Chapter 2 Alternatives (Including the Preferred Alternative)

2.1 Introduction

This chapter describes and compares four action alternatives selected for detailed analysis. It also describes a No Action Alternative, which represents Grand Canyon's existing fire management program. Each action alternative is a separate proposal for managing hazardous fuels and restoring fire to park ecosystems. Action alternatives differ in combination and implementation of strategies used to accomplish Chapter 1 objectives. Also included in Chapter 2 are actions common to all alternatives (including mitigations), identification of the environmentally preferred alternative, and descriptions of alternatives considered but eliminated from further study. Table 2-8 summarizes major components across alternatives and Table 2-9 lists environmental consequences between alternatives. A table summarizing treatment costs by alternative is provided in Table 2-10.

The Fire Management Plan alternatives are analyzed using average acreage treated by specific project types, over a period of years. Projects are dependent on several factors including weather and resource availability. Because those factors are somewhat unpredictable, seasons and entire years occur when fire program staff cannot implement some planned projects. Therefore, the treatment schedule (Appendix D) is a dynamic schedule which accommodates weather constraints, fire personnel and equipment availability, and mitigations identified in Chapter 4. This FEIS/AEF is a decision tool for creating a Fire Management Plan that will guide the fire management program until conditions change or the park chooses to develop a new proposed action, including new fire management direction.

2.2 Description of Proposed Action

The NPS is considering four action alternatives and one No Action Alternative (continuing the existing program, as amended in the existing Fire Management Plan.

By revising the current FMP, the NPS will adjust management direction from the existing plan to 1) accommodate new national and NPS policy and new scientific information, and 2) accomplish revised program goals and objectives. Fire management plans are intended to be both strategic and operational, guiding the full range of fire program activities that support land and resource management objectives.

Action alternatives (Alternatives 2, 3, 4, and 5) propose a variety of fire, fuel, and vegetation treatments to accomplish objectives for ecosystem maintenance, ecosystem restoration, and hazardous fuel reduction for the GRCA wildland fire management program. These treatments would also meet long-term goals of Grand Canyon's General and Resource Management Plans, as well as fulfill requirements of the National Fire Plan and Federal Fire Policy (See Chapter 1).

2.3 Process for Formulating Alternatives

Council on Environmental Quality regulations state that all reasonable alternatives must be explored and evaluated (40 CFR 1502.14). Further, alternatives must be based on principles of reasonability, purpose, need, and goals and objectives for taking action. The action alternatives for this NEPA process were developed from comments and concerns expressed by the public; input from Federal, state, and local agencies; tribal consultation; guidance from existing park plans; policy guidance from the National Fire Plan; NPS and Federal wildland fire management policy; and research, monitoring, protocol, implementation strategies, and experience from the existing fire management program.

Alternative development for this FMP FEIS/AEF began with scoping. Prior to the September 2003 Notice of Intent, the NPS mailed a letter to interested parties soliciting written public input on the proposed FMP. In October 2003, a series of open house meetings were held to reaffirm previously identified agency and public issues and identify new issues and concerns (See Appendix B).

The GRCA Fire Management Interdisciplinary Team used descriptions of the existing fire management program (Alternative 1, No Action) with proposed program goals and objectives, policies and planning guidance, and public issues and concerns described in Appendix B to consider individual actions and develop four new alternatives (Action Alternatives 2, 3, 4, and 5). Once the alternative concepts had been developed, they were more fully evaluated in the framework of meeting or, as appropriate, balancing criteria outlined below.

Environmental consequences of implementation were identified by the planning team, park staff, and consultants. Following internal administrative review, proposed alternatives were refined and finalized.

The Preferred Alternative was chosen after evaluating each alternative based on how well the alternative, 1) achieved the purpose of and need for a Grand Canyon Fire Management Plan, 2) achieved the goals of GRCA's General and Resource Management Plans, and 3) addressed public issues and concerns.

These proposed alternatives represent a full range of wildland fire management strategies. Each alternative is technically achievable, provides a range of options to meet management goals and objectives, and is fiscally reasonable. A description of each alternative's environmental effects follows in Chapter 4.

2.3.1 Criteria

NPS staff used Chapter 1's program goals and objectives, NPS policies and planning guidance, and public concerns to fully develop four action alternatives carried into detailed analysis. In addition, alternatives were reexamined to insure they satisfied criteria based on the many acts, laws, and regulations under which GRCA operates.

Primary issues identified through public comment evaluation are
- Ecological restoration of Grand Canyon through use of natural fire
- Local impacts to air- and visual-resource quality
- Cultural resource protection
- Structure and community protection
- Appropriate prescribed fire use
- Coordination with adjacent landowners and neighboring land management agencies

Many topics were directly related to the proposed FMP's goals and objectives, and have been incorporated including reducing fire risk in the wildland-urban interface; using natural fire as a process to maintain park ecosystems; coordinating with other Federal, state, county, local, and American Indian tribal governments through fire management collaboration; and protecting wilderness values through best management practices.

2.4 Ecological Basis for Alternatives

Information on fire history and fire ecology was used to assess ecological conditions of plant communities in the past and present. Based on differences between these two sets of conditions, a series of Desired Conditions were identified cooperatively by fire managers and GRCA natural and cultural resource specialists. These Desired Conditions represent characteristics of healthy and functioning vegetation ecosystems based on existing scientific knowledge and professional judgment. In some instances there is not much detail or resolution, rather the descriptions are coarse. Desired Conditions are meant to guide fire management actions and serve as a map for achievement. Because GRCA fire strategies and tactics are to be based on the best available science, the FMP planning team recognizes that Desired Conditions will likely change over time as new information becomes available. Existing and target conditions, along with an analysis of expected fire behavior under differing weather conditions, were used to determine the type, amount, and location of fire management activities for proposed alternatives. Management action refinements will occur through the adaptive management process.

Not all vegetation types were assessed. The Fire Management Program focuses in forests above the rim. Desired Conditions were developed for vegetation types most likely fire affected (Spruce-Fir, Mixed-Conifer, Ponderosa, Piñon-Juniper). Other park vegetation types have very low fire occurrence.

2.4.1 Spruce-Fir Forests

2.4.1.1 Reference Conditions Spruce-Fir Forests

The following explains evidence that suggests spruce-fir forests formerly burned as infrequent stand-replacement fires and more frequent, less severe ground fires. Existing research for Southwestern fire regimes in spruce-fir forests includes work from Moir 1993, Swetnam and Baisan 1996, Allen 2002a, and others. There is strong evidence that fire has been an important natural driver in spruce-fir forests (Leiberg et al. 1904, Merkle 1954, Grissino-Mayer et al. 1995, Fulé et al. 2003a).

There is some evidence suggesting a stand-replacement fire regime existed in the Southwest. Grissino-Mayer et al. (1995) reported trees older than 300-years in a stand in southeastern Arizona, and suggested they dated to a stand-replacement fire. A stand-replacement fire regime has also been proposed for GRCA (Merkle 1954, White and Vankat 1993). In addition, some historical accounts can be interpreted as suggestive of past stand-replacement fire. Lang and Stewart (1910) stated the Kaibab Plateau in general contained "vast denuded areas, charred stubs and fallen trunks and the general prevalence of blackened poles" and that "old fires extended over large areas at high altitudes, amounting to several square miles."

North Rim research in Little Park and at Galahad Point (Fulé et al. 2003a) specifically addressed current forest stand composition and fire regimes from ponderosa pine to spruce-fir forests. Fire-initiated forest stands (indicative of stand-replacing fire events) were distinguished by age and species composition data, and delineated by tree groups that originated following stand-replacement fire. North Rim's forest stands are difficult to classify when grading from mixed-conifer to spruce-fir. Neither remote sensing nor ground reconnaissance on North Rim revealed large areas of fire-originated trees, as would be produced by stand-replacement fires. Fulé's research indicated the truer spruce-fir stands, primarily on north and east aspects, had 71% fire-initiated plots, indicating stand-replacement fire created current forest structure in those plots. On west and south aspects a mixed-severity fire regime was indicated, with 51% fire-initiated plots versus 49% non-fire-initiated plots. Most historic fire scars were recorded during summer; wide-ranging fires correlated with dry years that generally followed several wet years. Mean fire intervals from 1700 to 1879 were 8.8 years for 10% scarring (15.9 years at greater than 9,022 feet elevation) and 31.0 years for 25% scarring.

2.4.1.2 Existing Conditions Spruce-Fir Forests

Spruce-fir forest, dominated by Engelmann spruce and subalpine fir is the least common coniferous forest in GRCA and the Southwest, covering less than 0.5% of Arizona and less than 2% of New Mexico (Moir and Ludwig 1979, Alexander 1987). This limited distribution magnifies importance of spruce-fir forests in and adjacent to GRCA.

Spruce-fir forest occupies North Rim's highest elevations, generally 8,202-9,186 feet (Merkle 1954, White and Vankat 1993). It occurs across all topographic positions above approximately 8,858 feet, but is limited to relatively moist sites such as north-facing hillsides and valley bottoms at lower elevations where mixed-conifer forest occupies drier sites (White and Vankat 1993). Therefore, the spruce-fir to mixed-conifer forest transition is indistinct, involving a stand mosaic largely determined by topographic position.

Fulé et al. (2003a) indicated that past forests were significantly less dense with significantly lower basal area than contemporary forests. Translating this stand density to fuel characteristics changes expectations for resulting fire behavior and post-fire effects. Some current spruce-fir stands are decadent with a growing fuel ladder understory of fir and spruce. These stands are not likely to support running crown

fire. Passive crown fire will occur, but higher dead-and-down fuel loading will cause additional post-fire mortality through tree bole girdling. In some spruce-fir stands, resulting fire effects from passive crown fire and additional mortality from tree girdling will mimic historic fire effects through fire-initiated stands. In spruce-fir stands with full tree crowns and less understory tree ladder fuels from younger age class trees, running crown fire will only be supported in high to extreme conditions such as 97th percentile weather. It is expected that more surface fire will be sustained, burning dead-and-down fuels. Some tree mortality will occur from girdling caused by fire burning understory duff and litter.

Various authors have suggested that current structure and composition of Southwest spruce-fir forests are in the natural range of variation present before Euro-American influence. They reasoned that, 1) the fire exclusion period has been shorter than fire intervals for a presumed crown-fire regime (White and Vankat 1993, Dahms and Geils 1997, Laughlin et al. 2005), and 2) stands may have been little affected by historic livestock grazing (Dahms and Geils 1997). Wherever fire exclusion was effective, there would be fewer early successional stands, shifts toward Engelmann spruce and subalpine fir in aspen stands (Moir 1993), greater fuel loads (Fulé et al. 2004), and increased landscape homogeneity (White and Vankat 1993, Fulé et al. 2003a). However, for the surface/passive crown fire portion of this mixed-severity fire regime, evidence indicates fire suppression has been effective, promoting dead-and-down fuels build-up and live ladder fuels.

Investigation at GRCA (White and Vankat 1993, Fulé et al. 2003a) indicate mean canopy cover of about 50%, with individual stands 20-85%. Densities average 950 trees/hectare (ha) for trees greater than 2.5 centimeters (cm) diameter, and 1400 trees/ha for trees greater than one meter height, and mean basal area is 28-41 m^2/ha. Generally, Engelmann spruce is most abundant. Compared to values reconstructed for 1880, today's forests are denser and have greater basal area. Overall, fire management activities of the last two decades have had little effect on GRCA's spruce-fir forest.

Current forest stand structure will contribute to a mixed fire regime ranging from surface fires in spruce-fir stands with full canopies and reduced younger-aged understory stems, to passive and sustained crown fire under appropriate weather conditions. Older spruce-fir stands with declining or missing tree crowns and dense younger-aged understory will have surface and passive crown fire. Additional post-fire mortality may occur in these stands because current fuel loading will increase fire residence time (which girdles tree boles).

2.4.1.3 Desired Conditions — Spruce-Fir Forests

Maintain a diverse vegetative landscape with patches of variable tree densities by managing and monitoring natural ecosystem processes (fire, insects and disease, drought, etc).

Desired conditions include
- Manage fire processes according to the current NPS policy
- Restore topographic heterogeneity of vegetation types and maintain a mixed-severity fire regime
- Return stand-replacing fire event characteristics to the range described in reference conditions
- Allow processes that provide structural complexity
- Manage fuel loads at levels consistent with reference conditions
- Collaborate with adjacent agencies in managing cross-boundary fires
- Monitor post-fire vegetation response to provide information for adaptive management process

2.4.2 Mixed-Conifer Forests

2.4.2.1 Reference Conditions — Mixed-Conifer Forests

Research suggests lower elevation mixed-conifer forests on North Rim experienced frequent surface fires. At higher elevations research shows a mix of about 20% fire-initiated mixed-conifer stands

(indicative of stand-replacing fire events) and about 80% non-fire-initiated stands. Fulé suggests historic burn intensities resulted in a "highly mixed spatial pattern of fire-initiated and non-fire-initiated groups" in Grand Canyon's mixed-conifer forests. Research also indicated that past forests were less dense and had lower basal area than contemporary forests. Total tree densities ranged from 150 to 337 trees/ha. Basal area ranged from about 10 to 18 m^2/ha (Fulé et al 2003a).

Historical lightning occurrence records suggest "that lightning alone may always have been sufficient to maintain frequent fire regimes. Fire sizes prior to European settlement reached at least hundreds of hectares for fires scarring 25% or more of samples distributed across study areas, and probably reached many thousands to tens of thousands of hectares" (Fulé et al, 2003b). However, fire size is indicative of crossing forest types and elevational gradients.

Mixed-conifer forest structure prior to Euro-American settlement was characterized by stand densities greater than encountered in ponderosa forests. Grand Canyon reconstruction studies indicate there were approximately 150 to 350 stems per hectare over 2.5 cm diameter breast height (dbh); the earliest actual survey (Lang and Stewart 1910) found 208 stems/hectare greater than 15.2 cm dbh. Bureau of Forestry (BOF) 1935 plots located in mixed-conifer forests indicate that 50 years after fire-regime disruption there were an average 639 trees/hectare over 10 cm dbh and 254.3 trees/hectare over 30 cm dbh on 12 mixed-conifer plots (Vankat et al. 2005). Not all of this apparent large increase in small- and medium-sized trees can be explained by fire exclusion or growth into these size classes. The 1935 survey may indicate there were park areas with densities greater than reported by Lang and Stewart (1910) or reconstructed by Fulé et al. (2003, 2004). These plots indicate GRCA landscape pattern heterogeneity.

2.4.2.2 Existing Conditions Mixed-Conifer Forests

Southwestern mixed-conifer landscape patterns are largely heterogeneous (Moir 1993, White and VanKat 1993, Fulé et al. 2003). It is probable they were even more heterogeneous prior to Euro-American influence (Fulé 2003). Vankat et al. (2005) describe topographically determined variability in GRCA mixed-conifer as

- Relatively dry sites such as ridge tops and south- and west-facing slopes have stands dominated by ponderosa pine and Douglas fir
- More mesic sites, such as north- and east-facing slopes, have stands dominated by various combinations of ponderosa pine, Douglas fir, white fir, and quaking aspen
- Relatively moist, forested valley bottoms have stands dominated by blue spruce and ponderosa pine, often with white fir and quaking aspen. Some sites have spruce-fir stands dominated by Engelmann spruce and subalpine fir

Contemporary forest conditions for mixed-conifer ecosystems show structural change that includes increased conifer seedling survival, (especially white fir), conifer invasion into meadows, decreased aspen abundance, increased canopy closure, and forest floor litter and deadwood accumulations. Overall forest condition is one of more dense stands. Tree canopy cover is at least 25%, but can near 100% (GRCA Fire Monitoring Plan 2000). From historic reconstruction, total densities ranged from 150 to 337 trees/ha, about 16-24% as dense as current forest conditions; basal area ranged from about 10 to 18 m^2/ha, about 36-46% as dense as current forest conditions (Fulé et al 2003a). Averages in GRCA studies have ranged from about 946 to 1,300 trees/ha greater than 2.5 cm dbh (Fulé et al. 2003a, Fulé et al. 2004).

North Rim's mixed-conifer forest varies across elevation and topographic aspect changes. Some dense mixed-conifer will not support running crown fire due to decadent tree crowns. Passive crown fire may increase in dense mixed-conifer pockets due to fuel ladders. Higher dead-and-down fuel loading will cause additional post-fire mortality through tree-bole girdling, but this may be species specific. Large diameter Douglas fir may resist post-fire mortality from tree girdling better than other species. In some mixed-conifer stands, resulting fire effects will mimic historic fire effects through fire-initiated stands.

Few large fires have burned in the mixed-conifer forest type prior to 2007. The 2000 North Rim Outlet Fire had a range of effects on approximately 12,000 park acres. Post-burn satellite imagery in park mixed-conifer stands from 2000 to 2006 showed a combined average of 42% low-severity, 24% moderate/low-severity, 19% moderate/high-severity, and 10% high-severity fire effects. (Fire Effects Monitoring and Inventory System [FIREMON] composite burn index field sampling methodology; described at http://www.landfire.org/media/la_final.pdf).

For fire processes, current forest stand structure will contribute to a bimodal fire regime of primarily surface fire in stands with full canopies and reduced younger-aged understory stems, to passive and sustained crown fire under appropriate weather conditions. Older aged stands with declining or missing tree crowns and dense younger aged understory will have surface and passive crown fire. Post-burn mortality may increase in these stands because current fuel loading will increase fire residence time (which girdles tree boles).

2.4.2.3 Desired Conditions Mixed-Conifer Forests

The NPS seeks to maintain a climate-adapted, mixed-conifer structure and associated function by managing natural ecosystem processes (fire, insects and disease, drought, etc).

Management actions are specifically intended to reduce tree density by smaller size classes and tree species, reduce total fuel loading as measured across the landscape, and maintain 46-60 trees per hectare of 16-plus inch (40.6 cm) dbh size classes (NPS 2000). Specific consideration was given to maintaining mixed-conifer forest structure as suitable habitat for Mexican spotted owls. Although desired future conditions are not presented in the same manner as the MSO Recovery Plan target conditions, it is believed that maintaining 46–60 trees/ha greater than 16 inches diameter across the landscape, and limiting moderate/high and high severity fire to 30% of the mixed-conifer forest type will insure Recovery Plan threshold conditions are met. Limited fire effects plot data indicate that the 70% of mixed-conifer habitat that will burn in low and moderate/low severity ranges will achieve, after two years, Recovery Plan target threshold levels, and a portion of acreage burned in the moderate/high severity range will have structural characteristics similar to target threshold levels. The Recovery Plan calls for specific structural target thresholds on 35% of the planning area.

Desired conditions include
- Manage fire processes according to the current NPS policy
- Maintain a mixed-severity fire regime
- Restore topographic heterogeneity of vegetation types
- Manage fuel loads to best influence mixed-severity fire regime and limit high-severity burned patch size
- Collaborate with adjacent agencies in managing cross-boundary fires
- Monitor post-fire vegetation response to provide information for adaptive management process

Specific desired stand structure conditions may include
- Tree densities greater than 31 cm dbh should range from 54 to 105 trees/ha with a few dense stands approaching 254 conifers/ha although scattered patches will lack trees due to the fire-effects mosaic characteristic of a mixed-severity fire regime
- Trees greater than 61 cm dbh should be maintained at 16 to 32 trees/ha although scattered patches will lack trees due to the fire-effects mosaic characteristic of a mixed-severity fire regime
- The majority of effort in mixed-conifer systems should be directed at reducing the large number of small diameter trees established since Euro-American settlement, and reestablishing vegetation and fire regime topographic heterogeneity

2.4.3 Ponderosa Forests

2.4.3.1 Reference Conditions Ponderosa Forests

In GRCA, ponderosa pine forests occur on both South and North Rims. Research in GRCA indicates the ponderosa ecosystem was maintained by frequent, low-intensity fires that burned across the landscape. Prior to 1880 fires were most frequent in ponderosa pine stands located on lower elevation plateaus or points (mean fire return interval three to nine years). Fires were less frequent at higher elevations on North Rim, tended to burn in relatively drier years, and tended to burn over larger landscape portions (mean fire return interval five to nine years). Researchers indicated that either two or three large surface fires burned across each North Rim study site since European settlement. "To some extent, these sites may be rare representatives of nearly-natural conditions due to the relatively undisrupted fire regimes in a never-harvested forest setting" (Fulé et al. 2003b).

Grand Canyon fire management distinguishes between North Rim and South Rim ponderosa pine stands. Historic references for South Rim ponderosa pine stands suggest a tree density of 47 to 62 trees/ha containing over 90% basal area of ponderosa pine; other species included piñon, juniper, and Gambel oak. In general, crown cover was less than 25% with trees clumped in groups of 2 to 44 individuals. All size classes were represented on the landscape, but the pattern was discontinuous having discrete age class tree groupings due to time between disturbance and regeneration events. Total fuel loads ranged from 0.5 to 23 tons/ha (NPS 2000). Additional South Rim reconstruction studies suggest ponderosa pine average densities ranged from 94 to 174 trees/ha greater than 2.5 dbh cm (Fulé et al. 2002a).

North Rim ponderosa pine was characterized as 99-138 trees/ha of 40.6+ cm dbh size classes. Pole-sized trees less than 15 cm diameter were estimated in groups of 200 to 400 stems/ha. Fuel loads ranged from 0.5 to 23 tons/ha (NPS 2000). Additional research determined that North Rim ponderosa sites exhibited much greater productivity with ponderosa pine densities averaging 151 to 156 stem/ha greater than 2.5 cm and trees greater than 15.2 cm averaging 124 to 141 per hectare. (Fulé et al. 2002a; Fulé et al. 2002b).

The historic stand structure of ponderosa ecosystems is generally described as open canopy with scattered larger-diameter trees and abundant herbaceous understory.

2.4.3.2 Existing Conditions Ponderosa Forests

Ponderosa ecosystem contemporary forest conditions show a structure change including increased pine seedling survival, pine invasion into meadows, canopy closure, and pine litter and deadwood forest floor accumulations (Mast 2003). The overall forest condition is one of more dense stands; however, research on three sites (Powell, Fire, and Rainbow Points) indicated "nearly no change in pine density over…120 years" (Fulé et al 2002a). A South Rim experimental site analyzed by Fulé et al. (2002a) exhibited plots ranging from 783 to 3,693 stems per ha. In the Grandview area, ponderosa pine stems greater than 2.5 cm averaged 646 per ha while Gambel oak contributed 293 stems per ha (Fulé et al. 2002b) which is a denser stand than represented by historic tree data. This forest structure change has implications for overall stand health. Competition for water and nutrients can reduce older pine vigor, leaving them susceptible to infestations of dwarf mistletoe, insects such as mountain pine beetles, and root rot (Mast 2003).

In areas such as Powell Plateau and Fire Point where historical fire regime has been less disrupted, ponderosa pine densities average 249 and 193 stems/ha respectively (Fulé et al. 2002b). Stems greater than 15.2 cm dbh make up 141 trees/ha on Powell Plateau and 149 trees/ha on Fire Point. Gambel oak densities are 289 per ha on Powell Plateau and 79 at Fire Point. On Swamp Ridge, where historic fire regime has been disrupted, ponderosa pine density averages 156 trees/ha, but white fir has increased to 467 trees/ha. Since 1998 GRCA has increased annual acres burned through the prescribed fire program. Fire effects plots indicate a long-term trend moving ponderosa pine stands toward desired conditions (NPS 2000).

2.4.3.3 Desired Conditions — Ponderosa Forests

Grand Canyon ponderosa pine management depends on fire. Management goals include reducing tree density (outlined by size class) and ladder fuels, restoring fire as a process (predominantly surface fire with some passive crown fire), and increasing herbaceous ground cover and overall biodiversity levels (Allen et al. 2002b).
Desired conditions in ponderosa pine stands include

- Fire processes move across the landscape where appropriate
- A mosaic of diverse landscapes exists with patches of variable tree densities
- Rare stand-replacing fires generally occur in small patches
- A robust and diverse herbaceous understory exists where supported by soils and environmental factors
- Monitor post-fire vegetation response to provide information for adaptive management process

Desired structure conditions outlined in Table 2-1 roughly approximate the amount of ponderosa habitat on South Rim, drier North Rim sites (40%), and higher elevation North Rim sites (50%). These structure conditions are an achievable objective using manual treatments, and prescribed and wildland fire-use fire. Lower limits for desired conditions generally begin at the level of reconstruction studies on North and South Rims, while upper limits are the level of present day relict areas plus 10 to 20%. Added percentage for number of stems/ha at the upper limit is somewhat arbitrary, but reflects the fact that relict areas are generally drier ponderosa sites near the rim.

2.4.4 Piñon-Juniper Communities

2.4.4.1 Reference Conditions — Piñon-Juniper

Southwestern piñon-juniper vegetation fire regime is poorly understood because there have been few fire-history studies (Miller and Tausch 2001, Floyd et al. 2004, Miller 2005). A literature review for the western U.S. showed that 1) spreading surface fires have been uncommon (except possibly in savannas and areas transitional with ponderosa forest), 2) crown fires have been reported in many studies, and 3) mixed-severity fires are an unreported possibility (Baker and Shinneman 2004).

Piñon-juniper communities can be divided into three subtypes based on canopy structure, understory composition, and historic disturbance regimes (Romme et al. 2003). Prior to 1900, the fire regime is hypothesized to have consisted of frequent, low-severity surface fires in piñon-juniper savannas, moderately frequent, high-severity crown fires in piñon-juniper woodlands, and very infrequent, very high-severity crown fires in piñon-juniper forests (Romme et al. 2003). Piñon-juniper woodlands were estimated to have occupied less than three million hectares throughout the western U.S. (Gedney et al. 1999, Miller and Wigand 1994).

Research from Walnut Canyon National Monument indicates small fires probably occurred in the woodland in 1804, 1834, 1862, and 1880. Stand structures suggest tree density has increased significantly, probably in the last 200 years, but rate of increase slowed in recent decades. Fires occurred periodically through the woodland in the past, but these fires were not usually stand-replacing fires as might be expected under current stand conditions (Despain, D.W. and J.C. Mosley, 1990). The authors believe the Walnut Canyon stand is an expression of depauperate exposed soils left by the Sinagua and influences of early Flagstaff development.

Table 2-1 Ponderosa Forests Desired Conditions, GRCA

Target Conditions Ponderosa Pine	
Tree Density (stems/ha), Composition, Size Classes dbh	**Comments**
40% of landscape (South Rim and drier North Rim sites) with ponderosa pine/ha in the following size classes in cm dbh **DBH Ponderosa / Pine/Hectare** 2.5-15.1: 40-70 15.2-40.1: 30-40 40.2-91.2: 35-50 greater than 91.2: 1- 2 Total ponderosa pine stems/ha = 106 to 162	Gambel oak should be well represented on the landscape with 50 to 300 stems/ha contributing a basal area of 1 to 3 m^2/ha
50% of the landscape with ponderosa pine/ha (North Rim mesic sites tending toward mixed-conifer transition) in the following size classes in cm dbh **DBH Ponderosa / Pine/Hectare** 2.5-15.1: 40-100 15.2-40.1: 40-70 40.2-91.2: 40-70 greater than 91.2: 2- 3 Total ponderosa pine stems/ha = 122 to 243	
10% of the landscape in aggregate patches of dense stands of ponderosa pine and areas with a component of other conifers **DBH Ponderosa / Pine/Hectare** 2.5-15.1: 110-140 15.2-40.1: 110-140 40.2-91.2: 20 - 50 greater than 91.2: 1 - 3 Total ponderosa pine stems/ha = 241 to 333	

2.4.4.2 Existing Conditions Piñon-Juniper

In GRCA piñon-juniper vegetation occurs at elevations below ponderosa forest, with a transition at about 6,561 feet. The transition often consists of a mosaic of stands; piñon-juniper, including dominant trees, extends into low-elevation ponderosa forest as subcanopy and understory species. Piñon is usually more abundant than Utah juniper at higher elevations (Dick-Peddie 1993); vice-versa at lower elevations.

Post-settlement expansion of piñon-juniper woodlands is considered unprecedented when compared to prehistoric expansions (Miller and Wigand 1994). Recent estimates of piñon-juniper woodlands indicate more than 12 million hectares of the West are classified in these woodlands. Causes of woodland expansion are primarily attributed to fire's reduced role, introduction of domestic livestock grazing, climate shifts, and increases in atmospheric CO_2 (Miller, R.F. and Tausch, R.J. 2001).

Based on 15 fire-effects plots primarily south of Grand Canyon Village, piñon-juniper woodland species characterization is described as 90% piñon-juniper stems with ponderosa as an occasional overstory tree. Absolute canopy cover ranges from 20% to 60%. Understory is sparse with pole trees of the same species as overstory except for an occasional Gambel oak. Understory shrubs are comprised of Mormon tea, banana yucca, snakeweed, serviceberry, cliffrose, Apache plume, sagebrush, and rabbitbrush. Herbaceous plants include bluegrass, paintbrush, blue grama, locoweed, lupine, and squirreltail. Combined cover for brush and herbs is less than 50% (NPS 2000).

Post-fire vegetation dynamics in piñon-juniper depends on climate, soils, pre-fire conditions, and disturbance severity (Dick-Peddie 1993). In general, sites burned by crown fire are initially dominated by annual herbs, followed by perennial grasses and forbs, and later by shrubs then trees to form a woodland

or forest in 200 to 300 years (Arnold et al. 1964, Erdman 1970, Barney and Frischknecht 1974, Tress and Klopatek 1987, Dick-Peddie 1993, Paysen et al. 2000, Miller and Tausch 2001). The few GRCA studies indicate sagebrush is the primary shrub species in this successional sequence, and the shrub-dominated stage persists for decades, even as piñon and, to a lesser degree, Utah juniper invade (Schmutz et al. 1967, Jameson et al. 1962, Brian et al. 1999, Rowlands and Brian 2001).

Fire regime is dependent on crown closure and understory fine fuel loading. GRCA fire history records indicate fire starts in piñon-juniper woodlands are often single tree lightning strikes followed by monsoon-type moisture, limiting fire spread to a small area. When lightning starts are accompanied by dry fuels, winds, and low precipitation, fire can move rapidly through these woodlands resulting in active crown fire, again depending on crown closure and surface fuel loading.

2.4.4.3 Desired Conditions Piñon-Juniper

Maintain resilient piñon-juniper vegetative structure and associated function by managing and monitoring natural ecosystem processes (fire, insects and disease, soil fertility, upland hydrologic function, etc).
Desired conditions include

- Use manual/mechanical treatments near values at risk to reduce expected fire behavior in WUI
- Use prescribed fire to reduce fuel loading from manual/mechanical treatments
- Use adaptive management to refine treatment prescriptions
- Allow fire as a process in piñon-juniper woodlands
- Use information on natural fire regimes and vegetation dynamics to maintain diverse landscapes with patches of variable tree and understory plant densities and canopy cover

2.5 Annual Constraints to Burning

Safety, climate, fuels condition, resources availability, and smoke concerns impact annual fire management strategy implementation. A variety of fire management strategies provides the best opportunities to achieve management objectives. Some years are better than others for prescribed burns and, due to short-term climatic patterns such as El Nino and La Nina, natural wildland-fire activity also varies greatly between years. In drier years, managed wildland fire may play a very large fire program role, while prescribed fire may be used only minimally. In years of higher rainfall, wildland fires are infrequent while prescribed fire conditions may be favorable. Thus, prescribed fire may be used extensively in wet years when wildland fire activity is low.

After safety issues, the largest burn constraints are smoke management and air-quality regulations. Prescribed and wildland fires burning over two weeks generate complaints to local air districts. Smoke-management techniques, including large burn unit division into smaller blocks to check fire spread when dispersion conditions deteriorate, will be incorporated into prescribed fire and wildland fire plans. Smoke emissions are expected to decrease as target conditions are reached.

2.6 Strategies Used to Achieve Desired Ecosystem Conditions

Strategies available to fire managers to move forests closer to or achieve desired ecosystem conditions include use of fire and/or non-fire fuel treatments. These approaches are narrowed to different tactical operation types. Fire strategies include managing prescribed, wildland fire-use, and suppression fires. Strategies involving non-fire fuel treatments include manual treatments (crews with chainsaws and hand tools) and/or mechanical treatments (see Table 2-2).

2.6.1 Managed Wildland Fire

Any fire in wildlands, other than a prescribed or structural fire, is called a wildland fire. Lightning ignites most park wildland fires, though humans are also a cause. Fire managers are responsible for implementing a management response to each wildland fire. Responses include, but are not limited to, extinguishing, confining and/or containing the fire; monitoring the fire, or a mix of these responses. Responses for each wildland fire may change as environmental, fuel, and/or social conditions change. Wildland fires managed for resource benefit can use any response, as directed by the current NPS policy, and are called fire-use fires. Wildland fires managed under a suppression strategy must remain under such strategy throughout the fire's life. All human-ignited fires will be managed according to the current NPS policy.

Because fire is a natural process on the Coconino and Kaibab Plateaus, a mix of responses to wildland fires meets the goal of maintaining a natural environment. Wildland fires have been managed to meet resource objectives in GRCA since 1987. Managing natural fires for resource benefits helps maintain native vegetative communities, wildlife habitat, and wilderness character. Managing natural fires for resource benefit also helps maintain cultural resources such as landscapes and archaeological features by reducing fuel loads near features or on the landscape which, in turn, reduces threat of adverse impacts from future fires. Managed wildland fires for resource benefit at GRCA were rare occurrences during the early 1990s, but as knowledge about fire ecology and behavior and management experience increased, more fires were not suppressed.

Fires that grow large and burn for weeks or months typically experience three activity phases. Phase one (May-August) is establishment when, after a thunderstorm, a new fire spreads slowly on damp fuels. This phase can last for days or weeks depending on additional precipitation. In the second phase (July-October), fire spread and intensity can greatly accelerate as fuels dry. Depending on winds, relative humidity, and additional precipitation, fire can display alternating episodes of rapid movement and relative dormancy. This phase may continue for several weeks until the fire is confined by natural or human-made barriers or precipitation. During dry monsoonal seasons or droughts, it is common for fires to burn actively into November if no moisture arrives. In phase three, after late October, as days become shorter and seasonal temperatures lower, fire activity decreases. Fire may continue to burn for several more weeks, but may not actively advance as in phase two.

Because a fire may burn throughout summer and fall, effects of a managed wildland fire on plants, animals, soils, and cultural resources can vary throughout the fire area. A large fire typically burns from the onset of a dry monsoonal weather pattern (dry thunderstorms June-July) when vegetation may be completely cured, through the entire summer and into fall.

Effects mimic phases above with extensive fuel reduction occurring during high activity periods when fuels are driest, and less so with a wet monsoonal season or as summer progresses into fall. Depending on fuel moisture conditions, a fire may have areas of very little or total fuel consumption. Hotter areas create small to large canopy openings (gaps). Gaps allow light on the forest floor, creating an environment for establishment or restoration of plants requiring more sunlight than found in dense, overgrown forests. Environmental condition and wildland fire variability create a landscape effect mosaic. This mosaic is difficult to replicate using prescribed fire, and more difficult to replicate with mechanical/manual methods.

Table 2-2 Hazardous-Fuel Reduction Techniques for Mechanized/Manual Fuel Reduction Projects

Techniques for Mechanical/Manual Hazard-Fuel Reduction	Description
Mechanized Tree and Shrub Removal (feller-bunchers and forwarding)	Wheeled/tracked equipment with a cutting head severs stem and lays tree down. Stems stacked whole, or mechanically de-limbed and stacked, for transport by self-loading forwarder. Used for live tree removal
Conventional Tree and Shrub Removal (saws, skidders, and grapplers)	Hand crews walk to each tree and fell/limb tree with chainsaw. Tracked or rubber-tired tractors with a grapple pick up trees or logs and drag to areas where they are loaded onto trucks or piled for burning. Used for removal of live and dead trees and shrubs
Machine Crushing/Shredding	Tracked equipment travels to each tree or stump to allow shredder head access to vegetation that needs shredding. Vegetation is crushed under tracks or shredded by flail cutters and left onsite. Various equipment types are used for reduction of live trees, shrubs, and dead-and-down material
Machine Piling	Tracked or rubber-tired tractor grapples or pushes vegetation with front blades into piles; or tracked excavator with bucket and thumb grapples and piles vegetation. Used following tree removal or to prepare dead-and-down material for burning or chipping
Yarding	Cables are suspended from landing and trees or logs are attached to cable and lifted or dragged to natural opening or landing areas. May use fetching arches which reduce surface disturbance. Used to remove freshly cut or dead-and-down material from burn units
Low-Impact Skidding	Cut trees are skidded using horses or ATVs. May use fetching arches which reduce surface disturbance. This technique is size-limiting: large trees, live or dead, exceed capability
Hand Cutting/Piling	Hand crews drive or walk to fuel-reduction areas and cut with chainsaws. Hand crews pile in place or carry and drag vegetation to burn sites
Hand Cutting/Chipping	Hand crews drive or walk to fuel reduction areas and cut with chainsaws. Vegetation transported to chipper; chipper towed through unit or staged at approved location. Chips broadcast two-inches deep, trucked to park areas for use, sold at cost, or given away
Hand Cutting/Lop and Scatter	Hand crews drive or walk to fuel reduction areas and cut with chainsaws. Vegetation is dispersed onsite and cut to maximize soil contact. Depth of material does not exceed 24 inches. Eventually consumed through broadcast burning or natural decomposition
Limb Removal (Trees standing after thinning project complete)	Lower (up to six feet) limbs (living or dead) cut to remove ground and ladder fuels
Pile Burning (Machine or hand piles)	Piles allowed to cure, then ignited when fuel and weather conditions appropriate. Used to remove surface- and ladder-fuel component reducing risk for broadcast-burning at later date. Pile elimination may occur combined with broadcast burning if appropriate to objectives
Pile and Leave (Area would be broadcast-burned in five years)	Piles stay onsite longer but are removed during broadcast-burn
Chip and Broadcast (Broadcast-burn after fuel reduction)	Vegetation chipped at landings or throughout treatment unit. Chip depth, fuel moisture, and ignition pattern considered in burn-prescription to mitigate smoke-production and fire-effects concerns
Chip and Broadcast (Leave less than two-inch depth)	Chips dispersed directly from chipper chute and spread to avoid chip accumulations greater than two inches
Chip and Haul	Chips generated into commercial chip van or piled and loaded in trucks for use as fiber or fuel. Chips donated for outside needs, hauled to park sites; may be sold at cost or given away

2.6.2 Prescribed Fire

Prescribed fires are management-ignited fires intentionally lit to meet specific resource objectives when predetermined and approved conditions are met. GRCA has used prescribed fire since 1980 to meet a variety of resource goals and objectives. Goals associated with past prescribed-fire operations include: mimicking natural-fire events; decreasing risks to safety, life, property, and resources from future wildfires; and reducing negative wildland-fire impacts to historic structures and archeological sites. Past prescribed-fire objectives include dead-and-down fuel reduction; seedling, sapling, and pole-sized tree reduction; and large overstory tree protection.

Prescribed fire can be applied in strategic locations using special techniques. For example, igniting fires that burn hot enough to create canopy openings creates gaps that protect remaining forest canopy from unwanted wildland fire or encourage aspen regeneration. Openings, typical of a naturally fire-influenced forest, can break up crown fires near areas where protection of life, property, and resources is critical.

Other prescribed fires are implemented to reduce dead-and-down fuels and understory vegetation without creating overstory canopy openings. These low-intensity fires achieve resource objectives.

GRCA fire managers ignited 72 prescribed fires 1980 through 2006, burning a total of 52,136 acres. Acres treated yearly vary from zero to 9,700. Prescribed burn units usually require multiple burns to meet protection and resource objectives. The first prescribed burn typically kills understory and midstory vegetation and consumes ground fuels. A second burn cleans up fuel from burned vegetation and thins new plants sprouted after the first burn. Subsequent burns maintain a fire-influenced forest and reduce fuel accumulated since the last fire. In GRCA, 7 to 15 years typically pass between prescribed burns.

2.6.2.1 Pretreatment for Prescribed Fire

Pretreatment of prescribed burn units involves removing trees, shrubs, and dangerous snags pre-burn to help keep fire in designated boundaries or protect specific resources. Manual equipment (including chainsaws) to remove trees and shrubs can increase pretreatment safety and effectiveness, especially in areas near WUI. In addition, pretreatment significantly increases protection of cultural resources and specific natural resource sites (nest trees) from prescribed burning's damaging effects. Removing fuels around sensitive resources prior to burning increases firefighter ability to contain the burn. Many designated prescribed burn units near communities, highways, and park boundaries will need considerable pretreatment.

2.6.3 Non-Fire Fuel Treatments

Techniques available to reduce or remove hazardous fuels in forest systems are, generally, burning or mechanically/manually removal. NPS guidance RM-18, Wildland Fire Management, defines manual treatment as "use of hand-operated power tools and hand tools to cut, clear, or prune herbaceous and woody species." Manual treatments reduce hazardous fuels, create defensible space and/or reduce crown fire risk in WUI, and pretreat prescribed and wildland fire-use perimeters.

Prescribed fire, managed wildland fire, and mechanical and/or manual trees and shrub removal are proposed in all action alternatives to remove or reduce fuels. Only the No Action Alternative excludes mechanical equipment use. Mechanical fuel removal may involve wheeled or tracked vehicles. Manual fuel removal involves chainsaws, other portable hand-held equipment like gas-powered trimmers (WEEDEATER©) and hand tools. Specific laws prohibit some mechanical fuel-reduction techniques in specific areas. For example, use of wheeled or tracked vehicles in wilderness is prohibited. No new roads will be constructed for any non-fire fuel-treatment project.

All four action alternatives propose a variety of methods to mechanically remove live and dead trees and surface fuels (see Table 2-2). These mechanical techniques accomplish the dual objectives of removing

hazardous fuels and moving forested areas toward desired conditions. Mechanical fuel treatments will only occur in areas designated as either Primary WUI or directly adjacent to Hwy 64 and 67.

2.6.4 Adaptive Management

Analysis and fire management strategies proposed in this Fire Management Plan EIS/AEF are based on the best science currently available. However, the GRCA Fire Management Program recognizes that uncertainties exist. For this reason, adaptive management will be a cornerstone of this Fire Management Plan. Adaptive management is a system of management practices based on clearly identified outcomes, monitoring to determine if management actions are meeting outcomes, and, if outcomes are not met, facilitation of management changes that will best ensure outcomes are met or re-evaluated (40 CFR; 516 DM 4.16). NPS guidance in RM-18, Wildland Fire Management, directs NPS units to use the adaptive management process to plan, implement, and evaluate the fuels management portion of fire management programs. During the adaptive management process, evaluation of planning effectiveness, collaborative process effectiveness, monitoring data, accomplishment of objectives, and operational implementation should guide review and revision of project objectives and, when necessary, program adjustment. The general process for adaptive management is outlined in Figure 2-1.

The GRCA Fire Management program employs the adaptive management process to evaluate and adjust both programmatic and individual treatment activities. At the smallest temporal scale (i.e., hours), fire managers use real-time monitoring data to assess whether treatment-level objectives are being met, and to adjust the tactical approach to a treatment. During the first five years following treatments, fire managers use short-term monitoring data to evaluate both treatment and programmatic objectives and to adjust future treatment objectives, implementation strategies, and monitoring design. Every five years after program implementation, fire managers evaluate programmatic goals, desired conditions, and strategies and make necessary adjustments to the program as a whole. The following paragraphs provide additional information on how GRCA's Fire Management Program implements each step in the adaptive management process.

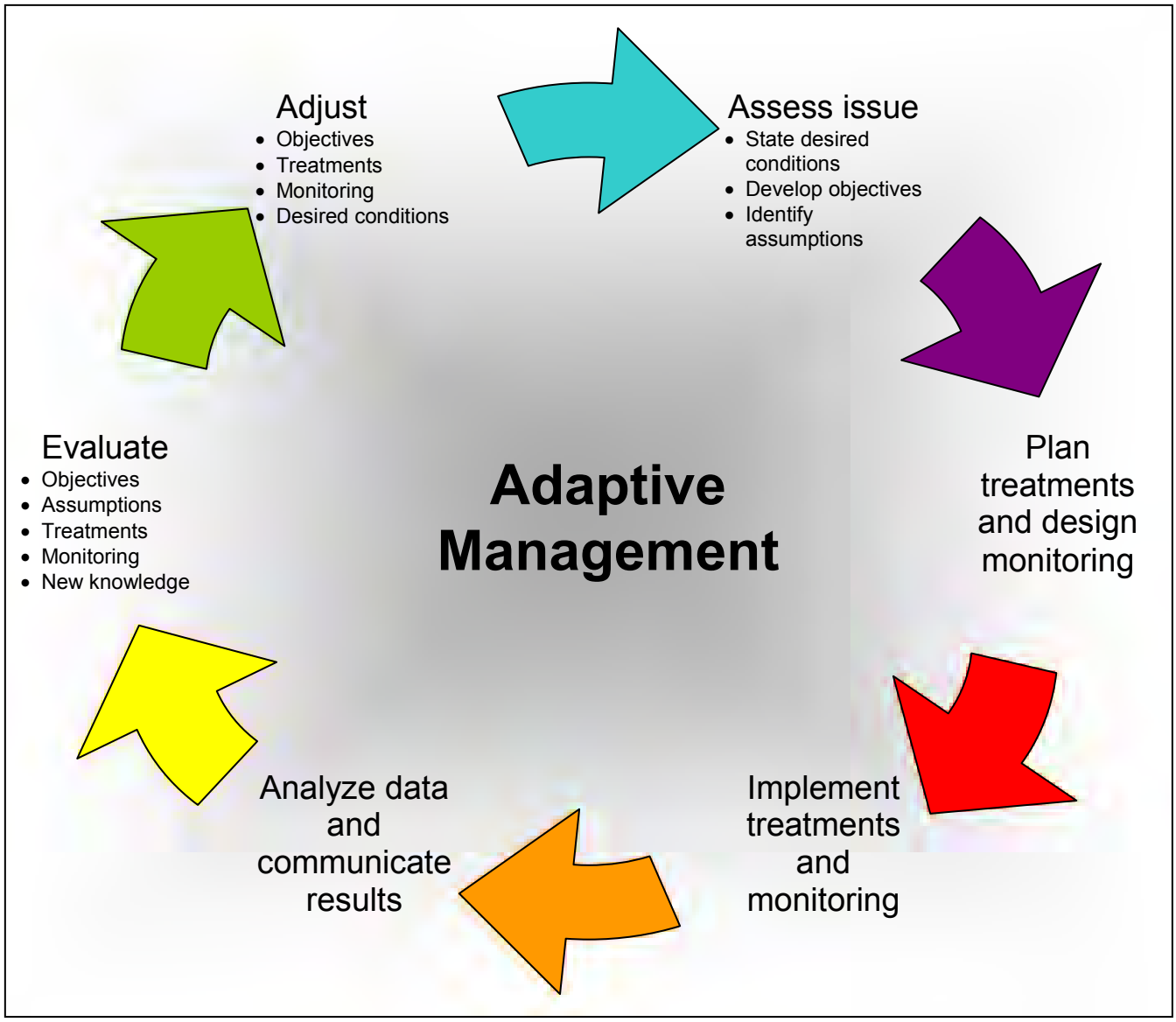
Assess Issue Desired conditions and programmatic fire management goals and objectives are established during Fire Management Plan development using guidance in the Resource Management Plan and General Management Plan. An interdisciplinary team of fire and resource management professionals uses available monitoring and research data and stakeholder and public input during the NEPA compliance process to identify uncertainties and propose potential management activities.

Plan Treatments and Design Monitoring The Fire Management Plan includes a long-term treatment schedule, details on treatment strategies employed, programmatic objectives, and the Wildland and Prescribed Fire Monitoring Plan that details monitoring goals and design. Individual treatment plans are developed to provide detail on treatment techniques (ignition patterns, non-burning measures), treatment prescription (e.g. fuel moisture, wind speed and direction, fire behavior), treatment timing (seasonality, time of day), preservation techniques (lining roost trees, wrapping combustible resources), and treatment monitoring. All treatment plans are reviewed by a park interdisciplinary team prior to implementation.

Implement Treatments and Monitoring To be effective for adaptive management, careful records will be kept of actions taken. Daily records of management activities and fire behavior, weather, and smoke observations are kept and compiled as part of the post-treatment report.

Analyze Data and Communicate Results Data analysis and communication occurs on a number of time scales. Information may be available within the day (such as implementation strategy or air quality impacts), at the treatment completion (such as overall treatment effectiveness or initial fire effects), or a year or more after treatment (burn severity, long-term mortality of target or non-target vegetation). A fire ecology program report, an ESA section 7 compliance report, and a NHPA compliance report are completed each year and provided to appropriate internal and external stakeholders to aid in program activity evaluation.

Figure 2-1 The Adaptive Management Process



Evaluate The evaluation process includes both targeted and synoptic program assessment. In some cases, evaluation can be quantitative (comparing measured effects with predicted affects), while in other cases, a qualitative, or even subjective analysis may be required (for example, trade-offs between visibility impact and fuel reduction). The evaluation process occurs after each treatment as an After Action Review (AAR), after each season during the annual review, and once every five years in a comprehensive program review. The evaluation process should result in a concise comparison of desired and achieved program effects.

Adjust The adjustment phase may be the most critical link in the adaptive management process; it links past with future actions. Based on the program evaluation, opportunities for improvement may become apparent. Such opportunities may include adjusting fire prescriptions, methods of public outreach, modifying tactical responses, or many other actions. In the adjustment phase, these

opportunities are applied to future actions. Monitoring and evaluation of different resources may occur on different time scales (ranging from days to a few years), so the adjustment phase may be ongoing, rather than a specific action. Overall, the adjustment phase is most likely to occur daily for tactical issues on a given fire, post-fire for immediate resource concerns, annually as part of the Fire Management Plan annual review, and as needed in burn plan development or revision.

Planning and implementation activities, questions used in evaluation, and potential adjustments to the program or program elements vary with time since program initiation. Table 2-2a outlines typical considerations at each stage of program implementation.

Table 2-2a Adaptive Management Considerations at Various Stages of Fire Program Implementation

Stage of Implementation	Planning and Implementation	Evaluation Questions	Potential Adjustments
Individual treatments	**1** Determine priority treatments based on programmatic goals **2** Draft project plan that includes objectives, implementation parameters (prescription, timing, ignition approach, resource protection activities) and monitoring approach **3** Have plan reviewed by park interdisciplinary team **4** Implement monitoring and treatment **5** Compile fire weather, behavior, qualitative fire effects data, and communicate results during AAR	**During Treatment** • Is treatment being implemented safely? • Do weather observations support predictions? • Is fire behavior expected and appropriate for meeting objectives? • Are smoke observations as predicted and acceptable? • Are qualitative real-time fire effects observations consistent with objectives? **Following treatment (AAR)** • Was the treatment implemented as planned? If not, why? • Were safety goals met? If not, why? • Do fire behavior, smoke, and qualitative fire effects observations suggest resource objectives were met? • Are there ways to improve future treatments?	**During Treatment** • Change ignition plan • Postpone treatment **Following Treatment** • Alter prescription or ignition plan for next treatment • Alter resource protection activities for next treatment • Alter monitoring strategy for next treatment
Annual review	**1** Assess whether treatment priorities have changed based on activities from previous season and programmatic goals **2** Determine whether policy changes will lead to programmatic changes **3** Compile information from evaluation and adjustments on individual treatments **4** Compile immediate quantitative fire effects data from previous season and summarize fire effects information to date in Fire Ecology Annual Report	• Were all treatments in previous season implemented as planned? If not, why? • Did treatments applied in previous season meet treatment-level objectives and support programmatic goals and objectives? If not, why? • Are there new techniques or knowledge that can be applied to treatments in the upcoming season? Are these techniques covered under existing compliance	• Alter long-term treatment schedule • Alter objectives for upcoming treatments • Alter prescriptions, ignition plans, and/or resource protection activities for upcoming treatments • Alter monitoring approach for upcoming treatments • Initiate research • Employ new techniques

Stage of Implementation	Planning and Implementation	Evaluation Questions	Potential Adjustments
	5 Compile information for ESA section 7 compliance in annual report to USFWS **6** Compile information for NHPA compliance in annual report	documents? • Was monitoring sufficient to evaluate treatments and objectives? If not, why? • Were assumptions made for planning and monitoring valid? If not, why?	
Programmatic Review (every five years)	**1** Assess whether treatment priorities have changed based on activities from previous five years **2** Determine whether policy, park planning direction, or environmental or social changes occurred that will lead to programmatic changes **3** Compile information from annual evaluations and adjustments **4** Compile long-term fire effects monitoring data and new relevant research	• Was program implemented as planned in the previous five years? If not, why? • Have treatments applied in the previous five years met programmatic goals and objectives? If not, why? • Are there new techniques or knowledge that should be added to the program? Are these techniques covered under existing compliance documents? • Was monitoring sufficient to evaluate programmatic objectives? If not, why? • Have monitoring or research results confirmed or contradicted program assumptions? • Are current programmatic objectives and treatment strategies leading toward desired conditions? • Are desired conditions still valid after considering new knowledge?	• Alter treatment strategies • Alter long-term treatment schedule • Alter programmatic objectives • Alter monitoring approach • Initiate research • Alter desired conditions

Since the previous Fire Management Plan EA, the Fire Management Program has undertaken the following adaptive management activities

- Initiated a new planning process (this document) to reevaluate fire management strategies and fire management units
- Formed an interdisciplinary team of fire and resource management professionals to review programmatic and treatment-specific plans
- Adjusted program strategies to allow greater use of wildfires for resource benefits and use of prescribed fires across a wider range of environmental conditions
- Formalized monitoring strategies, monitoring responsibilities, and quality control and data management procedures in the GRCA Fire Effects Monitoring Plan (NPS 2000)
- Introduced aerial ignition for prescribed fire
- Incorporated two new monitoring strategies (burn severity mapping and rapid assessment protocol plots) into the program
- Revised programmatic vegetation and fuels objectives to include both restoration and maintenance components
- Initiated annual reports on the Fire Ecology Program and the ESA section 7 and NHPA compliance activities

- Completed annual program reviews and formal reviews of two escaped prescribed fires (Outlet and Long Jim III)

Adaptive Management Example for Mexican Spotted Owl Restricted Habitat

Even though the GRCA Fire Management Program has been operating for three decades, this FMP revision includes new activities in higher-elevation mixed-conifer forests where management outcomes are uncertain, and opportunities to apply learning is high. Since this action has potential to negatively affect Federally designated critical habitat for the Mexican spotted owl (MSO), the adaptive management process will be critical to managing protection of habitat for a threatened species while restoring a mixed-severity fire regime. To reduce potential effects of fire on MSO habitat elements, Alternatives 2 through 5 include a mitigation measure to limit amount of moderate/high and high severity fire in the mixed-conifer forest type and MSO mixed-conifer restricted habitat to less than 30% across the landscape. The following adaptive management steps will be taken to ensure this mitigation measure is met.

- **Assess Issue** Balance programmatic objectives (Section 1.4) of maintaining critical habitat for listed species, conducting fire management activities in proposed wilderness in a manner that will not diminish suitability for designation, minimizing smoke impacts on human health and air quality values, restoring and maintaining ecosystems within the range of desired conditions, and setting priorities for treatment activities based on departure from natural fire return intervals and desired conditions. Ensure effects to MSO restricted mixed-conifer habitat elements are minimized by limiting moderate/high and high severity fires to less than 30% of the mixed-conifer forest type and MSO mixed-conifer restricted habitat.
- **Plan Treatments and Design Monitoring** Treatment plans will be developed for prescribed fires in the mixed-conifer forest type. Plans will include the objective of minimizing moderate/high and high severity fire effects. Various implementation activities designed to reduce amount of moderate/high and high severity fire effects, such as developing prescriptions that meet burn objectives and reduce crown fire amount, developing ignition strategies likely to minimize head fires, and igniting fires at various times of day or in various seasons, will be considered during the planning phase. All treatment plans will be reviewed by a park interdisciplinary team prior to implementation. Severity percentages will be monitored using the national burn severity mapping protocol. In addition, with implementation of this Fire Management Plan, newly designed rapid assessment protocol (RAP) plots will be installed in mixed-conifer restricted habitat to provide unit-specific information on fire effects. Variables monitored with RAP plots will include tree basal area, canopy cover, tree size class distribution, and large downed woody debris.
- **Implement Treatments and Monitoring** Treatment implementation will follow the sequence outlined in the long-term treatment schedule described in Appendix D. Monitoring implementation and data management will follow guidelines in the revised GRCA Wildland and Prescribed Fire Monitoring Plan (NPS 2009). Possibility exists for unplanned ignitions in the mixed-conifer forest type prior to prescribed fire implementation. If this occurs, fire and resource managers will assess ignition location, time of year, location of fire sensitive natural and cultural resources, past seasonal precipitation amounts and precipitation forecasts, number and effects of past fire events in and near the fire area, potential for positive and negative effects on resources, and potential to meet programmatic objectives (including the limit on higher severity fire) prior to a decision to suppress or manage the fire. If a decision is made to manage an unplanned fire, fire managers may choose to use additional firing operations from defensible control lines to back fire into the wind or direct fire into previously burned areas to minimize potential for higher severity fire effects. Tactical areas may be created through fuel reduction projects near roads to create defensible areas to contain fire spread or facilitate potential firing operations. Containment and control operations may occur on sections of a fire with potential for higher severity effects. Burn severity monitoring will be completed for unplanned fire events, and plot-based monitoring may occur if there are established plots in the fire area.

- **Analyze Data and Communicate Results** Quantitative burn severity mapping data are available 8 to 13 months following fire; however, qualitative information on burn severity can be obtained through aerial reconnaissance during or immediately after fire events. RAP plot data on prescribed fires will be available by January of the year following the fire for variables assessed immediately post-fire. Some variables, such as overstory tree mortality, may be best assessed several years following fire, and data on those variables will be available when ecologically appropriate. During unplanned fire events, the park interdisciplinary team will be notified as the ground situation changes and will be updated on fire behavior, weather, and real-time fire effects observations. Information on burn severity and plot-based monitoring data in mixed-conifer restricted habitat will be included in the annual report to the U.S. Fish and Wildlife Service, and the annual Fire Ecology Program report.
- **Evaluate** Evaluation of treatment implementation and real-time fire effects will occur continuously during prescribed fires and unplanned events. Post-fire evaluations of treatment implementation and qualitative fire effects will occur during an AAR involving both fire and resource management personnel. Annual meetings will occur with USFWS to review and assess yearly and cumulative effects of fire management activities on MSO habitat. Questions listed in Table 2-x are examples that can be used as a guide in these evaluations. Regarding MSO restricted habitat in particular, the evaluation team will assess new techniques that could further reduce amount of higher severity fire in MSO restricted habitat but still meet project and programmatic objectives. The evaluation will also assess whether the 30% mitigation measure is effective for meeting the programmatic objective of maintaining sufficient critical habitat primary constituent elements for listed species. Documentation of these evaluations will be appended to the FMP annually, as will changes agreed on for the next fire season. The FMP will be a living document that reflects results of adaptive management year-to-year.
- **Adjust** Adjustments to treatment and programmatic implementation and monitoring plans can be made at any time. Tactical adjustments can occur during prescribed and unplanned fires if fire situation evaluation reveals objectives are not being met. Changes to burn prescriptions, ignition strategies, and plan objectives can be made for subsequent fires if evaluation reveals recent fires have not met treatment and/or programmatic objectives. In addition, fire program strategies (i.e., use of prescribed fire and management of wildfire for resource benefits) in the mixed-conifer forest type can be altered if managing fire in this forest type consistently fails to meet treatment and/or programmatic objectives.

During implementation of adaptive management, if environmental effects from fire activities are outside the scope of the analysis for the EIS, the park will revisit FMP compliance documents and determine if updated documentation is needed.

2.6.5 Fire Management Units

Identification of Fire Management Units (FMUs) is critical to effective management of a wildland fire program. A FMU is a land-management area definable by generally unique combinations of

- dominant management objectives and management constraints
- topographic features
- access
- political boundaries
- values to be protected
- vegetative communities and fuel types, or
- major fire regime groups

For this planning effort, plant communities were the basis for developing initial fire management units, then modified to reflect other factors listed above.

2.6.5.1 Fire Management Units Existing Program Alternative 1

Under Alternative 1, Existing Program, FMUs from the 1992 Fire Management Plan remain. Factors used to define three FMUs are fuel types and similarities in fire behavior and effects. The Ponderosa Pine, Mixed-Conifer, and Piñon-Juniper FMUs for Alternative 1 are shown on Map 2-1 and described below.

Ponderosa Pine FMU **Physical Description** **Alternative 1**

The Ponderosa Pine FMU includes three sections 1) South Rim from Hermits Rest east to Coconino Rim, 2) Uinkaret Mountains around Mt. Emma, bounded on the north and west by the park boundary and on the east and south by Tuweep Valley, and 3) Powell Plateau's higher elevations (North Rim). Topography is generally flat on the plateaus, but can range from 0–60% slope, including all aspects. South Rim and Powell Plateau sections are generally flat. Mount Emma section has a sloping, generally east aspect.

Access on South Rim is via park roads including Hermit Road and Desert View Drive. Hermit Road connects with State Route 64 in Grand Canyon Village. Desert View Drive connects with State Route 64 to Cameron on the east and Williams on the south. Access to the Mount Emma section is via county roads that cross the Arizona Strip from St. George, Utah and Fredonia, Arizona. These roads are 60 miles or more of maintained dirt, but none enter the FMU itself. Access to Powell Plateau section is by trail from Swamp Point on North Rim. The 30-mile dirt road to Swamp Point is only open seasonally.

Ponderosa Pine FMU **Values to Be Protected** **Alternative 1**

The Ponderosa Pine FMU includes the park's most visited portion—South Rim around Grand Canyon Village—and large WUI areas. It is the most used Grand Canyon viewing platform. Its rolling forest contrasts with the rugged canyon and arid plateau to the south and east.

Ponderosa Pine FMU values to be protected include

- Safety of firefighters, park employees, and the public
- Air-quality-related values (entire unit)
- Proposed wilderness (Mount Emma and Powell Plateau sections)
- Real property (see Fire Exclusion Areas below)
- Cultural resources (entire unit)
- Fire-dependent ecosystems (entire zone)
- Boundaries with adjacent landowners including U.S. Forest Service (USFS) Kaibab National Forest (Tusayan District), Bureau of Land Management (BLM), NPS Lake Mead National Recreation Area (LAME), (Grand Canyon—Parashant National Monument [GCPNM] Mt. Emma section)
- Fire Exclusion Areas (see below)

Ponderosa Pine FMU Fire Exclusion Areas (FEA) include

- Grand Canyon Village (including South Entrance Station and Yavapai Museum)
- Supai Camp
- Hermits Rest
- Hance Air Quality Monitoring Site
- Abyss Air Quality Monitoring Site
- South Rim Forest Restoration Plots
- Yaki Point—South Kaibab Trailhead
- South Rim Shooting Range
- Hopi Point Telecommunications Site
- Historic Grandview Entrance Station

Ponderosa Pine FMU **Weather Cycles and Extremes** **Alternative 1**

A number of weather stations are located throughout GRCA. The fire weather National Fire Danger Rating System (NFDRS) station that best represents weather in South Rim's Ponderosa Pine FMU is Tusayan (identification number 020207). On North Rim, Swamp Ridge and Lindberg Hill (station 020220) best represent the weather. Detailed station catalog information for all park weather stations can be found in the Grand Canyon National Park and Kaibab National Forest NFDRS Operating Plan (USFS 2008).

Generally, GRCA's climate is typical for Southwestern upland areas. Weather service records for Grand Canyon Village from 1903-2004 are typical for this FMU. Annual precipitation averages 16 inches. Low humidity and high summer temperatures result in high evapo-transpiration rates. Summer convective thunderstorms usually occur early July through early September, and often contain lightning. Snow is possible late October into early May. Total snowfall averages 57 inches (see Appendix C). Snow

accumulations are usually moderate, less than 12 inches, although deeper accumulations are possible in higher elevations.

Spring and early summer months are normally dry; summer highs average 82°F, but have reached 105°F with relative humidity in single digits. Winter temperatures have dropped to -20°F but average lows are 19°F (see Appendix C). Frost-free periods range from 101 days on North Rim to 148 days on South Rim. Most of the year prevailing winds are from the southwest.

Ponderosa Pine FMU **Fuels, Fire Behavior, and Effects** **Alternative 1**

Interpretation of data from monitoring plots by Northern Arizona University (Covington et al. 1999) show that the total dead-and-down fuel loadings on South Rim range from 1.55 to 6.82 tons per acre. The Monitoring Type Description Sheet for South Rim and North Rim ponderosa pine show typical total fuel loads of two to eight tons per acre with averages estimated from 0.2 to 9.3 tons per acre. Monitoring Type Description Sheets are found in the Grand Canyon Fire Effects Monitoring Plan (NPS 2000).

The primary overstory tree is ponderosa pine, represented by NFDRS Fuel Model C (open pine with grass understory) for the South Rim forest and the majority of North Rim sites, and NFDRS Fuel Model U (western long needle pine) in some North Rim areas.

Fire behavior is largely a function of fuels and weather. Untreated area fuels include thickets of younger pine under older stands of large trees that create continuous fuel ladders from surface to tree crown, supporting a mixed-severity fire regime. Treated area fuels are more open in the understory, creating fuel ladder breaks. Fire behavior in previously treated areas would be predominately low-severity fire regime.

The oak component in the ponderosa pine forest type is maintained by periodic fire. The shrubby oak midstory on western North Rim may be important for animals. Presence of multi-aged oak and locust thickets in recent burned areas and wide distribution of these clones suggest the modern shrubby understory may have been characteristic of pre-settlement forests (Covington et al. 2000).

Mixed-Conifer FMU **Physical Description** **Alternative 1**

Mixed-conifer FMU encompasses North Rim's Kaibab Plateau (excluding Powell Plateau). Kaibab Plateau topography is mostly flat to rolling, cut by a number of generally north-south trending drainages and minor canyons that generally radiate from the Plateau's summit near North Rim Entrance Station. Walhalla Plateau is the unit's south-easternmost topographic feature.

Access is via State Route 67 into North Rim, the Scenic Road to Cape Royal, and a network of dirt roads leading to other canyon viewpoints such as Point Sublime and Swamp Point. All roads are closed in winter by snow, and reopen in late spring as snow melts and tree falls are cleared. In spite of the road network, large unit sections are difficult to access due to distance from roads and dense vegetation.

Mixed-Conifer FMU **Values to be Protected** **Alternative 1**

GRCA Kaibab Plateau forests are often cited in literature as some of the least disturbed forests in Arizona. Many travelers consider the Kaibab Plateau's forests and meadows a prelude and counterpoint to the rugged Grand Canyon.

Specific Mixed-Conifer FMU values to be protected include

- Safety of firefighters, park employees, and the public
- Air-quality-related values (entire unit)
- Boundaries with adjacent landowners, including the Kaibab National Forest, and BLM and LAME (GCPNM, Mt. Emma section)

- Proposed wilderness (Mount Emma and Powell Plateau sections)
- Real property (see Fire Exclusion Areas)
- Cultural resources (entire unit)
- Fire-dependent ecosystems (entire unit)
- Fire Exclusion Areas (see below)

Mixed-Conifer FMU Fire Exclusion Areas for this unit include

- North Rim Developed Area and CC Hill
- Kanabownits Cabin and Fire Lookout
- North Rim Entrance Station
- North Rim Fire Lookout
- Greenland Lake Cabin
- Lindbergh Hill Remote Area Weather Station (RAWS) Site
- North Rim Forest Restoration Plots
- North Rim dynamite cache (Marble Flats)
- North Rim Shooting Range

Mixed-Conifer FMU **Weather Cycles and Extremes** **Alternative 1**

The automated weather station that best represents unit weather is the Bright Angel Station (020211) located at the North Rim Helibase at 8,300 feet elevation. The other station is Lindbergh Hill (020220), a permanent RAWS established in 1993 and located approximately five miles north of the Bright Angel Station at 8,800 feet elevation.

Generally, climate is typical for Southwestern highland areas, and National Weather Service records for the Bright Angel Ranger Station dated 1948-2004 (see Appendix C), characterize this FMU. Summertime high temperatures are relatively mild, averaging 75°F, but have reached 92°F. Winters are cold, with average lows of 18°F, but getting as cold as -23°F. North Rim's annual precipitation averages 26 inches. Low humidity and high summer temperatures result in high evapo-transpiration rates. Summer convective thunderstorms usually occur early July through early September, and often contain lightning. Snow is possible late October into early May. North Rim snowfall averages 137 inches (over 11 feet) and has reached 273 inches (almost 23 feet). Accumulations can be deep and persistent.

Mixed-Conifer FMU **Fuels, Fire Behavior, and Effects** **Alternative 1**

Vegetative communities are mixed-conifer with areas of nearly pure ponderosa pine on North Rim's southern ends. Wolf and Mast (1998) found most North Rim fires occurred during monsoon circulation in July and August, and that these results were consistent with lightning-ignited fires recorded by the park. From 1926 to 1992, 128 wildland fires were caused by lightning and 8 by humans.

On Northern Arizona University's North Rim study location, dead-and-down fuels ranged from 12.33 to 34.47 tons per acre (Covington 1999). Pre-burn data from park downed-fuel inventory summaries for mixed-conifer for 22 plots on North Rim showed 36.90 tons per acre (includes litter and duff loads). The NFDRS Fuel Model that best represents this forest is NFDRS G (closed stands of short-needled conifer with heavy accumulations of dead-and-down fuels).

Fire effects information from specific monitoring plot assessments for over five years post-burn is available for various mixed-conifer stands. Results indicate a wide range of response from no impacts to overstory species densities to profuse regeneration of aspen in higher severity (NPS 2000).

Fire behavior is a function of fuels, weather and, to a lesser degree, North Rim topography. Fuels can be continuous from surface to crown, supporting a mixed-severity fire regime. Deeper organic duff and litter can increase ground fire residence time. Fire behavior is also governed by mid- and overstory density and laddering potential. Dense thickets may support high-intensity surface fire, intermittent or sustained crown fire that can become independent of surface fire spread under extreme burning conditions.

Piñon-Juniper FMU **Physical Description** **Alternative 1**

Piñon-Juniper FMU (piñon-juniper woodlands, grasslands, and shrublands) vegetative types have been combined for management purposes, and in keeping with policies to keep unit numbers to a minimum. This FMU includes most of the park. Topography is exceedingly variable including rolling plateaus on both rims (portions of the Coconino, Kanab, and Hualapai), heavily dissected plateaus in the canyon (Sanup, Esplanade, and Tonto), and rugged cliffs and steep slopes on canyon walls.

Access to rim plateaus is possible via a few, primitive dirt roads. These roads can become impassable due to weather (especially snow and flash floods). With the exception of North Rim's Tuweep Valley, rugged areas below the rim are only accessible by air or foot, if at all.

Piñon-Juniper FMU **Values to be Protected** **Alternative 1**

Piñon-Juniper FMU values to be protected include

- Safety of firefighters, park employees, and the public
- Proposed wilderness (Mount Emma and Powell Plateau sections)
- Air-quality-related values (entire unit)
- Cultural resources (entire unit)
- Fire-dependent ecosystems (entire unit)
- Boundaries with adjacent landowners, including the Kaibab National Forest (Tusayan District), and BLM and LAME (GCPNM on the Mt. Emma section)
- Real property (see Fire Exclusion Areas below)
- Fire Exclusion Areas (see below)
- Tribal lands

Piñon-Juniper FMU Fire Exclusion Areas include

- Desert View
- Indian Garden
- Cottonwood Campground
- Phantom Ranch
- Tusayan Ruins and Museum
- Muav Saddle Cabin
- Signal Hill Lookout/Pasture Wash Ranger Station
- Roaring Springs residence and pump house
- Lees Ferry

Piñon Juniper FMU **Weather Cycles and Extremes** **Alternative 1**

Weather conditions vary widely through this unit. Higher elevations share conditions with North or South Rims (discussed above under Mixed-Conifer and Ponderosa Pine FMUs, respectively). Lower elevation conditions become progressively hotter and drier, reaching desert conditions represented by Weather Service records beginning in 1948 from Phantom Ranch (see Appendix C). There, annual precipitation is only nine inches. Low humidity and high summer temperatures result in high evapo-transpiration rates. Summer convective thunderstorms usually occur early July through early September, but rainfall and lightning diminish rapidly below the rim. Snow is rare on the canyon floor, and any accumulations at higher elevations tend to melt in a few days. Snowmelt can sufficiently waterlog soils on rim plateaus making winter travel difficult.
Spring and early summer months are normally dry. Summer highs rise with decreasing elevation, averaging 104°F, and have reached 120°F at Phantom Ranch. Winter temperatures can be mild at low elevation, averaging 38°F at Phantom Ranch. Prevailing winds are typically from the southwest on rim plateaus, and up or down canyon below the rim, with frequent inversions mid-fall through mid-spring.

Piñon-Juniper FMU **Fuels, Fire Behavior, and Effects** **Alternative 1**

In piñon-juniper woodlands, 90% of overstory stems are those two trees, with occasional ponderosa pine. Canopy cover can vary from 20–60%, with generally sparse understory except where Gambel oak occurs in small patches. Brush and herbaceous cover is less than 50%. Pre-burn fuel loads range from 6 to 26 tons

per acre on park monitoring plots according to the Grand Canyon Fire Effects Monitoring Plan (NPS 2000). The NFDRS Fuel Model that best represents this forest is NFDRS F (intermediate brush).

Desert shrublands below piñon-juniper woodlands are composed of a variety of desert shrub species, grasses, and ephemerals. Barren rock frequently outcrops, disrupting fuel continuity. Various riparian shrubs and trees grow near the Colorado River, springs, seeps, and some other watercourses, often with a dense understory. These isolated areas are the park's most biologically diverse environments. General characteristics of Alternative 1's three Fire Management Units are summarized in Table 2-3.

2.6.5.2 Fire Management Units Alternatives 2, 3, 4 and 5 Action Alternatives

For Action Alternatives (2, 3, 4 and 5), eight new FMUs are proposed to better reflect management opportunities and constraints. Proposed FMUs are still based on plant communities—the basis of each unit's different fuel characteristics and fire regimes. These FMUs have dissimilar levels of development, meteorology, history, and values at risk (prehistoric and historic use, species of concern, access, etc.). Proposed FMUs reflect management and tactical considerations, have clearly identifiable boundaries, and unique management issues (summarized in Table 2-4).

Action alternative FMUs are shown on Map 2-2. Note that those park areas not shown (generally the Lees Ferry and Sanup Plateau areas) are continuations of the Inner Canyon FMU.

Kaibab Summit Fire Management Unit Physical Description Action Alternatives

The Kaibab Summit FMU includes the park's highest elevations (North Rim's Kaibab Plateau). This FMU lies east of Arizona Route 67 and north of the Scenic/Cape Royal Road. Vegetation is typically referred to as spruce-fir forest. However, the unit is a complex mosaic of spruce-fir, with Douglas fir and ponderosa pine in drier locations. Meadows and aspen groves are interspersed throughout.

Unit access is almost exclusively from bordering roads including Route 67, the Scenic Road, and adjacent USFS roads on Kaibab National Forest's North Kaibab District. The road to Point Imperial enters the unit's southeast corner. The interior is only accessible on foot or from the air.

Kaibab Summit FMU Values to be Protected Action Alternatives

Forests of the Kaibab Summit are often cited in literature as some of the least disturbed spruce-fir forests in Arizona. Many travelers consider the Kaibab Plateau's forests and meadows a prelude and counter-point to the rugged Grand Canyon ahead.

Specific Kaibab Summit FMU values to be protected include

- Air-quality-related values (entire unit)
- Proposed wilderness
- Cultural resources (entire unit)
- Fire-dependent ecosystems (entire unit)
- Fire Exclusion Areas (see below)
- Safety of firefighters, park employees, and the public
- Boundaries with adjacent landowners including Kaibab National Forest (North Kaibab District)
- Federally listed threatened and endangered species (TES), species of concern, and their habitat

Kaibab Summit FMU Fire Exclusion Areas for this unit are

- North Rim Entrance Station
- North Rim Fire Lookout
- Lindbergh Hill RAWS Site

Table 2-3 FMU Characteristics, Alternative 1, Existing Program/No Action

Fire Management Unit Characteristics for Alternative 1			
	Ponderosa Pine	**Mixed-Conifer**	**Grass – Shrub – Piñon – Juniper**
Acres	42,899	92,150	1,057,569
% of Park	3.60%	7.73%	88.65%
Management Constraints			
Access	Network of public and administrative roads on South Rim; foot or helicopter to Mt. Emma and Powell Plateau sections	Sparse network of public and administrative roads; large interior areas with no roads	Sparse networks of roads and trails in some rim areas, otherwise remote; most in-canyon areas only accessible by helicopter
Values To Be Protected, Managed, or At Risk	Canyon-viewing platform, near-natural ecosystem, wilderness values in Powell Plateau and Mt. Emma sections.WUI areas include Grand Canyon Village	Best representation of this vegetation type in Arizona, canyon-viewing platform, wilderness values. Wildland-Urban Interface areas include North Rim developed area on Bright Angel Point	Rim areas are canyon-viewing platform, wilderness values. Wildland-Urban Interface areas include Desert View
Management Focus	Maintain native ecosystems; protect life, property and safety, especially in WUI	Restore and maintain native ecosystems, protect life, property and safety, especially in WUI	
Role of Fire	Ponderosa pine forest structure depends on frequent surface fires	Mixed-conifer structure depends on frequent surface fires, spruce-fir forest species intolerant of fire; infrequent stand-replacing fire occurs	Mixed-fire regimes may occur in piñon-juniper (more research needed); sparse desert vegetation and fuels do not support fire as major disturbance agent
Fire Regime Alteration	Heavy understory developed in absence of fire; much restored to open understory by managed fire	Relatively homogeneous forest structure developed in absence of fire; also possibly some meadow encroachment and fewer aspen	Unknown, possible canopy closure; extensive growth of annual exotics (i.e., cheat-grass) could fundamentally alter fire regime
Tactical Considerations	Some heavy fuels; limited escape routes; limited water resources	Heavy fuels; little ground access; few water resources; limited helispots; few natural fuel breaks; remote	Remote, long access routes; limited water resources

Table 2-4 FMUs for Alternatives 2, 3, 4, and 5 (Action Alternatives)

FMUs For Alternatives 2, 3, 4 and 5	Dominant Characteristics
Kaibab Summit	• Best relic spruce-fir communities on Kaibab • Vegetative communities as described in desired conditions
Plateau	• Greatest challenges to restore natural forest structure and process • Poor internal access
Peninsulas	• Approaching natural conditions • Good access • Frequent return interval • Air quality and sociological challenges
Fire Islands	• Generally unaltered fire regime and community • Isolated (access and fire spread)
Backcountry Uplands	• Mix of piñon-juniper communities with poorly understood fire histories
WUI Developed Areas	• Fire poses greatest risks to life, safety, and property
Secondary WUI	• Management focus to protect adjacent interfaces (including town of Tusayan)
Inner Canyon	• Generally unaltered fire regime • Limited role for fire • Very difficult access

Kaibab Summit FMU Weather Cycles and Extremes Action Alternatives

The automated weather station that best represents unit weather is Lindbergh Hill (020220), a permanent RAWS established in 1993 located approximately five miles north of Bright Angel Point at 8,800 feet.

Generally, climate is typical for Southwestern highland areas, and National Weather Service records for Bright Angel Ranger Station dated 1948-2004, characterize, but may be somewhat warmer and drier than, this FMU. Summer high temperatures are relatively mild, averaging 75°F, but have reached 92°F. Winters are cold with average lows of 30°F, but as cold as -23°F. Annual precipitation averages 26 inches on North Rim. Low humidity and high summer temperatures result in high evapo-transpiration rates. Summer convective thunderstorms usually occur early July through early September, and often contain lightning. Snow is possible late October into early May. North Rim snowfall averages 137 inches (over 11 feet) and has reached 273 inches (almost 23 feet). Accumulations can be deep and persistent.

Kaibab Summit FMU Fuels, Fire Behavior, and Effects Action Alternatives

Vegetative communities in the Kaibab Summit FMU are mixed-conifer with spruce, fir, and aspen dominating the landscape. Ponderosa pine is present, but widely scattered throughout on ridgetops and south-facing slopes. Herbaceous vegetation is scattered throughout the FMU but not abundant. Fuels are patchy or discontinuous where soils are thin and rocky but more continuous on slopes where soils are deeper. There is significant amount of dead-and-down large woody material. Some dead-and-down is from recent wind events while other materials are decades old. Large dead-and-down material has fallen atop other logs creating clumps of large woody material up to four-feet high.

Forests in the Kaibab Summit FMU are classed as moderate departure from historic fire regime. Even though most of this FMU has not experienced fire in the past 100 years, historic fire regime is highly variable with long-interval high- and mixed-severity fire with 15-30 year intervals (Fulé et al. 2003a).

The NFDRS Fuel Model that best represents fuels is NFDRS G (closed stands of short-needled conifer with heavy accumulations of dead-and-down fuels). Spruce trees have branches that touch the ground making them susceptible to torching from even low-intensity fires. Susceptibility for torching creates opportunities for long-range spotting. Spruce bark is thin, making trees vulnerable to severe fire effects even with low-intensity fire. Fire effects on spruce-dominated north slopes of the Poplar Fire show that some groups or stands of spruce died from low- or moderate-intensity fires. Lack of char on trees boles above breast height indicate that fire moved though these groups or stands as surface fire, and that spruce died by damage to the tree at or just above ground level.

Plateau Fire Management Unit **Physical Description** **Action Alternatives**

The Plateau FMU consists of the Kaibab Plateau's southern slope. Topography slopes south down and west across the unit. This regional slope is broken by a number of valleys radiating west and south from highlands near North Entrance Station. Many of these valleys have meadow-covered floors, and include Little Park and The Basin, two of the park's largest meadows. Forests range from ponderosa pine in drier locations, through mixed-conifer forest including Douglas fir, to spruce-fir forest communities in moister environments. In addition to meadows, aspen stands are interspersed through-out. Refer to Map 2-2.

Access to the Plateau FMU is almost exclusively from roads along its boundaries. Only Arizona Route 67 on the east is paved; the others (including USFS roads just outside the park's northern boundary) are dirt. All roads are closed in the winter. Clearing treefall from dirt roads is often not complete until early summer. Access to the Plateau FMU interior is either on foot or from the air.

Plateau FMU **Values to be Protected** **Action Alternatives**

GRCA forests on the Kaibab Plateau are often cited in literature as some of the least disturbed in Arizona. Many travelers consider the Kaibab Plateau's forests and meadows a prelude and counterpoint to the rugged Grand Canyon ahead.

Specific Plateau FMU values include

- Air-quality-related values (entire unit)
- Boundaries with adjacent landowners, including Kaibab National Forest (North Kaibab District)
- Proposed wilderness
- Real property (see Fire Exclusion Areas)
- Safety of firefighters, park employees, and the public
- Plateau Fire Exclusion Areas (see below)
- Federally listed threatened and endangered species, species of special concern and habitat
- Vegetative communities described in desired conditions
- Cultural resources (entire unit)

Plateau FMU Fire Exclusion Areas are

- Adjacent North Rim Developed Area
- Kanabownits Fire Lookout
- North Rim dynamite cache (Marble Flats)
- North Rim Shooting Range

Plateau FMU **Weather Cycles and Extremes** **Action Alternatives**

The automated weather station best representing Plateau FMU weather is Bright Angel Station (020211) located at the North Rim Helispot at 8,300 feet. The other is Lindbergh Hill (020220), a permanent RAWS established in 1993 located approximately five miles north of Bright Angel Station at 8,800 feet.

Generally, climate is typical for Southwestern highland areas, and National Weather Service records for Bright Angel Ranger Station dated 1948-2004, characterize the Plateau FMU. Summertime high temperatures are relatively mild, averaging 75°F, but have reached 92°F. Winters are cold, with average lows of 30°F, but get as cold as -23°F. North Rim's annual precipitation averages 26 inches. Low humidity and high summer temperatures result in high evapo-transpiration rates. Summer convective thunder-

storms usually occur early July through early September and often contain lightning. Snow is possible late October into early May. North Rim snowfall averages 137 inches (over 11 feet) and has reached 273 inches (almost 23 feet). Accumulations can be deep and persistent.

Plateau FMU Fuels, Fire Behavior, and Effects Action Alternatives

Plateau FMU vegetative communities are mixed-conifer with areas of nearly pure ponderosa pine on drier (generally south-facing) exposures. Ponderosa pine ecosystems are considered well adapted to recurrent, low-intensity fire with occasional flare-ups and isolated torching where fuels have concentrated or pockets of dense thickets occur. Herbaceous vegetation, once abundant in the understory, has been replaced by thick needle mats and downed woody materials. This decline in herbaceous component has led to two changes in the fuels complex: a reduced ability for surface fires to carry, and an eventual increase in ponderosa pine regeneration. Thus, a more common fuels and fire behavior characteristic in this vegetation type, given present conditions particularly on North Rim, is high-severity fires (Harrington and Sackett 1998).

In mixed-conifer and ponderosa pine systems, current accumulations of organic matter (litter, duff, and coarse organic materials) indicate retarded decomposition and cycling. Further, fire suppression and resulting regime alteration has led to creation of a relatively even-aged ponderosa pine understory. Reduction in overall spread of early fires has caused fuel loading increases.

In this vegetation type, fuels and associated tree densities were likely to have been more open before 1850. Although years of fire suppression reduce herbaceous diversity in mixed-conifer forests due to canopy closure (Covington and Moore 1994), the likelihood of stand-replacement crown fire increases with increased fuel loads and invading fire-intolerant species.

Wolf and Mast (1998) found most North Rim fires occurred during monsoon circulation July and August; these results were consistent with park-recorded lightning-ignited fires. 1926 to 1992, 128 wildland fires were caused by lightning; 8 by humans.

On Northern Arizona University's North Rim study location, dead-and-down fuels ranged 12.33 to 34.47 tons per acre (Covington et al 1999). Pre-burn data from park downed-fuel inventory summaries for mixed-conifer for 22 North Rim plots showed 36.90 tons per acre (includes litter and duff loads). The NFDRS Fuel Model that best represents this forest is NFDRS G (closed stands of short-needled conifer with heavy accumulations of dead-and-down fuels).

Fire effects information from specific monitoring plot assessments for over five years post-burn is available for various mixed-conifer stands. Monitoring results indicate a wide response range, from no impacts to overstory species densities to profuse aspen regeneration in higher severity (NPS 2000).

Fire behavior is a function of fuels, weather and, to a lesser degree, North Rim topography. Fuels can be continuous from surface to crown, supporting mixed-severity fire regime. Deeper organic duff and litter can increase ground fire residence time. Fire behavior is also governed by mid and overstory density and ladder potential. These dense thickets may support high-intensity surface fire, intermittent or sustained crown fire that can become independent of surface fire spread under extreme burning conditions.

Peninsulas Fire Management Unit Physical Description Action Alternatives

Peninsulas FMU is composed of broad promontories reaching from North Rim's Kaibab Plateau into Grand Canyon, and a section of South Rim's Coconino Plateau's higher elevations. These forested areas are close to, and often nearly surrounded by, Grand Canyon. In contrast to the canyon, Peninsulas topography is flat to rolling, with a general slope to the south interrupted by relatively shallow valleys draining into or away from Grand Canyon (North and South Rim respectively).

Access to the Peninsula FMU is via paved roads, including Cape Royal Road and Desert View Drive. Point Sublime and Swamp Ridge peninsulas are accessed via dirt roads. Old administrative roads on Tiyo Point peninsula are closed. Away from these roads, access is by foot or air, and several helispots.

Peninsulas FMU **Values to be Protected** **Action Alternatives**

Peninsula FMU forests are dominated by ponderosa pine stands. In the last decade, managed fire has succeeded in restoring and opening these ponderosa forests to stand densities more closely aligned with reference condition. These forests frame some of Grand Canyon's most spectacular overlooks, and are the primary focus of many park visits.

Specific Peninsulas FMU values to protect include

- Air-quality-related values (entire unit)
- Boundaries with adjacent landowners, including Kaibab National Forest (North Kaibab and Tusayan Districts)
- Proposed wilderness
- Real property (see Fire Peninsulas Exclusion Areas below)
- Safety of firefighters, park employees, and the public
- Federally listed threatened and endangered species, species of special concern, and their habitat
- Cultural resources (entire unit)
- Fire Exclusion Areas (see below)
- Vegetative communities as described in desired conditions

Peninsulas FMU Fire Exclusion Areas are

- Nearby North Rim Developed Area
- Kanabownits Cabin
- Greenland Lake Cabin
- North Rim Forest Restoration Plots
- Hance Air Quality Station
- Historic Grandview Entrance Station

Peninsulas FMU **Weather Cycles and Extremes** **Action Alternatives**

The fire weather NFDRS station that best represents weather in the Peninsula FMU on South Rim is Tusayan (020207). On North Rim, Swamp Ridge best represents weather.

Generally, climate is typical for Southwestern highland areas, with cold winters, windy springs, and very dry early summers. Low humidity and high summer temperatures result in high evapo-transpiration rates. Summer convective thunderstorms usually occur early July through early September, and often contain lightning. Snow is possible mid-October to mid-May.

National Weather Service records for Bright Angel Ranger Station dated 1948-2004, characterize this North Rim FMU. Summer high temperatures are relatively mild, averaging 75°F, but have reached 92°F. Winters are cold, with average lows of 30°F, but as cold as -23°F. North Rim annual precipitation averages 26 inches. North Rim snowfall averages 137 inches (over 11 feet) and has reached 273 inches (almost 23 feet). Accumulations can be deep and persistent. North Rim's frost-free period averages 101 days.

On South Rim, National Weather Service records for Grand Canyon Village dated 1903-2004 are typical for this FMU. Annual precipitation averages 16 inches (Appendix C). Total snowfall averages 57 inches (see Appendix C). Snow accumulations are usually moderate, less than 12 inches, although deeper accumulations are possible in higher elevations. Spring and early summer months are normally dry, and summer highs average 82°F, but have reached 105°F with relative humidity in single digits. Winter temperatures have dropped to -20° F, but average 1°F (Appendix C). South Rim's frost-free period averages 148 days. Prevailing winds are typically from the southwest.

Peninsulas FMU **Fuels, Fire Behavior, and Effects** **Action Alternatives**

Ponderosa pine forests dominate the Peninsula FMU. Data interpretation from Northern Arizona University's monitoring plots (Covington et al. 1999) show that South Rim's total dead-and-down fuel loadings ranged 1.55 to 6.82 tons per acre. The Monitoring Type Description Sheet for South Rim and North Rim ponderosa pine show typical total fuel loads of two to eight tons per acre with averages estimated from 0.2 to 9.3 tons per acre.

The primary overstory tree is ponderosa pine, represented by NFDRS Fuel Model C (open pine with grass understory) for South Rim's forest and the majority of North Rim sites where past fires occurred, and NFDRS Fuel Model U (western long-needle pine) in areas where past fires have not occurred.

Fire behavior is largely a function of fuels and weather. Untreated area fuels include younger pine thickets under older large tree stands that create continuous fuel ladders from surface fuels to tree crowns, supporting mixed-severity fire regime. Treated area fuels are more open in the understory and create fuel ladder breaks. Fire behavior in previously treated areas would be mostly low-severity fire regime.

The oak component in the ponderosa pine forest type is maintained by periodic fire. Presence of multi-aged oak and locust thickets in recent burned areas and wide clones distribution suggest the modern shrubby understory may have been characteristic of pre-settlement forests (Covington et al. 2000).

Fire Islands Fire Management Unit **Physical Description** **Action Alternatives**

The Fire Islands FMU consists of four isolated mesas or plateaus, completely surrounded by the Grand Canyon. Little management action (fire suppression or otherwise) has altered the ecosystem processes on these remote areas, thus they are invaluable resources for understanding park pre-Euro-American forests (e.g., Fulé 2003). Their generally flat summits range from a few hundred acres atop Wotans Throne to thousands of acres on Powell Plateau. Forest communities include ponderosa pine on Wotans Throne, Shiva Temple, and higher elevations of Powell Plateau, and piñon-juniper communities on lower reaches of Powell Plateau and Fishtail Mesa. Aside from a single trail to Powell Plateau, access to the Fire Islands FMU is from the air (or technical rock climbing).

Fire Islands FMU **Values to be Protected** **Action Alternatives**

Fire Islands FMU management actions are focused on preserving the nearly pristine forests in both form and function, so these forests can continue as valuable scientific research areas and ecological benchmarks for other park areas.

Specific Fire Islands FMU values to protect include

- Cultural resources (entire unit)
- Federally listed threatened and endangered species, species of concern, and their habitat
- Air-quality-related values (entire unit)
- Proposed wilderness
- Boundaries with adjacent landowners including the Kaibab National Forest (North Kaibab District)
- Safety of firefighters, park employees, and the public
- Vegetative communities described in desired conditions

Fire Island Fire Exclusion Areas

- There are no FEA in the Fire Islands FMU

Fire Islands FMU **Weather Cycles and Extremes** **Action Alternatives**

Because of their variable elevations, weather cycles in the Fire Islands FMU range from the relatively cool and wet ponderosa pine environments of the Peninsula FMU (above) to the hotter, drier piñon-juniper environments of the Backcountry Uplands FMU (below). Lightning strikes, especially during late

summer's monsoon season, are probably relatively more frequent than on nearby plateaus. Warm updrafts from the surrounding canyon also create a hotter, drier microclimate along the rim, especially on south- and west-facing cliffs and slopes.

Fire Islands FMU Fuels, Fire Behavior, and Effects Action Alternatives

The eastern Fire Island FMU sections (Wotans Throne, Shiva Temple, and the northern two-thirds of Powell Plateau) support ponderosa pine forests similar to the Peninsula FMU. Data interpretation from Northern Arizona University monitoring plots (Covington et al. 1999) show that total dead-and-down fuel loadings on South Rim ranged 1.55 to 6.82 tons per acre. The Monitoring Type Description Sheet for South and North Rim ponderosa pine show typical total fuel loads of two to eight tons per acre with averages estimated from 0.2 to 9.3 tons per acre. Fuels in this FMU are best represented by NFDRS Fuel Model C (open pine with grass understory).

Fire behavior is largely a function of fuel and weather. Untreated fuels include younger pine thickets under older large tree stands creating continuous fuel ladders from the surface to tree crowns, supporting a mixed-severity fire regime. Treated area fuels are more open in the understory which creates fuel ladders breaks. Fire behavior in previously treated areas would be predominately low-severity fire regime.

The oak component in the ponderosa pine forest type is maintained by periodic fire. Presence of multi-aged oak and locust thickets in recent burned areas and wide clone distribution suggest modern shrubby understory may have been characteristic of pre-settlement forests (Covington et al. 2000).

Backcountry Uplands Fire Management Unit Physical Description Action Alternatives

Backcountry Uplands is the park's lowest elevation forested FMU, and the most fragmented. Vegetation communities include piñon-juniper woodlands, sagebrush meadows, and juniper savannas. A few moist areas contain ponderosa pine stands or stringers (especially near Mount Emma). Coconino Plateau (South Rim), Backcountry Uplands reach from Pasture Wash area east to near Hermits Rest, then resume below Buggeln Hill from Moran to Pinal Points. On Marble Platform below Desert View, Backcountry Uplands extend from the park's southern boundary north to the Little Colorado River Gorge. On North Rim, the FMU contains all of the Kanab Plateau and Uinkaret Mountains (near Mount Emma).

Backcountry Uplands FMU Values to be Protected Action Alternatives

Backcountry Uplands FMU values to be protected include

- Air-quality-related values (entire unit)
- Real property (see Fire Exclusion Areas)
- Cultural resources (entire unit)
- Federally listed threatened and endangered species, species of concern, and their habitat
- Proposed wilderness
- Safety of firefighters, park employees, and the public
- Boundaries with adjacent landowners, including Kaibab National Forest (Tusayan District), BLM (Arizona Strip Field Office), LAME (GCPNM), Navajo Nation, and Havasupai Tribe
- Fire Exclusion Area (see below)
- Vegetative communities described in desired conditions

Backcountry Uplands FMU Fire Exclusion Areas include

- Signal Hill Lookout/Pasture Wash Ranger Station

Backcountry Uplands FMU Weather Cycles and Extremes Action Alternatives

The fire weather NFDRS station that best represents weather in the Backcountry Uplands FMU is Tusayan (020207). Detailed station catalog information for all park weather stations can be found in GRCA's Fuel Moisture and Fire Weather Monitoring Plan, Branch of Fire and Aviation Management.

Generally, climate is typical for Southwestern highland areas with cold winters, windy springs, and very dry early summers. Low humidity and high summer temperatures result in high evapo-transpiration rates. Summer convective thunderstorms usually occur early July through early September, and often contain lightning. Snow is possible mid-October into mid-May.

National Weather Service records for Grand Canyon Village dated 1903-2004, are typical for higher elevations in the Backcountry Uplands FMU, with lower elevations somewhat warmer and drier, and represented by records from the Tuweep Ranger Station (1948-1985). Annual precipitation ranges 12 inches at Tuweep (TU) to 16 inches at Grand Canyon Village (GCV) (see Appendix C). Total snowfall averages 7 (TU) to 57 (GCV) inches. Snow accumulations are usually moderate, less than 12 inches. Spring and early summer months are normally dry, and summer highs average 82°F (GCV) to 92°F (TU), but have reached 108°F (TU) with relative humidity in single digits. Winter temperatures have dropped to -20°F (GVC), but average lows are 1°F (see Appendix C). The frost-free period is generally like South Rim, 148 days. Prevailing winds are typically from the southwest.

Backcountry Uplands FMU Fuels, Fire Behavior, and Effects Action Alternatives

In piñon-juniper woodlands, 90% of overstory stems are of those two trees, with occasional ponderosa pine. Canopy cover can vary from 20–60%, with a generally sparse understory except for Gambel oak in small patches. Brush and herbaceous cover is less than 50%. Pre-burn fuel loads range 6 to 26 tons per acre on park monitoring plots (NPS 2000). Cheatgrass, an invasive exotic plant species may, in some areas, carry fire through sparse shrub cover that previously would not have sustained fire spread. The NFDRS Fuel Model that best represents this forest is NFDRS F (intermediate brush).

Fire behavior in piñon-juniper woodlands can range from creeping surface fire during times of no wind and/or high humidities to high-intensity crown fire with long-range spotting during times of high winds and low humidities.

Primary Wildland-Urban Interface FMU Physical Description Action Alternatives

The primary Wildland-Urban Interface FMU includes eight sections. The largest is on South Rim and extends from Hermits Rest to Shoshone Point and south to include Grand Canyon Village. A second South Rim section extends from Tusayan Museum to Desert View. On North Rim, Bright Angel Point and the North Rim developed area are the third largest WUI FMU section. Four smaller sections in the Cross-Canyon Corridor (Kaibab and Bright Angel Trails) surround Roaring Springs developments, Cottonwood Camp-ground, Phantom Ranch, and Indian Garden. The last section is a small area surrounding Tuweep Ranger Station. The three large rim sections are generally flat to rolling, with piñon-juniper woodlands around Desert View, a mixture of piñon-juniper and ponderosa pine near Grand Canyon Village, and ponderosa pine and mixed-conifer forests on Bright Angel Point. The four Cross-Canyon Corridor units are on the canyon's floor and support riparian vegetation with desert shrubs around their margins. The Tuweep section supports a sparse piñon-juniper growth.

Access to all but the Cross-Canyon Corridor section is by road (albeit, a 60-mile dirt road to Tuweep); Grand Canyon Village and Bright Angel Point sections include a network of public and administrative roads that provide ready access. The four Cross-Canyon Corridor sections are accessible only by foot, mule, or air, and all have established helispots.

Primary WUI FMU Values to Be Protected Action Alternatives

Primary WUI FMU values to be protected include

- Air-quality-related values (entire unit)
- Cultural resources (entire unit)
- Real property (see Fire Exclusion Areas
- Proposed wilderness (Mount Emma and Powell

below)
- Fire-dependent ecosystems (entire unit)
- Fire Exclusion Areas (see below)
- Federally listed threatened and endangered species, species of concern, and their habitat

Plateau sections)
- Boundaries with adjacent landowners, including Kaibab National Forest (Tusayan District), and BLM and LAME (GCPNM on the Mt. Emma section)
Safety of firefighters, park employees, and the public

Primary WUI FMU Fire Exclusion Areas include
- North Rim Developed Area
- CC Hill
- Tuweep Ranger Station
- Grand Canyon Village
- Supai Camp
- Hermits Rest
- Abyss Air Quality Monitoring Site
- Yaki Point—South Kaibab Trailhead
- Hopi Point Telecommunications Site
- South Rim Shooting Range
- Desert View
- Tusayan Museum and pueblo ruin
- Indian Garden
- Phantom Ranch
- Cottonwood Campground
- Tusayan Ruins and Museum
- Roaring Springs residence and pump house

Primary WUI FMU Weather Cycles and Extremes Action Alternatives

Weather and climatic conditions in the Wildland-Urban Interface FMU cover the entire range of conditions found in GRCA from North Rim's cool conifer forests to the Inner Canyon's hot desert. In general, precipitation comes in winter (as snow at higher elevations) and during summer monsoons (whose thunderstorm rains may evaporate before reaching the canyon floor). Conditions in South Rim sections (Grand Canyon Village and Desert View) are similar to those summarized for the Backcountry Uplands FMU. Bright Angel Point experiences weather like that of the Peninsula FMU. The remaining sections are typified by the Inner Canyon FMU, although the Tuweep section is somewhat cooler and moister than the four Cross-Canyon Corridor sections.

Primary WUI FMU Fuels, Fire Behavior, and Effects Action Alternatives

Ponderosa pine forests characterize much of the WUI FMU Bright Angel Peninsula and Grand Canyon Village sections. Piñon-juniper woodland covers most of Desert View and Tuweep sections and drier locations in the Grand Canyon Village section. Desert shrub and riparian vegetation are characteristic of the four small Cross-Canyon Corridor sections.

Where the primary overstory tree is ponderosa pine, the Monitoring Type Description Sheet for South and North Rim show typical total fuel loads of two to eight tons per acre with averages estimated from 0.2 to 9.3 tons per acre. NFDRS Fuel Model C (open pine with grass understory) best represents South Rim's forest and the majority of North Rim sites where past fires have occurred, and NFDRS Fuel Model U (western long-needle pine) best represent areas where past fires have not occurred.

Fire behavior is largely a function of fuels and weather. Fuels in untreated areas include thickets of younger pine under older stands of large trees which creates continuous fuel ladders from surface fuels to tree crowns, supporting a mixed-severity fire regime. Fuels in treated areas are more open in the understory and create fuel ladder breaks. Fire behavior in previously treated areas would be predominately low-severity fire regime.

In piñon-juniper woodlands, 90% of overstory stems are of those two trees, with occasional ponderosa pine. Canopy cover can vary from 20–60%, with a generally sparse understory except for Gambel oak in small patches. Brush and herbaceous cover is less than 50%. Pre-burn fuel loads range 6 to 26 tons per acre on park monitoring plots (NPS 2000). Cheatgrass, an invasive exotic plant species may, in some areas,

carry fire through sparse shrub cover that previously would not have sustained fire spread. The NFDRS Fuel Model that best represents this forest is NFDRS F (Intermediate brush).
Fire behavior in piñon-juniper woodlands can range from creeping surface fire during times of no wind and/or high humidities to high-intensity crown fire with long range spotting during times of high winds and low humidities.

Secondary Wildland-Urban Interface FMU Physical Description Action Alternatives

The Secondary Wildland-Urban Interface FMU on the Coconino Plateau (South Rim) is divided into two sections, the first generally south of Grand Canyon Village, the second southwest of Desert View. Both areas slope to the southwest, but this overall slope is broken by shallow valleys sub-parallel to this regional slope. Vegetation is piñon-juniper woodland with stringers of ponderosa pine in moister valley bottoms.

Access to both sections is provided by a network of public and administrative roads (although the administrative roads in the Desert View section are short). Outside the park boundary, USFS roads approach the park, and some connect with park roads. Overall, access is generally good.

Secondary WUI FMU Values to be Protected Action Alternatives

The Secondary WUI FMU is managed to promote natural ecosystems in such a way as to provide an additional protection layer to the WUI FMU. Because prevailing winds (especially during fire season) are from the southwest, maintaining lower fuel loads in these fire-adapted forests decreases risk of fires traversing, or originating in, this FMU and threatening the WUI FMU.

Secondary WUI FMU values to be protected include

- Vegetative communities as described in desired conditions
- Air-quality-related values (entire unit)
- Federally listed threatened and endangered species, species of concern, and their habitat
- Safety of firefighters, park employees, and the public
- Cultural resources (entire unit)
- Real property
- Boundaries with adjacent landowners including Kaibab National Forest (Tusayan District)

Secondary WUI FMU Fire Exclusion Areas

- There are no fire exclusion areas in the Secondary WUI FMU

Secondary WUI FMU Weather Cycles and Extremes Action Alternatives

The fire weather NFDRS station that best represents weather in the Secondary WUI FMU is Tusayan (020207).

Generally, climate is typical for Southwestern highland areas with cold winters, windy springs, and very dry early summers. Low humidity and high summer temperatures result in high evapo-transpiration rates. Summer convective thunderstorms usually occur early July through early September, and often contain lightning. Snow is possible mid-October into mid-May.

National Weather Service records for Grand Canyon Village dated 1903-2004 are typical for the Secondary WUI FMU, although the Desert View section is a bit warmer and drier. Annual precipitation averages 16 inches (see Appendix C). Total snowfall averages 57 inches. Snow accumulations are usually moderate, less than 12 inches, although deeper accumulations are possible in higher elevations. Spring and early summer months are normally dry, and summer highs average 82°F, but have reached 105°F with relative humidity in single digits. Winter temperatures have dropped to -20°F, but average 1°F. The frost-free period is 148 days on South Rim. Prevailing winds are typically from the southwest.

Secondary WUI FMU Fuels, Fire Behavior, and Effects Action Alternatives

Ponderosa pine forests characterize much of the Grand Canyon Village section of the Secondary Wildland-Urban Interface FMU. Piñon-juniper woodland covers most of the Desert View section, and drier locations in the Grand Canyon Village section.

Where the primary overstory tree is ponderosa pine, the Monitoring Type Description Sheet for South and North Rim show typical total fuel loads of two to eight tons per acre with averages estimated from 0.2 to 9.3 tons per acre. NFDRS Fuel Model C (open pine with grass understory) best represents South Rim's forest and the majority of North Rim sites where past fires have occurred, and NFDRS Fuel Model U (western long-needle pine) best represent areas where past fires have not occurred.

Fire behavior is largely a function of fuels and weather. Fuels in untreated areas include thickets of younger pine under older stands of large trees which creates continuous fuel ladders from surface fuels to tree crowns, supporting a mixed-severity fire regime. Fuels in treated areas are more open in the understory which creates fuel ladder breaks. Fire behavior in previously treated areas would be predominately low-severity fire regime.

In piñon-juniper woodlands, 90% of overstory stems are of those two trees, with occasional ponderosa pine. Canopy cover can vary from 20–60%, with a generally sparse understory except for Gambel oak in small patches. Brush and herbaceous cover is less than 50%. Pre-burn fuel loads range 6 to 26 tons per acre on park monitoring plots (NPS 2000). Cheatgrass, an invasive exotic plant species may, in some areas, carry fire through sparse shrub cover that previously would not have sustained fire spread. The NFDRS Fuel Model that best represents this forest is NFDRS F (Intermediate brush).
Fire behavior in piñon-juniper woodlands can range from creeping surface fire during times of no wind and/or high humidities to high-intensity crown fire with long range spotting during times of high winds and low humidities.

Inner Canyon Fire Management Unit Physical Description Action Alternatives

The Inner Canyon FMU covers most of GRCA, and includes all areas below the rim. Terrain is generally rugged, with steep slopes and high cliffs characteristic of Grand Canyon. The Inner Canyon does have some relatively flat areas, including Sanup and Tonto Plateaus and the Esplanade, but even these areas are intricately dissected by tributary canyons and the Colorado River gorge. Bedrock outcroppings are common, especially at lower elevations, and disrupt fuel continuity. Vegetative communities are variable, with upper canyon wall communities similar to forest types on the rim above, but with various desert shrub communities dominating lower elevations. Oases near springs, seeps, and more reliable watercourses support relatively lush riparian communities.

Access to the Inner Canyon FMU is almost entirely by foot or air. Only one road enters the FMU, to Toroweap Overlook, a 70-mile dirt road. Colorado River whitewater limits access (indeed, the river itself is only accessible by road at either end of the park, or across the Hualapai Reservation at Diamond Creek). Boat access to the canyon's lower 40 miles is possible across upper Lake Mead, but would only be suitable for near-shore activities.

Desert shrublands below piñon-juniper woodlands are composed of a variety of desert shrub species, grasses, and ephemerals. Barren rock frequently outcrops, disrupting fuel continuity. Various riparian shrubs and trees grow near the Colorado River, springs, seeps, and other watercourses, often with a dense understory. These isolated areas are the park's most biologically diverse environments.

Inner Canyon FMU Values to be Protected Action Alternatives

The Inner Canyon is, of course, the prime GRCA visitor attraction. Most view the area from the rims, but a small percentage of visitors enter the Inner Canyon FMU by foot, mule, or raft.

Inner Canyon FMU values to be protected include

- Safety of firefighters, park employees, and the public
- Air-quality-related values (entire unit)
- Boundaries with adjacent landowners, including Kaibab National Forest (North Kaibab District), and BLM (Arizona Strip and Kingman Field Offices), LAME (GCPNM), Navajo Nation, Havasupai Indian Reservation, and Hualapai Indian Reservation
- Proposed wilderness
- Real property (see Fire Exclusion Areas below)
- Cultural resources (entire unit)
- Federally listed threatened and endangered species, species of concern, and their habitat
- Vegetative communities as described in desired conditions
- Fire Exclusion Areas (see below)

Inner Canyon Fire Exclusion Areas

- Private inholdings (near Asbestos Canyon and Vulcan's Throne)
- Indian Garden
- Phantom Ranch
- Cottonwood Campground
- Lees Ferry
- Muav Saddle Cabin
- Tuweep Ranger Station and campground
- Roaring Springs residence and pump house

Inner Canyon FMU Weather Cycles and Extremes Action Alternatives

Weather conditions vary widely through the Inner Canyon FMU. Higher elevations share conditions with North or South Rim (described above). Lower elevation conditions become progressively hotter and drier, reaching desert conditions represented by Weather Service records beginning in 1948 from Phantom Ranch (Appendix C). There, annual precipitation is only nine inches. Low humidity and high summer temperatures result in high evapo-transpiration rates. Summer convective thunderstorms usually occur early July through early September, but rainfall and lightning diminish rapidly below the rim. Snow is rare on the canyon floor, and any accumulations at higher elevations tend to melt in a few days.

Spring and early summer months are normally dry. Summer highs rise with decreasing elevation, averaging 104°F, and have reached 120°F at Phantom Ranch. Winter temperatures can be mild at low elevation, averaging 38°F at Phantom Ranch. Although prevailing wind for most of the region is typically southwestern, the canyon tends to channel winds either up- or down-canyon. In the absence of stronger winds, a shallow surface flow commonly drains into the canyon at night. Although daytime updrafts rise from the entire canyon, local updrafts of heated air above sun-warmed cliffs are common in afternoon. Inversions of varying depth and intensity develop frequently late September through mid-March.

Inner Canyon FMU Fuels, Fire Behavior, and Effects Action Alternatives

Fire behavior in most of the Inner Canyon is fast moving, low-intensity grass and shrub fires, or fires that involve a single juniper and a small ground fire. Due to many natural fire barriers (rock outcrops, cliffs, etc.) these fires are normally small. No fires in the Inner Canyon FMU and away from forested rim edges have exceeded 100 acres in the past ten years, and this trend is expected to continue. Management actions on Inner Canyon FMU fires are small (2-5 firefighters) and short (2-5 hours), and this trend is expected to continue. Approximately one Inner Canyon fire is suppressed annually as most fires go out naturally.

Most Inner Canyon naturally started fires are inaccessible, or accessible only by helirappel. Past naturally ignited fires have occurred far from known values at risk. Lack of values at risk and abundance of natural barriers often means risks to firefighters (rapelling from helicopters to suppress fires) is too great, thus most Inner Canyon naturally ignited fires are monitored by air or from the rim, and no other management actions are taken.

Most human-caused Inner Canyon fires occur on Colorado River banks or along trail corridors. These fires often occur in light, flashy fuels surrounded by natural fire-spread barriers. Suppression actions have occurred on these fires, but often only involve mop-up (putting out hot spots with water or grubbing hot spots with hand tools) since many fires stop at natural fuel breaks before firefighters arrive. Access to these fires is by helicopter.

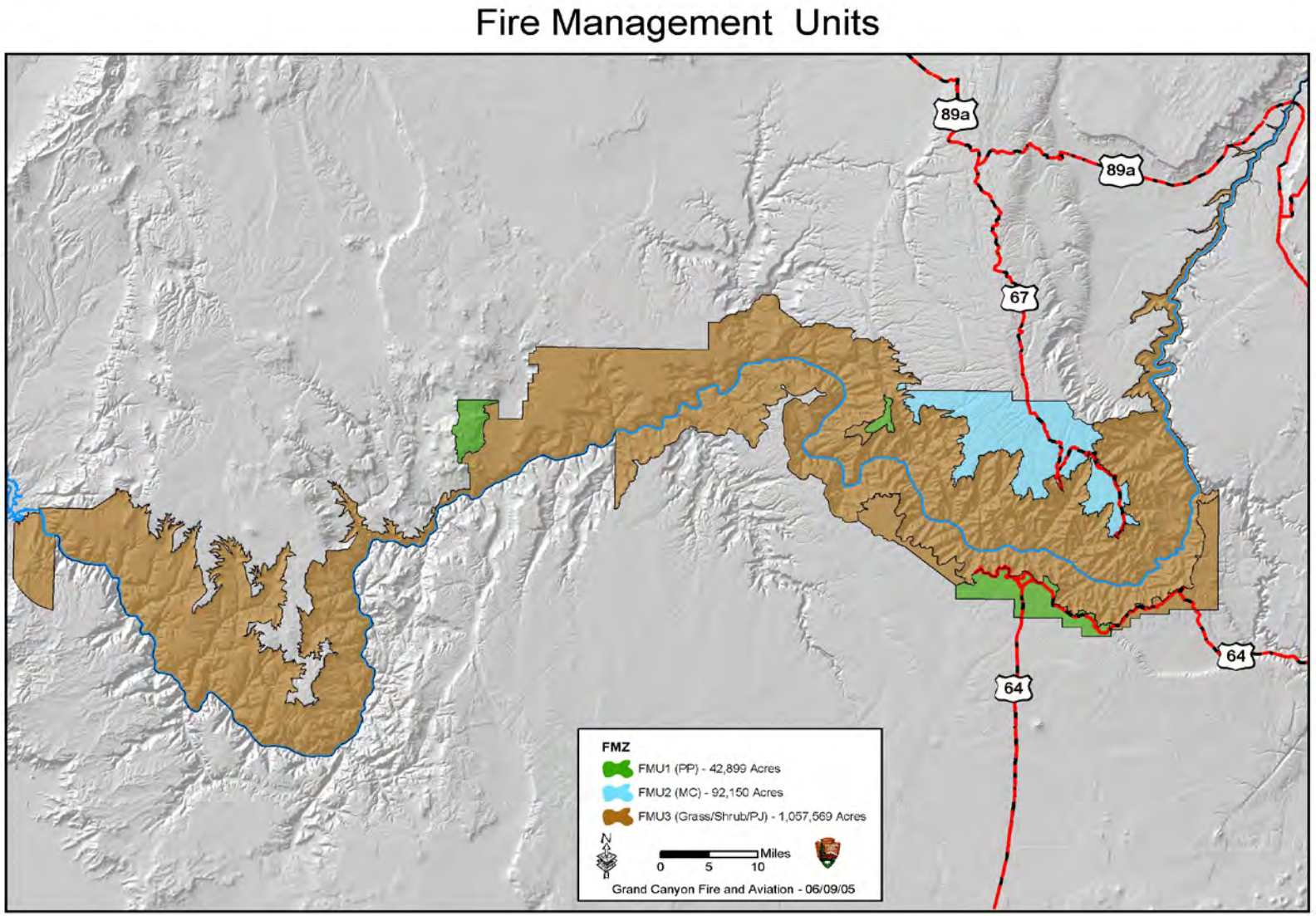
Brush and forest fuels occur in the Inner Canyon FMU, but only along the rim edge. These forest, brush, or grass fuels may occur within 100 feet of the rim, but could also extend more than 1,000 feet below the rim. There is often no fuel break at the rim edge, so fires that start in forest fuels above the rim have potential to drop over the rim and continue to burn until they reach natural barriers. Potential for fire spread below the rim exists for planned and unplanned ignitions. Fire location, fuel continuity below the rim, and natural barrier number andsize relate to fire spread. Observed fire behavior is often backing or flanking fire with small uphill fire runs. These uphill runs have occurred in Gamble oak brush. Fire has not entered areas below the rims defined as MSO PAC. Ground-based suppression actions cannot be safely accomplished in fuels just below the rim as no escape routes or safety zones exist, and terrain is extremely steep and rugged. Helicopter aerial suppression actions have been successful at times with small helicopters often unsuccessful, while large helicopters that carry a large amount of water are more effective. When portions of Inner Canyon FMU are included in the Maximum Management Area for a fire, or when fires go below the rim, management action points are defined and real-time decisions are made in discussions with resource advisors to balance impacts from fire with impacts from suppression efforts. A range of actions have been taken on fires determined on a case-by-case basis considering adjacency and impacts to sensitive resources including allowing the fire to progress naturally, aerial suppression efforts, or protection efforts along the rim to stop fire from re-emerging from the canyon.

Table 2-5 provides further description and comparison of the eight Action Alternative FMUs.

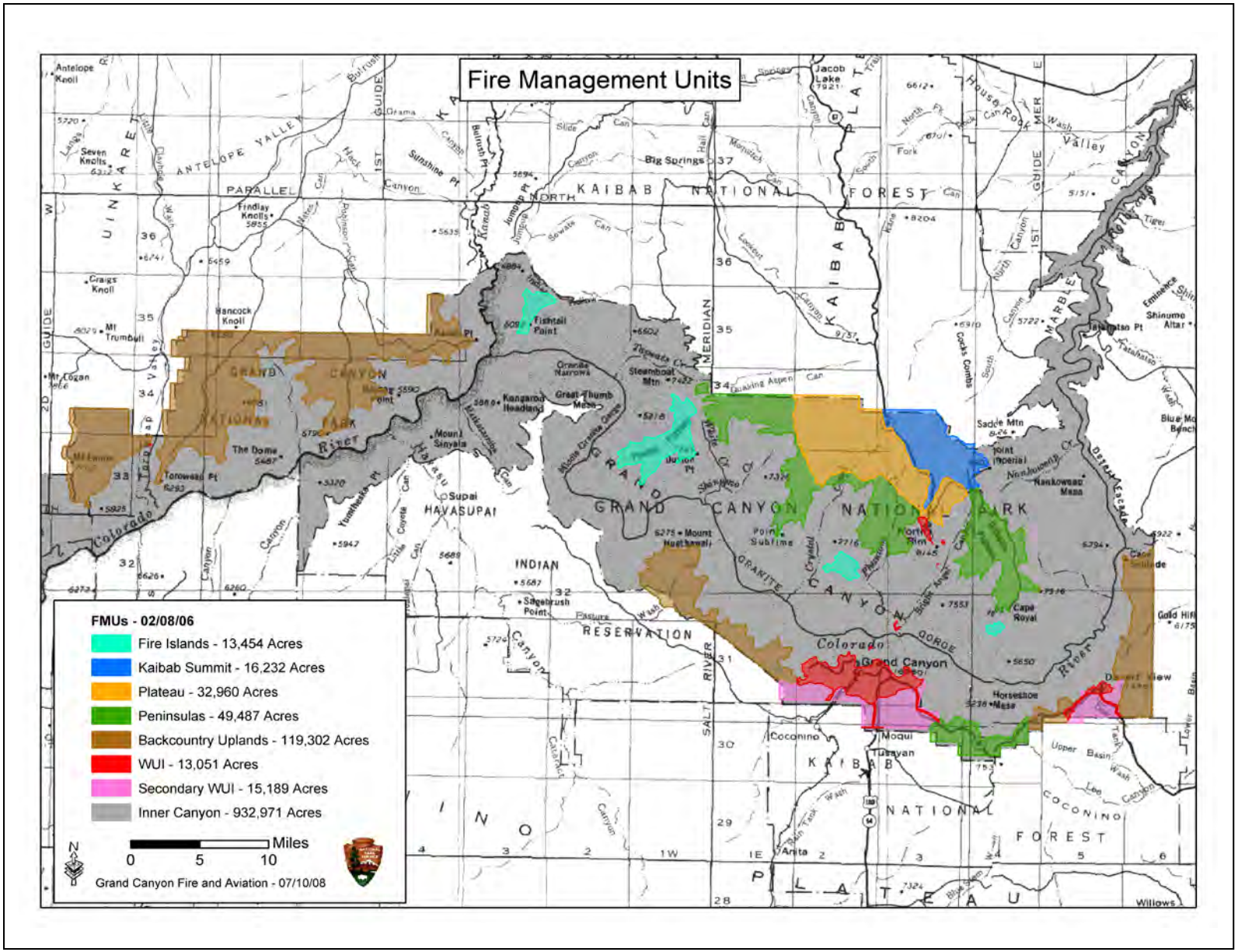
Table 2-5 Summary Highlights, Action-Alternative FMUs

Fire Management Unit Characteristics for Action Alternatives								
	Kaibab Summit	**Plateau**	**Peninsulas**	**Fire Islands**	**Backcountry Uplands**	**Primary WUI**	**Secondary WUI**	**Inner Canyon**
Acres	15,879	32,564	48,807	13,454	119,069	14,611	15,188	933,032
% of Park	1.33%	2.73%	4.09%	1.13%	9.98%	1.22%	1.27%	78.23%
Management Constraints				Only Wildland Fire Use		No wildland fire use Mechanical fuel reduction allowed	No wildland fire use	
Access	Public roads on margins; little interior	Public roads on most margins; little interior	Networks of public and administrative roads	Hiking / technical climbing; helicopter	Networks of roads and trails but remote; some helicopter only	Excellent	Very good fire road network	Very few roads, some foot access; mostly helicopter access
Values to be Protected, Managed, or At Risk	Best relic spruce-fir ecosystem in Arizona; wilderness	Best represen-tation of this vegetation type in Arizona; wilderness	Canyon viewing platform; near-natural ecosystem; wilderness	Topograph-ically isolated relic eco-systems with unaltered fire regimes	Canyon viewing platform; wilderness	Life, property, historic resources; canyon viewing platform	Protects the primary WUI	Natural communities; very susceptible to exotic plant conversions; wilderness
Management Focus	Maintain native ecosystems	Restore and maintain native ecosystems	Restore and maintain native ecosystems	Preserve best regional examples of natural fire regimes, a very important scientific resource	Restore and maintain native ecosystems	Protect life and property in natural setting	Augment WUI protection with native ecosystems	Maintain native ecosystems

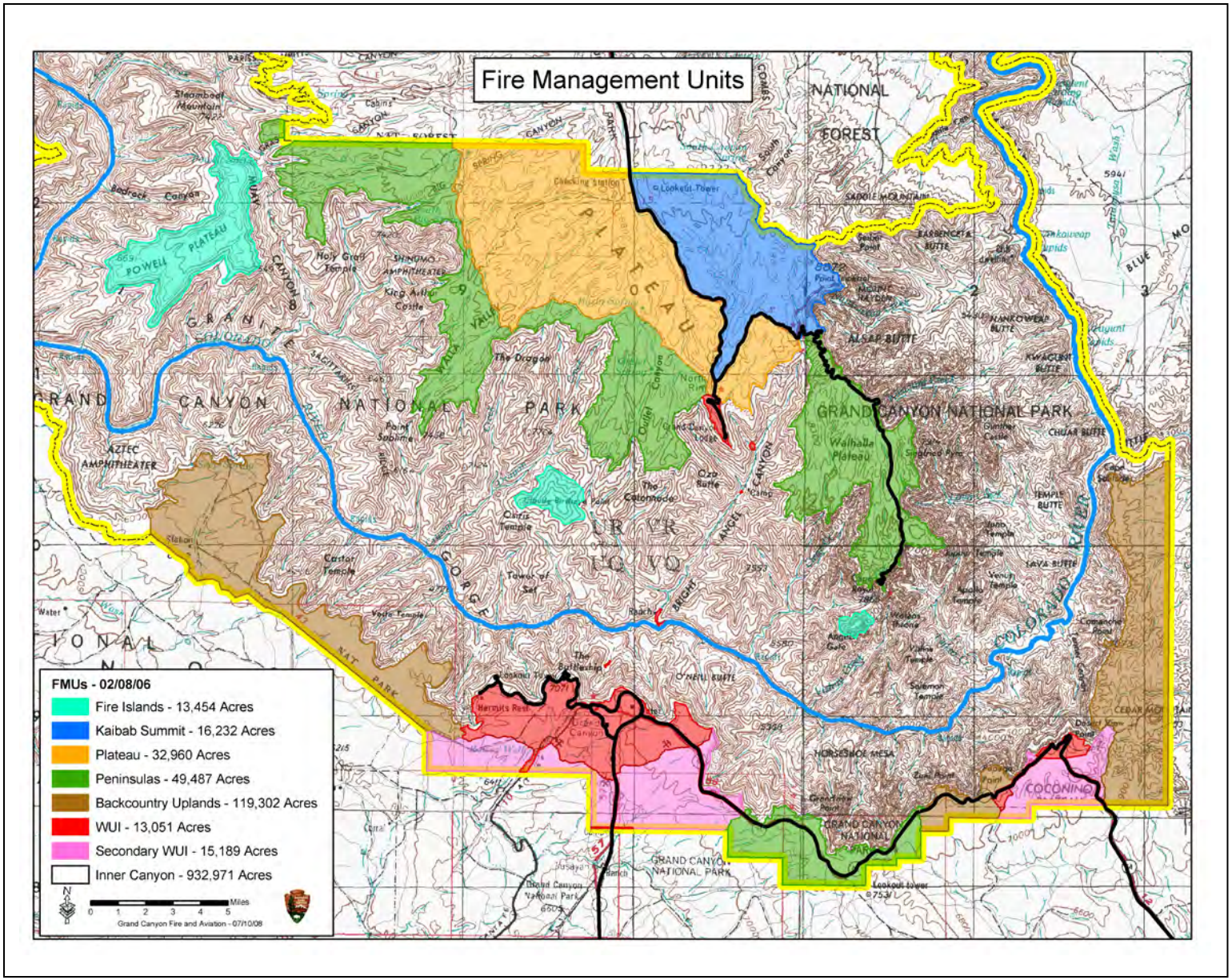
Fire Management Unit Characteristics for Action Alternatives								
	Kaibab Summit	**Plateau**	**Peninsulas**	**Fire Islands**	**Backcountry Uplands**	**Primary WUI**	**Secondary WUI**	**Inner Canyon**
Acres	15,879	32,564	48,807	13,454	119,069	14,611	15,188	933,032
% of Park	1.33%	2.73%	4.09%	1.13%	9.98%	1.22%	1.27%	78.23%
Role of Fire	Spruce-fir forest species are intolerant of fire; mixed-severity fire regime and infrequent stand-replacing fire occurs	Mixed-conifer forest structure depends on mixed-severity fire	Ponderosa forest structure depends on frequent surface fires	Ponderosa forest depends on frequent surface fires; mixed fire regimes in other types require more research	Mixed fire regimes may occur in this type; more research is needed	See Peninsulas and Backcountry Uplands description	See Peninsulas and Backcountry Uplands description	Sparse vegetation and fuels do not support fire as a major disturbance agent
Fire Regime Alteration	Little change to fire regime, possibly some meadow encroachment and fewer aspen	Relatively homogeneous forest structure developed in absence of fire	Heavy understory developed in absence of fire, much restored to open understory by managed fire	Essentially unaltered, cited in literature as best relics of pre-Euro-American conditions	Unknown; possible canopy closure	Heavy understory developed in absence of fire, little restored to open under-story by managed fire	Heavy understory developed in absence of fire, much restored to open understory by managed fire	Extensive growth of annual exotics (i.e., cheat-grass) could fundamentally alter fire regime
Tactical Considerations	Heavy fuels, little road access, few water resources, limited helispots, few natural fuel breaks, remote	Heavy fuels, little ground access, few water resources, limited helispots, few natural fuel breaks, remote	Some heavy fuels, limited escape, limited water resources	Isolated with difficult access but very little potential for spread beyond mesa tops	Remote, long access routes, limited water resources	Immediate proximity to developments, utilities, hazardous materials, evacuation challenges	Close proximity to develop-ments, utilities, hazardous materials, evacuation challenges	Difficult access (helicopter), few water resources, remote



Map 2-1 Fire Management Unit Boundaries, Alternative 1, No Action (Existing Program)



Map 2-2 Fire Management Unit Boundaries, Alternatives 2, 3, 4, and 5 (Action Alternatives)



Map 2-3 Fire Management Unit Boundaries, Alternatives 2, 3, 4, and 5 (Action Alternatives) Heart of the Canyon

2.7 Alternatives Under Consideration

The NPS identified five alternatives for analysis while developing the proposed GRCA FMP. As required by NEPA, a No Action Alternative describes the existing Fire Management Program as described in the current Fire Management Plan. Four action alternatives have been crafted in response to identified program goals and needs. Each aims to restore and maintain natural ecosystems and to protect people, communities, resource values, and infrastructure from unwanted fire. The five alternatives under consideration follow.

There are two acreage estimates for prescribed fire in alternatives 1, 2, and 4. Some impact topics (air quality, soundscape, park operations) used acreage estimates that count prescribed fire acres each time a burn unit is treated. Burn units listed for two treatments in the long-term treatment schedule (Appendix D) were counted twice when adding total number of acres treated with prescribed fire for each alternative. For example: the Range prescribed fire unit (1,640 acres) is planned for prescribed fire treatment in 2008 and 2017 under Alternative 1. The Range unit would then add to a total of 3,280 acres of prescribed fire for Alternative 1.

Other impact topics (vegetation and fire ecology, exotic plants, wildlife, special status wildlife, soils and watersheds, cultural resources, wilderness, socio-economics, visitor experience), counted the burn unit acres once, regardless of the number of treatments. For example: the Range prescribed fire unit (1,640 acres) is planned for prescribed fire treatment in 2008 and 2017 under Alternative 1. The Range unit would then add up to 1,640 acres for Alternative 1. Any impacts from subsequent prescribed fire entries would be similar to or less than impacts assessed from the first prescribed fire entry for all impact topics listed in this paragraph.

Alternative 1 No Action, Existing Program
Continues the existing program including fire suppression, fire use, prescribed fire, and limited manual fuel-reduction treatments, and continues three existing Fire Management Units (See 2.8).

Alternative 2 Mixed Fire Treatment Program
Resembles the No Action Alternative but uses newly defined Fire Management Units. Combines suppression, fire use, prescribed fire, and non-fire treatments with additional options of mechanical and manual hazard-fuel treatment techniques. Focus is on restoring and maintaining park ecosystems with prescribed fire and fire-use fire, and reducing hazard fuels in WUI areas using prescribed fire and non-fire treatments (See 2.8 and 2.9).

Alternative 3 Non-Fire Treatment Emphasis
Combines suppression, fire use, prescribed fire, and mechanical and manual hazard-fuel reduction techniques. Focus is on fuel-reduction projects in the Wildland-Urban Interface to reduce wildfire hazard to park communities and values at risk. Prescribed fire would focus on the WUI, and fire use would occur when fire management staff can manage a fire without reducing WUI operations (See 2.8 and 2.9).

Alternative 4 Prescribed Fire Emphasis
Combines suppression, fire use, prescribed fire, and mechanical and manual hazard-fuel reduction techniques. Focus is on restoring park ecosystems with prescribed fire to desired conditions prior to managing fire in those areas with fire use. Fire use would only occur in areas that meet desired-condition criteria. Non-fire treatments and prescribed fire would occur in the WUI (See 2.8 and 2.9).

Alternative 5 Fire Use Emphasis
Combines suppression, fire-use, and prescribed fire, and mechanical and manual hazard-fuel reduction techniques. Focus is on restoring park ecosystems and maintaining historical fire regimes through fire-use management. WUI and values at risk protection occur through prescribed fire and thinning operations (See 2.8 and 2.9).

2.7.1 Alternative 1 No Action, Existing Program

The No Action Alternative would continue the existing direction of GRCA's Fire Management Program as described in the current Fire Management Plan, as amended. Objectives of the existing program focus on protecting human life, health, and property; protecting values at risk from wildfire; using prescribed and wildland fire to restore fuel loads and ecosystem structure; restoring fire as an essential ecological process; and reducing hazard fuels to protect developed areas. The No Action Alternative is composed of two primary elements 1) continued use of three existing Fire Management Units to categorize GRCA habitat for purposes of fire management planning and implementation and 2) continued use of suppression, wildland fire use, prescribed fire, and manual fuel-reduction treatments.

The No Action Alternative assumes a similar or slightly higher level of suppression would occur as occurred 1993–2005. Successful suppression of small fires (in areas treated with past fires) should improve. However, large areas with poor access have not burned in the last 100 years, and risk of large-scale wildfire in these areas is very high. Wildland fires managed as suppression actions averaged 1,705 acres annually from 1993-2005.

Prescribed fire would continue under a Long-Term Treatment Schedule (see Appendix D, Figure 2-3, and Map 2-4), resulting in an average of 5,840 acres treated annually. As the Fire Management Program's prescribed fire portion moves into more complex burn units (like mixed-conifer areas with high fuel loads and ladder fuels), risks associated with these projects increase.

Annual acreage managed as Wildland Fire Use is expected to increase as natural fire regimes are restored, though it is difficult to predict by how much. It is feasible to assume that acres treated under a wildland fire use strategy could rise to an annual average of 5,000 acres from the current 13-year average (1993-2005) of 3,568 acres. Acres treated with future prescribed fires may actually decrease under this alternative as acres treated under a wildland fire use strategy increase and treat those future prescribed fire acres.

Under the No Action Alternative, existing manual fuel-reduction treatments would continue in the piñon-juniper habitat of FMUs 1 and 3 in areas not proposed as wilderness including Grand Canyon Village, Hermits Rest, Desert View, and along main routes between these developments (Highway 64 and West Rim Drive). Manual treatments in spruce-fir habitat (FMU 2) would continue, primarily aimed at prescribed fire unit preparation, WUI protection, and the main route in and out of North Rim (Highway 67). Level of activity would continue at an estimated 10-60 acres per year with an average 40 acres per year, and would employ prescription elements for treatments detailed below. This alternative will accomplish the least protection in the WUI. See Tables 2-8 through 2-11 for a comparison of the five proposed alternatives.

Thinning standards for Wildland-Urban Interface areas under the existing program (No Action Alternative) consist of the following (levels of thinning and fuel removal decrease as distance from structures increases to the quarter-mile limit).

- Thin up to a 15-foot canopy clearance, removing trees up to ten inches dbh
- Limb each tree four-to-six feet above the ground to reduce ladder fuels
- Remove up to 80% of dead-and-down woody debris 3–12 inches dbh
- Remove up to 50% of dead-and-down woody debris larger than 12 inches dbh
- Flush-cut all stumps as low to the ground as possible
- Do not cut any snags (dead trees) greater than 12-inches dbh unless the snag poses a threat to crew or public safety

Also, under the existing program, standards for manual fuel thinning in the immediate vicinity of structures (to establish and maintain defensible space) are

- Prune all trees within 30 feet of structures three-to-six feet from the ground. Height of limbing will depend on vegetative cover beneath the tree
- Cut all tree limbs overhanging, and in contact with, any roof by a maximum of ten feet. If conditions warrant the entire tree may be removed
- Cut all tree limbs in direct structural contact back to three-to-six feet from the structure
- Remove 80% of dead material on the ground greater than three inches diameter within thirty feet of structures
- Create ten feet of space between tree crowns within 30 feet of each structure

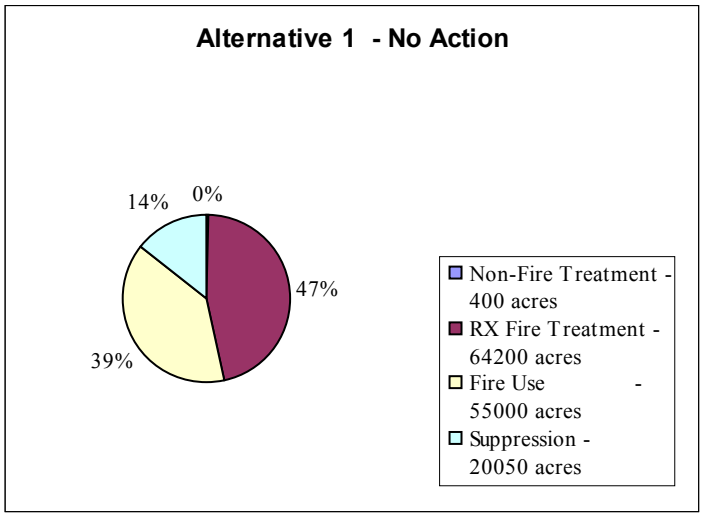
If there are questions about applicability of any standard as applied to protection of visual values, cultural features, or other park resources, clarification is requested from the park Landscape Architect and/or Division of Science and Resource Management staff before a project is implemented.

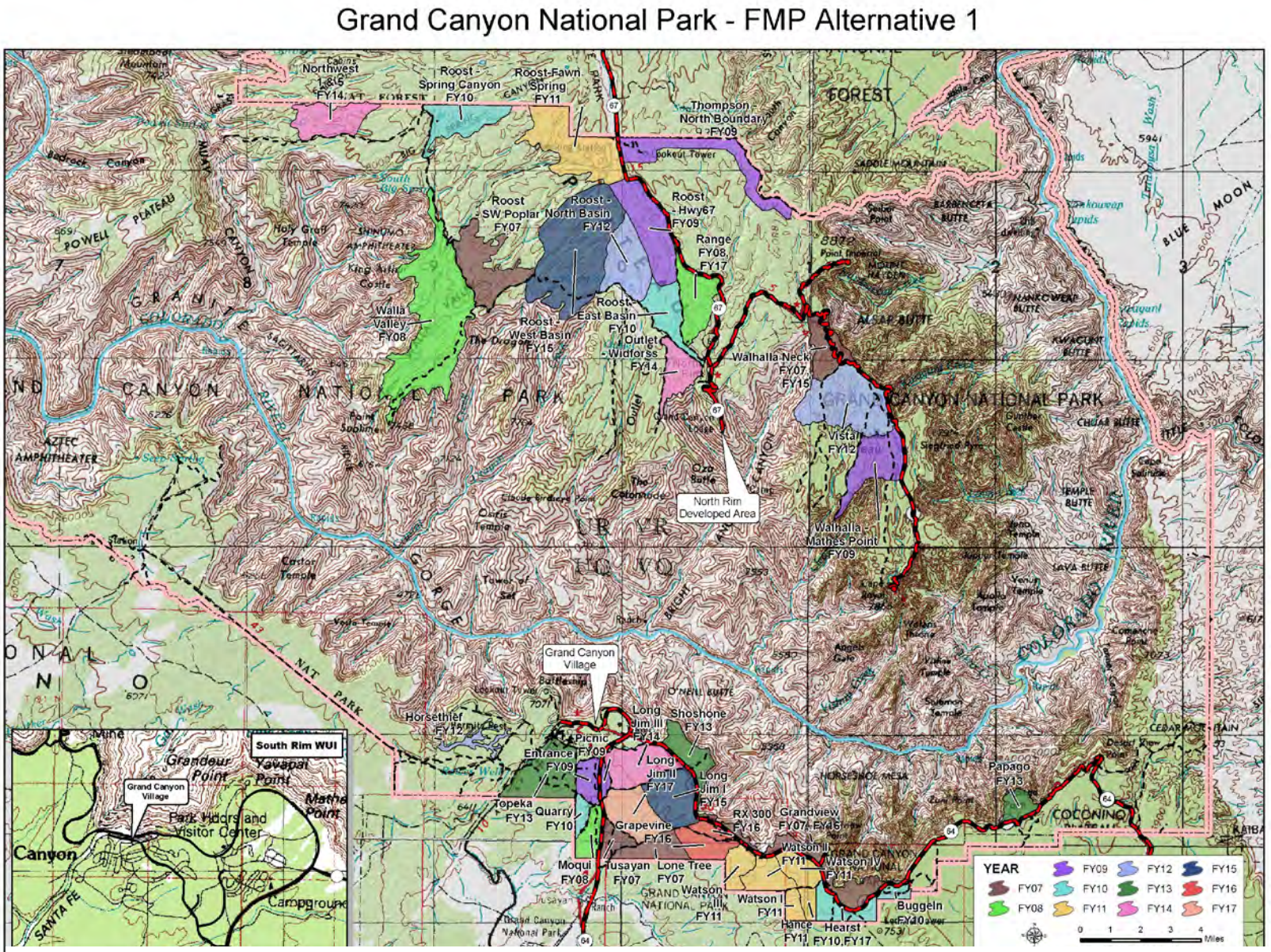
Considerations when planning fuel-break construction include

- Retain a level of surface forbs (broadleaf plants with little or no woody material) and other plants to discourage invasive plant species
- Establish key photo points and monitoring plots to monitor post-treatment vegetative recovery and colonization by invasive, nonnative plant species
- Outline all proposed operations in the project plan for review by GRCA resource staff
- As much as possible, maintain soil quality and nutrients by leaving twigs, green leaves, and needles onsite which retain proportionately more nutrients than other plant portions
- Retain vegetative or litter cover over soil surface to minimize erosion
- Protect water quality and yield by mitigating adverse impacts of ground disturbance and providing undisturbed buffer units within riparian areas

Alternative 1 is a balanced approach to managing hazardous fuels, restoring natural fire regimes, and suppressing unwanted fires but lacks the increased focus needed to protect the WUI through hazard fuel reduction projects. This alternative would cost approximately $159.00/acre, less than three of the other alternatives due to the lack of high-cost non-fire treatments.

Figure 2-3 Treatment Totals for each Treatment Type, Alternative 1, No Action





Map 2-4 Alternative 1 Prescribed Fire and Non-Fire Treatment Map through 2017

2.7.2 Alternative 2 (Preferred Alternative) Mixed Fire Treatment Program

The Mixed Fire Treatment Program Alternative would continue the existing direction of GRCA's Fire Management Program with limited changes. Changes include use of new Fire Management Units (Map 2-2) and development of a Wildland-Urban Interface treatment program involving manual and mechanical fuel-reduction methods. Alternative 2 would continue use of suppression, wildland fire use, prescribed fire, and manual fuel-reduction treatments.

Alternative 2, Mixed Fire, assumes a similar or slightly higher level of suppression would occur through the life of the plan as occurred 1993–2005.

Prescribed fire would continue under a Long-Term Treatment Schedule (see Appendix D, Figure 2-4, and Map 2-5), resulting in an average 5,840 acres treated annually. As the Fire Management Program's prescribed fire portion moves into more complex burn units (like mixed-conifer areas with high fuel loads and ladder fuels), risks associated with these projects increase.

Annual acreage managed as Wildland Fire Use is expected to increase as natural fire regimes are restored, though it is difficult to predict the amount. It is feasible that acres treated under a wildland fire use strategy could rise to an annual average 5,000 acres from the current 13-year average (1993-2005) 3,568 acres. Acres treated with future prescribed fires may actually decrease under this alternative as acres treated under other wildland fire strategies increase and treat those future prescribed fire acres.

Mechanical and manual fuel-reduction treatments within the WUI would also be carried out under a Long-Term Treatment Schedule (see Appendix D, Figure 2-4, and Map 2-5), resulting in an average of 225 acres treated annually. The increase in treated WUI acres will decrease wildland fire risks and increase safety in these areas.

Thinning standards (accomplished by manual or mechanical means) for WUI under Alternative 2 are found in National Fire Protection Association (NFPA) Codes, Chapter 4 Assessing Wildland Fire Hazards in the Structure Ignition Zone (online at http://www.nfpa.org/). Additional guidelines can be found in the 2006 International Wildland-Urban Interface Code available at http://www.nwcg.gov/pms/docs/PMS310-1-january-2006.pdf.

- Thin up to a 12-foot canopy clearance, removing trees up to ten inches dbh
- Limb trees four-to-six feet above the ground to reduce ladder fuels
- Remove up to 60% of dead-and-down woody debris 3–12 inches dbh
- Remove up to 50% of dead-and-down woody debris larger than 12 inches dbh
- Flush-cut all stumps as low to the ground as possible
- Slash from thinning operations may be removed, lopped, and scattered for a future broadcast burn; piled and burned in place; or chipped on or offsite
- Modifications to degree of thinning may occur in the historic landmark district or adjacent to individually listed National Register of Historic Places Buildings

Standards for manual fuel thinning in the immediate vicinity of structures (to establish and maintain defensible space) are found in NFPA Codes, Chapter 4 Assessing Wildland Fire Hazards in the Structure Ignition Zone. Additional guidelines can be found in the 2006 International WUI Code.

- Prune all trees within 50 feet of structures and increase the height to live crown to prevent surface fire from transitioning to crown fire.
- Cut all tree limbs overhanging and in contact with any roof by a maximum of ten feet. If conditions warrant the entire tree may be removed
- Cut all tree limbs in structural contact back to three-to-six feet from the structure
- Remove 80% of dead material on the ground greater than three inches diameter within 30 feet of structures

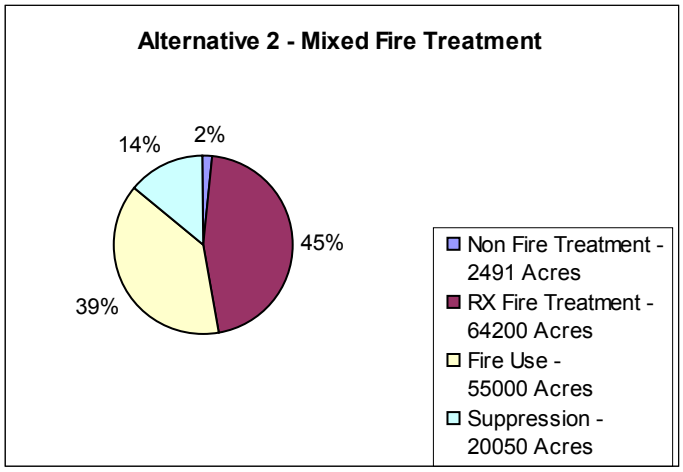
• Create ten feet of space between tree crowns within 30 feet of each structure

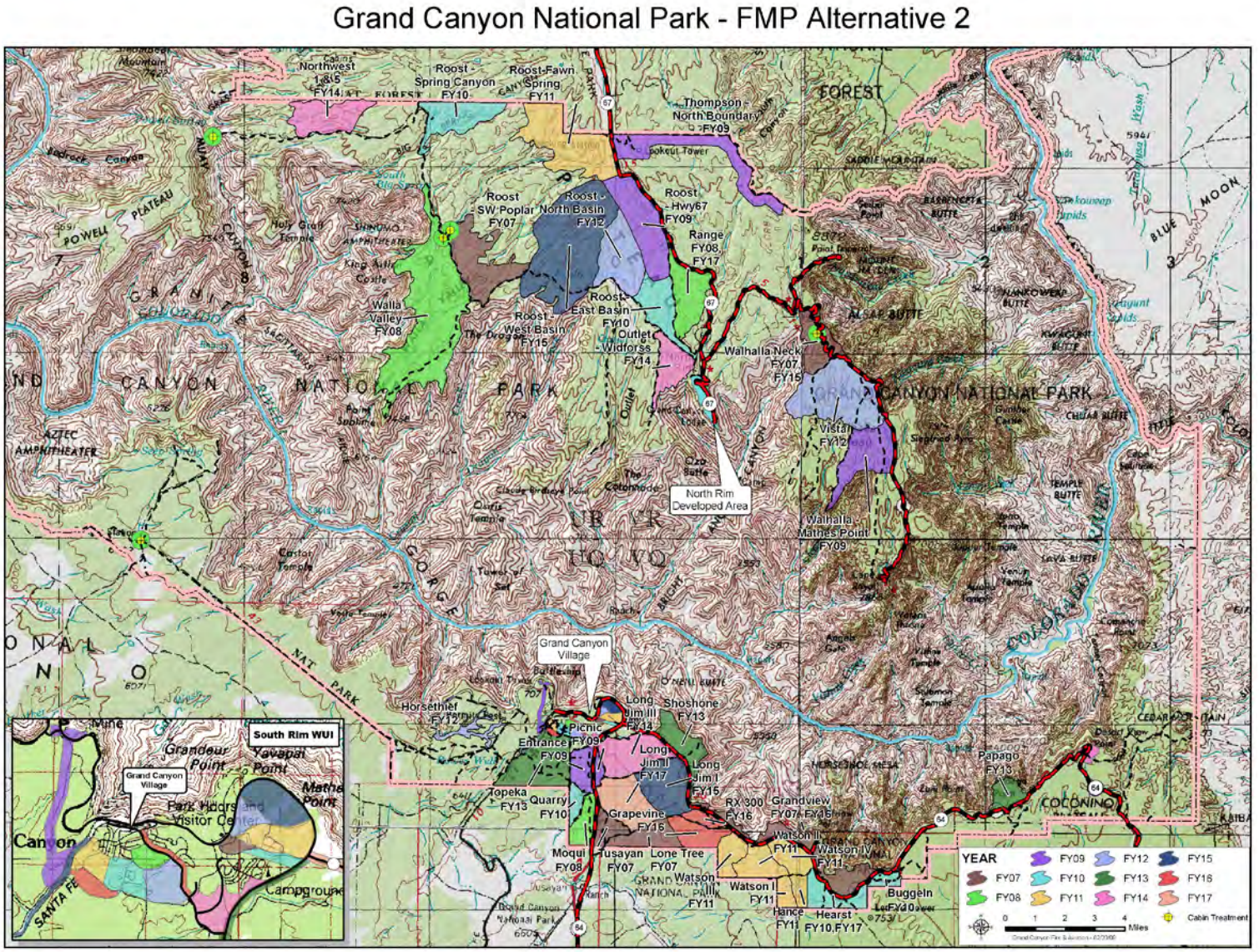
Additional treatment units not identified in the treatment schedule may also be accomplished, including residential areas that have or have not been treated in the past. For example, some thinning has occurred in the historic district, but only in areas within 30 feet of structures. Additional thinning may occur in or outside that 30-foot space to expand defensible space and meet desired conditions throughout the WUI.

Total cost and cost/acre for this alternative is higher than the No Action Alternative, at approximately $167.00/acre, without a significant increase in total number of treated acres.

Increased cost is due to increased manual thinning and use of mechanical thinning. This alternative also maintains a balance of fire management strategies without emphasizing or favoring any specific strategy. Alternative 2 is a balanced approach to managing hazardous fuels, protecting the WUI, restoring natural fire regimes, and suppressing unwanted fires.

Figure 2-4 Treatment Totals for Each Treatment Type for Alternative 2 Mixed Fire Treatment Program





Map 2-5 Alternative 2 Prescribed Fire and Non-Fire Treatment Map through 2017

2.7.3 Alternative 3 Non-Fire Treatment Emphasis

Alternative 3 would change the existing direction of GRCA's Fire Management Program through inclusion of a large mechanical- and manual-thinning component along with the wildland fire use and suppression program. The mechanical and manual thinning program would comprise the majority of the fire management staff's planning and implementation efforts. Thus, the wildland fire use and prescribed fire programs would be reduced due to time and/or resource constraints.

Alternative 3 Non-Fire Treatment Emphasis assumes an increase in suppression level through the life of the plan compared to 1993-2005. Acres burned under a suppression strategy would increase by an estimated 30% due to lack of effort in restoring fire regimes and fuel conditions (primarily in North Rim forests) through wildland fire use or prescribed fire. Large areas with poor access have not burned in the last 100 years, and risk of large-scale wildfire in these areas is very high. As fuel loads increase, fires will grow more quickly with greater intensity, reducing effectiveness of firefighters and fire-suppression equipment. Wildland fires managed as suppression actions are assumed to average 2,370 acres annually through the life of the plan.

Prescribed fire would continue under a Long-term Treatment Schedule (Appendix D, Figure 2-5, and Map 2-6), resulting in an average 2,300 acres treated annually. Emphasis for most prescribed fire treatments will be in the WUI to maintain light fuel loads.

Annual acreage managed as Wildland Fire Use is expected to fall due to fire staff commitments to accomplishing non-fire treatment. Fire-use fires would still be part of the Fire Management Program when staff is available to manage the fire. It is feasible that fire use acres would burn an annual average of 800 acres from the current 13-year average (1993-2005) of 3,568 acres.

WUI mechanical and manual fuel-reduction treatments would be carried out under a Long-term Treatment Schedule (Appendix D, Figure 2-5, and Map 2-6), resulting in an average 360 acres treated annually.

Thinning standards (accomplished by manual or mechanical means) for WUI under Alternative 3 are found in NFPA Codes, Chapter 4 Assessing Wildland Fire Hazards in the Structure Ignition Zone. Additional guidelines can be found in the 2006 International Wildland-Urban Interface Code.

- Thin up to a 12-foot canopy clearance, removing trees up to ten inches dbh
- Limb trees four-to-six feet above the ground to reduce ladder fuels
- Remove up to 60% of dead-and-down woody debris 3–12 inches dbh
- Remove up to 50% of dead-and-down woody debris larger than 12 inches dbh
- Flush-cut all stumps as low to the ground as possible
- Slash from thinning operations may be removed, lopped, and scattered for a future broadcast burn; piled and burned in place; or chipped on or offsite
- Modifications to degree of thinning may occur in the historic landmark district or adjacent to individually listed National Register of Historic Places Buildings

Also, standards for manual fuel thinning in the immediate vicinity of structures (to establish and maintain defensible space) are found in NFPA Codes, Chapter 4 Assessing Wildland Fire Hazards in the Structure Ignition Zone. Additional guidelines can be found in the 2006 International WUI Code.

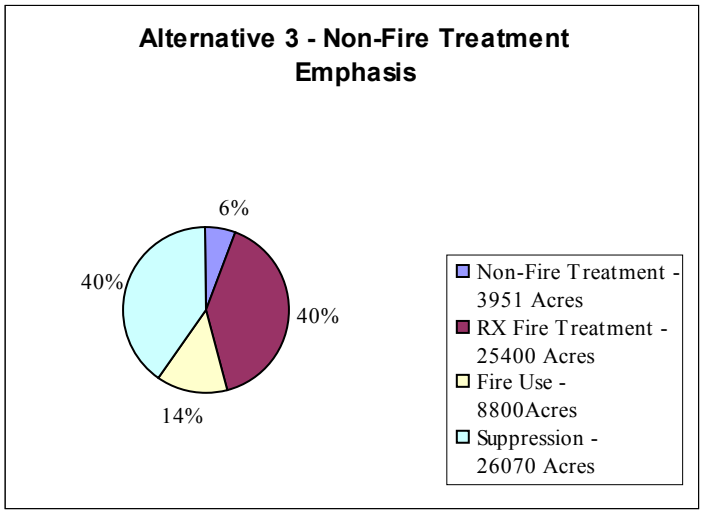
- Prune all trees within 50 feet of structures and increase the height to live crown to prevent surface fire from transitioning to crown fire.
- Cut all tree limbs overhanging and in contact with any roof by a maximum of ten feet. If conditions warrant the entire tree may be removed
- Cut all tree limbs in structural contact back to three-to-six feet from the structure

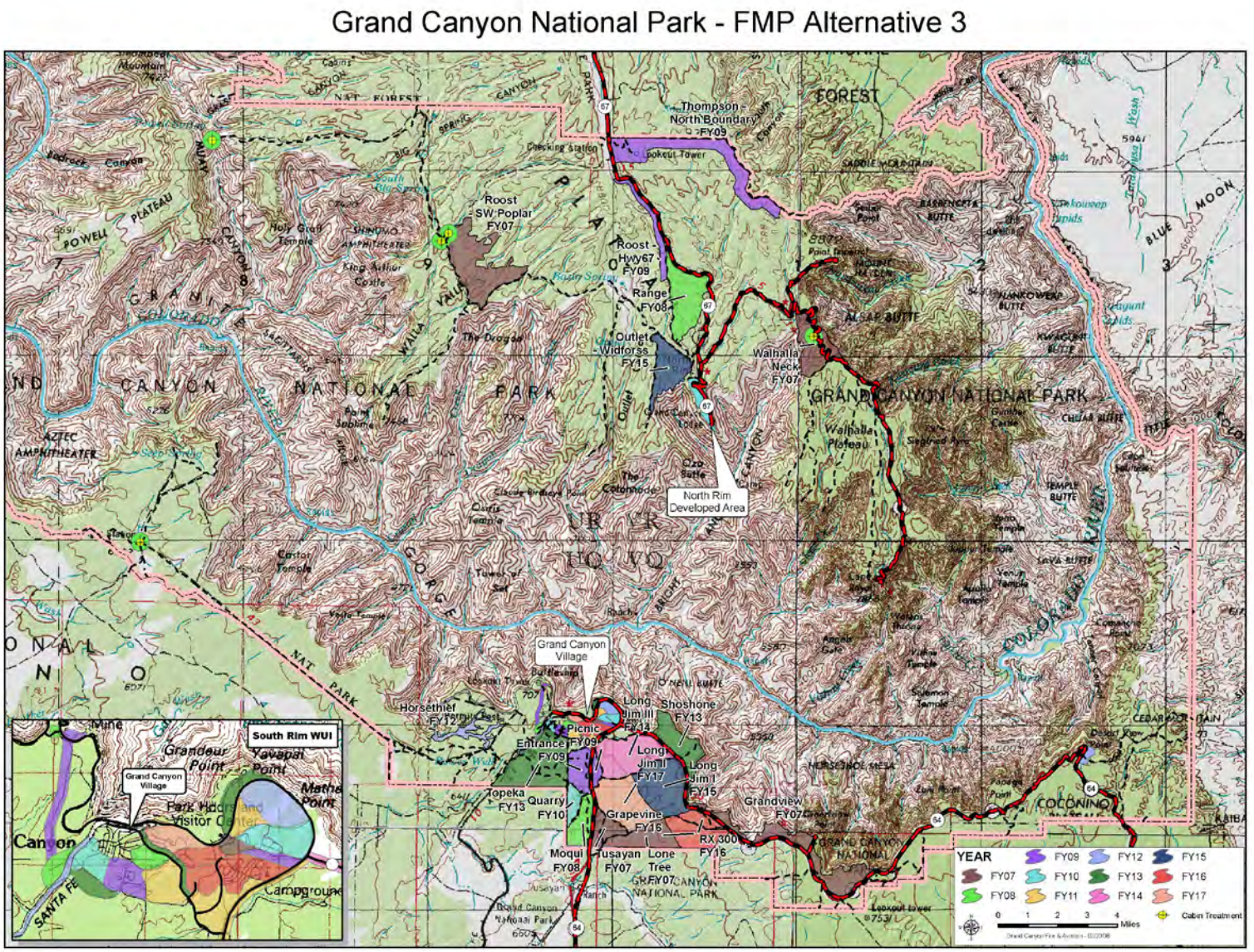
- Remove 80% of dead material on the ground greater than three inches diameter within 30 feet of structures
- Create ten feet of space between tree crowns within 30 feet of each structure

Additional treatment units not identified in the treatment schedule may also be accomplished, including residential areas that have or have not been treated in the past. For example, some thinning has occurred in the historic district, but only in areas within 30 feet of structures. Additional thinning may occur in or outside that 30-foot space to expand defensible space and meet desired conditions throughout the WUI.

Protecting the WUI through prescribed fire, manual thinning treatments, and mechanical treatments is the focus of Alternative 3. The speed at which thinning occurs, and the number of acres treated with non-fire treatments in the primary WUI, will be faster and larger than any other alternative. Through the life of the plan, Alternative 3 proposes to treat the least amount of acres with fire and non-fire treatments, which would mean moving the least amount of acres toward desired vegetative structural conditions. This alternative is also the most expensive at approximately $225.00/acre due to the high cost of non-fire treatments. This alternative does not use a balance of all fire management strategies but focuses primarily on non-fire treatments. Alternative 3 does not continue progress made toward restoring natural fire regimes or maintaining fire-adapted ecosystems through use of prescribed fire and wildland fire use. The suppression program would grow as more fires are suppressed. Under Alternative 3 community protection will occur at the cost of restoring fire regimes.

Figure 2-5 Treatment Totals for each Treatment Type for Alternative 3 Non-Fire Treatment Emphasis





Map 2-6 Alternative 3 Prescribed Fire and Non-Fire Treatment Map through 2017

2.7.4 Alternative 4 Prescribed Fire Emphasis

Alternative 4 would change the existing direction of GRCA's Fire Management Program by increasing the amount of prescribed fire. The prescribed fire program would be solely responsible for achieving desired vegetative structural conditions. Any area not identified as being at desired conditions would not be eligible for management with fire use, creating a suppression response. Therefore, the wildland fire use program would initially be reduced to a few small areas.

Alternative 4 assumes an increased suppression level through the life of the plan compared to 1993–2005. Acres burned could increase by an estimated 20% due to decrease of fire-use fires and multiple prescribed fire entries needed to move an area to desired conditions. Successful suppression of small fires (in areas previously treated with fire) should improve. However large areas with poor access have not burned in the last 100 years, and risk of large wildfire in these areas is very high. As the prescribed fire portion of the Fire Management Program moves into more complex burn units (like mixed-conifer areas with high fuel loads and ladder fuels), risks associated with these projects increase, thus increasing the chance of escaped prescribed fire. Wildland fires could rise to an average 2,190 acres annually.

Prescribed fire would continue under a Long-term Treatment Schedule (Appendix D, Figure 2-6, and Map 2-7), resulting in an average 9,930 acres treated annually. The prescribed fire program would emphasize treating WUI areas to maintain light fuel loads and protect park communities. The prescribed fire program would also emphasize moving current vegetative structural conditions toward desired conditions outside the WUI. Time and effort needed for planning and implementing this level of prescribed fire would mean less effort toward planning and implementing non-fire treatments.

Annual acreage managed as Fire Use is expected to fall due to lack of suitable areas that meet desired conditions. It is feasible that fire-use acres would burn an annual average 500 acres from the current 3,568 acre 13-year average (1993-2005).

Mechanical and manual fuel-reduction treatments in the WUI would be carried out under a Long-term Treatment Schedule (Appendix D, Figure 2-6, and Map 2-7), resulting in an average 75 acres treated annually.

Thinning standards (accomplished by manual or mechanical means) for WUI under Alternative 4 found in NFPA Codes, Chapter 4 Assessing Wildland Fire Hazards in the Structure Ignition Zone. Additional guidelines can be found in the 2006 International Wildland-Urban Interface Code.

- Thin up to a 12-foot canopy clearance, removing trees up to ten inches dbh
- Limb trees four-to-six feet above the ground to reduce ladder fuels
- Remove up to 60% of dead-and-down woody debris 3–12 inches dbh
- Remove up to 50% of dead-and-down woody debris larger than 12 inches dbh
- Flush-cut all stumps as low to the ground as possible
- Slash from thinning operations may be removed, lopped, and scattered for a future broadcast burn; piled and burned in place; or chipped on or offsite
- Modifications to degree of thinning may occur in the historic landmark district or adjacent to individually listed National Register of Historic Places Buildings

Standards for manual fuel thinning in the immediate vicinity of structures (to establish and maintain defensible space) are found in NFPA Codes, Chapter 4, Assessing Wildland Fire Hazards in the Structure Ignition Zone. Additional guidelines can be found in 2006 International Wildland-Urban Interface Code.

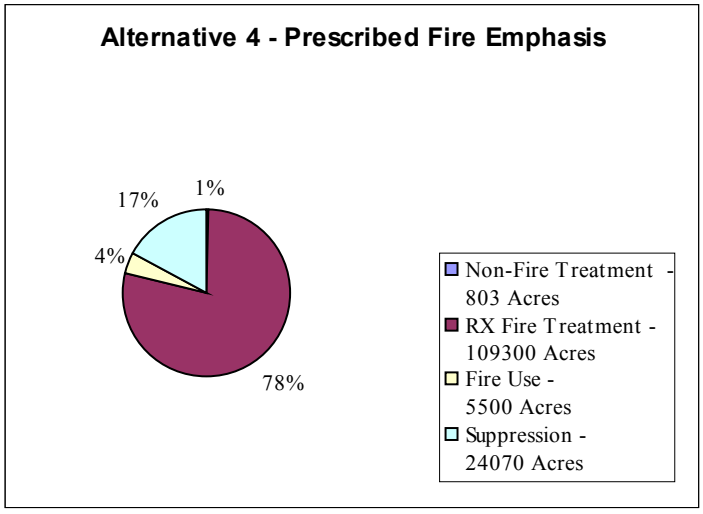
- Prune all trees within 50 feet of structures and increase the height to live crown to prevent surface fire from transitioning to crown fire.
- Cut all tree limbs overhanging and in contact with any roof by a maximum of ten feet. If conditions warrant the entire tree may be removed

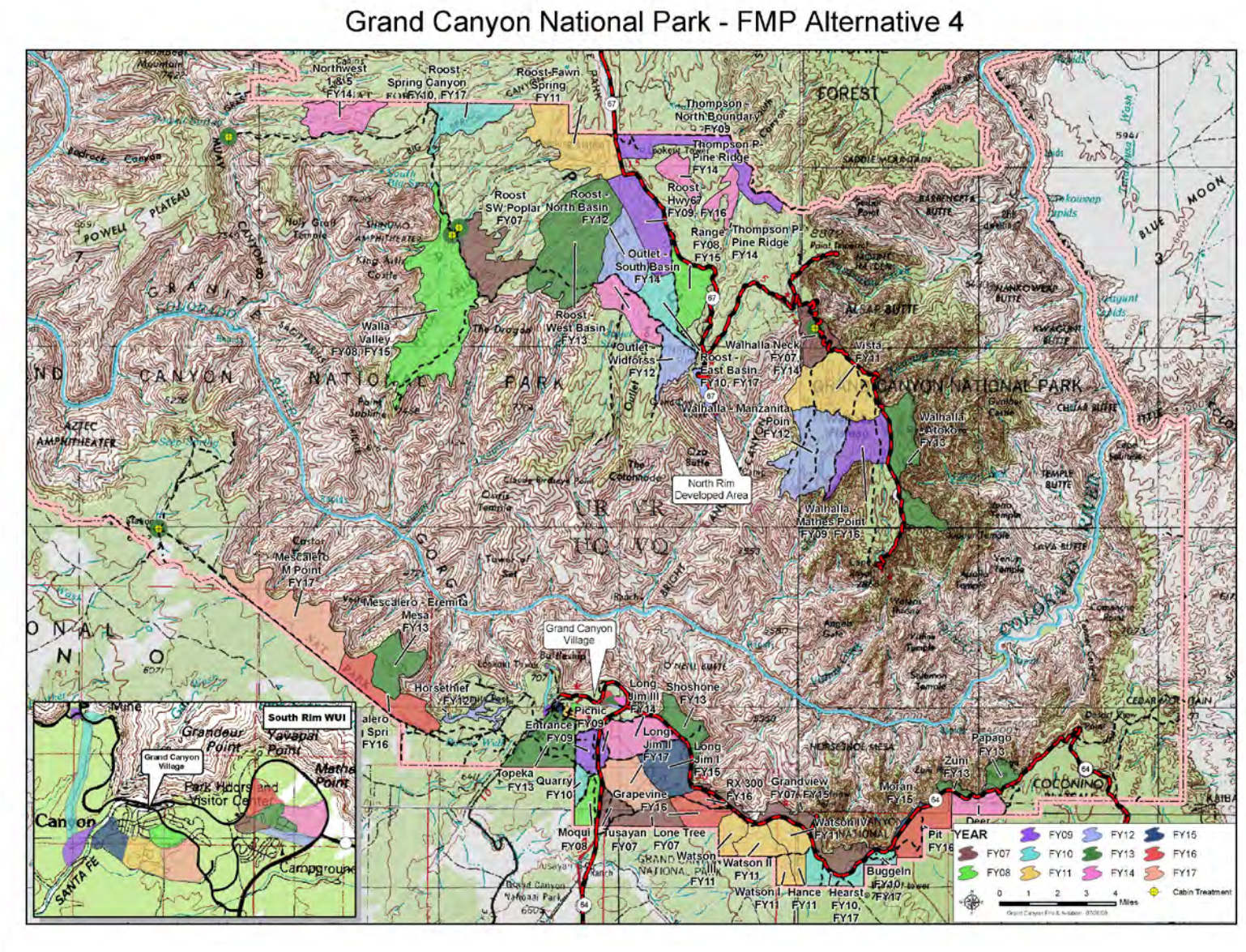
- Cut all tree limbs in structural contact back to three-to-six feet from the structure
- Remove 80% of dead material on the ground greater than three inches diameter within 30 feet of structures
- Create 10 feet of space between tree crowns within 30 feet of each structure

Additional treatment units not identified in the treatment schedule may also be accomplished. This includes residential areas that have or have not been treated in the past. For example, some thinning has occurred in the historic district, but only in areas within 30 feet of structures. Additional thinning may occur in or outside that 30-foot space to expand defensible space and meet desired conditions throughout the WUI.

Through the life of the plan, Alternative 4 proposes to treat the largest amount of acres with fire and non-fire treatments. Alternative 4 does not allow many opportunities to manage wildland fire under a fire-use strategy which may reduce the chance of having a mosaic of fire effects throughout the park. This alternative is the least expensive at approximately $124.00/acre due to use of aerial techniques to ignite large prescribed burn units in a very short time. Large time commitments will be required to plan and prepare such a large prescribed fire program, thus this alternative requires the largest time commitments for park fire staff.

Figure 2-6 Treatment Totals for each Treatment Type Under Alternative 4 Prescribed Fire Emphasis





Map 2-7 Alternative 4 Prescribed Fire and Non-Fire Treatment Map through 2017

2.7.5 Alternative 5 Fire Use Emphasis

Alternative 5 would change the existing direction of GRCA's Fire Management Program by expanding amount (acres and number of incidents) of fire use. Alternative 5 would emphasize managing fire for maintenance and restoration of fire-dependant ecosystems. Managing wildfire under a fire-use strategy would be applied in all park areas except the WUI. The prescribed fire program focus would be limited to protecting values at risk, developing defendable management action points or maximum manageable areas, and reducing wildfire risk in the WUI. Prescribed fire treatments would be phased out of the proposed wilderness area, but would occur in and around park boundaries and the WUI. Non-fire treatments would only occur in the WUI.

Alternative 5 assumes a decrease in suppression fires through the life of the plan compared to 1993–2005 because more fires will be managed under a fire-use strategy. Acres burned under a suppression strategy would decrease by an estimated 10% due to increased number of fires approved and managed under a fire-use strategy. Wildland fires managed with suppression actions would be assumed to average 1,640 acres annually. These suppression acres account for fires that would not be considered for management under a fire-use strategy for reasons including political pressures, air quality issues, staffing concerns, national preparedness concerns, etc.

Prescribed fire would continue under a Long-term Treatment Schedule (Appendix D, Figure 2-7, and Map 2-8), resulting in an average 2,720 acres treated annually. Prescribed fire would also be used as a restoration and maintenance tool, but implementation would be focused on the WUI.

Annual acreage managed as fire use is expected to increase due to acceptance of fire use as a restoration and maintenance tool. It is feasible that fire-use acres would burn an annual average 8,000 acres from the current 13-year average (1993-2005) of 3,568 acres.

Mechanical and manual fuel-reduction in the WUI would be carried out under a Long-term Treatment Schedule (Appendix D, Figure 2-7, and Map 2-8), resulting in an average 245 acres treated annually.

Thinning standards (accomplished by manual or mechanical means) for WUI under Alternative 5 are found in NFPA Codes, Chapter 4 Assessing Wildland Fire Hazards in the Structure Ignition Zone. Additional guidelines can be found in the 2006 International Wildland-Urban Interface Code.

- Thin up to a 12-foot canopy clearance, removing trees up to ten inches dbh
- Limb trees four-to-six feet above the ground to reduce ladder fuels
- Remove up to 60% of dead-and-down woody debris 3–12 inches dbh
- Remove up to 50% of dead-and-down woody debris larger than 12 inches dbh
- Flush-cut all stumps as low to the ground as possible
- Slash from thinning operations may be removed, lopped, and scattered for a future broadcast burn; piled and burned in place; or chipped on or offsite
- Modifications to degree of thinning may occur within the historic landmark district or adjacent to individually listed National Register of Historic Places Buildings

Standards for manual fuel thinning in the immediate vicinity of structures (to establish and maintain defensible space) are found in NFPA Codes, Chapter 4 Assessing Wildland Fire Hazards in the Structure Ignition Zone. Additional guidelines can be found in the 2006 International WUI Code.

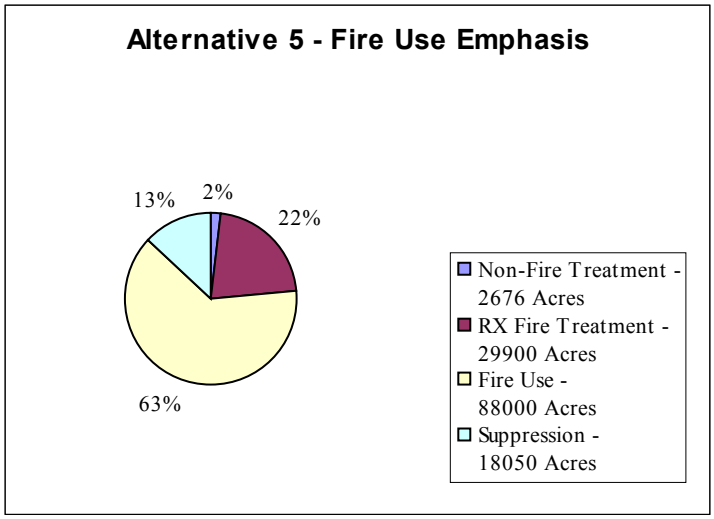
- Prune all trees within 50 feet of structures and increase the height to live crown to prevent surface fire from transitioning to crown fire.
- Cut all tree limbs overhanging and in contact with any roof by a maximum of ten feet. If conditions warrant the entire tree may be removed
- Cut all tree limbs in structural contact back to three-to-six feet from the structure

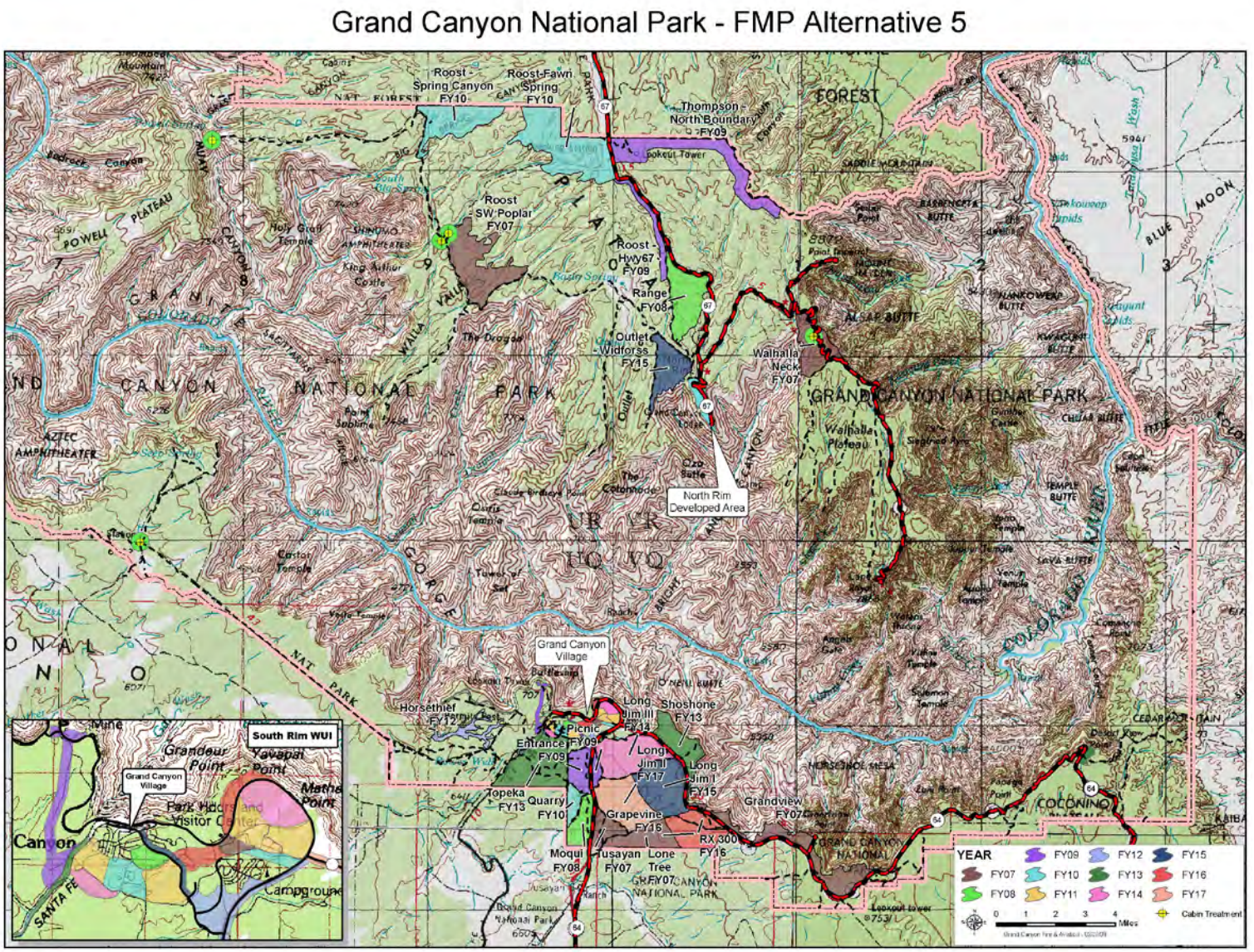
- Remove 80% of dead material on the ground greater than three inches diameter within 30 feet of structures
- Create ten feet of space between tree crowns within 30 feet of each structure

Additional treatment units not identified in the treatment schedule may also be accomplished. This includes residential areas that have or have not been treated in the past. For example, some thinning has occurred in the historic district, but only in areas within 30 feet of structures. Additional thinning may occur within or outside that 30-foot space to expand defensible space and meet desired conditions throughout the WUI.

Alternative 5 would require more non-park fire managers and fire fighters than any other alternative. Fire-use teams and fire-use modules would be needed more frequently, as compared to the existing program, to assist with the increased number of fire-use fires. Managing wildland fire under a fire-use strategy will increase opportunities of developing a mosaic of fire effects throughout the park. Due to reduction of prescribed fire planning and preparation needs, more attention could be spent on planning and implementing non-fire treatments. This alternative includes the second largest non-fire treatment program, allowing completion of all but a few treatment units in the WUI. This alternative is the second most expensive alternative at approximately $195.00/acre due to non-fire treatments and potential long duration of managing large wildland fire-use fires.

Figure 2-7 Treatment Totals for each Treatment Type Under Alternative 5 Fire Use Emphasis





Map 2-8 Alternative 5 Prescribed Fire and Non-Fire Treatment Map through 2017

2.8 Elements Common to all Alternatives

2.8.1 Relationship of GRCA Fire Program to other Fire Management Entities

Grand Canyon's fire management program is just one program among thousands nationally with fire management responsibilities. Each individual program or unit works under a regional and national office. These offices assist fire management programs with funding of personnel, property, projects, developing fire and safety policies, training standards, and courses. Consult Appendix E for information regarding NPS fire program and responsibilities.

Relationship of GRCA Fire Program to other Fire Management Entities
National Interagency Fire Center **Elements Common to all Alternatives**

The National Interagency Fire Center (NIFC), located in Boise, Idaho, is the nation's support center for wildland firefighting. Eight different agencies and organizations are part of NIFC. Decisions are made using the interagency cooperation concept because NIFC has no single director or manager.

The Boise Interagency Fire Center (BIFC) was created in 1965 because the U.S. Forest Service, Bureau of Land Management, and National Weather Service saw the need to work together to reduce duplication of services and costs and coordinate national fire planning and operations. The NPS and Bureau of Indian Affairs (BIA) joined BIFC in the mid-1970s. The U.S. Fish and Wildlife Service (USFWS) joined in 1979. The center's name was changed in 1993 from the Boise Interagency Fire Center to the National Interagency Fire Center to more accurately reflect its national mission.

NIFC Interagency Standards for Fire and Aviation Operations or Red Book, current version, gives an overview of the NPS fire management organization. For more information visit http://www.nifc.gov.

Relationship of GRCA Fire Program to other Fire Management Entities
Wildland Fire Leadership Council **Elements Common to all Alternatives**

The Wildland Fire Leadership Council (WFLC), established in April 2002 by a Memorandum of Understanding between the Secretaries of Agriculture and Interior, supports implementation and coordination of the National Fire Plan and Federal Wildland Fire Management Policy (see Chapter 1). More information is available at http://www.forestsandrangelands.gov/. GRCA's fire management program follows Council directions to ensure current fire policy is understood and followed.

Relationship of GRCA Fire Program to other Fire Management Entities
U.S. Fire Administration (USFA) **Elements Common to all Alternatives**

As an entity of the Department of Homeland Security's Federal Emergency Management Agency, the mission of the USFA is to reduce life and economic losses due to fire and related emergencies, through leadership, advocacy, coordination, and support. The USFA works independently, in coordination with other Federal agencies, and in partnership with fire protection and emergency service communities to provide public education, training, technology, and data initiatives. For more information visit http://www.usfa.dhs.gov.

2.8.2 GRCA Fire Management Organization and Responsibilities **Elements Common to all Alternatives**

Grand Canyon's Fire Management Program is directed by the Fire Management Officer (FMO) who also functions as Chief, Branch of Fire and Aviation.

The following general staff positions report directly to the Chief, Branch of Fire and Aviation

- Deputy Fire Management Officer
- Aviation Officer
- South Rim District FMO
- North Rim District FMO

The following staff positions report directly to the Deputy Fire Management Officer

- Fire Ecologist/Planner
- GIS Specialist
- Communication Center Manager (jointly supervised through an operating agreement with the Kaibab National Forest)

The Helicopter Manager reports directly to the Aviation Officer.

Implementation of the proposed FMP and overall program responsibility lie with the Chief, Fire and Aviation, including short- and long-term program and financial planning and fiscal responsibility. Consult Appendix E, Attachment A for a GRCA Fire and Aviation Organizational Chart.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives Relationship of GRCA Fire Organization to Park Organization

Fire and Aviation Management is a branch in the Division of Visitor and Resource Protection. The Fire Management Officer is the branch chief and reports directly to the Chief Ranger, who reports to the Deputy Superintendent.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives Superintendent Responsibilities and Delegations

The Superintendent is responsible to the Regional Director for safe and efficient implementation of fire-management activities, including cooperative activities with other agencies or landowners in accordance with delegations of authorities. The Superintendent is responsible to approve and periodically assess and certify by signature, fire and aviation management actions. This responsibility may be delegated to another organizational level under certain conditions.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives Fire Management Program

Fire Management Program elements common to all alternatives are

- All human-caused fires will be managed using the current NPS policy
- Collaboration with neighboring agencies and private land owners will remain a vital element in fire management program success
- Non-fire fuel treatments may occur in proposed wilderness to protect values at risk
- Thinning and reduction of dead-and-down fuels and some live fuels may occur on prescribed fire unit boundaries to reduce risk of high-intensity fire along those boundaries
- Thinning and reduction of dead-and-down fuels and some live fuels along roads, trails, and fire line may occur during wildland fire use fire management
- Changes to existing treatment schedules would be limited prior to FY10 due to existing project funding and preparation schedules
- Seasonality: South Rim prescribed fires could be implemented any month to meet prescription parameters; North Rim prescribed fires would not likely occur December, January, and February

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives Public and Firefighter Safety Fire Management Program

Public and firefighter safety is the first priority for all alternatives. National Fire Policy states, “Firefighter and public safety is the first priority, and all fire management plans and activities must reflect this

commitment." Director's Order 18 echoes this direction, "The NPS is committed to protecting park resources and natural ecological processes, but firefighter and public safety must be the first priority in all fire management activities." The proposed GRCA FMP, regardless of selected alternative, enacts the following to ensure firefighter and public safety.

- Ensure compliance with safe fire management practices by all fire employees
- Require experience, training, physical fitness, and safety practice knowledge for fire operation leaders
- Require wildland fire safety standards annual training for wildland fire operations personnel
- Require mandatory annual hands-on fire shelter deployment training
- Adhere to safety training requirements listed in RM-18
- Adopt qualifications standards for Incident Command System (ICS) positions as listed in National Wildfire Coordinating Group 310-1 Wildland Fire Qualification Subsystem Guide available at http://www.nwcg.gov/pms/docs/PMS310-1-january-2006.pdf
- Address safety concerns in a Job Hazard Analysis (JHA) in all project plans (refer to RM-18, Chapter 3 for JHA process and format)
- Give safety briefing prior to initiating project work
- Write an Incident Action Plan (IAP) for each operational shift on all large suppression, prescribed, and wildland fire-use fires. Every IAP will include a safety message
- Authorize all personnel to exercise emergency authority to stop and prevent unsafe acts
- Empower all employees to refuse unsafe assignments and identify safe alternatives to accomplish the mission
- Adopt the Wildland Fire Safety and Health Network (SAFENET) ground-based safety incident reporting system. Information at http://safenet.nifc.gov
- Conduct After Action Reviews (AAR). The Project Leader or Incident Commander will conduct AAR after each project or incident shift to evaluate safety and effectiveness of work performed, and identify and discuss encountered hazards
- Report and investigate all wildland fire incidents resulting in human entrapment, fatalities, or serious injuries, or that have potential to result in such, as required by RM-18
- Manage critical incidents following checklists and processes contained in the National Wildfire Coordinating Group's Agency Administrator Guide to Critical Incident Management available at http://www.nwcg.gov/pms/docs/PMS310-1-january-2006.pdf
- Equip all personnel on wildland fires with proper personal protective equipment (PPE) as described in RM-18. All personnel will carry a fire shelter on wildland fires at all times
- Adhere to special PPE requirements specific to particular operations (i.e., power saws, helicopters) by all personnel
- Assign an operationally qualified person, who can maintain communications with the incident management team and recognize potential problem fire behavior, to accompany untrained visitors
- Ensure all vehicles and drivers engaged in fire management activities meet Government Services Administration (GSA) and agency standards, as well as state licensing requirements
- Ensure all personnel engaged in wildland fire activities adhere to RM-18 health screening/medical surveillance and fitness requirements
- Provide all fire-management personnel three hours of duty time per week to achieve and maintain physical fitness levels prescribed in RM-18. Firefighters whose fulltime duties are 100% arduous duty-related (helitack, hand crew, engine crew, prescribed fire) will be provided one hour per day for fitness training when circumstances allow
- Assign radios to all fire crews and monitors working on wildland fires. Special permission must be obtained from incident manager for individuals to work alone on actively burning fires
- Close trails and roads providing access to mechanical fuel reduction projects, managed, unwanted, or prescribed wildland fires, if such fires and/or projects present unacceptably hazardous conditions to visitors. Backcountry permits will not be issued for trailheads leading to hazardous areas. Roads and trails will remain closed until hazard is abated

- Institute smoke warning signs on roadways and/or traffic control during wildland fires as conditions warrant and at the direction of the Burn Boss, Incident Commander, Safety Officer, or a visitor-protection representative
- Close (by Superintendent's order) park areas or entire park when any threat to public or firefighter safety exists from wildland fire or fire management activities. When and if such action occurs, adjacent agencies and authorities will be notified as soon as possible to help manage or evacuate the closure
- Clear (of debris) hazardous fuels areas adjacent to publicly or privately owned structures or along likely evacuation routes. This requirement falls on the owner, renter, or agency having jurisdiction. The minimum requirement for creating defensible space is a 30-foot radius around any structure and 10 feet on either side of a roadway
- Implement, or continue implementation of, approved project-level plans designed to create fuel conditions that support defensible space and public safety protection objectives in and around South and North Rim developments (for example, the Bright Angel Mechanical Fuel Reduction and Prescribed Fire Project Plan [NPS 1998]).

All aviation program safety protocols will be contained in the Aviation Management Plan.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives
Public Information and Education Fire Management Program

Public information and education are cornerstones of a successful fire management program. Without an informed and supportive park and concessions staff, local and visiting public, partner organizations, and youth, the fire program and the resources it is designed to benefit will most likely not succeed.

Policy direction provided in DO-18 states "…the NPS will administer its wildland fire program in a manner that will…educate employees and the public about the scope and effect of wildland fire management, including fuels management, resource protection, prevention, hazard/risk assessment, mitigation and rehabilitation, and fire's role in ecosystem management."

Table 2-6 summarizes steps to promote an active and informed public fire information and education.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives
Wilderness Fire Management Program

GRCA fire managers conduct an annual Minimum Requirement Analysis (See Appendix A, Attachment A) to address strategic and tactical options for prescribed fire, fire effects monitoring, and wildland fire use activities in wilderness. These annual assessments define the minimum activity necessary to conduct an operation with hand tools or some combination of hand and motorized equipment including aircraft.

In addition, maps identifying sensitive wilderness resources are annually updated and maintained. These maps are used by Resource Advisors during wildland fire incidents to identify where retardant cannot be used unless human life is at stake, locate fire-sensitive cultural resources or sensitive plant and animal populations, and identify where camps or helispots should not be made. Heavy equipment use (on fires with suppression objectives) requires written approval by the Superintendent; that authority is delegated to the Incident Commander on an incident-by-incident basis.

GRCA fire management incorporates interagency MIST standards and guidelines on all fires in wilderness, regardless of ignition type or management strategy (See Appendix A, Attachment B)

South Rim roads and trail systems will be used for vehicle and firefighter access and for containment lines. Two-track dirt roads, closed to the public but available for administrative use, will remain available for firefighters during fire events and fuels and monitoring projects. These roads will be cleared of downed logs in spring and throughout the fire season to maintain quick ingress and egress. Fuel reduction projects along roads or trails may also occur prior to prescribed fire projects to minimize fire intensities, provide better public and firefighter safety, and increase containment holding capabilities.

North Rim roads and trail systems cross proposed wilderness boundaries. Roads and trails outside proposed wilderness will be used for vehicle and firefighter access and containment lines. These roads include both paved roads like Highway 67 and two-track dirt roads open for public use. These roads will be cleared of downed logs in spring and throughout the fire season to maintain quick ingress and egress. Fuel reduction projects along roads may occur prior to prescribed fire projects to minimize fire intensities, provide better public and firefighter safety, and increase containment holding capabilities.

Table 2-6 Fire Information and Education at GRCA

Task	Responsible Party
Develop active partnership to promote fire education among staff and visitors	• Fire Management • Interpretation • Division of Science and Resource Management
Include fire education in interpretive staff training	• Fire Management • Interpretation
Incorporate wildland fire management and fire's role into interpretive walks and evening programs	• Interpretation
Create visitor center exhibits to educate the public about fire's role	• Interpretation
Station interpreters at significant fires near visitor-use areas to educate visitors about fire's role. Where fires are particularly visible from major overlooks or high-use areas a roving Fire Information Officer or interpreter gives talks about fire and smoke	• Interpretation
Develop mobile exhibits near fire management projects	• Interpretation
Post-fire updates on the park's Daily Report and web page	• Fire Management
Notify adjacent communities by press release before implementing prescribed fires	• Public Affairs
Deliver effective information about fires to local communities and media	• Public Affairs • Fire Information Officers
Reply promptly to all media and public queries	• Public Affairs • Fire Information Officers
Make information about wildland fire, smoke, the FMP, and ecosystem restoration readily available	• All
Provide additional interpretive staff during emergency fire situations to provide visitor information and assist the incident information officer, if requested	• Interpretation

Road or trail systems closed to the public and in proposed wilderness may also be used as containment lines during fire events but will only provide vehicle access in an emergency. Emergencies include medical emergencies and situations when a fire vehicle is necessary to keep a fire within a specified containment area. These roads and trails will not be cleared of downed logs in spring or throughout the fire season, except during a fire event or when used for emergency purposes. Clearing or using roads and trails in proposed wilderness will be conducted in keeping with minimum requirement analysis protocols.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives
Fire Aviation Resources Fire Management Program

South Rim Helibase is used for emergency purposes, mostly medical evacuations, and seasonal fire operations. The helibase is adjacent to South Rim fire operations buildings and close to the South Rim Village area. There is an established North Rim helispot with two landing pads and office space used during emergency medical and fire events. The fire aviation program also maintains eight landing pads in the canyon used for medical events and inner-canyon logistical support. Maintenance and use of inner canyon helispots in proposed wilderness will be conducted in keeping with minimum requirement analysis protocols.

The GRCA helitack program includes a helibase manager with a crew of nine and one light helicopter (with pilot) during fire season, and is staffed year-round with a minimum of a helicopter manager and a helicopter. The helibase fire staff also host an interagency helicopter training academy (HTA) allowing firefighters with aviation training needs from around the country to work with the GRCA helitack crew and gain fire aviation experience.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives
Communication and Coordination Fire Management Program

Williams Interagency Dispatch Center manages fire communications for Kaibab National Forest and Grand Canyon National Park. Dispatch is staffed year-round with at least one dispatcher and, during peak fire season, up to seven employees. Williams Dispatch Center manages eight repeater frequencies, eight radio repeater sites, and nine additional radio frequencies for both the forest and the park.

Williams Dispatch Center coordinates all wildland fire orders for firefighters and equipment and tracks order status during the local fire event. The center also coordinates filling national firefighter orders with local fire staff. Management of firefighter qualifications, firefighter availability, fire reporting databases, and ADEQ smoke permit information also occur year-round at Williams Dispatch Center.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives
Fire Management Budgeting Fire Management Program

NPS fire management funding is derived from two sources, one fixed and the other a shared national fund for emergency wildland fires.

Fixed funds at the NPS level are managed for program operations and planned projects (authorized project funds). Fire operations and projects include preparedness activities, permanent and seasonal staffing, training, monitoring, fire GIS, fuels management, fire prevention and education, aviation, and equipment purchases. These funds are currently based on the Fire Program (FIREPRO) analysis and budget process, which is a workload and complexity analysis based on the third worst year in the previous ten. This process allows program managers some flexibility in determining annual program needs. The FIREPRO budget process will be replaced in the next few years by the Fire Program Analysis (FPA) system. FPA is an interagency planning process designed to increase economic efficiency by promoting more accurate allocations of shared resources and personnel. The budget process is ongoing and requires time, energy, and personnel commitments.

National emergency funds are managed for wildland fire operations. In the NPS, authority exists at the local level to open accounts against these funds to cover all expenditures related to wildland fire management, regardless of ignition source or selected management strategy. Along with annual appropriations, agency guidance is provided in a policy memo outlining administrative procedures in implementing this budgetary authority.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives
Fire Reporting Fire Management Program

GRCA fire staff are required to complete a fire report for all natural and human-caused fires that start in park boundaries. A fire report, completed within ten days after the fire is declared out, is sent to the Williams Interagency Dispatch Center. The fire report is then entered into the Fire Occurrence Reporting Module of the Wildland Fire Management Information System (WFMI) by dispatch center staff. The fire report includes fire start date, fire size, ignition source (human or natural), containment date and time, control date and time, date and time fire declared out, a fire perimeter map, and a fire events narrative. Data are used to assist national and local funding priorities and staffing levels, and to maintain a national and local historical fire occurrence data base.

Hazardous fuel reduction projects including prescribed fire, wildland fire use, and manual fuel reduction projects are also reported in the National Fire Plan Operations and Reporting System (NFPORS). This reporting system assists regional and national offices track accomplishments and costs associated with regionally or nationally funded projects. Elements of this reporting system also include restoration, rehabilitation, and community assistance projects.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives
Fire Effects Monitoring Fire Management Program

GRCA managers recognize the importance of having a science-based program that relies on current and best-available information. Since 1989 GRCA has maintained an active fire-effects monitoring program.

For each major vegetation type where prescribed fire has been used (piñon-juniper, ponderosa, mixed-conifer, and spruce-fir forests), permanent fire-effects monitoring plots were established prior to treatment and then re-examined immediately post-burn. The plots have been revisited on a one-, two-, five-, and ten-year post-burn schedule to monitor fire effects on vegetation and fuels. To date, 143 plots have been installed, and 100 have burned. Some ponderosa areas on both rims have been treated with prescribed fire more than once. In these plots, trends in fuel load, plant composition, tree density, insects and disease, shrub density, and burn severity are continually examined. Data from these plots are analyzed to determine if prescribed fire activities meet desired ecological conditions.

GRCA is also an active participant in the National Burn Severity Mapping Program (NBSMP). Since 2001, burn severity assessments have occurred annually using Composite Burn Index (CBI) protocols. Between 2001and 2006, 665 CBI-style plots have been installed in the park, providing Normalized Burn Ratio (NBR) satellite-correlated severity data on 21 fires over 68,000 total acres. These protocols gather field data and satellite imagery one year after a fire; hence, 2006 data was collected and mapped on fires that burned in 2005. (For more information on the NBSMP, CBI protocols, and/or NBR visit http://www.burnseverity.cr.usgs.gov).

The fire effects monitoring program allows fire managers to evaluate effectiveness of prescribed and wildland fire-use activities and adapt future practices to better meet resource management objectives.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives
Resource Protection Surveys Fire Management Program

The GRCA Fire Management Program coordinates protection of cultural and natural resources potentially affected by fire management activities through a program that includes project area annual surveys and/or inventories, a potential effects assessment, and mitigation measures development to prevent adverse effects to site-specific resources.

Wildlife biologists and archeologists conduct appropriate review and survey of project areas and work in conjunction with fire managers to develop burn plans to meet specific objectives while protecting resources in a project area. Site-specific measures may include such activities as coordinating timing of burns to minimize breeding-bird impacts from smoke or noise, wrapping or foaming fire-sensitive archeological sites, or constructing control lines around such sites.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives Fire-Related Research Fire Management Program

Ongoing research by the park Division of Science and Resource Management, Northern Arizona University, and other institutions has begun to answer questions posed in GRCA's Resource Management Plan relating to undesirable effects of almost 100 years of fire suppression in northern Arizona forests, and in initial research stages investigating ways to restore and sustain altered forest ecosystems. The results of numerous ecological research projects for GRCA can be found at: http://www.eri.nau.edu/joomla/.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives Fire Research Needs Fire-Related Research Fire Management Program

One area of fire ecology that remains poorly understood is the varied fire regimes of piñon-juniper vegetation subtypes. Few studies to date have been conducted in Arizona. Fire-history compilations based on fire scar and fire-record data along with forest stand reconstruction studies are needed to determine natural fire regimes of this extensive vegetation type. With a better understanding of the natural role of fire in these systems, fire managers can take an active and informed role in restoring and maintaining GRCA's piñon-juniper woodlands.

Recent conversations with Native American tribes have initiated an interest in these fire research topics

- Conduct an ethnographic plant-use study and effects of fire-use and prescribed fire seasonality
- Determine aboriginal fire use and its effect on systems and/or perceptions of what is now present

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives National Burn Severity Mapping Project Fire-Related Research Fire Management Program

The joint NPS-U.S. Geological Survey National Burn Severity Mapping Project addresses the need to quantify fire effects over large, often-remote regions and long time intervals. It reflects collaborative efforts to bring previous research into operational implementation for fire managers and scientists. The project focuses on NPS units and adjoining lands, mostly beginning with fire-year 2000, although earlier burns have been examined in some areas. NBSMP combines the processing, data archive, and remote sensing expertise of the USGS Earth Resources Observation Systems Data Center, the local knowledge and field sampling capability of the NPS, and the fire-effects research of the USGS Northern Rocky Mountain Science Center to deliver an effective approach to mapping severity.

The NBSMP website provides access to accumulating data. Search and query functions lead users to individual burn information pages. Product deliverables may be retrieved, including textual information, graphic images, digital spatial data, and metadata. Through such standardized methodology and products, information can be compared or aggregated across multiple burns. For more information visit http://burnseverity.cr.usgs.gov/fire_main.asp.

GRCA's fire management program takes advantage of this technology to track burn severity on all large fires in park boundaries. Prescribed fire data shows whether the burn project met or exceeded severity objectives. Data from wildland fire-use fires shows fire-severity percentages over the fire area, and helps determine if fire effects were a mosaic of all fire severities or if large sections of the fire area burned outside the natural range of variability. Burn severity information is gathered annually from satellite

images during summer months after the burn when vegetation is at peak greenness. Imagery is ground-truthed by the fire-effects crew, and the final product is displayed for all interested parties through GIS.

GRCA Fire Management Organization and Responsibilities Elements Common to all Alternatives Joint Fire Science Project Fire-Related Research Fire Management Program

The Joint Fire Science Program (JFSP) was established in 1998 to provide scientific information and support for wildland fuel and fire management programs. The program is a partnership of six Federal agencies: USFS, BIA, BLM, NPS, USFWS, and USGS.

JFSP received specific direction from Congress to address four areas: fuels inventory and mapping, fuels treatments evaluation, fuels treatments scheduling, and development of protocols for monitoring and evaluation. In 2001, Congress further directed JFSP to expand research efforts in post-fire rehabilitation and stabilization, local assistance, and aircraft-based remote sensing. JFSP-sponsored research also examines other fire-related issues including air quality, smoke management, and social aspects of fire and fuels management. Fire researchers have successfully tapped this research fund source to conduct GRCA fire ecology studies.

JFSP's purpose is to provide wildland fire and fuels information and tools to specialists and managers, helping make the best possible decisions and develop sound, scientifically valid plans. For more information visit http://www.firescience.gov.

2.9 Elements Specific to Action Alternatives

2.9.1 Proposed Elements Common to Action Alternatives Alternatives 2, 3, 4, and 5

- GRCA is divided into eight new Fire Management Units (compare Maps 2-1 and 2-2)
- WUI treatment areas and priorities do not change, but implementation pace varies by alternative
- Wildland fire-use fire would not be used as a management tool in the two WUI FMUs
- Hwy 64 and Hwy 67 are not classified within either WUI FMU, but these roads and their corridors are primary public escape routes and would be included as areas where mechanical and manual thinning is proposed. For project planning and funding purposes, work associated with these road corridors (300 feet from road centerline) would be designated WUI projects
- It is anticipated that up to 80% of proposed thinning projects would be completed under contracted services (using local or regional resources)
- Increased allowance of moderate/high and high burn severity in mixed-conifer compared to the No Action Alternative. A mitigation addressing increased high and moderate/high severity states: "Assess the amount of moderate/high and high severity fire through composite burn index monitoring after each managed fire in the mixed-conifer vegetation type above the rim. Use the adaptive management process to adjust burn prescription, ignition pattern, burn seasonality, and/or pre-treatment to ensure no more than 30% of the mixed-conifer vegetation type and MSO mixed-conifer restricted habitat burns with moderate/high and high severity. This includes high and moderate/high fire severity from past fires (2000 to present) (Table 4-15a), and all fires that will occur within the scope of this planning document." The allowance of 30% high and moderate/high severity is not meant to be a target, but is a maximum amount. The park has described tools for planned and unplanned fires that will help keep the level of high and moderate/high severity to a minimum
- The adaptive management process will be used during the planning, implementation, and review process for each fire event with the intent that more tools can be developed to continue to minimize high and moderate/high fire severity effects
- The adaptive management process and evaluation listed in Figure 2-2 will be used

2.9.2 Manual and Mechanical Hazard Fuel-Reduction Treatments Specific to Alternatives 2, 3, 4, and 5 — Action Alternatives

Under Alternatives 2, 3, 4, and 5 manual and mechanical fuel-reduction treatments would occur in WUI piñon-juniper habitat in areas not proposed as wilderness including North Rim Developed Area, Grand Canyon Village, Hermits Rest, Desert View, and along main routes between these developments (Highway 67, North Rim; Highway 64, South Rim).

RM-18 defines manual treatment as "use of hand-operated power tools and hand tools to cut, clear, or prune herbaceous and woody species." Manual treatments reduce hazardous fuels, create defensible space, reduce crown fire risk in the WUI, and pretreat perimeters of prescribed and wildland fire-use fire.

RM-18 defines mechanical treatment as "use of wheeled tractors and crawler-tractors or specially designed vehicles with attached implements, e.g. saw heads, excavators, fetching arches, and disks and blades." Mechanical treatments also reduce hazardous fuels, create defensible space, reduce crown fire risk in the WUI, and pretreat prescribed and wildland fire-use fire perimeters. See Table 2-2 for a description of manual and mechanical techniques.

2.9.2.1 Thinning Standards Specific to Alternatives 2, 3, 4, and 5 — Action Alternatives

Thinning standards (accomplished by manual or mechanical means) for WUI under Alternative 5 are found in NFPA Codes, Chapter 4 Assessing Wildland Fire Hazards in the Structure Ignition Zone. Additional guidelines can be found in the 2006 International Wildland-Urban Interface Code.

- Thin up to a 12-foot canopy clearance, removing trees up to ten inches dbh
- Limb trees four-to-six feet above the ground to reduce ladder fuels
- Remove up to 60% of dead-and-down woody debris 3–12 inches dbh
- Remove up to 50% of dead-and-down woody debris larger than 12 inches dbh
- Flush-cut all stumps as low to the ground as possible
- Slash from thinning operations may be removed, lopped, and scattered for a future broadcast burn; piled and burned in place; or chipped on or offsite
- Modifications to degree of thinning may occur in the historic landmark district or adjacent to individually listed National Register of Historic Places Buildings

Also, standards for manual fuel thinning in the immediate vicinity of structures (to establish and maintain defensible space) are found in NFPA Codes, Chapter 4 Assessing Wildland Fire Hazards in the Structure Ignition Zone. Additional guidelines can be found in the 2006 International WUI Code.

- Prune all trees within 50 feet of structures, and increase the height to live crown to prevent surface fire transitioning to crown fire.
- Cut all tree limbs overhanging and in contact with any roof by a maximum of ten feet. If conditions warrant the entire tree may be removed
- Cut all tree limbs in structural contact back to three-to-six feet from the structure
- Remove 80% of dead material on the ground greater than three inches diameter within 30 feet of structures
- Create ten feet of space between tree crowns within 30 feet of each structure

Mechanical and manual fuel-reduction treatments in the WUI would be carried out under a Long-Term Treatment Schedule (see Appendix D). Additional treatment units not identified in the treatment schedule may also be accomplished, including residential areas that have or have not been treated in the past. For example, some thinning has occurred in the historic district, but only in areas within 30 feet of structures. Additional thinning may occur within or outside that 30-foot space to expand defensible space and meet desired conditions throughout the WUI.

2.10 Alternatives Eliminated from Further Study

During the public scoping process for this FMP EIS several alternative actions were recommended. Others were suggested by scientists, technical specialists, and the GRCA FMP IDT. While all suggestions were considered, and several were included as alternatives or alternative elements, some were eliminated from detailed study per 40 CFR 1502.14(a). Reasons for dismissal include

- Technical or economic infeasibility
- Inability to meet objectives or resolve project need
- Duplicative with other less environmentally damaging or less sensitive alternatives
- In conflict with an approved park plan, NPS or Federal policy; thus, implementation requires a major plan or policy change
- In conflict with this document's purpose and need statement
- Environmental impacts too great

The following alternatives were dismissed from further study.

Natural Fire Only Strategy **Eliminated from Further Study**

This alternative would minimize management actions by allowing wildfire managed under a fire-use strategy to accomplish management objectives without benefit of prescribed fire or non-fire fuel-reduction treatments. All human-ignited fires would be suppressed, as would naturally ignited fires that pose unacceptable risk to human safety, park resources, or neighbors. Fire would also be suppressed if resources (staff and equipment) to manage long-term fire events were unavailable.

This alternative was dismissed from analysis due to conflicts with NPS and Federal wildland fire management policies and potential for long-term and severe air quality impacts. Also, this alternative does not adequately address overall risk of unwanted cross-boundary wildland fire due to lack of strategically placed prescribed fire projects adjacent to the boundary as in analyzed alternatives. Program goals ensuring protection of life and health and private and public property would not be met under this alternative because little or no proactive, preventive fuel reduction would occur.

Full Suppression of All Wildland Fires Localized Non-Fire Treatments **Eliminated from Further Study**

All natural and human-ignited wildland fires would be suppressed. Wildland fire use would not occur and no prescribed fire projects would be implemented to restore or maintain natural systems. Prescribed burning would only occur in conjunction with limited manual fuel treatments around developments. Non-fire treatments to reduce fuels would be used to protect values at risk and WUI.

This alternative was eliminated from detailed analysis because it would not meet goals to restore and maintain native park ecosystems or use fire to protect wildlife, vegetation, cultural resources, and wilderness character. This alternative would not incorporate new scientific information nor conform to NPS and Federal wildland fire management policy. Specifically, research and monitoring data show conclusively that suppression of all wildland fires would lead to continued altered forest ecosystems, increased fuel loads, and future crown-fire potential as overstory canopies close. Unacceptable threats to life, property, and park boundary areas would occur over the long term.

Full Suppression and Landscape-Level Manual Treatments **Eliminated from Further Study**

This alternative was eliminated from detailed analysis because it does not respond to Chapter 1's purpose and need or meet goals related to fire's natural role and use to accomplish protection objectives. This alternative does not incorporate new scientific information and does not conform to NPS and Federal wildland fire management policy. Air quality protection objectives would be met in the short term because virtually no smoke emissions would be produced from management burning. Over the long term,

unnatural fuel amounts would continue to accumulate, and inevitably unwanted wildfires would occur, producing heavy smoke. Ecological objectives involving beneficial effects from prescribed and wildland fire-use fire would not be accomplished. Fire promotes nutrient recycling, exposes mineral soil, regulates structure, encourages native species diversity, and maintains other ecosystem dynamics. Further, manual fuels management would not be sufficient in scope or timing to stay abreast of fuel accumulations and continued undesirable forest structure alteration over time.

Full Suppression and Maximum Mechanical Treatments **Eliminated from Further Study**

This alternative was eliminated from analysis because it does not respond to Chapter 1's purpose and need or meet goals and objectives. This alternative is not responsive to new scientific information (i.e., the goal to "use the adaptive management process to incorporate monitoring results and the best available scientific knowledge into all areas of fire management"), and does not conform to NPS and Federal wildland fire management policy. Without fire use benefits, fuels would accumulate and forest structure would alter further, particularly in proposed wilderness where mechanical equipment would likely not meet minimum tool requirements. Smoke impacts would be sharply reduced with this alternative, but necessary ecological benefits described above would not be realized.

Suppression, Prescribed Fire, and Manual Treatment Strategies (No Wildland Fire Use) **Eliminated from Further Study**

This alternative was dismissed from detailed analysis because it conflicts with NPS and Federal wildland fire management policies. Without the wildland fire use strategy, this alternative would only accomplish those goals and objectives for which prescribed fire and manual treatments apply. For instance, the stated goal to "…restore park ecosystems to a natural, resilient condition by the re-establishment of natural fire regimes…" would only be partially met with prescribed fire. It is anticipated that without fires managed under a fire use strategy, much more time would be required to accomplish fuel reduction and ecosystem objectives, particularly where applying manual treatment strategies to mimic the same ecosystem effect is concerned. Further, those FMUs with high departure from desired conditions would be at more risk of undesirable outcomes (e.g., extreme fire behavior, stand-replacement fire, threats to park values) if wildland fire use is not part of the strategy.

Suppression, Wildland Fire Use, and Manual Treatment Strategies (No Prescribed Fire) **Eliminated from Further Study**

This alternative was eliminated from detailed analysis because it does not meet goals and objectives related to protection of human health and safety, private and public property, and natural and cultural resources. Management would not have the flexibility of determining timing and location of wildfires as with planned prescribed fires. Fire's ecological benefits would be similarly reduced, particularly near park boundaries. Prescribed fire would not be used as a strategy to consume residual debris from manual treatments near values at risk. Debris disposal costs would escalate as would potential suppression costs. Under a fire use strategy, a fire's size and duration may have to be sharply reduced in some cases if preventive fuel reduction using prescribed fire were not a management option.

2.11 Environmentally Preferred Alternative

The environmentally preferred alternative is defined by the Council on Environmental Quality as the alternative that best meets the following criteria or objectives, as set out in Section 101 (b) of the National Environmental Policy Act (42 USC 4331).

1. Fulfill the responsibility of each generation as trustee of the environment for succeeding generations;
2. Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;

3. Attain the widest range of beneficial uses of the environment without degradations, risk to health or safety, or other undesirable and unintended consequences;
4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety, of individual choice;
5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities;
6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

The following section is based on results of the impact analysis for each alternative as presented in Chapter 4 and summarized in Table 2-7. The environmentally preferred alternative for the proposed Fire Management Plan is the alternative that best meets or exceeds requirements set forth in NEPA section 101(b) as defined above.

Criterion 1 *Fulfill the responsibility of each generation as trustee of the environment for succeeding generations*

A primary threat to environmental resources is landscape-scale high-severity fire. As environmental trustees for future generations, our goal is to manage fire in fire-adapted ecosystems to maintain and restore desired forest conditions. Such management would allow ecosystems to be resilient to any threat such as insect infestation, climate change, and other environmental factors.

Criterion 2 *Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings*

When desired conditions are met, hazard-fuel loads are lower which moderates higher-severity fires, and forests become safer for visitors (backcountry and developed areas). Fewer widespread high-severity fires also protect landscape aesthetics, natural and cultural resources, and the WUI.

Criterion 3 *Attain the widest range of beneficial uses of the environment without degradations, risk to health or safety, or other undesirable and unintended consequences*

To attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences, the proposed fire management program must allow for wide array of visitor uses.

Criterion 4 *Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety, of individual choice*

To preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety, fire management alternatives should incorporate a variety of tools

Criterion 5 *Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities*

Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities

Criterion 6 *Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources*

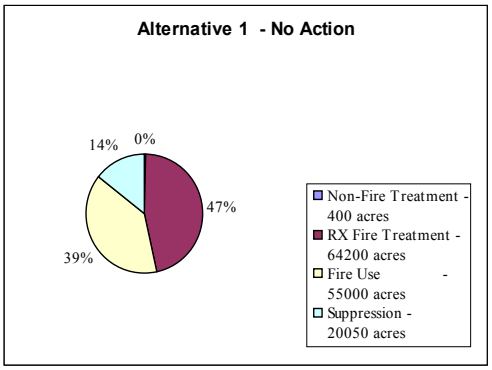
To enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

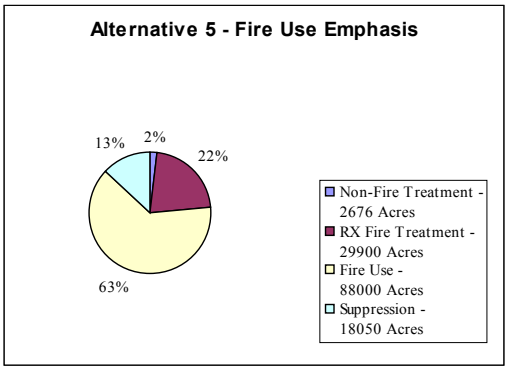
Based on the analysis in Table 2-7, Alternative 2, Mixed Fire Treatment Program, best achieves NEPA section 101(b) criteria and is the Preferred Alternative. This alternative exceeds or meets each criterion.

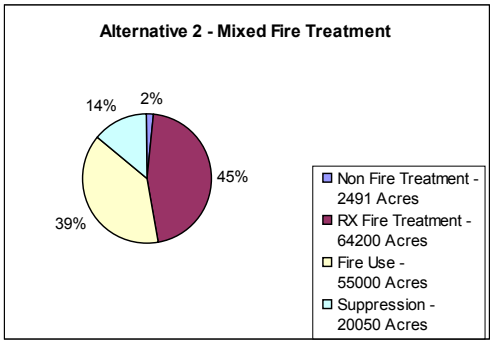
Table 2-7 How Each Alternative Meets NEPA Section 101(B) Criteria

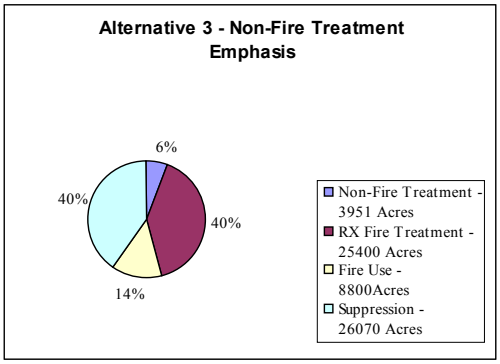
Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
1 Fulfill the responsibility of each generation as trustee of the environment for succeeding generations	**Meets** Mitigation requirements for low-severity fire in mixed-conifer limits the trend toward desired conditions	**Exceeds** Ability for a wider array of fire severities and application of fire use results in a greater trend toward historic pattern of fire severity and spatial complexity, especially in mixed- conifer	**Does Not Meet** Due to limited fire treatments this alternative allows vegetation outside the WUI to trend further away from desired conditions	**Does Not Meet** Emphasis on prescribed fire cannot restore and maintain desired conditions	**Meets** Potential for greatest ecosystem benefits and trend toward desired conditions, but greatest risk due to fire timing, unknown environmental conditions and uncertainty due to dependence on natural starts
2 Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings	**Does Not Meet** Least reduction in risk for high-intensity wildfire that could destroy infrastructure and cause evacuations and/or park closures	**Meets** Expanded WUI treatments provide safety to infra-structure and people. Moves toward a healthier and more aesthetically pleasing forest	**Does Not Meet** Hazard fuel treatments emphasize safety in the WUI, but rest of park receives minimal treatment and is in greatest risk of high-severity fire	**Meets** Includes less WUI than other action alternatives. Emphasis on prescribed fire cannot restore and maintain desired conditions	**Meets** Includes second highest WUI amount. Potential for greatest benefits to ecosystem and trend toward desired conditions. Greatest risk due to fire timing, unknown environmental conditions, and uncertainty due to dependence on natural starts
3 Attain widest range of beneficial uses of environment without degradations, risk to health or safety, or other undesirable and unintended consequences	**Meets** Overall, a variety of uses even though some impacts to visitors	**Meets** With incorporation of WUI and range of severity for prescribed fire in mixed-conifer, wider range of severity would improve for a wider range of uses	**Does Not Meet** For the park as a whole does not provide for widest range of beneficial uses to fire program. This would limit use of fire in a fire-dependent ecosystem	**Meets** Emphasis on prescribed fire may reduce risk but limits amount of restoration	Meets Primary focus on natural starts which gives more uncertainty and limits variety of uses
4 Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety, of individual choice	**Meets** Opportunities for surveys and pretreatment of cultural sites prior to prescribed burns and non-fire treatments in WUI. Decreased potential for high-severity fire. Wildland fire use has less opportunity for survey and pretreatment		**Does Not Meet** Has highest levels of suppression; therefore, the highest potential for high-severity wildfire effects and damaging suppression impacts	**Meets** With emphasis on prescribed fire, there are more opportunities for pretreatment surveys and protection of archeological sites prior to prescribed burns	**Does Not Meet** Limited opportunities to protect and survey before fire-use fires and is safety dependent. Since the majority of acres are wildland fire use and suppression, ability to pretreat is reduced

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
5 Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities	**Meets** Provides balance between visitor use and resources benefits		**Does Not Meet** Only the human factor is considered and not resources	**Meets** Provides balance between visitor use and resources benefits	**Meets** Provides balance between visitor use and resources benefits
6 Enhance quality of renewable resources and approach maximum attainable recycling of depletable resources	**Meets** Provides balance in all park forest ecosystems, but does not provide any significant treatment activities in the piñon-juniper and WUI	**Exceeds** Provides the most opportunities for restoration and maintenance of forest ecosystems	**Does Not Meet** Limited number of acres treated. Not moving park as a whole toward desired conditions	**Meets** Returning fire into dependent ecosystems enhances resources quality. May not enhance as much as both prescribed fire and fire use but moves toward desired conditions	**Meets** Getting fire back into a fire-dependent ecosystem enhances resources quality. May create best restoration opportunities. Greatest risk due to fire timing and unknown environmental conditions. Greater uncertainty due to dependence on natural starts









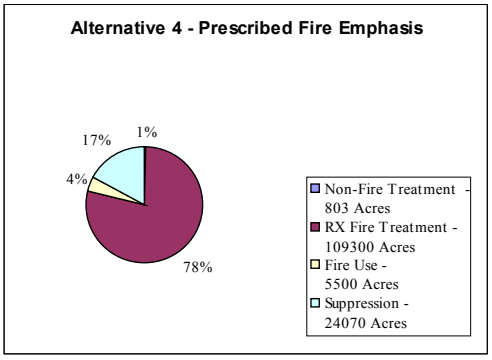


Figure 2-8 Treatment Totals for Each Treatment Type Compared Across Alternatives

Table 2-8 Summary of Alternatives

Components	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred Alternative	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Suppression	20,050 acres 1215 hours flight time 96 road/trail closure days	20,050 acres 1215 hours flight time 96 road/trail closure days	26,070 acres 1580 hours flight time 126 road/trail closure days	24,070 acres 1459 hours flight time 116 road/trail closure days	18,050 acres 1094 hours flight time 86 road/trail closure days
Prescribed Fire	64,200 acres 161 hours flight time 52 road/trail closure days	64,200 acres 161 hours flight time 52 road/trail closure days	25,400 acres 64 hours flight time 20 road/trail closure days	109,300 acres 273 hours flight time 88 road/trail closure days	29,900 acres 75 hours flight time 24 road/trail closure days
Wildland Fire Use	55,000 acres 355 hours flight time 100 road/trial closure days	55,000 acres 355 hours flight time 100 road/trial closure days	8,800 acres 57 hours flight time 16 road/trail closure days	5,500 acres 35 hours flight time 10 road/trail closure days	88,000 acres 568 hours flight time 160 road/trail closure days
Manual Thinning	400 acres 400 operation days	375 acres 375 operation days	592 acres 592 operation days	120 acres 120 operation days	401 acres 401 operation days
Mechanical Thinning	0 acres	2,117 acres 529 operation days	3,358 acres 840 operation days	682 acres 171 operation days	2,275 acres 569 operation days
Cost	$22,230,000 $159.00/acre	$23,690,000 $167.00/acre	$14,400,000 $224.00/acre	$17,370,000 $124.00/acre	$27,030,000 $195.00/acre

Table 2-9 FMP Goals and Objectives by Alternative

Goals/Objectives	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred Alternative	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Goal 1 Protect human health and safety and private and public property					
Conduct wildland fire management activities with the most current risk assessment and mitigation techniques available to ensure firefighter and public safety is the highest priority	No mechanical thinning, thus minimal WUI protection and unable to mitigate WUI fire hazards	Equal combination of all fire management tools to mitigate fire hazards	Emphasizes non-fire treatment at expense of prescribed fire and WFU. Lowest number of total treated acres. Highest suppression acres and untreated fuels	Emphasizes prescribed fire at expense of non-fire WUI treatment. Will not be able to mitigate all WUI fire hazards	Even with WFU emphasis, second highest in non-fire WUI treatment. Lowest amount of suppression fire
	Does not meet objective	*Meets objective*	*Does not meet objective*	*Does not meet objective*	*Meets objective*
Use non-fire fuel treatments in areas where wildland fire use is not practical due to safety or smoke concerns. Even in these areas, however, future fire will be used as fully as possible to maintain desired conditions once restored through non-fire fuel treatments	Only allows 400 acres of manual thinning. Will take too long to protect WUI	Allows combination of mechanical and manual thinning operations to protect WUI. Third highest non-fire treatment acreage	Emphasizes WUI treatment. Most non-fire WUI acres treated	Emphasized prescribed fire at expense of WUI non-fire treatment. Second lowest non-fire treatment acres	Second most WUI non-fire treatment acres
	Does not meet objective	*Meets objective*	*Meets objective*	*Does not meet objective*	*Meets objective*
Minimize smoke impacts on human health	Prescribed fire treated acres allow managers flexibility to pick times of good ventilation. Large WFU acres do not allow the same flexibility	Prescribed fire treated acres allow managers flexibility to pick times of good ventilation. Large WFU acres do not allow the same flexibility.	Lowest number of fire treated acres, thus has lowest smoke impacts.	Large prescribed fire acres means managers have some flexibility to pick times of good ventilation but not enough to minimize impacts	Emphasis on WFU does not allow managers flexibility to pick times of good ventilation
	Does not meet objective	*Does not meet objective*	*Meets objective*	*Does not meet objective*	*Does not meet objective*
Provide fire management workforce with training, equipment, operating procedures, safety measures, and information needed to manage risks and perform activities safely	No mechanical thinning, so does not provide opportunity for safer thinning equipment	Provides tools to accomplish activities safely	Provides tools necessary to accomplish activities. Highest suppression acres where many injuries occur	Provides tools to accomplish activities. Uses aerial ignition reducing prolonged exposure to fire environment	Provides tools to accomplish activities. WFU management minimizes tactical activities, thus minimizing potential injuries
	Does not meet objective	*Meets objective*	*Does not meet objective*	*Meets objective*	*Meets objective*

Goals/Objectives	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred Alternative	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Goal 2 Restore and maintain park ecosystems in a natural, resilient condition					
Maintain ecosystems that are within the range of desired conditions (see Chapter 2) through natural processes within policy constraints	Balanced approach of fire treatments. Second highest WFU acres, creating opportunities to maintain ecosystems	Balanced approach of fire treatments. Second highest WFU acres, creating opportunities to maintain ecosystems	Emphasizes WUI thinning over natural fire processes. Very limited WFU program	Emphasizes pre-scribed over natural fire processes. Very limited WFU program	WFU emphasis allows natural process to restore and maintain ecosystems with fire
	Meets objective	*Meets objective*	*Does not meet objective*	*Does not meet objective*	*Meets objective*
Restore ecosystems that are not within the range of natural variability to desired conditions (see Chapter 2) and maintain them through natural processes within policy constraints	Balanced approach of fire treatments creating opportunities to restore ecosystems with prescribed fire and restore/maintain ecosystems with WFU	Balanced approach of fire treatments creating opportunities restore ecosystems with prescribed fire and restore/maintain ecosystems with WFU	Emphasizes WUI thinning over natural fire processes and prescribed fire. Very limited ecosystem restoration and maintenance program	Large prescribed program will be primary tool for ecosystem restoration. Limited WFU program will maintain ecosystems that are within desired conditions. Focus on restoration	WFU emphasis allows natural process to restore and maintain ecosystems with fire. Focus of limited prescribed fire program is to restore ecosystems to encourage additional WFU
	Meets objective	*Meets objective*	*Does not meet objective*	*Meets objective*	*Meets objective*
Set priorities for treatment activities based on site-specific information including: departure from natural fire-return intervals, desired conditions (see Chapter 2), and other relevant factors	Long-term treatment schedule prioritized areas furthest from desired conditions and WUI. Additional WFU use for restoration of areas outside desired conditions will also occur	Long-term treatment schedule prioritized areas furthest from desired conditions and WUI. Additional WFU use for restoration of areas outside desired conditions will also occur	Focus on WUI treatments; departure from desired conditions was not considered except on limited basis	Long-term treatment schedule prioritized areas furthest from desired conditions and WUI	Long-term treatment schedule prioritized treating areas like boundary to assist with WFU management. Treatment schedule did not fully consider departure from natural fire-return intervals or desired conditions
	Meets objectives	*Meets objectives*	*Does not meet objective*	*Meets objective*	*Does not meet objective*

Goals/Objectives	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred Alternative	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Goal 3 Protect the park's natural, cultural, and social values					
Managing the ecosystem and natural processes are the primary objectives that will lead to healthy critical habitat for listed threatened, endangered and sensitive species	Balanced approach of fire treatments. Second highest WFU acres, creating opportunities to maintain ecosystems	Balanced approach of fire treatments. Second highest WFU acres, creating opportunities to maintain ecosystems	Emphasizes WUI thinning over natural fire processes. Very limited WFU program. Program focus on WUI and not rest of forest ecosystems	Emphasizes prescribed over natural fire processes. Very limited WFU program	Emphasizes WFU and natural processes over prescribed fire. Primary focus is allowing natural processes to restore and maintain forest ecosystems
	Meets objective	*Meets objective*	*Does not meet objective*	*Does not meet objective*	*Meets objective*
Use fire management tools and techniques to maintain, restore, and protect cultural resources while minimizing adverse impacts from fire and fire management activities	Balanced approach of fire treatments allows pre-treatment surveys and protection in prescribed and some WFU fires	Balanced approach of fire treatments allows pre-treatment surveys and protection in prescribed and some WFU fires	Survey and protection measures occur in WUI, but limited survey and protection measures occur outside WUI. Highest suppression acres that do not include appropriate survey and protection measures	Most opportunities for pre-burn protection work due to prescribed fire focus	Some survey and protection measures with WFU but not as much as prescribed fire. Success of resource protection depends on access, fire behavior, safety
	Meets objective	*Meets objective*	*Does not meet objective*	*Meets objective*	*Meets objective*
Conduct fire management activities in proposed wilderness in a manner that will not diminish suitability for designation or result in changes to the current wilderness proposal (Appendix A)	All fire activities will occur under concurrence with a MRA	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Meets Objective	*Meets Objective*	*Meets objective*	*Meets objective*	*Meets objective*
Use minimum-impact management techniques to reduce impacts to wilderness values, cultural and soil resources, and to limit spread of invasive plant species	Uses MIST is a mitigation measure for this alternative and a SOP for all fire management operations	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Meets objective	*Meets Objective*	*Meets objective*	*Meets objective*	*Meets objective*

Goals/Objectives	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred Alternative	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Minimize smoke impacts on air quality values including visibility	Prescribed fire treated acres allow managers flexibility to pick good ventilation times. Large WFU acres do not allow same flexibility	Prescribed fire treated acres allow managers flexibility to pick good ventilation times. Large WFU acres do not allow same flexibility	Lowest number of fire treated acres, thus has lowest smoke impacts	Large prescribed fire acres mean managers have some flexibility to pick good ventilation times but not enough to minimize impacts	Emphasis on WFU does not allow managers flexibility to pick good ventilation times
	Does not meet objective	*Does not meet objective*	*Meets objective*	*Does not meet objective*	*Does not meet objective*
Goal 4 Promote a science-based program that relies on current and best-available information					
Conduct research that will help understand natural fire regimes, refine prescriptions, provide data for fire behavior models, and effectively implement the Fire Management Program	Supports research opportunities	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Meets objective	*Meets objective*	*Meets objective*	*Meets objective*	*Meets objective*
Monitor and evaluate fire management activities (managed wildland fires, prescribed burns, fuel reduction treatments) to assess effects on natural and cultural resources and social values	Fire monitoring program will continue along with staffing of a fire archeologist and fire biologist	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Meets objective	*Meets objective*	*Meets objective*	*Meets objective*	*Meets objective*
Update fire return-interval departures, desired conditions (see Chapter 2), fire treatment priorities and prescriptions as relevant data become available	Adaptive management and fire monitoring	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Meets objective	*Meets objective*	*Meets objective*	*Meets objective*	*Meets objective*
Goal 5 Educate, inform, consult, and collaborate with tribes, stakeholders, and the public					
Maintain government-to-government and informal relationships with Native American tribes to exchange knowledge about fire management and traditional cultural practices	The fire archeologist and cultural resource program will continue to improve relationships	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Meets objective	*Meets objective*	*Meets objective*	*Meets objective*	*Meets objective*

Goals/Objectives	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred Alternative	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Develop and implement a proactive process that disseminates current and accurate information to the public, park employees, media representatives, and cooperators that encourages support of the Fire Management Program	Fire information efforts will continue with help from fire staff, public affairs office, the Division of Interpretation, and other Federal agency information and education personnel	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Meets objective	*Meets objective*	*Meets objective*	*Meets objective*	*Meets objective*
Conduct wildland fire prevention, education, and other activities in communities in and adjoining the park. Work in collaboration with local communities, county, state, and Federal fire agencies with fire-management interests	Fire prevention and education activities will continue to occur under a variety of strategies with help from fire staff, public affairs office, Division of Interpretation, and other Federal agency information and education personnel	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Meets objective	*Meets objective*	*Meets objective*	*Meets objective*	*Meets objective*
Develop interpretive displays and educational programs, with the Division of Interpretation, to foster understanding and acceptance of the Fire Management Program	Fire education activities continue under a variety of strategies with help of fire staff, public affairs office, Division of Interpretation, and other Federal agency information and education personnel	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	Meets objective	*Meets objective*	*Meets objective*	*Meets objective*	*Meets objective*

Table 2-10 Summary of Ten-Year Treatment Costs for Each Proposed Treatment Schedule (See Appendix D, Long-term Treatment Schedule)

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
TREATED ACRES					
Acres Prescribed Fire	64,200	64,200	25,400	109,300	29,900
Acres Wildland Fire Use	55,000	55,000	8,800	5,500	88,000
Acres Suppression	20,050	20,050	26,070	24,070	18,050
Acres Manual Thinning	400	375	592	120	401
Acres Mechanical Thinning	0	2,117	3,358	682	2,275
Total Acres Treated	**139,650**	**141.742**	**64,220**	**139,672**	**138,626**
Average Acres Treated/Year	**12,695**	**12,886**	**5,838**	**12,697**	**12,602**
COSTS					
Prescribed Fire	$5,080,146	$5,080,146	$2,009,902	$8,648,909	$2,365,987
Wildland Fire Use	$10,831,150	$10,831,150	$1,732,984	$1,083,115	$17,329,840
Suppression	$5,847,182	$5,847,182	$7,602,794	$7,019,534	$5,263,922
Manual Thinning	$475,064	$445,125	$702,704	$142,440	$475,987
Mechanical Thinning	$0	$1,481,900	$2,350,600	$477,400	$1,592,500
Total Project Costs	**$22,233,542**	**$23,685,503**	**$14,398,984**	**$17,371,398**	**$27,028,236**
Average Cost / Treated Acre	**$159**	**$167**	**$224**	**$124**	**$195**

Treatment costs for all alternatives were developed in conjunction with treatment schedules. All costs were calculated on a per acre basis, then multiplied by the number of acres for each treatment to determine total cost.

Costs associated with Table 2-10 include several assumptions developed using past treatment costs, and discussions with fuels specialists at the NPS Intermountain Regional Office. Assumptions include

- Average cost/acre for prescribed fire including treatment and survey costs is $79.13/acre ($34.13/acre treatment, $45/acre survey)
- Average cost/acre for wildland fire use is $196.93/acre
- Average cost/acre for suppression is $291.63/acre
- Average cost/acre for manual thinning is $1187/acre
- Average cost/acre for mechanical thinning and fuel removal is $700/acre
- Mechanical thinning will accomplish 85% of the thinning project acres
- Costs for all future projects will be similar to project costs from the past six years
- Costs were calculated using past project costs including 13 prescribed fire projects from 2003-2006, all wildland fire-use acres from 2003-2006, and all suppression fires from 2000-2006

Treatment costs for prescribed fire listed above does not include base funding involved in project planning and execution. Current fiscal policy does not allow park staff to shift base hours out of base accounts and into project accounts for prescribed fire. The same policy allows park staff to shift base funding to wildland fire-use and suppression fires. Due to this policy, true costs for implementing wildland fire-use and suppression fires can be tracked with greater precision. It is uncertain how many base-funded hours are actually spent on prescribed fires, so the actual cost of the prescribed fire program would be higher if those base hours could be shifted to project accounts.

Table 2-11 Impacts by Alternative and Impact Topic

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Vegetation and Fire Ecology	Beneficial, major, regional, long-term impacts to vegetation composition and structure in ponderosa pine forests	Beneficial, major, regional, long-term impacts to vegetation composition and structure in ponderosa pine forests	Adverse, moderate, regional, short-term impacts to vegetation composition and structure in ponderosa pine forests	Adverse, minor to moderate, regional, short-term impacts to vegetation composition and structure in ponderosa pine forests	Beneficial, major, regional, long-term impacts to vegetation composition and structure in ponderosa pine forests
	Beneficial, moderate to major, short- to long-term, regional, direct and indirect impacts to insects, pathogens, drought in ponderosa pine forests	Beneficial, moderate to major, short- to long-term, regional, direct and indirect impacts to insects, pathogens, drought in ponderosa pine forests	Adverse, moderate to major, short- to long-term, regional, direct and indirect impacts to insects, pathogens, drought in ponderosa pine forests	Adverse, minor to moderate, short-term, regional, direct and indirect impacts to insects, pathogens, drought in ponderosa pine forests	Beneficial, moderate to major, short- to long-term, regional, direct and indirect impacts to insects, pathogens, drought in ponderosa pine forests
	Impacts from suppression fires with large crown fires at 97th weather percentile in mixed-conifer forests would be adverse, moderate to major, long term, local, but would also have beneficial, moderate impacts	Impacts from suppression fires with large crown fires at 97th weather percentile in mixed-conifer forests would be adverse, moderate to major, long term, local	Impacts from suppression fires with large crown fires at 97th weather percentile in mixed-conifer forests would be adverse, moderate to major, long term, local	Impacts from suppression fires with large crown fires at 97th weather percentile in mixed-conifer forests would be adverse, moderate, long term, local	Impacts from suppression fires with large crown fires at 97th weather percentile in mixed-conifer forests would be adverse, moderate, long term, local
	Beneficial, moderate, short-term, regional impacts in mixed-conifer forests.	Beneficial, major, long-term, regional impacts in mixed-conifer forests due to more spatial complexity from less restrictive mitigation measures	Beneficial, minor, short-term, local impacts in mixed-conifer forests due to more spatial complexity from less restrictive mitigation measures	Beneficial, moderate, short-term, regional impacts in mixed-conifer forests due to more spatial complexity from less restrictive mitigation measures	Beneficial, major, long-term, regional impacts in mixed-conifer forests due to more spatial complexity from less restrictive mitigation measures
	Beneficial, moderate, long-term, regional, direct and indirect impacts to insects pathogens, drought in mixed-conifer forests	Beneficial, moderate, long-term, regional, direct and indirect impacts to insects, pathogens, drought in mixed-conifer forests	Adverse, moderate, short-term, regional, direct and indirect impacts to insects, pathogens, drought in mixed-conifer forests	Beneficial, moderate - major, short-term, regional, direct and indirect impacts to insects, pathogens, drought in mixed-conifer	Beneficial, moderate - major, long-term, regional, direct and indirect impacts to insects, pathogens, drought in mixed-conifer
	Beneficial, minor, long-term, local impacts to predicted fire regime and fire behavior in areas where prescribed fire treatment occurs in spruce-fir forests	Beneficial, minor to moderate, long-term, local impacts to predicted fire regime and fire behavior in areas where treatment will occur in spruce-fir forests	Adverse, moderate, short-term, regional impacts to predicted fire regime and fire behavior in spruce-fir forests since there is a very low probability of WFU	Adverse, moderate, short-term, regional impacts to predicted fire regime and fire behavior in spruce-fir forests since there is a very low probability of WFU	Beneficial, moderate to major, long-term, local to regional impacts to predicted fire regime and fire behavior in spruce-fir treatment areas

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Vegetation and Fire Ecology	Beneficial, moderate, long-term, regional impacts to term, regional impacts to insects, pathogens, drought in treated areas of spruce-fir forest	Beneficial, major, long-term, regional impacts to insects, pathogens, drought in treated spruce-fir forests	Adverse, moderate, short-term, regional impacts to insects, pathogens, drought in spruce-fir forests	Beneficial, moderate, short-term, local impacts to insects, pathogens, drought in treated spruce-fir forest	Beneficial, major, long-term, regional impacts to insects, pathogens, drought in treated spruce-fir forest
	Adverse, minor impacts to predicted fire regime and fire behavior in areas where treatment occurs in piñon-juniper forests due to lack of treatments	Adverse, minor impacts to predicted fire regime and fire behavior in areas where treatment occurs in piñon-juniper forests due to lack of treatments	Adverse, minor impacts to predicted fire regime and fire behavior in piñon-juniper forests due to lack of treatments	Beneficial, moderate, local, short term impacts to predicted fire regime and fire behavior in areas where treatment occurs in piñon-juniper forests	Adverse, minor impacts to predicted fire regime and fire behavior in piñon-juniper forests due to lack of treatment
	Beneficial, moderate, local impacts to predicted fire regime and fire behavior in montane-subalpine grass lands after planning period	Beneficial, moderate, local impacts to predicted fire regime and fire behavior in montane-subalpine grass lands after planning period	Predicted fire regime and behavior after planning period similar to Alt. 2 except for a decrease in beneficial impact of fire treatments on forest encroachment in adjacent grasslands	Beneficial, moderate, local impacts to predicted fire regime and fire behavior in montane-subalpine grass lands after planning period	Beneficial, moderate, local impacts to predicted fire regime and fire behavior in montane-subalpine grass lands after planning period
	Beneficial, minor, local, short-term impacts for fire potential in the WUI	Beneficial, minor, local, short-term impacts for fire potential in the WUI	For predicted fire regime and behavior after the planning period, there would be a reduction in fuel load; effect would be beneficial, major, regional, short term	Beneficial, minor, local, short-term impacts for fire potential in the WUI	Beneficial, minor, local, short-term impacts for fire potential in the WUI
	Beneficial, moderate to major, local to regional cumulative impacts in treated areas, and adverse, major cumulative impacts in untreated areas	Beneficial, moderate to major, local to regional cumulative impacts in treated areas; adverse, major cumulative impacts in untreated areas	Adverse, major, regional, long-term cumulative impacts on departure from historic fire regime across all vegetation types due to lack of treatments	Beneficial, moderate, regional, long-term cumulative impacts in treated areas; adverse, major cumulative impacts in untreated areas	Beneficial, moderate to major, local to regional cumulative impacts in treated areas; adverse, major cumulative impacts in untreated areas

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Vegetation and Fire Ecology	Past and proposed fire severities in GRCA would be adverse negligible moderate; and beneficial, negligible to moderate, local, short to long term. Past and proposed fire severities in the same forest types in and adjacent (GRCA and KNF) lands would be adverse, negligible to minor, and beneficial negligible to moderate, local to regional, short to long term.	Past and proposed fire severities in GRCA would be adverse negligible to moderate; and beneficial negligible to moderate, local, short to long term. Past and proposed fire severities in the same forest types in and adjacent (GRCA and KNF) lands would be adverse, negligible to moderate, and beneficial negligible to moderate, local to regional, short to long term.	Past and proposed fire severities in GRCA would be adverse negligible to major and beneficial negligible to moderate, local, short to long term. Past and proposed fire severities in the same forest types in and adjacent (GRCA and KNF) lands would be adverse, negligible to moderate, and beneficial negligible to moderate , local to regional, short to long term.	Past and proposed fire severities in GRCA would be adverse negligible to moderate and beneficial negligible to moderate, local, short to long term. Past and proposed fire severities in the same forest types in and adjacent (GRCA and KNF) lands would be adverse, negligible to moderate, and beneficial negligible to moderate, local to regional, short to long term.	Past and proposed fire severities in GRCA would be adverse negligible to moderate and beneficial negligible to moderate, local, short to long term. Past and proposed fire severities in the same forest types in and adjacent (GRCA and KNF) lands would be adverse, negligible to moderate , and beneficial negligible to moderate, local to regional, short to long term.
Special Status Plant Species	Adverse, negligible to moderate, local, short- to long-term, direct and indirect impacts to special status plants from fire and fire activities in ponderosa	Adverse, negligible to moderate, local, short- to long-term, direct and indirect impacts to special status plants from fire and fire activities in ponderosa	Adverse, negligible to moderate, local, short- to long-term, direct and indirect impacts to special status plants from fire and fire activities in ponderosa	Adverse, negligible to moderate, local, short- to long-term, direct and indirect impacts to special status plants from fire and fire activities in ponderosa	Adverse, negligible to moderate, local, short- to long-term, direct and indirect impacts to special status plants from fire and fire activities in ponderosa
	Beneficial, minor to moderate, local, short- to long-term impacts from habitat improvement and movement toward natural range of variability for fire regime in ponderosa pine	Beneficial, minor to moderate, local, short- to long-term impacts from habitat improvement and movement toward natural range of variability for fire regime in ponderosa pine	Beneficial, minor, local, short- to long-term impacts from habitat improvement and movement toward natural range of variability for fire regime in ponderosa pine forests	Beneficial, negligible to moderate, local, short- to long-term impacts from habitat improvement and movement toward natural range of variability for fire regime in ponderosa pine	Beneficial, minor to moderate, local, short- to long-term impacts from habitat improvement and movement toward natural range of variability for fire regime in ponderosa pine
	Adverse, negligible, short-term, local impacts from manual thinning projects	Adverse, minor, short- to long-term, local impacts from manual/mechanical thinning projects	Adverse, minor, short- to long-term, local impacts from manual/mechanical thinning projects	Adverse, minor, short- to long-term, local impacts from manual/mechanical thinning projects	Adverse, minor, short- to long-term, local impacts from manual/mechanical thinning projects
	Adverse, minor to moderate, local, short- to long-term, direct and indirect impacts from fire and fire activities in mixed-conifer forests	Adverse, minor to moderate, local, short- to long-term, direct and indirect impacts from fire and fire activities in mixed-conifer forests	Adverse, minor to moderate, local, short- to long-term, direct and indirect impacts from fire and fire activities in mixed-conifer	Adverse, minor to moderate, local, short- to long-term, direct and indirect impacts from fire and fire activities in mixed-conifer	Adverse, minor to moderate, local, short- to long-term, direct and indirect impacts from fire and fire activities in mixed-conifer
	Adverse, negligible to minor, local, short-term impacts from fire and fire activities in piñon-juniper forests	Adverse, negligible to minor, local, short-term impacts from fire and fire activities in piñon-juniper forests	Adverse, negligible to minor, local, short-term impacts from fire and fire activities in piñon-juniper	Adverse, negligible to minor, local, short-term impacts from fire and fire activities in piñon-juniper	Adverse, negligible to minor, local, short-term impacts from fire and fire activities in piñon-juniper

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Special Status Plant Species	Adverse, negligible to mod-erate, long-term, local indirect impacts from introduction or increase of exotic species	Adverse, negligible to moderate, long-term, local indirect impacts from introduction or increase of exotic species	Adverse, negligible to mod-erate, long-term, local in-direct impacts from exotic species introduction or increase	Adverse, negligible to moderate, long-term, local indirect impacts from introduction or increase of exotic species	Adverse, negligible to moderate, long-term, local indirect impacts from introduction or increase of exotic species
	Adverse none to moderate local to regional short to long term cumulative impacts from past, present, and reasonably foreseeable actions	Adverse, none to moderate, local to regional, short- to long-term, cumulative impacts from past, present, and reasonably foreseeable actions	Adverse, none to moderate, local to regional, short- to long-term, cumulative impacts from past, present, and reason-ably foreseeable actions	Adverse, none to moderate, local to regional, short- to long-term, cumulative impacts from past, present, and reason-ably foreseeable actions	Adverse, none to moderate, local to regional, short- to long-term, cumulative impacts from past, present, and reasonably foreseeable actions
Exotic Plant Species	Adverse, minor to moderate, local, long-term impacts from vehicle use	Adverse, minor to moderate, local, long-term impacts from vehicle use	Adverse, minor to moderate, local, long-term impacts from vehicle use	Adverse, minor to moderate, local, long-term impacts from vehicle use	Adverse, negligible to minor, local, long-term impacts from vehicle use
	Adverse, minor to moderate, local, long-term impacts from handline construction and manual thinning	Adverse, minor to moderate, local, long-term impacts from handline construction and manual thinning	Adverse, minor to moderate, local, long-term impacts from handline construction and manual thinning	Adverse, minor to moderate, local, long-term impacts from handline construction and manual thinning	Adverse, minor to moderate, local, long-term impacts from handline construction and manual thinning
	Adverse, minor to moderate, local, long-term impacts from moderate/high and high severity fire	Adverse, minor to moderate, local, long-term impacts from moderate/high and high severity fire	Adverse, minor to moderate, local, long-term impacts from moderate/high and high severity fire	Adverse, minor to moderate, local, long-term impacts from moderate/high and high severity fire	Adverse, minor to moderate, local, long-term impacts from moderate/high and high severity fire
	Adverse, negligible to minor, local, long-term impacts from increased human and animal activities	Adverse, negligible to minor, local, long-term impacts from increased human and animal activities	Adverse, negligible to minor, local, long-term impacts from increased human and animal activities	Adverse, negligible to minor, local, long-term impacts from increased human and animal activities	Adverse, negligible to minor, local, long-term impacts from increased human and animal activities
	No impacts because no mechanical thinning	Adverse, minor to moderate, local, long-term impacts from mechanical thinning equipment use	Adverse, minor to moderate, local, long-term impacts from mechanical thinning equipment use	Adverse, negligible to minor, local, long-term impacts from mechanical thinning equipment use	Adverse, minor to moderate, local, long-term impacts from mechanical thinning equipment use
	Adverse, minor to moderate, regional, long-term cumulative impacts from past, present, and reasonably foreseeable actions	Adverse, minor to moderate, regional, long-term cumulative impacts from past, present, and reasonably foreseeable actions	Adverse, minor to mod-erate, regional, long-term cumulative impacts from past, present, and reason-ably foreseeable actions	Adverse, minor to moderate, regional, long-term cumulative impacts from past, present, and reasonably foreseeable actions	Adverse, minor to mod-erate, regional, long-term cumulative impacts from past, present, and reason-ably foreseeable actions

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Wildlife	Adverse, negligible to minor, local, short-term effects to invertebrates during fire activities; beneficial, minor to moderate local, long-term effects after the activity	Adverse, negligible to minor, local, short-term effects to invertebrates during fire activities; beneficial, minor to moderate local, long-term effects after the activity	Adverse, negligible to minor, local, short-term effects to invertebrates during fire activities; beneficial, negligible to minor local, long-term effects after the activity	Adverse, negligible to minor, local, short-term effects to invertebrates during fire activities; beneficial, minor to moderate local, long-term effects after the activity	Adverse, negligible to minor, local, short-term effects to invertebrates during fire activities and beneficial, minor to moderate local, long-term effects after the activity
	Adverse, negligible, local, short-term indirect impacts to herpetofauna that use mesic habitat; beneficial, negligible, local, short-term indirect impacts to herpetofauna that prefer open, early successional habitats from habitat modification	Adverse, minor to mod-erate, local, short- to long-term indirect impacts to herpetofauna that use mesic habitat; beneficial, minor to moderate, local, short-term indirect impacts to herpetofauna that prefer open, early successional habitats from habitat modification	Adverse, negligible to moderate, local, short- to long-term indirect impacts to herpetofauna that use mesic habitat; beneficial, minor to moderate, local, short-term indirect impacts to herpetofauna that prefer open, early successional habitats from habitat modification	Adverse, negligible to min-or, local, short- to long-term indirect impacts to herpetofauna that use mesic habitat; beneficial, minor to moderate, local, short-term indirect impacts to herpetofauna that prefer open, early successional habitats from habitat modification	Adverse, minor to mod-erate, local, short- to long-term indirect impacts to herpetofauna that use mesic habitat; beneficial, minor to moderate, local, short-term indirect impacts to herpetofauna that prefer open, early successional habitats from habitat modification
	Beneficial, negligible, local, short- to long-term indirect impacts to raptors that use forest openings and open understory for foraging	Beneficial, minor to moderate, local, short- to long-term indirect impacts to raptors that use forest openings and open understory for foraging	Beneficial, minor, local, short- to long-term indirect impacts to raptors that use forest openings and open understory for foraging	Beneficial, minor, local, short- to long-term indirect impacts to raptors that use forest openings and open understory for foraging	Beneficial, minor to moderate, local, short- to long-term indirect impacts to raptors that use forest openings and open understory for foraging
	Small mammals that prefer grasses and forbs would initially receive adverse, negligible, local, short-term impacts, but would likely receive beneficial impacts due to new growth of grass and forbs	Small mammals that prefer grasses and forbs would initially receive adverse, negligible, local, short-term impacts, but would likely receive beneficial, negligible, local, long-term impacts due to new growth of grass and forbs	Small mammals that prefer grasses and forbs would initially receive adverse, negligible, local, short-term impacts, but would likely receive beneficial, negligible to moderate, local, long-term impacts due to new growth of grass and forbs	Small mammals that prefer grasses and forbs would initially receive adverse, negligible, local, short-term impacts, but would likely receive beneficial, negligible to moderate, local, long-term impacts due to new growth of grass and forbs	Small mammals that prefer grasses and forbs would initially receive adverse, negligible, local, short-term impacts, but would likely receive beneficial, negligible to moderate, local, long-term impacts due to new growth of grass and forbs
	Beneficial, short- to long-term impacts to carnivores from increased prey visibility; adverse, negligible, local, short-term impacts to carnivores from habitat disturbance during fire activities	Beneficial, negligible to moderate, local, short- to long-term impacts to carnivores from increased prey visibility; adverse, negligible, local, short-term impacts to carnivores from habitat disturbance during fire activities	Beneficial, negligible to moderate, local, short- to long-term impacts to carnivores from increased prey visibility; adverse, negligible, local, short-term impacts to carnivores from habitat disturbance during fire activities	Beneficial, minor to moderate, local, short- to long-term impacts to carnivores from increased prey visibility; adverse, negligible, local, short-term impacts to carnivores from habitat disturbance during fire activities	Beneficial, minor to moderate, local, short- to long-term impacts to carnivores from increased prey visibility; adverse, negligible, local, short-term impacts to carnivores from habitat disturbance during fire activities

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Wildlife	Adverse, negligible, local, short-term impacts to ungulates from fire activities, but indirect impacts from increased forage from fire activities beneficial, minor to major, local, long term	Adverse, negligible, local, short-term impacts to ungulates from fire activities, but indirect impacts from increased forage from fire activities beneficial, minor to moderate, local, long term	Adverse, negligible, local, short-term impacts to ungulates from fire activities, but indirect impacts from increased forage from fire activities beneficial, negligible to minor, local, long term	Adverse, negligible, local, short-term impacts to ungulates from fire activities, but indirect impacts from increased forage from fire activities beneficial, minor to moderate, local, long term	Adverse, negligible, local, short-term impacts to ungulates from fire activities, but indirect impacts from increased forage from fire activities beneficial, minor to moderate, local, long term
Special Status Wildlife	Beneficial, moderate, local to regional, long-term impacts to Northern Goshawk habitat in treated areas, but adverse, negligible, local, short-term impacts to nesting sites during fire activities	Beneficial, moderate, local to regional, long-term impacts to Northern Goshawk habitat in treated areas, but adverse, negligible, local, short-term impacts to nesting sites during fire activities	Beneficial, minor to moderate, local, long term impacts to Northern Goshawk habitat in treated areas, but adverse, negligible, local, short-term impacts to nesting sites during fire activities	Beneficial, minor to moderate, local, long-term impacts to Northern Goshawk habitat in treated areas, but adverse, negligible, local, short-term impacts to nesting sites during fire activities	Beneficial, moderate, local to regional, long-term impacts to Northern Goshawk habitat in treated areas, but adverse, negligible, local, short-term impacts to nesting sites during fire activities
	Beneficial, negligible, local, long-term impacts to MSO habitat in treated areas, but adverse, minor to moderate, local, long-term impacts where suppression fires occur in mixed-conifer	Adverse, minor, local, long-term impacts to MSO habitat in treated areas, and adverse, minor, local, long-term impacts where suppression fires occur in the mixed-conifer forest	Adverse, minor, local, long-term impacts to MSO habitat in treated areas, and adverse, minor, local, long-term impacts where suppression fires occur in the mixed-conifer forest	Adverse, minor, local, long-term impacts to MSO habitat in treated areas, and adverse, minor, local, long-term impacts where suppression fires occur in the mixed-conifer forest	Adverse, minor, local, long-term impacts to MSO habitat in treated areas, and adverse, minor, local, long-term impacts where suppression fires occur in the mixed-conifer forest
	Beneficial or adverse, negligible to minor, local, short- to long-term impacts to California condors by maintaining foraging habitats but reducing roost trees	Beneficial, negligible - minor, local, short- to long-term impacts on California condors by opening dense stands to create better foraging habitat; adverse, negligible to minor, local impacts to roosting habitat	Negligible impacts on California condor habitat due to limited amount of treatment	Beneficial, minor to moderate, local, long-term impacts on California condors by improving foraging habitat; adverse, negligible to minor local, long-term impacts to roosting habitat	Beneficial minor to moderate local long-term im-pacts on California condors by improving foraging habitat; adverse, negligible to minor local long-term to roosting habitat
	Beneficial, local, long-term impacts to Kaibab squirrel habitat	Beneficial, local, long-term impacts to Kaibab squirrel habitat	Negligible impacts to Kaibab squirrel habitat	Beneficial, minor to moderate local, long-term impacts to Kaibab squirrel habitat	Beneficial, minor to moderate local, long-term impacts to Kaibab squirrel habitat
	Beneficial, negligible to moderate, local, long-term impacts in treated areas on American peregrine falcon	Beneficial, minor to moderate, local, long-term impacts in treated areas on American peregrine falcon	Beneficial, minor to moderate, local, long-term impacts in treated areas on American peregrine falcon	Beneficial, minor to moderate, local, long-term impacts in treated areas on American peregrine falcon	Beneficial, minor to moderate, local, long-term impacts in treated areas on American peregrine falcon
	No direct impacts to bald eagles from proposed treatments	Beneficial, negligible to minor, local, long-term impacts to bald eagles from proposed treatments	Beneficial, negligible to minor, local, long-term impacts to bald eagles from proposed treatments	Beneficial, minor to moderate, local, long-term impacts to bald eagles from proposed treatments	Beneficial, negligible to moderate, local, long-term impacts to bald eagles from proposed treatments

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Special Status Wildlife	Beneficial, negligible to moderate local, long-term impacts to foraging habitat of Allen's big eared bat, Pale Townsend's big eared bat, spotted bat, greater western mastiff bat, and long-legged myotis	Beneficial, minor to moderate local, long-term impacts to foraging habitat of Allen's big eared bat, Pale Townsend's big eared bat, spotted bat, greater western mastiff bat, and the long-legged myotis	Beneficial, minor to moderate local, long-term impacts to foraging habitat of Allen's big eared bat, Pale Townsend's big eared bat, spotted bat, greater western mastiff bat and the long-legged myotis.	Beneficial, negligible to mod-erate local to regional, long-term impacts to foraging habitat of Allen's big eared bat, Pale Townsend's big eared bat, spotted bat, greater western mastiff bat, and the long-legged myotis	Beneficial, minor to mod-erate local to regional, long-term impacts to foraging habitat of Allen's big eared bat, Pale Town-send's big eared bat, spotted bat, greater western mastiff bat, and long-legged myotis
	Negligible, local impacts to golden eagle and Ferruginous hawk due to limited treatment amount proposed in the piñon-juniper forest type	Negligible, local impacts to golden eagle and Ferruginous hawk due to limited treatment amount proposed in the piñon-juniper forest type	Negligible, local impacts to golden eagle and Ferruginous hawk due to limited amount of treatment proposed in the piñon-juniper forest type	Negligible, local impacts to golden eagle and Ferruginous hawk due to limited amount of treatment proposed in the piñon-juniper forest type	Negligible, local impacts to golden eagle and Ferruginous hawk due to limited amount of treatment proposed in the piñon-juniper forest type
	Negligible impacts to Swainson's hawk from proposed fire treatments	Beneficial, minor to moderate, local, long-term impacts to Swainson's hawk from proposed fire treatments	Beneficial, minor to moderate, local, long-term impacts to Swainson's hawk from proposed fire treatments	Beneficial, minor to moderate, local, long-term impacts to Swainson's hawk from proposed fire treatments	Beneficial, minor to mod-erate, local, long-term impacts to Swainson's hawk from proposed fire treatments
Cultural Resources	Adverse, negligible to minor, local, short-term impacts from planned fire management activities where vulnerable resources can be avoided	Adverse, negligible to minor, local, short-term impacts from planned fire management activities where vulnerable resources can be avoided	Adverse, negligible to minor, local, short-term impacts from planned fire management activities where vulnerable resources can be avoided	Adverse, negligible to minor, local, short-term impacts from planned fire management activities where vulnerable resources can be avoided	Adverse, negligible to minor, local, short-term impacts from planned fire management activities where vulnerable resources can be avoided
	Adverse, negligible to major, local to regional, short- to long-term impacts from unplanned fire management activities in which it could be difficult to avoid or pretreat cultural resources	Adverse, negligible to major, local to regional, short- to long-term impacts from unplanned fire management activities in which it could be difficult to avoid or pretreat cultural resources	Adverse, negligible to major, local to regional, short- to long-term impacts from unplanned fire management activities in which it could be difficult to avoid or pretreat cultural resources	Adverse, negligible to major, local to regional, short- to long-term impacts from unplanned fire management activities in which it could be difficult to avoid or pretreat cultural resources	Adverse, negligible to major, local to regional, short- to long-term impacts from unplanned fire management activities in which it could be difficult to avoid or pretreat cultural resources
	Adverse, minor to moderate, local, short-term cumulative impacts, and adverse to beneficial, minor to moderate, local, long-term cumulative impacts depending on the activity	Adverse, minor to mod-erate, local, short-term cumulative impacts with increased potential impacts from soil disturbance and compaction in the WUI; and adverse to beneficial, minor to moderate, local, long-term cumulative impacts depending on activity	Adverse, minor to moderate, local, short-term cumulative impacts; adverse to beneficial, minor to moderate, local, long-term cumulative impacts depending on the activity, with less beneficial impacts outside WUI from reduced treatment acreage proposed	Adverse, minor to moderate, local, short-term cumulative impacts, but less than Alternative 1 due to emphasis on prescribed fire; adverse to beneficial, minor to moderate, local long-term cumulative impacts depending on the activity	Adverse, minor to moderate, local, short-term cumulative impacts; adverse to beneficial, minor to moderate, local, long-term cumulative impacts depending on the activity

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Cultural Resources	Fuels reduction in WUI areas that contain historic structures would have beneficial, local, short- and long-term cumulative impacts that increase through time from minor to major	Fuels reduction in WUI areas that contain historic structures would have beneficial, local, short- to long-term cumulative impacts that increase through time from minor to major, with additional beneficial impacts than Alternative 1 by further reducing risk of unwanted fire in cultural landscapes	Fuels reduction in WUI areas that contain historic structures would have beneficial, local, short- to long-term cumulative impacts that increase through time from minor to major, with additional beneficial impacts than Alternative 1 by further reducing risk of unwanted fire in cultural landscapes	Fuels reduction in WUI areas that contain historic structures would have beneficial, local, short- to long-term cumulative impacts that increase through time from minor to major, with additional beneficial impacts than Alternative 1 by further reducing risk of unwanted fire in cultural landscapes	Fuels reduction in WUI areas that contain historic structures would have beneficial, local, short- to long-term cumulative impacts that increase through time from minor to major, with additional beneficial impacts than Alternative 1 by further reducing risk of unwanted fire in cultural landscapes
Air Quality	Negligible direct impacts to human-health and air quality for all pollutants	Negligible direct impacts to human-health and air quality for all pollutants	Beneficial, major, regional direct impacts to human-health and air quality for all pollutants except sulfur dioxide which would be beneficial, moderate, regional	Beneficial, negligible, regional direct impacts to human-health and air quality for all pollutants except particulates and sulfur dioxide which would be adverse, minor, regional	Beneficial, minor, regional direct impacts to human-health and air quality for all pollutants except carbon dioxide and nitrogen ox-ides which would be bene-ficial, negligible, regional
	Cumulative impacts to human health negligible from carbon monoxide and particulates; moderate from ozone	Cumulative impacts to human health negligible from carbon monoxide and particulates; moderate from ozone	Cumulative impacts to human health negligible from carbon monoxide and particulates; moderate from ozone	Cumulative impacts to human health negligible from carbon monoxide and particulates; moderate from ozone	Cumulative impacts to human health negligible from carbon monoxide and particulates; moderate from ozone
	Cumulative impacts to air quality negligible for carbon monoxide; moderate for ozone and particulates	Cumulative impacts to air quality negligible for carbon monoxide; moderate for ozone and particulates	Cumulative impacts to air quality negligible for carbon monoxide; moderate for ozone and particulates	Cumulative impacts to air quality negligible for carbon monoxide; moderate for ozone and particulates	Cumulative impacts to air quality negligible for carbon monoxide; moderate for ozone and particulates
Soils and Watershed	Adverse, minor to moderate, local, short-term impacts from proposed treatments and suppression fires on soil erosion and sediment transport	Adverse, minor to moderate, local, short-term impacts from proposed treatments and suppression fires on soil erosion and sediment transport	Adverse, minor to moderate, local, short-term impacts from proposed treatments and suppression fires on soil erosion and sediment transport	Adverse, minor to moderate, local, short-term impacts from proposed treatments and suppression fires on soil erosion and sediment transport	Adverse, minor to moderate, local, short-term impacts from proposed treatments and suppression fires on soil erosion and sediment transport
	Adverse, negligible, local, short-term impacts to soil biota and soil nutrients	Adverse, minor to moderate, local, short-term impacts to soil biota and soil nutrients	Adverse, minor, local, short-term impacts to soil biota and soil nutrients	Adverse, minor to moderate, local, short-term impacts to soil biota and soil nutrients	Adverse, minor to moderate, local, short-term impacts to soil biota and soil nutrients
	Adverse, moderate, local, short- and long-term direct impacts to biological soil crust if impacted	Adverse, moderate, local, short- and long-term direct impacts to biological soil crust if impacted	Adverse, moderate, local, short- and long-term direct impacts to biological soil crust if impacted	Adverse, moderate, local, short- and long-term direct impacts to biological soil crust if impacted	Adverse, moderate, local, short- and long-term direct impacts to biological soil crust if impacted

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Soils and Watershed	Beneficial, minor to moderate, local, short- and long-term impacts to soil nutrients available to plants	Beneficial, minor to moderate, local, short- and long-term impacts to soil nutrients available to plants	Beneficial, minor, local, short- and long-term impacts to soil nutrients available to plants	Beneficial, minor to moderate, local, short- and long-term impacts to soil nutrients available to plants	Beneficial, minor to moderate, local, short- and long-term impacts to soil nutrients available to plants
	Adverse, negligible, local, short-term impacts to soil compaction from manual thinning	Adverse, minor, local, short-term impacts to soil compaction from manual and mechanical thinning	Adverse, minor to mod-erate, local, short-term impacts to soil compaction from manual/mechanical thinning	Adverse, minor, local, short-term impacts to soil compaction from manual and mechanical thinning	Adverse, minor, local, short-term impacts to soil compaction from manual and mechanical thinning
	Adverse, minor, local, short-term direct and indirect impacts to stream hydrography, groundwater, water quality	Adverse, minor to moderate, local, short- to long-term impacts to stream hydrography, groundwater, water quality	Adverse, minor to moderate, local, short- to long-term impacts to stream hydrography, groundwater, water quality	Adverse, minor to moderate, local, short- to long-term impacts to stream hydrography, groundwater, water quality	Adverse, minor, local, short- to long-term impacts to stream hydrography, groundwater, water quality
	Adverse, minor, local, short-term cumulative impacts from treatments near GRCA, upstream of proposed GRCA activities, and occur within one year of each other	Adverse, minor, local, short-term cumulative impacts from treatments near GRCA, upstream of proposed GRCA activities, and occur within one year of each other	Adverse, minor, local, short-term cumulative impacts from treatments near GRCA, upstream of proposed GRCA activities, and occur within one year of each other	Adverse, minor-moderate, local, short-term cum-ulative impacts from treat-ments near GRCA, up-stream of proposed GRCA activities, and occur within one year of each other	Adverse, minor-moderate, local, short-term cumulative impacts from treatments near GRCA, up-stream of proposed GRCA activities, and occur within one year of each other
	Adverse to beneficial, minor to moderate, local, long-term cumulative impacts depending on activity	Adverse to beneficial, minor to moderate, local, long-term cumulative impacts depending on activity with a slight increase in potential soil impacts in primary and secondary WUI FMUs	Adverse to beneficial, minor to moderate, local, long-term cumulative impacts depending on activity with increased in potential soil impacts in primary and secondary WUI FMUs	Adverse to beneficial, minor to moderate, local, long-term cumulative impacts depending on activity with increased treated acres from prescribed fire	Adverse to beneficial, minor to moderate, local, long-term cumulative impacts depending on activity with increased in treated acres from wildland fire use
Soundscape	Adverse, minor to major, local, short-term impacts from prescribed fire activities	Adverse, minor to major, local, short-term impacts from prescribed fire activities	Adverse, minor to major, local, short-term impacts from prescribed fire activities	Adverse, moderate to major, local, short-term impacts from prescribed fire activities	Adverse, minor to major, local, short-term impacts from prescribed fire activities
	Adverse, negligible to major, local, short-term impacts from wildland fire use activities	Adverse, negligible to major, local, short-term impacts from wildland fire use activities	Adverse, negligible to major, local, short-term impacts from wildland fire use activities	Adverse, negligible to major, local, short-term impacts from wildland fire use activities	Adverse, minor to major, local, short-term impacts from wildland fire use activities
	Adverse, minor to major, local to regional, short-term impacts from suppression activities	Adverse, minor to major, local to regional, short-term impacts from suppression activities	Adverse, minor to major, local to regional, short-term impacts from suppression activities	Adverse, minor to major, local to regional, short-term impacts from suppression activities	Adverse, minor to major, local to regional, short-term impacts from suppression activities
	Adverse, moderate to major, local, short-term impacts from manual thinning activities	Adverse, moderate to major, local, short-term impacts from manual thinning activities	Adverse, moderate to major, local, short-term impacts from manual thinning activities	Adverse, moderate to major, local, short-term impacts from manual thinning activities	Adverse, moderate to major, local, short-term impacts from manual thinning activities

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Soundscape	No impacts because no mechanical thinning	Adverse, major, local, short-term impacts from mechanical thinning activities	Adverse, major, local, short-term impacts from mechanical thinning activities	Adverse, major, local, short-term impacts from mechanical thinning activities	Adverse, major, local, short-term impacts from mechanical thinning activities
	Results of prescribed and wildland fire-use fires, and manual thinning are indirect, beneficial, moderate to major, local to regional, long term	Results of prescribed and wildland fire-use fire, and manual/mechanical thin-ning are indirect, beneficial, moderate to major, local to regional, long term	Results of prescribed and wildland fire-use fires, and manual/mechanical thinning are indirect, beneficial, moderate to major, local to regional, long term	Results of prescribed and wildland fire-use fires, and manual/mechanical thinning are indirect, beneficial, moderate to major, local to regional, long term	Results of prescribed and wildland fire-use fires, and manual/mechanical thinning are indirect, beneficial, moderate to major, local to regional, long term
	Results from suppression fire are indirect, adverse, moderate to major, local, long term	Results from suppression fire are indirect, adverse, moderate to major, local, long term	Results from suppression fire are indirect, adverse, moderate to major, local, long term	Results from suppression fire are indirect, adverse, moderate to major, local, long term	Results from suppression fire are indirect, adverse, moderate to major, local, long term
	Adverse, major, regional, long-term cumulative impacts to soundscape from aircraft overflights not related to fire management activities	Adverse, major, regional, long-term cumulative impacts to soundscape from aircraft overflights not related to fire management activities	Adverse, major, regional, long-term cumulative impacts to soundscape from aircraft overflights not related to fire management activities	Adverse, major, regional, long-term cumulative impacts to soundscape from aircraft overflights not related to fire management activities	Adverse, major, regional, long-term cumulative impacts to soundscape from aircraft overflights not related to fire management activities
Wilderness Character	Beneficial, negligible to moderate, local to regional, long-term impacts to vegetation composition and structure	Beneficial, minor to major, local to regional, long-term impacts to vegetation composition and structure	Adverse, negligible to major, local to regional, short-long-term impacts to vegetation composition and structure from lack of WFU and prescription fire	Beneficial, moderate to major, local to regional, long-term impacts to vegetation composition and structure in most forest types due to large amount of fire treatment planned for those areas	Beneficial, moderate to major, regional, long-term impacts to vegetation composition and structure
	Adverse, minor, local, short-term impacts from physical fire management activities	Adverse, minor, local, short-term impacts from physical fire management activities	Adverse, minor, local, short-term impacts from physical fire management activities	Adverse, minor to moderate, local, short-term impacts from physical fire management activities	Adverse, minor, local, short-term impacts from physical fire management activities
	Adverse, negligible to minor, short-term, local cumulative impacts from actions inside and outside the park on wilderness character	Adverse negligible to minor short-term, local cumulative impacts from actions inside and outside the park on wilderness character	Adverse, moderate, long-term, regional cumulative impacts from actions in-side and outside the park on wilderness character	Adverse, negligible to min-or, short-term, local cum-ulative impacts from ac-tions inside/outside park on wilderness character	Adverse, negligible to minor, short-term, local cumulative impacts from actions inside/outside park on wilderness character
	Beneficial, minor to major, long-term, regional cumulative impacts from reduction of threat of high-intensity suppression fires	Beneficial, minor to major, long-term, regional cum-ulative impacts from re-duction of threat of high-intensity suppression fires	Adverse, moderate, long-term, regional cumulative impacts from reduction of threat of high intensity suppression fires	Beneficial, moderate, long - term, regional cumulative impacts from reduction of threat of high-intensity suppression fires	Beneficial, minor to major, long-term, regional cumu-lative impacts from reduc-tion of threat of high-intensity suppression fires

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Wilderness Character	Adverse, negligible to major, short to long-term, local and regional impacts due to other components of wilderness character such as soundscape and cultural resources	Adverse, negligible to major, short to long-term, local and regional impacts due to other components of wilderness character such as soundscape and cultural resources	Adverse, negligible to major, short to long-term, local and regional impacts due to other components of wilderness character such as soundscape and cultural resources	Adverse, negligible to major, short to long-term, local and regional impacts due to other components of wilderness character such as soundscape and cultural resources	Adverse, negligible to major, short to long-term, local and regional impacts due to other components of wilderness character such as soundscape and cultural resources
Visitor Experience	Adverse, minor to moderate, short term, local from visual and health impacts to visitors during specific days	Adverse, minor to moderate, short term, local from visual and health impacts to visitors during specific days	Adverse, minor to moderate, short or long term, local from visual and health impacts to visitors during specific days	Adverse, minor to moderate, short term, local from visual and health impacts to visitors during specific days	Adverse, minor to moderate, short and long term, local from visual and health impacts to visitors during specific days
	Adverse, direct, negligible, short-term, local impacts to visitors from manual/mechanical treatment, equipment noise, restricted access, and reduced visual quality from slash piles	Adverse, direct, negligible to minor, short-term, local impacts to visitors from manual/mechanical treatment, equipment noise, restricted access, and reduced visual quality from slash piles	Adverse, moderate, short-term, local impacts to visitors from manual/mechanical treatment equipment noise, restricted access, and reduced visual quality from slash piles	Adverse, direct, negligible to minor, short-term, local impacts to visitors from manual/mechanical treatment equipment noise, restricted access, and reduced visual quality from slash piles	Adverse, direct, negligible-minor, short-term, local impacts to visitors from manual/mechanical treatment equipment noise, restricted access, and reduced visual quality from slash piles
	Beneficial, negligible, long-term, local impacts to visitors from improved aesthetics	Beneficial, minor to major, long-term, local impacts to visitors from improved aesthetics	Beneficial, moderate to major, long-term, local impacts to visitors from improved aesthetics	Beneficial, moderate, long-term, local impacts to visitors from improved aesthetics	Beneficial, minor to major, long-term, local impacts to visitors from improved aesthetics
	Adverse, minor to moderate, local, indirect, short-term impacts to river users from reduced visibility	Adverse, minor to mod-erate, local, indirect, short-term impacts to river users from reduced visibility	Adverse, minor, local, indirect, short-term impacts to river users from reduced visibility	Adverse, minor, local, indirect, short-term impacts to river users from reduced visibility	Adverse, minor to mod-erate, local, indirect, short-term impacts to river users from reduced visibility
	Adverse, minor to moderate, local, short-term impacts to backcountry users from reduced visibility and restricted access	Adverse, minor to mod-erate, local, short-term impacts to backcountry users from reduced visibility and restricted access	Adverse, minor to mod-erate, local, short-term impacts to backcountry users from reduced visi-bility and restricted access	Adverse, moderate, local, short-term impacts to backcountry users from reduced visibility and restricted access	Adverse, moderate, local, short-term impacts to backcountry users from reduced visibility and restricted access
	Beneficial, minor to mod-erate, local, long-term impacts to backcountry users as conditions approach natural fire regime, forest aesthetics would generally improve	Beneficial, moderate to ma-jor, local, long-term impacts to backcountry users as conditions approach natural fire regime, forest aesthetics would generally improve	Beneficial, minor, local, long term impacts to back-country users as conditions near natural fire regime, forest aesthetics would generally improve in limited fire treated areas	Beneficial, moderate, local, long-term impacts to backcountry users as conditions approach natural fire regime, forest aesthetics would generally improve	Beneficial, major, local-regional, long-term impacts to backcountry users as conditions approach natural fire regime, forest aesthetics would generally improve
	Adverse, minor, local, short term to air tour visitors from reduced visibility	Adverse, minor, local, short term to air tour visitors from reduced visibility	Adverse, negligible to minor, local, short term to air tour visitors from reduced visibility	Adverse, minor, local, short term to air tour visitors from reduced visibility	Adverse, moderate, local, short term to air tour visitors from reduced visibility

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Visitor Experience	Adverse, minor to moderate, local, short-term impacts to cumulative effects from reduced visibility	Adverse, minor, local, short-term impacts to cumulative effects from reduced visibility	Adverse, minor, local, short-term impacts to cumulative effects from reduced visibility	Adverse, moderate, local, short-term impacts to cumulative effects from reduced visibility	Adverse, moderate, local, short-term impacts to cumulative effects from reduced visibility
	Beneficial, minor to major, local, long-term impacts to cumulative effects from improved forest aesthetics	Beneficial, major, local, long-term impacts to cumulative effects from improved forest aesthetics	Beneficial, minor to moderate, local, long-term impacts to cumulative effects from improved forest aesthetics	Beneficial, moderate to major, local, long-term impacts to cumulative effects from improved forest aesthetics	Beneficial, major, local, long-term impacts to cumulative effects from improved forest aesthetics
Socio-economic Environment	Adverse, minor, short term, local from increased suppression fire obscuring visibility and causing shorter regional visitation lengths	Adverse, minor, short term, local from increased suppression fire obscuring visibility and causing shorter regional visitation lengths	Adverse, minor, short term, local from increased suppression fire obscuring visibility and causing shorter regional visitation lengths	Adverse, minor, short term, local from increased suppression fire obscuring visibility and causing shorter regional visitation lengths	Adverse, minor, short term, local from increased suppression fire obscuring visibility and causing shorter regional visitation lengths
	Beneficial, minor to moderate, long term, local from fuels reduction treatment creating enhanced landscape aesthetics in high use areas like the WUI	Beneficial, minor to moderate, long term, local from fuels reduction treatment creating enhanced landscape aesthetics in high use areas like the WUI	Beneficial, moderate to major, long term, local from fuels reduction treatment creating enhanced landscape aesthetics in high use areas like the WUI	Beneficial, minor, short term, local from fuels reduction treatment creating enhanced landscape aesthetics in high use areas like the WUI	Beneficial, minor, short term, local from fuels reduction treatment creating enhanced landscape aesthetics in high use areas like the WUI
	Beneficial, moderate to major, long-term, regional impacts from increased engagement and collaboration on fire management with other agencies and local communities	Beneficial, moderate to major, long-term, regional impacts from increased engagement and collaboration on fire management with other agencies and local communities	Beneficial, moderate to major, long-term, regional impacts from the increase engagement and collaboration on fire management with other agencies and local communities	Beneficial, moderate to major, long-term, regional from more rapid restoration of fire-adapted ecosystems and increased engagement and collaboration on fire management with other agencies and local communities	Beneficial, moderate to major, long term, regional from more rapid restor-ation of fire-adapted ecosystems and increased engagement and collabor-ation on fire management with other agencies and local communities
	Adverse, major, long term, regional from lowest (limited) WUI treatment that would not reduce pot-ential for damaging WUI fire	Beneficial, minor-moderate, long term, regional from WUI treatment to reduce potential for damaging WUI fire	Beneficial, moderate, long term, regional from highest WUI treatment to reduce potential for damaging WUI fire	Beneficial, minor, long term, regional from WUI treat-ment to reduce potential for damaging WUI fire	Beneficial, moderate, long term, regional from WUI treatment to reduce potential for damaging WUI fire
	Beneficial, minor to moderate long-term, regional cumulative impacts when combined with current and future projects on neighboring lands	Beneficial, moderate long-term, regional cumulative impacts when combined with current and future projects on neighboring lands	Beneficial, moderate to major long-term, regional cumulative impacts when combined with current and future projects on neighboring lands	Beneficial, moderate long-term, regional cumulative impacts when combined with current and future projects on neighboring lands	Beneficial, moderate to major long-term, regional cumulative impacts when combined with current and future projects on neighboring lands

Impact Topics	Alternative 1 No Action Existing Program	Alternative 2 Mixed Fire Treatment Preferred	Alternative 3 Non-Fire Emphasis	Alternative 4 Prescribed Fire Emphasis	Alternative 5 Fire Use Emphasis
Park Management and Operations	Negligible, long term, regional, since this is the no-action alternative	Adverse, negligible to moderate, long term, regional due to increases in mechanical thinning operations, program costs, and operation days[1]	Beneficial, minor to major, long term, regional from reduction of total program costs and lowest park personnel days. Adverse, moderate, long-term, regional from high cost/acre and fewest acres treated	Beneficial, negligible to major, long term, regional from reduction of total program costs and lowest cost/acre	Beneficial, negligible, long term, regional from decreased in-park personnel days. Adverse, moderate to major, long-term, regional from increase in operation days and program costs

[1] An Operation Day is defined as: each day a project or activity is occurring. Example, if a thinning project takes a crew 10 days to cut down brush and another 5 days to remove the brush, the project lasted for 15 operation days.