Rowe Mesa, NM Landscape Assessment

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Collaborative Forest Restoration Program

Santa Fe National Forest – Pecos/Las Vegas Ranger District

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Abstract

Natural (lightning-ignited), frequent, low-severity fire historically occurred across Rowe Mesa from at least the mid-1500's until the late 1800's, when increased Euro-American land use and heavy grazing removed the grass fuels and stopped all fires. Coincident with the beginning of fire exclusion in the late 1800's, much of the ponderosa pine overstory was cut. These two events resulted in an increase in tree density (currently averaging 376 trees/acre in Piñon/Juniper (PJ)- and Ponderosa pine (PIPO)-dominated forest types), favoring the less fire-tolerant PJ species. Decades of fuel-wood harvesting (and illegal harvest of trees > 12" drc) has further reduced the density of old, large trees on the mesa, such that the diameter of living trees is only half that of the cut stumps. Modeled fire behavior for a problem wildfire scenario (97th percentile weather) in current fuels indicates that 65% of Rowe Mesa will have fire behavior (> 4 ft flame lengths) that will require dozers or air tankers for suppression. Optimized treatment locations on 20% of the landscape reduced modeled fire rate of spread on 69% of the landscape. We suggest prioritizing treatment locations based on ability to reduce fire behavior at the landscape scale, while protecting the remaining stands of pre-1880 trees, and promoting prescribed and managed fire to restore and maintain ecosystem function.

Additional key results:

- The PJ type covers almost half (47%) of the 77,580 acre management unit and the remaining half is split between grassland (29%) and ponderosa pine (24%).
- 50% of the live trees in the vegetation plots were *Pinus edulis* (piñon pine) and 36% were *Pinus ponderosa* (ponderosa pine).
- 15% of the landscape was "crushed" in the 1970's to convert PJ forest to grassland
- The mean diameter of live trees (12.3 cm dbh, n = 2236) is approximately half the diameter of cut stumps (24.2 cm drc, n = 303).
- 87 % of live tree regeneration is PIED.
- Fire-scarred trees recorded frequent (11 yr mean fire interval, 10% scarred), low severity, May-June fires in forests currently dominated by PIPO and PJ across the mesa from 1546-1899.
- The east central mesa edge near Punta de la Mesa San Jose has the highest modeled probability of burning, has a high density of lightning ignitions and had the highest historical fire frequency.
- The historical forest was less dense, had more large trees, a higher percentage of PIPO, and more grass cover.

TABLE OF CONTENTS Page

MAPS Page

1. INTRODUCTION

1.1 Physical landscape

The landscape assessment covers 77,580 acres within the management unit on Rowe Mesa (Figure 1). The management unit boundary was determined by the mesa edge to the east and the Forest Service boundary to the north, west, and south. The maximum manageable area (89,085 acres) includes the Forest Service land below the mea edge to the east. The remainder of the document describes features located within the 77,580 acre management unit. Within the management unit there are 6,586 acres of private inholdings (8.5% of total area) that are concentrated in the north.

The mesa is 27 miles long by 3 to 9 miles wide and is oriented along a southeast to northwest axis. It is relatively flat, with a mean slope of 4 degrees (Figure 2). Slopes are generally south-facing (mean aspect = 186 degrees), but all aspects are present (Figure 3). Elevation decreases from north to south and to a lesser extent from east to west (Figure 4). Maximum elevation is 8054 ft (2455m) and minimum is 6440 ft (1963m).

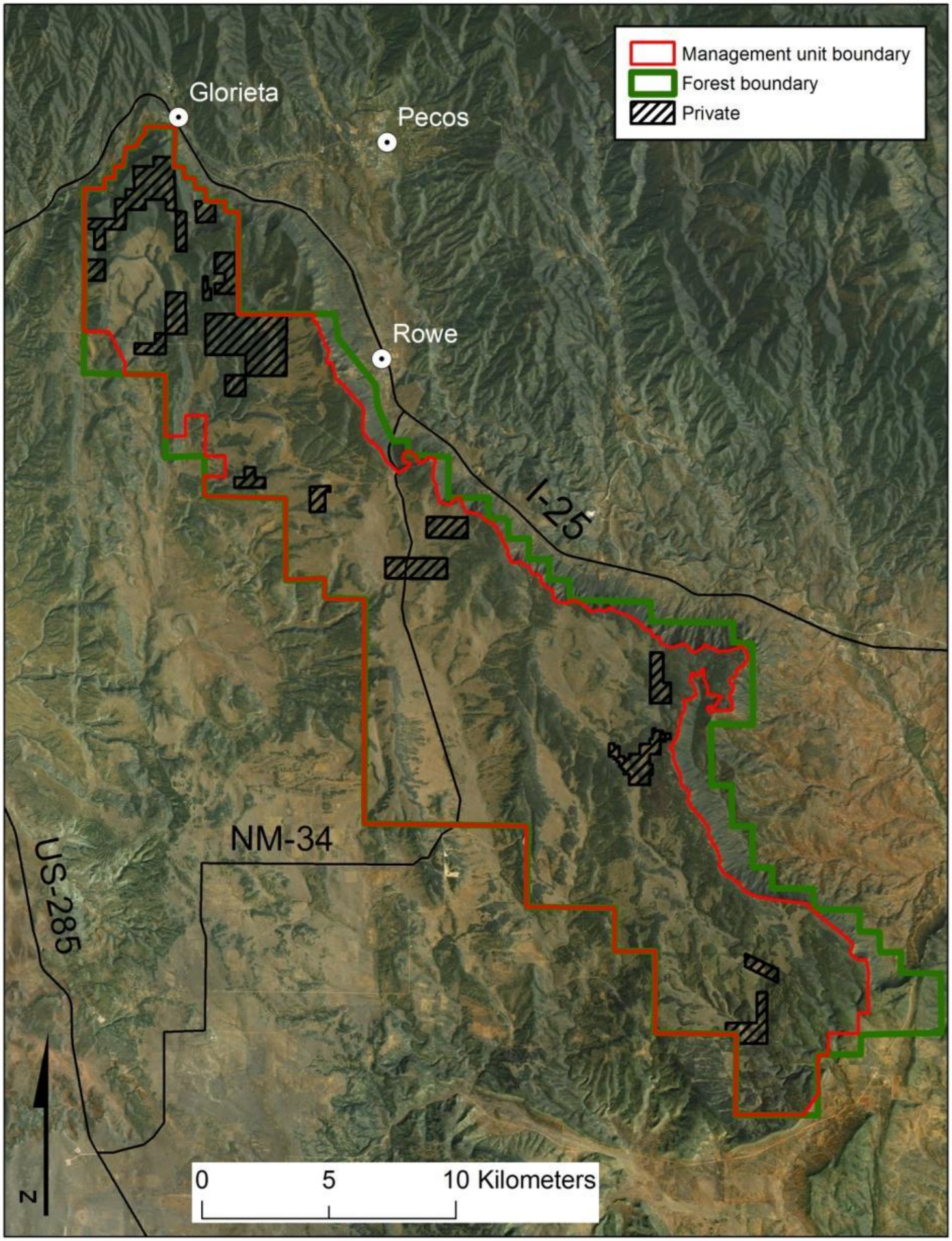

Figure 1. Rowe Mesa CFRP management unit (77,580 acres), forest boundary and private land.

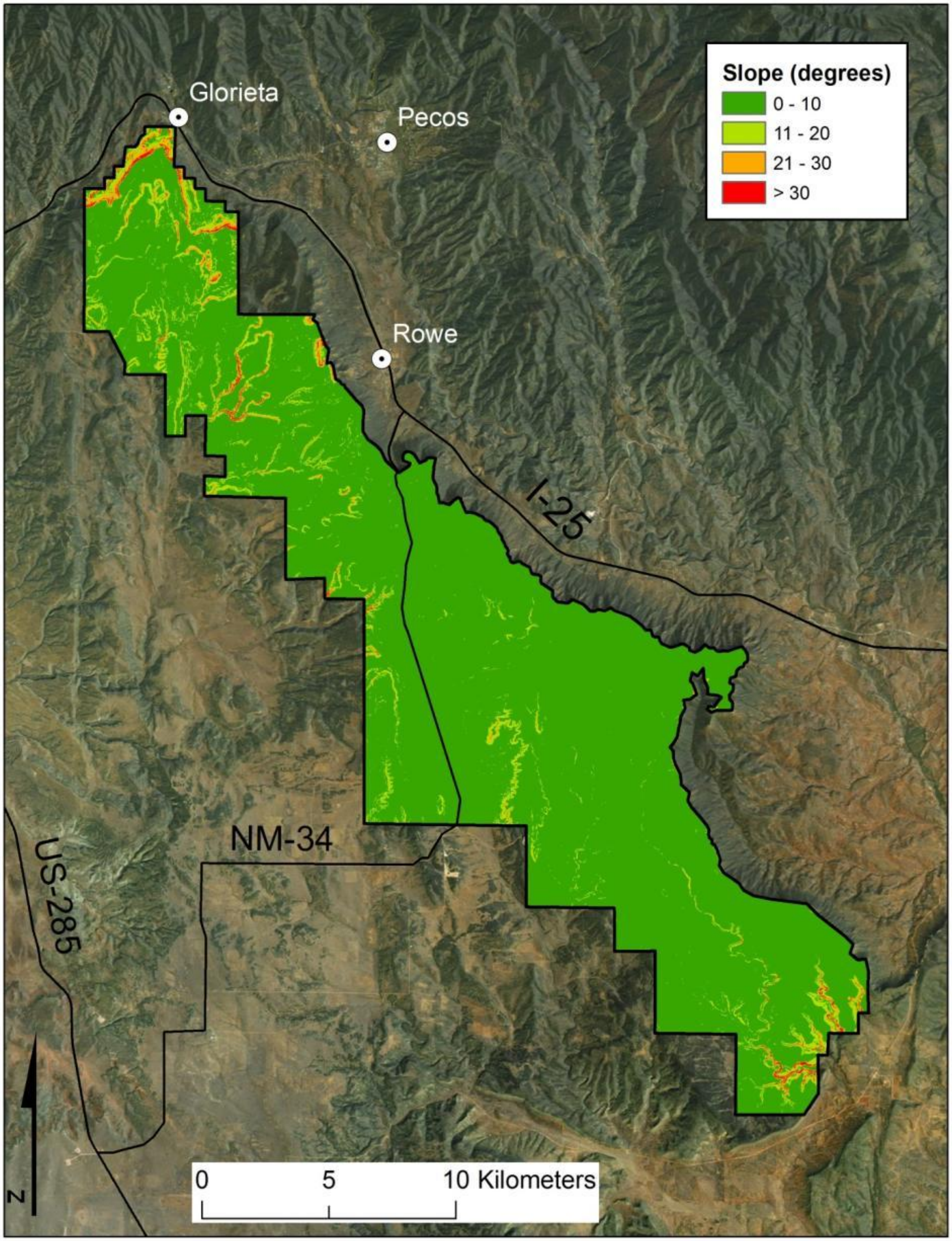

Figure 2. Rowe Mesa slope indicating generally flat terrain.

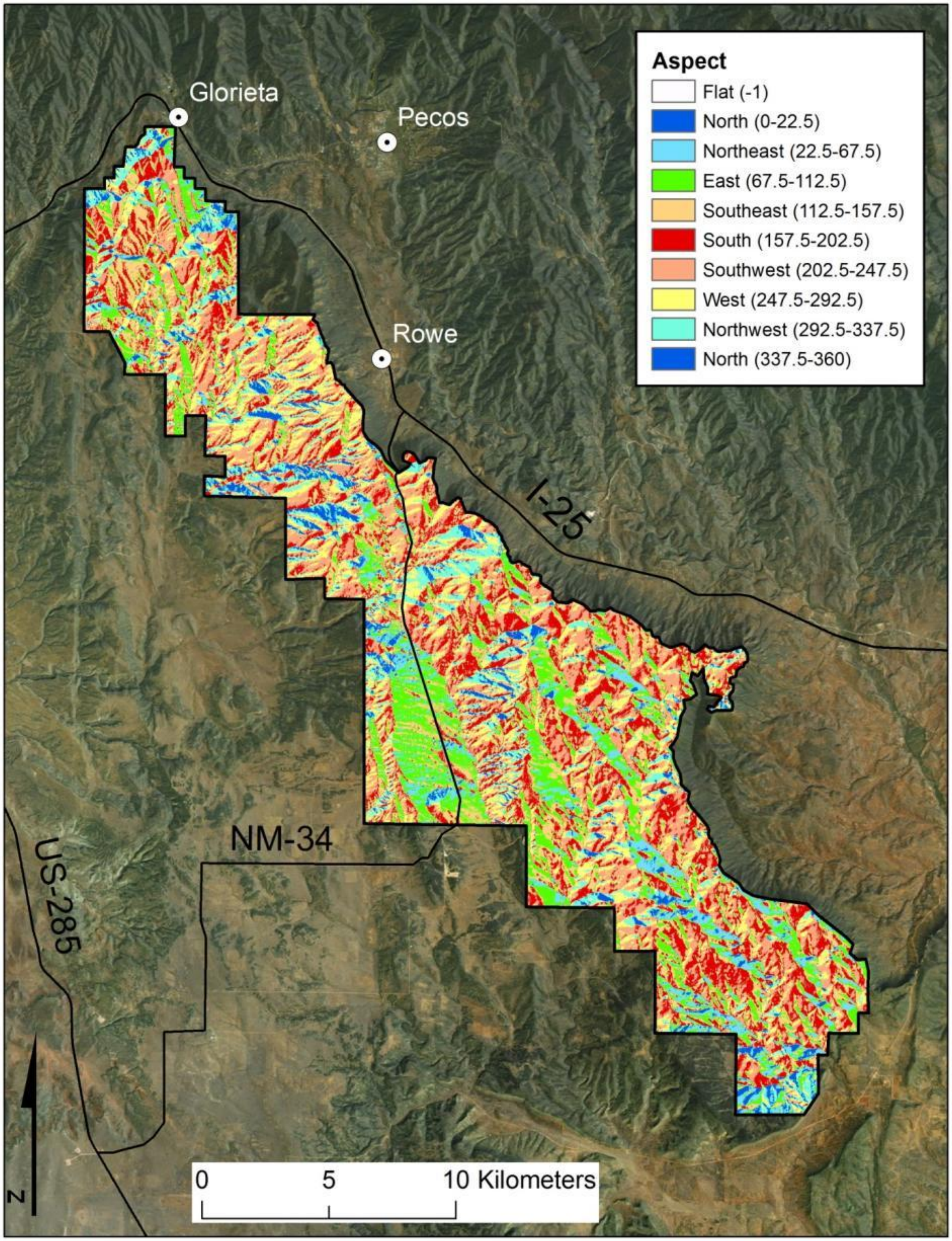

Figure 3. Rowe Mesa aspect indicating generally south- to west-facing terrain.

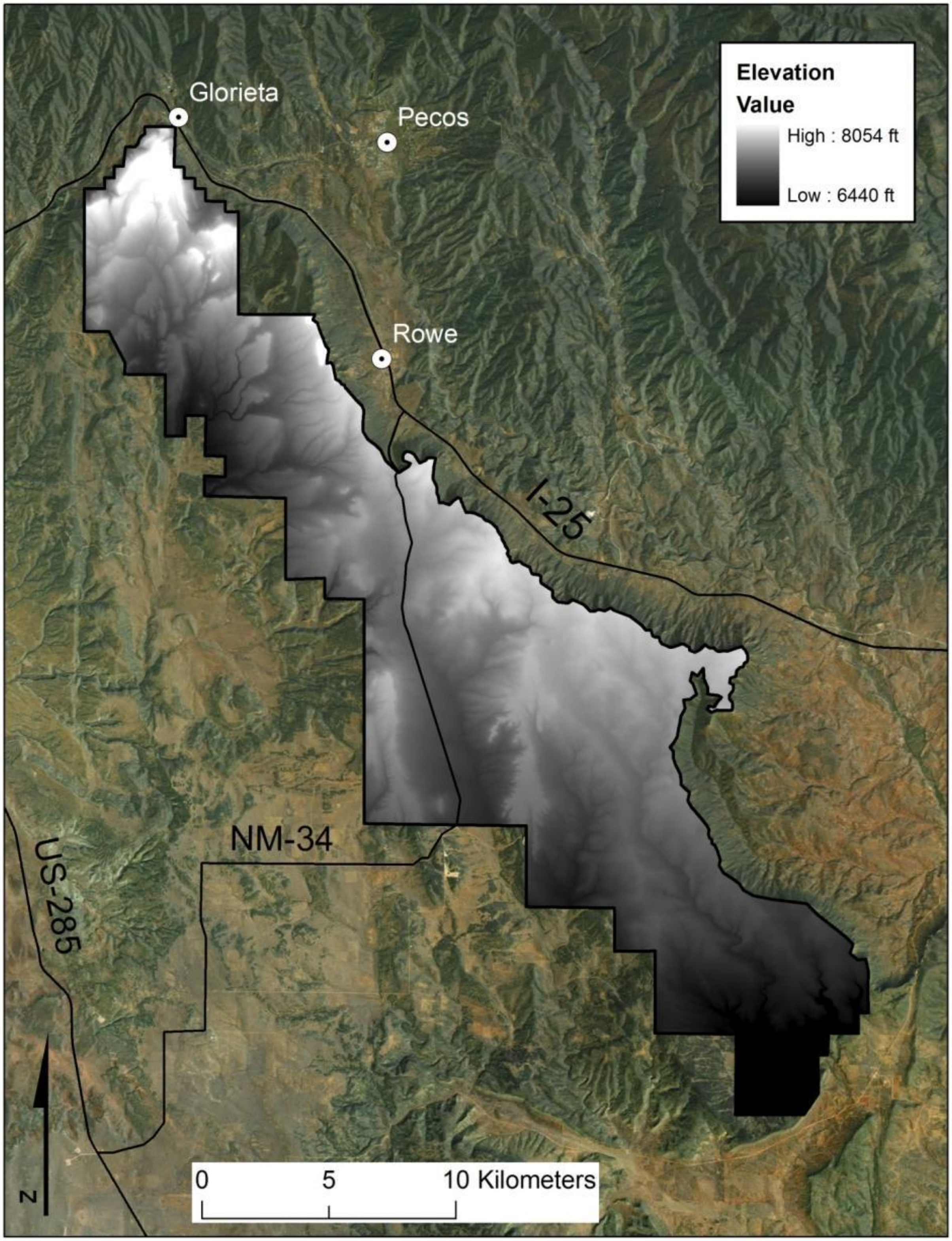

Figure 4. Rowe Mesa elevation indicating generally higher elevations on the north and east mesa edges.

1.2 Climate

At the Pecos Ranger Station (6969 ft elevation, < 10 km north of the mesa) the annual average high temperature is 65.2 °F, low is 33.4 °F (1970-2000). Annual average precipitation is 17.4 inches, peaking in July and August during the monsoon (Figure 5). Wind is predominantly from the west-southwest during the months with the greatest number of fire ignitions (May – July, Figure 6).

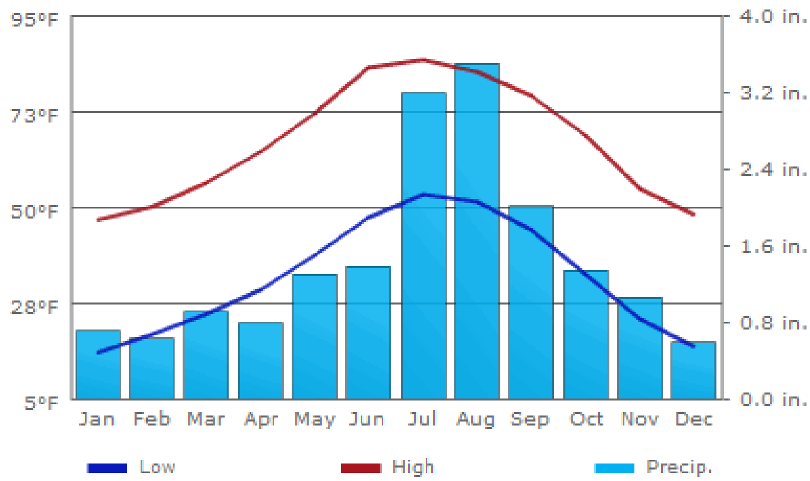

Figure 5. Pecos, NM Climograph (6969 ft) showing mean monthly precipitation, high and low temperature (http://www.usclimatedata.com/climate.php?location=USNM0229, 8/15/2011).

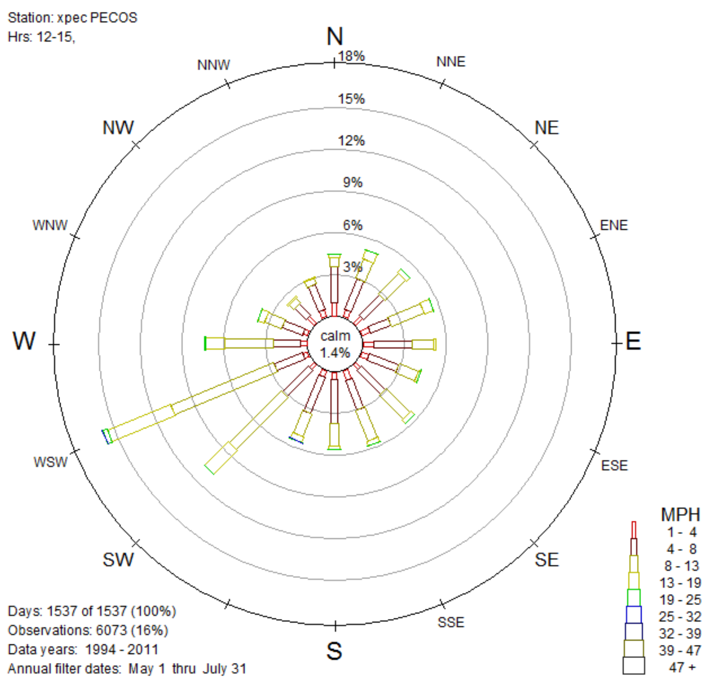

Figure 6. Windrose from Pecos RAWS station showing dominant wind direction from the west-southwest during the months with the most fire ignitions (May 1 – July 31, 2011).

2. EXISTING CONDITIONS

2.1 Vegetation types

The existing vegetation includes three major types: grassland, piñon/juniper (PJ), and ponderosa pine (Figure 7, Table 1). Because of the elevation range (6500ft – 8000ft) and dry south- and west-facing slopes on Rowe Mesa, this landscape sits at the transition zone or ecotone between PJ and ponderosa pine vegetation. It is rare to find pure stands of PJ or ponderosa pine. Depending on slope or elevation, one type may be more dominant (i.e., lowest elevation, south-facing slopes are dominated by PJ and vice versa). The PJ type covers almost half (47%) of the total area. PJ is composed of *Juniperus monosperma* (JUMO, one-seed juniper), *Juniperus scopulorum* (JUSC, Rocky mountain juniper), and *Pinus edulis* (PIED, piñon pine). PJ is generally found on the interior, lower-elevation slopes, ridges and mesitas. The remaining half of the mesa is split between grassland (29%) and ponderosa pine (24%). *Pinus ponderosa* (ponderosa pine, PIPO) is generally found at the highest elevations along the north and east mesa edges, north-facing slopes and in the drainage bottoms. Gramma (*Bouteloua* spp.)–dominated grasslands cover the wide, flat interior valleys. *Quercus undulata (w*avy-leaf oak) is a common understory shrub in both the PJ and PIPO forest.

Young (<100 yrs old), sparse PJ with an herbaceous and shrub oak understory is found along the margins of the grassland/PJ boundaries. This type consists of combinations of JUSC, JUMO, and/or PIED at varying densities. There are generally two types of young PJ: 1) post-crusher re-vegetation - a mechanical tree crusher was used to convert PJ forest to grassland in the 1970's (see section 4.1 and Appendix A) and 2) grassland encroachment - a combination of favorable climate and lack of fire has allowed PJ regeneration in some areas that were historically maintained as open grassland by fire.

We added the young PJ class to the vegetation map using 1) the Landfire Existing Vegetation (EVT) layer and 2) a newly generated "tree crusher" layer. The sparse, young PJ type was classified differently than the older PJ forests in the Landfire EVT layer. Using aerial photos and field reconnaissance it was determined that EVT shrub classes were actually the young, sparse PJ regeneration and shrub oak. These layers were converted to the Young PJ/shrub oak type. In addition, a newly generated crushed tree layer was used to determine additional areas of young PJ/shrub oak. These two young PJ/shrub oak types were combined and added to the 3-class vegetation map to create a new 4-class vegetation map (Figure 8). Based on this map, there is 14,049 acres of young PJ/shrub oak (18% of the landscape). With this young PJ/shrub oak class added, the percent of grassland is reduced to 18% (Table 2), with older PJ forests still the dominant type (40%).

Table 1. Area of dominant vegetation in 3 classes.

Vegetation Type	Area (acres)	Area (ha)	Percent
Grassland	22132	8957	29
Piñon/Juniper	36573	14800	47
Pondeosa pine	18869	7636	24
Other	6	3	<1

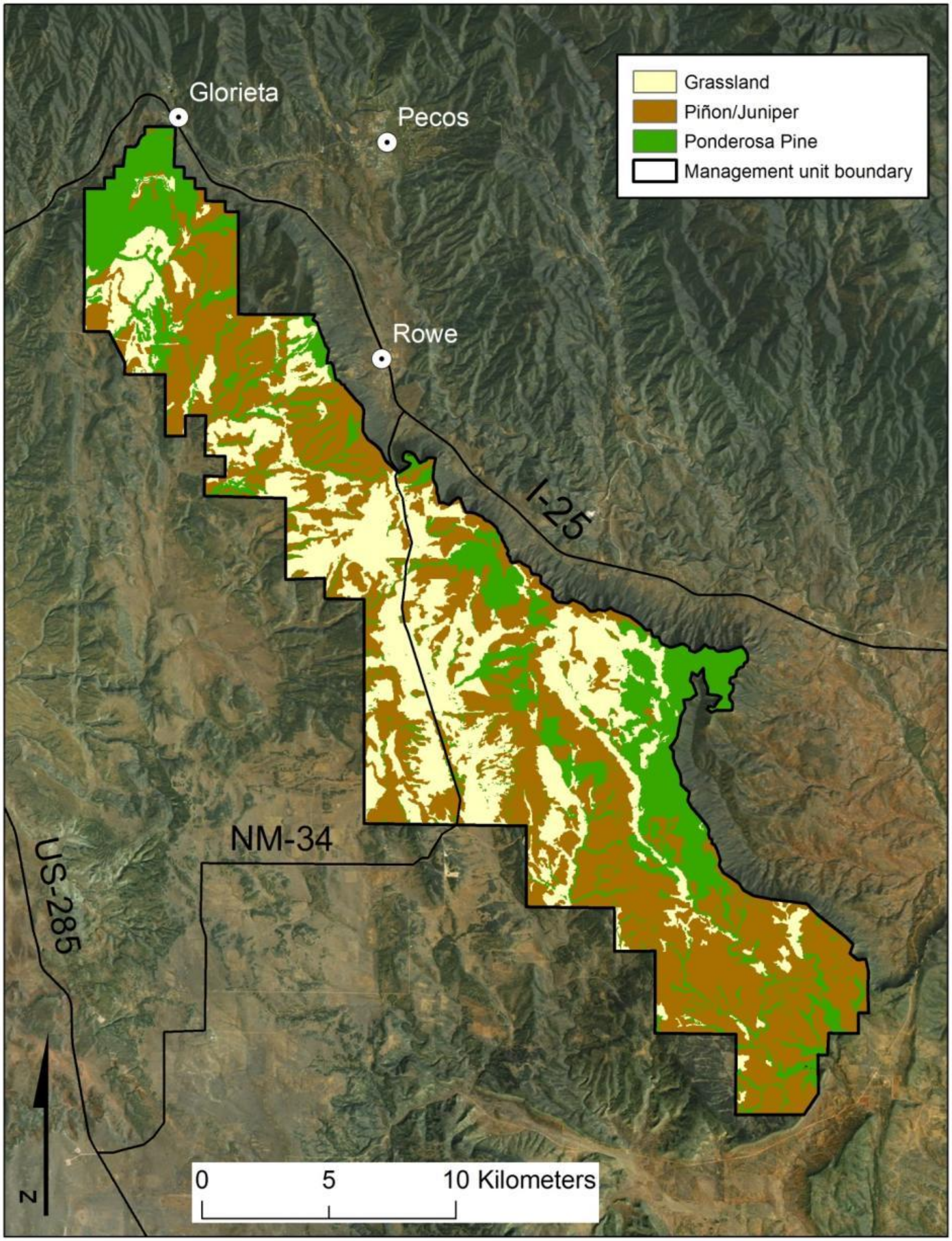

Figure 7. Rowe Mesa vegetation types with 3 classes: grasslands, piñon/juniper, and ponderosa pine.

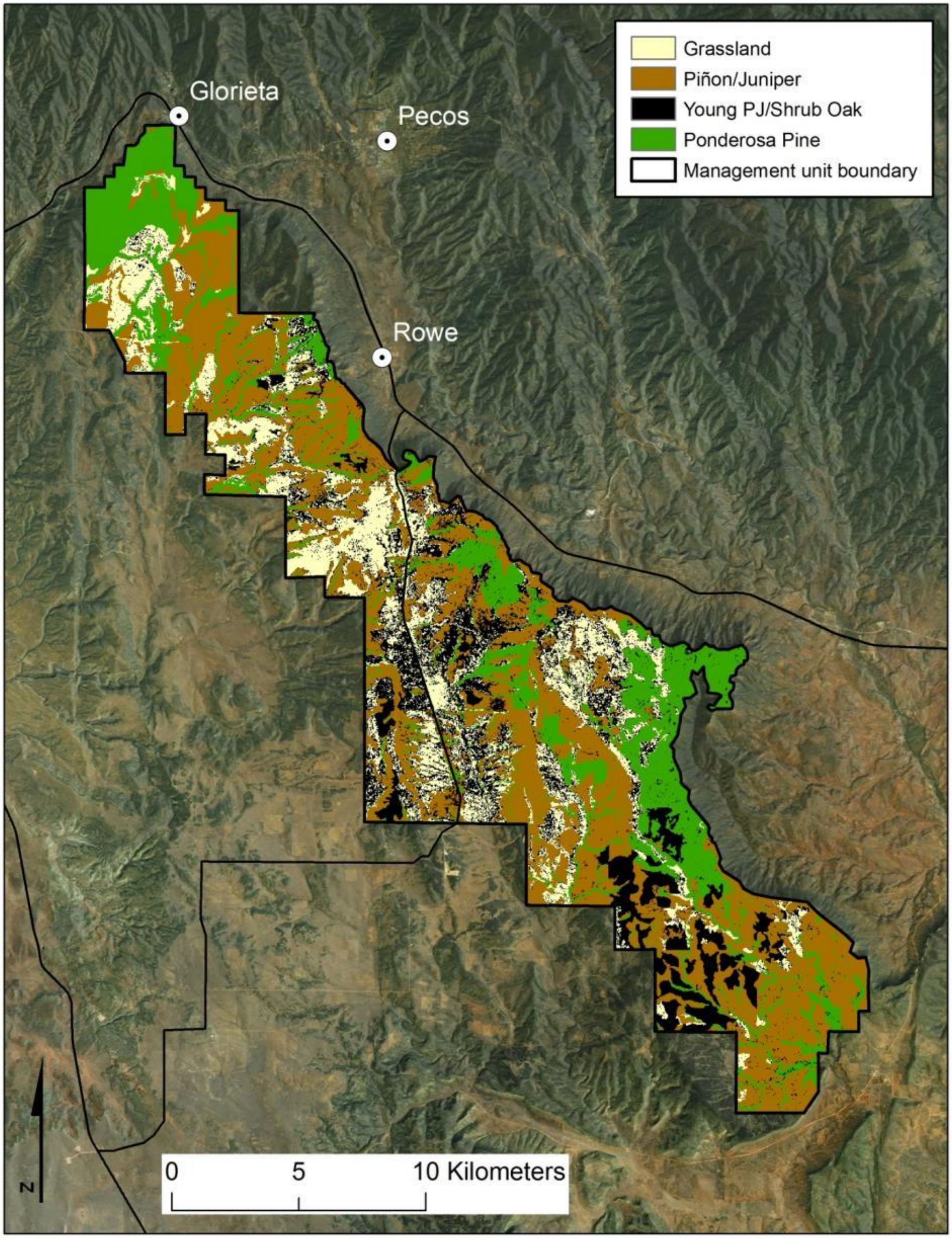

Figure 8. Rowe Mesa vegetation types with a “young PJ” class added.

Table 2. Area of dominant vegetation with the inclusion of a “young PJ/shrub oak” class.

Vegetation	Acres	Hectares	Percent
Grassland	14210	5750	18
Piñon/juniper	31025	12555	40
Young PJ/shrub oak	14049	5685	18
Ponderosa pine	18292	7403	24
Other	6	3	<1

2.2 Forest composition, regeneration, structure and cover - methods

We quantified the current forest tree composition, age, regeneration, canopy cover and ground cover within 0.2 hectare (ha) circular fixed-radius (25.2 m) plots. We sampled two vegetation plots in each of the 6 fire scar sampling areas (n=12 total vegetation plots, Figure 9). Plots were centered on a randomly selected fire-scarred tree or group of fire scarred trees. Within the plots we measured the diameter at breast height (dbh) and recorded the species of all living trees > 5cm dbh. For dead trees, logs, and stumps > 5cm diameter at root collar (drc) we measured drc and recorded the species. Within a 1 m wide X 25 m long belt transect that was centered on a randomly selected radius of the circular plot we measured canopy cover, ground cover and recorded species and height of all tree regeneration (< 5cm dbh). Regeneration density was extrapolated to number /acre from the transect density (number/25m^2).

2.3 Forest composition and regeneration

Fifty percent of the live trees in all plots were PIED and 36% were PIPO (Table 3). Six of the twelve plots were dominated by PIED (i.e., greatest number of live trees) and the other six were dominated or co-dominated by PIPO (Figures 10a and b). All PIED-dominated plots contained PIPO and all PIPO-dominated plots contained PJ species. This is an illustration, at the stand level, that these are PIPO/PJ transition forests. Live tree regeneration at all plots was dominated by PIED (87%, Table 3, Figures 10a and b). A total of only 4 JUSC, 3 JUMO and 1 PIPO regeneration were present in all the plots. This suggests that the forests may be transitioning toward PIED-dominated.

Table 3. Mean percent of live trees and tree regeneration (<5cm dbh) by species at 12 vegetation plots.

	JUMO	JUSC	PIED	PIPO
Trees	2	13	50	36
Regeneration	5	7	87	2

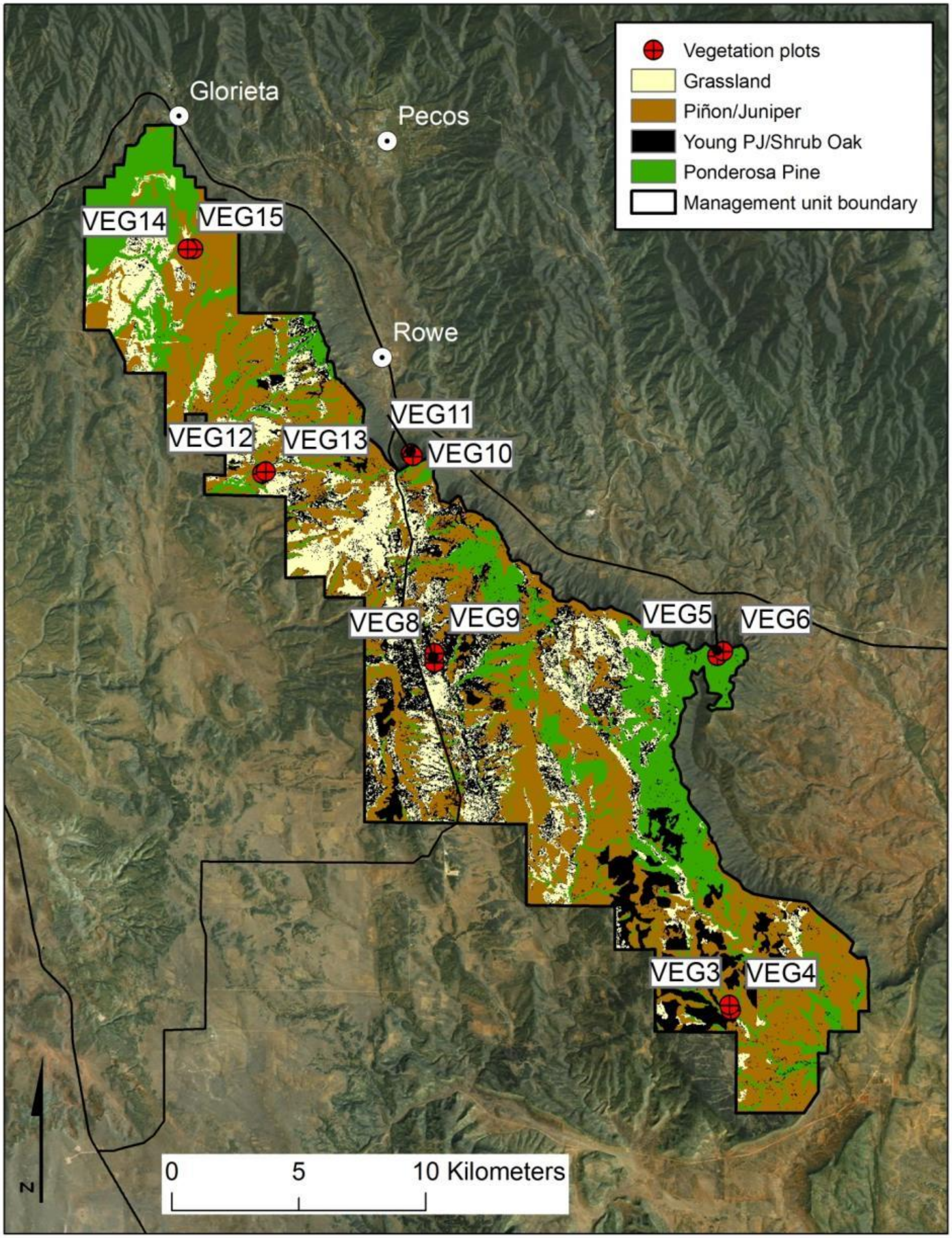

Figure 9. Rowe Mesa vegetation composition, cover, and regeneration plots (e.g., VEG10).

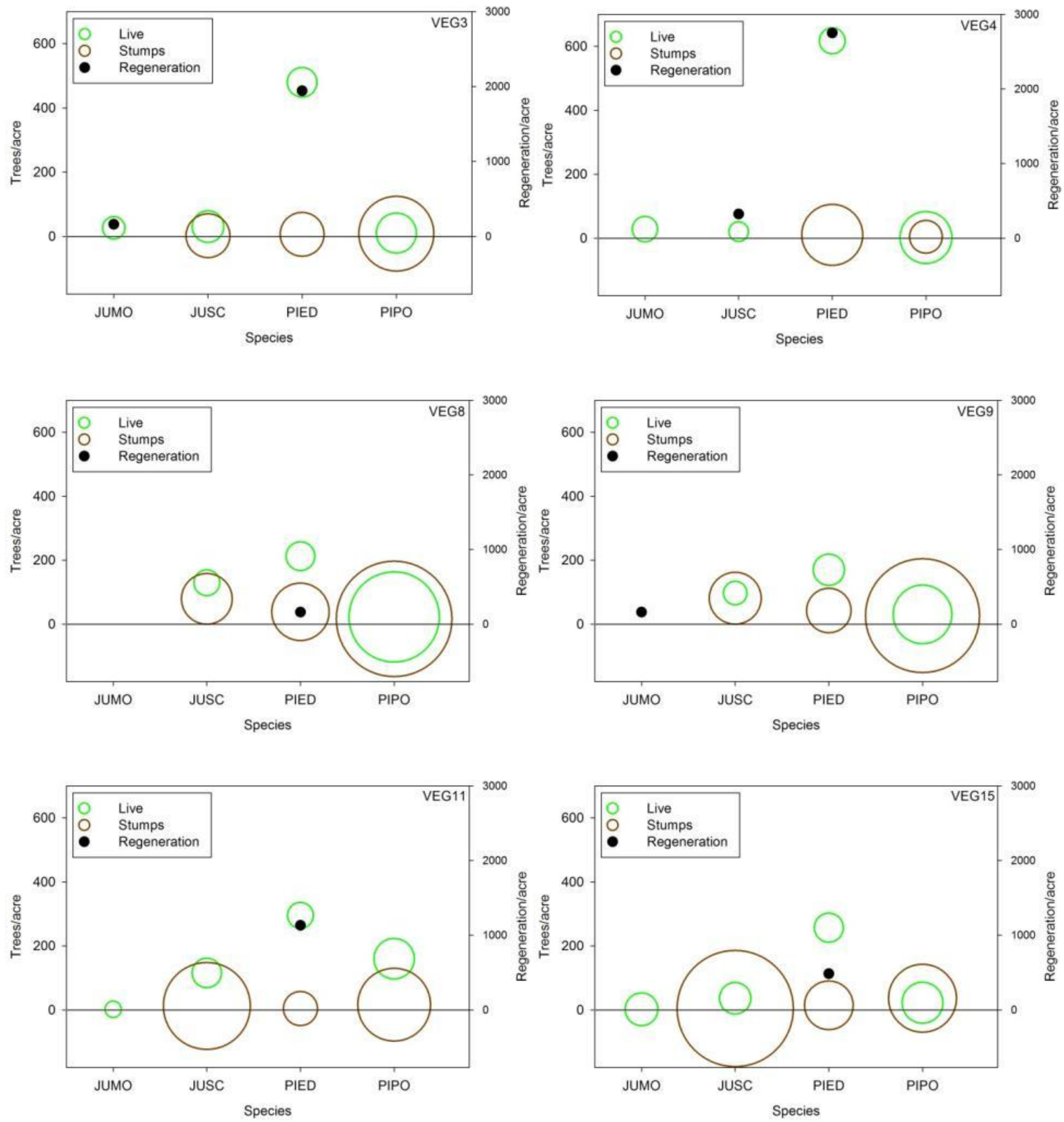

Figure 10a. Density and mean diameter (bubble size) of live trees, tree regeneration (<5cm dbh), and stumps in 0.2ha plots with a plurality of live PIED. Stump diameter = drc and live diameter = dbh. Maximum mean diameter = 42.5 cm and minimum = 5.0 cm. JUSC = *Juniperus scopulorum*, JUMO = *Juniperus monosperma*, PIED = *Pinus edulis*, and PIPO = *PInus ponderosa*.

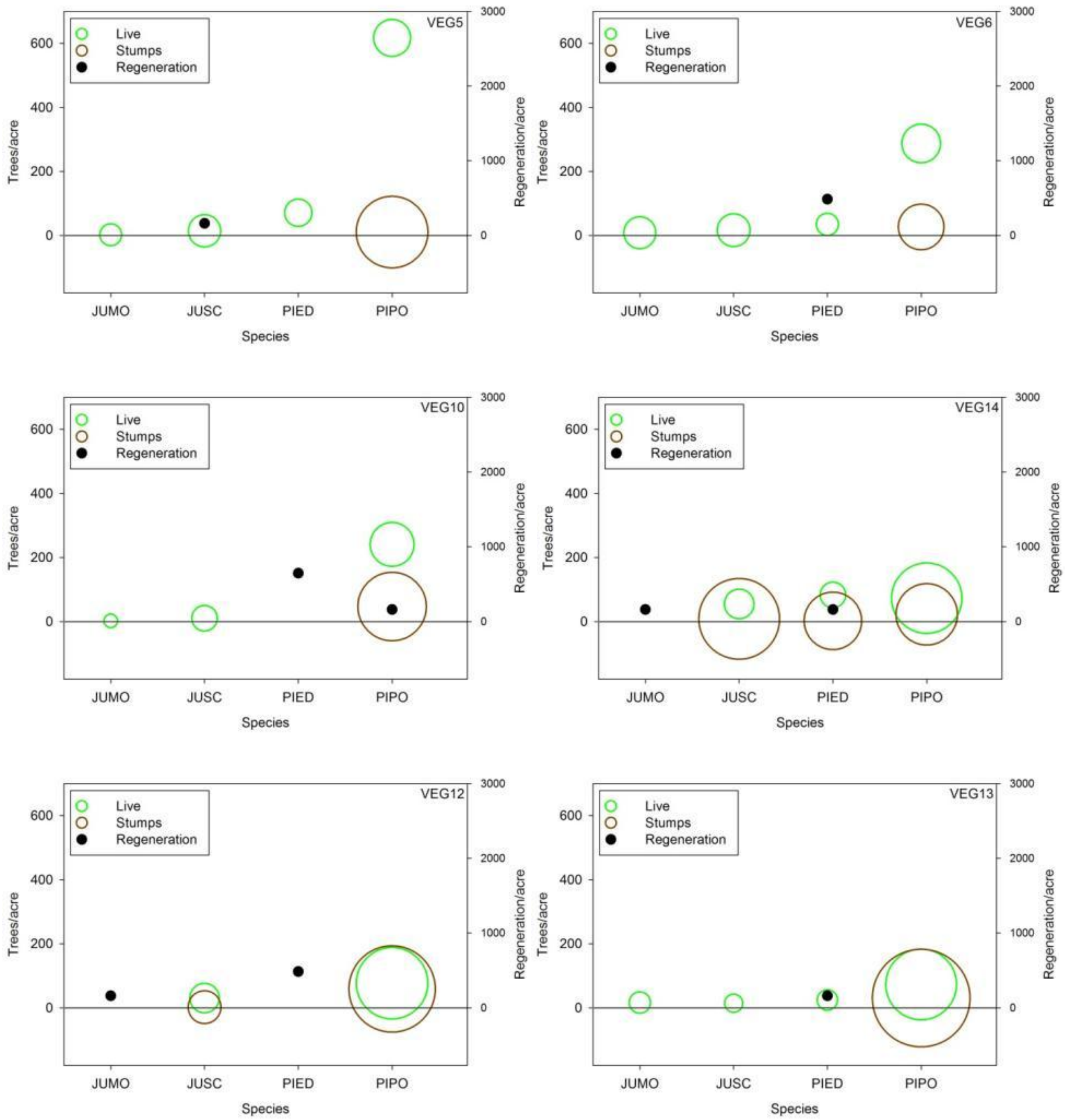

Figure 10b. Density and mean diameter (bubble size) of live trees, tree regeneration (<5cm dbh), and stumps in 0.2ha plots with a plurality of live PIPO. See Figure 10a for remainder of caption.

2.4 Forest structure

Mean tree density at all plots was 376 trees/acre (Figure 11, Table 4). Mean tree density was 38% greater in PIED-dominated plots (425 trees/acre) versus PIPO-dominated (308 tree/acre). Maximum tree density was 704 trees/acres at plot VEG5, a PIPO-dominated plot in an area with the highest pre-1900 fire frequency and where the mean diameter of the cut PIPO stumps was twice that of the living trees (Figure 10b). This suggests that tree harvesting and fire cessation have converted that stand from a relatively open, large-tree dominated stand to a dense, small-tree dominated stand. Minimum tree density was 107 trees/acre at a PIPO-dominated plot (VEG12). At this plot, the mean diameter of the living PIPO (26 cm dbh) was similar to the stumps (31 cm drc, Figure 10b). This indicates that the overstory was not completely harvested and could have provided enough shade to prevent dense PIPO regeneration. The mean diameter of all live trees (12.3 cm dbh, n = 2236) is approximately half the mean diameter of all cut stumps (24.2 cm drc, n = 303). This suggests that the forests are transitioning toward dominance by small trees likely due to two factors: (1) tree harvesting and (2) anomalously high levels of regeneration that have survived due to the lack of fire (Figures 10a and b).

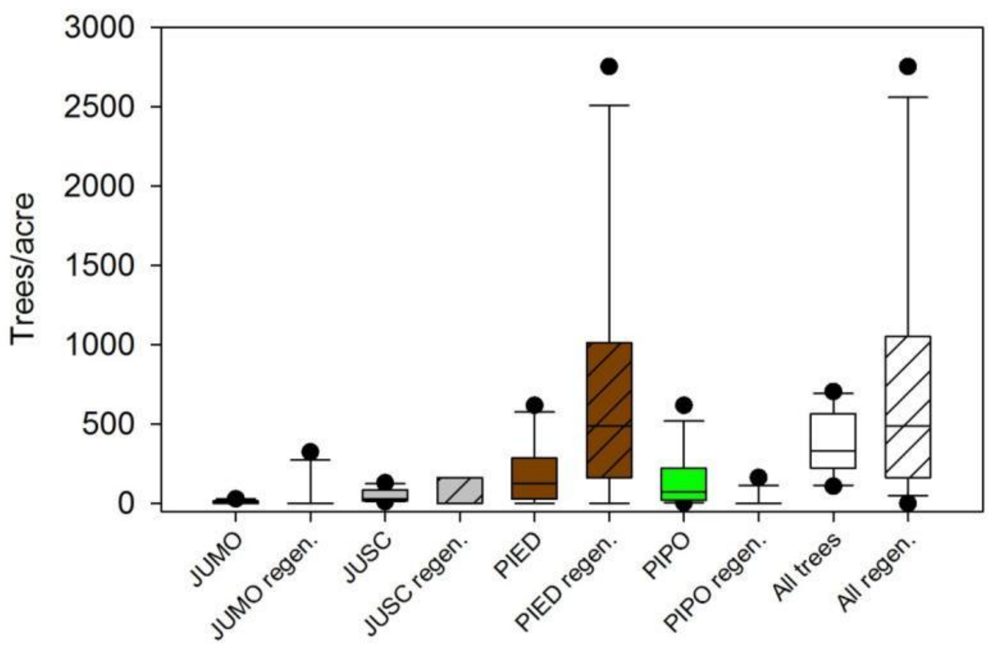

Figure 11. Density of live trees and tree regeneration (<5cm dbh) at 12 vegetation plots. Boxes illustrate 25th to 75th percentiles and median (line). Error bars illustrate 10th and 90th percentile and black dots are outliers.

Table 4. Density (trees/acre) of live trees and tree regeneration (<5cm dbh) at 12 vegetation plots.

		JUMO	JUSC	PIED	PIPO	All
Mean	trees	7	47	187	135	376
	regen.	40	54	701	13	809
Maximum	trees	28	129	617	617	704
	regen.	324	162	2752	162	2752
Minimum	trees	0	10	0	2	107
	regen.	0	0	0	0	0

2.5 Ground cover

Ground cover was dominated by litter (<5 cm diameter, Figure 12). Nine of ten plots had >50% litter cover and the remaining plot was dominated by rock. Grass cover was present at half of the 12 plots and maximum cover at a plot was only 12%. So although there are large grassland areas on the mesa, within the PJ and PIPO forests we sampled there was very little grass or herbaceous cover.

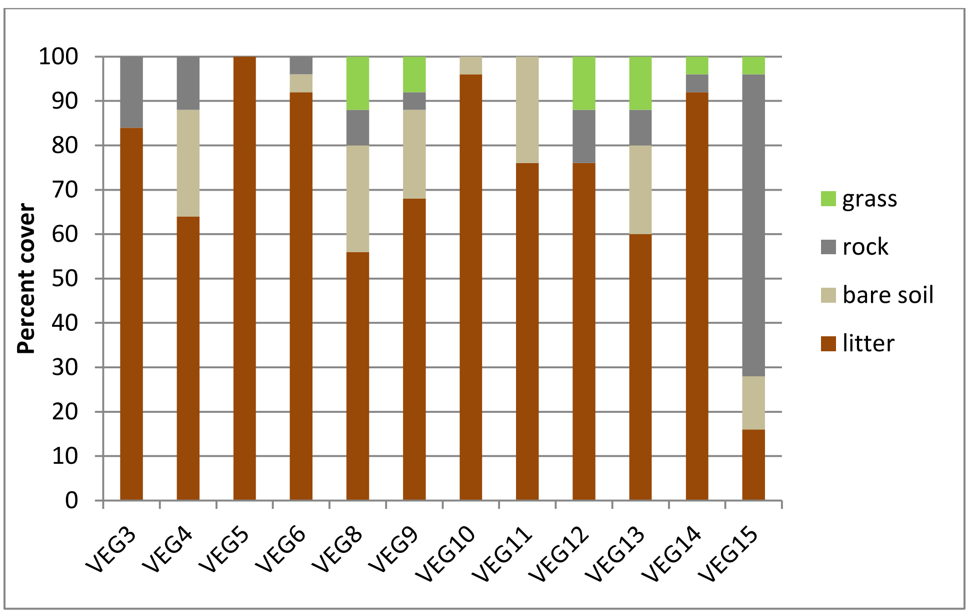

Figure 12. Percent ground cover in randomly located belt transect in each of 12 vegetation plots.

2.6 Fire

There were 45 wildfire ignitions on Rowe Mesa between 1973 and 2009 (Figure 13). During this 37-year period, 43% of the years had no ignitions. During the remaining "fire years" there was an average of greater than three fires per year. Most (69%) of the fires were started by lightning. Peak months for ignition were June (29%), July (27%), and May (18%), coinciding with the season of monsoon convective storms that produce lightning. Total area burned was 1075 acres (1973 -2009). Peak area burned occurred in June (coinciding with regional patterns, Barrows 1978), but most of this acreage was from one fire (Hurtado Fire, June 2007, 801 acres). Cool season precipitation (prior October – current May) was 75% of average during years with multiple ignitions and 110% of average on years with zero ignitions.

2.7 Fire Modeling with Flammap

FlamMap is a fire behavior mapping and analysis program that computes potential fire behavior characteristics (spread rate, flame length, fireline intensity, etc.) over a landscape for constant weather and fuel moisture conditions (http://www.firemodels.org/index.php/national-systems/flammap, 9/2011). The GIS data required to run Flammap were obtained from the most recently updated Landfire data (Landfire Refresh 2008, LF_1.1.0, Rollins 2009). Data layers include elevation, slope, aspect, fuel model, canopy cover for surface fire simulation and stand height, canopy base height and canopy bulk density for crown fire simulation.

Fire model inputs were based on the RAWS data from Pecos, NM (ID, 291202). Station elevation (8200ft) was similar to the highest elevations in the management unit and the wind patterns were more similar than the other nearby RAWS station (Santa Fe Watershed). Weather data were analyzed from May 1 – July 31, which is when 73% of ignitions and 98% of area burned occurred in the management unit (1973-2009). This period is similar to when the maximum daily ERC (Energy release component) exceeds the 90th percentile (ERC$\geq$82, April 16 – July 8, 1994 - 2011). Extreme (97th percentile) weather and fuel moisture values were used to parameterize the "problem fire" simulations (Table 5). The weather inputs are likely conservative (less severe), because the majority of Rowe Mesa is at lower elevation than the Pecos RAWS station. Wind vectors were adjusted for topography using Wind Ninja (version 2.1.0, http://www.firemodels.org/, 10/15/11)

Table 5. Fuel moisture and wind data used to parameterize the fire simulations.

Percentile	1hr	10hr	100hr	herb	woody	20' wind (mph)	wind direction
97th	0.86	1.47	3.34	1.59	60	17	WSW

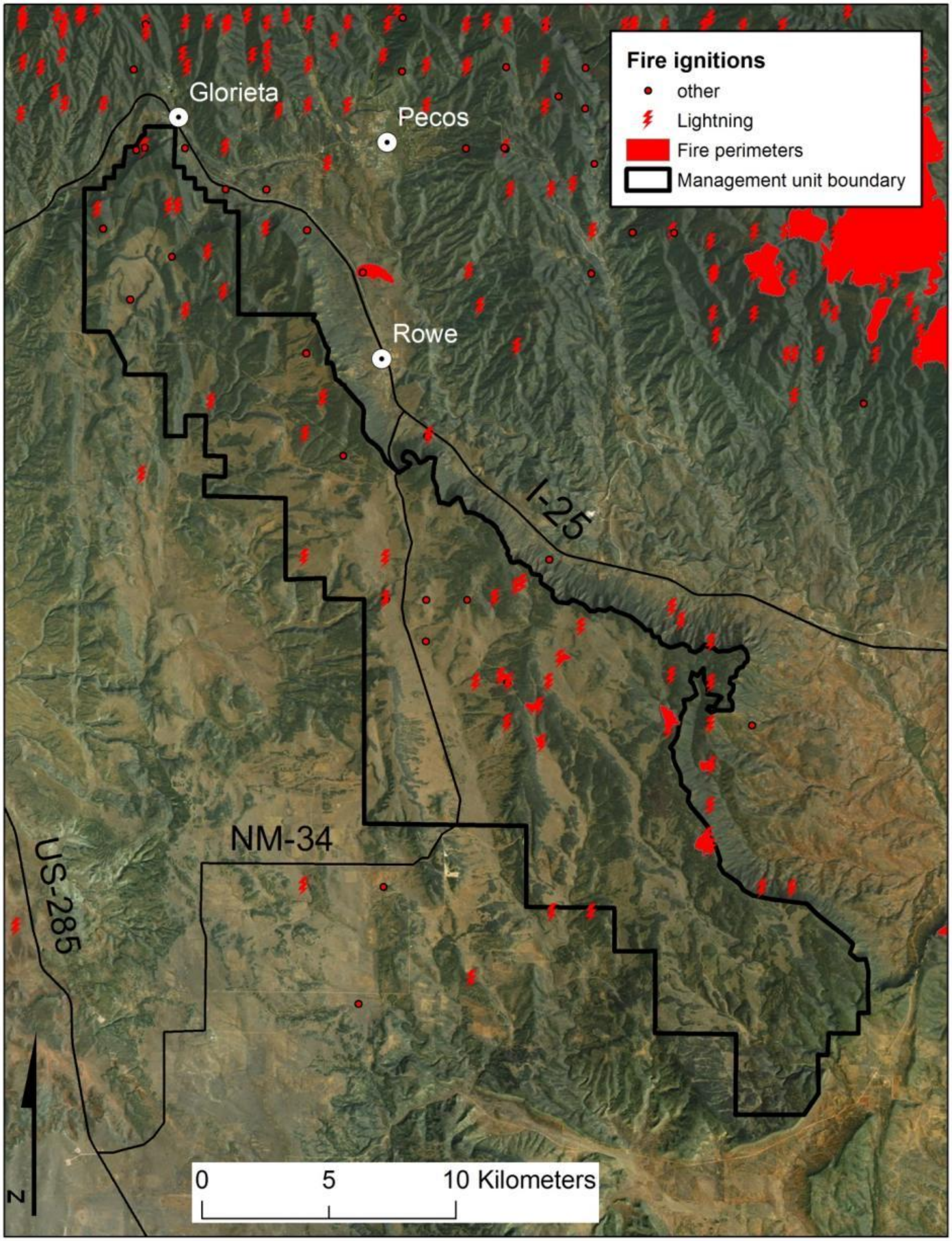

Figure 13. Rowe Mesa (and adjacent areas) wildfire ignitions, cause, and fire perimeters (1973 -2009).

Ten fire behavior fuel models (Scott and Burgan 2005) covered more than 50 acres within the management unit (Figure 14, Table 6). The two fuel models covering the largest percentages of the mesa are the GS2 grass/shrub type (60%) and the GR2 grass type (18%). Timber litter and timber understory types cover the majority of the remaining area. The GS2 model is described by Scott and Burgan (2005) as "shrubs 1-3 feet high, grass load is moderate, spread rate high and flame length is moderate." This model occurs within the PJ vegetation types on Rowe Mesa. The GR2 model is described as "moderately coarse continuous grass, average depth about 1 foot. Spread rate high; flame length moderate." This model occurs within the Grass vegetation type.

Table 6. Area and percent cover of fire behavior fuel models on Rowe Mesa.

Fuel model	Type	Acres	Hectares	Percent
GS2	grass/shrub	46932	18993	60
GR2	grass	13820	5593	18
TL3	timber litter	5201	2105	7
TU1	timber understory	4860	1967	6
SH7	shrub	4294	1738	6
TL8	timber litter	1674	678	2
GR1	grass	578	234	1
TU5	timber understory	265	107	<1
GS1	grass/shrub	104	42	<1
SH1	Shrub	57	23	<1

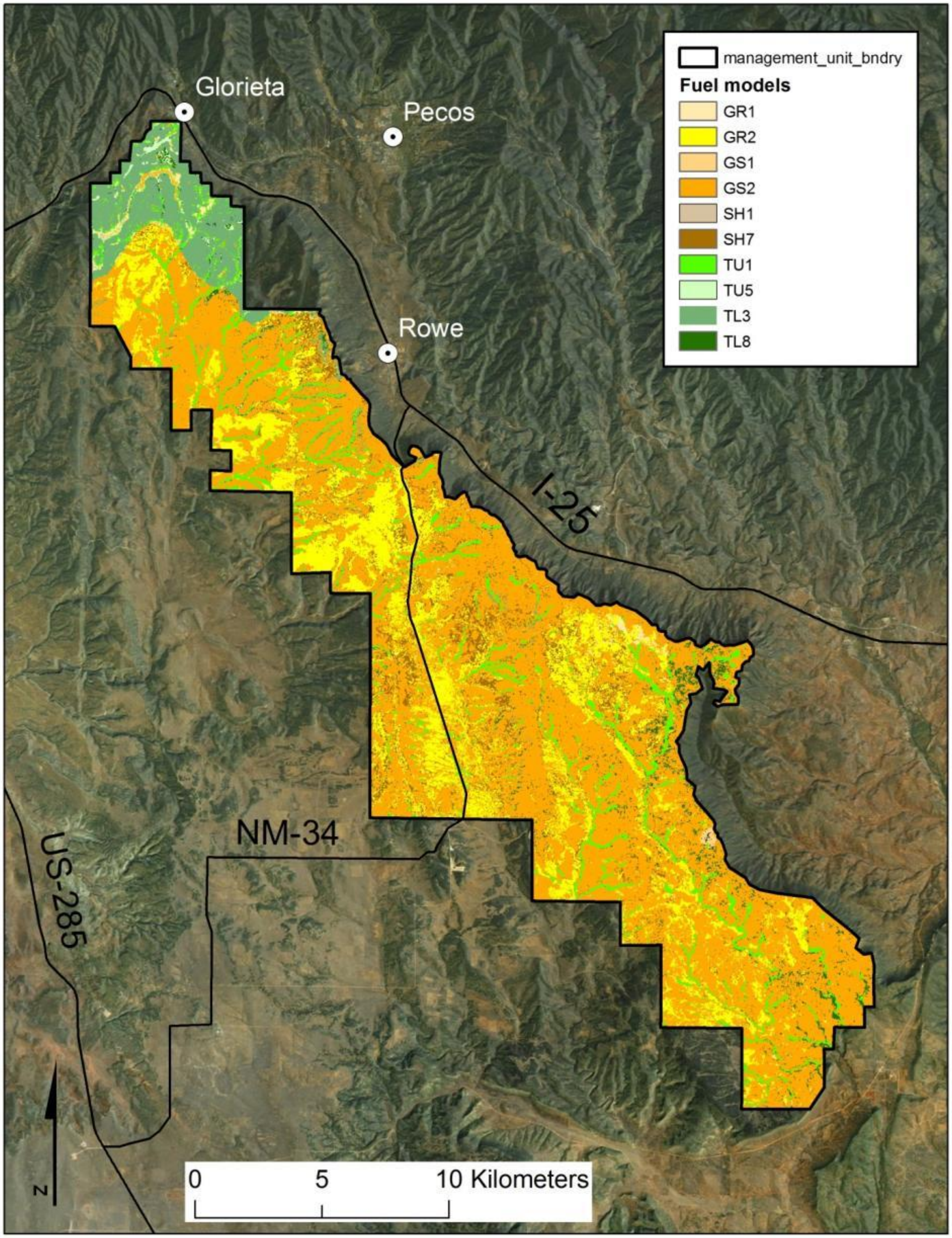

Figure 14. Rowe Mesa fuel models derived from Landfire Refresh 2008 (LF_1.1.0). GR= grass, GS = grass/shrub, SH=shrub, TU=timber-understory, and TL= timber litter.

Modeled fire behavior for a problem wildfire (97th percentile weather) under existing conditions indicates 65% of Rowe Mesa will have > 4ft flame lengths (Figure 15). The standard description for fire suppression activities for this fire behavior from the Hauling chart (Table 7) is: "Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold fire. Equipment such as dozers, engines, and retardant aircraft can be effective."

Table 7. Hauling chart describing fire suppression activities by flame-length class.

Flame length (ft)	**Fire Suppression Interpretation**
0 – 4	Persons using hand tools can generally attack fires at the head or flanks. Hand line should hold the fire.
4 – 8	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold fire. Equipment such as dozers, engines, and retardant aircraft can be effective.
8-11	Fires may present serious control problems such as torching, crowning, and spotting. Control efforts at the head of the fire will probably be ineffective.
11+	Crowning, spotting, and major runs are common; control efforts at the head of the fire are ineffective.

FlamMap was then used to determine the probability of fire burning at a particular location across the Rowe Mesa landscape under existing fuel conditions. Conditional burn probabilities were derived from 1000 simulated random ignition locations, 97th percentile weather, west-southwest wind direction, and 1200 minute (4 day) burn period. Conditional burn probability is calculated by dividing the number of times an area burns by the total number of simulated fires (1000).

The area that is most likely to burn (36 percent of the time) regardless of ignition location is the east-central mesa edge (Begoso area, Figure 16). Interestingly, this area also had a relatively high number of lightning ignitions (1973-2009, Figure 13). Considering actual ignition locations would increase the probability of the area burning. The area that is least likely to burn (with some areas not burning in 1000 simulated fires) is the far northern portion of the mesa. The burn probability map was used as one layer to prioritize areas that have a high probability of burning for potential treatment.

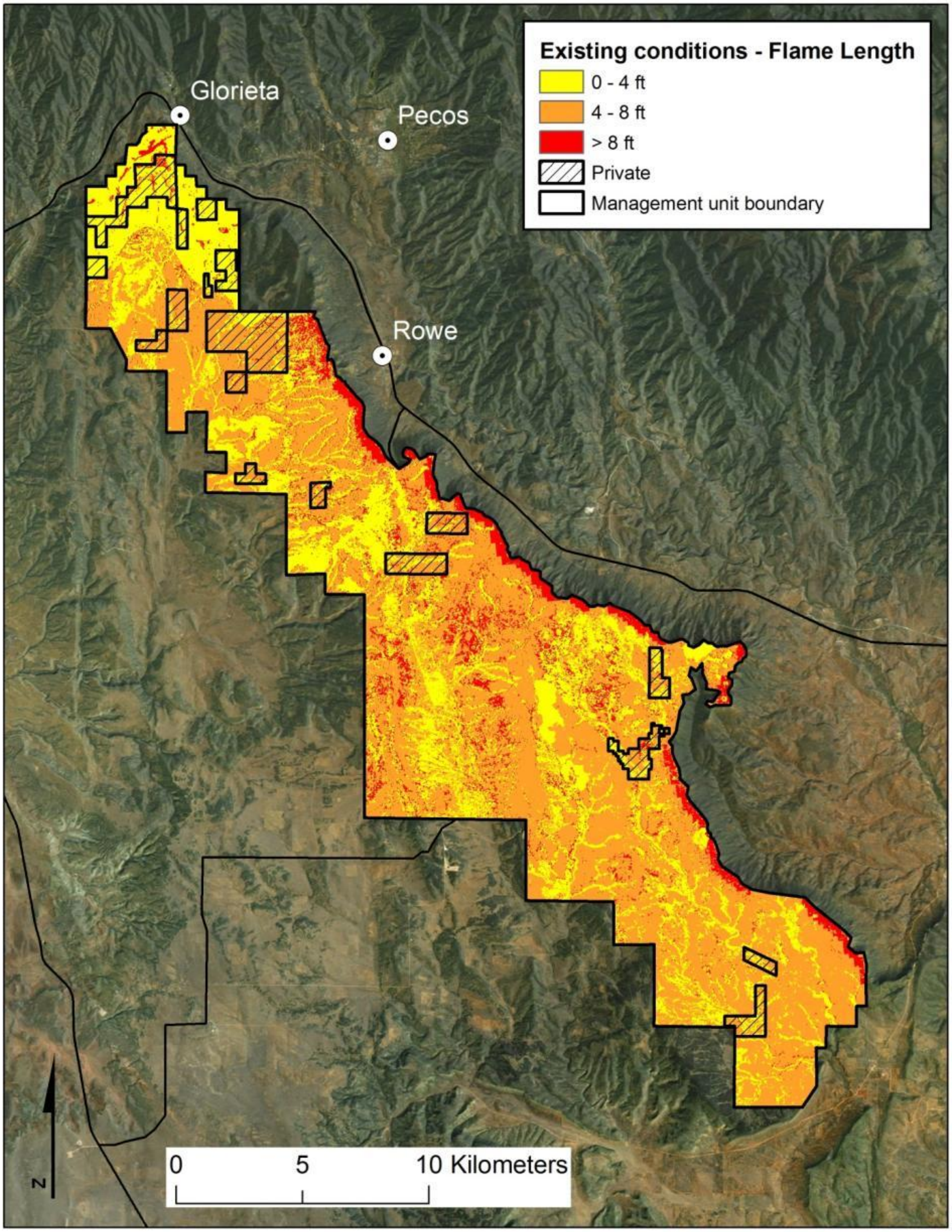

Figure 15. Rowe Mesa FlamMAP modeled flame length with existing conditions under wildfire scenario.

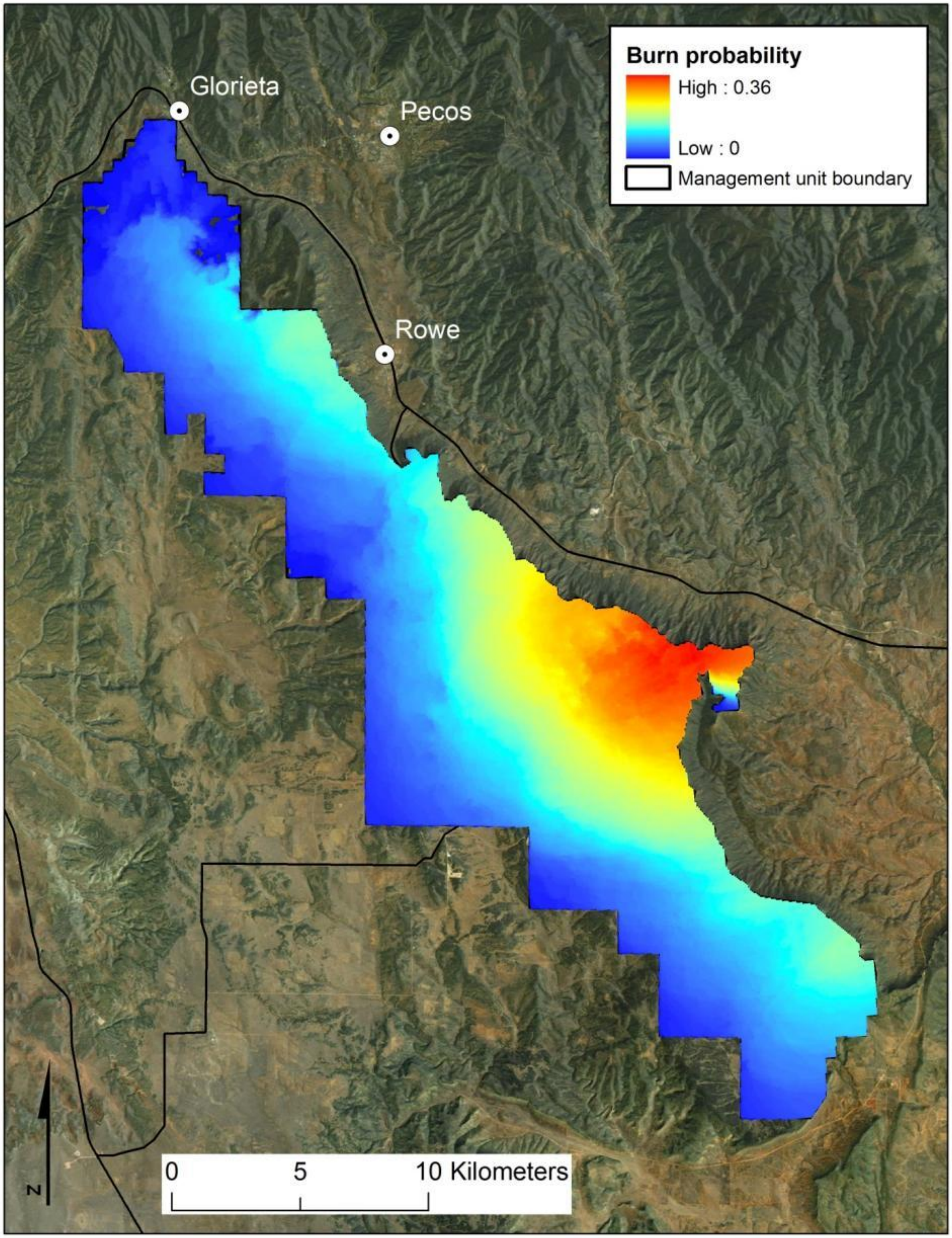

Figure 16. Rowe Mesa conditional burn probability derived from 1000 simulated random ignition locations, 97th percentile weather, west-southwest wind direction, and 1200 minute burn period.

3. HISTORICAL CONDITIONS AND DEPARTURE

3.1 Vegetation cover types

No historical vegetation maps from early surveys were found, nor were the 1935 aerial photos available for comparison with current vegetation maps. We used written descriptions from early surveys (Stabler 1906), field observations (of stumps and residual unharvested stands) to assess historical vegetation cover. Descriptions from the 1906 survey, which was conducted as part of the inclusion of Rowe Mesa into the Pecos National Forest, indicate that heavy grazing and selective harvest for railroad ties had already changed the landscape from historical (pre-1880) conditions. Descriptions of certain areas on the mesa include, "very badly eaten out by goats and sheep" and "cut over for ties". Descriptions of stands of potential saw timber (PIPO) were also mentioned. These descriptions are consistent with the many large PIPO stumps that are found beneath the dense young PJ thickets (e.g., Figure 17). This indicates that the overstory PIPO component was historically more extensive.

Open canopy PJ savannas and woodlands with large, mature "tree-form" PIED were also historically more extensive. This is based on photos from the tree crushing (e.g., Figures A1 & A2 – Appendix A), and structure of adjacent PJ forests on Forest land, and adjacent private land (e.g., Figure 18). Overall cover of grasslands, however may have been similar or possibly less than the current conditions. It is likely that many of the forest/grassland borders have been encroached by young PJ species due to fire suppression, particularly near the PIPO forest type. This decrease in grassland may have been offset or surpassed by tree-crushing that converted PJ forest/savanna to grassland.

A map of historical vegetation types would likely be similar to current cover, with a few major differences including: 1) conversion from PJ savanna/woodland to grassland or sparse, young PJ on an estimated 15% of the landscape(11, 472 acres) due to tree crushing, 2) an unknown percent of PIPO-dominated forest was converted to <100 year-old, dense PJ dominated forest by logging and fire suppression, and 3) the relative proportion of PIPO and PJ species within a stand has shifted toward PJ due to post fire-suppression regeneration in formerly fire-maintained, open PIPO-dominated savannas.

3.2 Forest composition and structure

The pre-1880 forest had more large trees and lower tree densities compared to the current forest (Figures 10a & b).

<u>PIPO-dominated</u>: The PIPO forest was historically less dense (<100 trees/acre), contained larger diameter trees, and had a lower percentage of PJ species.

<u>PJ-dominated</u>: The historical PJ type was generally less dense (but likely more dense than PIPO) and contained a higher percentage of large trees, including PIPO in the wetter sites.

<u>Grassland</u> – Grass was historically denser and had greater cover in the PJ, PIPO, and Grassland types. TEU surveys that indicate grassland soil and cover types are presently forested. Additional evidence of reduced grass cover is deduced from trees with multiple fire scars in locations currently surrounded by bare soil (e.g., ROW801 – Appendix B). The fact that fires promptly stopped circa 1880 when grazing

increased also indicates that grass cover was reduced compared to historical conditions that supported a frequent fire interval (Savage & Swetnam 1990).

Figure 17. Photograph of large (>60cm drc) PIPO stump (with hat for scale) surrounded by young PJ.

Figure 18. Open PJ forest with old (> 250 years), tree-form PIED forest adjacent to tree-crushed areas.

3.3 Fire

Fire history was reconstructed using tree-ring fire-scar methods (Dieterich and Swetnam 1984). Fire scar samples were collected from 7 sites distributed across the mesa in both PIPO- and PJ-dominated forest (Figure 19). Fire scars recorded frequent (mean fire interval, 10% scarred = 12 yrs, Table 8), low severity fires in PIPO- and PJ-dominated forests across the mesa from 1546-1899 (Figure 20). The last widespread fire was 1876, just prior to the arrival of the railroad in 1879 and the beginning of intensive livestock grazing. The position of the fire scars within the tree-ring indicates that historical fires predominantly occurred in the late spring-early summer (May and June), coinciding with the current timing of dry lightning. The highest historical fire frequency was recorded in the PIPO-dominated east-central mesa edge (Begoso area), and the lowest at the north end of the mesa. Interestingly, this is consistent with the spatial pattern of modeled burn probability (Figure 16) and may relate to wind and topography-driven fire spread patterns. Historical fire extent ranged from being recorded by 1 tree to > 35% of the sampled trees, at a majority of the sample sites across the mesa. For example, a widespread fire in 1725 was recorded by 30% of the trees at 5 of the 7 sampling sites (Figure 21). Interpolating fire area between the sites that burned in 1725 results in an estimated fire area of 37,459 acres. The presence of trees with multiple fire scars, spread across the mesa suggests that historical fires were generally low-severity. We did not observe obvious, even-aged post-fire stands or large numbers of downed logs that were likely killed by fire. Thus, no evidence of historical stand-replacing fire patches was observed. Additionally, the 1906 forest survey did not mention areas of recently severely burned forest, but does mention evidence of “light ground fire” (Stabler 1906).

Forests that contained a historical component of ponderosa pine experienced a frequent, low severity fire regime. This includes many stands that are currently dominated by <100 year-old pinon and juniper trees with ponderosa pine only present as stumps. Highest fire frequencies were recorded on the east Mesa rim, where modern lightning ignitions are common, modeled fires tend to spread, and the ponderosa pine stands are more homogenous. The proportion of pre-1880 PIPO to PIED/JUSC is probably a good indication of the historical fire regime: more PIPO=more frequent and more continuous burning, more PIED and JUSC = less frequent and more patchy. This is due in part to the nature of the sites each species prefers and the nature of the needle litter produce by each species. PIPO prefer more mesic, more productive sites and produce higher volumes of more aerated needle litter that burns readily. PIED and PJ prefer more xeric, less productive sites and produce less burnable needle litter.

Table 8. Fire interval analysis statistics for Rowe Mesa (1483-2011).

Filter	Number of intervals	Mean fire interval (yrs)	Median fire interval (yrs)	Weibull median fire interval (yrs)	Minimum interval (yrs)	Maximum interval (yrs)
all scars	82	4.29	3.00	3.41	1	33
10%	29	11.76	9.00	9.62	2	47
20%	7	41	27.00	35.00	10	87

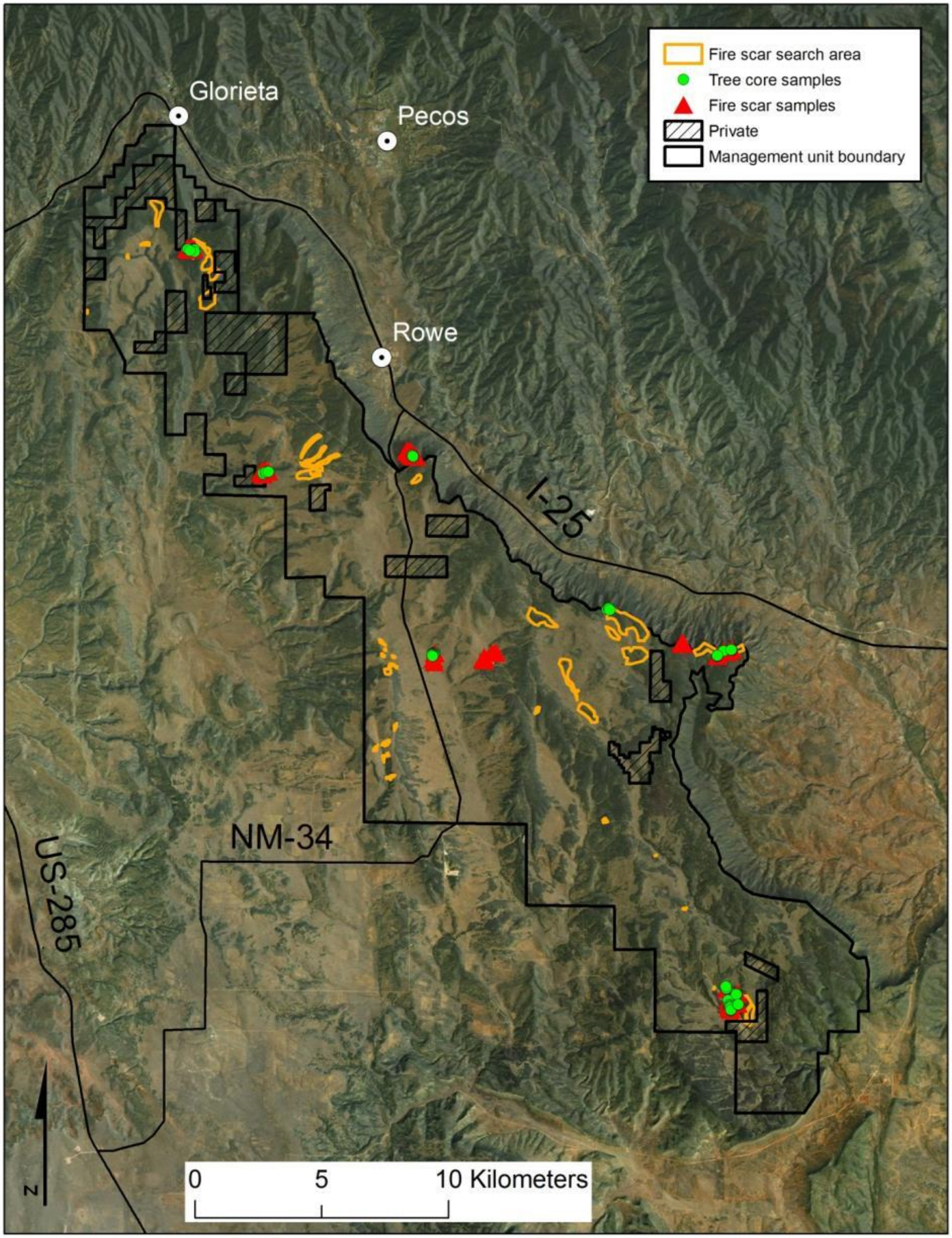

Figure 19. Rowe Mesa fire scar search areas, fire scar and tree core sample locations.

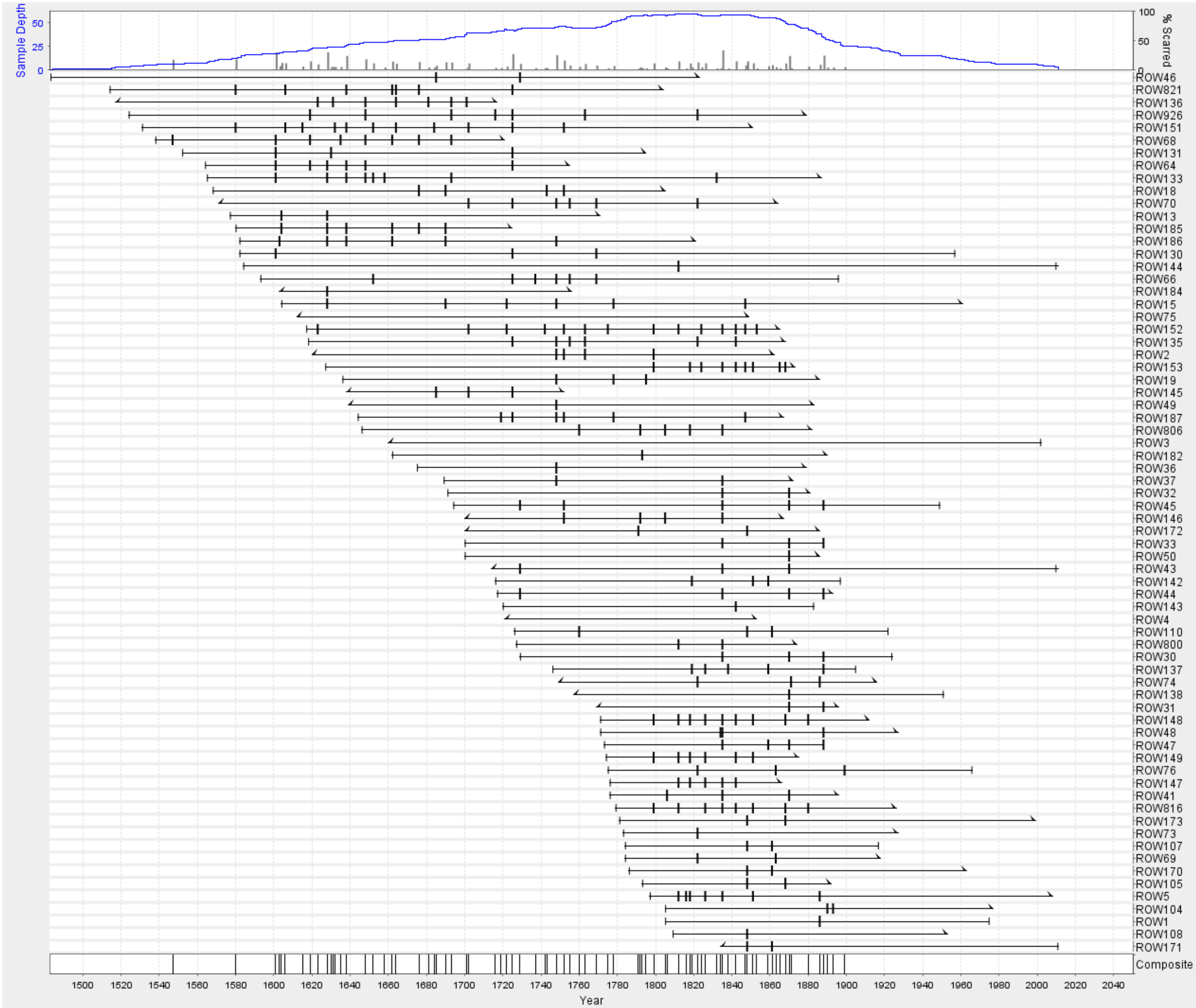

Figure 20. Rowe Mesa fire history reconstructed from 70 trees at 7 sites (1483 - 2011). Horizontal lines are trees and dark vertical lines are fires.

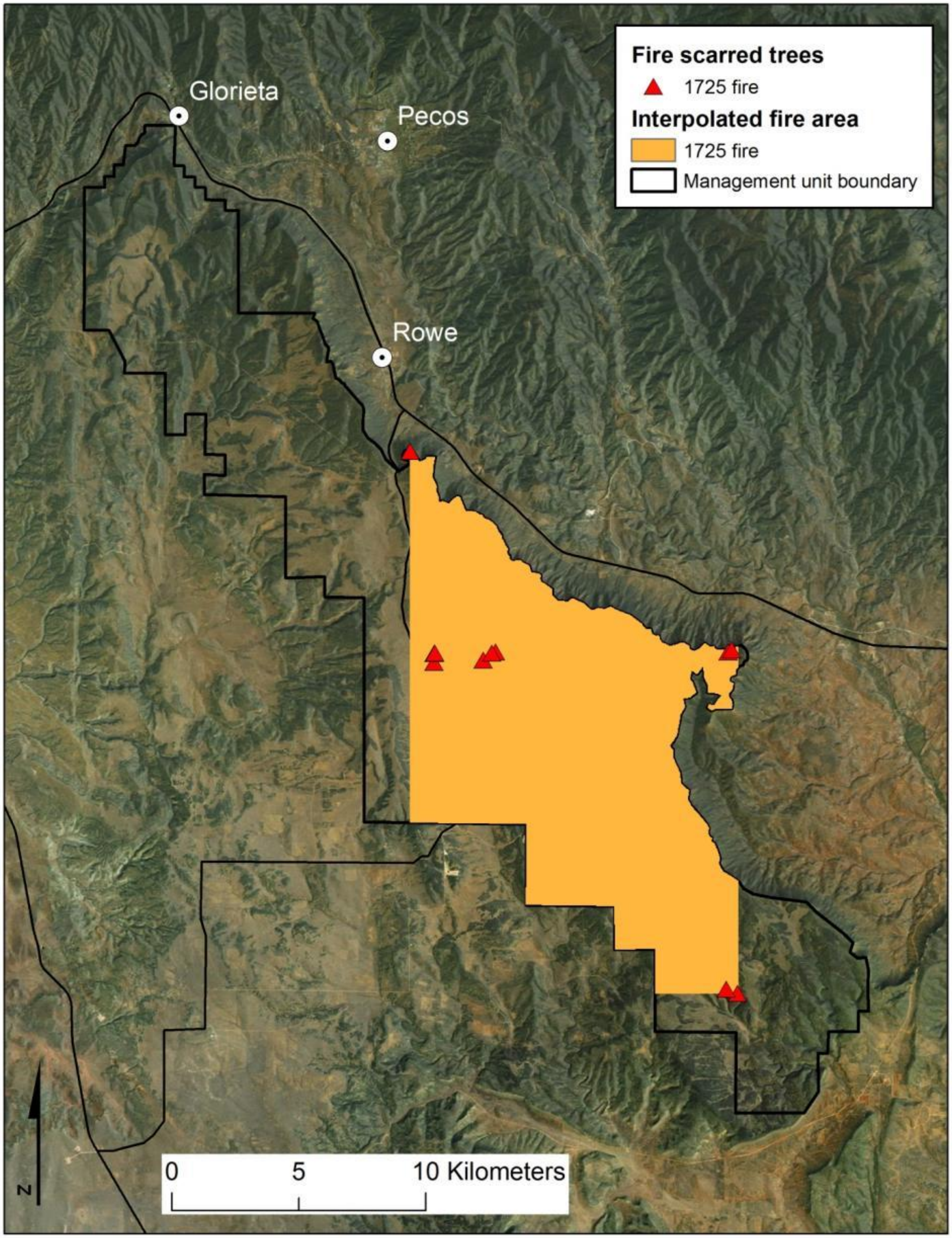

Figure 21. Location of all trees (n=12) with a fire scar in 1725 and IDW interpolated fire area (37,459 acres).

3.4 Relating fire occurrence and tree regeneration

The frequency of historical fire occurrence and tree establishment varied through time (Figure 22). Periods of high fire frequency (mid 1700's and mid 1800's) had low tree establishment, because young trees were burned and killed. Conversely, periods of low fire frequency (e.g., circa 1800 and circa 1900) generally resulted in higher numbers of regenerating trees. This link between fire and tree-regeneration is additional evidence that the human-caused cessation of fires after 1900 allowed both PIPO and PIED to regenerate en masse, resulting in the high density of small trees less than 100 years old in much of the current PJ and PIPO forest (Figures 10a and b).

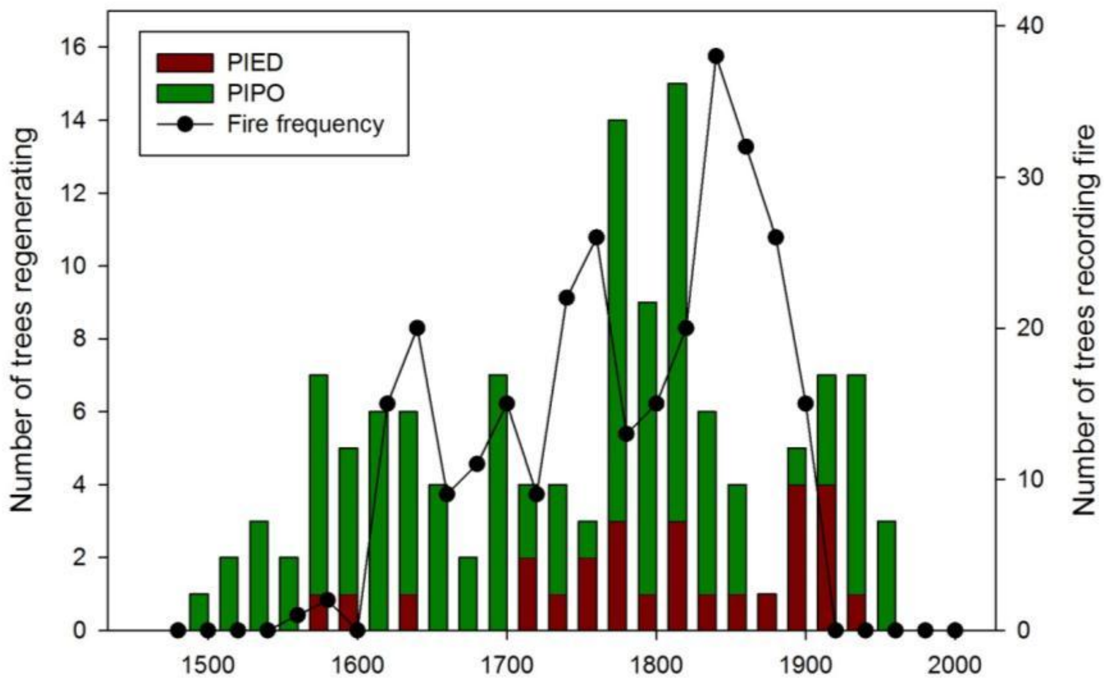

Figure 22. Tree regeneration by species and number of trees recording fire (in 20-year bins).

4. MANAGEMENT

4.1 Existing treatments

The available GIS data (1974-2011) indicate that the majority of the mechanical treatment and prescribed fire has occurred in the central portion of the mesa (Figure 23). Between 2008 and 2011 there have been 5 prescribed fires totaling 2552 acres. Data available on mechanical treatments (1974-2010) indicate 9948 acres have been thinned or mechanically treated (this includes the Barbero CFRP area awaiting treatment). Prior mechanical treatments to remove PJ forests and create more grass cover (e.g., tree crushing & herbicide treatments) occurred over large areas throughout the mesa.

[1]An activity called "crushing" was conducted on Rowe Mesa in the mid-1970s which mechanically pushed down trees such as juniper and pinon pine in order to open up more areas for grass growth for livestock grazing. Crushing involved using a vehicle with a large, heavy cylinder usually with blades that could push over and cut up the trees. In order to determine crushing areas on Rowe Mesa, 1966 vintage 24k topographic maps with green/woodland tint were overlaid the 1980s aerial imagery that were printed by 7.5 quad. Areas where vegetation was removed could easily be seen. Mylar was taped over the topo maps and areas where vegetation was removed were drawn on the mylar. The mylars were scanned and then the polygons were digitized into GIS. Areas were further refined by looking at 1970s vintage resource photography where a somewhat stubbled pattern could be seen on the photos. The woodland tint on the 1966s topo maps was dervived using photogrammetry methods with overlapping aerial photos acquired in 1964 to determine the edge of the wooded areas, and generally showed treed areas as green and open or grassy areas as white. An estimated 11,472 acres (15% of the management unit) were crushed (Figure 24).

4.2 Archeology

Cultural resource surveys for thin and/or burn treatments are in progress on 14,210 acres in the southeastern portion of the mesa (Figure 25). The surveys are scheduled to be completed in the late-summer of 2012. High densities of archeological sites have been found on the east mesa edge and near the canyons in the south. Additional completed cultural resource surveys cover 11,767 acres located in the south central part of the mesa. Completed and ongoing surveys total 25,977 acres (33% of management unit).

[1]Crusher section and data contributed by Richard Romero and Julie Leutzelschuab (SFNF S.O.)

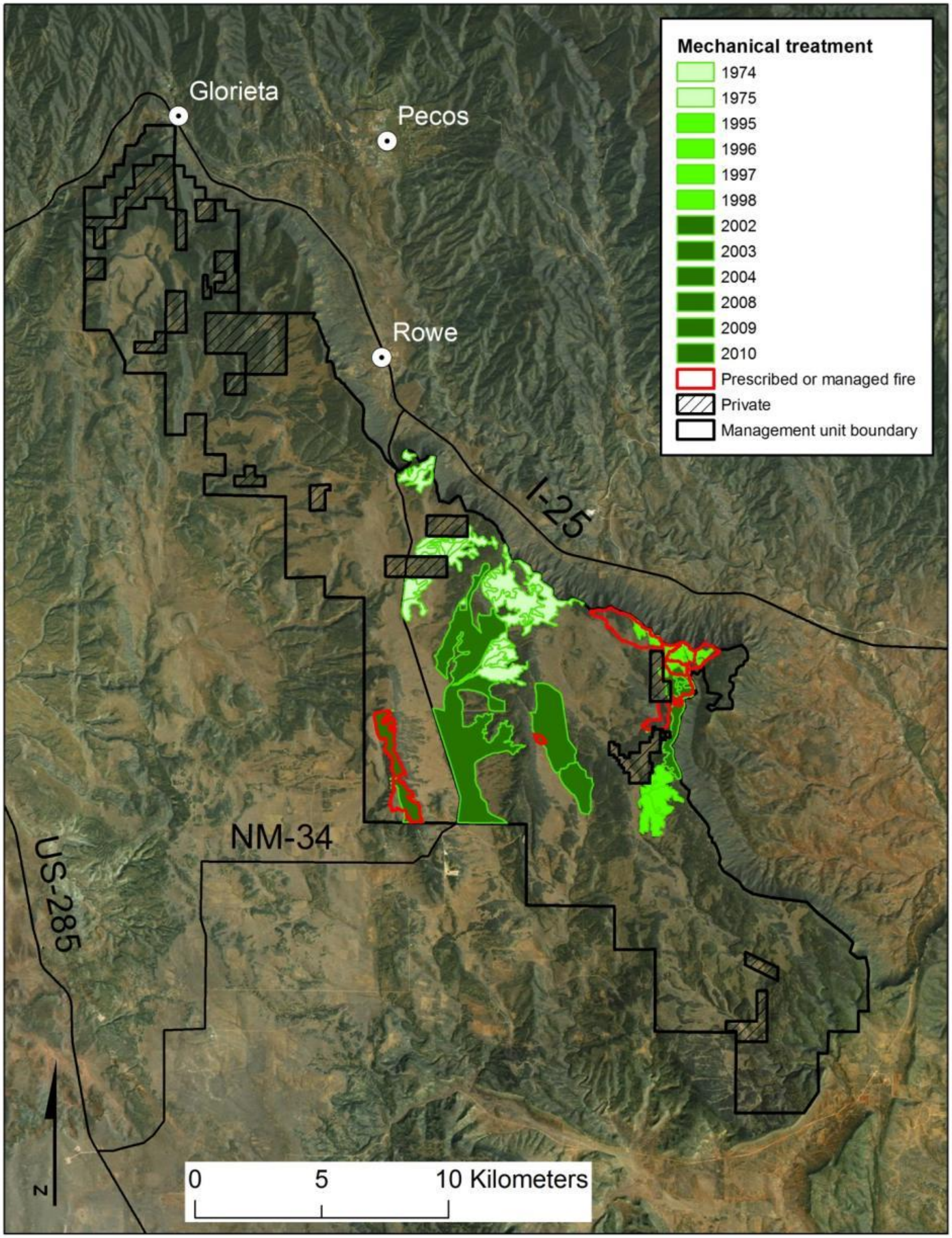

Figure 23. Rowe Mesa mechanical treatments and prescribed and managed fire (1974-2011).

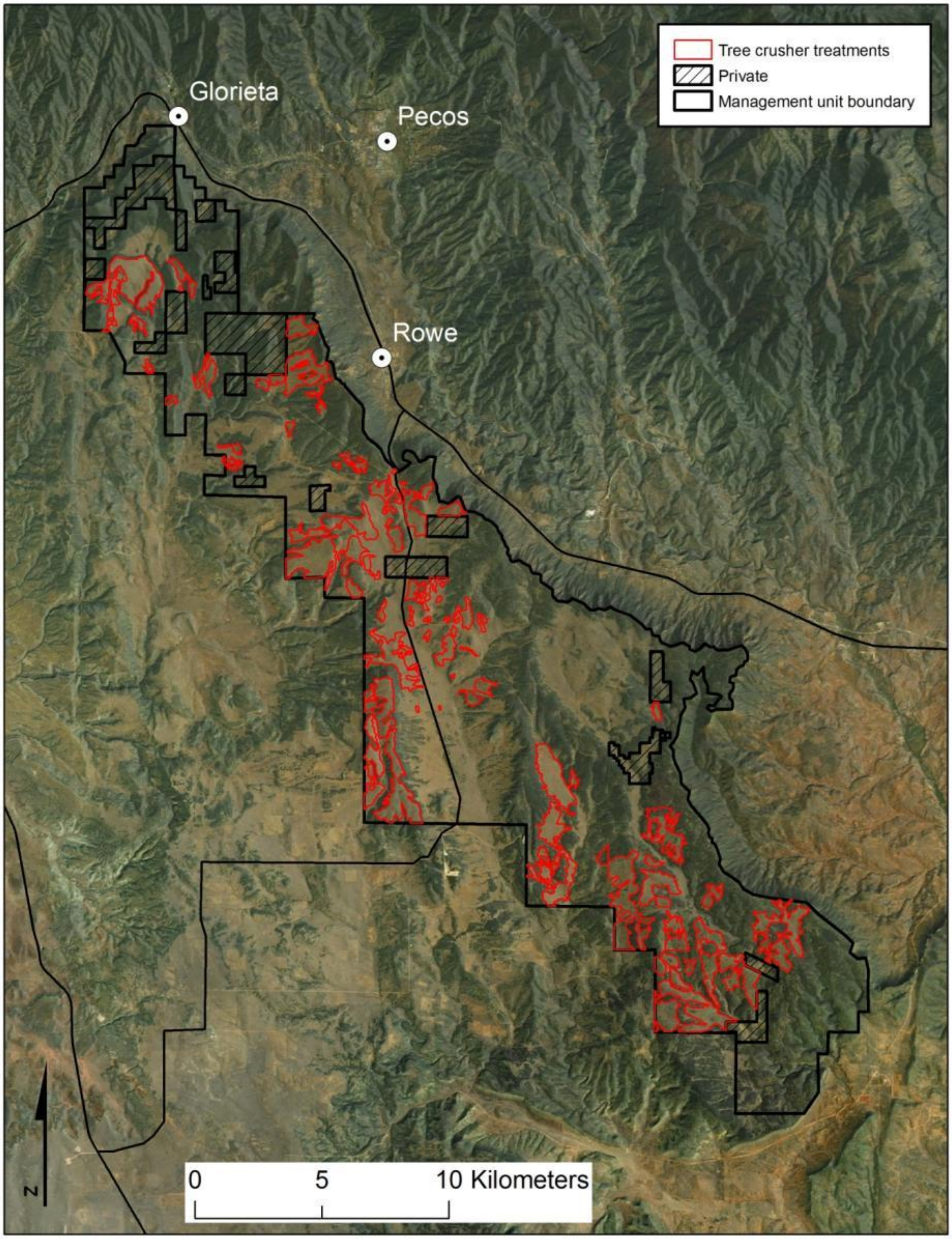

Figure 24. Rowe Mesa 1970's tree-crusher treatment areas estimated from change in forested area between 1960's topographic maps and 1980's aerial photos (courtesy of Julie Luetzelschwab, SFNF S.O.).

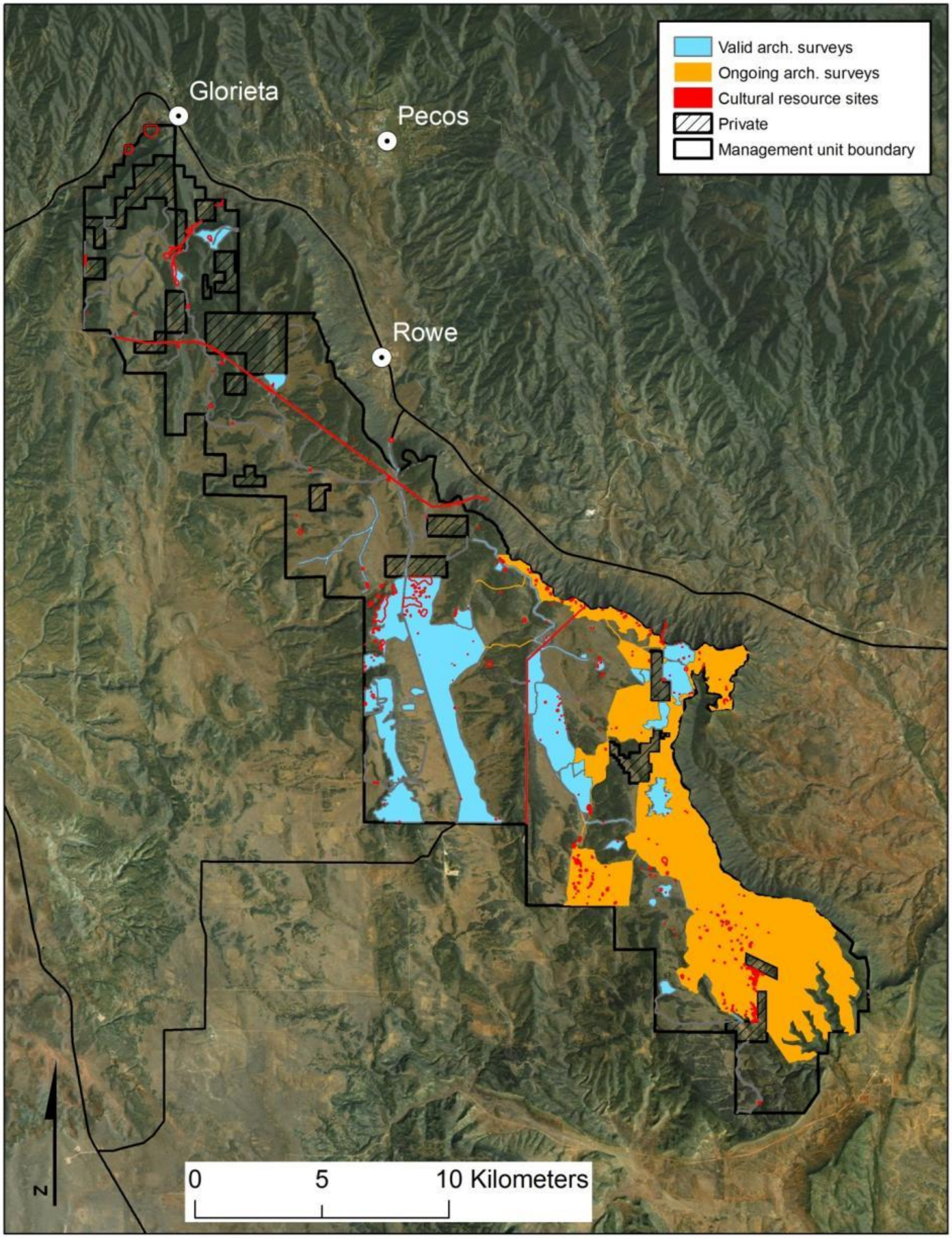

Figure 25. Rowe Mesa cultural resource sites, valid surveys and ongoing surveys (scheduled completion, 9/2012).

4.3 FlamMap Fuel Treatment Optimization

Dispersed, strategically placed treatments are most effective at reducing modeled fire size, flame length and spread rate at a landscape scale, particularly when only a small portion of the landscape can be treated (e.g., <20%) (Finney et al. 2007, Ager et al. 2010). The FlamMap fuel treatment optimization model (Finney 2007) was used to determine fuel treatment locations on 20% of Rowe Mesa that most effectively reduced fire rate of spread. The FlamMap treatment optimization model was parameterized with 97^{th} percentile weather for a problem wildfire (Table 5) and a 500m limit on treatment length.

Optimized treatment of 20% of the landscape increased fire arrival time (i.e., slowed fire spread) when compared to the untreated landscape, particularly in downwind areas (Figure 26). Fireline intensity was also noticeably reduced in the central portion of the mesa on the treated landscape (Figure 27). Overall, optimized treatment of 20% of the landscape reduced modeled fire rate of spread on 69% of the landscape (Figure 28). Therefore, treating in optimized locations not only reduces fire behavior within the treatments, but outside of the treatment areas too. Modeled optimized treatment locations were used to prioritize potential areas for treatment (Figure 29).

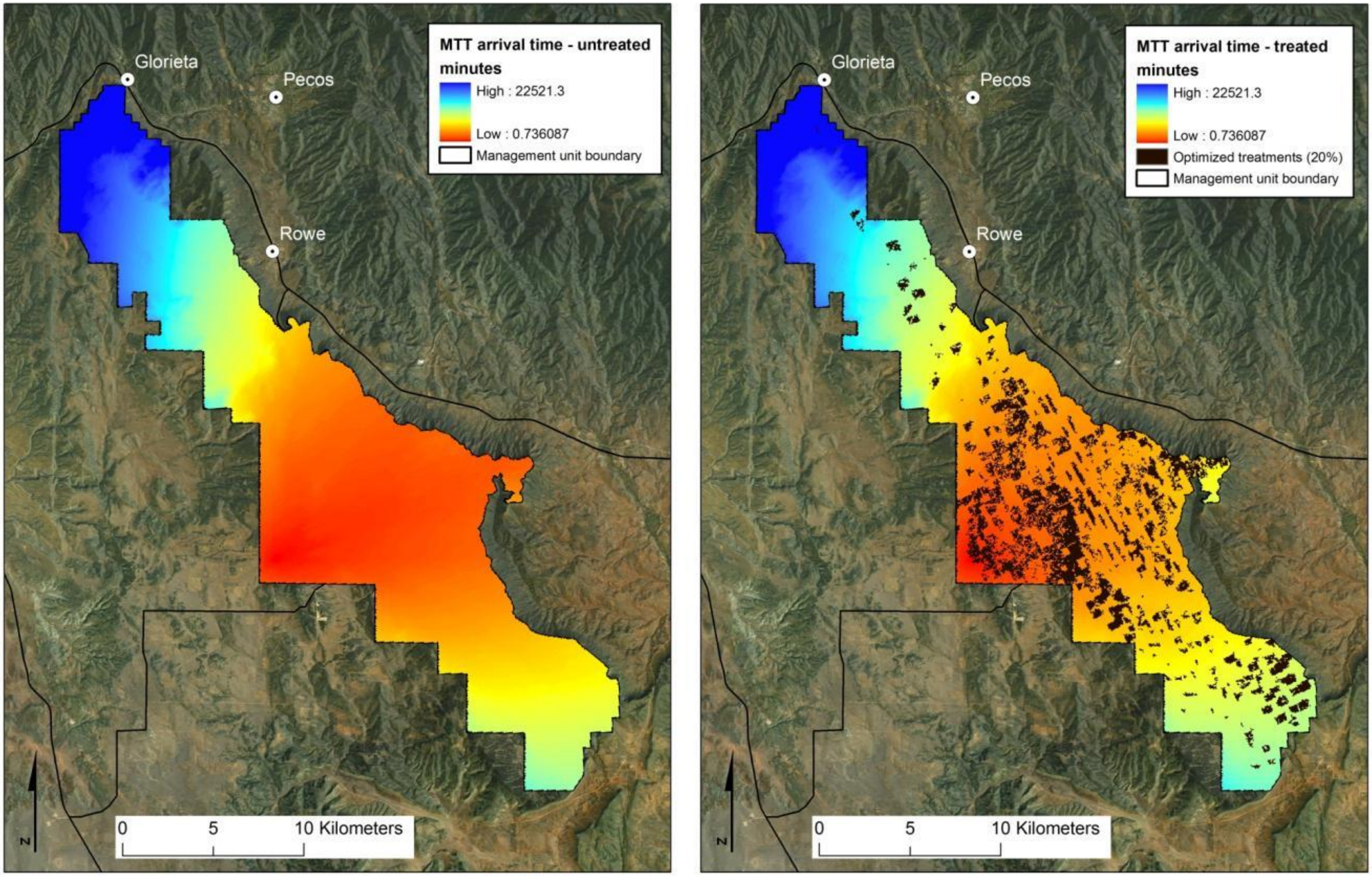

Figure 26. Minimum travel time (MTT) fire arrival time for untreated landscape (left) and treated landscape with optimized treatments (black) covering 20% of landscape (right).

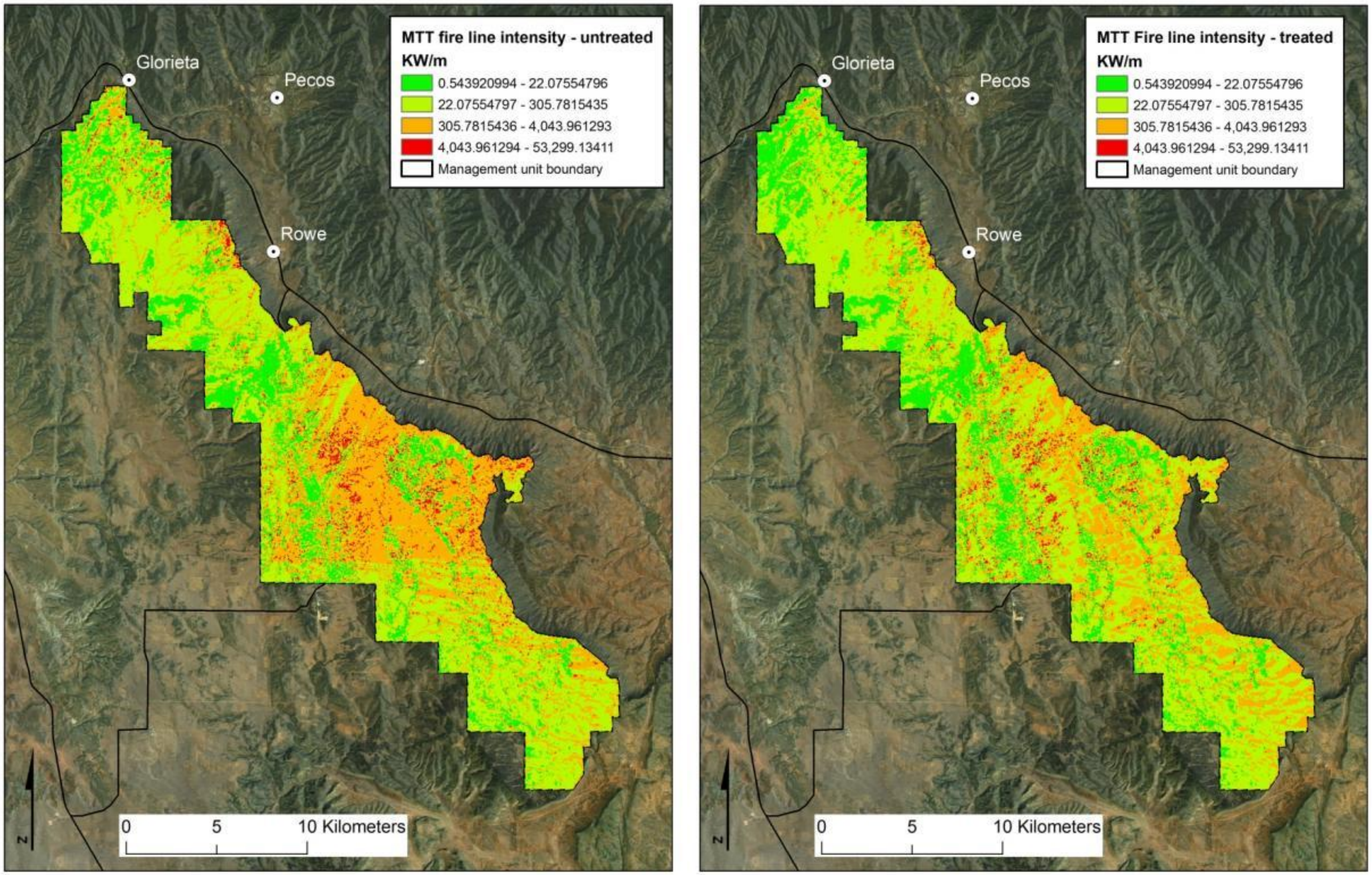

Figure 27. Minimum travel time (MTT) fire line intensity for untreated landscape (left) and treated landscape with optimized treatments covering 20% of landscape (right).

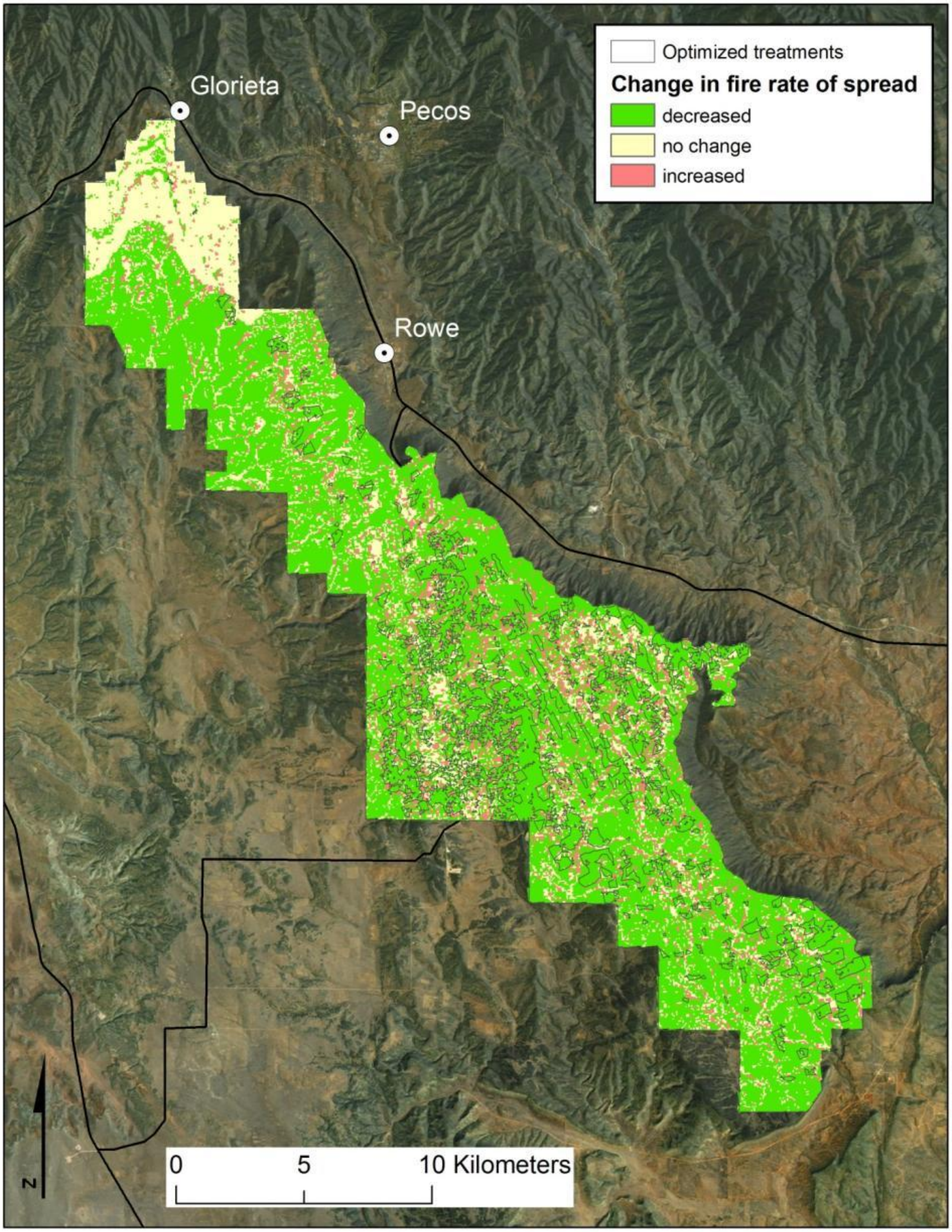

Figure 28. Change in modeled fire rate of spread between untreated landscape (existing conditions) and optimized treatment (grey outline) of 20% of the landscape.

4.4 Restoration and maintenance recommendations

The goals of the restoration and maintenance recommendations (per the CFRP) are to reduce the threat of large, high intensity wildfires on Rowe Mesa and enhance the long-term resilience of the forest ecosystems. Priorities include:

1. preserve remaining stands of old and large trees,

2. protection of private property, and

3. protection of pinyon pine, juniper and ponderosa pine forests from crown fire.

These goals will be achieved by the creation of:

1) strategically-placed thinned forest stands,

2) strategically placed fuel breaks, and

3) a prescribed fire and managed wildfire maintenance program.

The choice of areas to be treated by thinning will be chosen for:

1) ability to reduce fire behavior within and outside of the treatment area based on FlamMAP treatement optimization results,

2) evidence of historical fire and existing tree density that is highly departed from historical conditions, and

3) greatest presence of historical stand elements (that is, the inclusion of old-growth trees of any species).

4.5 Recommendations by vegetation type:

<u>PIPO-dominated</u>: prescribed or managed fire **recommended** to burn with low intensity at approximately 10 year intervals (ranging from 5 to 25 years). If live tree density > 100 trees/acre, thin or masticate trees < 9" dbh (leaving all mature > 16" dbh PIPO, PIED and JUSC) to reduce ladder fuels and high severity fire risk. **Prioritize** stands with pre-1900 (orange bark and/or > 16 cm dbh) PIPO trees and within Optimized Treatment areas (Figures 26 & 28) and/or on east-central mesa rim in high probability burn area (Figure 17).

<u>PJ-dominated</u>:

1) PJ forest dominated by mature (> 12" dbh, > 120 years old) tree-form PIED and/or JUSC – prescribed fire alone **not recommended** if any of the following is true: 1) insufficient surface fuels, 2) unnaturally high density of young PJ, and/or 3) fuel-wood cutting slash that would generate high intensity fire and kill remaining mature overstory. Prescribed or managed low intensity fire **possible** in stands with patchy fuels, light grass or litter load and no ladder fuels adjacent to mature trees. Mechanical treatment **possible** to reduce density of young (<100yrs old) PJ adjacent to mature PIED or JUSC.

2) Young PJ/Shrub Oak –

a) tree crusher areas – **no ecological basis for recommendations**

b) PIPO-dominated forest/grassland border – prescribed and managed fire **recommended** at intensity and intervals sufficient to kill majority of young PJ regeneration and prevent high density PJ stands that could carry crown fire into adjacent PIPO forests.

c) PJ-dominated forest/grassland border – prescribed and managed fire **recommended** at intensity and intervals sufficient to kill majority of young PJ regeneration and prevent high density PJ stands that could carry crown fire into adjacent PJ forests with remnant mature PIED or JUSC.

3) Grassland – prescribed and managed fire **recommended** if rested from grazing at least one year post-fire to allow herbaceous and soil recovery.

4.6 Treatment area prioritization and selection

Proposed areas to begin archeological surveys and the NEPA process for thin and burn treatments were prioritized and determined by overlaying areas with:

1) High burn probability
2) Modeled flame length > 4ft
3) High density of optimized treatment locations
4) PIPO-dominated vegetation type (highest pre-1900 fire frequency and most departed structure)
5) Proximity to treated, NEPA-cleared, and ongoing cultural survey areas (to form larger potential burn areas)

6) Large (> 500 acres), contiguous forested area (at risk of high severity fire)
7) Presence of pre-1880 (pre-fire exclusion) trees
8) Potential to carry fire following treatment (sufficient needle litter or grass)
9) Proximity to east mesa edge, which would allow fire to burn against the edge without spotting down into the fuels below

Many of the prioritized treatment locations are within the 14,000 acre area of ongoing cultural resource surveys initiated by Santa Fe National Forest Supervisors Office. Due to the uncertainty in completion date for these areas, our final top-priority areas (totaling 3000 acres) were outside of the ongoing and completed survey areas (Figures 29 & 30). Survey crews contracted through the CFRP grant are currently conducting cultural resource surveys on these areas, with the intention of completion in November 2011.

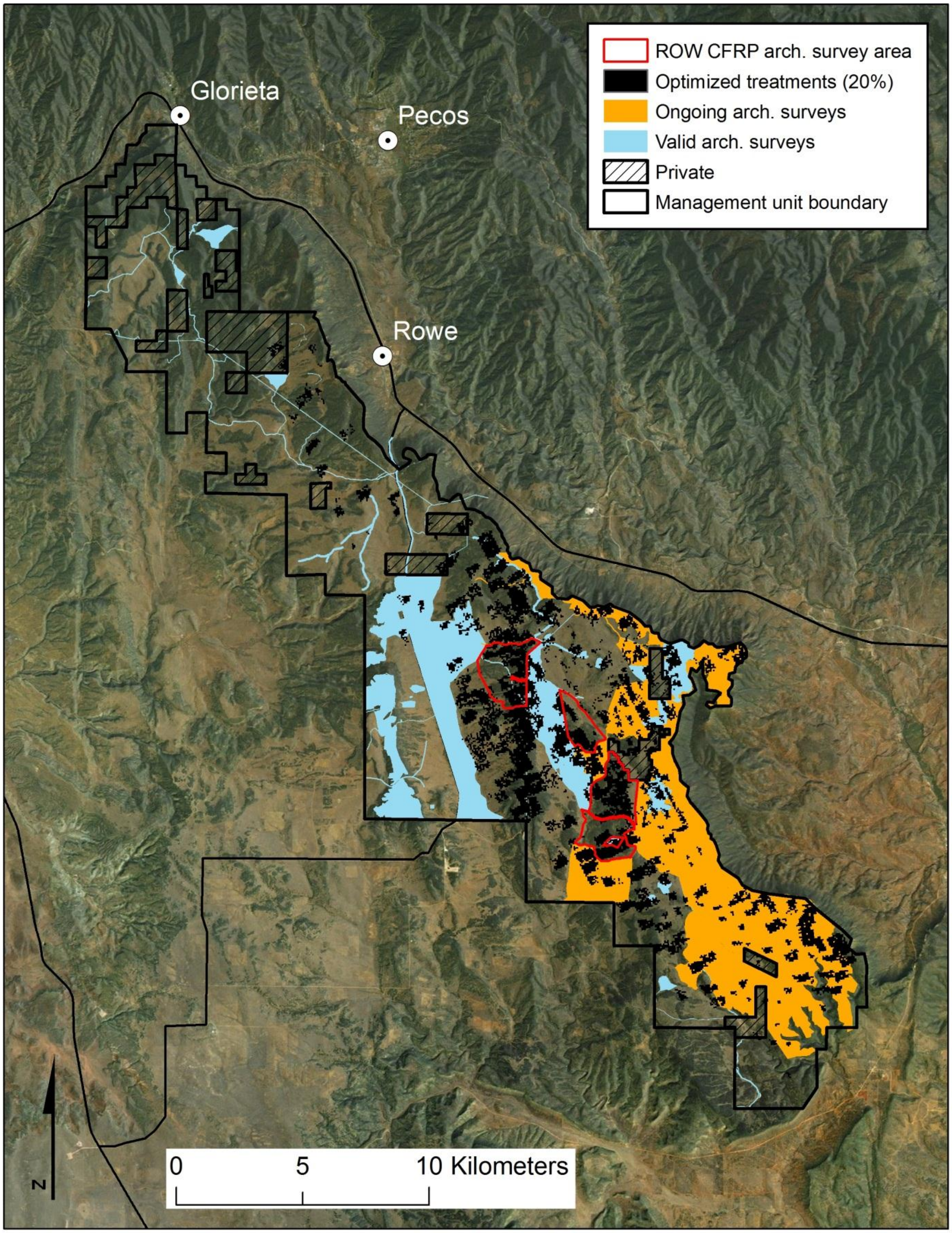

Figure 29. Landscape view of Rowe Mesa CFRP project cultural resource survey areas (totalling 3000 acres) for thin and burn treatments.

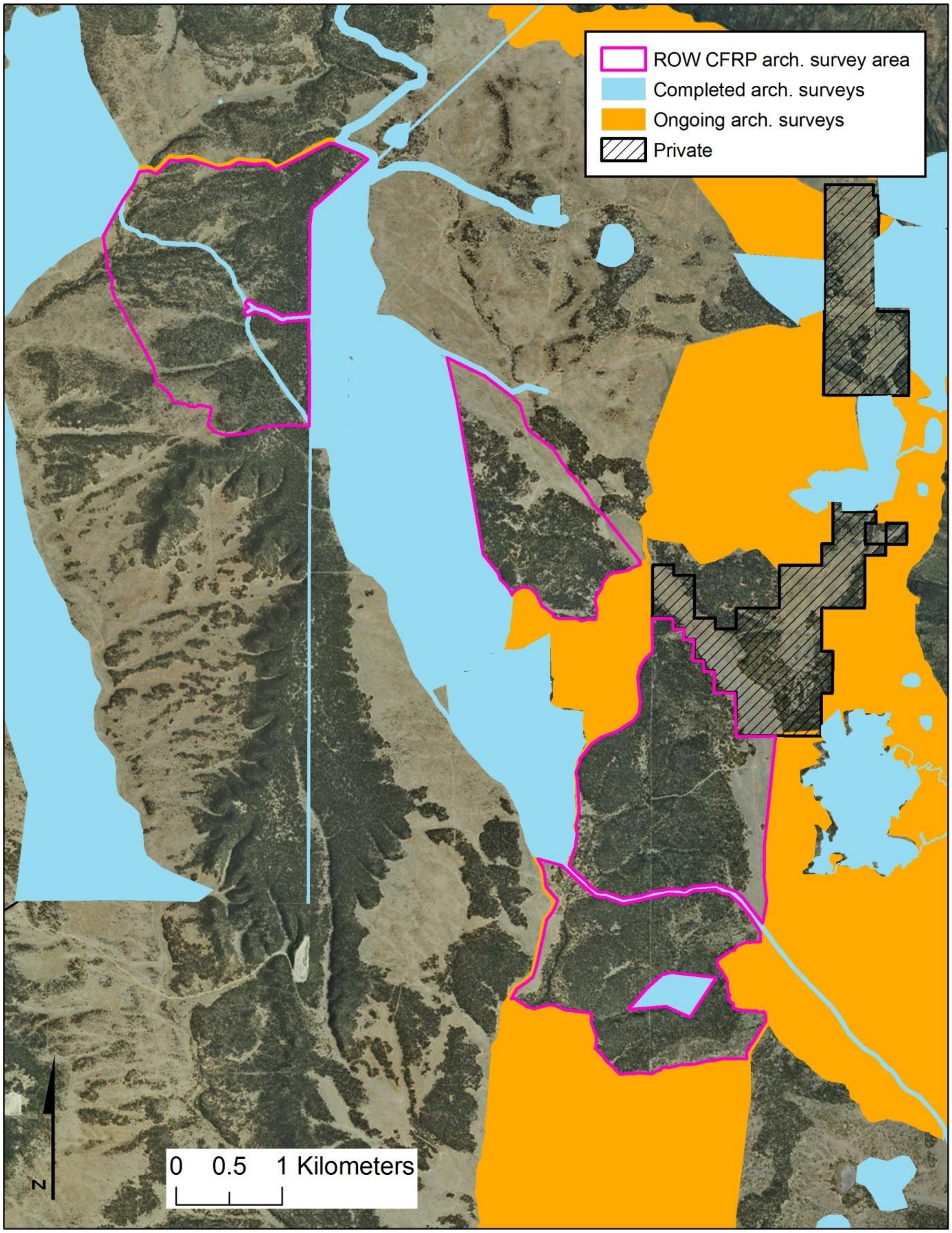

Figure 30. Close-up view of Rowe Mesa CFRP project cultural resource survey areas (totalling 3000 acres) for thin and burn treatments.

Literature Cited

Ager, A.A., N.M. Vaillant, and M.A. Finney. 2010. A comparison of landscape fuel treatment strategies to mitigate wildland fire risk in the urban interface and preserve old forest structure. For. Ecol. Manag. 259(8):1556 –1570.

Barrows, J. 1978. Lightning fires in southwestern forests. Rep. Unpublished report to USDA Forest Service, Northern Forest Fire Laboratory, under Cooperative Agreement 16-568 CA, 154 pp. [Available from Rocky Mountain Research Station Library, 240 West Prospect Rd., Fort Collins, CO 80526.].

Dieterich JH, Swetnam TW (1984) Dendrochronology of a fire-scarred ponderosa pine. *Forest Science* **30,** 238-247.

Finney, M.A. 2007. A computational method for optimizing fuel treatment locations. Intl. J. Wildl. Fire. 16:702-711.

Finney, M.A., R.C. Seli, C.W. McHugh, A.A. Ager, B.Bahro, and J.K. Agee. 2007. Simulation of long-term landscape-level fuel treatment effects on large wildfires. Intl. J. Wildl. Fire. 16:712-727.

Rollins MG (2009) LANDFIRE: a nationally consistent vegetation, wildland fire, and fuel assessment. *International Journal of Wildland Fire* **18,** 235-249.

Savage M, Swetnam TW (1990) Early 19th-century fire decline following sheep pasturing in a Navajo ponderosa pine forest. *Ecology* **71,** 2374-2378.

Scott, Joe H.; Burgan, Robert E. 2005. **Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model**. Gen. Tech. Rep. RMRS-GTR-153. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72 p.

Stabler, H.O. 1906. Proposed addition to the Pecos National Forest New Mexico. US Forest Service.

Appendix A - Tree crusher photos

Figure A1. Photograph of tree crusher on Rowe Mesa, NM.

Figure A2. (Left) Crushed site and 40 ton crusher. (Right) PJ converted to grassland with crusher.

Appendix B - Fire scar sample ROW 801

This PIPO tree (cut snag and stump in photo) survived repeated low severity fires from 1676-1878, but is now surrounded by dense young PJ and dirt. This dry site likely did not recover from the heavy late-19th century grazing which removed the grasses that used to carry fires.

Fire scar dates - ROW 801	
Year	**Feature**
1651	Pith
1676	Fire scar
1725	Fire scar
1752	Fire scar
1772	Fire scar
1792	Fire scar
1805	Fire scar
1842	Fire scar
1857	Fire scar
1878	Fire scar
1936	Bark

Appendix C

Tree poaching

The assessment indicates that the mean diameter of stumps is twice the diameter of the living forest in both PIPO and PIED-dominated stands. Illegal harvesting of PIPO, PIED and JUSC greater than the fuel-wood diameter cap is possibly a more serious threat to the few remaining large and old (pre-1900) trees on the mesa than high intensity fire. Many instances of large trees cut during the 2010 and 2011 field season were observed across the mesa. GPS points and photos of some harvesting that occurred this summer are available if helpful. This should be considered a serious threat and new possible strategies should be considered to reduce it. Increased public awareness of the age and the rarity of old trees may be one strategy. This could include one page handouts and/or public displays in the District offices of tree “cookies” indicating the old age of some relatively small diameter trees. The UofA Laboratory of Tree-Ring Research and I would be willing to work with you to develop some of these ideas and materials.

Figure C1. Photograph of illegally cut, pre-settlement (> 130 years old, note orange bark and large diameter) PIPO on Rowe Mesa (9/2011).