VALLES CALDERA NATIONAL PRESERVE

Wildland Fire Environment

Existing Condition Report

VALLES CALDERA TRUST

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Existing Condition – Wildland Fire Environment

This section provides an assessment of the current fuels and fire hazard within the Valles Caldera National Preserve considering the historical fire weather conditions, current fuel conditions, and fire behavior potential within the preserve.

Methodology

Fuels Data Acquisition, Critique, and Modification

A considerable amount of vegetation data has been developed for the VCNP. Plant alliances have been mapped at a six meter resolution preserve-wide (Muldavin E., 2006) and the vegetation of the preserve has also been delineated from aerial photography and entered into a corporate geodatabase. The forested stands stratified by composition and structure into 35 strata for inventory which was conducted preserve-wide using common stand exam inventory protocol (intensive Tree, Fuels, Vegetation Composition), entered into FSVEG, and exported into an FVS database. Although the FVS data included the necessary attributes for assessing stand-level fire behavior potential it was not appropriate or at the extent required for the desired landscape scale assessment. Therefore, LANDFIRE (www.landfire.gov) data was also downloaded for an extent expanding beyond the VCNP boundary which also incorporates the Southwest Jemez Mountains Landscape (SWJML) Assessment project area of which the VCNP is a part of as shown in Figure 1.

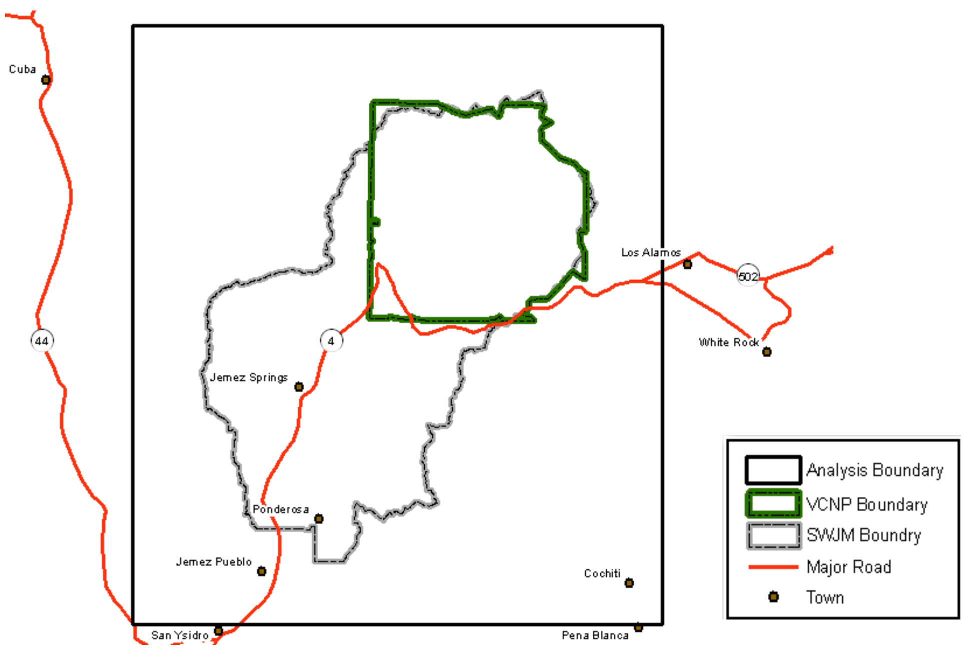

Figure 1 - Map of analysis area with VCNP and SWJM Landscape Assessment area boundaries.

LANDFIRE is a national vegetation and fuels mapping project that provides nationally consistent and seamless geospatial data products for use in strategic wildland fire analysis and modeling. LANDFIRE geospatial data layers of elevation, aspect, slope, fire behavior fuel model, canopy cover, canopy height, canopy base height, and canopy bulk density are used together to make up the "landscape" file required by the FlamMap fire behavior modeling system (Finney, 2006) used in this analysis.

LANDFIRE data, as well as any other geospatial dataset, requires careful evaluation especially when being applied at local scales (Stratton, 2009). In collaboration with the Santa Fe National Forest a workshop was held to critique the LANDFIRE data to be used at the larger SWJM Landscape Assessment extent. Modifications were made to the data based on field visits, local knowledge, comparison to local fuel data sources (including the VCNP inventory), and knowledge and expertise of LANDFIRE fuel mapping methodology. The following observations and modifications were made to the LANDFIRE National[1] data within the assessment area:

- In some vegetation types fire behavior fuel model modifications were made to better reflect the primary fire-carrying fuel type and fuel loading
- Canopy cover generally appeared high and was modified as recommended in the December 2006 LANDFIRE notification: http://www.landfire.gov/notifications16.php
- Canopy base height generally appeared high and was modified as recommended in the December 2006 LANDFIRE notification: http://www.landfire.gov/notifications15.php
- All layers were reprojected to the local NAD 1983, UTM zone 13 north coordinate system to minimize true north/grid north distortion (http://www.landfire.gov/notifications21.php)

A custom fuel model was developed for the wet meadows within the VCNP. These areas are characteristic of a high load grass model; however, their live fuel moistures are much higher than the upland grasslands. The custom fuel model (114) was developed with the same fuel characteristics as GS4 (104); however, the live fuel moistures are modeled differently.

Historical Fire Weather Analysis

Remote Automated Weather Stations (RAWS) collect fire weather that is archived and available through KCFAST (http://fam.nwcg.gov/fam-web/kcfast/mnmenu.htm) and the Western Region Climate Center (http://www.raws.dri.edu/index.html). Weather for this analysis was initially obtained from two RAWS stations. The period of record and some station information is included in Table 1. The Jemez station data was determined to best represent the planning area based on input from the Santa Fe National Forest, the VCNP, and a review of the data.

[1] Three versions of LANDFIRE data were available at the time of this analysis: Rapid Assessment, National, and Rapid Refresh. LANDFIRE National was used for this analysis.

Table 1 - RAWS station information in the vicinity of the VCNP.

Station Name	Station Number	Record Period	Elevation (ft)
Jemez	290702	1966 - 2009	8000
Tower	290801	1964 - 2009	6500

Fuel moisture and wind drive fire behavior in each of the fuel models. Historic fire weather was analyzed to determine winds and fuel moisture conditions during the fire season using FireFamilyPlus (Systems for Environmental Management & USDA - Forest Service, 2002). FlamMap adjusts dead fuel moisture values for each pixel of the landscape to account for the effect of aspect, elevation, slope, and canopy cover. The adjustment is based on weather conditions preceding the analysis period, referred to as the conditioning period. Two conditioning periods were developed from the Jemez RAWS station data to represent dry and the driest (maximum) fuel moisture conditions recorded at the station. Wind speed and direction are direct inputs into fire behavior calculations. Hourly winds were assessed to determine direction and speed of predominant winds and the strongest winds recorded. Wind Wizard (Butler, et al., 2006) was used to model variability of wind speed and direction due to topography across the landscape Figure 2.

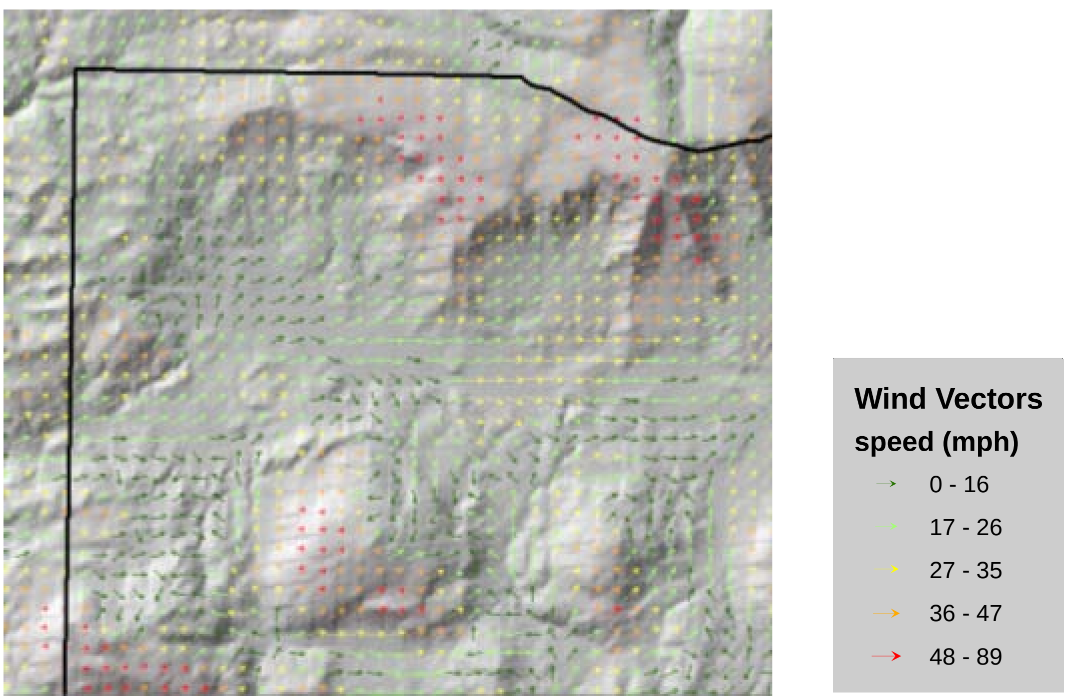

Figure 2 - Wind vectors depicting the influence of topography on wind speed and direction in the Valle San Antonio (northwest corner of the VCNP). Arrows represent speed and direction the wind is blowing.

Fire Behavior Potential

Fire behavior is driven by the combination of fuels, topography, and weather across the landscape. Surface fire (Figure 3, left) is fire that burns in the surface fuels (grass, shrubs, litter, dead and down branch wood, and short trees in contact with the ground surface). Crown fire refers to fire burning in the tree canopy. Two types of crown fire can be modeled in fire behavior modeling systems. Passive crown fire (Figure 3, center), also referred to as torching, kills individual or small groups of trees. Active crown fire (Figure 3, right), also referred to as continuous or running crown fire, involves the entire surface and canopy fuel complex spreading from tree to tree through the canopy stratum. Crown fires are more difficult to control and have more severe and lasting effects than surface fire due to the increased rate of spread, increased intensity, and likelihood to start spot fires long distances ahead of the fire front from lofted embers. It should be noted that surface fires and passive crownfires can also burn with high intensities and spread with the wind across large landscapes.

Figure 3 - Surface fire (left), passive crown fire (center), active crown fire (right)

The FlamMap fire modeling system (Finney, 2006) was used to assess the distribution of potential fire behavior characteristics in the analysis area. Specific characteristics assessed were fireline intensity expressed as flame length, rate of spread, and type of crown fire activity. Additionally, FlamMap was used to estimate burn probability. Burn probability, as used in FlamMap, is defined as the number of times a pixel burned as a proportion of the total number of fires simulated. Five thousand random ignitions were used in the simulations. Burn probabilities are related to the sizes of fires that occur on a given landscape. Large fires burn a larger portion of the landscape than small fires and therefore a given pixel is likely to be burned by multiple fires resulting in a higher burn probability.

Fire Weather

Energy Release Component (ERC) is a commonly used indicator of drought and fire potential that is calculated from fuel moistures and is used to assess the fire season. A review of the ERC throughout the year and historic fires on the Jemez Ranger District indicates that fires occur throughout the year; however, the primary fire season occurs between April and October with best conditions for active fire May through June, peaking in late June (Figure 4 and Figure 5). The Jemez Mountains typically experience a monsoon season beginning in mid-July or August.

While this can moderate fire behavior, fires do ignite and can spread during this time. Most years also have a post-monsoon increase in fire behavior and potential which can last through November (i.e. a bimodal fire season).

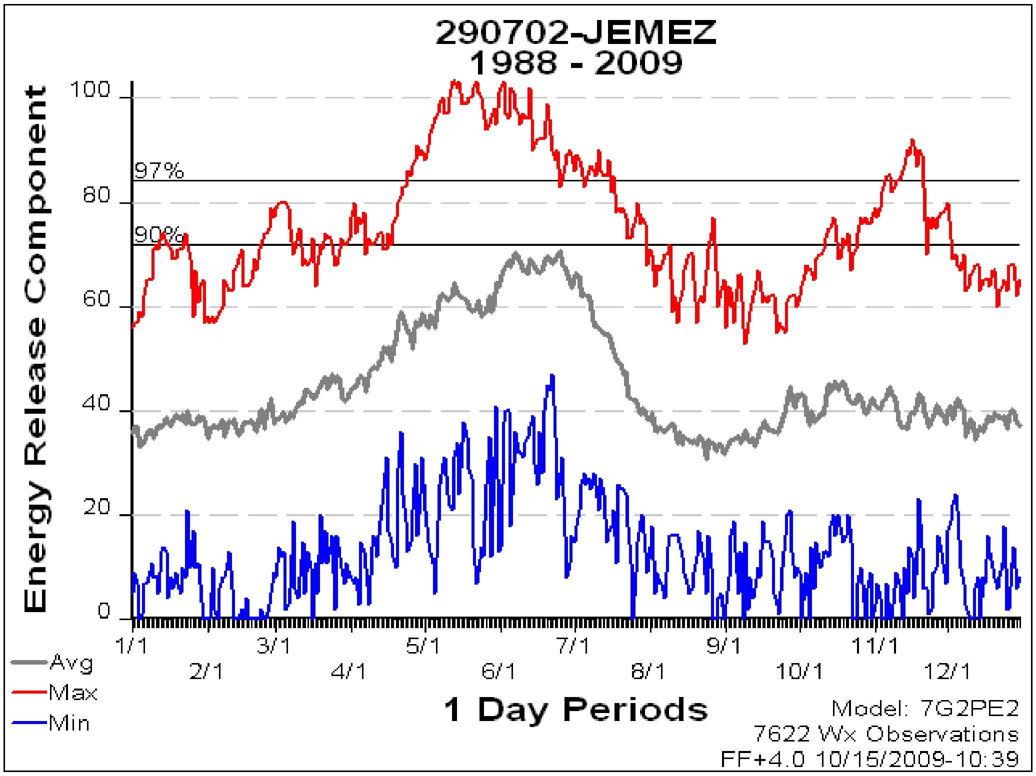

Figure 4 - Energy Release Component from the Jemez RAWS station based on year round data, 1989 - 2009.

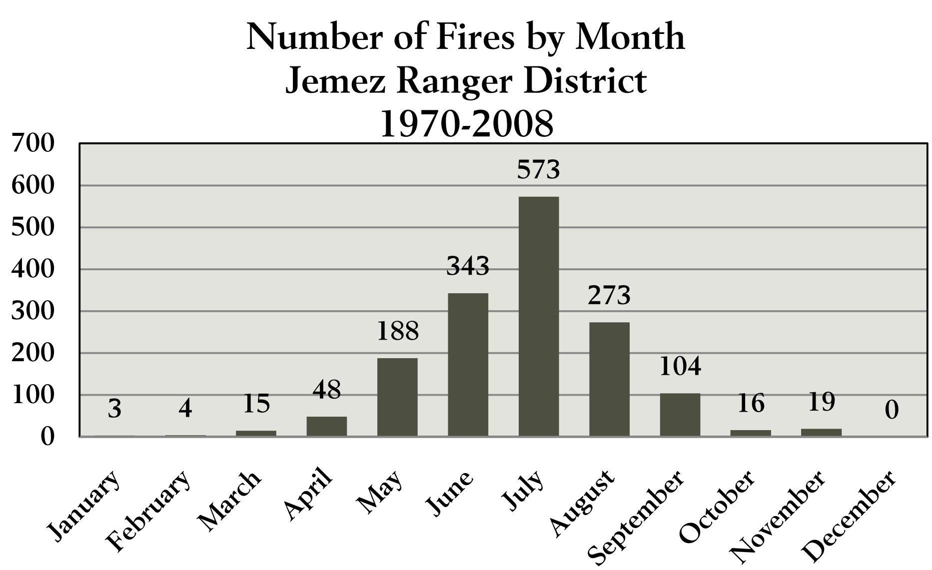

Figure 5 - Fire occurrence 1970 to 2008 on the Jemez Ranger District, Santa Fe National Forest. Number at top of bar is the number of fires starting in each month for the twenty-nine year period.

Approximately 90 percent of human and lightning ignited fires from 1970 to 2008 occurred when the ERC(G) was above 32 which is at the 28th percentile (1988 - 2008). Eighty-five percent of fires greater than 10 acres initiated when the ERC(G) was above 40 (43rd percentile).

To model fire behavior in FlamMap, fuel moistures and conditioning periods were selected to represent the Dome Fire (1996) and Cerro Grande Fire (2000). Both fires burned in late spring with dry fuel moistures and strong winds. Conditions during the Dome Fire were the maximum recorded from 1966 to 2009 while the conditions during Cerro Grande Fire approximate the 90th percentile conditions for 1988 – 2009. These conditions are referred to as maximum and dry in this report. Fuel moistures were conditioned using weather data from the time periods these fires exhibited very active fire, including crown fire. FlamMap runs were completed with conditioned fuel moistures at 4:00 pm. One hour fuel moistures for the maximum conditions ranged from 1 to 6 percent across the landscape with a modal value of 2 percent. For dry conditions, one hour fuel moistures ranged from 2 to 9 percent with a modal value of 4 percent.

Live herbaceous and woody fuel moistures vary greatly depending on time of season. Based on live fuel moisture guidelines (Scott and Burgan 2005), live herbaceous and live woody fuels are assumed 2/3 cured (60 percent herbaceous, 90 percent woody) for the maximum conditions and 1/3 cured (90 percent herbaceous, 120 percent woody) for dry conditions in the standard fuel models. For the wet meadows of the VCNP, live fuel moistures are assumed at full vigor (120 percent herbaceous, 150 percent woody). Generally fire in fuels with shrubs (grass shrub, shrub, and timber understory models) will have more active fire behavior when live woody fuel moisture is below 100 – 120 percent, depending on species and location. By using the selected live fuel moistures, the modeled fire behavior in this analysis will reflect more active fire behavior in fuel models that incorporate live fuels during maximum conditions.

Winds during the daylight hours (1000 to 2000 hours) are somewhat variable, but are predominantly out of the southwest to west (Figure 6). Wind gusts of 30 to 40 miles per hour are fairly common. Winds of 30 mph from the southwest were used for analysis.

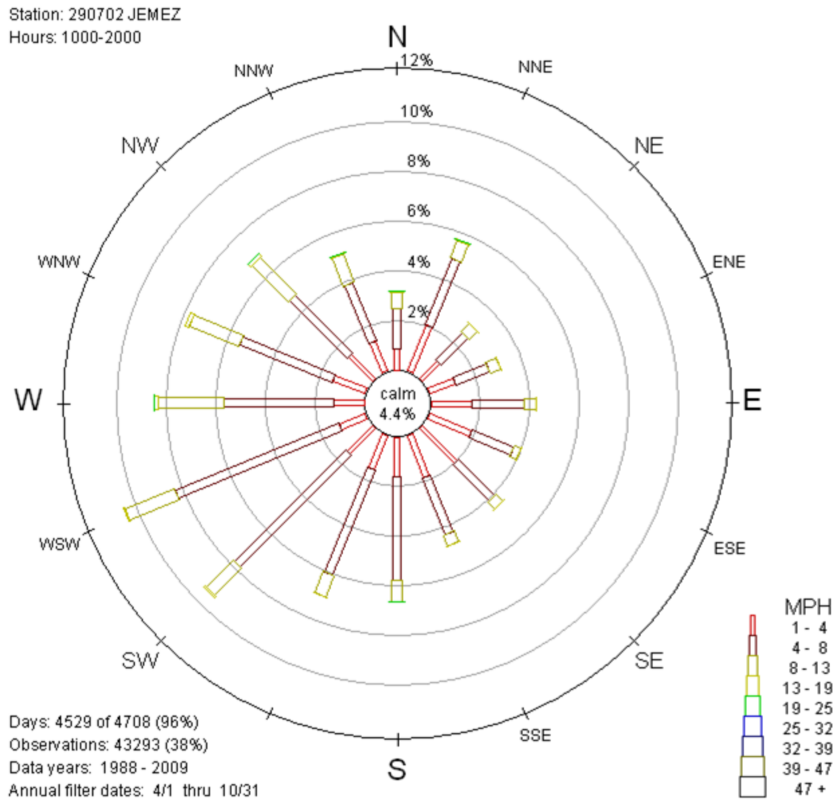

Figure 6 - Wind rose based on the Jemez RAWS, 1988 - 2009, April 1 through October 31, 1000 - 2000 hours.

Fuels

A fire behavior fuel model is a set of fuelbed inputs used to predict surface fire behavior and transition to crown fire. The distribution of fuel models in the VCNP is shown in Table 2.

Table 2 - Current distribution of fire behavior fuel models in the Valles Caldera National Preserve.

Fuel Model	Fuel Model Descriptor	Acres	Percent of Total
TU5	Very high load, dry climate timber-shrub	33,924	39
TL3	Moderate load conifer litter	12,050	14
TU1	Low load dry climate timber-grass-shrub	10,902	13
GR2	Low load, dry climate grass	10,279	12
Custom	Moderate load, dry climate wetland	6,602	8
TL8	Long needle litter	5,246	6
GR4	Moderate load, dry climate grass	3,321	4
GS2	Moderate load, dry climate grass-shrub	1,884	2
GS1	Low load, dry climate grass-shrub	851	1
GR1	Short, sparse dry climate grass	261	<1
TL1	Low load, compact conifer litter	251	<1
SH7	Very high load, dry climate shrub	167	<1
SH1	Low load, dry climate shrub	9	<1

Fifty-two percent of the assessment area is mapped as a timber-understory (TU) fuel model depicting a combination of forest litter and herbaceous or shrub fuels as the primary carrier of fire. Twenty percent of the area is mapped with a timber litter (TL) fuel model where the primary carrier of fire is down and dead woody fuel. Twenty-eight percent of the area is mapped as a grass (GS), grass-shrub (GS), or shrub (SH) fuel model. Figure 7 shows the spatial distribution of the fire behavior fuel models across the VCNP landscape.

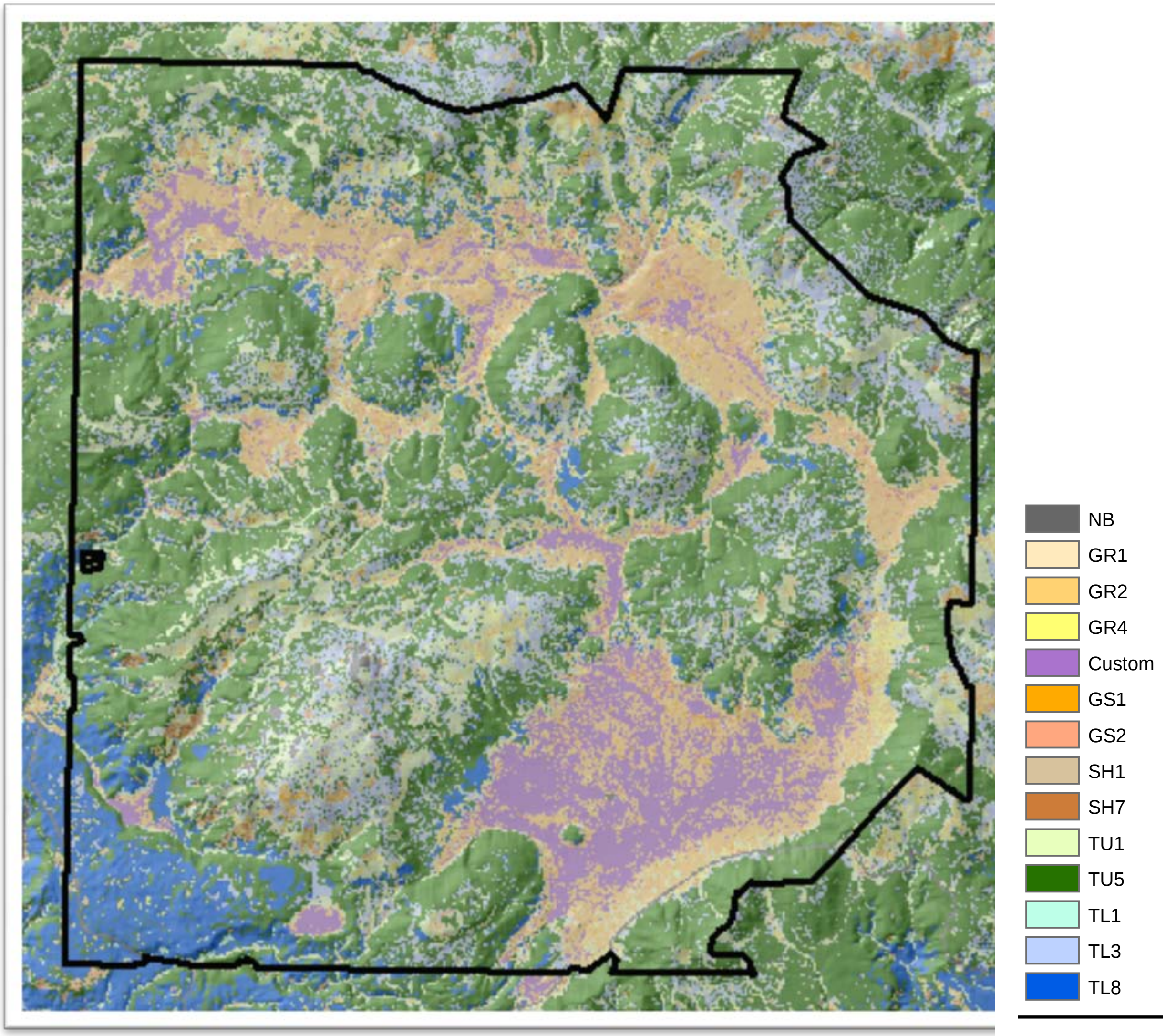

Figure 7 - Fire behavior fuel models within the VCNP.

Fire Behavior Potential

Fire behavior characteristics are directly related to fire behavior fuel models and canopy fuel characteristics but vary with fuel moisture, wind, and topography across a landscape. Modeled minimum, maximum, and mean flame lengths and rates of spread; and distribution of fire type for each fuel model under dry and maximum conditions are included in Table 3 and Table 4.

Table 3 - Current fire behavior characteristics under dry conditions, VCNP. Note that flame length includes flame length when crown fire is predicted.

Fire Behavior Characteristics by Fuel Model – Dry Conditions										
Fuel Model	Acres	Minimum Flame Length (ft)	Maximum Flame Length (ft)	Mean Flame Length (ft)	Minimum Rate of Spread (ch/hr)	Maximum Rate of Spread (ch/hr)	Mean Rate of Spread (ch/hr)	Surface Fire (% of FM)	Passive Crown Fire (% of FM)	Active Crown Fire (% of FM)
TU5	33,924	2	342	84	1	421	90	0.7	44.5	54.8
TL3	12,050	<1	185	1	<1	425	3	99.7	0.0	0.2
TU1	10,902	<1	160	1	<1	423	2	99.7	0.0	0.2
GR2	10,279	1	75	5	1	253	38	99.0	1.0	0
Custom	6,602	<1	1	1	<1	2	2	100	0.0	0
TL8	5,246	1	169	10	1	361	19	88.2	4.4	7.5
GR4	3,321	1	39	8	2	277	48	89.5	10.5	0
GS2	1,884	1	98	7	1	311	44	92.6	7.0	0.5
GS1	851	<1	1	1	<1	6	5	100	0	0
GR1	261	1	2	2	1	12	10	100	0	0
TL1	251	<1	1	1	<1	2	1	100	0	0
SH7	167	6	38	22	6	358	119	100	0	0
SH1	9	1	1	1	1	2	2	100	0	0

Total Fire Behavior Characteristics – Dry Conditions										
Flame Length (ft)	Acres	Percent		Rate of Spread (ch/hr)	Acres	Percent		Crown Fire Activity	Acres	Percent
>0 - 4	38,979	45		>0 - 1	8,540	10		Surface	50,785	59
>4 - 8	12,227	14		>1 - 5	26,332	31		Torching	15,920	19
>8 - 11	1,962	2		>5 - 10	5,516	6		Active	19,042	22
> 11	32,578	38		>10 - 20	5,390	6				
				>20 - 40	9,813	11				
				>40	30,155	35				

Table 4 - Current fire behavior characteristics under maximum conditions, VCNP. Note that flame length includes flame length when crown fire is predicted.

Fire Behavior Characteristics by Fuel Model – Maximum Conditions

Fuel Model	Acres	Minimum Flame Length (ft)	Maximum Flame Length (ft)	Mean Flame Length (ft)	Minimum Rate of Spread (ch/hr)	Maximum Rate of Spread (ch/hr)	Mean Rate of Spread (ch/hr)	Surface Fire (% of FM)	Passive Crown Fire (% of FM)	Active Crown Fire (% of FM)
TU5	33,924	3	435	113	1	555	129	0.2	33.0	66.8
TL3	12,050	<1	236	3	<1	560	8	98.5	0	1.5
TU1	10,902	1	252	11	<1	564	26	92.0	0.5	7.5
GR2	10,279	1	89	8	2	322	96	97.3	2.6	0.1
Custom	6,602	<1	1	1	<1	2	2	100	0	0
TL8	5,246	2	213	20	1	462	42	78.4	4.5	17.1
GR4	3,321	3	73	22	4	516	115	28.4	71.6	0
GS2	1,884	2	119	11	2	402	76	87.3	11.5	1.2
GS1	851	1	9	6	1	117	56	100	0	0
GR1	261	1	3	3	2	34	29	100	0	0
TL1	251	<1	1	1	<1	2	1	100	0	0
SH7	167	7	46	27	8	487	165	100	0	0
SH1	9	1	1	1	3	4	4	100	0	0

Total Fire Behavior Characteristics – Maximum Conditions

Flame Length (ft)	Acres	Percent		Rate of Spread (ch/hr)	Acres	Percent		Crown Fire Activity	Acres	Percent
>0 - 4	32,964	38		>0 - 1	3,082	4		Surface	46,792	55
>4 - 8	7,282	8		>1 - 5	26,640	31		Torching	14,374	17
>8 - 11	6,348	7		>5 - 10	5,528	6		Active	24,581	29
> 11	39,153	46		>10 - 20	3,153	4				
				>20 - 40	5,483	6				
				>40	41,860	49				

As shown in Figure 8 the proportion of the landscape expected to experience crown fire, active or passive, is related the presence of dense timber with heavy understory fuels. Wet meadows in the valles of the preserve should be resistant to fire spread unless there is drought which greatly reduces soil moisture and live herbaceous fuel moisture. If this should occur, the meadows could burn as a surface fire.

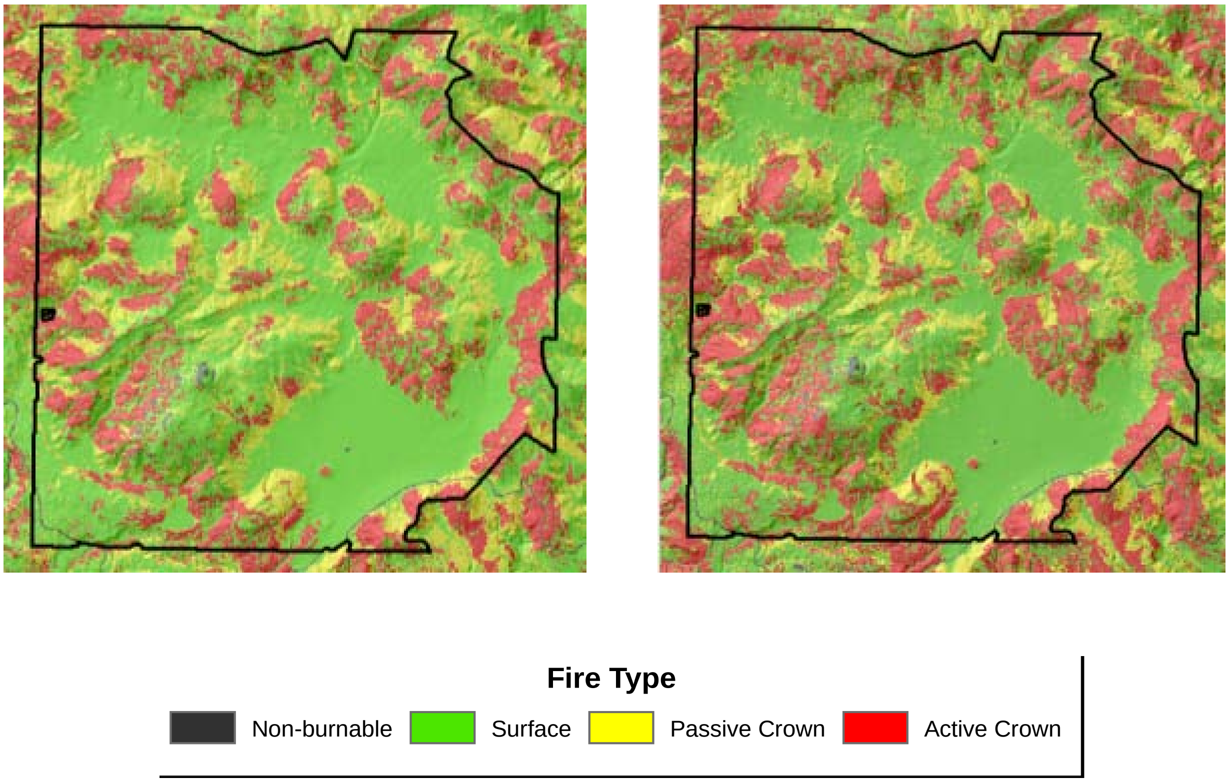

Figure 8 - Potential fire type under the two fuel moisture scenarios. The figure on the left was modeled under the dry scenario. The figure on the right was modeled under the max scenario.

The probability of fire burning on a landscape is greatly related to the spatial arrangement of fuels which determines how fires move across a landscape. As shown in Figure 9, under both fuel moisture scenarios fire is most likely to spread within and from the dry grasses of the valles into adjacent areas of timber-understory fuel models where slope and wind direction are factors (recirculation effect on back side of cerros – recalling Figure 2). Many of the forested slopes adjacent to the valles are represented by the TU5 fuel model (recalling Figure 7.) and are more susceptible to crown fire. Under max conditions the overall probability of burning in these areas increases as does the probability of burning areas further from the valles.

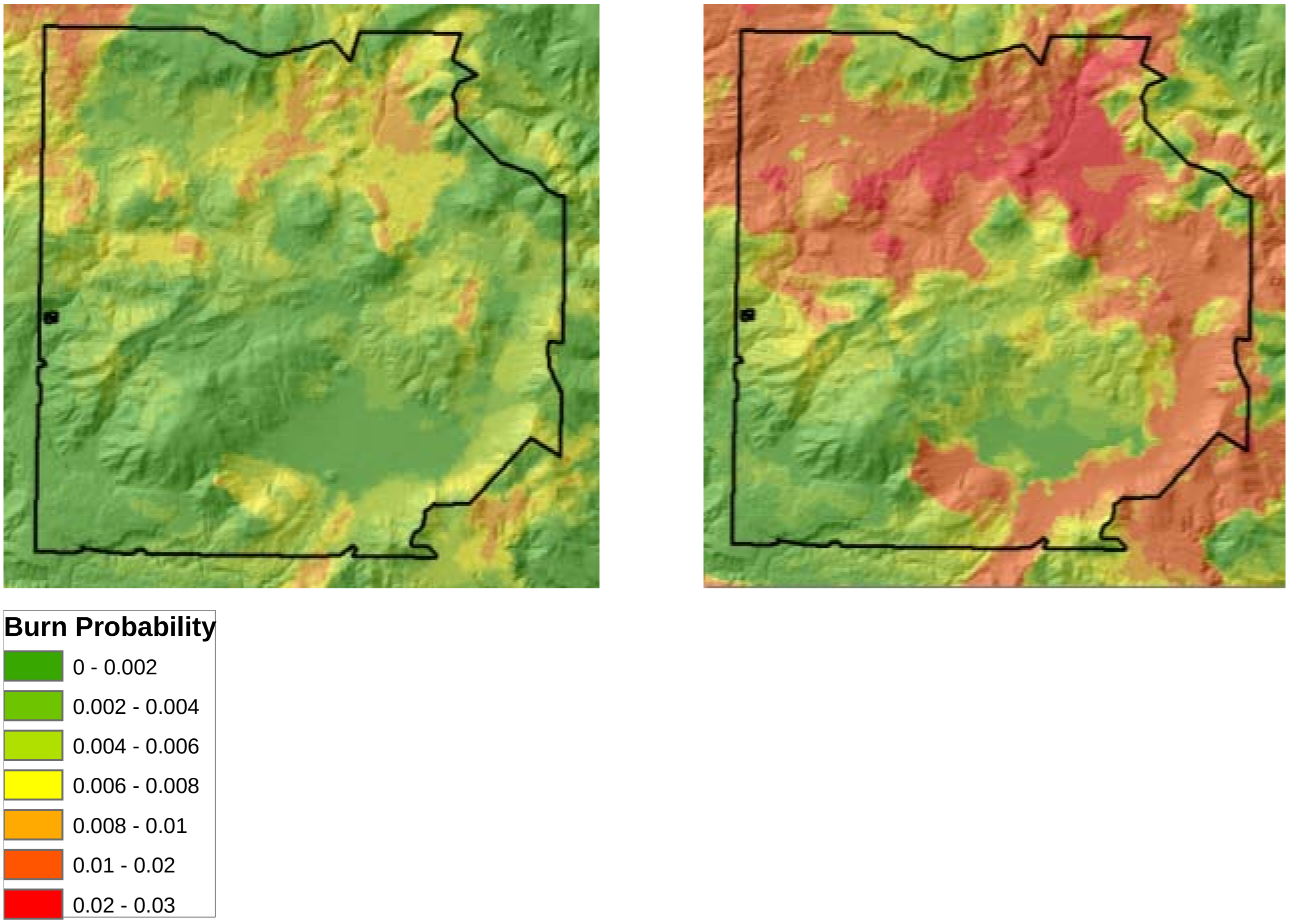

Figure 9 - Burn probability under the two fuel moisture scenarios. Burn probability was calculated as the number of fires that burn an individual pixel in proportion to 5,000 random ignitions. The figure on the left was modeled under the dry scenario. The figure on the right was modeled under the max scenario.

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Works Cited

Butler, B. W., Finney, M., Bradshaw, L., Forthofer, J., McHugh, C., Stratton, R., et al. (2006). WindWizard: A New Tool for Fire Management Decision Support. *Conference Proceedings: Fuels Management - How to Measure Success, March 28-30* (p. 10 pages). Portland, OR: USDA - Forest Service, Rocky Mountain Research Station.

Finney, M. A. (2006). An overview of FlamMap Modeling capabilities. *Fuels Management - How to Measure Success, March 28-30* (pp. 41-51). Portland, OR: USDA Forest Service, Rocky Mountain Research Station.

Muldavin E., P. C. (2006). *A Vegetation Map of the Valles Caldera National Preserve, NM.* Albuquerque: University of New Mexico, Natural History Museum.

Stratton, R. D. (2009). *Guidebook on LANDFIRE fuels data acquisition, critique, modification, maintenance, and model calibration. RMRS-GTR-153.* Fort Collins, CO: USDA - Forest Service, Rocky Mountain Reserach Station.

Systems for Environmental Management & USDA - Forest Service. (2002). *Fire Family Plus User's Gudie Version 3.0.* Missoula, MT: USDA - Forest Service Rocky Mountain Research Station.