Upper Mimbres Watershed Landscape Assessment

A Report Prepared for The Fire Learning Network

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Executive Summary

The Mimbres FLN demonstration project is located in southwest New Mexico, focused on a portion of the Wilderness District of the Gila National Forest. The primary objective of the FLN project is to work with a stakeholder group to conduct a rapid landscape-scale resource assessment that will provide a basis for developing a collaborative fire management plan for the Upper Mimbres Watershed.

Site

The project area includes approximately 535,000 acres, primarily encompassing the upper reaches of the Mimbres River. The Forest Service and private individuals are the two largest landholders in the watershed, owning approximately 173,000 acres (41%) and 183,000 acres (43%), respectively. The Bureau of Land Management and State Land Office hold a small percentage of the surface ownership within the upper watershed.

Existing Vegetation

The dominant vegetation type, a mosaic of juniper and pine-oak woodland, grades into semi-desert grassland at the lowest elevations of the upper watershed where soil moisture limits the cover of woody plants. At the higher elevations, the woodlands grade into coniferous vegetation.

Fire Regime Condition Class (FRCC)

In the Upper Mimbres watershed, almost 95% of the landscape is moderately to highly departed (Figure 2) from historical conditions. All of the upper elevation coniferous vegetation types at the highest elevations were classified as FRCC 3 due to a surplus of mid- and late- development closed canopy conditions. Shrub encroachment in the mid-elevation pine-oak and pinyon-juniper woodland and savanna and desert grassland vegetation types is the primary driver behind the condition class departure; nearly 100% of these vegetation types are in condition class 2.

Hazardous Fire Behavior

Fuel hazard was estimated using spatial predictions for flame length, crown fire activity, and rate of spread. The spatial distribution of flame length predicts high to extreme fire hazard over most of the Upper Mimbres watershed. Predictions were driven mainly by fuel model with the longest flame lengths (over 12 feet) occurring in shrub models, followed by flame lengths (over 4 feet) in grass fuel models. Crown fire potential in the Upper Mimbres Watershed is greatest in higher elevation timbered areas, particularly on more dense northern aspects. Rate of spread under the modeled conditions is high across most of the watershed, predicting extreme fire hazard, but this is likely overestimated.

Fuel hazard is highest in the upper elevations of the project area. The timber dominated upper elevations have higher fuel hazard than the shrub dominated mid-slopes and below. The greatest fuel hazard occurs on the northeastern and northwestern edges of the watershed where heavier fuel loading contributes to higher flame lengths and greater crown fire and spotting potential. The southern half of the watershed and lower elevations are dominated by grass fuels and present a lower fuel hazard.

Fuels Treatment

The effect of fuels treatments on FRCC and modeled fire behavior was examined for two prescribed burn treatment areas as well as several mechanical treatment areas. The scenarios are meant to demonstrate the potential of the models to capture desired treatment effects on fire behavior and FRCC. We generally assumed that following treatments the successional class became more open, fuel model moved from timber and shrub models to grass models, canopy base heights increased, and canopy closure decreased. The increase in canopy base height and the decrease in canopy closure were assumed to be mainly the result of thinning while changes in successional class and fuel model were assumed to be affected by burning. FRCC improved slightly overall. This reflects the relative size of the treatments to the total acreage of the watershed and demonstrates the scale of treatment required to bring the watershed as a whole into a less departed condition. The adjustments to fuel model, canopy cover, and crown base height resulted in a significant reduction in fire behavior in treated areas. Fuel hazard was reduced most by applying combined thin and burn treatments, with less of a reduction with only thinning or only burning.

Fuelwood Treatments

We identified potential fuelwood areas for this analysis as mesa tops and ridges with less than 10% slopes and road access on Forest Service land within the Upper Mimbres Watershed. We mapped approximately 8,500 acres of potential fuelwood areas. Historically the mesa tops had a low density of trees as a result of frequent burning. Currently, 95% of the potential fuelwood areas on the mesa tops are moderately to highly departed and contain a much higher density of trees.

Treatment Prioritization

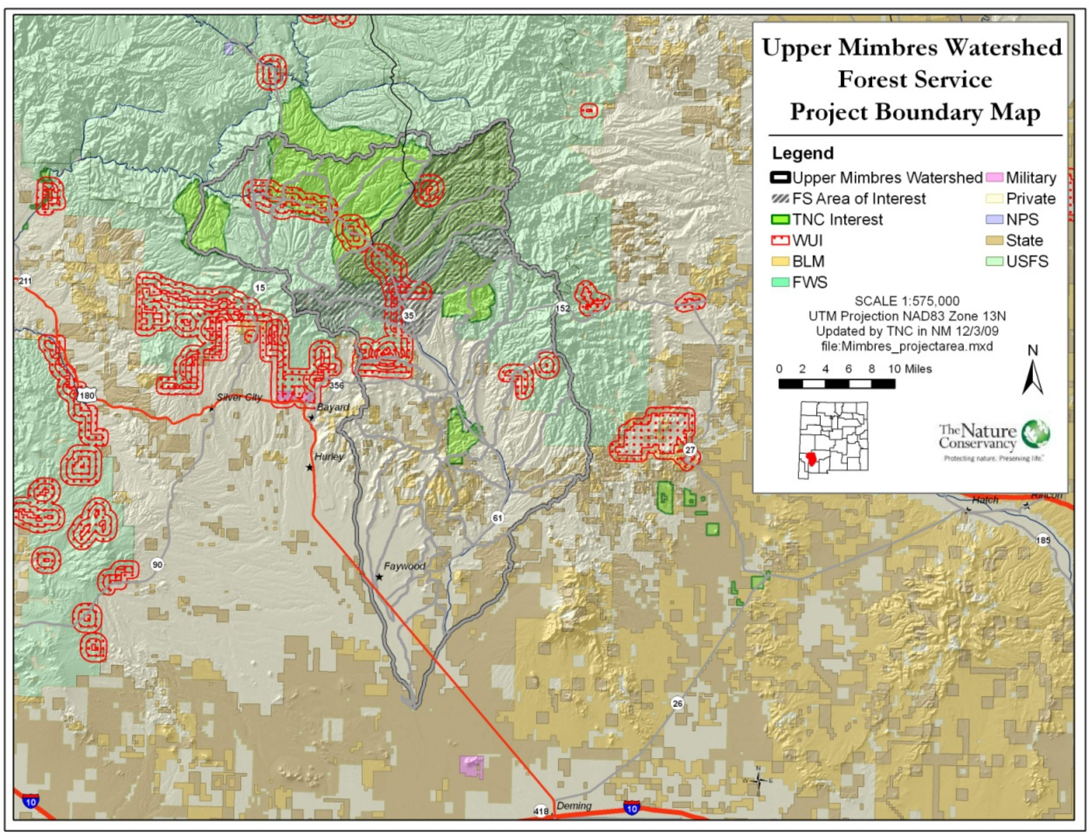
In order to distinguish potential treatment areas that would most effectively reduce fire threat affecting key resources/areas, we completed an overlay analysis of areas with high to extreme fuel hazards and areas of high fire influence in proximity to key areas identified for protection. Areas with high to extreme fuel hazard were developed using FlamMap. Areas of high fire influence include areas with high ignition probability and high spread potential. Key areas identified for protection include wildland urban interface (WUI) and sensitive habitat for Chihuahuan chub, Gila trout, Mexican spotted owl, and northern goshawk. When identifying potential treatments, we also considered previously NEPA cleared project areas and slopes where treatment is feasible (<40%); treatments on steep slopes could improve watershed function. The highest large fire spread potential values were selected out to identify high priority fuels treatment areas

Upper Mimbres Watershed: Landscape Scale Assessment

The Mimbres FLN demonstration project is located in southwest New Mexico, on and adjacent to the Wilderness District of the Gila National Forest. The primary objective of the FLN project is to work with a stakeholder group to conduct a rapid landscape-scale resource assessment that will provide a basis for developing a collaborative multijurisdictional fire management plan for the Upper Mimbres Watershed.

The project area includes approximately 535,000 acres along Sapillo Creek and the upper reaches of the Mimbres River (Figure 1). The Forest Service and private individuals are the two largest landholders in the upper watershed, owning approximately 173,000 acres (41%) and 183,000 acres (43%), respectively. The Bureau of Land Management and State Land Office hold a small percentage of the surface ownership (less than 15% combined) within the project area. The Forest Service has identified the project area and more specifically, the McKnight watershed, as a priority landscape for fire planning in the next fiscal year. Within the Forest Service lands, 53,828 acres have been identified as Wildland Urban Interface.

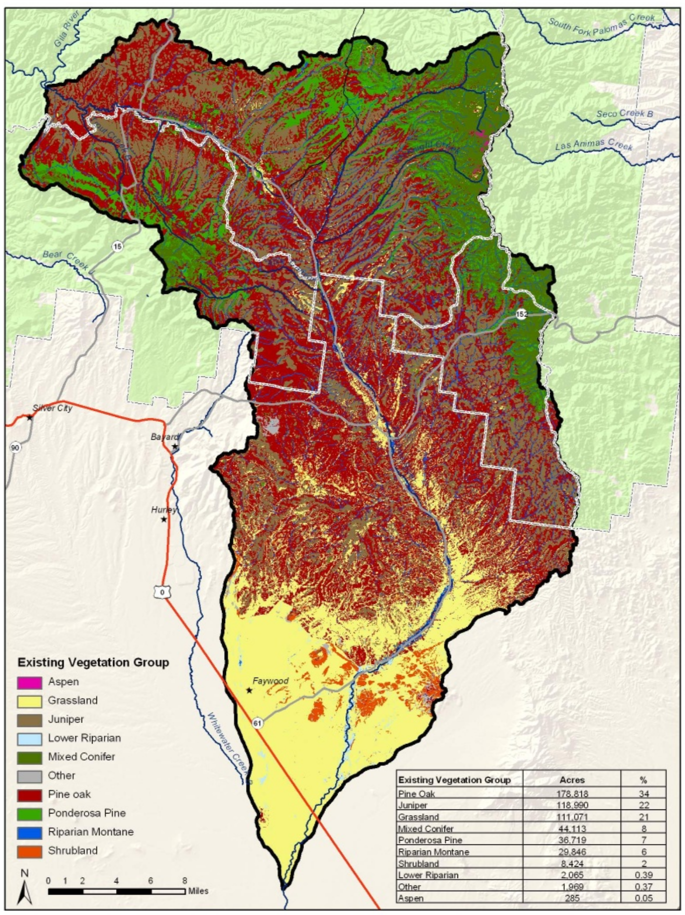
Figure 1 Ownership in the Upper Mimbres Watershed



Existing Vegetation

Mid-elevation woodland and savanna vegetation types dominate the Upper Mimbres Watershed (Figure 2, Table 1). The pine-oak vegetation type is characterized by evergreen oaks, alligator junipers and Mexican pines with an understory that is typically comprised of perennial grasses. The pine-oak vegetation type occurs in more xeric habitats of the foothills (1400 m – 2100 m) in a mosaic with juniper vegetation types, which in the Mimbres watershed are dominated by juniper. The juniper and pine-oak woodland vegetation mosaic grades into semi-desert grassland at the lowest elevations of the watershed where soil moisture limits the cover of woody plants. At the higher elevations of the watershed, the woodlands grade into coniferous vegetation, including mixed conifer forest and ponderosa pine woodland interspersed with small patches of aspen. McKnight Creek and the east and south forks of the Mimbres River support montane riparian vegetation and represents six percent of the watershed. Desert scrub vegetation, barren and agricultural sites comprises less than one percent of the landscape.

Figure 2. Existing Vegetation Groups in the Upper Mimbres Watershed.



Existing Vegetation Group	Acres	%
Pine Oak	178,818	34
Juniper	118,990	22
Grassland	111,071	21
Mixed Conifer	44,113	8
Ponderosa Pine	36,719	7
Riparian Montane	29,846	6
Shrubland	8,424	2
Lower Riparian	2,065	0.39
Other	1,969	0.37
Aspen	285	0.05

Table 1. This table displays the existing vegetation groups and acreage within the Upper Mimbres Watershed planning area. The category of "Other" indicates non-wildland vegetation groups such as urban and low elevation wildland vegetation groups that account for a small percentage of the overall vegetation, such as salt desert scrub.

Existing Vegetation Group	Acres	%
Pine Oak	178,818	34
Juniper	118,990	22
Grassland	111,071	21
Mixed Conifer	44,113	8
Ponderosa Pine	36,719	7
Riparian Montane	29,846	6
Shrubland	8,424	2
Lower Riparian	2,065	0.4
Other	1,969	0.4
Aspen	285	0.1

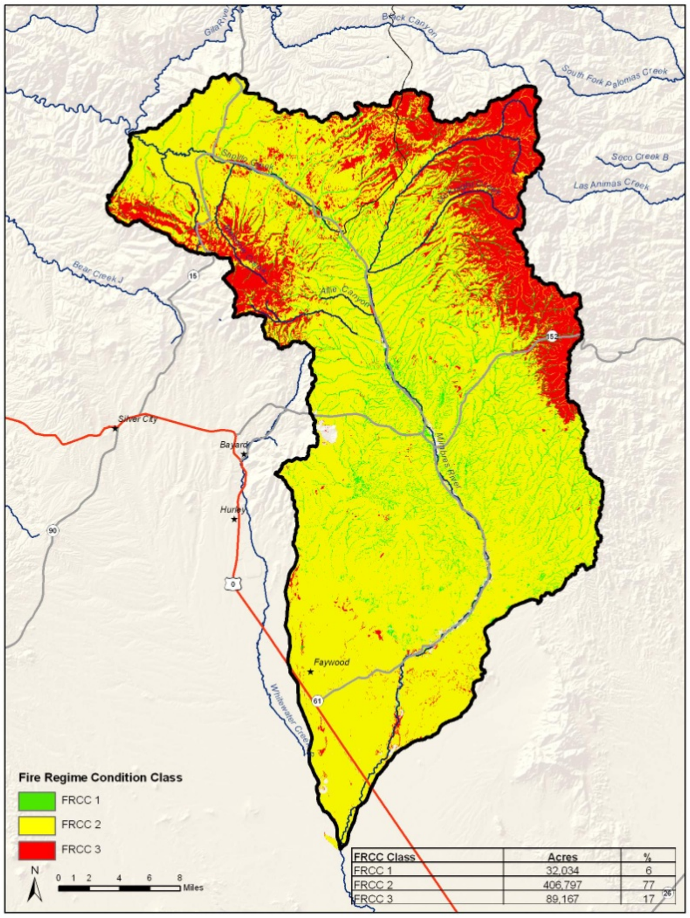
Fire Regime Condition Class

Fire Regime Condition Class (FRCC) is a classification system used to identify the amount of a vegetation type in the landscape which is in departure from its historic range of variability in composition, age/size structure, and canopy cover (Hann and Bunnell 2001). FRCC 1 represents conditions within the historic range of variability, while FRCC 2 and 3 represent moderately and highly departed conditions, respectively.

FRCC was modeled using the FRCC tool (FRCCMT ver. 2.2.0) developed by the National Interagency Fuels Technology Team. The FRCCMT tool produces spatial layers depicting vegetation departure based on FRCC methodology (Schmidt et al. 2001). Determination of the amount of departure is based on a comparison of the relative abundance of current successional classes (species composition, canopy closure, and age) within a biophysical setting (potential vegetation type) with a quantitative model of expected historical succession classes within the same biophysical setting. The succession class and biophysical settings input layers used in the FRCCMT tool were created by the LANDFIRE national project and are available online at http://www.landfire.gov/products_national.php.

In the Upper Mimbres Watershed, almost 95% of the landscape is moderately to highly departed (Figure 3) from historical conditions. All of the upper elevation coniferous vegetation types (mixed conifer and ponderosa vegetation groups) at the highest elevations were classified as FRCC 3. The departure in the mixed conifer vegetation types which include the LANDFIRE biophysical setting (BPS) classes of 1) upper montane conifer and oak forest and 2) mixed conifer forest and woodlands, is primarily a result of a surplus of mid-development closed and late development closed conditions. These surpluses are presumably an outcome of fire exclusion resulting in an increase in the abundance of fire-intolerant and shade-tolerant species which fill in the understory. In the ponderosa pine vegetation group, which include the LANDFIRE ponderosa pine woodland BPS and ponderosa pine savanna BPS classes, the ponderosa pine community has transitioned into an uncharacteristic state, which is defined by the LANDFIRE model as stands with a canopy cover of >60%.

Figure 3. Fire Regime Condition Class in the Upper Mimbres Watershed.



FRCC Class	Acres	%
FRCC 1	32,034	6
FRCC 2	406,797	77
FRCC 3	89,167	17

Again, this is the result of a decrease in frequent surface fires that has allowed for the development of denser stands dominated by young trees.

The semi-desert grassland and the mid elevation pine-oak and pinyon-juniper woodland and savanna vegetation types are nearly 100 percent in condition class 2 (Figure 3). The moderate departure within the grassland systems relates to the encroachment of shrubs into these vegetation types. Current research suggests that fire controls the abundance of shrubs and maintains desert grasslands (Brown and Archer 1999and Yao et al. 2002). However, precise fire frequency is not known for these systems (Schussman et al. 2006). Pre-1882 fire size has been estimated at 100s of square miles (Rollins et al. 2000).

Dense canopy conditions are the cause of the departure within the pine-oak systems. madrean lower montane pine-oak forest and woodland BPS classes are the largest components of the pine-oak systems within the project area and most was mapped in an uncharacteristic state. The uncharacteristic state is defined in the LANDFIRE model as stands with greater than 70% canopy cover. The departure within the juniper systems can be attributed to a surplus of mid-development conditions, which are described in the LANDFIRE model as a community dominated by young to mature alligator juniper and evergreen oak trees of various ages. Cover and density of juniper and pinyon trees in juniper systems have increased, most likely as a result of fire suppression, however, the components of the fire regime are not known with any certainty. Fire scar data is generally used to reconstruct fire return intervals. Research suggests that pinyons are poor recorders of fire scar data and that junipers false rings make dating the age of the trees inaccurate thus clouding the precision with which the components of the fire regime can be ascertained (Baker and Shinneman 2004).

Hazardous Fire Behavior

Measures of hazardous fire behavior are intended to identify both: (1) areas where fire would be difficult to control, with potential for large fire growth; and (2) areas where fire would potentially threaten firefighter safety, wildland-urban interface (WUI) areas, or critical wildlife habitat. Fire hazard is the product of fuel hazard (fire behavior that would occur if a particular fuel were to burn) and fire risk (the probability of a fire actually igniting). In this analysis, fuel hazard was estimated using spatial predictions for Flame Length (FL), Crown Fire Activity (CFA), and Rate of Spread (ROS). Then the fuel hazard was compared to fire history (estimate of fire risk) and WUI areas.

FL, CFA and ROS were modeled using the Fire Behavior Assessment Tool (FBAT, ver. 1.3.0). FBAT requires both spatial data and non-spatial weather data to model fuel hazard. A landscape file, which represents the spatial input of FBAT, was developed from layers available from landfire.gov. Fuel moisture and wind speed values, the non-spatial weather data need for FBAT, were based on historical data measured by the Gila Center Station RAWS station (id 292006). Data were downloaded from the National Fire and Aviation Management Web Applications website (fam.nwcg.gov/fam-web/), and analyzed using Fire Family Plus 4 (firemodels.org). Fuel moisture data were analyzed for a 20-year period from 1978-1998 using an analysis period of 15 days. Input values are summarized in Table 2 below.

The FBAT simulation was run using the 13 Anderson Fire Behavior Fuel Models and the default crown fire model (Anderson 1982). Foliar moisture content was decreased from 100% to 85% to represent midsummer conditions (see NWCG Fireline Handbook, Appendix B, table 6, page B-29). Wind speed was set to 20mph, which was a common daily maximum during summer months. Direction was set to uphill in order to model the worst case scenario. The critical threshold values for early and late June were used to establish Fuel Moisture Table values.

Outputs in FBAT were left at the default values, with the exception of class 3 flame length which was changed from 3.7 m (over 12 ft) to 3.4 m (over 11 ft) to correlate with the threshold at which all head fire tactics become ineffective. Otherwise, outputs were classified into three fuel hazard related categories based on behavior.

The spatial distribution of FL predicts high to extreme fire hazard over most of the Upper Mimbres Watershed (Figure 4). The FL predictions were driven mainly by fuel model;

with the longest flame lengths occurring in shrub models (Figure 3, Table 3). These areas fell into FL class 3 (over 11 feet) and correspond to extreme fire behavior, since direct attack by aerial methods is unfeasible and there is a high likelihood for fire to transition into tree crowns. High fire behavior with flame lengths over 4 feet, where aerial but not hand crew attack is feasible, occurred primarily in grass fuel models. Within the Upper Mimbres and Sapillo Watersheds, the grass fuel models are associated with the expanse of grassland vegetation at the lowest elevation and the savanna vegetation types, ponderosa pine and juniper, in the mid- to upper-elevations. The only large contiguous areas with FL class 1 are in the timber areas with a fuel model of 8 (short needle) or 9 (long needle). Much of this flame length class 1 is adjacent to fuel models with higher flame lengths, and therefore may present a greater fire hazard than is represented by FL alone.

Table 2. Fire Behavior Assessment Tool inputs and sources. The landscape file includes aspect, crown bulk density, crown base height, percent canopy cover, canopy height, elevation, fuel model, and slope information. Input fuel moisture values are listed followed by the actual historical range for June in parentheses.

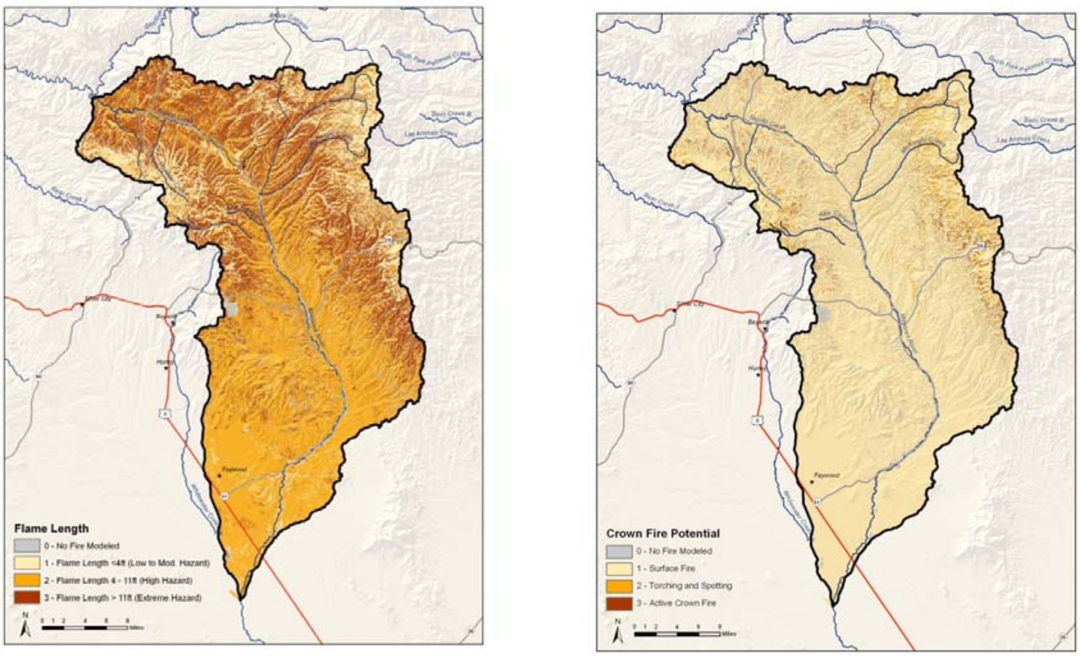
Input	Value	Source
Landscape file	(combination of 8 spatial layers)	http://www.landfire.gov/products_national.php
Foliar moisture content	85%	NWCG Fireline Handbook, Appendix B
Wind speed	20 mph	fam.nwcg.gov/fam-web/
1-hour fuel moisture	2% (2.1-2.4)	fam.nwcg.gov/fam-web/
10-hour fuel moist.	3% (3.0-3.3)	fam.nwcg.gov/fam-web/
100-hour fuel moist.	7% (6.5-7.7)	fam.nwcg.gov/fam-web/
Herbaceous fuel moisture	2% (2.1-2.4)	fam.nwcg.gov/fam
Woody fuel moisture	60% (60)	fam.nwcg.gov/fam

Table 3. 13 Fire Behavior Fuel Models.

Fuel Model	Fuel Group	Description	Representative Vegetation
1	Grass	Short grass (1 foot)	Western annuals
2	Grass	Timber (grass and understory)	Ponderosa savanna, open shrub
3	Grass	Tall grass (2.5 feet)	Tall grass prairie
4	Shrub	Chaparral (6 feet)	CA chaparral, southern rough
5	Shrub	Brush (2 feet)	Dense green shrubs, snowberry
6	Shrub	Dormant brush, hardwood slash	P-J with sagebrush, cured oak
7	Shrub	Southern rough	Southern rough
8	Timber	Closed timber litter	Short needle litter, mixed conifer
9	Timber	Hardwood litter	Long needle litter, ponderosa
10	Timber	Timber (litter and understory)	Timber w/ regeneration, dead and down
11	Slash	Light logging slash	3 in. < 11.5 tons/ac
12	Slash	Medium logging slash	3 in. < 34.6 tons/ac
13	Slash	Heavy logging slash	3 in. < 58.1 tons/ac

Crown fire potential in the Upper Mimbres Watershed is greatest in higher elevation timbered areas, particularly on more dense northern aspects when weather variables are held constant for all slopes (Figure 4). CFA class 3 (running crown fire) is dispersed across much of the northeast and northwest portions of the watershed where mixed conifer and ponderosa vegetation dominate. CFA class 1 is considered desirable due to ease of control and the much lower potential for spotting. However, because of the spotting potential from CFA class 3 areas, the fire hazard of adjacent areas may be underestimated by considering CFA alone.

Figure 4. Flame Length and Crown Fire Activity in the Upper Mimbres Watershed.

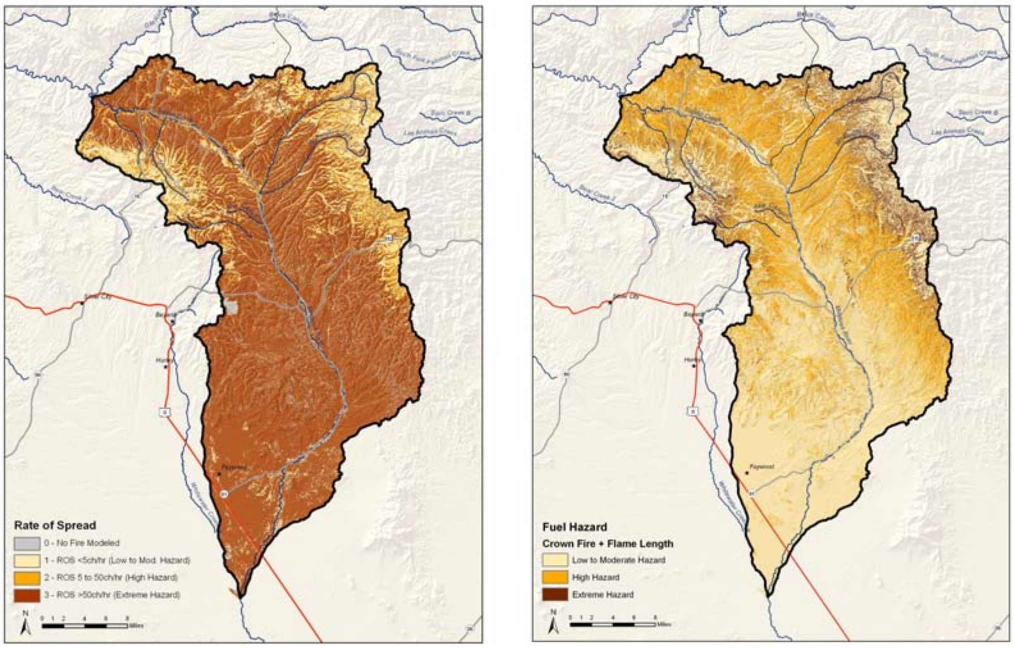


ROS under the modeled conditions is high across most of the watershed, predicting extreme fire hazard except at the highest elevations in timber fuel models (see Figure 5). Fire hazard may be poorly approximated by ROS alone. The actual continuity of the fuel bed for the shrub and grass fuel models is likely less than is being modeled and natural fuel breaks would slow fire spread. In timber fuels, spread due to spotting is not accounted for by the ROS calculation, and would likely increase the fire hazard.

In order to give a more complete description of fuel hazard for the project area, CFA and FL classes were summed, and an overall pattern emerged (see Figure 5). This fuel hazard is representative of high wind, dry, mid-summer conditions, and is meant to reflect the worst case scenario. Locations classified under extreme hazard have the greatest potential for difficult to control wildfire and large fire growth. This does not imply that fire in other areas would necessarily be less destructive or less likely to occur, or that prescribed fire treatments would be safer or easier to implement elsewhere.

Fuel hazard is highest on the northern (higher elevation) half of the project area on each side of the valley. The timber dominated upper elevations have higher fuel hazard than the shrub dominated mid-slopes and below. The greatest fuel hazard occurs on the northeastern and northwestern edges of the watershed where heavier fuel loading contributes to higher flame lengths and greater crown fire and spotting potential. The southern half of the watershed and lower elevations are dominated by grass fuels and present a lower fuel hazard.

Figure 5. Rate of Spread and Fuel Hazard (Crown Fire Activity plus Flame Length) in the Upper Mimbres Watershed.

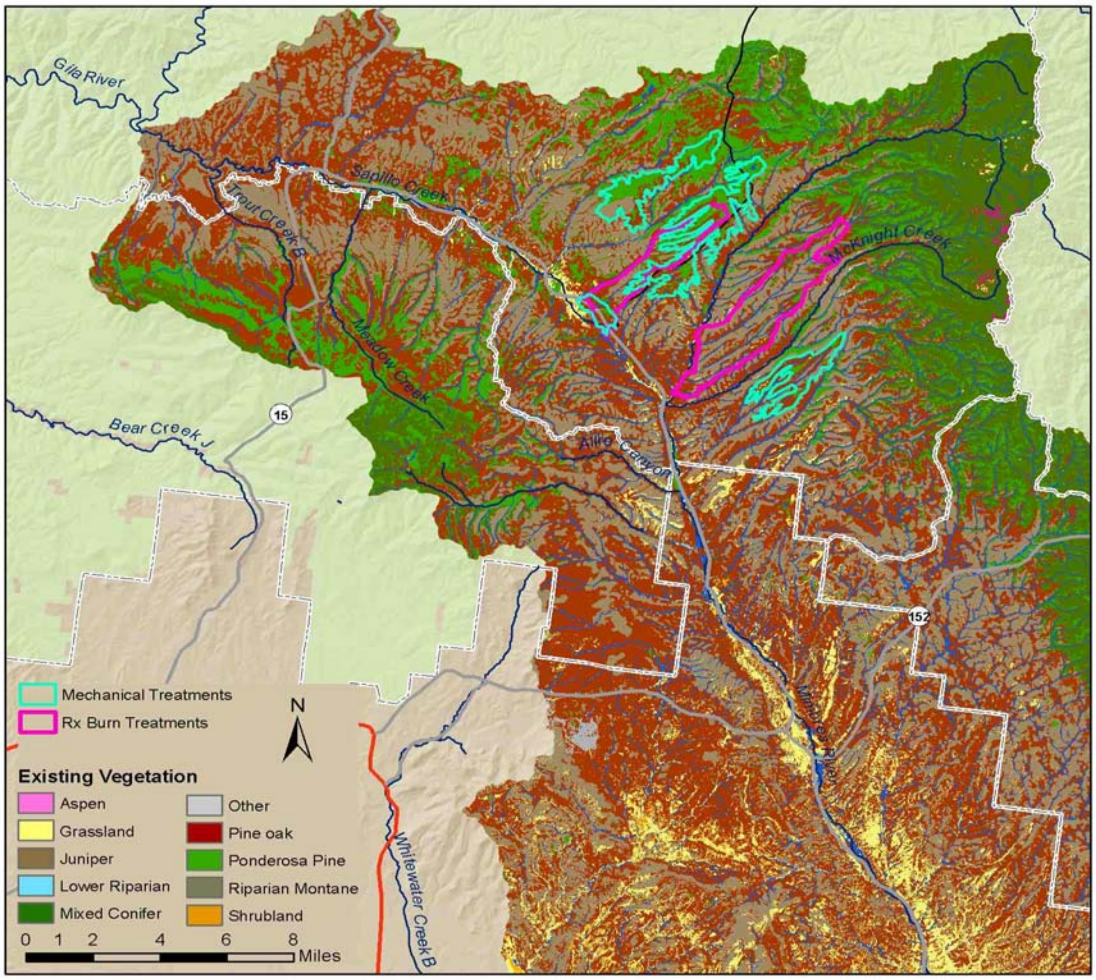


Fuels Treatment

The effect of fuels treatments on FRCC and modeled fire behavior was examined for two prescribed burn treatments as well as several mechanical treatment areas (Figure 6). Treatment boundaries for the mechanical treatments were developed by staff at Gila National Forest, Wilderness District and represent estimates of areas likely to be thinned in next 3 to 5 years. They do not represent areas cleared through the NEPA process. The burned area boundaries represent the Little McKnight and Linclon-Terry prescribed burn perimeters, which burned in the spring of 2009. However, the two prescribed burns were not fully executed due to hazardous weather conditions, thus the desired structural changes were only partially achieved.

Within the treatment areas five BPS's dominated. The most common of these was madrean pinyon-juniper woodland, followed in order by madrean encinal, southern rocky mountain ponderosa pine savanna, madrean lower montane pine-oak forest and woodland, and southern rocky mountain ponderosa pine woodland. Adjustments to the LANDFIRE spatial input layers were applied separately. Generally, to simulate treatments, initial vegetation conditions were adjusted so that sclass became more open; fuel model moved from timber and shrub models to grass; canopy base heights increased; and canopy closure decreased. The increase in canopy base height and the decrease in canopy closure were assumed to be mainly the result of thinning while changes in sclass and fuel model would be affected by burning. Thinning was assumed to be a more uniform treatment whereas burning has a mosaic of effects across the landscape. Thus, canopy base height and canopy closure were adjusted uniformly within

Figure 6: Location of treatment areas in the Upper Mimbres watershed



Each BPS, while sclass and fuel model were adjusted by random, pixel-by-pixel assignment to one of three classes. Within each BPS, 30% was unchanged (representing low intensity fire or unburned), 60% moved to a more open, grass-dominated state (moderate to high intensity fire), and 10% moved to an early successional grass/forb-dominated post fire state (very high intensity, stand-replacing fire). In the case of the uncharacteristic sclass (sclass=6), 60% was moved to either a mid- or late-successional open sclass in the proportion that those two sclasses (sclass=3 or 4) were previously present on the landscape. Madrean Pinyon Juniper has only three sclass options (early, mid, and late development), and thinning or burning will not alter the sclass except in the stand replacing case (10% of the treatment). Thus, the only modification made to sclass in Madrean Pinyon Juniper was to move 10% of both sclass 2 and 3 into post-fire early succession sclass 1. Table 4 summarizes all adjustments made to the input layers [1].

Table 4. Adjustments applied to initial vegetation conditions to assess the effect of fuels treatments on FRCC and modeled fire behavior (see text for more explanation).

		Modifications				
	Original value	**Madrean Encinal**	**Pine Oak Woodland**	**Madrean PJ Woodland**	**Ponderosa Woodland**	**Ponderosa Savanna**
Succession Class	**2**	60% → 3 10% → 1	60% → 3 10% → 1	10% → 1	60% → 3 10% → 1	60% → 3 10% → 1
	3	unchanged	unchanged	10% → 1	unchanged	unchanged
	5	unchanged	unchanged	unchanged	60% → 3 10% → 1	60% → 3 10% → 1
	6	60% → 3 and 4 10% → 1	60% → 3 and 4 10% → 1	unchanged	60% → 3 and 4 10% → 1	60% → 3 and 4 10% → 1
Fuel Model	**5**	60% → 2 10% → 1	60% → 2 10% → 1	60% → 2 10% → 1	60% → 2 10% → 1	60% → 2 10% → 1
	9	unchanged	unchanged	unchanged	60% → 2 10% → 1	60% → 2 10% → 1
Canopy Cover	**0-20%**	unchanged	unchanged	unchanged	unchanged	unchanged
	0-40%	unchanged	unchanged	Reduced to 20%	unchanged	unchanged
	40-100%	Reduced to 40%	Reduced to 40%	Reduced to 20%	Reduced to 40%	Reduced to 40%
Crown Base Heght	**0-1m**	Increased to 1m	Increased to 1m	unchanged	Increased to 1m	Increased to 1m
	>1m	unchanged	unchanged	unchanged	unchanged	unchanged

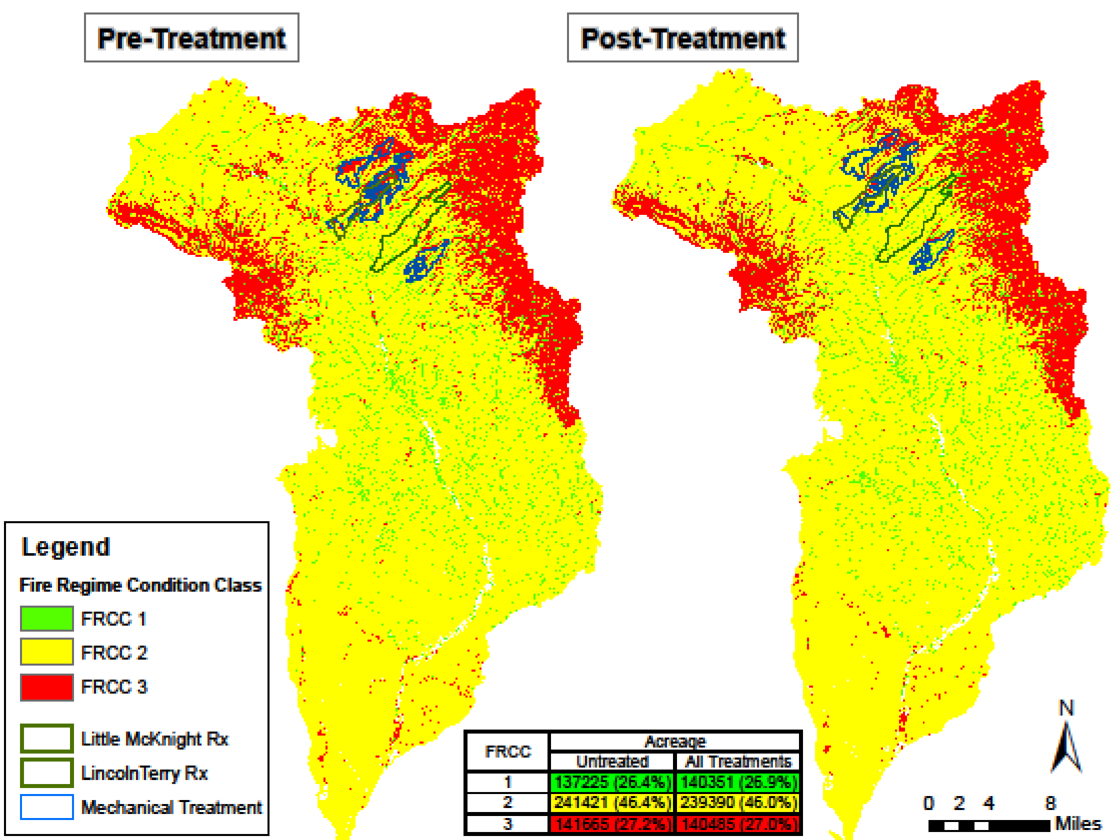
[1] The modifications made here most likely resemble the thin and burn treatment, which represents only 9.1% of the total treated area. Thinning only or burning only would likely result in more modest changes in the modeled outputs. For example, burning alone would not result in the level of canopy cover reduction that we assumed. Thinning alone would not create as much sclass 1 (post-fire early succession) or as much FM 1 (grass), and generally would not alter fuel models as much as burning, or thinning then burning.

For the purposes of this analysis the same adjustments were made to the model inputs regardless of the treatment type (e.g., thin, burn, thin and burn). The modeled outputs might be improved by applying more specifically tailored adjustments to each of the three scenarios; however, in the absence of actual treatment prescription parameters or desired outcome, best estimates were applied uniformly across all treatments. Thus, the results are not expected to represent the actual post-treatment state. The scenarios are meant to demonstrate the potential of the models to capture desired treatment effects on fire behavior and FRCC.

When FRCC was calculated using the adjusted sclass layer, the percentage of the landscape classified as moderately to highly departed decreased slightly from 73.6% to 72.6% (Figure 7). If each BPS is considered separately most sclasses did move toward the reference condition, but the improvement resulted in a lower FRCC classification only in Ponderosa Pine Savanna which moved from FRCC 3 to FRCC 2 (Table 5). The decrease for Ponderosa Pine Savanna can be attributed to two factors. First, the BPS was likely departed just enough to be classified as FRCC 3, so that small improvements dropped it to FRCC 2. Second, a larger percentage of the total Ponderosa Pine Savanna in the watershed was included in the treatment areas compared to the other BPS's (31%, compared for example to 4% of Pinyon-Juniper). That there were only slight improvements overall reflects the relative size of the treatments to the total acreage of the watershed, and it also demonstrates the amount of treatment that will be required to bring the watershed as a whole into a less departed condition.

The adjustments to fuel model, canopy cover, and crown base height resulted in a significant reduction in fire behavior in treated areas (Figures 8, 9, 10). The average flame length dropped from 3.6 feet pre-treatment to 3.0 feet post-treatment and crown fire activity also declined. The resultant Fuel Hazard calculation (FL + CFA) shifted from class 2 and 3 (high/extreme) to class 1 (low/moderate). Before treatment, class 1 made up 26.4% of the Upper Mimbres Watershed. Treatment increased that proportion slightly to 27.4%.

Figure 7. FRCC before and after adjustments were applied to initial vegetation layers to simulate prescribed burn and thinning treatments.



FRCC	Acreage	
	Untreated	All Treatments
1	137225 (26.4%)	140351 (26.9%)
2	241421 (46.4%)	239390 (46.0%)
3	141665 (27.2%)	140485 (27.0%)

Table 5. FRCC change by BPS and sclass. Positive change is highlighted in green, negative in orange. Original status is derived from the FRCC calculation using the original, pre-treatment vegetation condition (e.g., sclass distribution in different BPSs). Rows in which both colors occur moved toward the reference condition after treatment.

Biophysical Setting	Sclass	Original Status	Post-treatment change (acres)	Post-treatment change (%)
Madrean Lower Montane Pine-Oak/Encinal	A	Deficit	126.1	0.05%
Madrean Lower Montane Pine-Oak/Encinal	B	Deficit	-113	-0.03%
Madrean Lower Montane Pine-Oak/Encinal	C	Deficit	192.3	0.07%
Madrean Lower Montane Pine-Oak/Encinal	D	Surplus	60.2	0.03%
Madrean Lower Montane Pine-Oak/Encinal	E	0	1.1	0.001%
Madrean Lower Montane Pine-Oak/Encinal	U	Surplus	-266.9	-0.26%
Madrean Pinyon-Juniper Woodland	A	Deficit	3408	0.95%
Madrean Pinyon-Juniper Woodland	B	Surplus	-3870.1	-0.13%
Madrean Pinyon-Juniper Woodland	C	Deficit	520.6	0.02%
Madrean Pinyon-Juniper Woodland	D	Surplus	173.9	0.17%
Madrean Pinyon-Juniper Woodland	E	Surplus	10.4	0.01%
Madrean Pinyon-Juniper Woodland	U	Surplus	-242.9	-0.23%
Southern Rocky Mountain Ponderosa Pine Woodland	A	Deficit	83.2	0.05%
Southern Rocky Mountain Ponderosa Pine Woodland	B	Surplus	-42.5	-0.04%
Southern Rocky Mountain Ponderosa Pine Woodland	C	Deficit	249.5	0.15%
Southern Rocky Mountain Ponderosa Pine Woodland	D	Deficit	192.4	0.04%
Southern Rocky Mountain Ponderosa Pine Woodland	E	Surplus	-142.5	-0.12%
Southern Rocky Mountain Ponderosa Pine Woodland	U	Surplus	-340.1	-0.33%
Southern Rocky Mountain Ponderosa Pine Savanna	A	Surplus	60.4	0.05%
Southern Rocky Mountain Ponderosa Pine Savanna	B	Surplus	-20.2	-0.02%
Southern Rocky Mountain Ponderosa Pine Savanna	C	Deficit	125.9	0.09%
Southern Rocky Mountain Ponderosa Pine Savanna	D	Deficit	419.6	0.22%
Southern Rocky Mountain Ponderosa Pine Savanna	E	Deficit	-2.9	-0.003%
Southern Rocky Mountain Ponderosa Pine Savanna	U	Surplus	-582.9	-0.56%

Figure 8. FBAT Flame Length Class reduction due to adjustments applied to treatment areas.

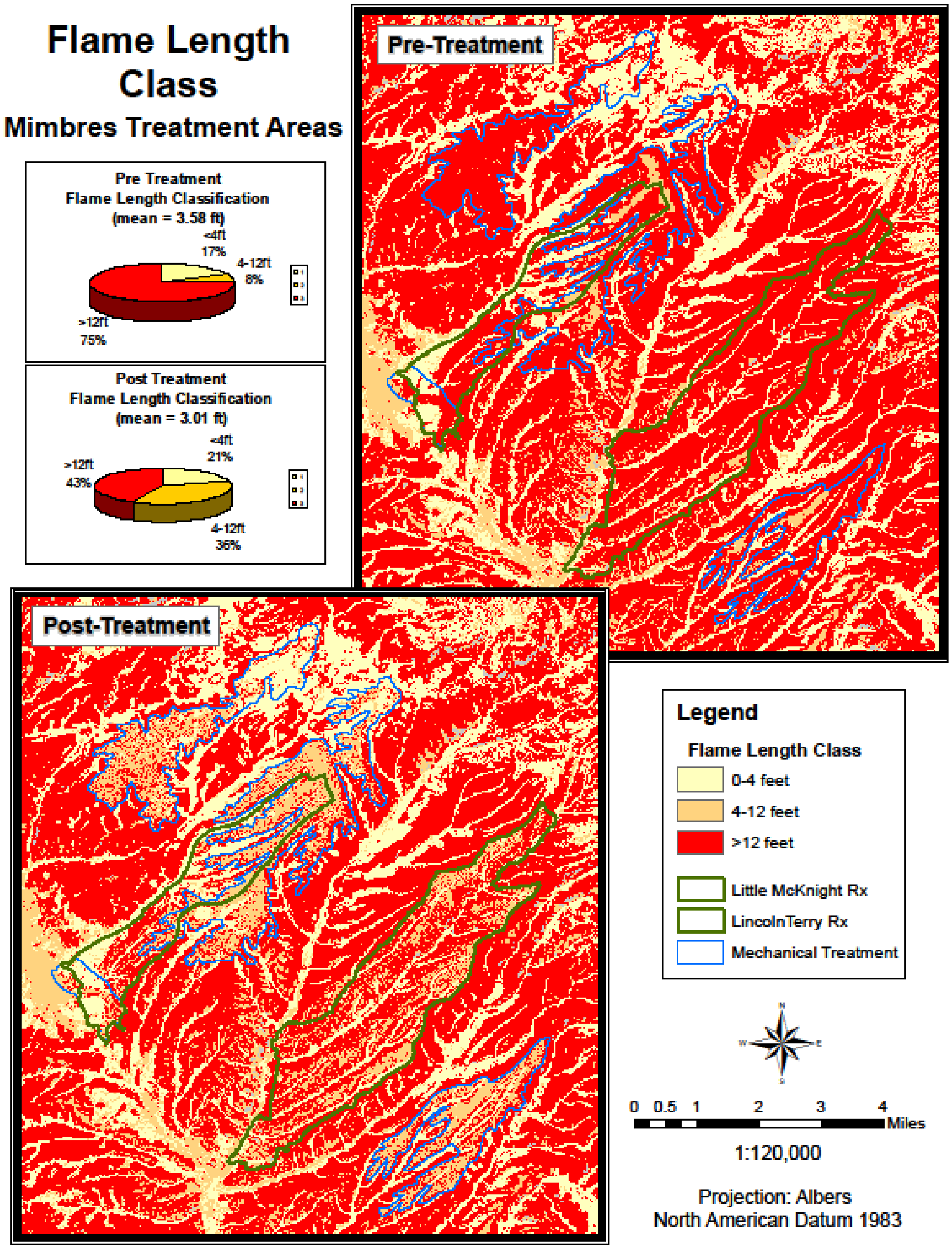


Figure 9. FBAT Crown Fire Activity reduction due to adjustments applied to treatment areas.

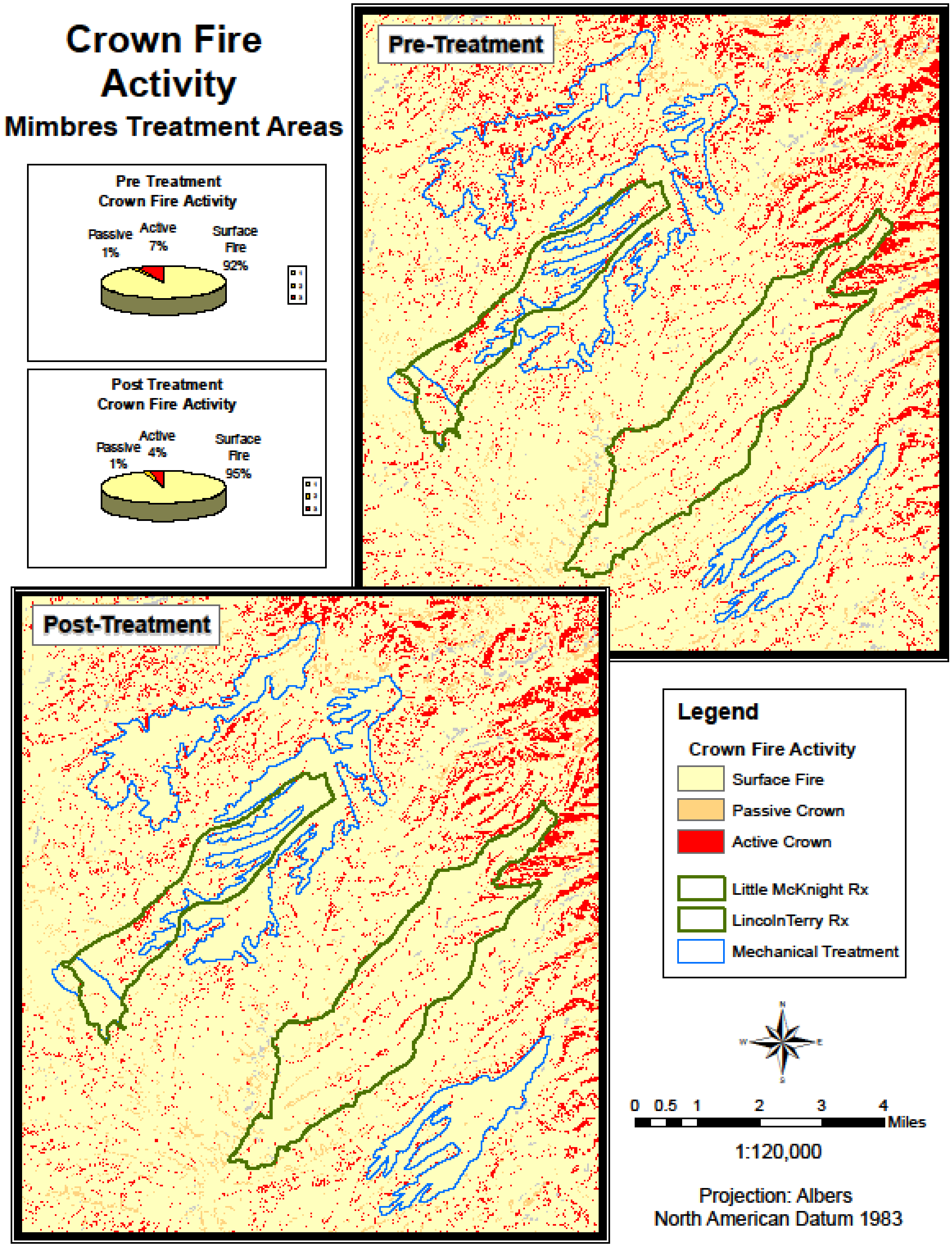
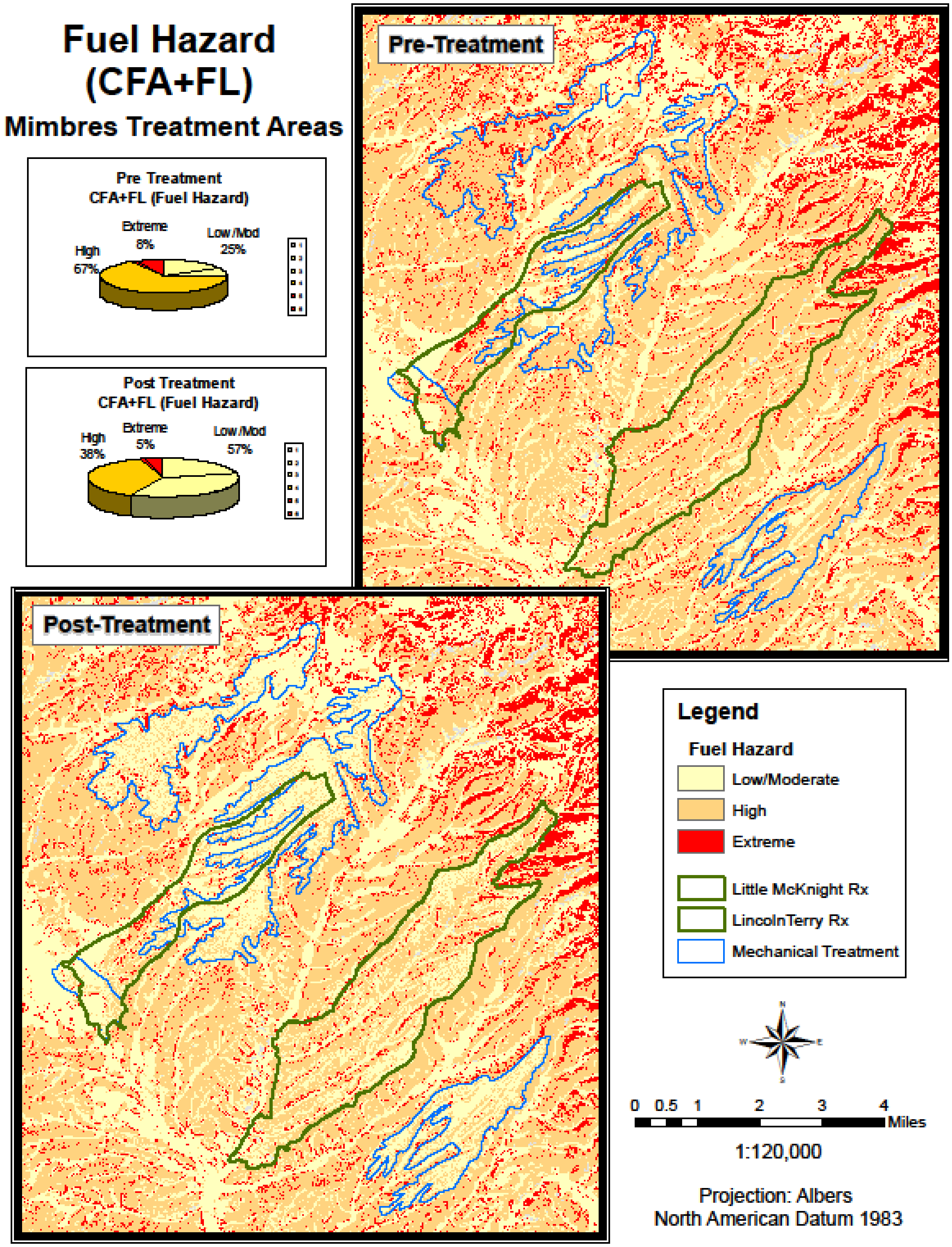


Figure 10. FBAT Fuel Hazard reduction due to adjustments applied to treatment areas. Fuel Hazard is the sum of Crown Fire Activity and Flame Length Class. Values below 4 are grouped as Low to Moderate, 4 is rated as High, and values over 4 are grouped as Extreme.



To compare how outputs would differ in a thin only scenario, we re-ran the FRCC and FlamMap analysis with the burn units excluded. We assumed that fewer acres were treated, and that adjustments made to the inputs were less extensive (to remove burn effects). Sclass, canopy cover, and canopy base height were adjusted as before, but only in thinned areas. Fuel model was not altered.

As expected, the results from thinning only were not as substantial. Fuel hazard was reduced much less than when all treatments were applied (Table 6), and only 0.6% of FRCC 2 and 3 in the landscape shifted to FRCC1, compared to 1.0% for all treatments (Table 7). Again, the assumptions made to define the adjustments applied to inputs do not necessarily reflect actual treatment prescriptions or post-treatment condition, but are best estimates in the absence of specific prescription information. The results do however provide a sense of the scale of necessary treatment to improve FRCC or ecological health of the landscape, and a representation of the anticipated effect of treatment on fire behavior. For example to shift just 5% of the project area into FRCC 1, approximately 26,000 acres would need to be treated. The current treatment projections for the project area are around 5,000 acres.

Table 6. Comparison of the Fuel Hazard distribution if no treatments are applied vs. Thinned, and Thinned plus Burned treatments. Acreages and percentages are for within treatment areas only.

Fuel Hazard (CFA+FL)	Acreage		
	No treatment	Thin Only	All Treatments
Low/Mod	3350 (25%)	3657 (27%)	7642 (57%)
High	8976 (67%)	8976 (66%)	5165 (38%)
Extreme	1163 (9%)	870 (6%)	682 (5%)

Table 7. Comparison of the FRCC class distribution if no treatments are applied vs. Thinned, and Thinned plus Burned treatments. Acreages and percentages are from the entire watershed.

FRCC	Acreage		
	No treatment	Thin Only	All Treatments
1	137225 (26.4%)	140351 (26.9%)	142458 (27.4%)
2	241421 (46.4%)	239390 (46.0%)	237504 (45.6%)
3	141665 (27.2%)	140485 (27.0%)	140107 (26.9%)

Fuelwood Treatments

Sustainable fuelwood harvest provides communities with a viable economic resource, historically important in the Mimbres Valley. Fuelwood removal may also reduce hazardous fuels and improve ecological health of an area. Objectives of the Wilderness District in administering past fuelwood areas on mesa tops in the Upper Mimbres Watershed include restoring tree density of pinyon and juniper woodlands to historic savanna-like conditions. Reduced tree density decreases competition for resources among trees and increases the vigor of residual trees. Decreasing tree canopy cover also typically increases grass cover which improves forage and habitat and creates fine fuels that can carry surface fires. Increasing ground cover improves overall watershed conditions by reducing erosion. The Wilderness District recognizes the social and ecological benefits of offering fuelwood areas to the local community.

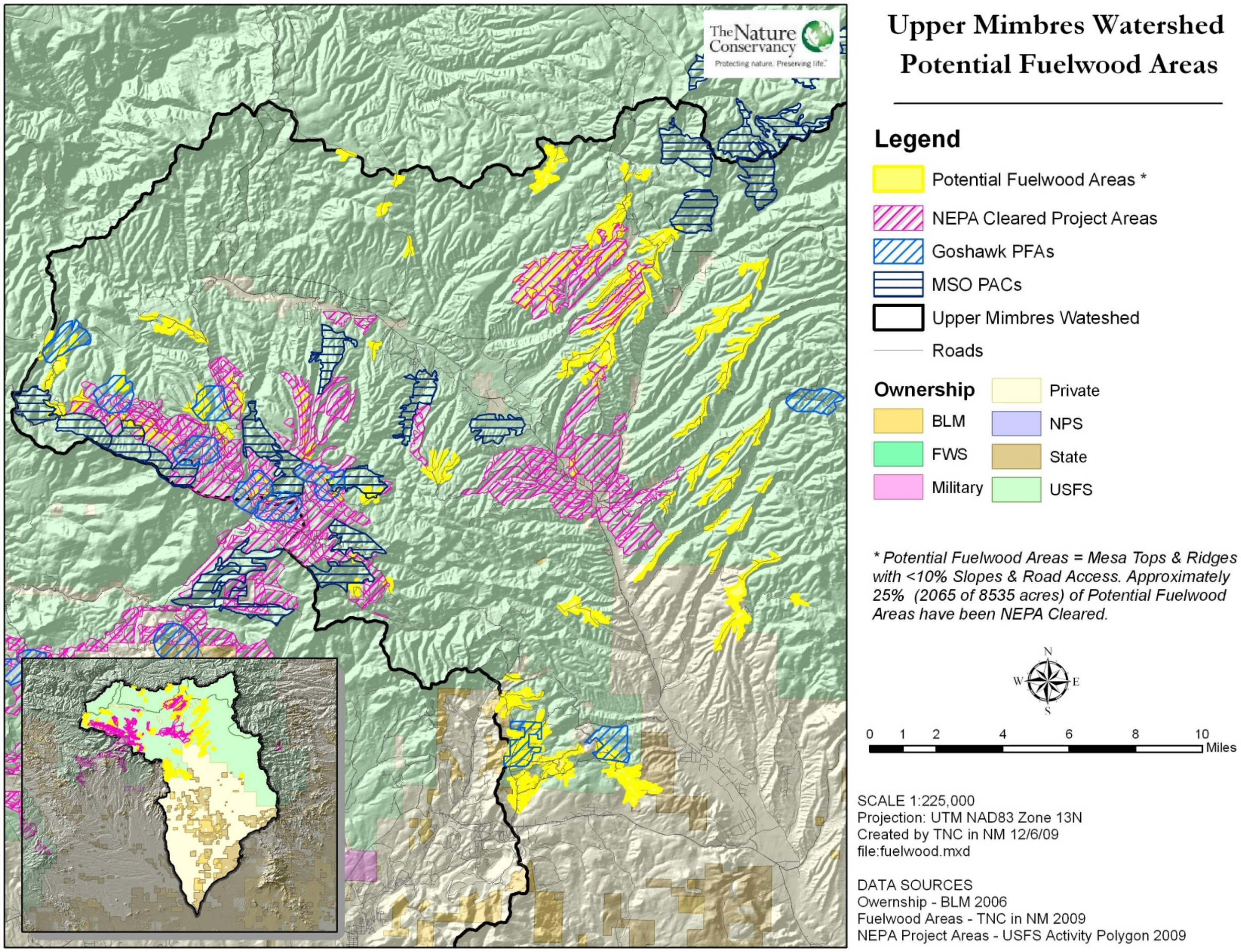
We identified potential fuelwood areas for this analysis as mesa tops and ridges with less than 10% slopes and road access on Forest Service land within the Upper Mimbres Watershed. We mapped approximately 8500 acres of potential fuelwood areas of which approximately 25 % or 2050 acres have been NEPA-cleared (Figure 11). Historically the mesa tops had a low density of trees as a result of frequent burning. Currently, 95% of the potential fuelwood areas on the mesa tops are moderately to highly departed and contain a much higher density of trees. Fuel hazard has also increased, but by a much smaller percentage, only 41%. Fuel hazard is tied not only to tree density but also to physical variables such as slope, so the smaller change should be expected since flame length and crown fire potential is not as high on gentle slopes as on steeper ones.

Treatment Prioritization

In order to distinguish potential treatment areas that would most effectively reduce fire threat affecting key resources/areas, we completed an overlay analysis of 1) areas with high to extreme fuel hazards and 2) areas of high fire influence in proximity to 3) key areas identified for protection. Areas with high to extreme fuel hazard were developed using FlamMap as described above. Areas of high fire influence include areas with high ignition probability and high spread potential; the method for mapping these areas is more fully described below. Lastly, key areas identified for protection include wildland urban interface (WUI) and sensitive habitat for Chihuahuan chub, Gila trout, Mexican spotted owl, and northern goshawk. Key areas included in the analysis are Gallinas Canyon, Sheep Corral Canyon (Sapillo Creek), Allie-McKnight Canyon (Mimbres), and Sheppard Canyon (Mimbres) watersheds. When siting potential treatments, we also considered previously NEPA cleared project areas and where treatment is feasible, areas with slopes < 40% which are considered accessible for mechanical treatment..

Areas with large fire growth potential were modeled using historic fire occurrence data and modeled fire spread pathways. In FlamMap, the minimum travel time function outputs an arrival time grid based on user defined fire origins and weather conditions. Fire origins data was based on the fire occurrence history for the Upper Mimbres Watershed, available from the US Forest Service and the State of NM from 1987 through 2007. The minimum travel time function also calculates major pathways of fire spread from a defined origin which can be used to calculate the influence of each pixel on fire spread, referred to as the node influence. Node influence was calculated under 5 initial conditions; one with fires starting at the two low points of the landscape with wind uphill, and four with a line of fire blown from each of the four cardinal directions across the landscape. These five modeled node influence layers were summed and then combined with the arrival time layer to create a large fire spread potential for each pixel. A higher pixel value in this final output equates to both higher probability of a fire occurring nearby (within 6 hours of burn time) and higher potential of a fire that burns that pixel to expand. The highest large fire spread potential values were selected out to identify high priority fuels treatment areas (Figure 12).

Figure 11. Potential fuelwood areas in the Upper Mimbres Watershed.



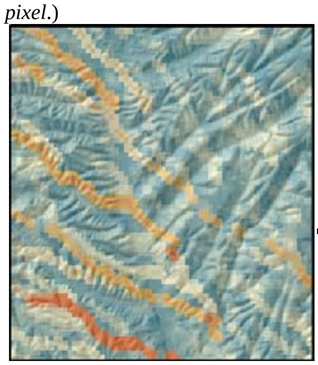
The ultimate location and prioritization of treatment areas will depend on the relative importance assigned to values at risk, and other factors such as planning costs. The overlaid layers in Figure 13 allow treatments to be located so as to maximize their impacts on fire growth near or in priority protection areas. We provide examples of possible treatments in the Sapillo Creek and Gallinas Canyon watersheds (see Figures 14 and 15). Areas were selected that: 1) are treatable (gradual slopes); 2) have a high to extreme fuel hazard and/or high large fire growth potential; and 3) will effect priority treatment areas (WUI and priority watersheds) either directly or by reducing fire risk downslope and/or downwind; with 4) preference given to NEPA cleared areas. High fuel hazard and large fire growth potential are common in and near the WUI along Sapillo Creek and the Mimbres River. Priority can be given to those areas that would also improve conditions in priority watersheds, and some of these have been previously NEPA cleared. Figure 13 does not prioritize treatments, but demonstrates where treatment is most needed as well as where it would have the most significant effect.

Gila Trout and Chihuahuan Chub

Protection of remaining Gila trout and Chihuahuan chub populations is a key management goal of the Wilderness District. Both species are endangered and extremely vulnerable to siltation and severe erosion that would result from destructive, non-characteristic wildfires. We evaluated the potential for treatments for the three watersheds, 1) the Sheep Corral Canyon–Sapillo Creek watershed, 2) the Allie-McKnight Canyon watershed, and 3) the Sheppard Canyon–Mimbres River watershed, all of which contain populations of Gila trout or Chihuahuan chub. While treating mesa tops could restore historic pinyon-juniper savannas, Gila National Forest Staff recommend that treatment of steep slopes adjacent to creeks also be considered because they affect watershed function. Overall, approximately 28,400 acres (28%) lies on slope greater than 40% and are considered untreatable. Within the remaining treatable areas, 39% of the area (38,700 acres) is characterized by high to extreme fuel hazard and 3% of the area (2,600 acres) is potential fuel wood. Potential treatment areas within key trout and chub watersheds were delineated by distinguishing treatable slopes (<40%) from untreatable slopes (>40%) alongside fuelwood areas and Mexican spotted owl and northern goshawk habitat. Figures 16 to 18 detail the derived potential for treatments for each of the priority fish watersheds.

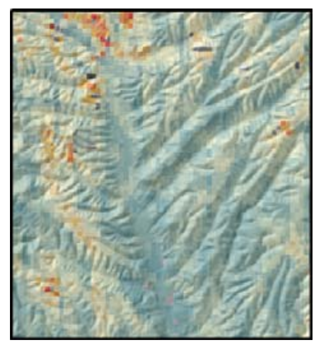
Figure 12: Process for the creation of Areas of High Fire Influence and Priority Treatment Areas.

Node Influence was calculated 5 times using different wind directions and represents the likelihood that a pixel will burn (*Values are the logarithm of the number of pixels that burn as a result of burning through a given pixel.*)

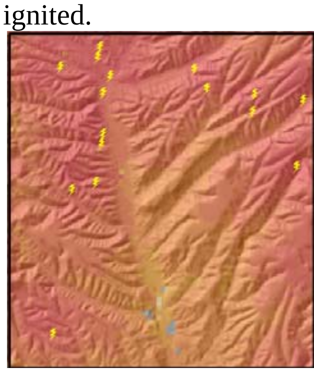


The 5 Node Influence layers were summed, and rescaled from 0 to 10.

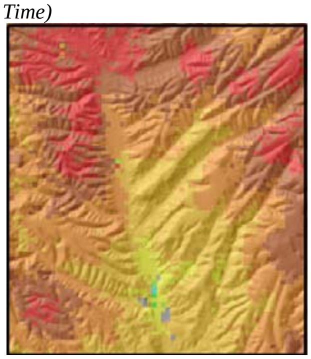
Summed Node Influence was multiplied by rescaled Minimum Arrival Time to produce a Large Fire Growth Potential value for each pixel.



Minimum Arrival Time from all historic fires was calculated for each pixel and represent the likelihood a pixel will be ignited.



Ignition Likelihood was rescaled from 0 to10. *(Values are the logarithm of the inverse of the Minimum Arrival Time)*



Finally, the highest values of Large Fire Growth Potential were extracted to represent Priority Treatment Areas. These areas are likely to have a fire ignition nearby, and fires that burn here are more likely to grow large.

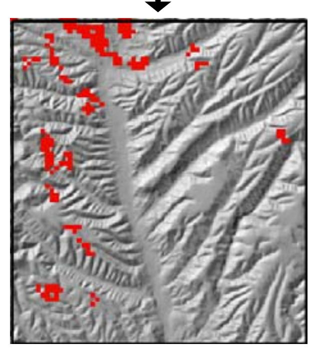


Figure 13: Fuel Hazard and high priority treatment areas where Fire Spread Potential is high along with priority protection areas.

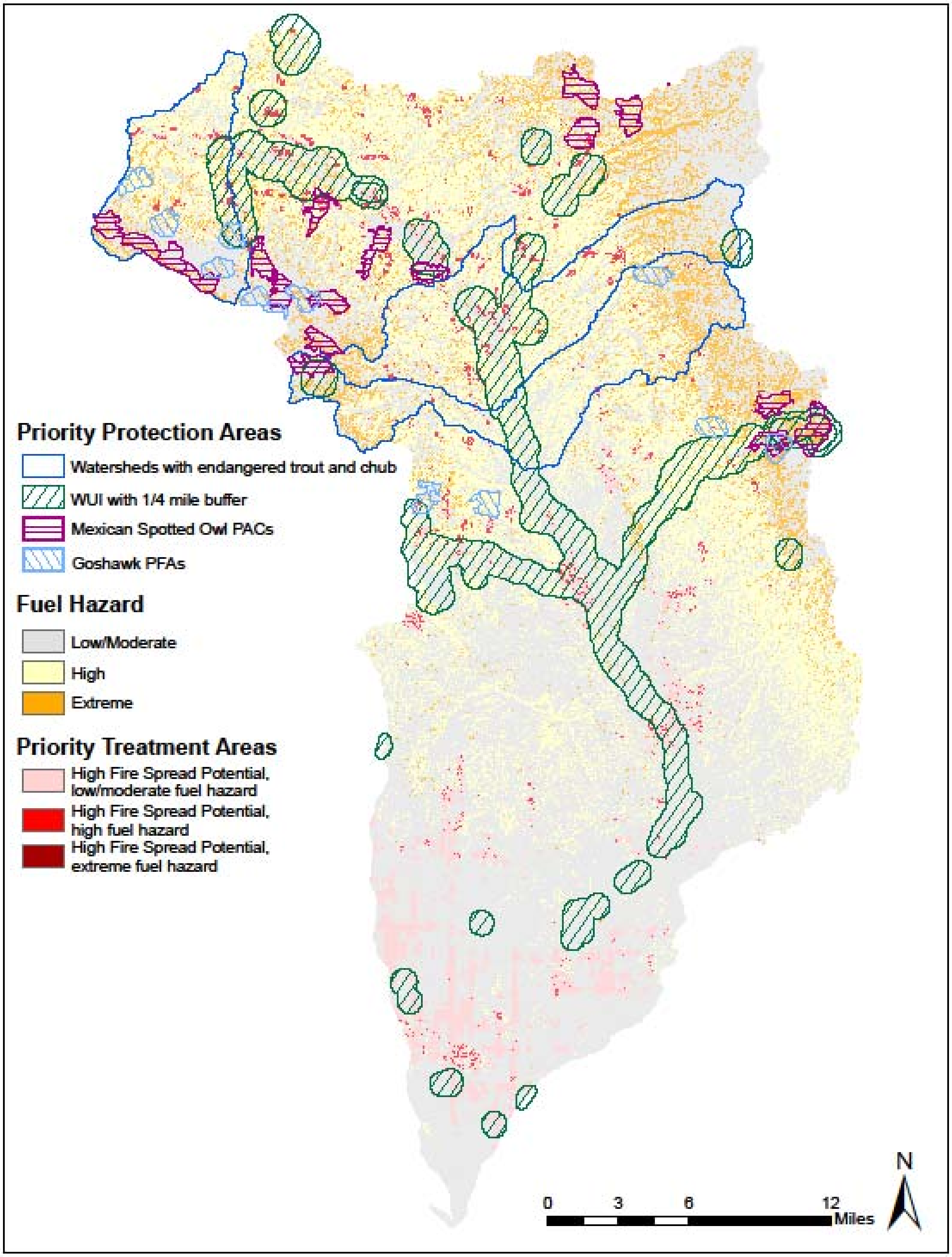


Figure 14: Identified Fire Spread Potential treatment areas in the high priority Gallinas Canyon watershed.

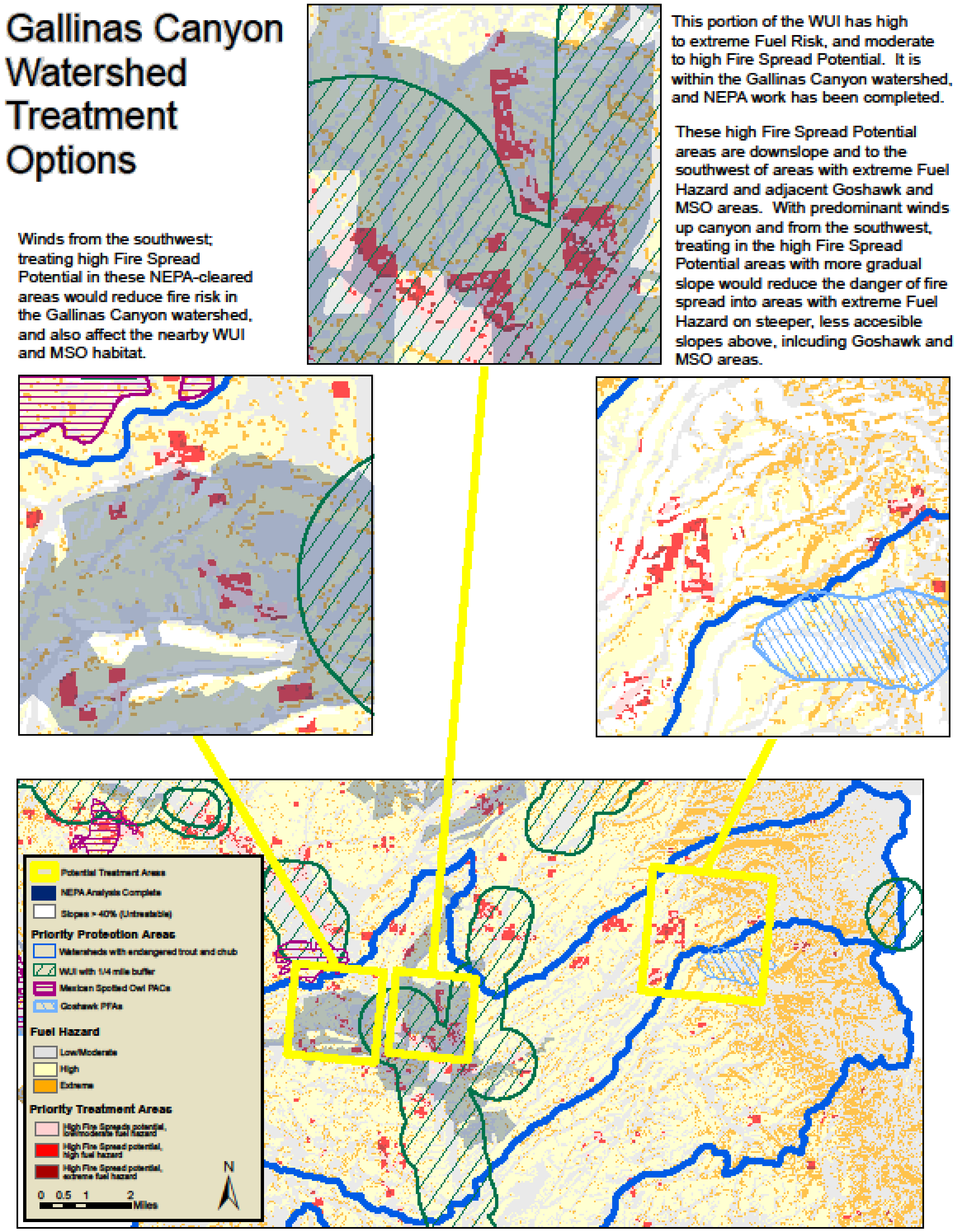


Figure 15: Identified Fire Spread Potential treatment areas in the high priority Sapillo Creek watershed.

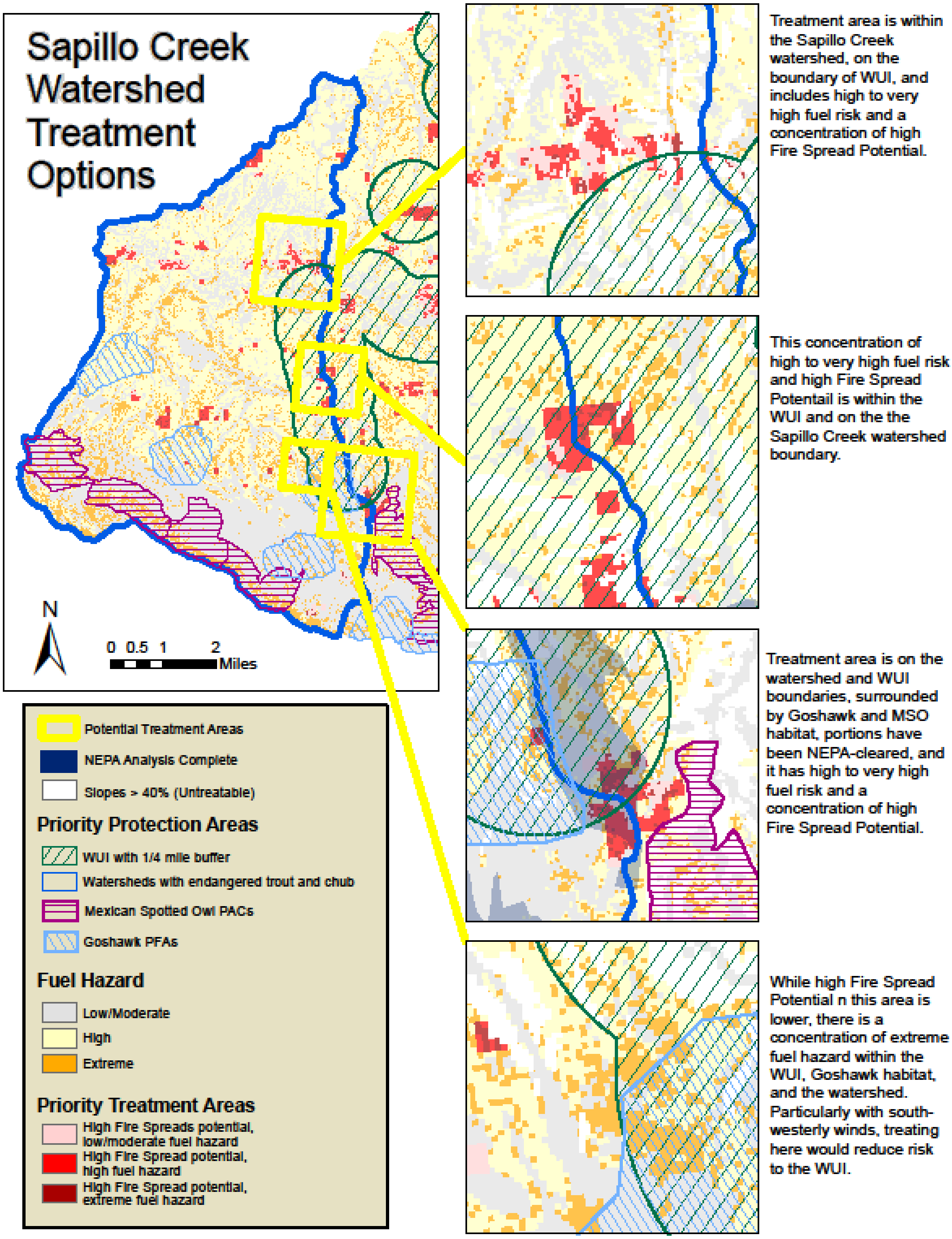


Figure 16: Potential for Treatment in the Sheep Corral Canyon-Sapillo Creek Watershed.

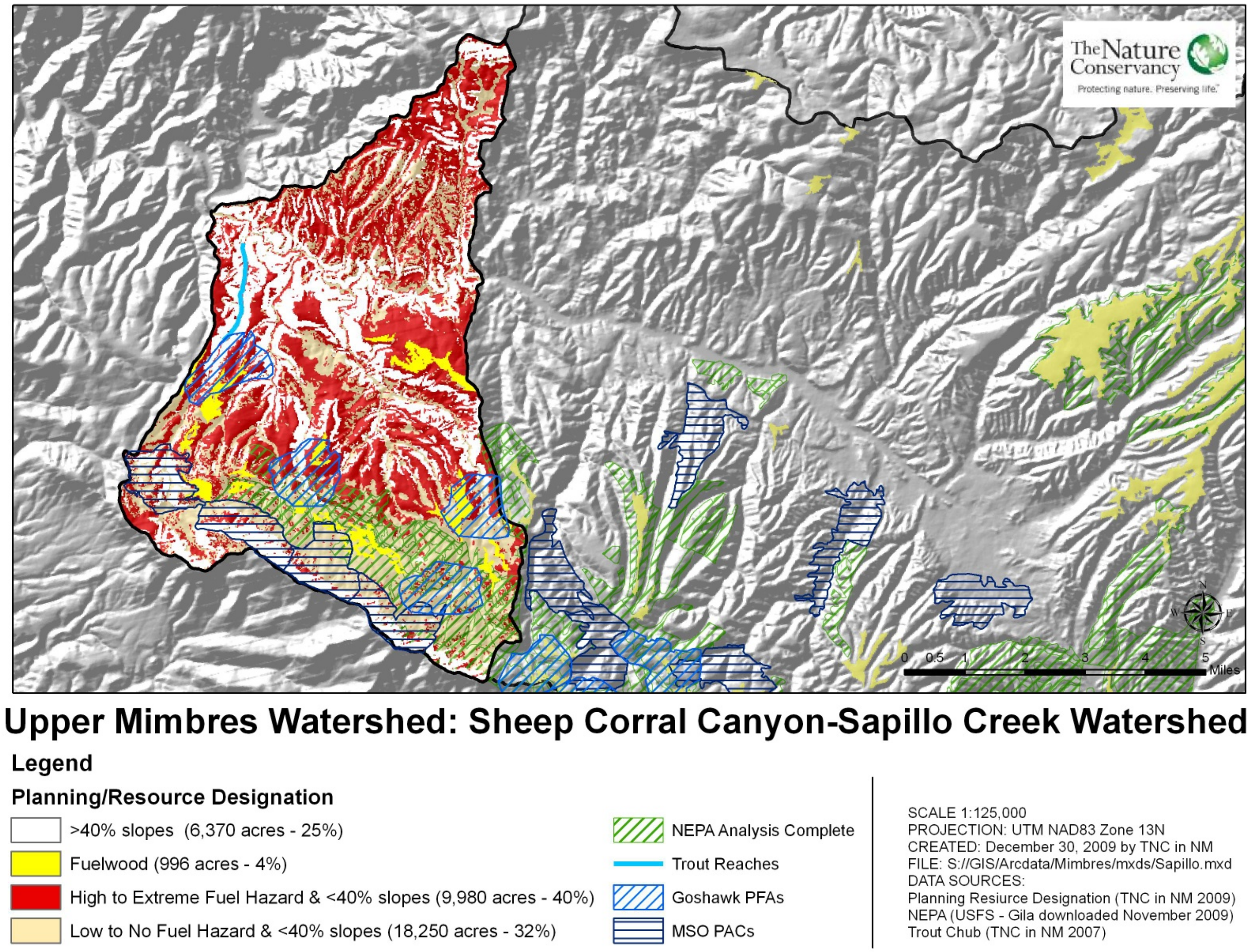


Figure 17: Potential for Treatment in the Allie-McKnight Canyon Watershed.

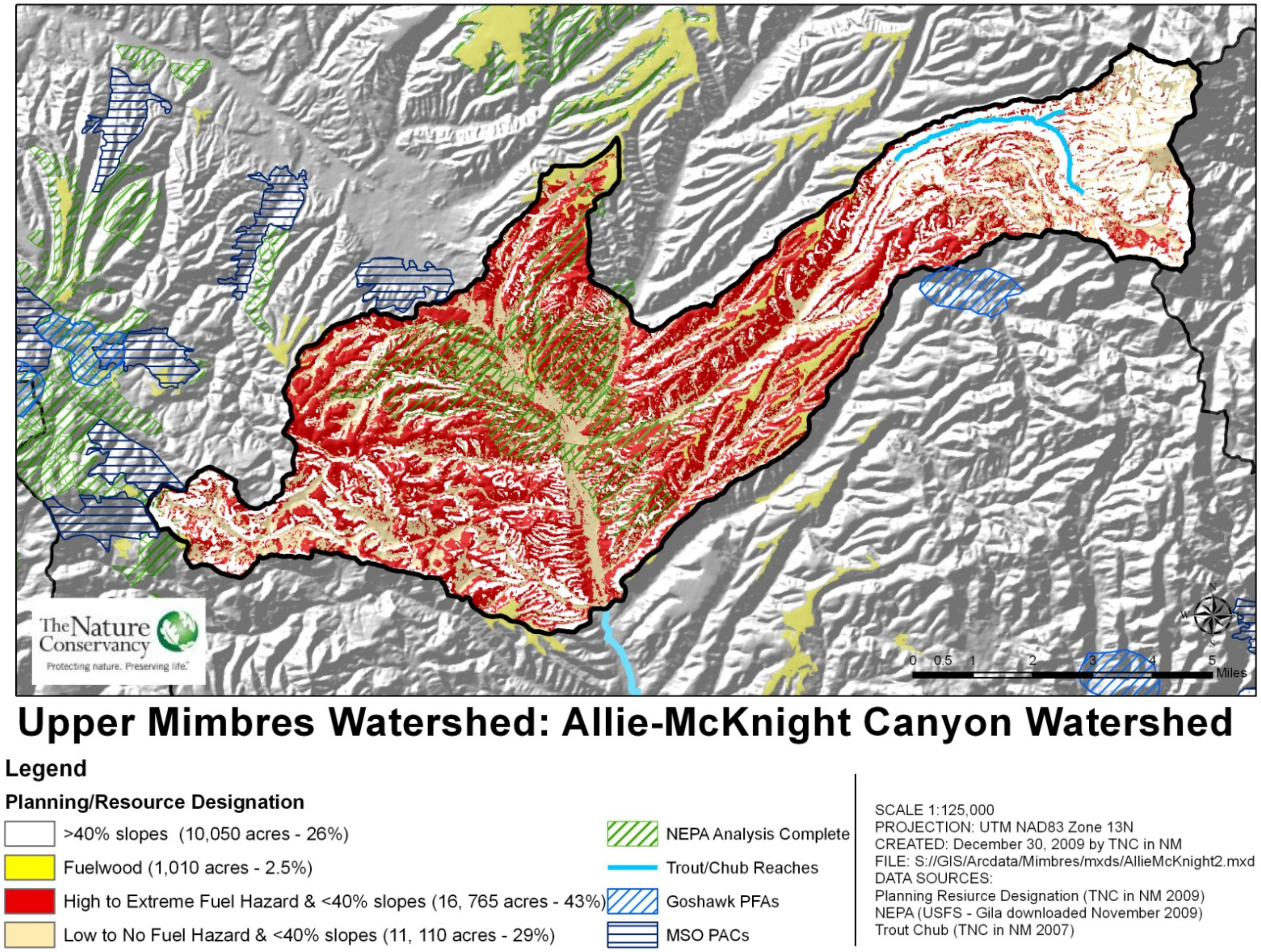
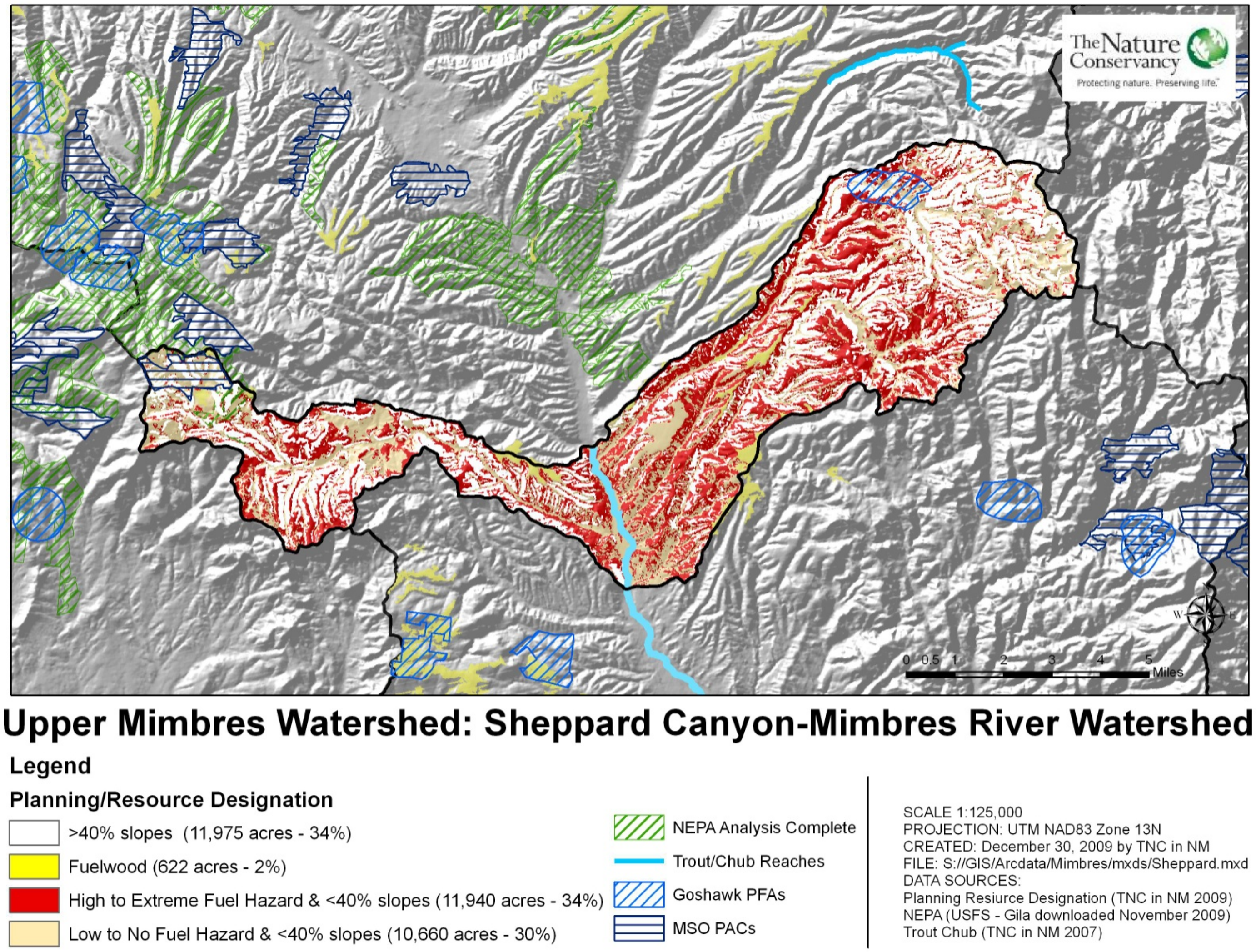


Figure 18: Potential for Treatment in the Sheppard Canyon-Mimbres River Watershed.



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