Upper Huerfano Fire Protection District
Fire Behavior Analysis

## 2021

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General Information

The Upper Huerfano Fire Protection District (FPD) is located in the northwest portion of Huerfano county. It is comprised of approximately 336,000 acres and ranges in elevation from 6,700 to the 14,344 foot Blanca Peak. The greater majority of the lands within the FPD are privately owned properties with some limited Bureau of Land Management and U.S. Forest Service lands. The largest town in the district is Gardner with few other towns in the district. Redwing is a small ranching community to the southwest of Gardner. There are few subdivisions within the district however there are many areas with concentrations of homes.
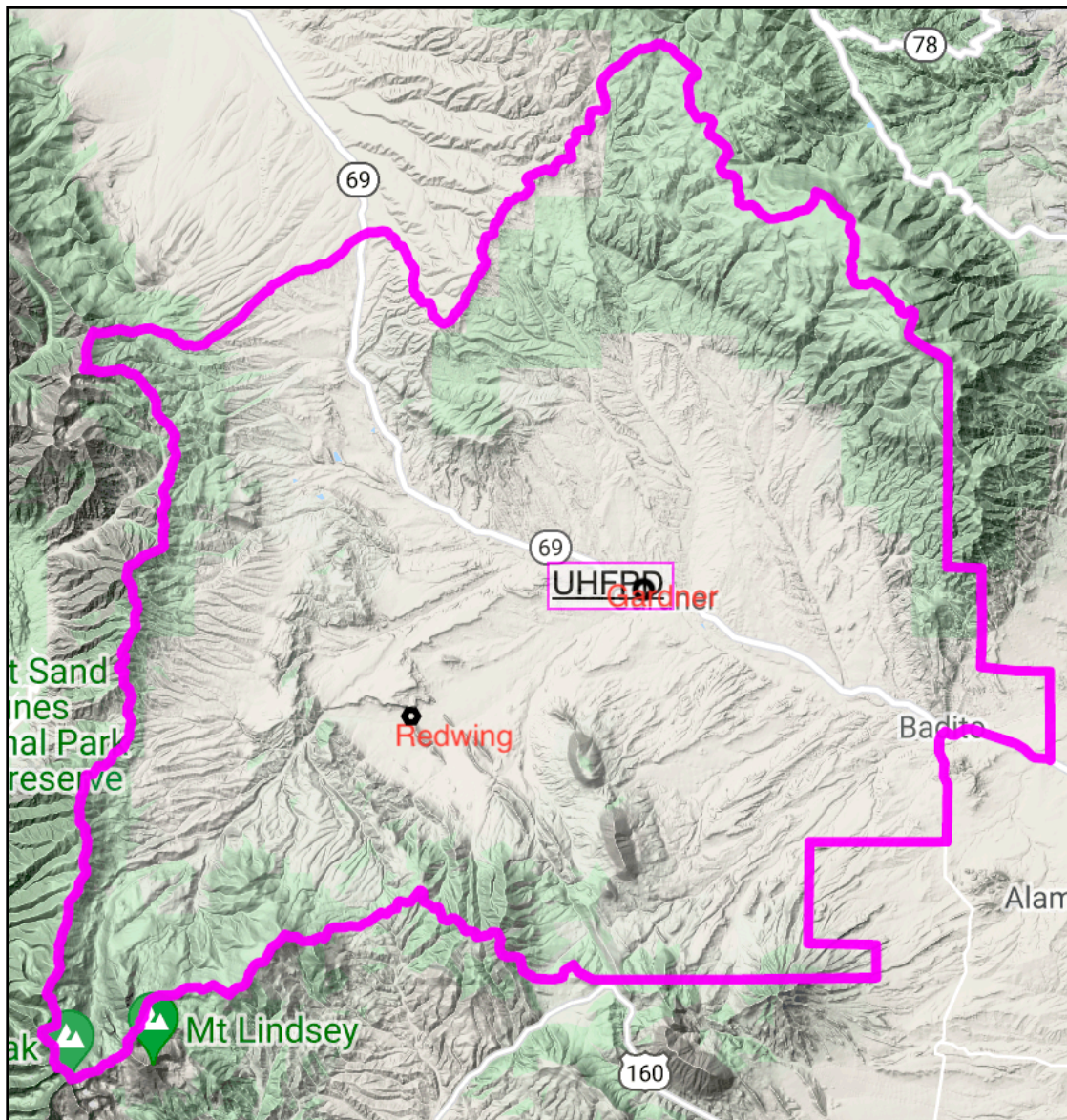
Fuel Model Information

The first step in this analysis was to use a Geographic Information System (GIS) based program to generate a landscape layer that included a fuel model layer for the area surrounding the subdivision. The basic characteristics of the layer can be scaled depending on the size of the landscape needed for analysis. The landscape is cut into squares (pixels) for analysis but is still a fairly coarse filter. In this case the pixels are 90 meters square, primarily due the size of the landscape. Several outputs are generated that can be overlaid on a base layer, such as a Google Earth satellite image. This does not generate a fire growth model nor does it imply that fire in one pixel influences fire in the adjoining pixels. Simply put, it is a way to see fire behavior calculations over a landscape in a spatial manner, rather than as numerical outputs.

Basic fire behavior runs were created using the Wildland Fire Decision and Support System (WFDSS) created by the Missoula Fire Lab and an inter-agency staff at the National Fire and Aviation Executive Board. The basic fire behavior outputs from the model use an extension of FlamMap to compute potential fire behavior characteristics (such as spread rate, flame length, and fireline intensity) over an entire landscape using constant weather and fuel moisture conditions for an instant in time. (https://wfdss.usgs.gov/wfdss/pdfs/intro_flammap3_(desktop).pdf)

The following information is primarily taken from Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model, Scott & Bergen, published by the USDA Forest Service, General Technical Report RMRS-GTR-153.

Within the FPD, each fuel model that carries fire, have specific fire behavior characteristics that can be measured; flame length, rate of spread (measured in chains per hour, ch/h) and crown fire activity, to name a few.   The fuel model layer shows examples of plant communities that are present within the fire protection district.

The following list are descriptions of the fuel models that are present within the Upper Huerfano Fire Protection District.

GR1 - 101 Sparse grass that is generally short, either naturally or by grazing. Spread rate is low (2-5 ch/h); flame length low (1-4 ft.). Primarily grasses that have been mowed or are just sparse in continuity. (Light Straw Yellow)

GR2 - 102 Moderately coarse continuous grass, average depth about 1 foot. Spread rate high (20-50 ch/h); flame length moderate (4-8 ft). (Medium Sunshine Yellow)

GR4 - 104 Moderately coarse continuous grass, average depth about 2 feet. Spread rate very high (50- 150 ch/h); flame length high (8-12 ft.). (Bright yellow)

GS1 - 121 Shrubs are about 1 foot high, low grass load. Spread rate moderate; flame length low. (Light Olive Drab)

GS2 - 122 Shrubs are 1 to 3 feet high, with a moderate grass load. Spread rate high (50-150 ch/h); flame length moderate (4-8 ft). Primarily a mixed shrub community with rabbit brush, greasewood and ornamental shrubs such as ground juniper. (Dark Olive Drab)

SH1 - 141 Low shrub fuel load, fuelbed depth about 1 foot; some grass may be present. Spread rate very low (0-2 ch/h); flame length very low (0-1 ft.). (Light Brown)

SH2 - 142 Moderate fuel load (higher than SH1), depth about 1 foot, no grass fuel present. Spread rate low (0-2 ch/h); flame length low (0-1 ft.). (Medium Brown)

SH5 - 145 Heavy shrub load, depth 4 to 6 feet. Spread rate very high (50-150 ch/h); flame length very high (12-25 ft.). (Medium Maroon)

SH7 - 147 Very heavy shrub load, depth 4 to 6 feet. Spread rate high (20-50 ch/h); flame length very high (12-25 ft). Primarily Gambel oak and alder species. (Maroon)

TU1 - 161 Fuelbed is a low load of grass and/or shrub with leaf and needle litter. Spread rate low (2-5 ch/h); flame length low (1-4 ft.). Primarily mixed conifer and aspen species. (Light Green)

TU5 - 165 Fuelbed is high load conifer litter with shrub understory. Spread rate moderate (5-20 ch/h); flame length moderate (4-8 ft). Mixed conifer species with Douglas fir and white fir intermixed with an occasional ponderosa pine. (Dark Green)

TL1 - 181. Light to moderate load, fuels 1 to 2 inches deep. Spread rate very low (0-2 ch/h); flame length very low (0-1 ft.). (Light Baby Blue)

TL2 - 182 Low load, compact timber litter. Spread rate very low (0-2 ch/h); flame length very low (0-1 ft).   Broadleaf litter from Aspen stands. (Bright Cyan Blue)

TL3 - 183 Moderate load conifer litter. Spread rate very low (0-2 ch/h); flame length low (1-4 ft). Ponderosa pine and other mixed conifer species. (Denim Blue)

TL5 - 185 High load conifer litter; light slash or mortality fuel. Spread rate low (2-5 ch/h); flame length low (1-4 ft.). (Dark Denim Blue)

TL6 - 186 Moderate load, less compact. Spread rate moderate (5-20 ch/h); flame length low (1-4 ft.). (Light Turquoise Blue)

TL8 - 188 Fuelbed composed of long-needle pine litter with moderate load and compactness may include small amount of herbaceous load. Spread rate moderate (5-20 ch/h); flame length low (1-4 ft). Primarily ponderosa pine leaf litter. (Medium Turquoise Blue)

TL9 - 189 Very high load broadleaf litter; heavy needle-drape in otherwise sparse shrub layer. Spread rate moderate (5-20 ch/h); flame length moderate ((4-8 ft.). (Dark Blue Green)
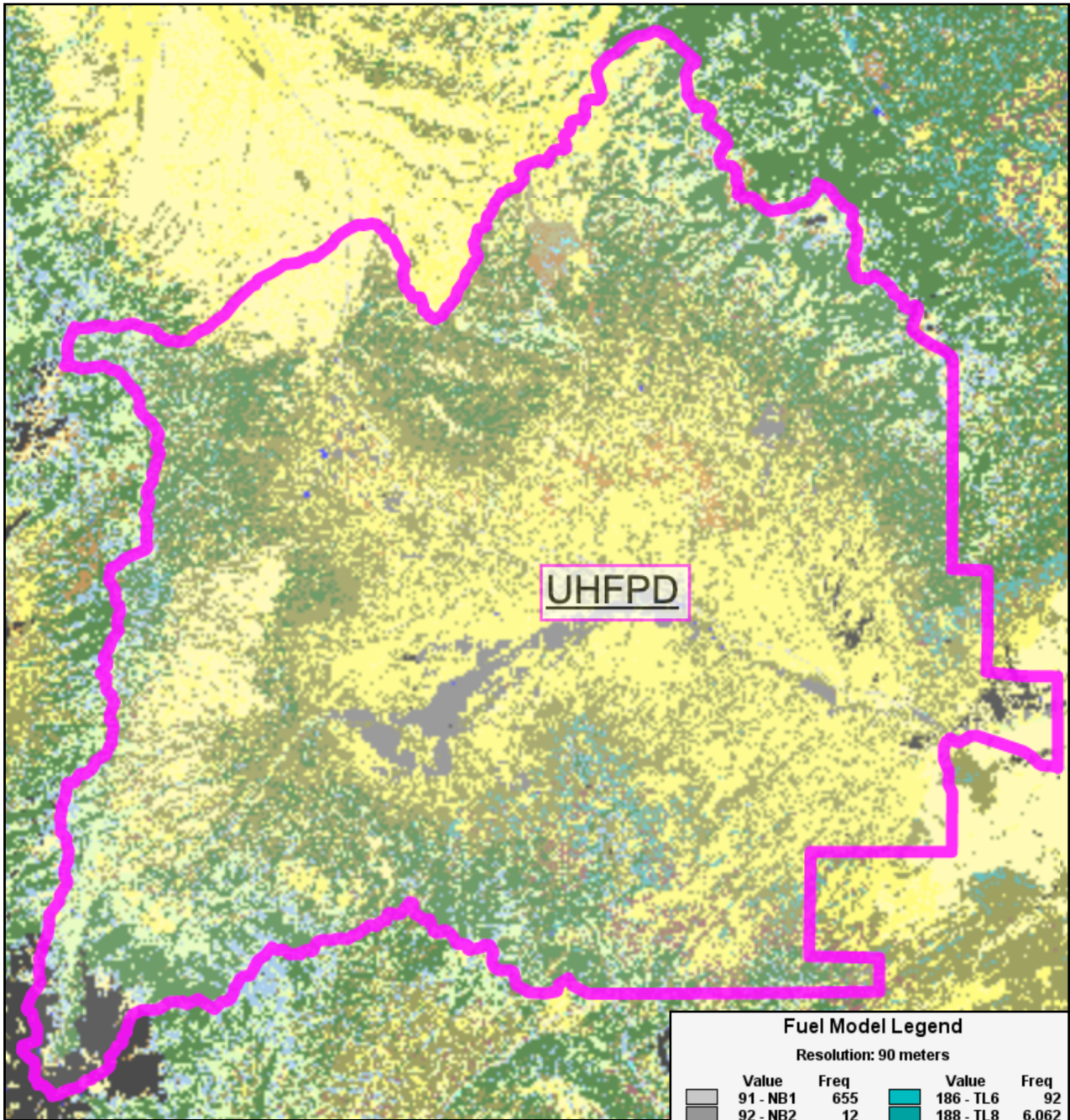
Fuel Model Legend

Resolution: 90 meters

Value	Freq		Value	Freq
91 - NB1	655		186 - TL6	92
92 - NB2	12		188 - TL8	6,062
93 - NB3	345		189 - TL9	2
98 - NB8	136		No Data	379
99 - NB9	4,138			
101 - GR1	2,280			
102 - GR2	18,917			
104 - GR4	27			
121 - GS1	1,402			
122 - GS2	28,004			
141 - SH1	1,393			
142 - SH2	1,243			
145 - SH5	80			
147 - SH7	7,997			
161 - TU1	14,961			
165 - TU5	59,451			
181 - TL1	761			
182 - TL2	432			
183 - TL3	13,170			
185 - TL5	199			

Upper Huerfano FPD Fuel Model Output

When viewing the fuel model information in the graphic above, one thing to note is that the landscape has not been updated within LandFire for the Spring Creek fire of 2018. The lower central portion of the FPD should have much more altered fuel models than is shown, meaning that there should be less of the green timber understory and brown shrub fuel models and most likely more of the yellow grass fuel models. Fuel models can be altered within WFDSS when doing these types of analyses but it is not as accurate as when it is updated for the disturbance. The fire perimeter can be overlaid on the landscape and individual fuel models changed to what would be a guess as to what the current fuel model might be, but this will not account for where islands of non-burned original fuel models were left behind. Given time, updates to the fuel models will be made by the LandFire team from satellite imagery and a more accurate display of fire behavior can be made.

At this point in time however it can be assumed that within the foot print of the Spring Creek fire, any fire behavior for the next several years will be less severe than predicted by this analysis. The upper left corner of the FPD shows the Medano fire from 2011 and this area has been updated by LandFire.

The legend for the fuel models gives a frequency of occurrence for each fuel model that is within the rectangle. A quick glance at the distribution shows that there is a large percentage of grass and grass/shrub (yellow and light browns) in the greater majority of the FPD. The predominance of the greens in the northeast, west and southern edges of the FPD shows the forested areas that are dominated by timber understory and timber litter fuel models. The timber understory models are primarily mixed conifer forests with a scattering of aspen mixed in. The timber litter models are mostly ponderosa pine stands.

Since fire behavior within the Spring Creek Fire was such high intensity on most of the landscape, it can be assumed that given the same weather and climate conditions, a fire might act and behave very similarly in the timber stands at the southwestern and northeastern ends of the FPD.
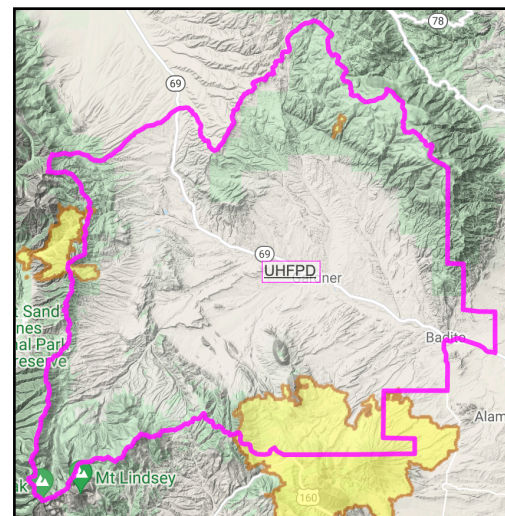
Baseline Modeling

Modeling for this assessment used some basic assumptions to arrive at a baseline of data and then created additional runs to try to build an array of scenarios that could lead to recommendations for mitigation work. Fuel model data is from the LandFire 2014 v.1.4.0 that is part of Wildfire Decision Support System (WFDSS). LandFire is a national database that is used to create spatial data for inputs into many modeling systems such as WFDSS. It is created using satellite images that are interpreted so as to arrive at many different parameters such as slope, crown density, and fuel models. In the process of doing satellite photo interpretation, very little is known about what if any work has been done on a particular piece of ground.

> "Predicting the potential behavior and effects of wildland fire is an essential task in fire management. Mathematical surface fire behavior and fire effects models and prediction systems are driven in part by fuelbed inputs such as load, bulk density, fuel particle size, heat content, and moisture of extinction. To facilitate use in models and systems, fuelbed inputs have been formulated into fuel models. A fuel model is a set of fuelbed inputs needed by a particular fire behavior or fire effects model. Different kinds of fuel models are used in fire science….. " (Scott and Burgan, 2005).

In this assessment the important assumption is that for each run of modeling no changes to structure within a fuel model has been made, such as thinning or limbing of trees.

Weather data for the baseline model tries to replicate the very dry conditions that were present very near the day the Spring Creek fire started on 6/29/2018.

Given:

Fire start date: 6/26/2018
Fire start time: 1300
Weather station data: Black Mountain RAWS station 10 miles north of the town of Gardner.

Foliar moisture content: 80%, down from the norm of 100%
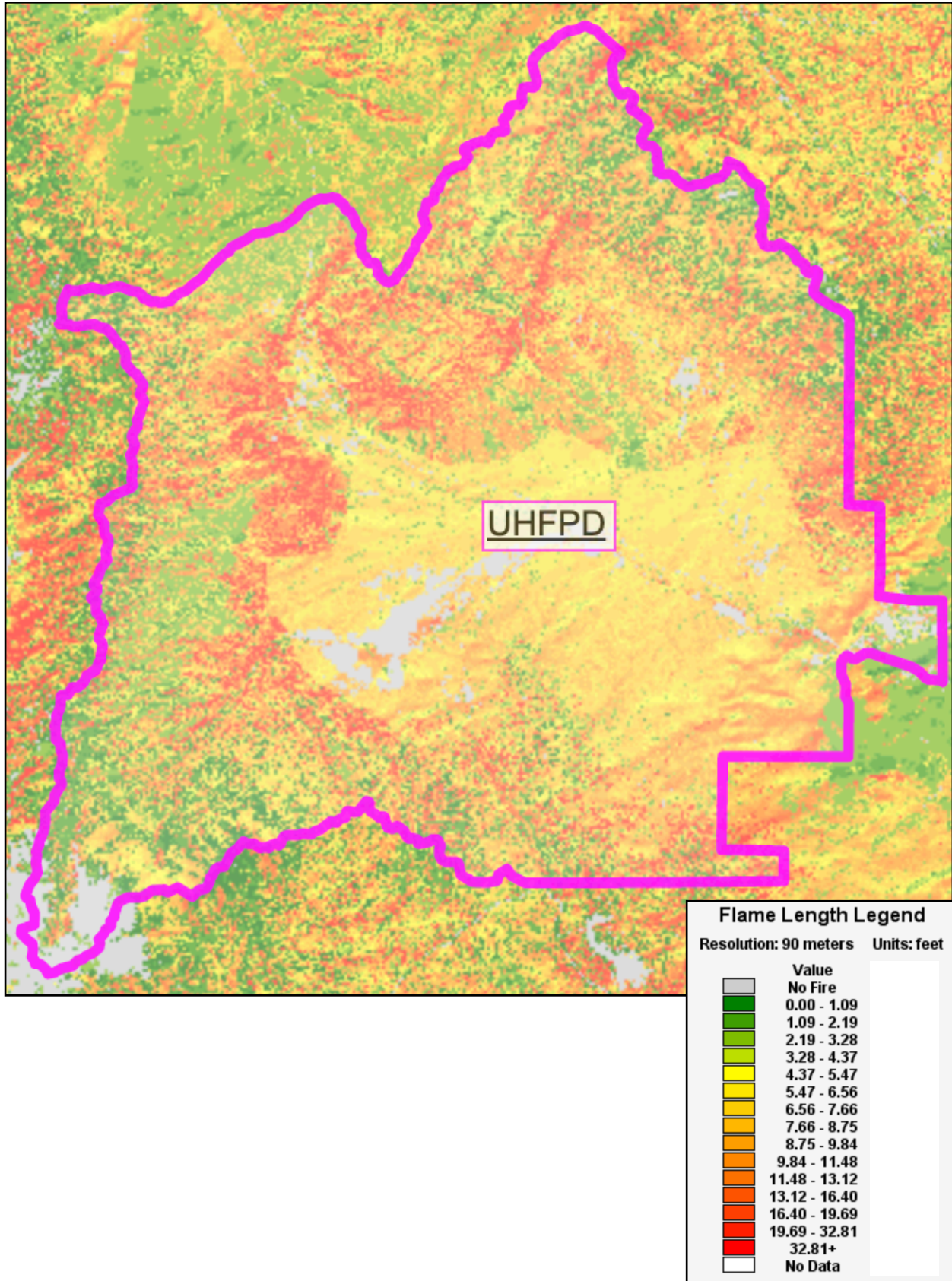Wind speed: 21 mph
Wind Direction: 220 degrees azimuth
Fuel Moisture: Dead fuel moisture, 1hr - 3%, 10hr - 4%, 100 hr - 5%
             Live fuel moisture, Herbaceous - 40% and Woody 70%.

Flame Length Legend

Resolution: 90 meters   Units: feet

|	Value
	No Fire
	0.00 - 1.09
	1.09 - 2.19
	2.19 - 3.28
	3.28 - 4.37
	4.37 - 5.47
	5.47 - 6.56
	6.56 - 7.66
	7.66 - 8.75
	8.75 - 9.84
	9.84 - 11.48
	11.48 - 13.12
	13.12 - 16.40
	16.40 - 19.69
	19.69 - 32.81
	32.81+
	No Data

UHFPD

Upper Huerfano Flame Length Output

Flame length output: Flame length is one of many possible fire behavior characteristics that can be used to quantify effects on a landscape. Flame length has a fairly direct correlation for the ability to control or fight a fire. There is no simple formula for arriving at flame lengths since there are many variables that come into play to estimate the length of flames in a fire, such as wind speed, air temperature, relative humidity, dew point, and live and dead fuel moisture content, just to name a few. Just because a fuelbed is primarily made of short grasses, doesn't mean it will have short flame lengths, quite the contrary, it could have long flame lengths but shorter duration fire. Conversely a stand of dense timber with a dense short needle bed underneath won't automatically produce longer flame lengths, just because the trees are taller than the grass, there are some fuel models that in this case might only produce 1-2 foot flames.

The dark green to light green colors are in the 0 to 4 foot range, the light yellow to orange are 4 to 8 foot and the reds are 8 foot and above. The output from FlamMap shows that the greater majority of the fire protection district predicts to have flame lengths in the 4 - 8 foot range and about the same number of 11 feet and higher. Flame lengths in this example are measured in feet.

When viewing the overall picture of the Upper Huerfano FPD note the general trends of where flame lengths could be higher or lower than in other areas. The district has these particular zones of fuels or flame lengths associated with them. Knowing exactly where a pixel lies on the ground is not as important at this large a scale, but knowing that there seem to be trends in a certain area is notable.
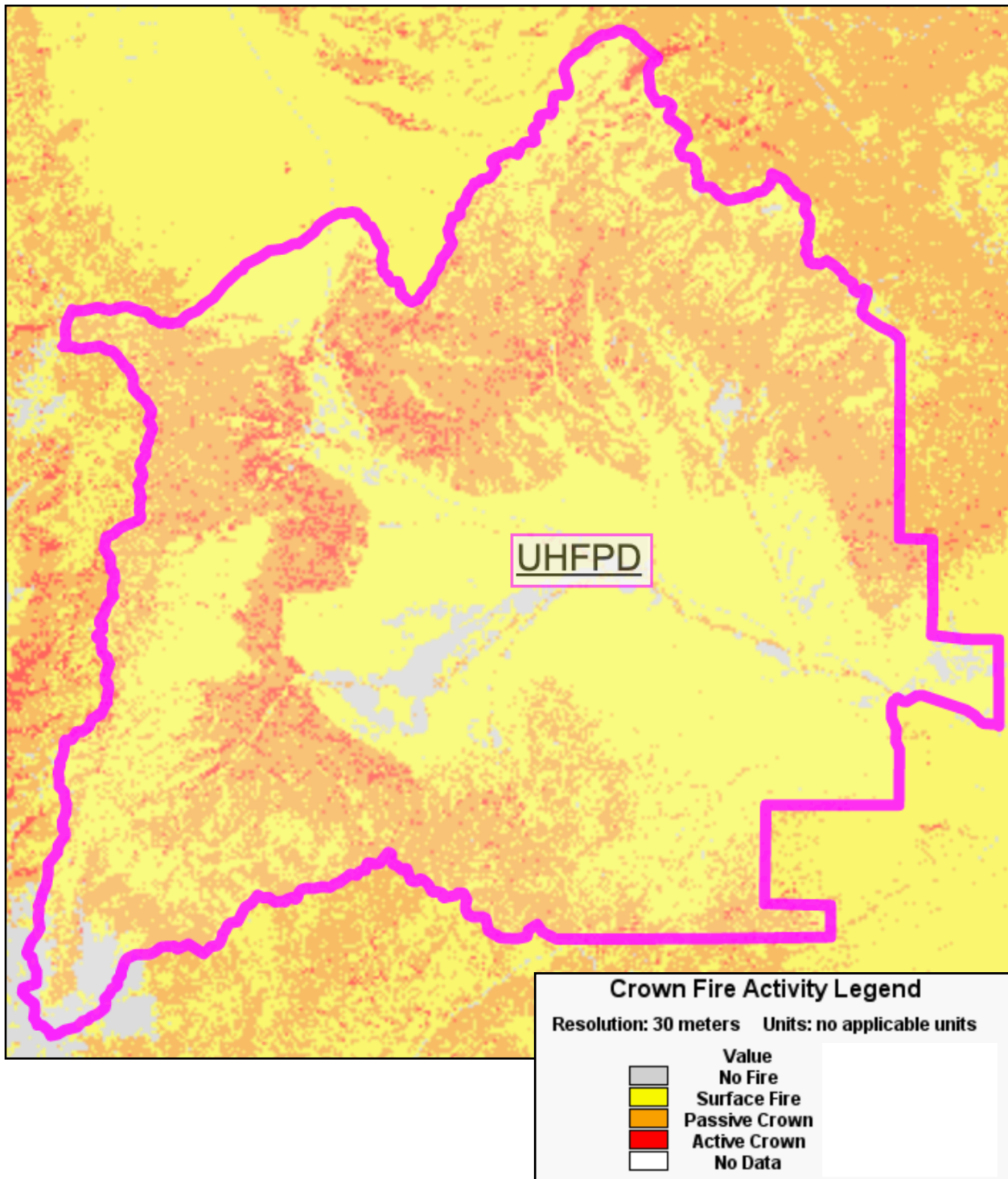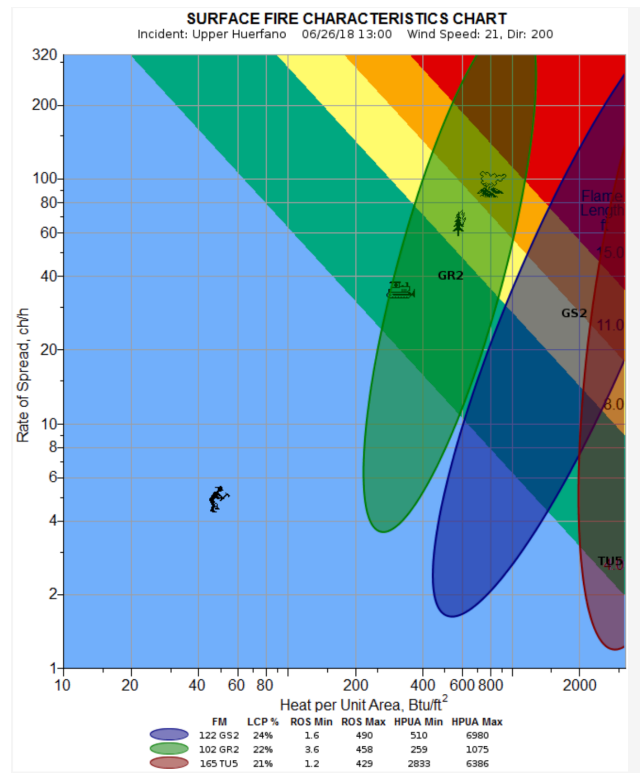
Upper Huerfano Crown Fire Activity Output

Crown Fire Activity output: FlamMap shows that Crown Fire activity for the FPD is mostly in the passive and surface fire categories and in relatively distinct zones.

Surface fire is a fire that is only on the surface litter and not in the crowns of the trees. Surface fires are much easier to control by hand crews and engine crews than other types of fire. Passive crown fire is a condition where trees independently torch the crowns and do not make large sustained runs from tree to tree. Passive crown fire is more problematic than surface fire in that when a tree torches it can throw fire brands into other trees, accumulations of leaves and needles on roofs and even into the eaves of houses, setting up a condition where structures could be lost. Passive crown fires generally require the use of water to help with control and hand crews are not very effective without some sort of support.

Given that this analysis assumes there has not been any mitigation work completed in the FPD or that the Spring Creek fire occurred in 2018, it can be assumed that depending on when a fire occurs during the day or what weather conditions that could present itself, passive crown fire activity could transition to active crown fire or only be surface fire.

Upper Huerfano Hauling Chart Output
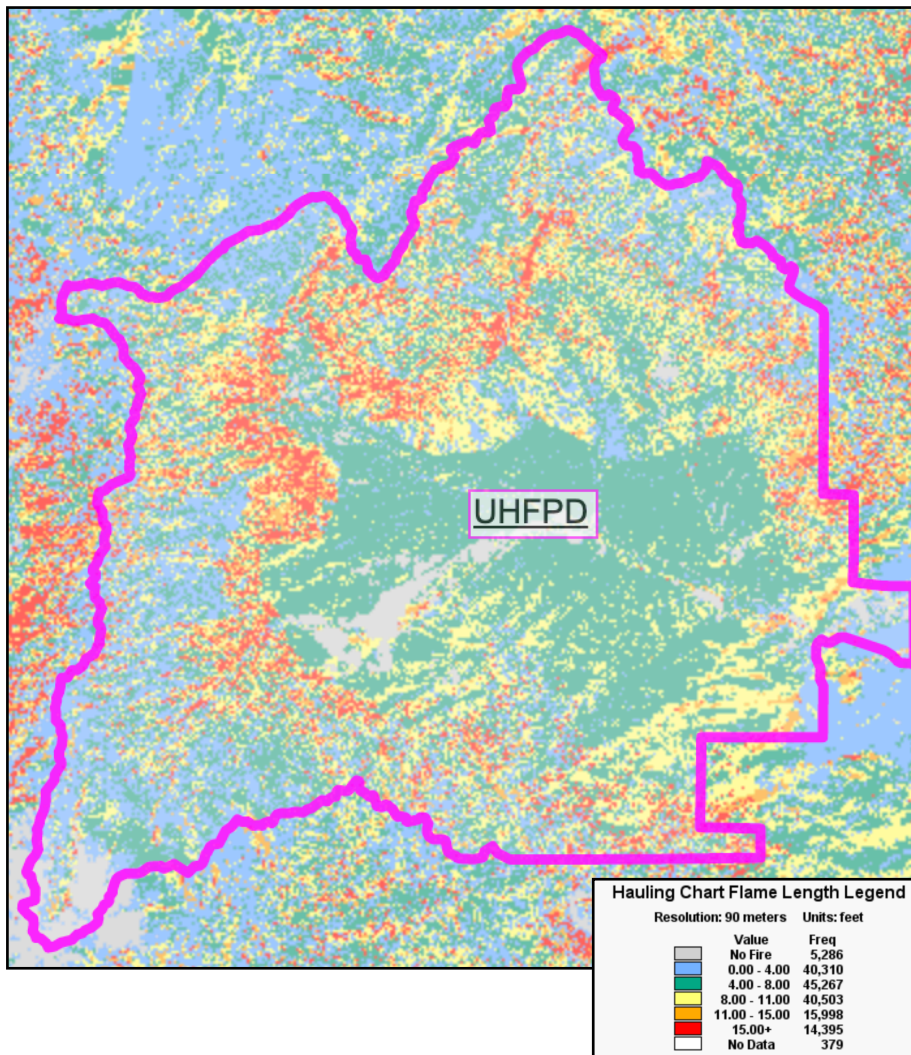
Hauling chart characteristics: One tool that fire managers use to help with analyzing what potentials a fire may have on the landscape is a chart called the Hauling chart. Outputs within the hauling chart help them to visualize areas where it might be easier to control a fire with just hand crews or where other resources might be needed. It is important to remember that this chart is tied back to the weather characteristics that are part of the inputs to the analysis and will change for each set of weather, time of year and fuel characteristics. In the attached analysis output one can see that there is a large percentage of the area in the blue or less than 4 foot flame length area, in the green or 4 - 8 foot flame lengths and the yellow or 8 - 11 foot flame lengths. The orange and red areas that are the 11 foot and over flame lengths and are in a distinct zone or elevation around the central valley. Some of these areas are within the Spring Creek fire footprint and would not be so problematic now and for the next several years since most of the heavier and flashier fuels have changed to less reactive fuels.
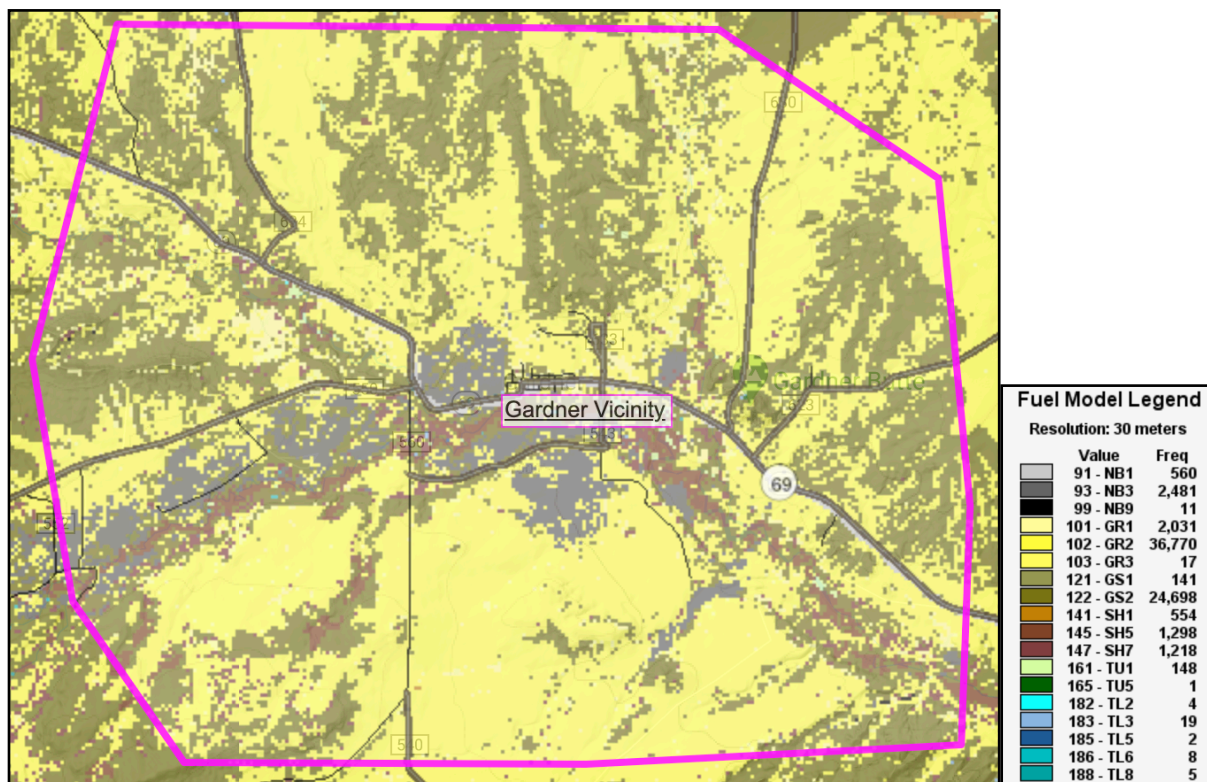

SURFACE FIRE CHARACTERISTICS CHART
Incident: Upper Huerfano   06/26/18 13:00   Wind Speed: 21, Dir: 200

FM	LCP %	ROS Min	ROS Max	HPUA Min	HPUA Max
122 GS2	24%	1.6	490	510	6980
102 GR2	22%	3.6	458	259	1075
165 TU5	21%	1.2	429	2833	6386

Area Specific Analysis

This next section will follow in a loose outline similar to the previous section to show the fuels in that analysis area and the subsequent fire behavior attributes but in a much more detailed manner. Each of the map outputs will be using a finer resolution, 30 meter pixels, to display the potential fire behavior within the area. In the case of the Gardner area the analysis area goes out about a two - two and half mile vicinity of the town and in the County Road 580 area it will be within one mile of the county road.

Gardner

The fuel models for the Gardner area are mostly in the grass and grass/shrub models with a few exceptions of non-burnable models. Along the creek bottoms in the riparian areas there is a significant amount of pure shrub models that are most likely willows, service berry and sumac. This area of the FPD has very limited amounts of Gambel oak. What limited areas of timber litter that are showing are under cottonwoods along the riparian area and/or an occasional blue spruce that has cropped up along the stream bottom.

Gardner Area Fuel Model Output