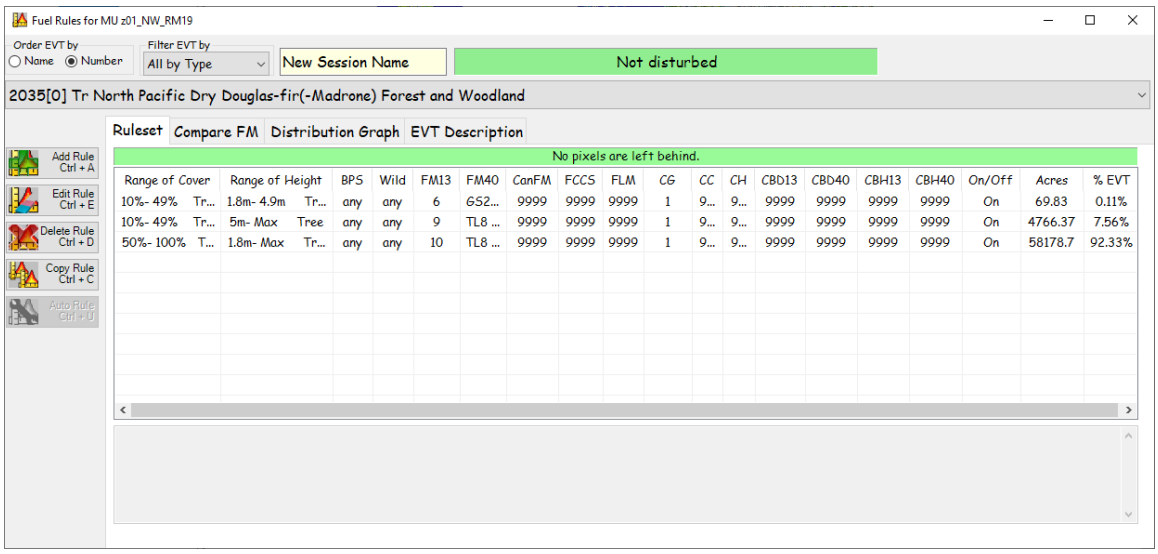


***Figure 6-9. FUEL Rules** dialog box.*

Tip: Click in the boxes at the top of the columns you are **not** interested in viewing to collapse those fields so you can more easily view the columns you wish to work with.

- (Optional) In the Fuel Rules dialog box (Figure 6-9), add a **Session Name in the box provided** if desired.
- 7.5.1 Fuel rule header selections. Use the drop-down window to select an appropriate "**Fuel Vegetation Number and Name**" (Figure 6-9). (This selection allows the user to go directly to the desired FVT and provides information on the dominant species present and type of vegetation that occupies the site). (See FVT Description tab in 7.5.5 Fuel rule page tabs for additional information.)

***Note**: The pixels left behind label will appear green when no pixels are left behind. If rules do not account for all pixels, or the rules overlap, the label will appear red indicating the number of missing pixels. (Figure 6-10)*

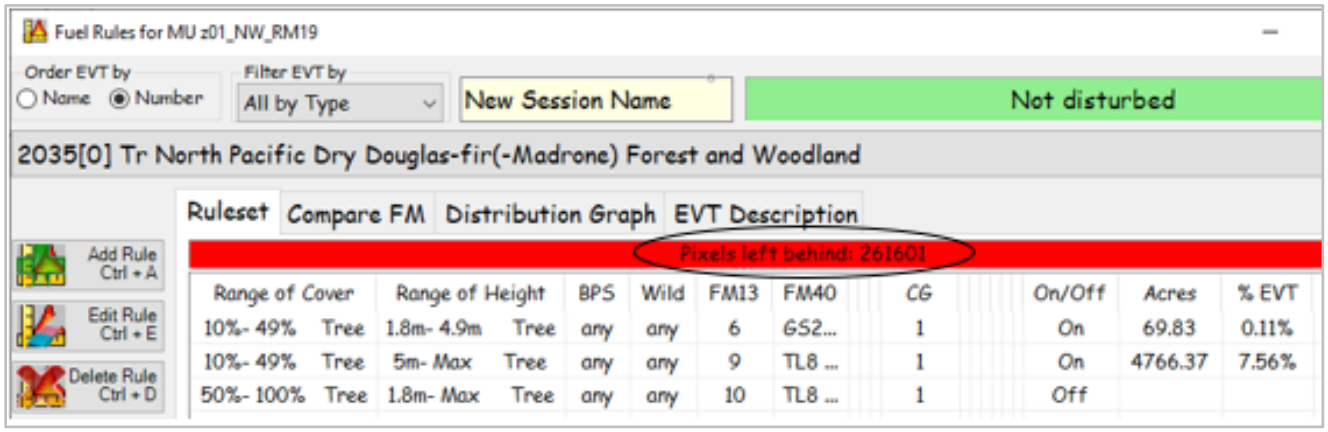


***Figure 6-10. FUEL Rules** dialog box showing pixels left behind.*

- Next you will need to choose a Fuel Rule icon (Figure 6-11). Available options include the following: **Auto Rule, Add Rule, Edit Rule, Delete Rule, and Copy Rule**. Each fuel rule opens a dialog box requiring user input. (See 7.5.5 Fuel rule page tabs for detailed information about each option.)

Copy Rule

- For this example, select the **Copy Rule** icon to copy rules from another Management Unit (Figure 6-11).

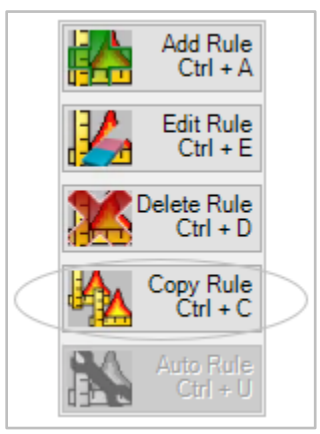


***Figure 6-11. Copy Rule** icon.*

The following **Copy Rules** dialog box will open (Figure 6-12).

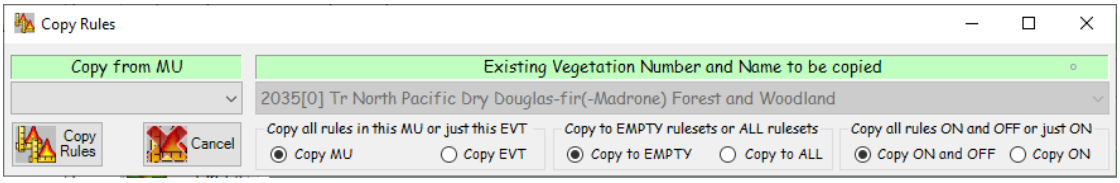


***Figure 6-12**. The **Copy Rules** dialog box.*

- Use the drop-down menu at the top left of the **Copy Rules** dialog box to select a MU (Management Unit) to copy *from* (Figure 6-12).
- Use the radio buttons to select whether to copy all the rules from the selected MU or to just copy the ruleset from the selected MU and Existing Vegetation Type (FVT). (**Copy MU** or **Copy FVT**)

  ***Note**: Use the drop-down menu under "**Existing Vegetation Number and Name to be copied**" to specify an FVT if **Copy FVT** is selected.*

- Use the radio buttons in the middle to copy rules into only the FVT rulesets that do not already have rules or copy all the rules even if rules already exist in the rulesets. This helps rulesets from getting duplicate rules. (**Copy to EMPTY** or **Copy to ALL**)
- Use the radio buttons at the far right to specify if you would like to "**copy all rules turned on and off**" (**Copy On and Off)** or just those rules that are turned on (**Copy On**).
- Click on the **Copy Rules** icon to continue.
- Verify that you want to copy all On and Off rules by clicking Yes (Figure 6-13).

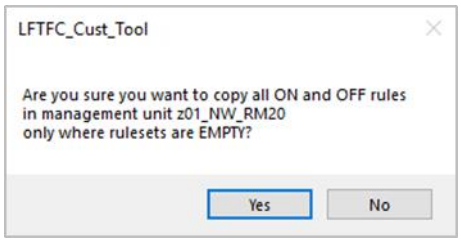


***Figure 6-13.** Verify that you want to copy all rules.*

- Close the **Copy Rules** dialog box when you are finished with edits. (It does not close automatically.)

Add Rule

A similar process is followed if a user wants to add a rule.

- To create new rules, click the **Add Rule** icon on the **Fuel Rules** page (Figure 6- 14).

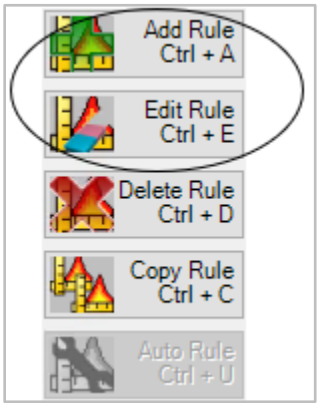


Figure 6-14. *Select the Add Rule icon on the FUEL Rules page to create your own rules.*

- After clicking **Add Rule** (or **Edit Rule)**, the following **Add and Edit Rules** dialog box will open (Figure 6-15).

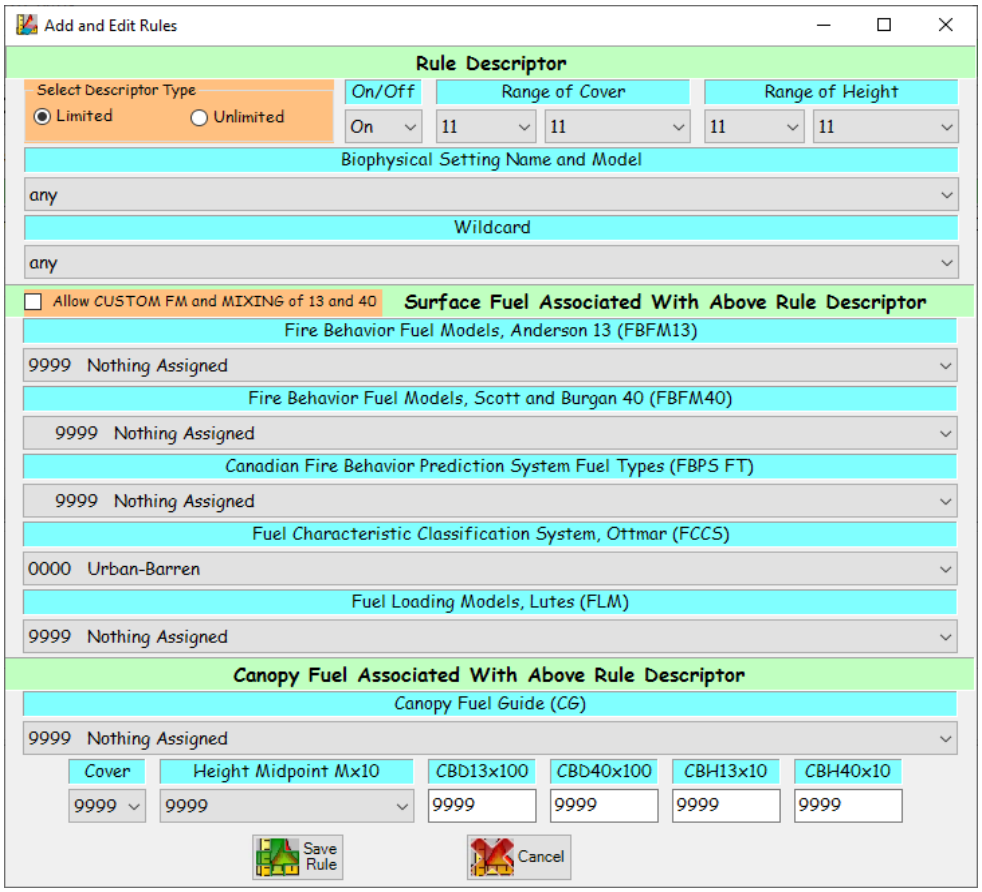


Figure 6-15. Add and Edit Rules *dialog box.*

- Select a **Descriptor Type** using the associated radio buttons at the upper left corner of the dialog box (Figure 6-15).
- Toggle the rule descriptor **On** or **Off** using the drop-down menu (Figure 6-15).
- Modify other fields as needed.
- Click the **Save Rule** button after changes have been made.

Note: *Selecting the "Limited" Descriptor Type option keeps the user from creating illogical combinations that the data do not support. The "Unlimited" option gives the user all combinations of cover and height in all life forms whether they exist in the data or not.*

Add RuleOther fuel rule input options are also available (**Auto Rule**, **Edit Rule**, and **Delete Rule**). See 7.5.4 Rule input options for detailed information describing these options.

6.4 Evaluating surface and canopy fuel assignments

The next step is to evaluate both surface and canopy fuel assignments.

- Open the **Fuel Rules** dialog box to the **Ruleset** page. Use the drop-down menu to select and highlight EVTs to account for all pixels. (See 7.5 Fuel rules for additional information on this subject.)
- Select the **Compare FM** tab on the **Fuel Rules** screen to compare the required CBH needed for torching and active crown fire initiation (Figure 6-16). (For additional information refer to 7.5 Fuel rules.)

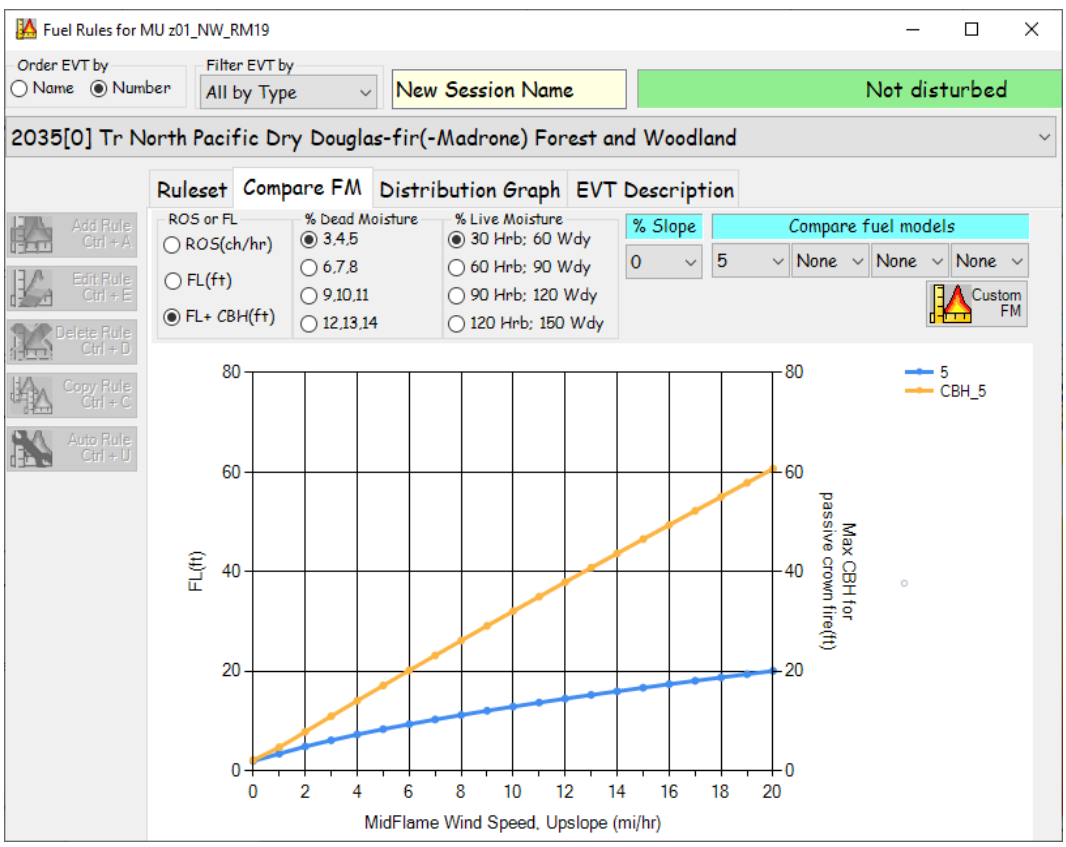


Figure 6-16. *Select* ***Compare FM*** *page tab.*

- Use the **Distribution Graph** tab to view the height of the vegetation by cover and the number of acres present in the selected FVT within the defined MU (Figure 6-17). For more information see 7.5 Fuel rules.

Figure 6-17. *Select* ***Distribution Graph*** *page tab.*

- Select the **EVT Description** tab to display an ecological description. This NatureServe website (https://explorer.natureserve.org/) serves as the basis for all LF EVTs.

For additional information on all aspects of working with Fuel Rules, refer to 7.5 Fuel rules.

6.5 Creating FUEL GRIDs menu

The next step is to create the grid menu.

- When the rules have been completed to your satisfaction as described above, select **Create FUEL GRIDs** on the LFTFC drop-down menu (Figure 6-18).

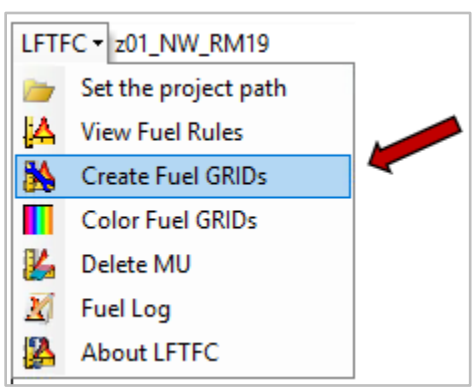


Figure 6-18*. Select* ***Create FUEL GRIDs*** *on the drop- down menu.*

The following dialog box will open with the **GRID Selection** tab visible as shown in Figure 6-19.

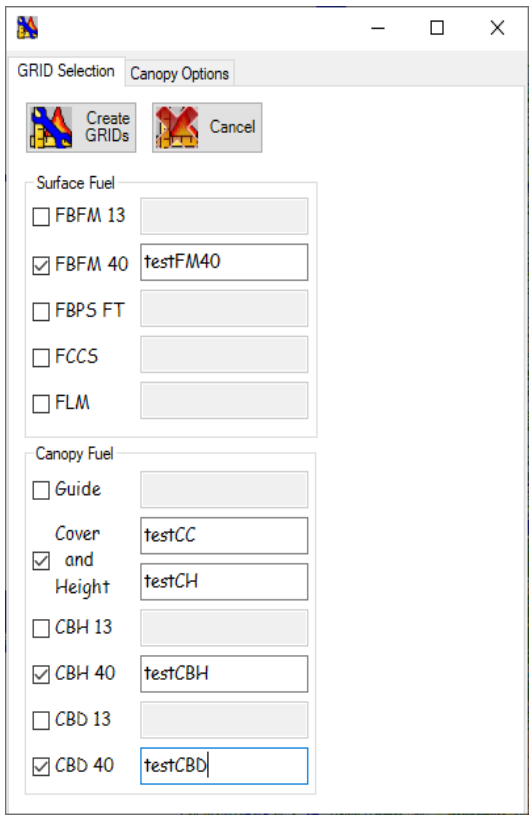


***Figure 6-19**. Complete the **GRID Selection** tab and click **Create GRIDs** when done.*

- Use the GRID **Selection** tab to name and create fuel layers.
- Check all the fuel layers you would like to include.
- Enter a name for the fuel layers in the boxes provided.

  ***Note**: After the boxes are selected with a check mark, the associated box for naming the layer is enabled (Figure 6-19).*

For more information on creating the grid menu, see 7.6 Creating new Grids.

6.6 Selecting canopy options (optional)

- Select **FUEL GRIDs** on the drop-down menu to open a dialog box (Figure 6-19).
- Click the **Canopy Option** tab to work with select canopy options if desired (Figure 6-20).

The **Canopy Options** tab allows you to make changes to the canopy layers in three ways:

1. (Default) Use rules that are not coded as "9999", indicating no data, in the rulesets to overwrite the predicted value.
2. (Default) Use built-in adjustment equations for CC and CH in disturbances.
3. Use a coefficient by which to multiply.

- Complete the **Canopy Options** tab by checking the appropriate boxes as desired.

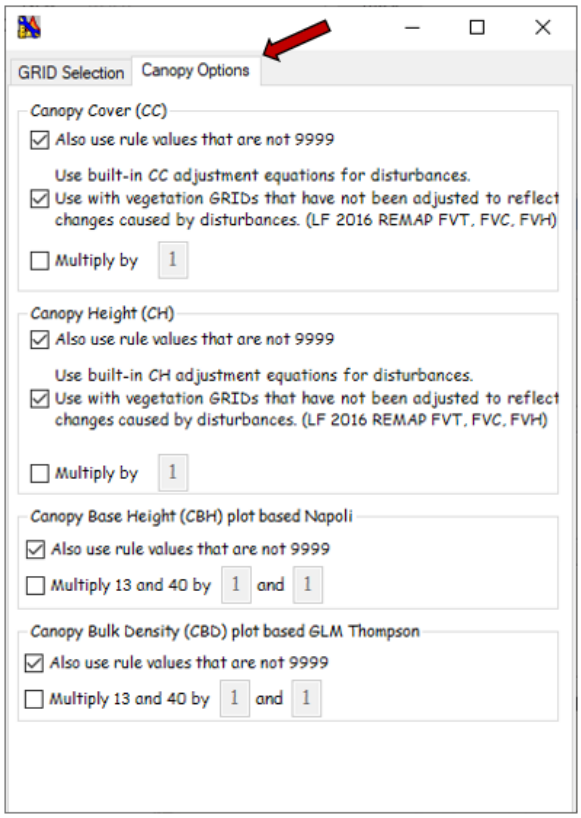


Figure 6-20. *Complete the* ***Canopy Options*** *tab (optional).*

For additional information, see 7.6 Creating new Grids.

6.8 Creating grids

- After you finish making your selections, click **Create GRIDs** (Figure 6-22).

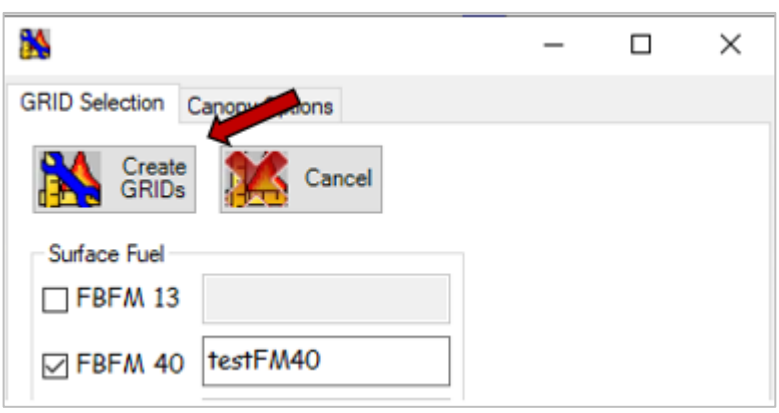


Figure 6-22. *Click Create GRIDs button*

Tip: Outputs are finished individually so be patient.

- Go to your project folders to view outputs.

6.9 Adjusting rulesets

At this point, you can adjust rulesets if necessary. If changes are needed, go back to the rules, make your changes, and then create the grids again.

6.10 Evaluating outputs

Finally, evaluate your outputs. Your edited outputs should now better reflect expected fire behavior and fuels characteristics for your area.

Chapter 7: Using LFTFC

7.1 The LFTFC toolbar
7.2 Creating a new project
7.3 Workspace settings
7.4 Management Units
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    7.5.1 Fuel rule header selections
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    7.5.5 Fuel rule page tabs
7.6 Creating new grids
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7.9 Fuel Log
7.10 About LFTFC

This chapter describes LFTFC's functionality. Each option is described in a sequential order wherever possible. If you prefer to see an overview of generalized tool operation, refer to Chapter 6: A quick start guide to running LFTFC. Because LFTFC offers many options, you may prefer to skip to sections of particular interest.

7.1 The LFTFC toolbar

The following diagram (Figure 7-1) shows elements of the LFTFC toolbar. Refer to the discussions below to learn more about the basic functions of each icon.

Figure 7-1. *The LFTFC toolbar.*

The down-arrow on the left opens the LFTFC drop-down menu, which contains seven functions as shown below (Figure 7-2). With this menu, the user can save, create, and import multiple projects with multiple Management Units.

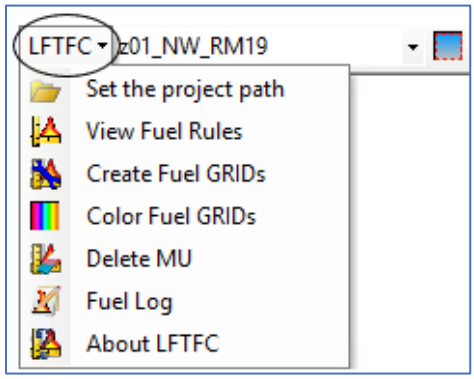

Figure 7-2. *The LFTFC drop-down menu.*

The second down-arrow on the toolbar is the Management Unit (MU) selection drop-down menu, which allows the user to select a MU once the project is set up (Figure 7-3). MUs can be as large as a LF map zone or as small as an initial fire incident that a user would like to calibrate and analyze.

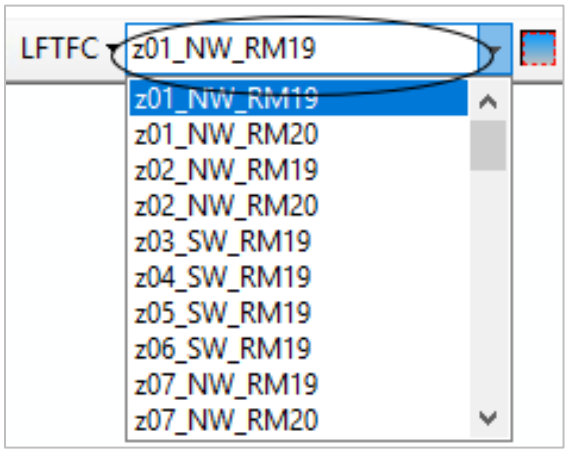

Figure 7-3. *LFTFC's Management Unit selection drop- down menu.*

The icon on the right of the toolbar is the **Add Management Unit** rectangle (Figure 7- 4).

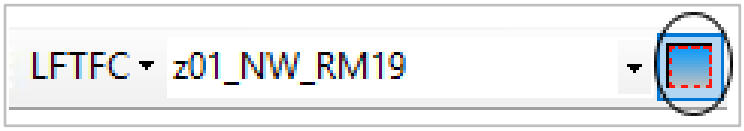

Figure 7-4. *LFTFC's Management Unit creation icon.*

This icon allows the user to select an area of interest, input the required data layers, and clip all the layers to the specified rectangle.

7.2 Creating a new project

- Start ArcMap and select **New Maps** as shown in Figure 7-5:

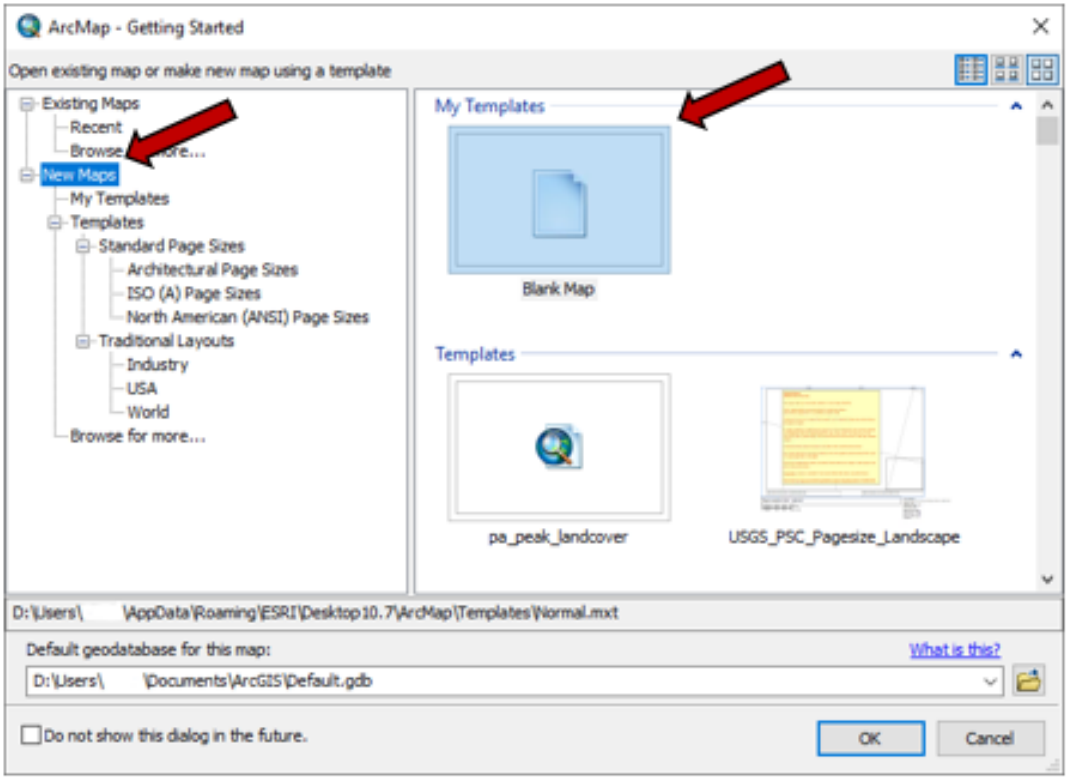

Figure 7-5. *Creating a new project.*

7.3 Workspace settings

Creating a filing system using good organization is an important first step. We suggest creating a directory called "**LFTFC_Projects**" on a convenient drive.

- To create a directory, click the drop-down menu on the LFTFC toolbar and select "**Set the project path**" (Figure 7-6).

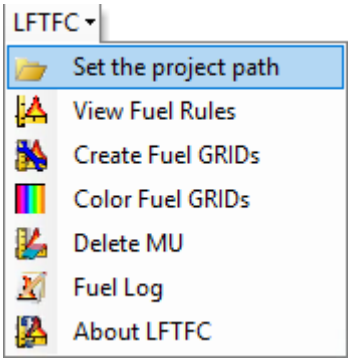

Figure 7-6. *Use the drop-down menu to select* ***Set the project path****.*

The following dialog box will open, allowing you to create a new directory as described (Figure 7-7).

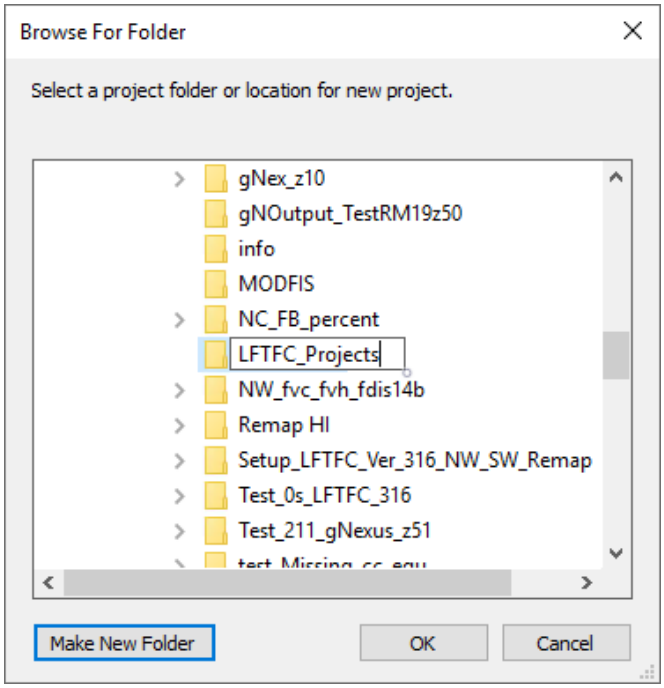

Figure 7-7. *Select a project location.*

- Navigate to the **LFTFC_Projects** directory you just created and click **OK**.

A **Create Project** window opens, allowing you to import data from previous projects or to create a project workspace (Figure 7-8)

- To create a project workspace, enter a name for the project and click the **Default** button. The tool will build a workspace folder under the **LFTFC_Projects** directory in the name you have specified.

  Note*: The naming convention follows the rules of ArcMap, which means a grid name can be no longer than 13 characters.*

Figure 7-8. *Create Project is used to enter a Project Name.*

> ***Note**: Click the **Default** button to continue, use the **Import** button to load an existing project, and click **Cancel** to close the **Create Project** dialog box.*

The newly created workspace folder will contain the **Input**, **MU**, and **Output** folders (Figure 7-9). These folders are used to store your work as well as the Microsoft Access database which is populated with the LF default fuels characteristics.

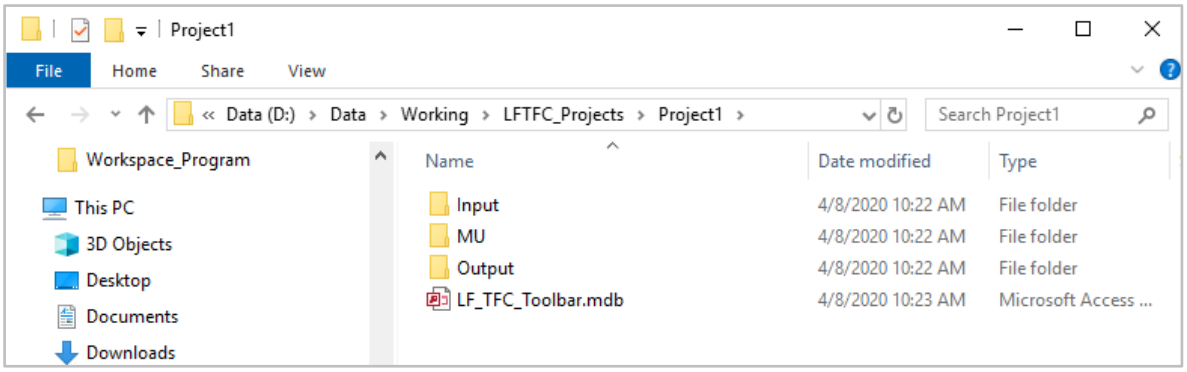

***Figure 7-9.** Contents of newly created folder.*

When the workspace folder is opened, the window next to the drop-down menu arrow is populated ("z01_NW_RM19" is shown in the following example). The LF map zone is indicated ("z01") as well as a designation that the information is for the LF Northwest Remap 2019 fuel characteristic data ("NW_RM19") (Figure 7-10).

***Figure 7-10.** Drop-down menu showing LF map zone.*

As new projects are developed, additional folders can be added to the **LFTFC_Projects** directory or new project folders can be created to further organize complex analyses.

7.4 Management Units

The Management Unit, or MU, is the basis for changing fuel characteristics for a particular area. The extent of the MU is user-defined and can be designated by coordinates or by the intersection of the input grid layers. Once the appropriate grid layers are combined through the **Add MU** function, the user can modify the fuel characteristics of the surface fuel model and canopy attributes as well as Fuel Characteristic Classification System (FCCS) or FLMs (Ottmar and others 2007; Lutes and others 2008). After modifications are complete, new fuel model and canopy attribute grids can be processed for use in analysis.

> ***Note**: The default data set includes MUs created for all LF map zones. These zones exist in relational Microsoft Access database form only and not as spatial grids in the MU folder. As new MUs are created, they will consist of a combined grid of the grid layers from the LF data set and any optional grid layers the user inputs into the wildcard. They will reside in the MU folder.*

- To begin, add Management Units by clicking on the MU icon located at the far right of the LFTFC toolbar, as shown below (Figure 7-11).

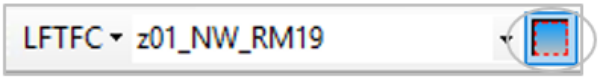

Figure 7-11. *Creating a Management Unit.*

The **Add Management Unit** dialog box opens, as shown below (Figure 7-12). It serves as a drawing rectangle, which is used to identify the spatial extent of the area to be analyzed or to define the Management Unit. In ArcMap, the icon works the same way as any tool used to define an extent.

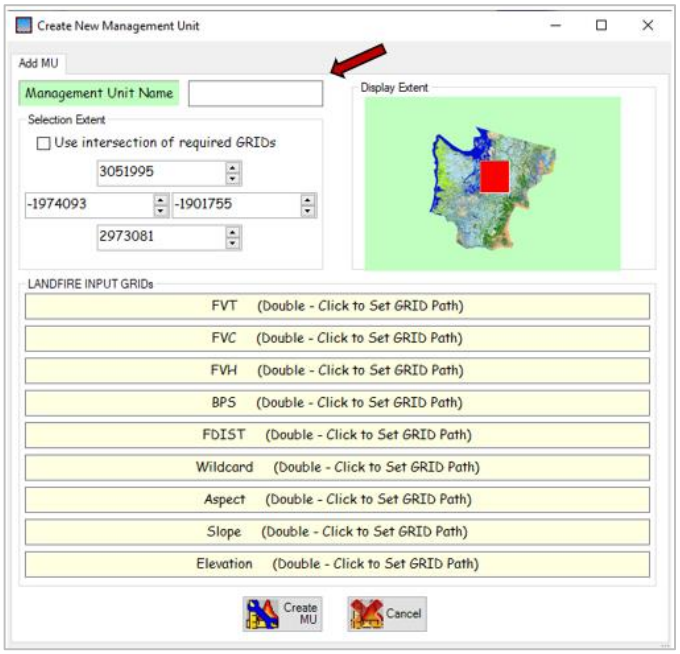

Figure 7-12. Add Management Unit *dialog box.*

- Specify coordinates in the **Selection Extent** window or use your cursor to drag an extent rectangle.
- With the **Add MU** tab selected, enter a Management Unit Name in the box provided.

The naming convention used to specify a Management Unit Name in the first box follows ArcMap rules. The grid name you use should not exceed 13 characters in length or include any special characters.

> ***Note****: The "**Set Project Directory**" drop-down selection (see 7.4 Management Units) sets the name of the path, but you will still need to name the file here in the **Add Management Unit** box. The file will be in your MU folder.*

LFTFC clips all grids to the extent of the smallest grid if the "**Use intersection of required GRIDs**" box located near the top of the screen is checked.

- Check the "**Use intersection of the required GRIDs**" box to clip all GRIDs to the extent of the smallest GRID.
- Un-check the "**Use intersection of the required GRIDs**" box to clip all GRIDs to the extent of the rectangle you specified.
- Input required layers (FVT, FVC, FVH, FDist and BpS) by double-clicking in the associated boxes to set a GRID path.

***Note**: All GRIDs must be in the same projection.*

The Wildcard option is optional and allows extra flexibility for the LFTFC user in some cases. For example, as discussed in Chapter 6: A quick start guide to running LFTFC, the wildcard option can be used in instances where a project boundary extends across several map zones. To facilitate ease of processing, the user can create the Management Unit (MU) with required GRIDs by map zone. The boundary GRID can then be used as a wildcard to define the area of interest.

- To use this option, double-click in the **Wildcard** box to add a wildcard GRID.

Aspect, slope, and elevation layers are optional.

- To add these optional layers, return to the **Add MU** page and double-click to add Aspect, Slope, and Elevation GRIDs if desired.

  ***Note**: Recall that all grids must be in the same projection*

7.5 Fuel rules

LFTFC's Fuel Rules function offers many features and is where the bulk of the modifications to spatially displayed data will be made. The following section will include descriptions of components and available options for: Fuel Rules, Column headers, Tab indicators, Fuel Rule sheets (page tabs), and Rule inputs.

The FVT, FVC, and FVH are comprised of existing vegetation for non-disturbed and pre-disturbance vegetation for disturbed areas. A fuel model can be assigned to represent how much fuel would describe the fuel bed by vegetation type: life form (Herb, Shrub, Tree) cover, height, biophysical setting, and any optional layer that may be used. In disturbed areas the pre-disturbance vegetation helps fuel specialists assign fuel rules by informing how much fuel was acted upon by the disturbance. For example, if a disturbance is blowdown it is helpful to know the pre-disturbance vegetation type, tree cover, and tree height so you can assign a fuel model to represent the type and amount of tree loading on the ground.

The second option on the LFTFC drop-down menu is "**FUEL Rules**," as shown below (Figure 7-13).

- Select **FUEL Rules** from the drop-down menu on the LFTFC toolbar.

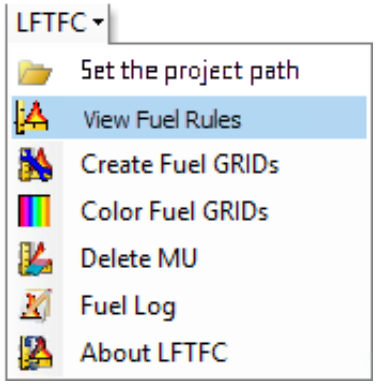

***Figure 7-13.** Selecting **FUEL Rules** from drop-down menu.*

The **Fuel Rules** screen will open with the **Ruleset** page displayed initially, as shown below (Figure 7-14).

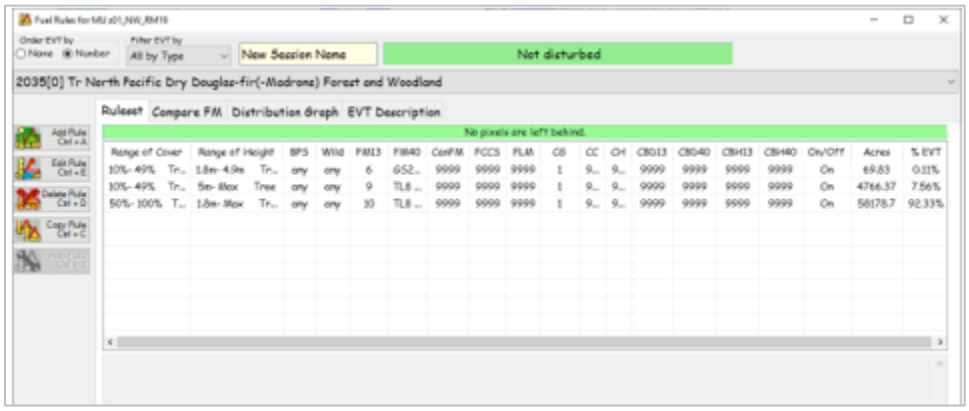

***Figure 7-14. Fuel Rules** dialog box showing **Ruleset** page.*

LFTFC users will spend most of their time working with this screen. Rulesets used to modify surface and canopy fuels are accessed here. The default data set loads with fuel rules for the surface fuel models that were developed through the LF Program and LF calibration meetings with local fuel experts.

The default data set is selected by pointing to its folder through "**Set Project Directory**" (see 7.4 Management Units). The database starts with fuel rules by FVT for all the LF map zones. Rulesets for all the FVTs in the selected map zone (LF Map Zone 01 in this example), become available to view or edit in the **FUEL Rules** screen.

There is a wealth of information within the default rulesets. Many users work with the **FUEL Rules** screen just to ensure that they understand the existing default rulesets before opting to make any modifications. The user should have good documentation and adequate reasons before making any changes to these rulesets.

Once you have determined that the rulesets within the default data set will suffice, or you have decided to make an MU with a revised set of rules or modify the existing ruleset in the default data, you can begin to work with LFTFC's **Ruleset** screen (Figure 7-15).

> ***Note:** You can add or edit existing notes by entering a session name at the top of the window, select a rule, and in the bottom section of the **Fuel Rules** page clicking inside of that screen.*

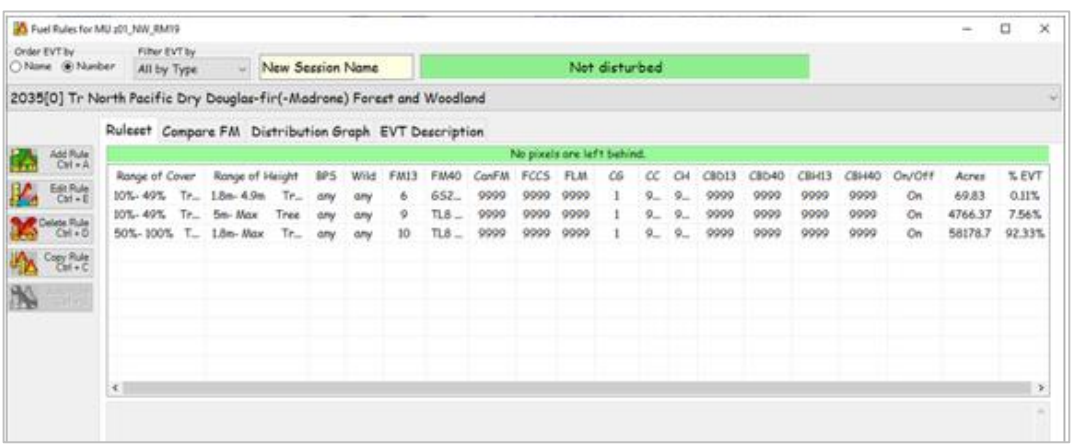

***Figure 7-15**. LFTFC's **Ruleset** screen on the **Fuel Rules** dialog box.*

To summarize, several general options are available at this point.

- If the default data set is reviewed and determined to be usable with no further modifications, a grid of the 13 or 40 FBFM and grids of canopy attributes (see Chapter 3: Inputs) can be made for use in fire potential and simulation software such as FARSITE or FlamMap (see 7.6 Creating new Grids).
- If the edits are made to the default database (see 7.5.4 Rule input options, then grids of the FBFMs and/or canopy attributes can be made. For additional information on this subject, see 7.6 Creating new Grids.
- If an MU was created for the purpose of developing rulesets for fuel characteristics when the MU is selected in the MU window (no fuels layer is added in as a wildcard) and the **FUEL Rules** selection is made on the LFTFC drop-down menu, the **FUEL Rules** window will open.

A "9999," indicating that there are no data, will be visible where all the ruleset information should be displayed. At this point, the user will need to copy a rule ("**Copy Rule**"), use auto rule ("**Auto Rule**"), create a rule through editing ("**Edit Rule**"), or add a rule ("**Add Rule**") for the FVC, FVH, FDist, BpS, FBFM, and canopy attributes for each ruleset in each FVT desired in the MU.

> ***Note:*** *Other options for editing rules exist and can be found by right clicking the values of existing rules. However, the options described above represent the most common functions in current use.*

7.5.1 Fuel rule header selections

The following header selection components are found at the top of the **Fuel Rules** page (Figure 7-16).

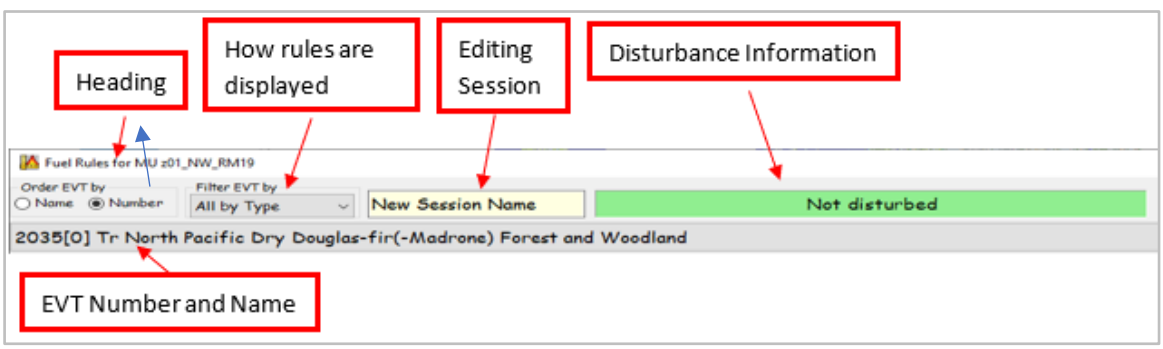

Figure 7-16. Fuel Rule *page headers.*

- **Heading** – displays Fuel Rules for the MU the user is viewing.
- **Session Name** – displays the notes for each rule so you can determine when changes were made.
- **Fuel Vegetation Type Number and Name** – displays FVT number and name in a drop-down window that allows the user to go directly to the desired FVT. The FVT informs the user as to the dominant species present as well as the type of vegetation that occupies the site. (See "FVT Description" in section 7.5.5 Fuel rule page tabs for additional information).

7.5.2 Column headers

The **Fuels Rules** box (Figure 7-17) is set up in spreadsheet design so that column headers can be collapsed and expanded as needed (Figures 7-17 and 7-18). One of the primary functions of this tool is to enable the user to highlight a row field and then select the **Edit Rule** icon to make changes to any of the attributes describing the fuels. When the row is highlighted, a text box at the bottom of the window opens, indicating any recent editing actions involving that rule.

Modifications are made by changing values directly in the boxes displayed. (See 7.5.4 Rule input options) for additional information on how headers are modified as rule inputs are developed).

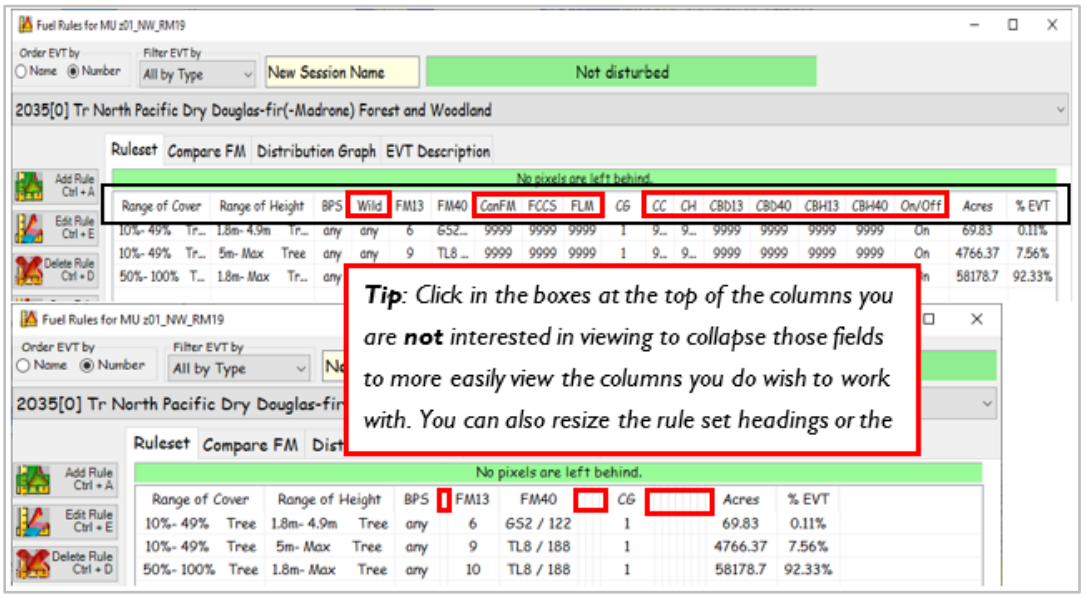

Figure 7-17. Column headers can be collapsed or expanded for convenience.

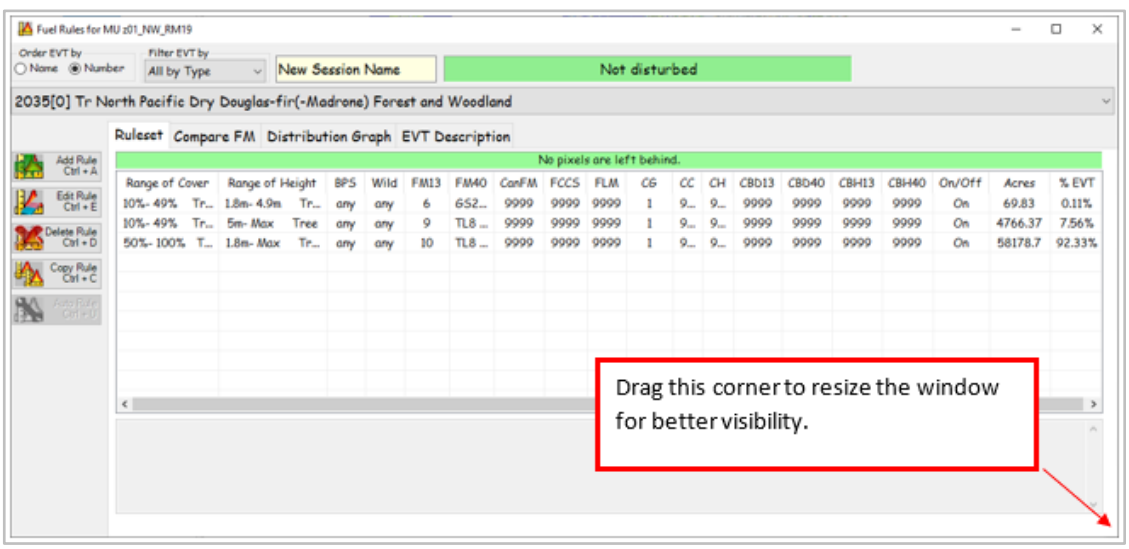

Figure 7-18. Working with display options.

Main column headers are described below.

- **Range of Cover** and **Range of Height** – cover ranges used to determine fuel characteristics are based on the vegetation depicted in the pixel. Life form cover and height provide information that can help determine fuel bed density in surface fuels and provide insights into CBH and CBD in the vegetation's canopy attributes.
- **Range of Height** – height ranges are used to determine fuel characteristics based on the existing vegetation depicted in the pixel. Life form height and cover provide information which can help determine fuel bed density in surface fuels and provide insights into CBH and CBD in the vegetation's canopy attributes

  Example: Mixed Conifer Woodland = FVT (2022, z02); from 10-39% closure (open); 0-max height; tree life form; any BpS; FBFM 6; FBFM40 GS2. In the first set, the rule implies Mixed Confer woodland in this map zone, and if it is open, shrubs or regeneration and grass will be growing in the openings, and it will burn in the surface fuel model as a shrub or grass shrub model.

- **BpS** – If the coverage of the FVT is too great, or if the specified vegetation displays different fuel characteristics within its range, the Biophysical Settings (BpS) may be used to indicate different fuel characteristics in different areas of the same FVT. For example, it might be advantageous to modify fuel characteristics for vegetation occurring on serpentine or other ultramafic soil types.

  Referring to the previous example (Mixed Conifer Woodland), the BpS is given as "any" so that for all BpS designations within z02 and FVT 2022, this rule would apply.

- **Wildcard (Wild)** – Wildcards serve the same general purpose as BpS: to further refine the scale of the fuel characteristic assignment. (See section 7.5 Fuel rules for more information on using wildcards).
- **FBFM 13 – FBFM 40 – Canadian FM – FCCS – FLM assignments** – The next columns indicate the fuel model assignments made for the 13 FBFM and 40 FBFM systems. In the default data set, these fuel model determinations were primarily made as a result of the calibration workshops held across the country.

LFTFC has been designed to incorporate other fuel descriptions systems, including the Canadian Fire Behavior Prediction System of Fuel Models (CFBPS FM), FCCS, and FLMs. A custom fuel model can also be used. The default data set, however, includes no information from these systems except CFBPS, which is only available in certain parts of the U.S.

- **Canopy Guide (CG) Toggle** – Modeled fire behavior in the wildland settings is dependent on many of the vegetation attributes; but in forested settings, the canopy is an important factor affecting fire behavior outputs. The Canopy Guide Toggle can be used to assess whether crown fire development is likely. In LFTFC, a switch has been incorporated to describe the effects of canopy. The switch has three user-controlled numeric settings as described below.
  - **0** = no canopy on the site.

  - **1** = canopy base height (CBH) and canopy bulk density (CBD) calculations from LF data sets are used to indicate the likelihood of crown fire on the site. This setting is used on a forested site (dominated by "tree" life form) where torching and crowning in the upper strata vegetation is common during times of fire activity.
  - **2** = This setting would be used on tree life form sites where torching and crowning are not likely to occur, such as in some hardwood communities. The mapping tool in this setting artificially raises CBH to 10 meters and lowers CBD to 0.012 kg/m³. Torching and crowning will not occur but the stand attributes (CH and CC) will be used in the calculations of surface fire behavior characteristics. The reason for keeping the canopy attributes in place is to adjust wind speed, shading, and sheltering for surface fire calculations.
  - **3** = This setting would be used on tree life form sites where torching would occur, but active crowning is not likely, such as in mixed hardwood and conifer communities. The mapping tool in this setting artificially lowers CBD to 0.03 kg/m³, but leaves CBH, CH, and CC as predicted
- **Canopy Cover (CC) and Canopy Height (CH)** – can be user-designated by individual ruleset while in editing mode. The default data set uses LF cover and height as portrayed in the range of cover and height columns.
- **CBH 13** and **CBH 40** – The user can specify CBH for a given Fuel Rule by individual ruleset for either of the surface fuel model grids they will be producing (see 6.3 Working with fuel rules for more information). Default values are assigned from linear regression equations derived from plots analyzed through various disturbance scenarios in Forest Vegetation Simulator (FVS). (Martin, Napoli, and Smail, personal communication).
- **CBD 13** and **CBD 40** – The user can specify CBD for a given Fuel Rule by individual ruleset for either of the surface fuel model grids they will be producing (see 6.3 Working with fuel rules for more information). Default values are taken from the General Linear Model (GLM).
- **On/Off** – A rule can be turned "On" or "Off" using a toggle switch. If a rule is turned off without accounting for the area in another rule, the total acres and percent coverage of the EVT may become out of balance (less than or greater than 100%). If a rule is turned "Off," the user can still view relevant notes about its history or past use.
- **Acres** and **Percent of EVT** – shows how many acres and percent of the FVT a specific rule covers. When out of balance (over or under 100%), the **Ruleset** sheet labels will indicate the problem (see 7.5.3 FVT label indicators).

7.5.3 FVT label indicators

The Ruleset page includes an FVT label that changes from red to green or green to red depending on if the pixels are accounted for in the rules. If the label is red in will indicate the number of missing pixels left behind. (Figure 7-19).

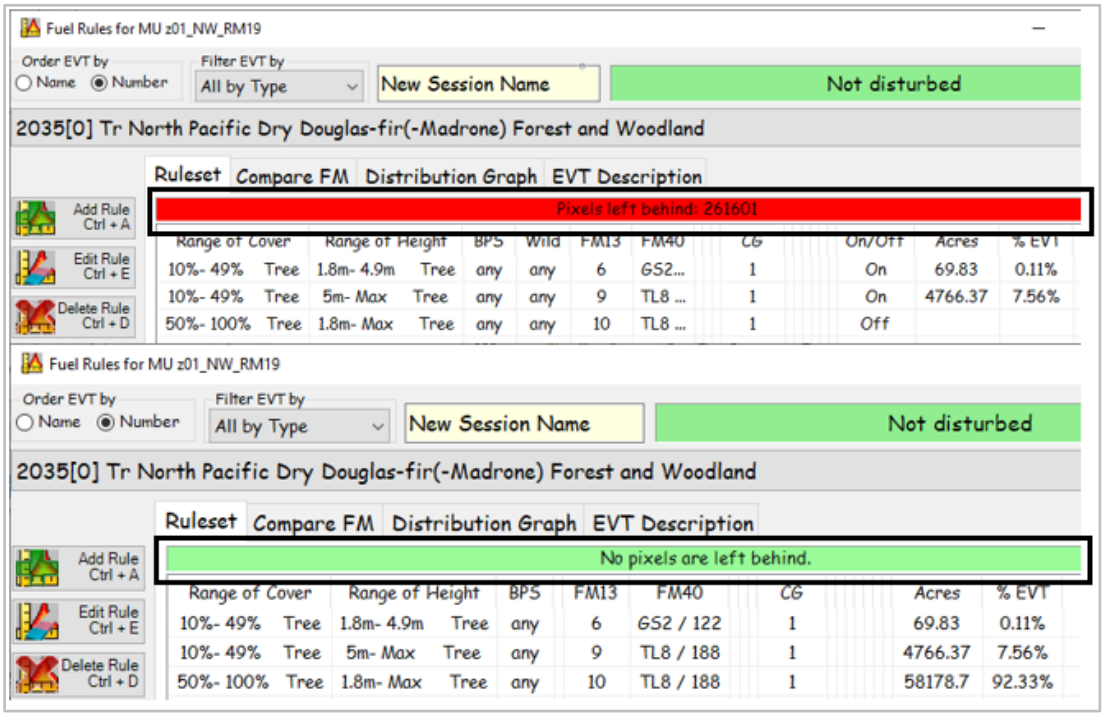

***Figure 7-19**. Ruleset page tab indicators*

Pixels left behind – indicates if there is a problem with the combinations of rulesets covering all the pixels in the grid of varying covers, heights, bps, and wildcard.

Rules are assigned by the order below:

1. Combinations or FVT, FVC, and FVH cannot overlap. They make up the base rule.
2. If Wildcard or BPS are used in a rule, then that rule takes precedence over any existing base rules that it overlaps.
3. If Wildcard and BPS are both used together in a rule, then that rule takes precedence over any existing base and Wildcard or BPS rules that it overlaps.

If necessary, you can account for missing pixels by using rule input options such as "**Add Rule**" or "**Edit Rule**." See 7.5.4 Rule input options for additional information.

7.5.4 Rule input options

The following section describes the function of each available rule input option in detail. A typical LFTFC user might opt to work with several of the rule options. Refer to the descriptions of interest.

LFTFC users can select from the following **Rule** input options: **Auto Rule**, **Add Rule**, **Edit Rule**, **Delete Rule**, and **Copy Rule** (Figure 7-20).

- **Auto Rule** – creates options for fuel rules from existing surface fuel models.
- **Add Rule** – enables users to create new rules.
- **Edit Rule** – used to modify existing rules.
- **Delete Rule** – used to delete rules that are no longer needed.
- **Copy Rule** – allows users to copy rules from other existing MUs.

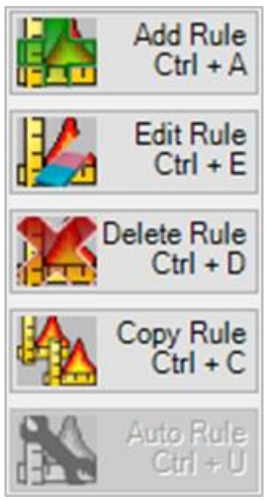

Figure 7-20. *Rule input options.*

- Rule inputs are selected by clicking one of the icons at the top left of the Fuel Rules dialog box (Figure 7-20).

Auto Rule

Auto Rule is used with surface fuel model grids incorporated into the wildcard slot. This function automatically builds rulesets and assigns surface fuel models to other extents of the MU.

The **Auto Rule** icon creates options for fuel rules from existing surface fuel model layers. For this option to work, the surface fuel model layer must be included when creating the Management Unit, and it must include an FBFM option.

Add Rule

The Add Rule option can be used when there are no available rules to edit. The Add Rule option may be appropriate if rules exist and EVTs have been added but EVTs are populated by "9999," indicating "no data," or when rulesets are split out into new cover and height rules and there are no existing applicable rules to edit.

For example, suppose a user had an existing rule specifying canopy cover of 10 to 49%, canopy height of 0-max, 9/TL6, and wanted to use a shrub model to depict the more open condition with smaller trees. The user could add a rule to state: canopy cover of 10 to 29%, canopy height of 0 to 25, 2/GS2, 10-29%, 25 – max, 9/TL6, and edit the existing rule to 30-49%, 0 – max, 9/TL6.

- To use the Add Rule option, click the **Add Rule** icon (Figure 7-20).

The **Add and Edit Rules** dialog box opens as shown (Figure 7-21).

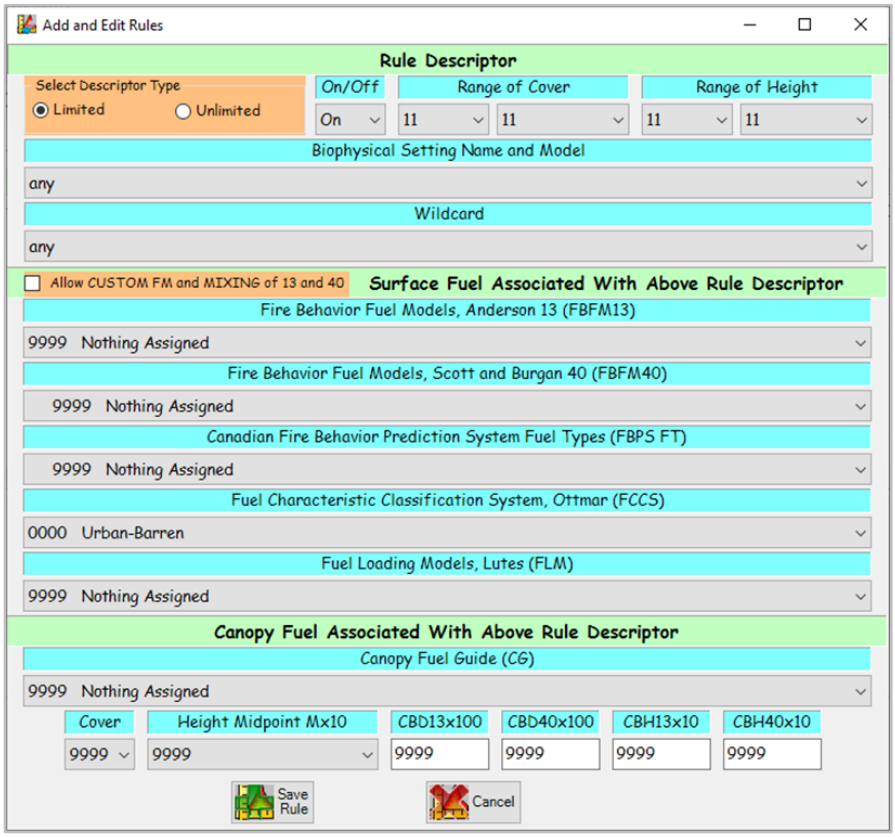

***Figure 7-21. Add and Edit Rules** dialog box.*

Components of the **Add and Edit Rules** dialog box and the steps required to use the Add Rule option are discussed below.

- To use the Add Rule option, you will need to complete the required input for the **Rule Descriptor**, **Surface Fuel Associated with Above Rule Descriptor**, and finally the **Canopy Fuel Associated with Above Rule Descriptor** boxes (Figure 7-21).

Rule Descriptor box

The **Rule Descriptor** box occupies the top portion of the **Add and Edit Rules** dialog box (Figure 7-21). Components are described as follows.

- **Select Descriptor Type** – Use the radio button to make your selection of either "**Limited**" or "**Unlimited**."

  Note: *Using the "**Limited**" Descriptor Type option keeps the user from creating illogical combinations that the data do not support. The "**Unlimited**" option gives the user all combinations of cover and height in all life forms whether they exist in the data or not.*

- Use the drop-down menu to toggle the Rule "**On**" or "**Off**."
- Use the drop-down menus to select a **Range of Cover** and **Range of Height**.
- Specify the **Biophysical Setting Name and Model** using the drop- down menu. (Refer to 3.1.1 Biophysical Settings Models and Descriptions (BpS) layer for additional information.)

- A **Wildcard** option can be selected from the associated drop-down menu. (Refer to 7.5 Fuel rules for more information on wildcards.)

Surface Fuel Associated with Above Rule Descriptor box

Use the **"Surface Fuel Associated with Above Rule Descriptor"** section in the middle of the **Add and Edit Rules** dialog box to make the following selections.

- Use drop-down menus to make assignments for FBFM13 and FBFM40, CFBPS FM, FCCS, and FLM.

Canopy Fuel Associated With Above Rule Descriptor box

This section of the dialog box is used to make canopy selections as described below.

- Make a Canopy Fuel Guide (**CG**) selection using the drop-down box.
- Add CC, CH, CBD, and CBH values in place of "9999", to express different fire behavior other than the default equation predictions. See Chapter 7.6 Creating new Grids

  Tip: When working with **Add Rule**, you must specify a **Canopy Fuel Guide (CG)**. If you do not, you will get a "9999" ("no value").

- Save rule by clicking on the **Save Rule** icon at the lower left.

Edit Rule

Use the Edit Rule selection when rules exist but modifications are desired, such as when there is a need to adjust canopy cover or canopy height from the default predictions.

Note: *Other options for editing rules exist and can be found by right clicking the values of existing rules. However, the options described above represent the most common functions in current use.*

Tip: Be aware that you may need to use **Add Rule** to cover any pixels missing if the whole range in the grid is not covered by the existing rule.

Example*: A ruleset for the Cottonwood Bosque FVT has the range of cover and height worked out in logical fashion for the FVT, but you know that under dry conditions, crowning is likely in this vegetation type. Currently, the ruleset has 8/TL3 and a canopy guide (CG) of 2, which will use just canopy to adjust shading and wind reduction. In this situation, to help model crowning, highlight the ruleset for 20-59% 0-max height. Use the drop-down box for FBFM13 to select FM10, hit the drop- down arrow for FBFM40 to select TL8-188, and use the drop-down menu for* ***Canopy Fuel Guide (CG)*** *to select "1." Save your edits by clicking on the* ***Save Rule*** *icon. Subsequently, the Bosque rulesets will be 10-19%, 0-max, 5/GS2; 20- 59%, 0-max, 10/TL8.*

- To use the Edit Rule option, click the **Edit Rule** icon on the Fuel Rules dialog box (Figure 7-20).

The **Add and Edit Rules** dialog box opens (Figure 7-21). Components of the Add and Edit Rule dialog box are the same as those described for the Add Rule option. They are repeated here for convenience. Components of the **Add and Edit Rules** dialog box and the steps required to use the Edit Rule option, are discussed below.

- To use the Edit Rule option, you will need to complete the required input for the **Rule Descriptor**, **Surface Fuel Associated with Above Rule Descriptor**, and the **Canopy Fuel Associated with Above Rule Descriptor** boxes (Figure 7-21).

The **Rule Descriptor** box occupies the top portion of the **Add and Edit Rules** dialog box (Figure 7-21). Components are described as follows.

- **Select Descriptor Type** – Use the radio button to make your selection of either "**Limited**" or "**Unlimited**."

  Note: *Using the "**Limited**" Descriptor Type option keeps the user from creating illogical combinations that the data do not support. The "**Unlimited**" option gives the user all combinations of cover and height in all life forms whether they exist in the data or not.*

- Use the drop-down menu to toggle the Rule "**On**" or "**Off**."
- Use the drop-down menus to select a **Range of Cover** and **Range of Height**.
- Specify the **Biophysical Setting Name and Model** using the drop- down menu. (Refer to 3.1.1 Biophysical Settings Models and Descriptions (BpS) layer for additional information).
- A **Wildcard** option can be selected from the associated drop-down menu. (See 7.5 Fuel rules for more information on using the wildcard option).

Surface Fuel Associated with Above Rule Descriptor Box

Use the **"Surface Fuel Associated with Above Rule Descriptor"** section in the middle of the **Add and Edit Rules** dialog box to make the following selections.

- Use drop-down menus to make assignments for FBFM13 and FBFM40, the CFBPS FM, FCCS, and FLM.

Canopy Fuel Associated With Above Rule Descriptor box

This section of the dialog box is used to make canopy selections as described below.

- Make a **Canopy Fuel Guide (CG)** selection using the drop-down box.
- Add CC, CH, CBD, and CBH values in place of "9999", to express different fire behavior other than the default equation predictions. See 7.6 Creating new Grids.
- Save rule by clicking on the **Save Rule** icon at the lower left corner of the dialog box.

Delete Rule

Use this option to delete rules that you no longer want (such as those that may conflict with other rulesets you have added).

- Delete rules by selecting to highlight the rules you would like to delete and then clicking on the **Delete Rule** icon. (Figure 7-22).

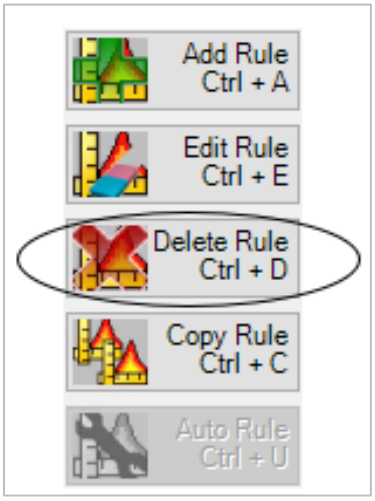

***Figure 7-22**. Select Delete Rule*

The following dialog box (Figure 7-23) opens, allowing you to verify that you really want to delete the rule.

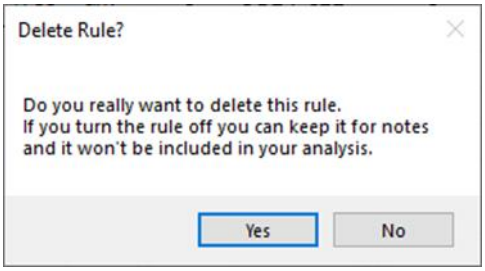

***Figure 7-23.** Dialog box verifying rule deletion.*

Copy Rule

Copying rulesets from LF National calibrated data using the **Copy Rule** input option gives the typical user a good starting point. From here, edits can be made to the copied rulesets and additional rules including BpS segmentations can be added.

- To copy a rule, click the **Copy Rule** icon on the **Fuel Rules** page. The following dialog box (Figure 7-24) will open.

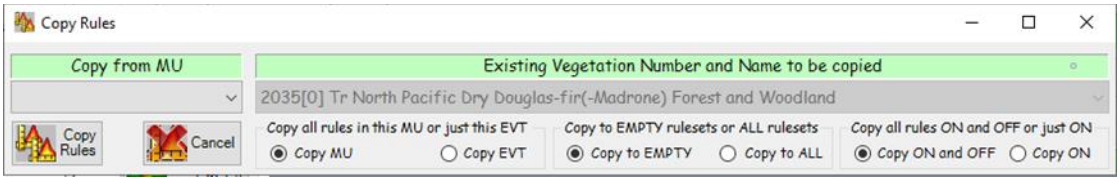

***Figure 7-24. Copy Rules** dialog box.*

- Use the drop-down menu at the top left of the **Copy Rule**s dialog box to select a MU to copy from (Figure 7-24).

- Use the radio buttons to select whether to copy all the rules from the selected MU or to just copy the ruleset from the selected MU and Existing Vegetation Type (FVT). (**Copy MU** or **Copy FVT**)

  Note: *Use the drop-down menu under "**Existing Vegetation Number and Name to be copied**" to specify an FVT if **Copy FVT** is selected.*

- Use the radio buttons to select whether to copy all the rules from the selected MU or to just copy the rule set from the selected MU and Existing Vegetation Type (FVT). (**Copy MU** or **Copy FVT**)

  Note: *Use the drop-down menu under **"Existing Vegetation Number and Name to be copied"** to specify an FVT if **Copy FVT** is selected.*

- Use the radio buttons in the middle to copy rules into only the FVT rulesets that do not already have rules or copy all the rules even if rules already exist in the rulesets. This helps rulesets from getting duplicate rules. (**Copy to EMPTY** or **Copy to ALL**)
- Use the radio buttons at the far right to specify if you would like to "**copy all rules turned on and off**" (**Copy On and Off**) or just those rules that are turned on (**Copy On**).
- Click on the **Copy Rules** icon to continue.
- Verify that you want to copy all On and Off rules by clicking Yes (Figure 7-25).

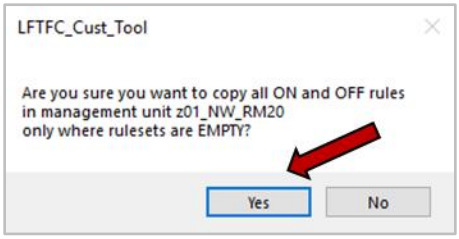

Figure 7-25: Verify that you want to copy all rules.

7.5.5 Fuel rule page tabs

Several page tabs are available on the **Ruleset** sheet to assist users in describing the fuel and fire behavior characteristics portrayed by their rulesets (Figure 7-26).

Tip: You can easily navigate between pages at any time by simply clicking the page tabs.

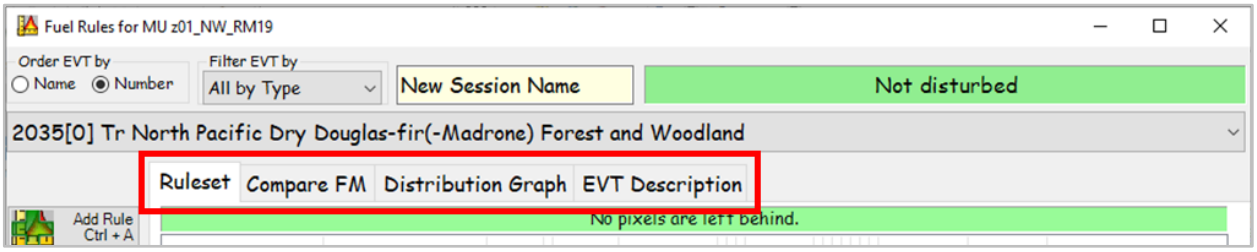

*Figure 7-26. **Fuel Rules** dialog box showing page tabs.*

These page tabs open tools that will help the user better understand the vegetation types being depicted on the site, life forms present in the spatial grid by cover and height, and associated fire behavior characteristics. **Fuel Rule** sheet pages are described below.

Ruleset

The **Ruleset** page is visible when the **Fuel Rules** dialog box opens. The **Ruleset** page and its features were described in detail in sections 7.5.1 Fuel rule header selections, 7.5.2 Column headers, 7.5.3 FVT label indicators, and 7.5.4 Rule input options. Refer to the appropriate sections for additional information.

Compare FM

This page graphically illustrates fire behavior traits, such as Rate of Spread (**ROS**) and Flame Length (**FL**) for surface fuel models in the FBFM 13 and FBFM 40 systems at various fuel moisture regimes, wind speeds and slope. A graphic display of CBH range that would initiate crown fire behavior at various fuel moisture regimes, wind speeds, and slope is also included (Figure. 7-27).

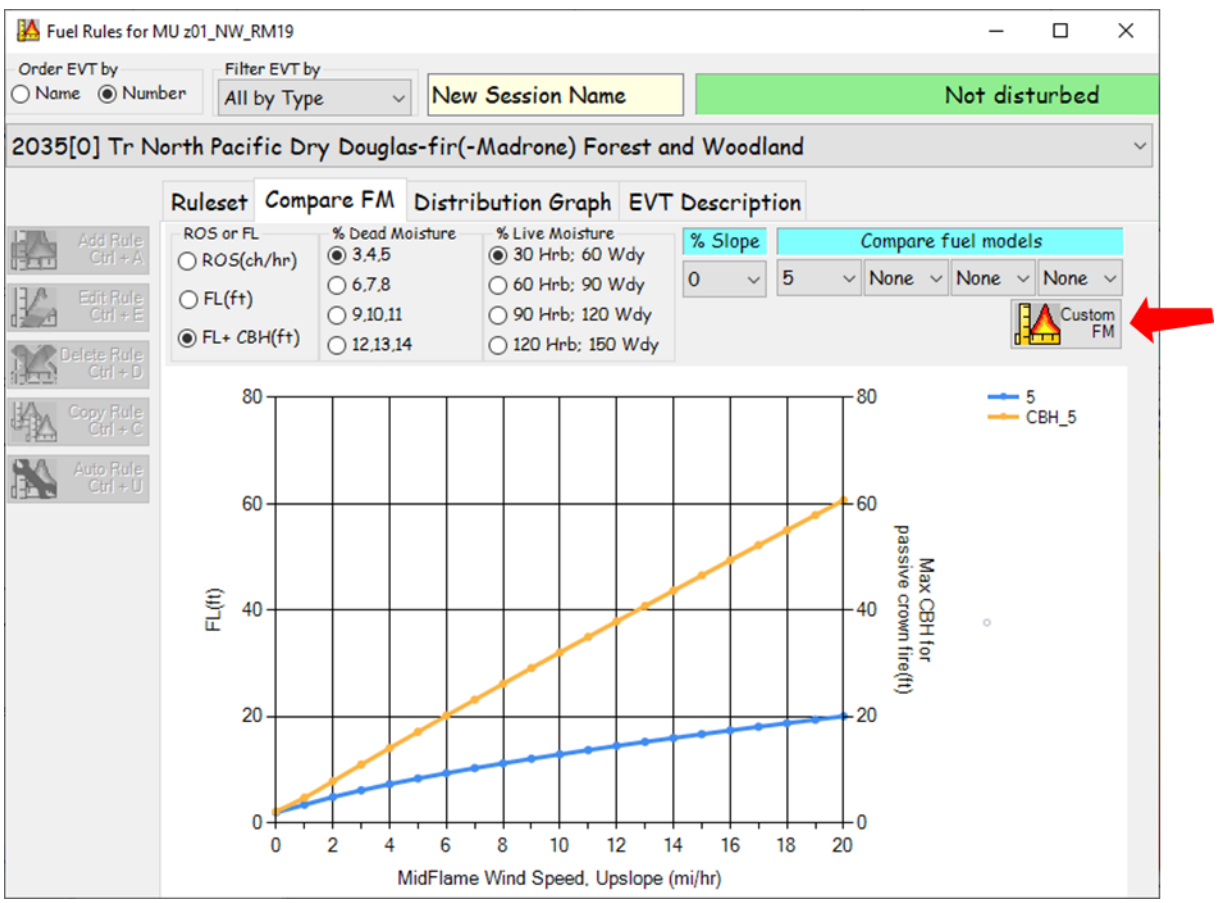

Figure 7-27: ***Fuel Rules*** *screen with* ***Compare FM*** *page displayed.*

- Use radio buttons to select desired ROS or FL, percent Dead Moisture, and percent Live Moisture.
- Use drop-down menus to enter percent slope and desired fuel models for comparison.

Note: *These options are very useful in determining FBFM13, FBFM40, and CBH for the fuel characteristics assignment displayed on the rulesets from the* ***Ruleset*** *sheet.*

The **Compare FM** page also allows the user to build and display fire behavior traits (ROS and FL) for custom fuel models at various fuel moisture regimes, wind speeds, and slope.

- This task is accomplished by clicking the **Custom FM** icon shown above (Figure 7-27).
- To create a custom model, select the fuel model you would like to start with in the box to the right of "**Fuel Model**."
- Make adjustments by selecting a parameter and then moving the slide adjustment (Figure 7-28).
    - Make any other desired adjustments by using appropriate radio buttons.
- Close the custom fuel model interface when finished by clicking the same button, now called "**Close Custom**" (Figure 7-28).

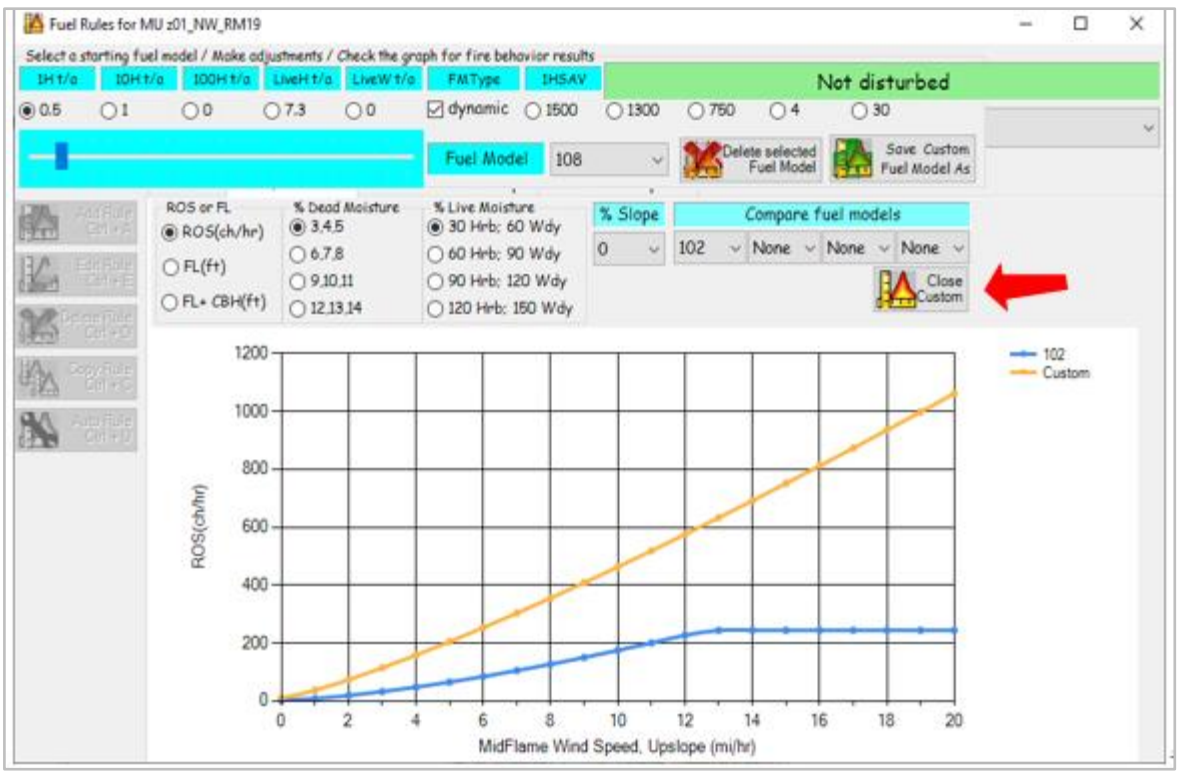

Figure 7-28: Create Custom Fuel Models page with Close Custom Fuel Model function.

- Once saved, the custom model will be available.

Distribution Graph

The **Distribution Graph** tab opens a graph that shows the distribution of acres of classified cover and height by life form that exist in the grid data for the entire FVT or by BpS or Wildcard (if a wildcard is used in the MU grid) (Figure 7-29).

You can use the **Distribution Graph** page (Figure 7-29) to view the height of the vegetation by cover and the numbers of acres present in the selected FVT within the defined MU.

The x-axis shows 10% breaks of cover by life form; the y-axis corresponds to the number of acres within the FVT in the MU's extent.

The legend displays the line indications by height corresponding to the percent cover and represents the number of acres.

To work with the Distribution Graph:

- Click on the **Distribution Graph** tab.
- Use the relevant drop-down menus to display the distribution of an FVT, BpS, or wildcard.

  ***Note**: In the legend a "T" is tree, "S" is shrub, and "H" is made up of herbaceous life form.*

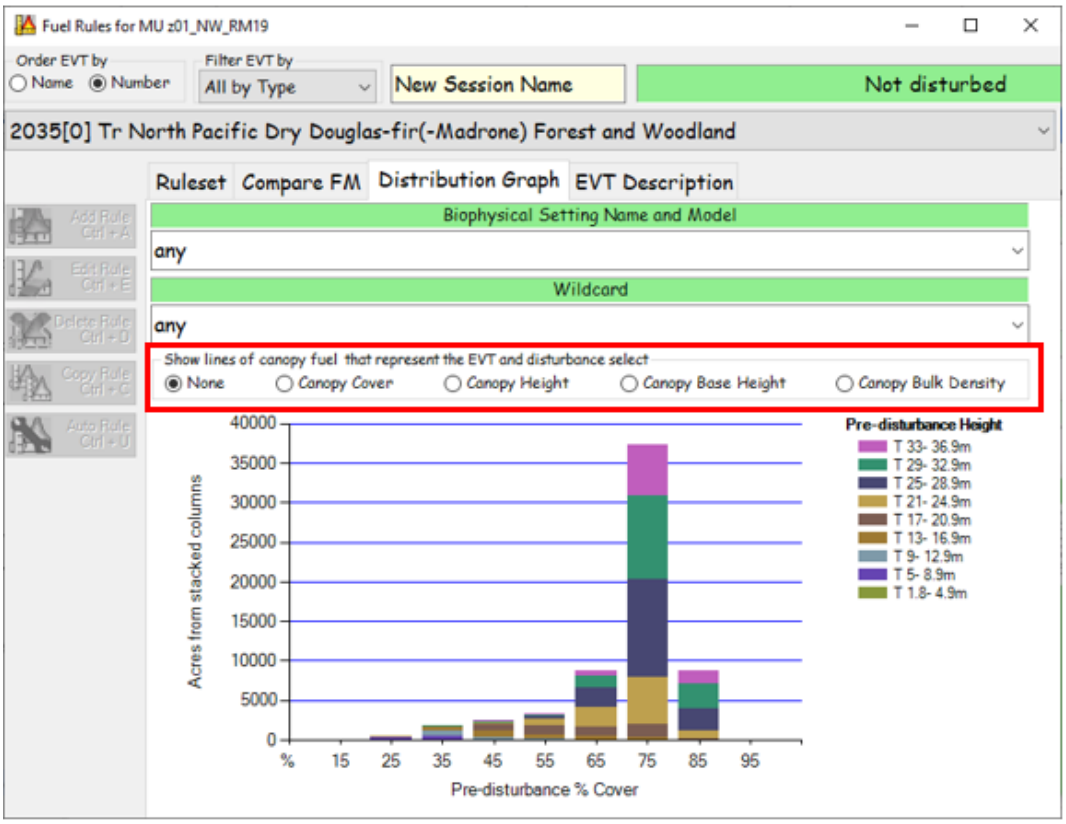

*Figure 7-29. **Fuel Rules** screen with **Distribution Graph** page displayed.*

***Note:** The selection buttons shown in the red square can add lines that represent what the predicted canopy fuel would be, non-disturbed and disturbed, for the selected FVT.*

EVT Description

Select the **EVT Description** tab to display an ecological description. This NatureServe website (https://explorer.natureserve.org/) serves as the basis for all LF EVTs.

7.6 Creating new Grids

Fuel characteristics can be edited or modified on a pixel by pixel basis, based on logical decisions determined by cover, height, vegetation, and biophysical settings incorporated into FBFMs.

Once the fuel rules have been added, deleted, or adjusted (7.5.4 Rule input options), you are ready to create the new layers.

- Select **FUEL GRIDs** on the LFTFC drop-down menu as shown (Figure 7-30).

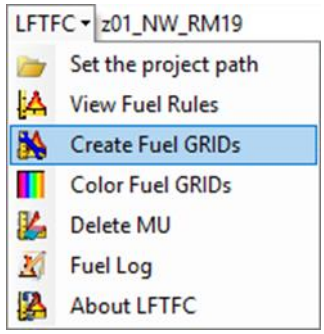

***Figure 7-30**. Use the LFTFC drop-down menu to select **FUEL GRIDs**.*

The following dialog box with the **GRID Selection** tab visible will open (Figure 7-31).

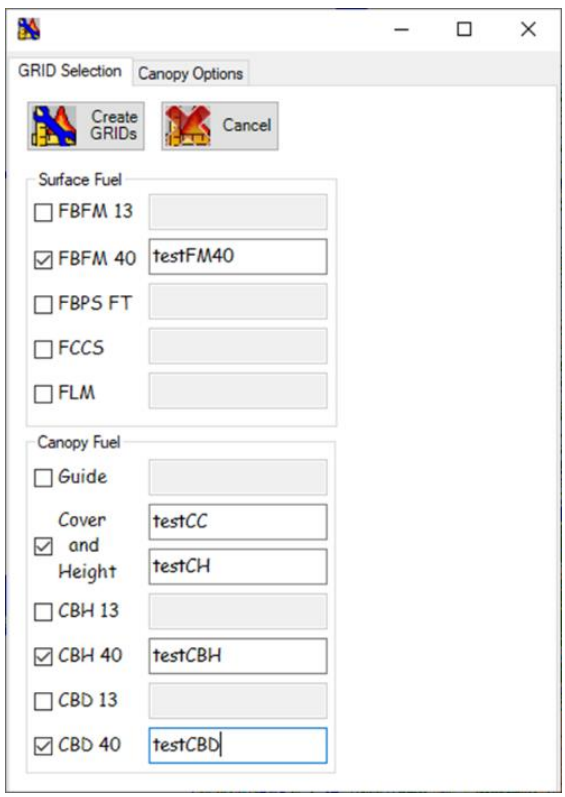

***Figure 7-31.** Fuel and canopy option selection box with **GRID Selection** screen visible.*

- Use the **GRID Selection** tab to create surface fuel layers.
- Select the layers you would like to include by checking the boxes to the left of the grid.
- Name the **Fuel layers** to be created in the box to the right of the selection.

  ***Note:** When naming the file, you do not need to include a file extension. However, the file name must not exceed a total of 13 characters in length and should not contain any spaces, leading numbers, or special characters (`~! @#$^()-+={ }[ ]|\?/:;'"< >, .).*

Tip: CBD 13/40 are the same and CBH 13/40 are the same, just check one box for each.

The **Canopy Options** page opens (Figure 7-32).

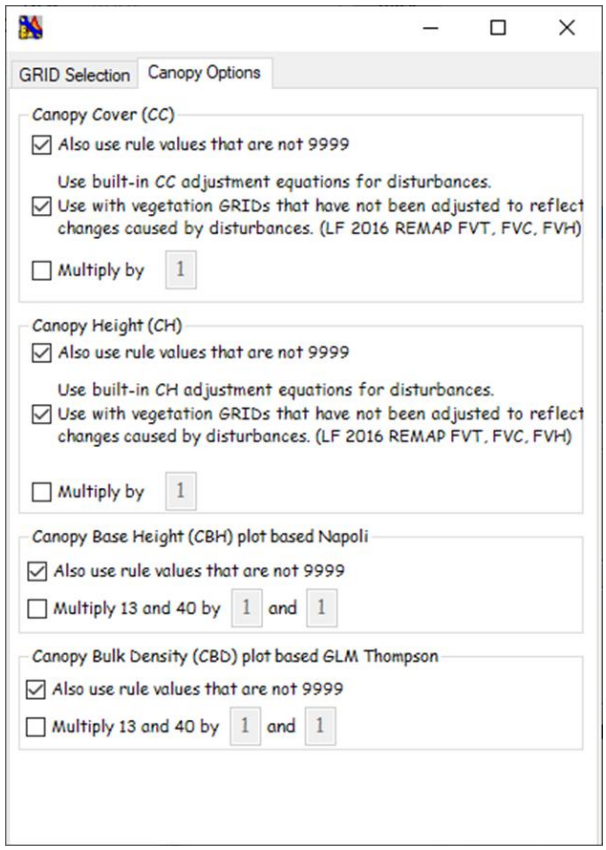

Figure 7-32. *GRID and canopy option selection box with* ***Canopy Options*** *screen visible.*

- CC and CH have three options:
  1. (Default) by using rules that are not coded as "9999" (indicating no data) in the rulesets to overwrite the predicted value.
  2. (Default) Use built-in adjustment equations for disturbances.
  3. Use a coefficient by which to multiply.
- CBH and/or CBD have two options:
  1. (Default) by using rules that are not coded as "9999" (indicating no data) in the rulesets to overwrite the predicted value.
  2. Use a coefficient by which to multiply.

  Note: *CBH and CBD are calculated using the pre-disturbance FVT, the value used for CC, and the value used for CH. The calculations for CBH and CBD can be overridden if option one is used, and a value is given in the fuel ruleset for a specific CBH and/or CBD rule.*

- When finished with both **GRID Selection** and **Canopy Options** tabs, make sure the **GRID Selection** page is open and click the **Create GRIDs** button. (Figure 7-31).

Errors in grid creation are usually due to mistakes with naming conventions, naming grids too similarly, or using names that are too long. If any pixels are left behind, a message will appear telling you which FVT has missing pixels and asking you if you would like to continue.

> **Tip**: If more changes are needed, go back to the rules, make your changes, and then create the grids again.

***Note**: The presence of "9999s" indicates that no relevant data are present in the grid.*

7.7 Fuel grid color palette

Fuel grid colors of your choice can be applied to FBFM13 and FBFM40, as well as to the CFBPS FM.

- To apply fuel grid colors, click **FUEL Color** on LFTFC's drop-down menu (Figure 7-33).

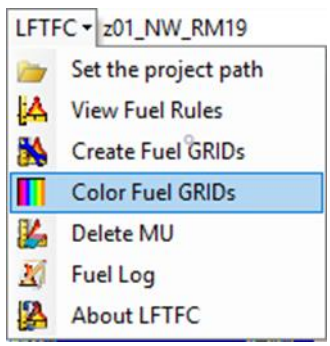

***Figure 7-33. Select FUEL Color** from the drop-down menu.*

The **Fuel Color Renderer** dialog box opens, as shown below (Figure 7-34).

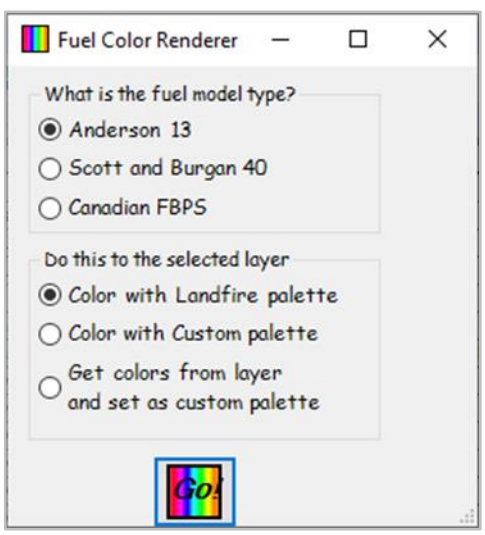

***Figure 7-34. Fuel Color Renderer** dialog box.*

The first box (**What is the fuel model type?**) is used to select the surface fuel layer.

- Select the option of your choice (FBFM13, FBFM40, or CFBPS FM

The second box (**Do this to the selected layer**) selects one of three possible options to set the color or to obtain the colors from the selected surface fuel layer. The user may choose to color selected layers with a LF palette, a custom palette, or to obtain colors from a layer and then set as a custom palette.

- Complete the box as desired using the radio buttons to make your selection

7.8 Deleting fuel Management Units

Use this function to delete fuel MUs that you no longer need or have replaced.

- Click **FUEL MU Delete** on the LFTFC drop-down menu to delete selected Management Units (Figure 7-35).

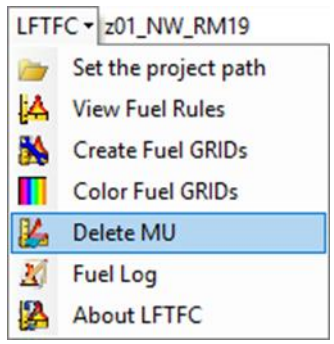

Figure 7-35. *Select* ***FUEL MU Delete*** *from the LFTFC drop-down menu.*

The following **Delete MU** dialog box will open (Figure 7-36).

- Click "**Yes**" to confirm your deletion.

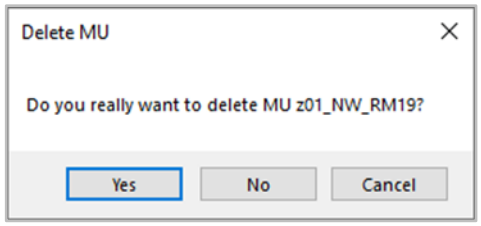

Figure 7-36. *Dialog box verifying deletion of MU.*

7.9 Fuel Log

The **Fuel Log** selection on the drop-down menu creates a text file consisting of all the changes and notes made for the life of the fuel rulesets.

- Select **FUEL Log** on the LFTFC drop-down menu to view the text file (Figure 7- 37).

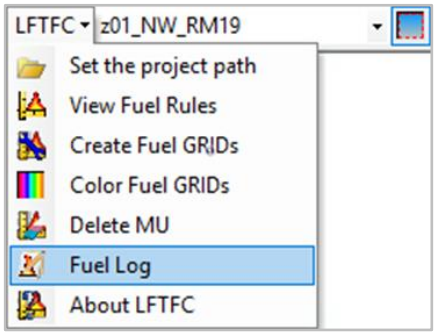

Figure 7-37. *Use the drop-down menu to open the FUEL Log file.*

7.10 About LFTFC

Clicking on **About LFTFC** in the drop-down menu displays the following screen (Figure 7-38), which includes information on version number and tool development.

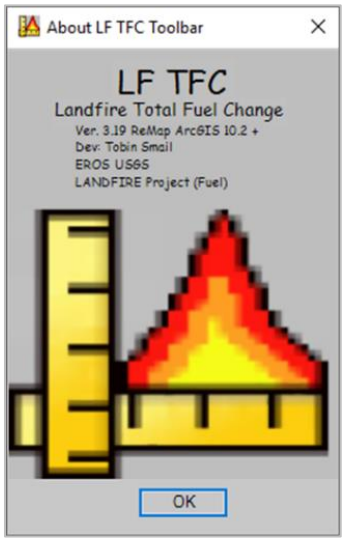

Figure 7-38. *"About LFTFC" screen.*

Chapter 8: Troubleshooting LFTFC – Common Errors, Symptoms, and Solutions

8.1 Common problems
8.1.1 Installation errors
8.1.2 Naming problems

8.1 Common problems

8.1.1 Installation errors

Be sure to uninstall any previous versions of LFTFC that may already be installed on your computer (see Chapter 5: Installing LFTFC Toolbar Add-in for additional information).

8.1.2 Naming problems

Errors in grid creation are usually due to mistakes with naming conventions, naming grids too similarly, or using names that are too long. File names must not exceed a total of 13 characters in length and should not contain any spaces, leading numbers, or special characters (`~! @#$^()-+={ }[ ]|\?/:;"'< >, .).

If any pixels are left behind, a message will appear telling you which EVT has missing pixels and asking you if you would like to continue.

To report a bug, please go to the Contact Us web page at https://www.landfire.gov/contactus.php or email us directly at helpdesk@landfire.gov.

Appendix A: References

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Appendix B: LF Canopy Cover and Height Classification

B.1 Canopy Cover Classification

TREE		
101	≥ 10	< 20
102	≥ 20	< 30
103	≥ 30	< 40
104	≥ 40	< 50
105	≥ 50	< 60
106	≥ 60	< 70
107	≥ 70	< 80
108	≥ 80	< 90
109	≥ 90	≤ 100
SHRUB		
111	≥ 10	< 20
112	≥ 20	< 30
113	≥ 30	< 40
114	≥ 40	< 50
115	≥ 50	< 60
116	≥ 60	< 70
117	≥ 70	< 80
118	≥ 80	< 90
119	≥ 90	≤ 100
HERBACEOUS		
121	≥ 10	< 20
122	≥ 20	< 30
123	≥ 30	< 40
124	≥ 40	< 50
125	≥ 50	< 60
126	≥ 60	< 70
127	≥ 70	< 80
128	≥ 80	< 90
129	≥ 90	≤ 100

B.2 Canopy Height Classification

TREE		
	Range (in meters)	
603	1.8	4.9
607	5	8.9
611	9	12.9
615	13	16.9
619	17	20.9
623	21	24.9
627	25	28.9
631	29	32.9
635	33	36.9
639	37	40.9
643	41	44.9
647	45	48.9
651	49	Maximum
SHRUB		
	Range (in meters)	
502	0	0.5
507	0.5	1.0
520	1.0	3.0
530	3.0	Maximum
HERBACEOUS		
425	0	0.5
475	0.5	1.0
499	1.0	Maximum

Appendix C: Downloading data using the LF Data Access Tool (LFDAT)

1. Once you are familiar with the LF Data Distribution site, acquiring LF data using the LF Data Access Tool (LFDAT) is the most efficient method and recommended if a broadband Internet connection is available. LFDAT allows a user to download and process LANDFIRE data directly within ArcMap.
2. LFDAT can be obtained directly from the LF web page (https://landfire.gov/download_lfdat.php#lftfct). Because the following information only briefly describes the use of the LFDAT, it is strongly recommended that the LFDAT tutorial be taken prior to this tutorial (The tutorial is found at the same location as the tool).
3. Open ArcMap to a new map document. From the LFDAT toolbar, click on LANDFIRE Map Zone down arrow and select a map from where you want to download data (CONUS, Alaska, or Hawaii).
4. To begin, click the **Get LANDFIRE National Map Data** tool icon: . With the tool, click to the upper left of the area of interest and drag a box to the lower right (Figure C-1).

Draw a box as many times as needed until you have the extent that you want. To do so, you will need to close out the *Download Data* window that appears after every extent box has been drawn.

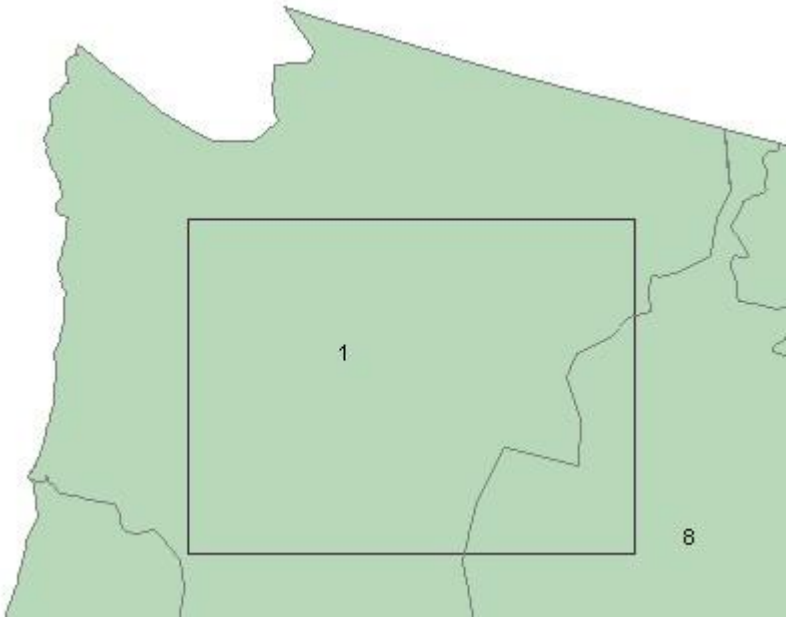

Figure C-1. Draw extent box.

5. Once you have the extent you want, save the extent in the *Download Data* window by typing a meaningful name in the box labeled *Save this extent as:* and click the **Save** icon: . You will only need to do this once for each extent.

This allows you to go back and download additional data with the same extent.

6. Click the down arrow to the left of *Request Download* and select the desired layer. For demonstration purposes, we chose the first layer, *13 Anderson Fire Behavior Fuel Models* (Figure C-2).

Figure C-2. *Request Download from LANDFIRE Data Distribution site.*

If you experience difficulties downloading data from the LF DDS via LFDAT, click the About LANDFIRE Data Access Tool button on the LFDAT toolbar and check for updates. If you continue to have problems, open your Internet browser to the LF DDS (http://landfire.cr.usgs.gov/viewer/) and click on **Help for LF Data Access Tool**.

7. With the 13 Fire Behavior Fuel Models selected from the list, click on the **Request Download** button. This button initiates a process that extracts the data from the Data Distribution site.
8. Click on the **Download** button from the *SDDS Request Summary Page* to save the data to your computer. After the Raster Extract completes, a File Download dialog box appears. Click **Save.**
9. In the *Save As* dialog box, navigate to a location of your choice. There are many options for assembling the data with LFDAT or by your own preference. For instructions on how to assemble and process LF data with LFDAT, please refer to the User Guide and Tutorials that are available with the software download.