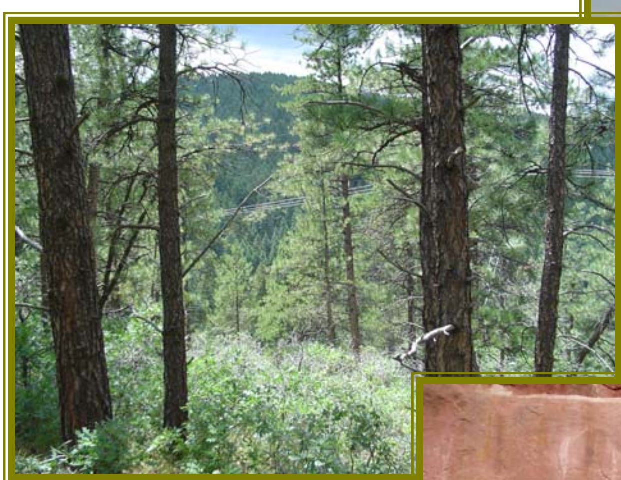
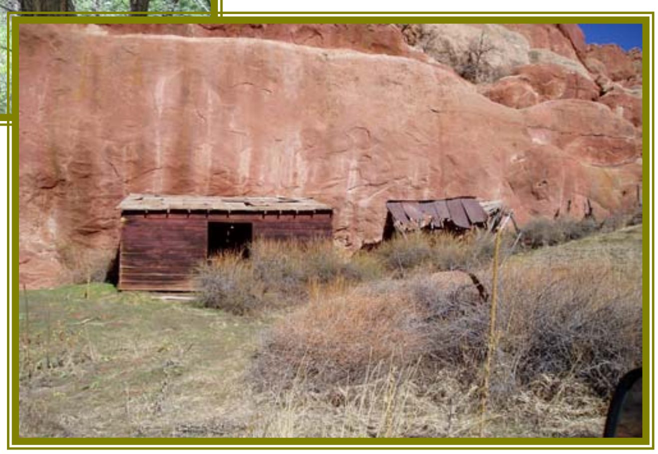
Colorado State Parks

Roxborough State Park

Fuels Management Plan

November, 2005





ROCKY MOUNTAIN ECOLOGICAL SERVICES, INC.

1. INTRODUCTION

As part of the National Fire Plan, the Federal Government has made funds available through the State Forester for state agencies to implement Hazardous Fuels Reduction Projects in order to reduce the risk of catastrophic wildfire events on State and Private lands. Colorado State Parks, working through the Colorado State Forest Service, has received National Fire Plan funds to reduce hazardous fuels in State Parks along the Front Range of Colorado, where the risk of catastrophic wildfire is highest. In partial fulfillment of reducing hazardous fuels in selected State Parks, a formal Fuels Management Plan is needed for these parks.

This plan provides a set of general recommendations, which will likely be modified due to site-specific needs, funding, implementation timing, available resources, and regulatory guidance. However, this plan is designed to outline areas within the park where fuels reduction activities will be suitable and desirable based on reducing risk of wildfire to park infrastructure, reduction of risk to park staff, visitors and fire suppression personnel, and ecological suitability of fuels reduction activities with current and desired vegetation conditions in targeted areas of the park.

Actual implementation of fuels reduction activities will likely be managed by Colorado State Forest Service personnel, with strong input and cooperation from State Parks Staff.

Proposed fuels reduction activities addressed in this report include:

- Thinning of dense oak brush stands for:
    - Creating fuel breaks in strategic areas
    - Creating defensible space around structures
    - Reduction of fuel loading along roadsides to facilitate evacuations
    - Improving forest health by renewing the decadent stand conditions

- Use of prescribed fire for:
    - Reduction in thatch and dead woody material
    - Ecological renewal of fire dependant ecosystems

This report is a cooperative effort between Colorado State Parks, Colorado State Forest Service, and Rocky Mountain Ecological Services, Inc.

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2. STEWARDSHIP PLAN GUIDANCE

The Roxborough State Park Stewardship Plan sites the effects of fire exclusion as a natural resource challenge second only to weed infestation (Gershman Associates, Inc. 2002). The Stewardship Plan recommendations for shrublands and forests include:

- Maintain or simulate natural fire for plant and animal habitat benefits
- Reduce the risk of wildfire to neighboring communities

The impacts of fire exclusion specific to Roxborough include a buildup of wildland fuels and reductions in biodiversity and ecosystem health to varying degrees. These negative effects exacerbate the issue of invasive exotics, sited as the primary resource challenge for the park.

In examining recent large fires, it would appear fire is determined to reintroduce itself to the area, regardless of management decisions. Since 1996, four very large fires have reached within ten miles of the parks boundaries (see map at end of document). As internal fire exclusion and external fire occurrence come face to face, the surrounding area is experiencing pronounced residential development bringing both values at risk and potential sources for ignition to the borders of Roxborough State Park.

The Goal of this plan is to provide recommendations for fire and fuels management in terms of wildfire mitigation and ecosystem health.

The Objectives of this plan are to provide guidelines to:

1) Create defensible space around park infrastructure, cultural resources, and roads
2) Mitigate the high wildfire hazards by strategically placed fuels reduction projects
3) Aesthetically develop the fuels mitigation projects in a high visibility and heavily used State Park
4) Reintroduce or simulate natural disturbances for the maintenance of native ecosystems

3. AREA DESCRIPTION

Roxborough State Park's 3,299 acres host scenery, native ecosystems, wildlife habitat, recreation areas, and historic sites. These values, and those adjacent to the park, are increasingly threatened either by the negative impacts of fire exclusion or catastrophic wildfire.

In fire management terms, the lands around Roxborough State Park are potential sources of undesired fire as well as areas to be protected from fire crossing from or originating on park land. The Pike National Forest borders the park on the west and southwest. Douglas County Open Space is found along the south and east sides of the park. Privately owned land is dispersed along eastern and northern boundaries.

From 5,900 to 7,280 feet, the diverse ecosystems include the lower montane forest, mixed foothill shrub thicket, mixed grassland, riparian and wetland communities.

The forested upper elevations are dominated by Douglas-fir (*Pseudotsuga menziesii*) with some ponderosa pine (*Pinus ponderosa*) and Rocky Mountain juniper (*Juniperus scopulorum*). Aspen (*Populus tremuloides*) stands are located in the park, including under the Mill Gulch powerline. The following table is of commonly associated plants in these communities.

Common Name	Scientific Name
Common juniper	*Juniperus communis*
Serviceberry	*Amelianchier alnifolia*
Shreddy ninebark	*Physocarpus monogynus*
kinnikinnick	*Arctostaphylos uva-ursi*
Snowberry	*Symphorocarpos albus*
blue gramma	*Chondrosum gracile*
prairie Junegrass	*Koeleria macrantha*
golden aster	*Heterotheca villosa*
beard-tongue	*Penstemon* spp

Shrub thickets cover the dry slopes of almost half of the park. Shrub communities also exist as a forest understory at higher elevations. Prevalent shrub species include Gambel's oak (*Quercus gambelli*), mountain mahogany (*Cercocarpus montanus*), buckbrush (*Ceanothus fendleri*), skunkbrush (*Rhus aromatica* ssp. *trilobata*), and snowberry. In some areas the Gambel's oak has grown beyond its familiar brush form into small trees up to eighteen feet tall. The mixed grasslands of the park's eastern third are home to a variety of native perennials. Though recovering from once intensive grazing, exotic species are becoming an increasing concern.

Figure 1: Much of the park has older, dying Gambel's oak, that ecologically thrives on disturbance.

4. METHODOLOGY

This plan examines site characteristics, values at risk, and the components of potential fire behavior. Specific treatments to mitigate the negative effects of wildland fire are then outlined and prioritized.

A literature review was focused on existing studies of Roxborough State Park, characteristics of fuels and flora found within the park and fuel treatments that have been applied to similar fuel types. The majority of the stands were systematically visited within the park boundaries to observe fuel loading, operability and stand ecology. Some of the more remote stands where access was extremely limiting to future operations were not visited. Wetlands, cliffs and riparian forests were not visited, however many of these features were traversed. Fuel models and loading were determined using photo series guides and subjective criteria (Anderson 1982, Fisher 1981, Ottomar et al 2000). Treatment guidelines were then developed for these specific conditions.

While a variety of treatment options exist for most situations, this project developed treatment guidelines based on site specifics. The potential fire behavior for pre- and post-treatment was then modeled to assess treatment value and assist in refinement of recommendations.

Based on these field visits, we digitized similar forest types into ArcMap 8.3. These stands have associated photos (for the most part) and fuels loading estimates in the ArcMap attribute tables. Fuels loading estimates were done using NFES 2293 (Fisher 1981), Anderson 1982, and PMS 832 (Ottmar et al 2000). In many cases, different fuels profiles from different photos were used to describe fuels, and then use a subjective approach to determining the amount of fuels loading.

Each stand was also assigned a Fuel Model. Fuel models are a means of describing a wide variety of combustible conditions found in a wildland environment. Thirteen standardized fuel models are used in wildfire behavior prediction. Fuel size class, fuels loading in tons/acre, fuel bed depth, and fuel continuity across a landscape are all factors that are considered when assigning a fuel model to a specific stand. Since it is unrealistic to expect thirteen descriptions to represent the wide continuum of fuel beds found in the wild, fuel models are often combined by the percentage of an area they cover.

Proposed project areas were then prioritized based on what we though would best:

- Protect park facilities from wildfires
- Provide fuels breaks in the park to allow suppression of fires before they did unacceptable damage to park resources.
- Protect the park from fires originating on adjacent private and Federal lands
- Provide needed stand management for ecological sustainability in the park while still providing fuels reduction and resource protection.

As part of this contract we were able to ground truth at least 90% of the stands, and Mindy Wheeler of WP Natural Resource Consulting, LLC was able to improve upon the existing GIS vegetation/fuels maps based on these site visits, however due to poor state of the GIS shapefiles when we received them, re-doing the entire GIS database for vegetation was beyond the scope and funding level for this project.

5. PROPOSED MITIGATION PROJECTS

5.1. Grasslands Prescribed Fire Project

5.1.1. Issues

While not always identified as a fire hazard, grass fuels are highly susceptible to ignition and can burn with surprising speed and intensity. This situation can be exacerbated by the invasion of the early curing and volatile Japanese brome (*Bromus japonicus*) and cheatgrass (*Bromus tectorum*).

Figure 2: Grasslands dominate the eastern side of the park

The grasslands that dominate the eastern third of the park are comprised of disturbance adapted short and mid grass species. The fire return interval of short and mixed grass prairies is variable, but historically ranged from less than 10 years to 35 years (USDA Forest Service 2005). Fire has been suppressed in this area for the past several decades, and grazing use was discontinued in 1979.

Disturbances such as fire and grazing are often a healthful and integral component to a grassland ecosystem, but response of the individual species is dependant upon phenology, fire severity, and site condition. Invasive species that have been identified as a potential problem include Japanese brome, cheatgrass, yellow sweetclover (*Melilotus officinale*), and white sweetclover (*Melilotus albus*). Fuels moneys will be paired with GOCO funds to ensure that weeds are addressed and treated post-prescribed fire.

The prevalent western wheatgrass (*Pascopyrum smithii*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), prairie Junegrass (*Koeleria macrantha*), and blue gramma (*Bouteloua gracilis*) regularly benefit from fire. Other codominants, Indian ricegrass (*Achnatherum hymenoides*), green needle grass (*Nassella viridula*), needle and thread (*Stipa comata*), and purple three-awn (*Aristida purpurea*), are more sensitive to fire. Depending on soil moisture and fire severity, there may be beneficial or moderately negative effects from fire. These species typically recover from negative impacts within one to three years (USDA Forest Service 2005).

Healthy native grasslands are desired communities within the park. Periodic fire helps maintain the vigor of the native grassland by reducing the thatch layer and stimulating growth. Healthy grasslands can more successfully resist invasive species, but fire can also allow an opportunity for exotics to take hold. These tradeoffs must be carefully weighed for each site prior to the application of fire.

5.1.2. Treatment Goals

1) Reduce the layer of thatch and litter in native grasslands.
2) Rejuvenate native grass communities.
3) Avoid impact to riparian areas and Preble's jumping mouse habitat
4) Avoid accelerating invasion of non-native grass and forb species

5.1.3. Treatment Options

Prescribed fire is expected to meet the treatment goals in areas without substantial exotic plant populations. It can be one of the more affordable options, with costs often in the $200 to $250 per acre range (S. Woods, pers. com. 2005). Concerns include preparation of holding lines, coordination of resources, timing with weather and smoke dispersal conditions, and potential for escape. Grass is perhaps the easiest fuel type in which to mitigation these concerns. All prescribed fires must be accomplished while adhering to the requirements set forth in the Biological Evaluation approved by US Fish and Wildlife Service in 2005.

1) For areas with little or no presence of Japanese brome, cheatgrass, or sweetclovers:

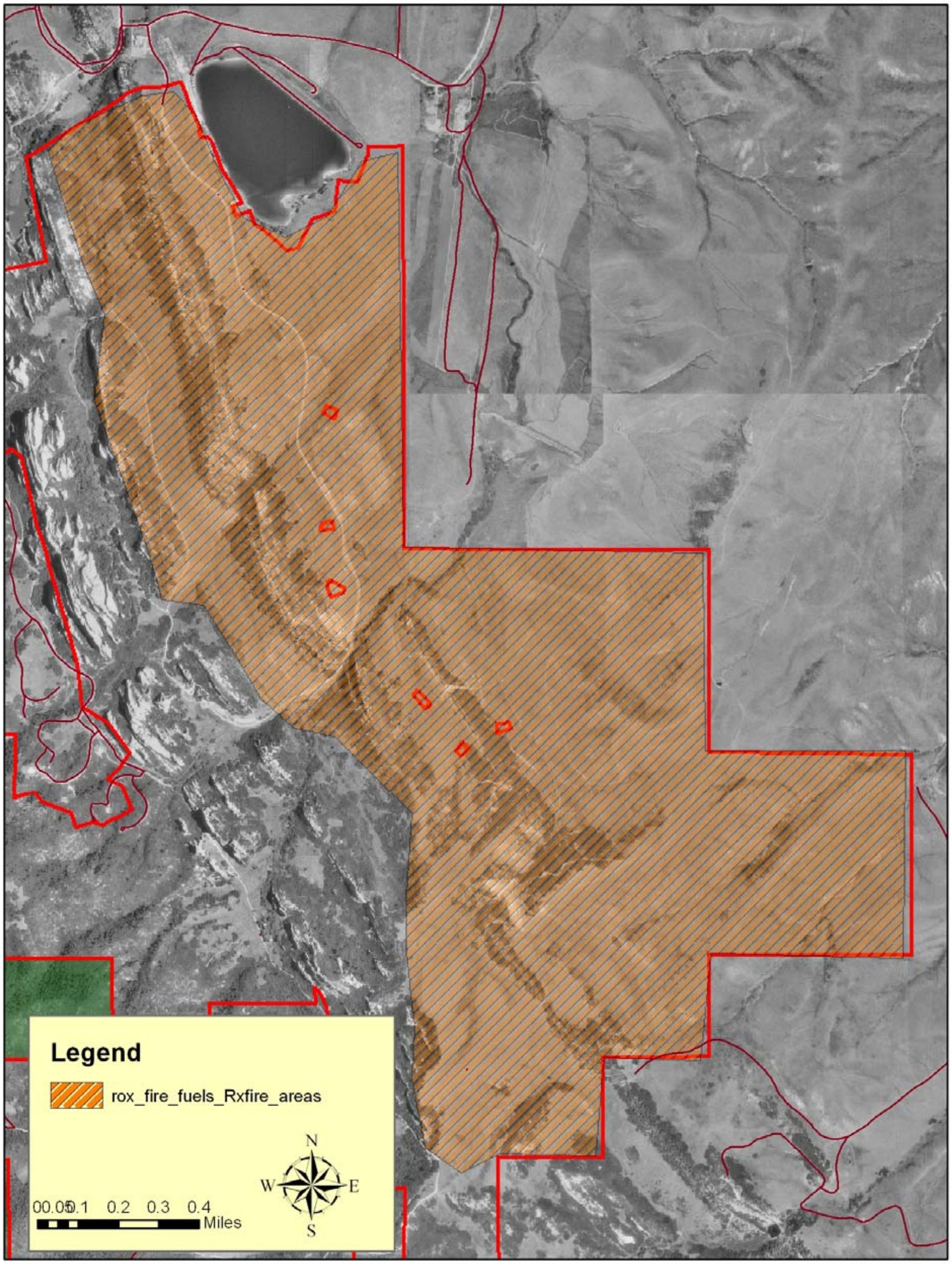
- Break the grasslands into prescribed fire units based on prevalence of invasive species and presence of logical control lines such as roads, trails, and topographic features.
- Burn the units from early winter (November) through early spring (March) in a rotation of five to fifteen years. Monitor each unit to help identify season, fire behavior, and fire return intervals that produce the most desirable results.

2) For areas with high prevalence of Japanese brome, cheatgrass, or sweetclovers:

- Application of fire should be avoided until other treatment options have been considered.
- While fire has been used to suppress these invaders, they more typically benefit from disturbance. A combination of treatments is often applied, including herbicides.

5.1.4. Future Maintenance and Considerations

Noxious weed management in these areas will require yearly treatment for the first two to three years, after this time, every other year treatments for maintenance will likely be sufficient. If native grasses do not establish themselves within a couple of years, reseeding the area with a locally native seed mix should be strongly considered. If funds are available in the beginning, staff should consider using a native seed mix (again, appropriate for the ecosystem) post-fire to help crowd-out exotics.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5.2. Gambel Oak Thinning

5.2.1. Issues

Almost 50% of the park is covered by shrublands comprised primarily of Gambel's oak with mountain mahogany, buckbrush, skunkbrush, snowberry, and yucca (*Yucca glauca*). The fire return intervals in Gambel's oak ranges from less than 30 years up to 100 years, and the condition of shrub stands reflect this variability (USDA Forest Service 2005). Through the absence of fire, Gambel's oak stands have grown decadent and reached heights of twelve to eighteen feet tall. Through age, frost kill, and drought stress these stands have built up a large dead component and constitute a serious hazardous fuel concern.

While tall, dense stands of Gambel's oak provide valuable cover for wildlife, they may provide poor forage and suppress the growth of forbs and grasses. Top killing of Gambel's oak and other shrub species typically promote vegetative sprouting (USDA Forest Service 2005). As such, mechanical or prescribed fire treatments alone, while insufficient to eradicate shrub stands, can serve to convert the stands to a more productive forage type and less hazardous fuel.

Figure 3: Photo of more large patches of decadent oakbrush with high dead components that could be rejuvenated by mechanical means

Application of prescribed fire in the park's brush fuels is problematic. Under conditions that will support the desired treatment goals, fire behavior may prove difficult to contain. There are areas of shrub thickets that are bordered by rock outcroppings and grasslands that may be candidates for fire reintroduction. Given the overall continuity of the shrub fuels and the proximity of dense residential development, any such project must be approached with extreme caution and is not recommended until after mechanical treatments reduce the fuels loading and continuity.

Depending on the size of the treatment area, access issues, and other issues the cost of hydro-axe treatment can range from $200 to $1,000 per acre. Hand thinning with saws can cost in excess of $1,500 to $2,000 per acre, not including chemical treatment. Hand thinning also requires subsequent disposal of the cut biomass.

5.2.2. Treatment Goals

As the oakbrush is so thick and decadent with high amounts of dead material, fuels hazards are very high to extreme in many areas of the park. Given the high cost of treating these stands, areas have been selected to address the following:

1) Create defensible space around park infrastructure and visitor egress roads while providing for esthetics
2) Create defensible space around historic sites and cultural resources
3) Initiate pilot projects for larger scale oak brush treatment
4) Treat oak brush, linking grasslands to create defensible fuel profiles

5.2.3. Treatment Options

Mechanical treatments are the preferred methods in the brush fuels at this time. Thinning and limbing with chainsaws is recommended where esthetics or access limitations are an issue. Saws can be used to limb and thin the brush understory, while leaving the mature oak canopy. This can be done with irregular edges to mimic more natural boarders. Herbicides can be applied to cut stumps in non-sensitive areas to prevent aggressive resprouting. Chemical treatment should be applied to the stumps within an hour of cutting. Garlon 4 has been used in the past with some success, but Arsenal has met even more favorable results in a BLM case study and does not have the twelve hour walk-back restriction that Garlon does (Dan Sokal, Glenwood Springs BLM 2005).

Larger scale treatments will begin with test plots in the southern end of the park. If the results are acceptable, further treatments in the area may be approved to link grasslands together, creating a lower intensity fuel zone (Appendix I, Map 2). Over the next ten years 30% to 50% of the oak thickets may be targeted for treatment. The hydro-axe is the recommended treatment for this project. This machine functions like a large lawnmower, masticating the brush and achieving the desired fuel reduction efficiently and without the need for off-site disposal. They are designed to create minimal soil disturbance and are able to create a patchy mosaic patterns amidst the brush.

5.2.4. Fuel Break along DC-5 (Upper Rampart) Road:

Following test plots, this will be the initial focus of treatment. The road affords access, provides a starting point for the project, and will assist in the defensibility of historic sites concentrated along his corridor.

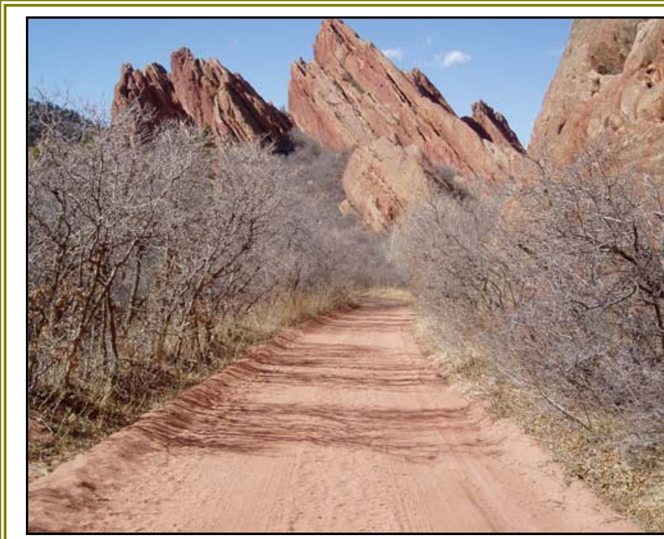

Figure 4: Dense brush impinges on portions of the upper Rampart Road.

1) Where access, size of the treatment area, and other factors allow, the more efficient treatment of brush fuels is with a Hydro-axe or similar machinery.

2) Where aesthetics are a concern:

- Oak thickets should be cut back from the road ten to thirty feet using irregular “edges”.
- Remaining brush within 100 feet of the road should be thinned to 1000 to 1500 stems per acre using chain saws.
- The focus should be on removing dead stems.
- Limbs and brush below 4.5 feet high should be reduced in favor of more mature oak, but periodic breaks in the canopy should be included.

5.2.5. Future Maintenance and Considerations

As Gambel’s oak and other shrubby species will aggressively re-sprout, it is important to consider using herbicides along high priority areas where re-growth is not desired. Widespread herbicide application to treated areas is not likely feasible due to aesthetics, ecosystem function, and cost. However in areas where fuel breaks and defensible space are the priority, then prevention and/or minimization of regrowth should be considered to keep fuels from becoming hazardously dense again. Application of Garlon or equivalent herbicide to recently (within 2 hours) cut stumps is recommended to prevent aggressive resprouting. Oak brush and other stands will regrow over time, but maintenance of already thinned stands will be considerably less intensive of work when compared to initial thinning and removal of large amounts of dead material. Some stands may need some pruning and treatment ever 5 to 10 years.

The openings in these stands should quickly become established with native grasses and forbs, but also possibly noxious weeds. Weed treatment in these areas should be anticipated. Reseeding should not be needed, as natives suitable to these areas should reestablish themselves within 3 years.

5.3. Creation of Defensible Space

5.3.1. Issues

In addition to the park's visitor center, there are at least four sites with historic buildings or ruins. The survivability of these structures will be enhanced by the creation of defensible space. Research indicates that radiant heat from a crown fire is unlikely to ignite structures with a minimum of 70 feet of defensible space (Cohen 1998). Direct flame impingement and embers may also ignite structures. If firefighters are defending structures, the defensible space should be at least four times the expected flame height around the structure (Scott 2003).

Figure 5: Even with noncombustible construction, the Visitors Center should have defensible space.

While the visitor center is fire resistant masonry and slate roof construction, the historic structures are extremely susceptible to ignition. Defensible space in the strictest sense might not be consistent with visual concerns or absolutely necessary. Specific recommendations for reducing fuels around the structures are outlined that can be quickly improved by crews in advance of a fire, yet retain some native vegetation close to the structures.

5.3.2. Treatment Goals

1) Reduce the potential for ignition of structures from radiant heat and flame impingement.
2) Create areas immediately surrounding structures that can be rapidly improved for increased defensibility.

5.3.3. Treatment Options

1) Visitors Center:

- North side: follow guidelines as provided for historic structures
- West side: within 15 feet of structure remove oak brush <3 inch dbh. Limb remaining trees to 3 feet
- East side: within 5 feet of structure remove oak brush <3 inch dbh. Limb remaining trees to 3 feet. Within 30 feet of structures reduce oak brush <3 inch dbh by 50%. Limb oak stems >3 inches dbh to 4 feet

2) Historic Buildings and Ruins:

- Within 100 ft of structures, create 5 ft spacing between mature (dbh > 4 inches) oak crowns and limb branches to 4.5 ft. Reduce brush height to 2 ft.
- Within 30 ft remove brush fuels (taller than 1' and dbh <4 inches)
- Within 15 ft of structure keep grass well trimmed
- Herbicide treatment (Garlon, Arsenal , or similar product) should be considered where consistent with visitor safety and natural resource constraints.

Figure 6: Some historic buildings may be worth spending mitigation dollars to protect them, others may be too far in disrepair.

3) Park Access Roadside Thinning:

- Approximately 0.5 miles east of the visitor center, the main park access road is impinged by brush. Brush fuels should be cleared a minimum of 30 feet on each side of this road.

5.3.4. Future Maintenance and Considerations

As Gambel's oak and other shrubby species will aggressively re-sprout, it is important to consider using herbicides along high priority areas where re-growth is not desired. Widespread herbicide application to treated areas is not likely feasible due to aesthetics, ecosystem function, and cost. However in areas where fuel breaks and defensible space are the priority, then prevention and/or minimization of regrowth should be considered to keep fuels from becoming hazardously dense again. Application of Garlon or equivalent herbicide to recently (within 2 hours) cut stumps is recommended to prevent aggressive resprouting. Oak brush and other stands will regrow over time, but maintenance of already thinned stands will be considerably less intensive of work when compared to initial thinning and removal of large amounts of dead material. Some stands

Figure 7: Access and egress from the visitor center must be protected.

may need some pruning and treatment ever 5 to 10 years.

The openings in these stands should quickly become established with native grasses and forbs, but also possibly noxious weeds. Weed treatment in these areas should be anticipated. Reseeding should not be needed, as natives suitable to these areas should reestablish themselves within 3 years.

5.4. MILLS GULCH FUELS BREAK

5.4.1. Issues

The Ponderosa pine and Douglas-fir forests along the Front Range of Colorado have a history of varied fire size, severity, and frequency. Throughout these forests, fire size has been found to range from one tree to landscape scale and from low severity to stand replacing fire behavior. Composite mean fire return intervals in these forest types range from 13 to over 40 years. In general, however, lower elevation ponderosa pine and south facing slopes are more prone to low severity surface fire, while high intensity burning and crown activity is more likely to occur at higher elevations and on northern exposures (Brown et al. 1999, Veblen et al. 2000).

Figure 8: Forest with brush understory is common on the west side of the park.

Veblen et al. (1996) believed that their data and previous studies (Goldblum and Veblen 1992) clearly established that the last 80 years of fire suppression have created a notable departure from the relatively high frequency fire regime of the pre-European settlement era. Photographic evidence was cited as indicative of "dramatic" increases in the density of ponderosa pine in the lower elevation woodlands and encroachment into meadows and grasslands. There is also evidence that Douglas-fir is becoming dominant on previously mixed sites due to fire exclusion (Peet 1981). The Xcel powerline on the west side of the park affords an opportunity to create a fuel break along the park boundary, while helping to protect a powerline and the neighboring community. With the current state of electrical power distribution, the loss of a major powerline during the summer months has extensive economic implications and brings the effects of wildland fire into the homes of major cities.

From the southwest corner of the park, the powerline trail runs north from the end of the upper Rampart Road. These south facing slopes can be treated by thinning or eliminating oak patches to link together grasslands. The trail then intersects with the powerline in the Mill Creek bottom. This area is dominated by aspen stands that will require minimal work. Much of the remainder of this proposed fuel break is Douglas-fir with oak understory.

These types of shaded fuel breaks are strategically located zones in which flammable vegetation has been removed or altered to decrease potential fire behavior. They are not intended to halt the spread of fire on their own, but to provide an anchor point for indirect attack efforts or even prescribed fire projects. The minimum width of a fuel break in timber is typically 200 feet (Agee 2000). This type of treatment usually involves the reduction of surface fuels, ladder fuels such as small trees and low branches, and thinning of the overstory. Such projects are not intended to be timber harvests, but the utilization of merchantable materials can be used to help defray costs.

Figure 9: Powerlines run along aspen stands on the western edge of the park

Further coordination with the Pike National Forest and Colorado State Forest Service is necessary before the Mills Gulch project is initiated. The Pike National Forest is planning a vegetation restoration project immediately to the west of Mills Gulch which may render this particular project redundant (Appendix I, Maps 2 and 3). This Upper South Platte Watershed Protection and Restoration Project is slated for the 2006 fiscal year (Culver 2005).

5.4.2. Treatment Goals

1) Create a shaded fuel break along the powerline on the west boundary of the park
2) Provide a viable area from which to initiate indirect attack
3) Create a zone unlikely to support the initiation or propagation of crown fire

5.4.3. Treatment Options

1) Create a shaded fuel break 200 to 250 feet wide, utilize and improve existing grass areas on south facing slopes and aspen stands in Mill Gulch.

2) In areas of shrub fuels:

- Eliminate brush to link or widen grass areas.
- Along the powerline trail and under the powerline itself, treat according to the DC-5 road guidelines (see section 4.2.4 above).
- When found as an understory to timber, thin to a minimum of 1200 stems per acre, reduce height to 2 feet, eliminate under tree canopies.

3) In forested areas:

- Reduce surface fuel load to approximately 5 tons per acre.
- Reduce surface fuel height to 2 feet or lower.
- Employ mechanically based logging to reduce basal area from 40 to 60 square feet / acre.
- On remaining trees, raise canopy base height from 5 to 12 feet high, but not greater than 40% of total foliage.
- Create 10 feet of clearance between crowns of trees or tree groups (max of 7 trees) (Dennis 1983, Fielder 2003, Village of Ruidoso 2004)

5.4.4. Future Maintenance and Considerations

As Gambel's oak and other shrubby species will aggressively re-sprout, it is important to consider using herbicides along high priority areas where re-growth is not desired. Widespread herbicide application to treated areas is not likely feasible due to aesthetics, ecosystem function, and cost. However in areas where fuel breaks and defensible space are the priority, then prevention and/or minimization of regrowth should be considered to keep fuels from becoming hazardously dense again. Application of Garlon or equivalent herbicide to recently (within 2 hours) cut stumps is recommended to prevent aggressive resprouting. Oak brush and other stands will regrow over time, but maintenance of already thinned stands will be considerably less intensive of work when compared to initial thinning and removal of large amounts of dead material. Some stands may need some pruning and treatment ever 5 to 10 years. Sprouting of aspen in these areas is permissible, as aspen usually does not contribute to fire intensity, and often allows understory grasses and forbs to have higher moisture contents due to shading.

The openings in these stands should quickly become established with native grasses and forbs, but also possibly noxious weeds. Weed treatment in these areas should be anticipated. Reseeding should not be needed, as natives suitable to these areas should reestablish themselves within 3 years. Aspen will likely sucker in localized pockets, which aforementioned is permissible.

6. ADDITIONAL FIRE PROTECTION CONCERNS

6.1. WATER SUPPLY

6.1.1. Issues

A reliable water supply is essential for structure preparation and defense during a wildfire. Within the park, there are no apparent reservoirs, ponds, or streams that are suitable for fire service use on a year round basis. The fire hydrant closest to the visitor center is over 2 miles away, placing it over 4 ground miles away from the historic Persse site. The delivery of water to the historic sites and inholdings along the upper Rampart Road would necessitate a shuttle operation along this one-lane dirt road to access fire hydrants in the Roxborough Park subdivision. The placement of a fire service water supply in the vicinity of the visitor center should be strongly considered. A water supply source along the upper Rampart Road is of secondary concern.

The use of water sources for fire suppression by helicopters can lead to myriad of problems if prior arrangements have not been made. Agreements between fire suppression agencies and reservoir owners may already exist, but this should be confirmed.

6.1.2. Options

1) Develop natural water supplies- Determine if draft sites can be developed along Willow Creek or other intermittent streams or springs.
2) Install improved water supplies- Install dry hydrants or cisterns that are easily accessed by suppression forces working near the visitor center and along the upper Rampart Road.
3) Helicopter dip sites- Ensure that preexisting agreements have been obtained and documented for the use of Rampart Reservoir and North Willow Creek Reservoir for helicopter bucket use.

6.2. Fire Department Response and Access

6.2.1. Issues

West Metro Fire Station 15 is immediately outside of the park entrance. Its structure engine, brush engine, and ambulance are staffed by four firefighters with wildland fire training. Second due engines respond from West Metro Station-14 and South Metro Fire Department.

Engine access to the visitor center along the main park road is excellent. The one-lane dirt road that provides access to the western half of the park is less tenable. The safety of access along the upper Rampart Road will be greatly enhanced once brush fuels have been cleared along the road. Both of these roads provide only one way in and out, requiring that safety zones along these roads be identified before fire crews can commit to assignments along them.

The Persse site may be accessed by brush engines using the Fountain Valley trail. This access may be compromised if trail conditions or vegetation clearance is not maintained.

6.2.2. Options

1) Vegetation clearance along roads- This will be achieved during the fuel break construction outlined in this report.
2) Safety zones- It may be helpful for suppression resources if potential safety zone sites are preplanned and identified on maps.

6.3. FIRE RECORD KEEPING

It should be noted that attempts to determine fire occurrence within Roxborough State Park from recent or historic records were unsuccessful. The Colorado State Forest Service, West Metro Fire Protection District, Pike National Forest, and the park itself were all contacted in an attempt to find fire occurrence information, with no success.

Accurate fire records are essential for determining trends in fire cause and specific environmental fire danger indicies. Fire prevention programs and fire danger rating systems are depend on this sort of information. As such, Roxborough State Park may wish to ensure that such records are being kept by the Colorado State Forest Service, West Metro, or the park itself. These records should include time, date, cause, size, location, and resources assigned as a minimum.

TREATMENT SUMMARY TABLE

Grassland Rx Fire	Acres	Priority	Treatment	Est. Cost
Unit #1	200	3	Broadcast Burn	$15,000
Unit #2	500	3	Broadcast Burn	$18,000
Unit #3	350	3	Broadcast Burn	$16,000
Planning Costs	NA	3	CSFS/CSP Planners	$10,000
Nox. Weed Treat	500	3	Spot Spraying	$4,000
Oak Thinning				
Hydro-Axe Units	300	2	Hydro Axe	$96,000
Hand-thinning Units	5	3	80% removed	$9,000
Chem. Application	15	2	Stump-treatment	$15,000
Nox. Weed Treat	300	2	Spot spraying	$3,000
D-Space				
Visitors Center	2	1	Thin	$700
Entrance Road	1	1	Thin	$2,500
Other Structures	2	1	Thin	$7,000
Chem Application	1	1	Stump treatment	$300
Nox. Weed Treat	1	1	Spot Spraying	$250
Rampart Road Thinning				
Hand Thinning	15	1	70% removed	$27,000
Chem Application	7	1	Stump treatment	$2,500
Nox. Weed Treat	10	1	Spot Spraying	$4,000
Mills Gulch Fuel Break				
Understory Thin	70	4	Hydro-Axe	$55,000
Overstory Thin	35	5	Mechanical	$30,000
Road Improvement	NA	3	Grading	$6,000
Nox. Weed Treat	15	4	Spot Spraying	$7,000

Assumptions for Treatment Summary Table:

RX Fire- Base cost of $200-$250 per acre, however after initial burning and planning is completed, costs should dramatically decrease. Estimates shown above should be on the high side. Unit acreages are arbitrary based on natural unit boundaries and roads to be used as existing containment lines. Using "wet lines" should be effective and relatively inexpensive, especially if local West Metro fire department resources are utilized.

Oak Thinning- Base cost of $800 per acre using Hydro-Axe. Larger units, or units treated back-to-back will reduce mobilization costs, which will be around $2,000. Hand thinning units should be only used in high visibility or high sensitivity areas, due to very slow production rates, and high costs. Hand thinning is based on a $1,800/hour rate for a hand crew. The cost estimates above may be a bit low for hand crews, unless Convict Crews are utilized. Chemical treatments should only be necessary near roads- the entire area does not need to be stump-treated. Acres are based on treating approximately ½ of the oak brush stands over time.

D-Space- Hand thinning will be utilized around structures. Most of the cut-stumps should be treated with Garlon or equivalent herbicide. The main entrance road should be thinned back as well, and cut-stump treated. Historical structures should be inventoried to determine which structures are worth doing defensible space around, and which ones are not, this could save some funds.

Rampart Road Thinning- Much of the oak next to the road could be hand-thinned to keep aesthetics high; however, Hydro-axe treatments would likely be cheaper, especially if the equipment has already been mobilized to the park. With the road adjacent to the oak brush, treating slash and brush may be easier by having a chipper on the road if hand thinning is used. In some areas, stump-treating should be considered if the road will be used as a fire break for some time, but simply regenerating the stand through thinning and treatment will produce a more fire-resistant stand with lower fire severity and intensity if the stand did burn.

Mills Gulch Fuels Break- As USDA Forest Service will be treating fuels quite close to Mills Gulch, having a large thinning or fuels manipulation project here may prove to be redundant. However if funds are available, then this fuels break would improve defensibility of the park, improve protection for Xcel's power line, and could be used to increase stand diversity in the area. Both understory manipulation of oakbrush and overstory thinning of ponderosa pine should be considered. Understory thinning should be done using machinery given the acres involved. Due to steeper slopes in this area, tracked vehicles would likely be necessary- possibly a smaller, more maneuverable piece of equipment such as a tracked skid-steer with a flail system may work well to thin out this oakbrush. Road work will be necessary to allow machinery into the area, regardless of the types of equipment used.

Skid-Steer Mounted Mower/Mulcher- Much cheaper than a Hydro-Axe, this kind of equipment works well in oakbrush-stumps may be a bit higher, but equipment is also much more maneuverable in tight spaces and in timber. This setup was used by RMES contractors (Larson Trucking out of Basalt, CO) in 2005, and was very cost-efficient; the only problem was that in warm weather the equipment overheated periodically and needed to stop to cool down. **For the cost table, I used a traditional Hydro-Axe rate, not one of these smaller units.**

7. NEEDS PRIOR TO PROJECT IMPLEMENTATION

Prior to Implementation, the following needs should be addressed:

1) Park boundaries need to be surveyed and flagged in thinning areas for easy identification.
2) Noxious weeds should be treated in project areas prior to burning/thinning operations.
3) Ensure Colorado State Forest Service has received mitigation measures required by State Parks and US Fish and Wildlife Service and ensure that contractors and/or parks staff overseeing the project implement such mitigations.

8. CONCLUSION

Roxborough State Park faces the challenge of overcoming the effects of fire exclusion amidst increasing suburban development and nearby large fire occurrences. By investing in wildland fuel reduction around park structures and roads, the defensibility of park values will be greatly enhanced. By working in conjunction with Xcel power, the Colorado State Forest Service and the Pike National Forest, a fuel break along the west side of the park can help protect not only powerlines, but the park itself. The careful reintroduction of fire into the park grasslands can be an invaluable tool for the maintenance of ecosystem health. Large-scale mechanical treatment of brush fuels can help reduce potential fire behavior and improve wildlife habitat.

All of these efforts require not only an initial investment but also a commitment to long-term maintenance. While there is no guaranteed defense against large scale, catastrophic crown fire, pursuing these projects will produce fire safety and ecosystem benefits. Responsible natural areas stewardship in the 21st century requires an effort to mitigate the negative impacts of wildfire and the hazard to fire suppression crews.

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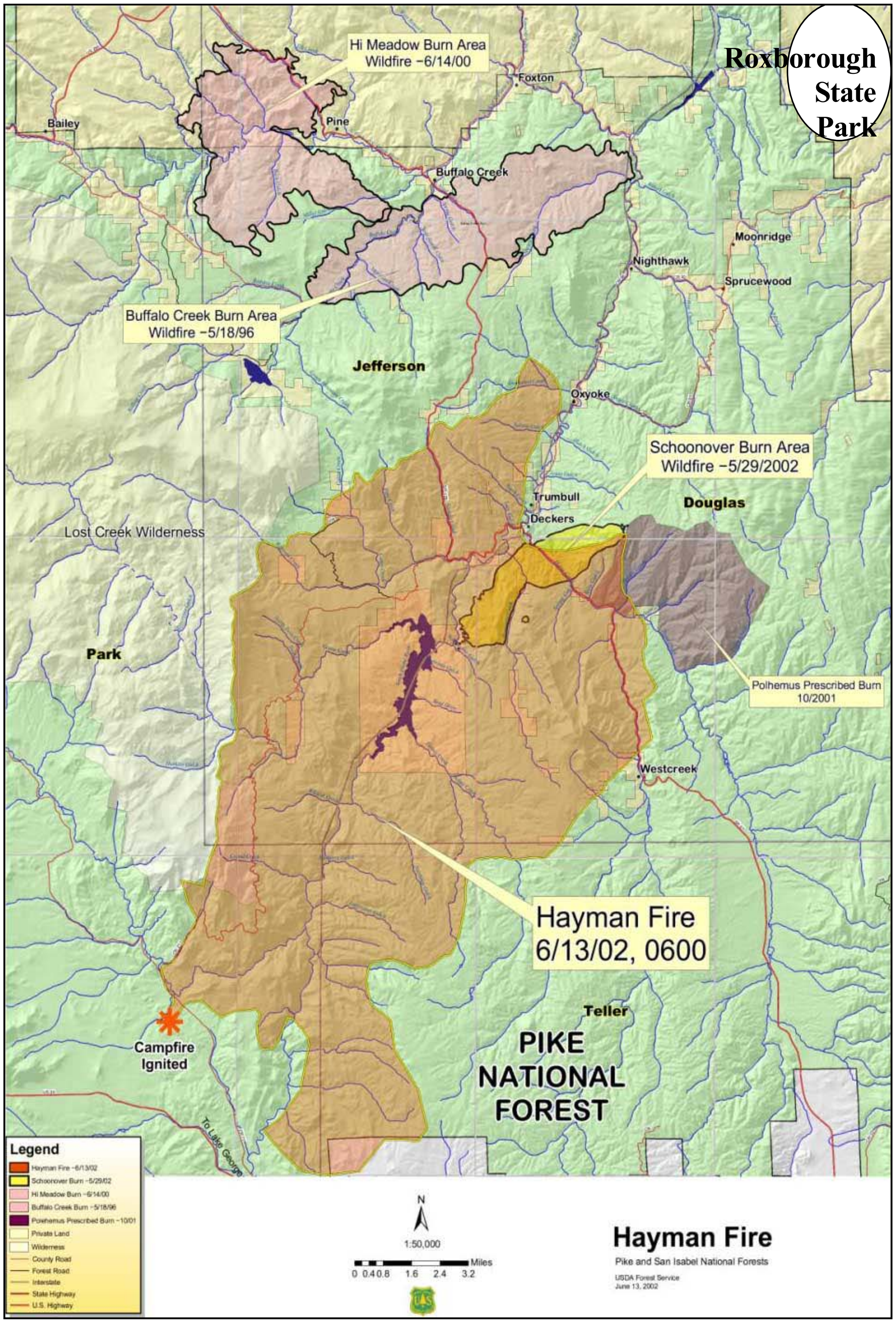
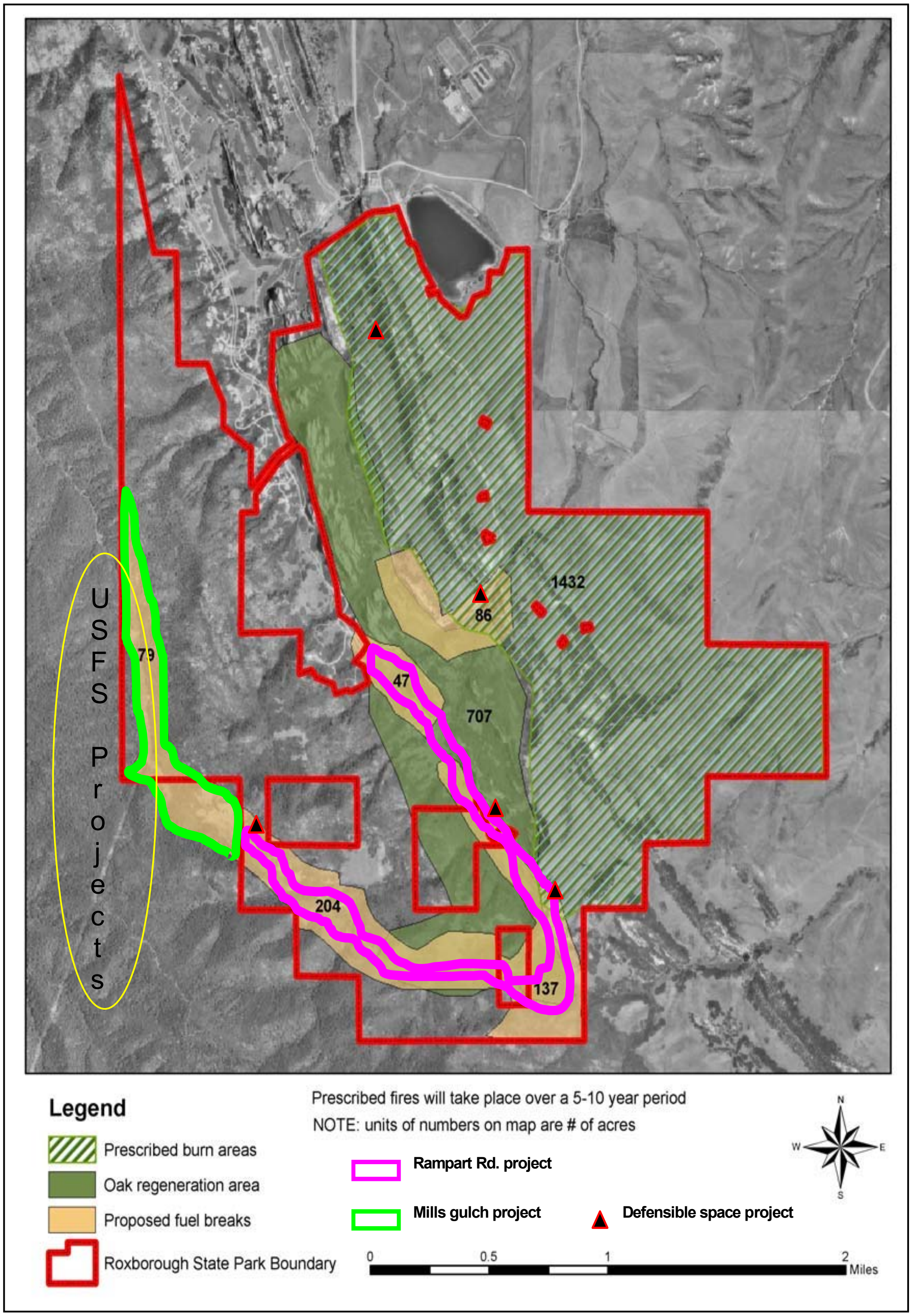
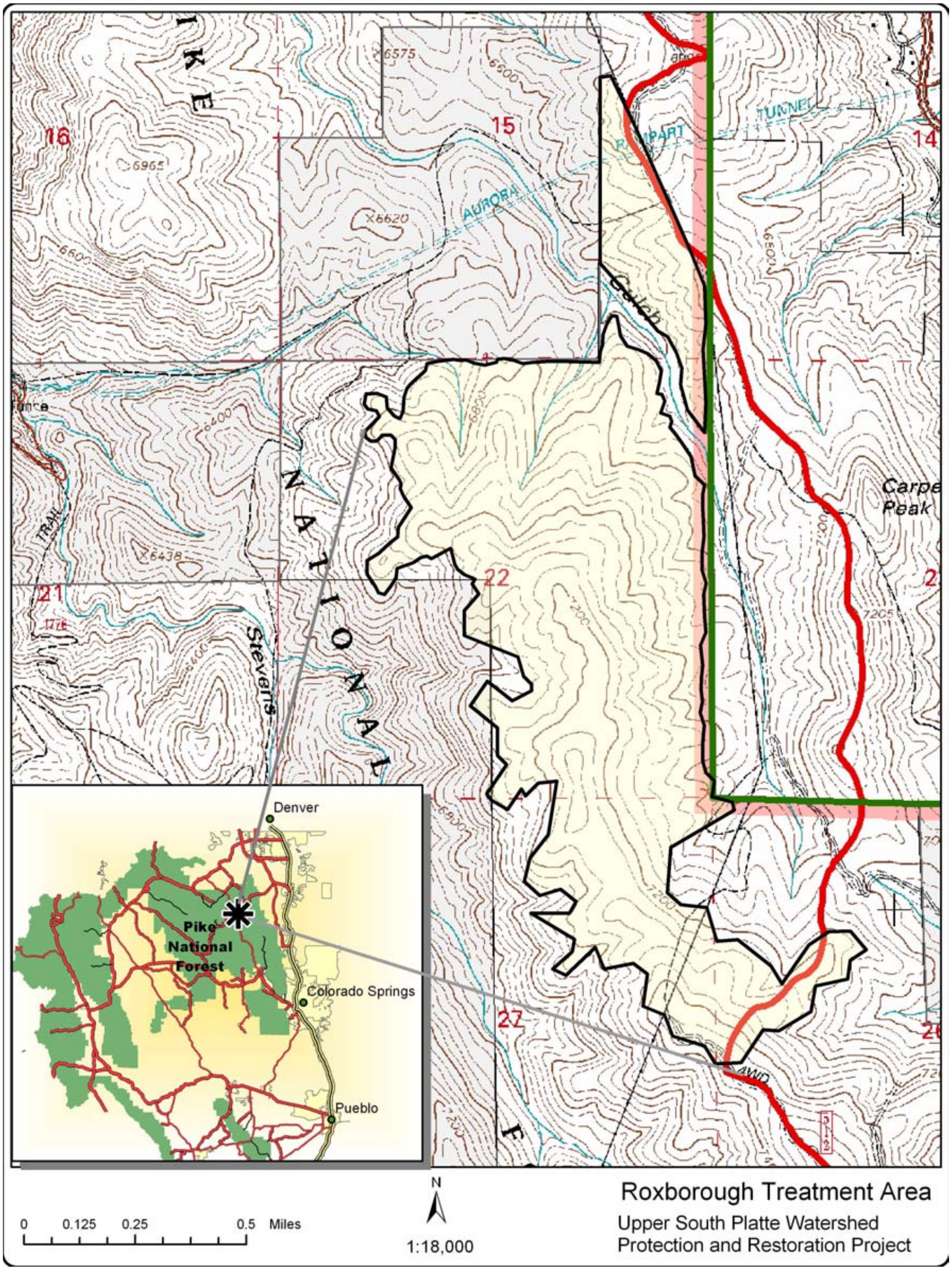
10. PROJECT MAPS- ROXBOROUGH STATE PARK



Map 1: Since 1996, four large fires have grown to within ten miles of Roxborough State Park's boundaries. <http://www.fs.fed.us/r2/psicc/hayres/maps/index.htm

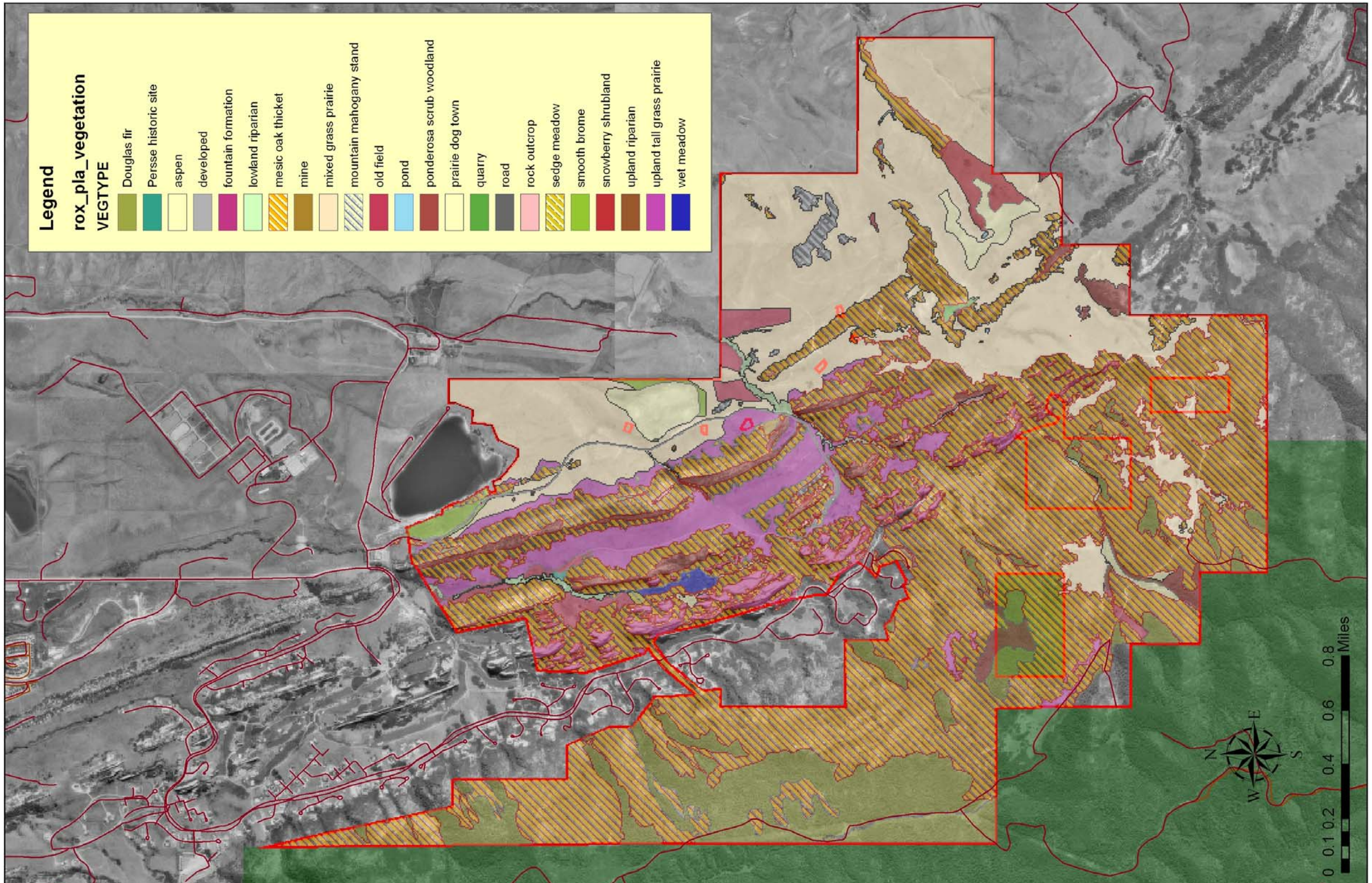


Map 2: Fuels mitigation project locations within the park, and on US Forest Service Lands

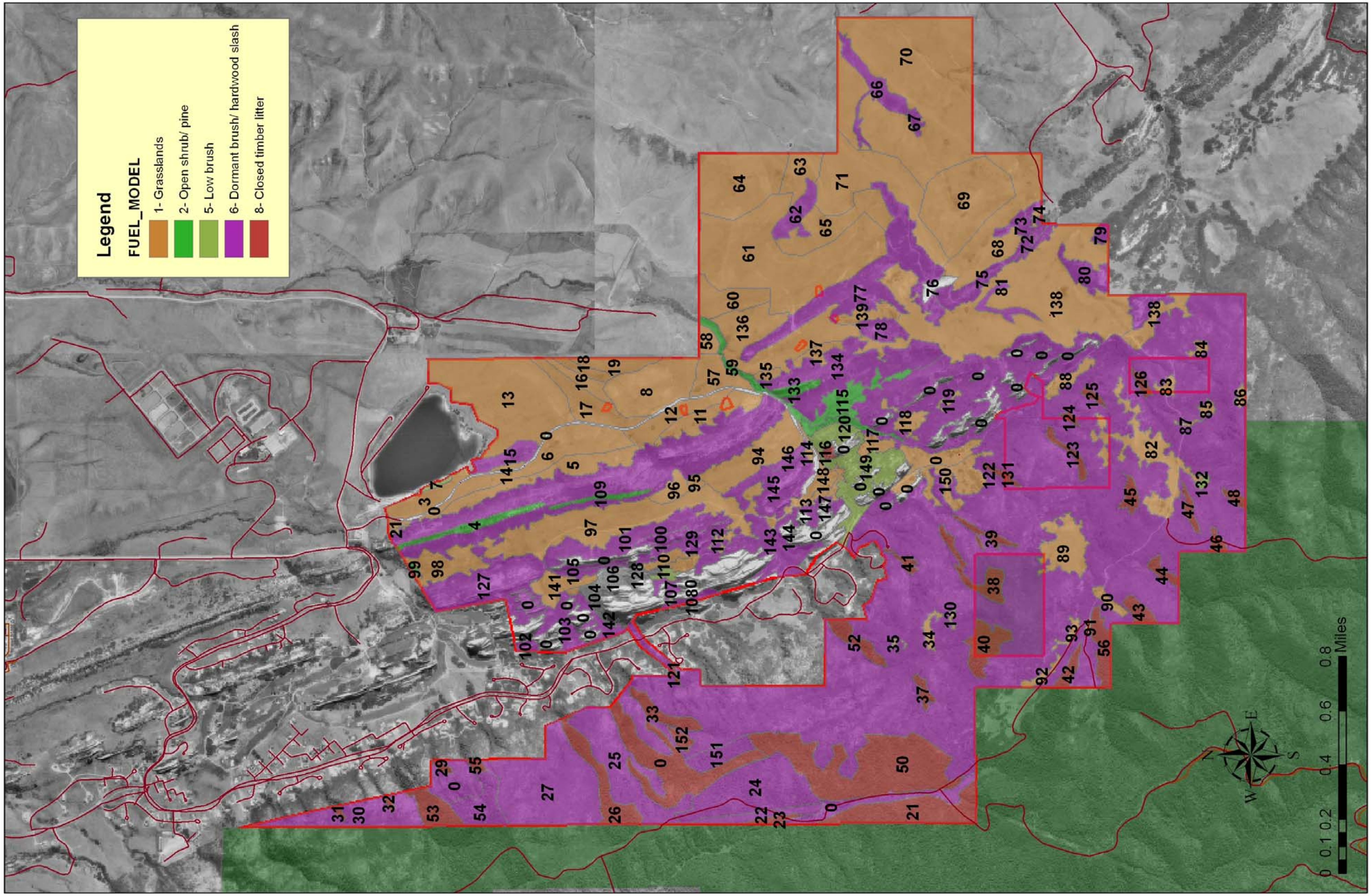


Map 3. Several hundred acres of the Pike National Forest are slated for a fuel reduction / vegetation restoration project. The project is located along the western boundary of Roxborough State Park.
Map courtesy of Mr. Steve Culver, Fisheries Biologist, Pike National Forest

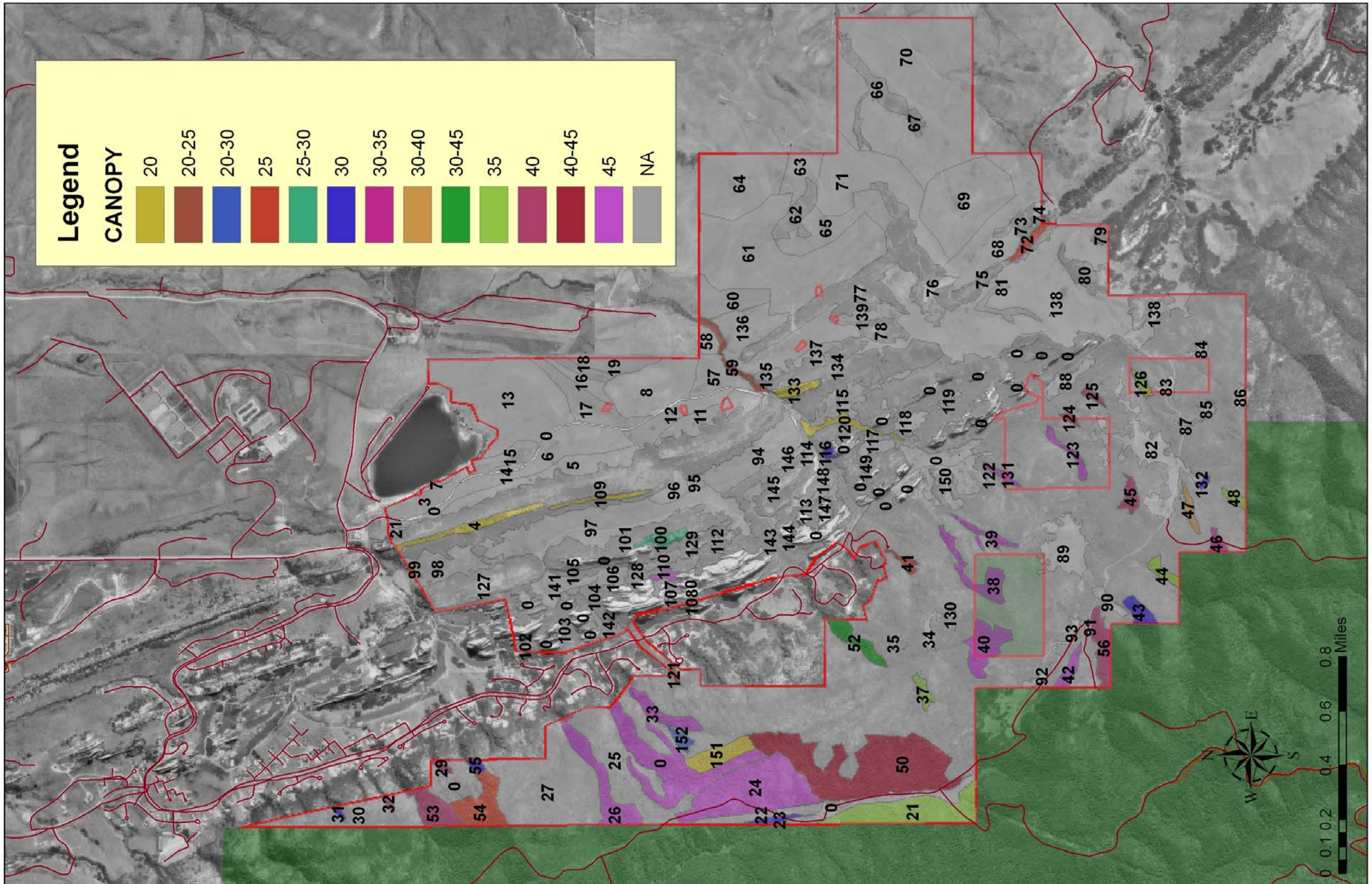
MAP 4: Vegetation types in Roxborough State Park



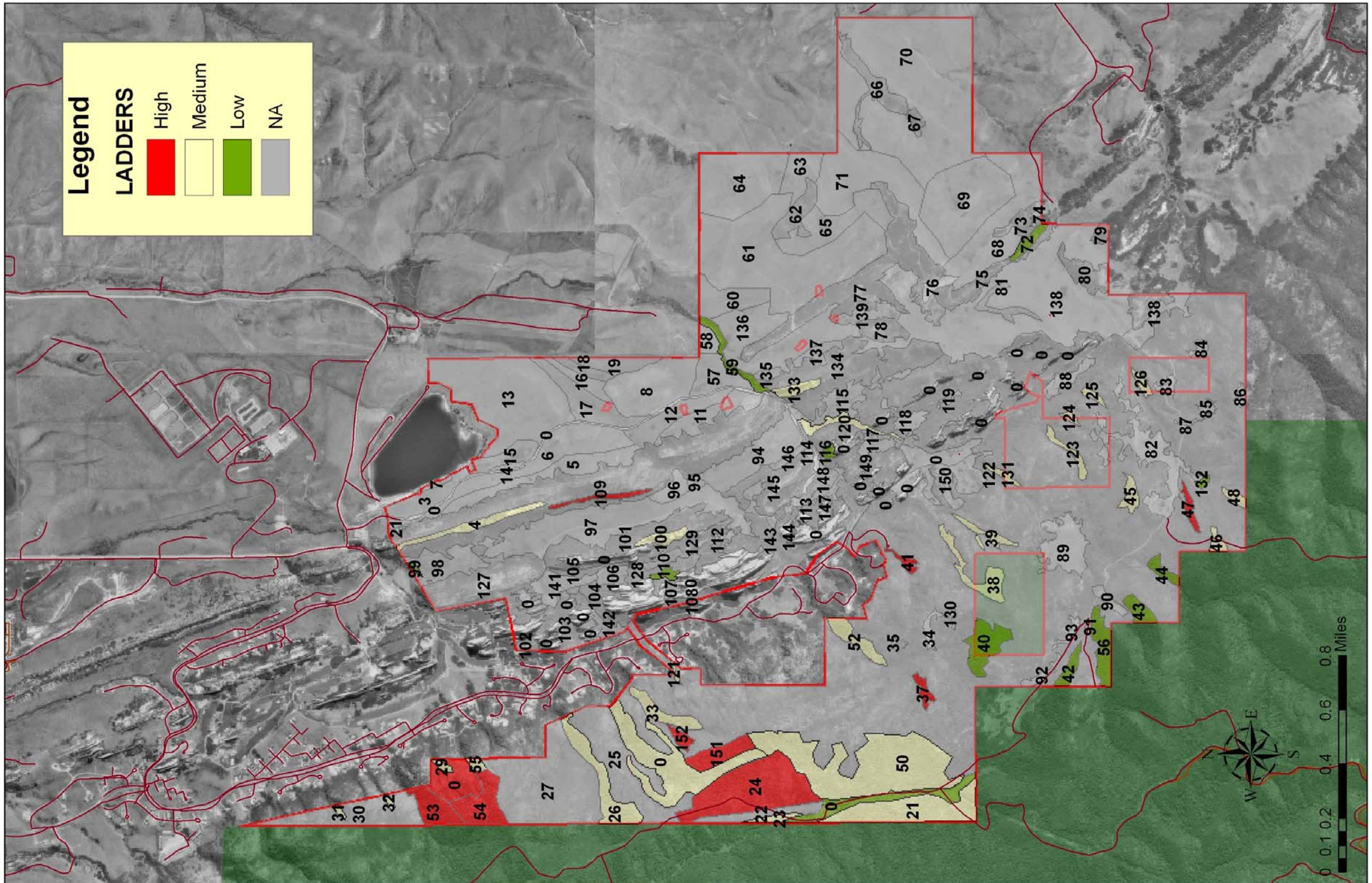
MAP 5: Fuel Types and Stand Numbers



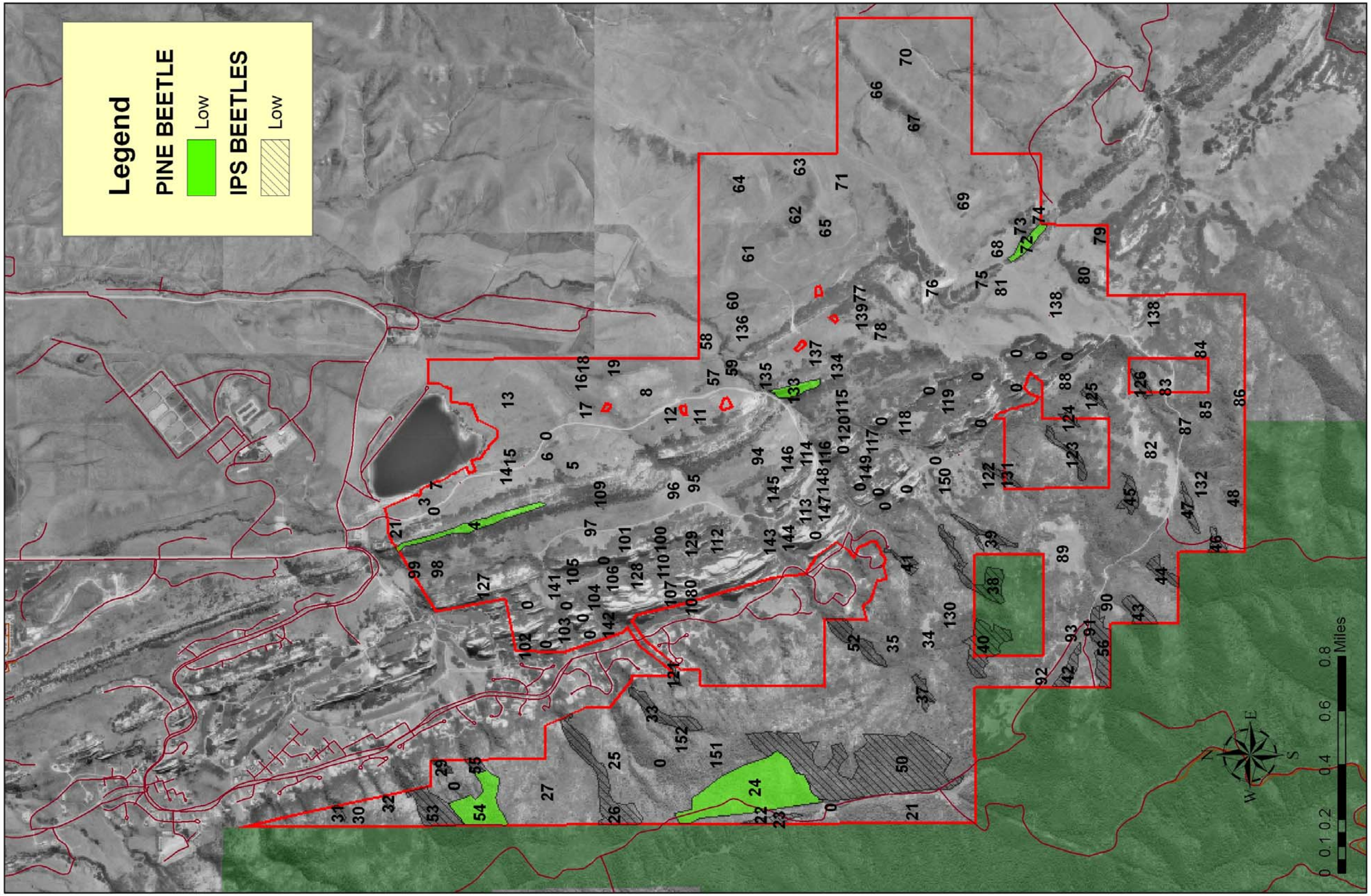
MAP 6: Canopy cover & stand numbers



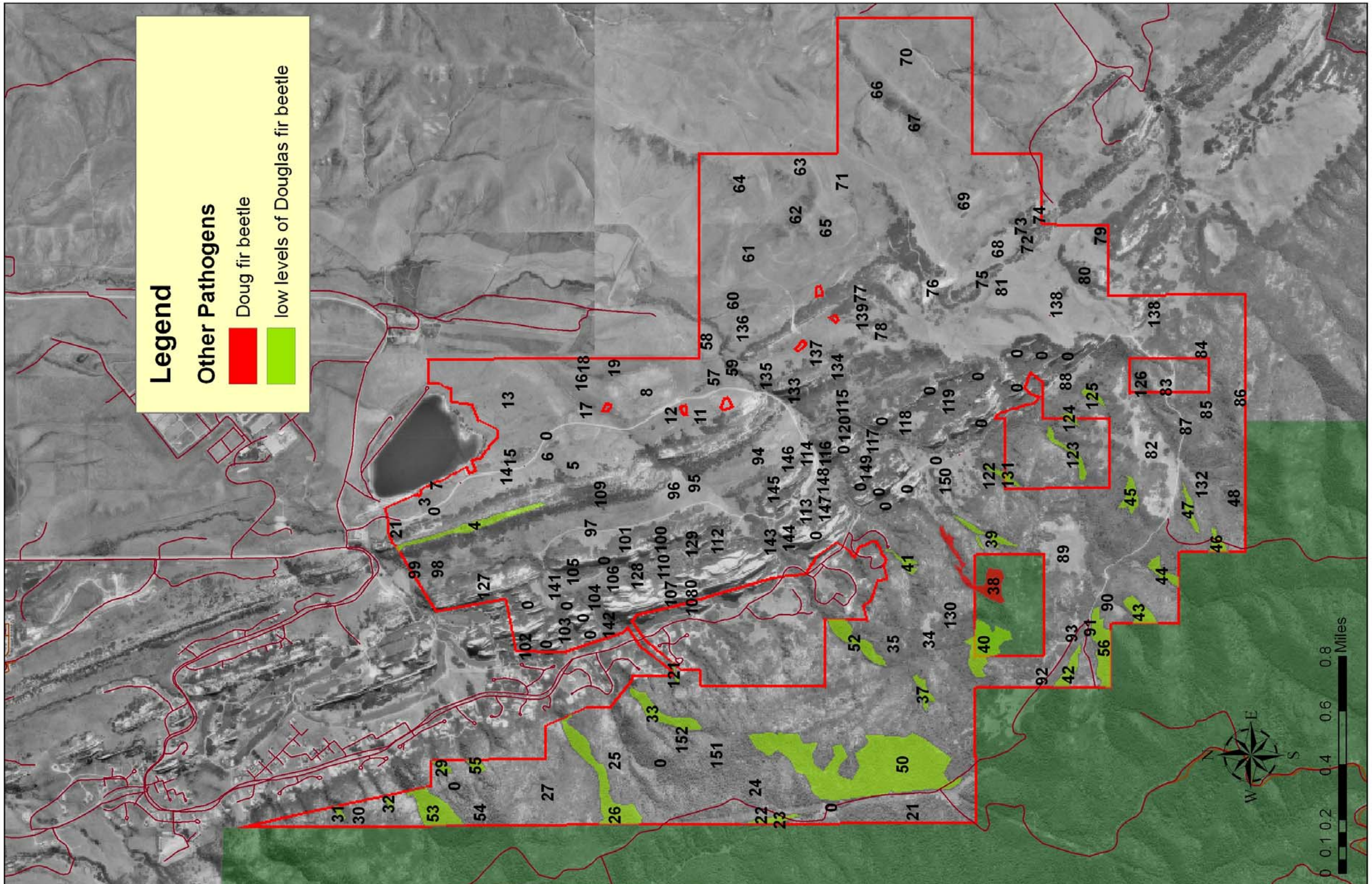
MAP 7: Amount of Ladder Fuels and Stand numbers- oakbrush stands by nature have high ladder fuels



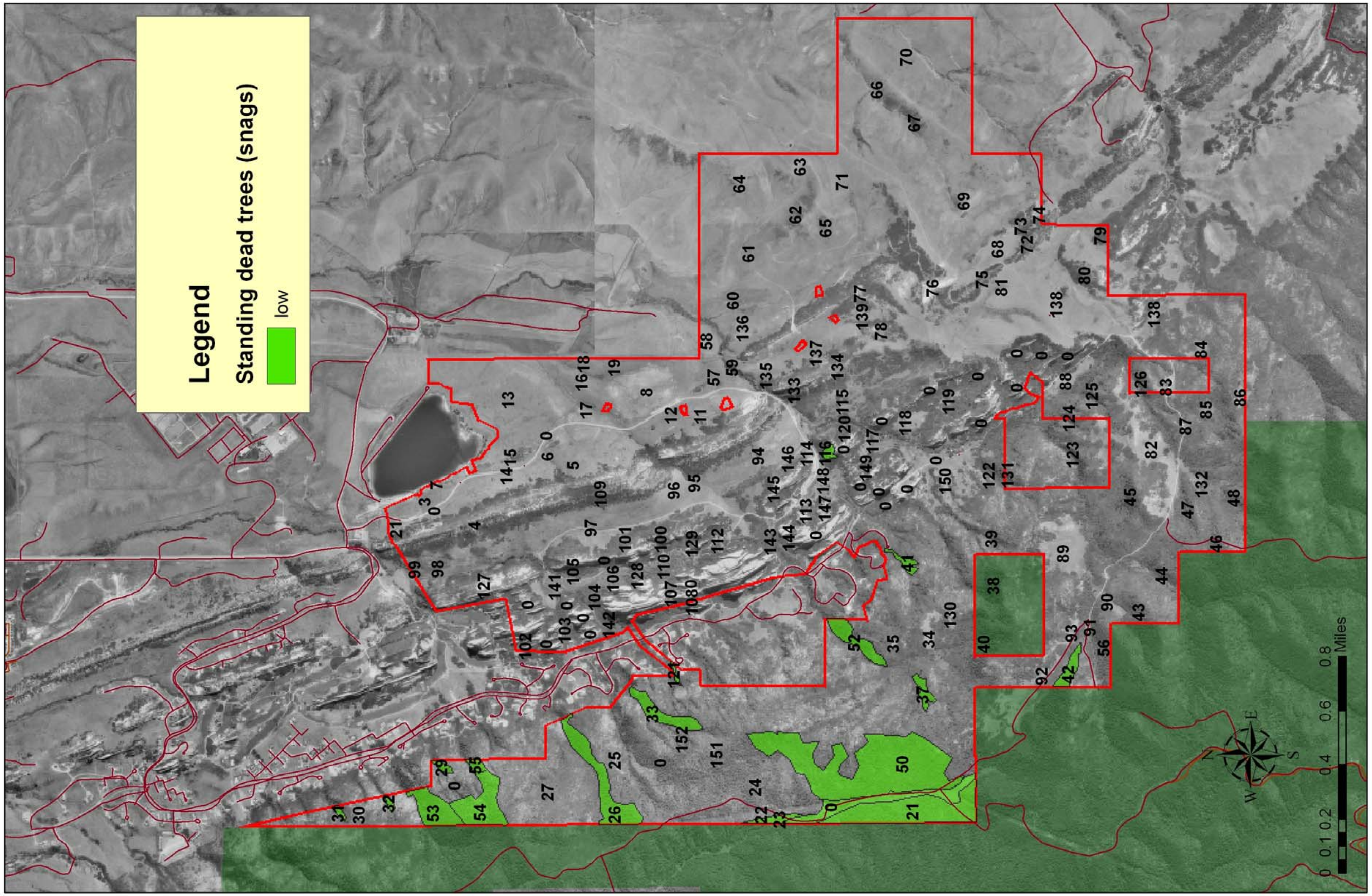
Map 8: Mountain Pine Beetle and Ips (spp.) beetle infestations



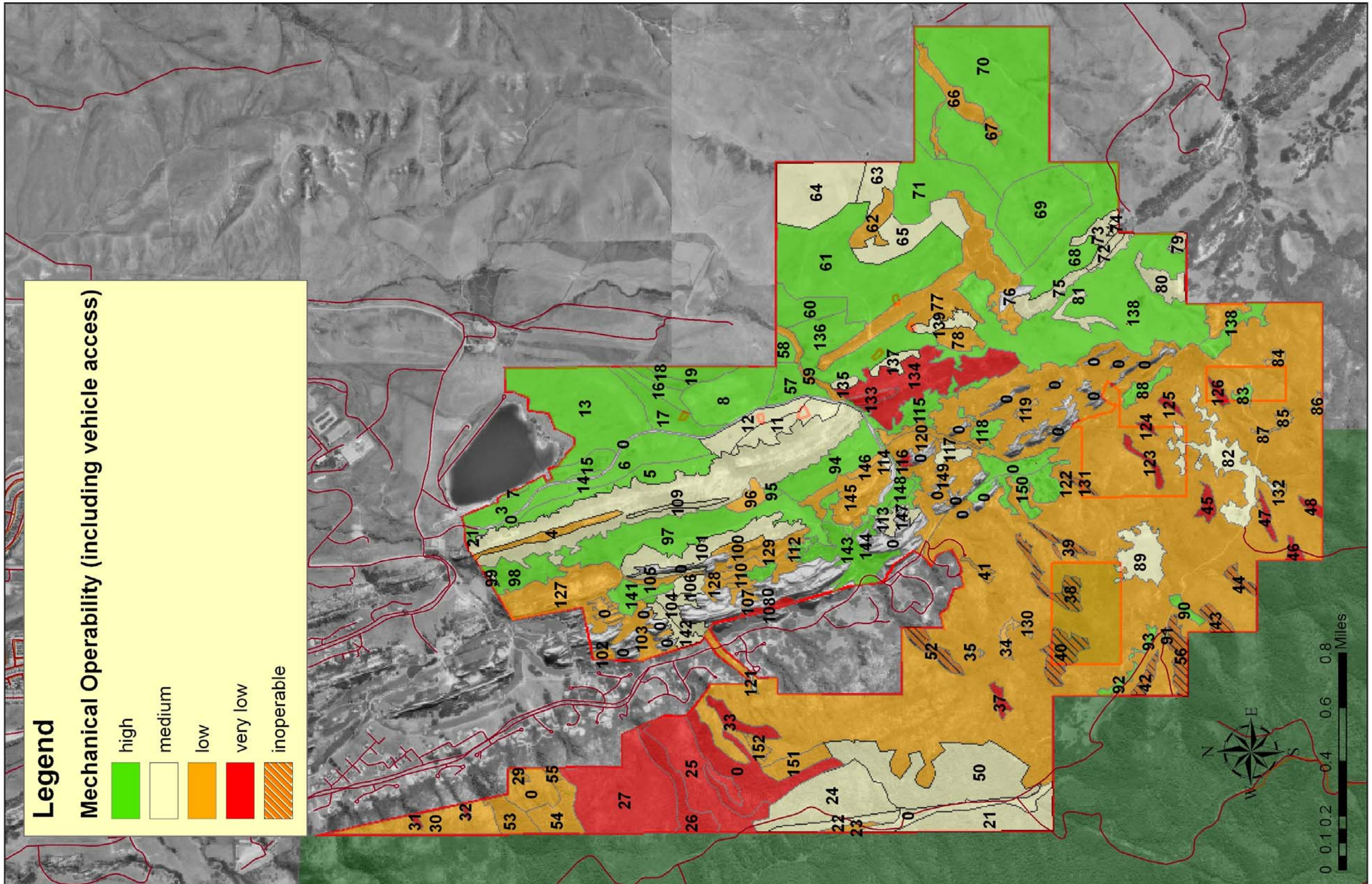
MAP 9: Other forest pathogens & stand numbers



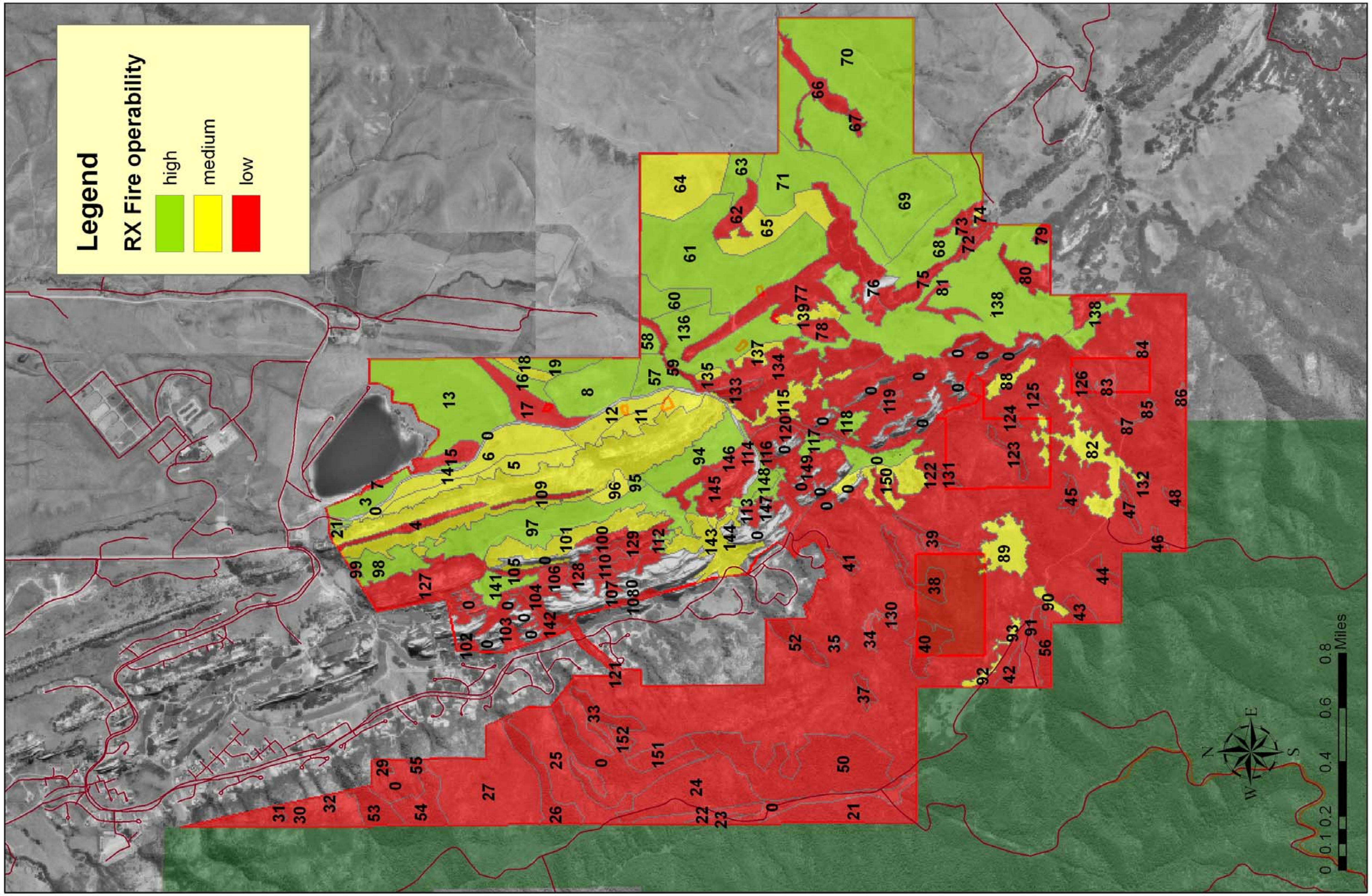
MAP 10: Standing dead trees (snags) and stand numbers



MAP 11: Mechanical operability (including vehicle access) & stand numbers



MAP 12: Prescribed fire operability & stand numbers



MAP 13: Fuels mitigation areas (D-Space, Thinning & Rx Fire), and park trails and roads