APPENDIX J

VEGETATION TREATMENTS AND FIRE MANAGEMENT IN THE KASHA-KATUWE TENT ROCKS NATIONAL MONUMENT PLANNING AREA

Major Land Resource Area

The project area covered by this RMP has been characterized by the Natural Resources Conservation Service (NRCS) as Major Land Resource Area (MLRA) No. 36—Western Plateau, subresource area WP-2—New Mexico and Arizona Plateaus and Mesas (USDA, NRCS 2004). It consists of broad mesas and plateaus interspersed with numerous deep canyons and dry washes, mesa breaks, and canyon walls. Scattered throughout the region are isolated volcanic peaks, cones, and lava flows.

This area is characterized as semi-arid, with distinct seasonal precipitation and temperature patterns associated with a continental climate. Average annual precipitation approaches 10-16 inches. Most of the precipitation comes in the form of local high-intensity summer storms of short duration. Such storms occur when warm, moist Gulf air moves inland and becomes unstable over the hot terrain, causing thundershowers. These usually occur in the late afternoon. A secondary peak in precipitation comes in the form of snow and rain/snow mix that occurs in late winter and early spring. Season, quantity, frequency, and intensity of precipitation typically vary greatly from place to place and from year to year. What precipitation does fall can be quite effective for vegetative response because it occurs during much of the growing season (April to October). The natural vegetation has, of course, evolved under these conditions, and the erratic precipitation pattern is the predictable norm (Dick-Peddie 1993).

Vegetation and Fire Regime

Climate, vegetation, and fire are frequently considered together in land use planning and environmental analysis. This is because climate (i.e., temperature, precipitation, solar degree days, and growing season) is the major determinant of vegetation patterns, while fire is a component of the natural ecological processes that supports, maintains, and/or alters a given plant community.

Dick-Peddie (1993) states: "In New Mexico, generally the vegetation changes on an available-moisture gradient (lower to higher) as follows: scrubland to grassland to woodland to forest. *Moisture availability* is considered here to be moisture available to plants for their establishment and maintenance. *Available moisture* is considered here as the moisture which is free to enter the roots. Moisture availability as the primary factor influencing vegetative patterns in New Mexico was recognized by Watson in 1912, when he wrote, 'The chief factor determining this change is moisture, the supply of which is largely determined by precipitation, ability to hold it, and protection from drying winds and sun.' . . . . Temperature and available moisture together can be considered primary factors producing vegetation patterns. Features that singly or in combination affect these two primary factors can be thought of as secondary. Examples of secondary factors affecting moisture availability are latitude, altitude, annual precipitation, evaporation rates, soil texture and structure, slope, exposure (aspect), salinity, and season."

The potential natural plant communities and associated vegetation within the Monument are highly diverse as a result of the variability of soils, elevation, annual and seasonal precipitation, temperature, degree of slope and aspect, and disturbance (USDA, NRCS 2004). Annual precipitation comes primarily in the form of rainfall during the months of July, August, and September, although wintertime precipitation in the form of snow, sleet, or rain is sometimes significant. The rainfall patterns generally favor warm-season perennial vegetation, while the

temperature regime tends to favor cool-season vegetation. This creates a complex community of plants on any given ecological site, which is quite susceptible to disturbance and is at or near its productive potential only when both the natural warm and cool-season dominants are present.

Soils described in the Sandoval County Soil Survey (USDA, SCS 1987, updated in 1992-1993) are assigned management potentials under two broad interpretations, Rangeland and Woodlands. The soils occurring within the Monument (see Map 9) and their management potential are listed below.

Map Unit Symbol	Soils Description	% Slopes	Management Potential	Acres
52	Totavi loamy sand	0-5	Woodland	35
104	Cochiti-Montecito association	1-30	Woodland	1,022
206	Pinitos loam	1-15	Woodland	58
300	Waumac (50%)-Bamac (30%) association	1-7	Rangeland	485
307	Flugle (60%)-Waumac (25%) complex	1-8	Rangeland	460
345	Espiritu (50%)-Bamac (35%) association	15-55	Rangeland	246
353	Cochiti-Espiritu association	15-55	Woodland	2,226
603	Laventana-Mirand very cobbly loam	15-55	Woodland	94
			Total	4,626

The management potentials (Rangeland/Woodland) are further broken down into site-specific descriptions and productivity, **based on a soil's capability to support and maintain the potential natural plant community** structure and function.

Within the rangeland capabilities are three range sites, described as "Sandy," "Savannah," and "Foothills" Ecological Site Descriptions (ESDs). These are located in valleys, mesa tops, and at the base of steep slopes, respectively. These sites normally occur on gently to moderately sloping topography that may range as high as 15 percent slope but averages less than 10 percent. The soils forming the three rangeland sites are found as associations or complexes that often produce indistinct boundaries between one ESD and another. Rangeland site productivity is measured in pounds of air dry forage per acre (lbs/ac) and is presented as a range for each ecological site under unfavorable and favorable growing conditions. Grazing capacity of rangeland is determined based on the site's current potential to produce forage balanced against a desired amount of residual vegetation/stubble height for watershed protection and the proper amount of forage to be harvested by grazing ungulates.

The Woodlands are described by indicator species with their productivity measured by Site Index (SI) and/or in cubic feet per acre (cuft/ac). The indicator species is the species that is common in the area and is generally, but not necessarily, the most productive on the soil. Site index is the average height, in feet, that the trees attain in a specified number of years. This index applies to fully stocked, even-aged, unmanaged stands. Site indexes shown in the table are averages based on measurements made at sites that are representative of the soil series and where the site has been free of past fire and disturbances. For non-timber species, such as oneseed juniper and Utah juniper, productivity is a measure of fiber (wood) in cubic feet per acre (cuft/ac).

The Monument has approximately 512 acres (9 percent) with slopes greater than 60 percent; these have little potential to support vegetation due to the steep slopes and shallow soils. Areas that are less than 60 percent slope are comprised of woodlands and forest, and as percent slope

Map Unit Symbol	Management Potential	Indicator Species Site Descriptions	Site Productivity SI :: cuft/ac, or lbs (air dry forage)/ac	Trees to Manage
52	Woodland	Utah juniper Oneseed juniper Ponderosa pine	 SI 75 :: 57 cuft/ac	-- -- Ponderosa pine
104	Woodland	Oneseed juniper Two-needle piñon	SI 34 :: 14 cuft/ac SI 51	-- --
206	Woodland	Oneseed juniper Two-needle piñon	 SI 45	-- Two-needle piñon
300	Rangeland	Sandy	325-860 lbs/ac	--
307	Rangeland	Sandy Savannah	325-860 lbs/ac 300-875 lbs/ac	-- --
345	Rangeland	Foothills	375-750 lbs/ac	--
353	Woodland	Oneseed juniper Two-needle piñon	 SI 25-51	-- --
603	Woodland	Ponderosa pine	SI 55-76 :: 43-57 cuft	Ponderosa pine

decreases the land's potential natural plant community moves toward a grass/shrub community.

Vegetation forms the basis for describing plant community structure and function. **Fire,** a component of the natural ecological processes, supports, maintains, and/or alters a given plant community. Ecological site descriptions developed by the NRCS are used to portray rangeland plant community structure, whereas fire regimes are used to classify the role fire played across the landscape. The presence of vegetation (fuels) is essential for fire to occur.

The concept of **Fire Regime** is used to broadly describe the fire frequency (average number of years between fires) and severity (amount of replacement) that may occur on dominant overstory vegetation. Two natural fire regimes were historically present in the Monument, both with an average fire frequency of less than 35 years. Under Fire Regime I (low and mixed severity fires), surface fires were most common and less than 25 percent of the dominant overstory vegetation was replaced. Under Fire Regime II (high severity fires), stand replacement fires were common and greater than 75 percent of the dominant overstory was replaced.

In addition to classification of the Monument lands into two historic Fire Regimes based on natural fire frequency, severity, and dominant overstory replacement, the lands have been further placed into **Fire Regime Condition (FRC) Classes** based on the degree of departure from the natural (historic) fire regime. Departure from historic fire regimes results in "alterations of key ecosystem components such as species composition, structural stage, stand age, and canopy closure. One or more of the following activities may have caused this departure: fire exclusion, timber harvesting, grazing, introduction and establishment of exotic species, insects and disease (introduced or native), or other management activities" (Schmidt et al. 2002).

FRC Class I is characterized as being within the natural range of variability for vegetation structure and function; fuel composition; fire frequency, severity and pattern; and other associated disturbances. Since the introduction of livestock grazing and implementation of fire suppression, the historic fire regime within the Monument has been significantly altered from a high frequency, low intensity fire regime to a low frequency, high intensity fire regime, with the result that none of the Monument lands are

FRC Class I. Based on departure from the natural fire regime, the Monument lands have been classified as FRC Class II (moderately altered from the natural fire regime, with moderate risk of losing key ecosystem components) or FRC Class III (significantly altered from the natural fire regime, with high risk of eliminating desired ecosystem components). The Statewide RMP amendment *Fire and Fuels Management Resource Management Plan Amendment and Environmental Assessment* (USDI, BLM 2004b) describes the Fire Regime Condition Classes for the vegetative communities or plant associations that occur on the Monument (Open Conifer Woodlands, Closed Conifer Woodlands, and Chihuahuan Desert Grasslands).

The **potential natural plant community** of woodlands and forest stands within the Monument is described as 70 percent piñon-juniper woodlands and 2 percent ponderosa pine forests, while the remaining 28 percent of the Monument consists of grass/shrub rangeland communities (USDA, SCS 1987, updated in 1992-93). On the basis of local fire history information (Allen 2002), the young ages of most piñon-juniper trees of the Pajarito Plateau located near Los Alamos, NM (Julius 1999), and soils data (McFadden et al. 1996), we believe that many upland mesa areas now occupied by dense piñon-juniper woodlands were formerly more open, with fewer trees and well developed herbaceous understories that: (1) protected the soil from excessive erosion during intense summer thunderstorm events, and (2) provided a largely continuous fuel matrix, which allowed surface fires to spread and maintain these vegetative types.

Shifts may occur in plant community dominance, structure, and function under natural disturbance. These natural disturbances—fire, drought, and insects—play a vital role in plant community dynamics and development of vegetation patterns. Other human-induced disturbances—logging, livestock grazing, and fire suppression—may also encourage changes in plant community structure and function. The following illustrates the effects to the potential natural plant communities from human-induced disturbance.

Settlement and the introduction of domestic livestock into the Rio Grande Valley by Euro-Americans began in 1598; however, significant livestock grazing did not occur until after the railroads linked the Southwest to commercial markets in the 1880s. Millions of sheep and cattle were placed onto the New Mexico landscape at that time, with unrestricted grazing on public lands. Sharp reductions in the herbaceous ground cover and associated litter resulted, effectively eliminating previously widespread surface fires. This was coupled with institutionalized fire suppression initiated by the Federal government after 1910. Severe drought during the 1950s contributed to declines in ground cover (Allen and Breshears 1998). Fire-sensitive piñon and juniper trees became established in densities unprecedented for at least the past 800 years. As these trees grew, they became increasingly effective competitors for water and nutrients. Thus a positive feedback cycle was initiated that favors tree invasion and decreased herbaceous ground cover (Allen 1989; Gottfried et al. 1995).

Arnold (1950), Cooper (1960), Madany and West (1983), Mitchell and Freeman (1993), Rummell (1951), and Savage and Swetnam (1990) have identified livestock grazing as a major cause in altering the historic fire regimes and increasing fire hazard. Past grazing of the low growing, continuous fine fuel by livestock has displaced the herbaceous plant community with brush and piñon-juniper. The loss of herbaceous ground fuels inhibits the occurrence of low intensity surface fires and fire spread that could control the ensuing brush and tree encroachment. The resulting increase in brush and tree densities supports destructive crown fires.

Shifts in the potential natural plant communities on the Monument are reflected in recent woodland inventories that record a striking departure in expected species composition. Fixed 0.05-acre plots done within the rangeland and woodland sites in 2004 reveal that 60 percent of the

stems are less than 4 inches in diameter and less than 100 years in age. The average stem density is 353 per acre with a range of 60 to 720 stems per acre. This represents an average spacing of 11 feet. These sites are dominated by oneseed juniper at 70 percent, followed by piñon at 30 percent (Borland 2004). The expected natural plant community of the piñon-juniper woodlands on the Monument is around 60 to 100 stems per acre.

These changes in vegetation patterns appear to be the result of differential accumulation of available moisture. Human-induced disturbance, livestock grazing, and fire suppression resulted in reduced herbaceous cover. Exposed bare ground increased, allowing rain water to flow across the interspaces rather than infiltrate where it fell. Water then accumulated in small depressions that provided more water than normal under grass cover so that junipers could become established (Dick-Peddie 1993).

The prevailing natural disturbances of drought and insects continue to dramatically influence the present condition of the vegetative communities within the Monument. Drought conditions have been acknowledged from 1994-1995 to present by meteorologists/climatologists throughout the Southwest. This regional drought has caused trees to become moisture stressed and susceptible to insect invasion and damage. As drought progressed, trees became unable to repel the piñon-bark (*Ips*) beetle with tree pitch. Insect populations of the Ips beetle have exploded, permitting them to move onto adjoining trees and woodlands. The smaller encroaching trees (less than 3 inches in diameter) are passed up by the *Ips* beetle; however, the older and larger trees are highly susceptible to their damage, eventually resulting in death. The extent of this outbreak within the Monument is obvious: on the average 88 piñon trees per acre are dead (Borland 2004).

The following ecological site descriptions (Sandy, Savannah, and Foothills), taken from the Sandoval County soil mapping unit summaries, describe the potential natural vegetation that would occur on the rangeland component of the Monument (USDA, SCS 1987, updated in 1992-1993).

Sandy ecological sites are characterized as having both warm- and cool-season grasses, scattered shrubs, half-shrubs, and forbs. Blue grama and western wheatgrass are co-dominants, with Indian ricegrass and dropseed closely associated. Principal shrubs and half-shrubs include fourwing saltbush, winterfat, and sand sagebrush. Rocky Mountain beeplant is often the most noticeable forb. Broom snakeweed is most common in certain wet years and when the plant community deteriorates from its potential. Potential natural plant communities have about 69 percent bare ground, 12 percent litter, and 15 percent grasses and forbs as an average percentage of the surface area. The overstory is 5 percent shrubs and half-shrubs with 0 percent tree canopy. Under unfavorable growing conditions, the historic potential plant community could produce 325 pounds per acre air dry plant matter while during favorable conditions the site's potential increases to 850 pounds per acre air dry plant matter. The Sandy ecological site fits the Chihuahuan Desert Grassland fire regime classification; however, recent disturbance to the plant community structure and the increasing number and density of shrubs and trees creates a grading effect into the Open and Closed Conifer Woodlands fire regimes. Fire frequency is variable and dependent upon plant community development and/or departure from the historic community and ignition source. Grassland types support fires and could occur in any given year provided the grasses are cured and dry enough to burn. Plant density is a critical factor in the grassland's ability to propagate fire. Heat output is relatively low from grass fuels, so fairly continuous fuels are necessary for fire spread to occur (Brown and Smith 2000). The current fire frequency is between 85 and 120 years due to the age of the larger size trees and recent fire suppression. Historic fire frequencies probably ranged from about 4 to 20 years (Fire Regime II).

Savannah ecological sites are characterized by the NRCS as scattered large tree-type piñons and/or junipers with open grass stands in between.

Understory grasses are dominated by blue grama, Western wheatgrass, Indian ricegrass, and sand dropseed. Piñon ricegrass and pine dropseed may also be found, usually beneath the trees and at the higher elevation ranges on the site. Winterfat and some forbs may occur in significant amounts. Broom snakeweed is most common in certain good rainfall years and when the understory plant community deteriorates from its potential. Reproduction of piñon and juniper is normally very slow and, historically, may have been controlled by natural fire. Tree canopy of the natural potential plant community averages approximately 25 percent. In exceptional cases, a few more or less even-aged ponderosa pines may occur on this site naturally. Reproduction of this species is ordinarily even less evident than that of piñon or juniper, and no more than 1 or 2 percent of the understory is likely to be made up of ponderosa seedlings, even in the absence of livestock grazing. Historic plant communities have about 65 percent bare ground, 15 percent litter, and 18 percent grasses and forbs as an average percentage of the surface area. The overstory is 15 to 30 percent shrubs and half-shrubs and 15 to 30 percent tree canopy. Under unfavorable growing conditions, the historic potential plant community could produce 300 pounds per acre air dry plant matter while favorable growing conditions improve the site's potential to 875 pounds per acre air dry plant matter.

Foothills ecological sites are characterized by the NRCS as a mixed shrub-grassland aspect with scattered oneseed juniper and some piñon trees. The tree component is more prevalent on the cooler, north-facing slopes, while shrubs and grasses prevail on south- and west-facing slopes. Dominant grasses on the north-facing slopes are blue grama, galleta, New Mexico feathergrass, and bottlebrush squirreltail. On the south-facing slopes black grama, little bluestem, sideoats grama, and blue grama are dominant. This site occurs as rolling to steep hills and foot slopes of steep mountains and sideslopes of high mesas. Slopes may range from 2 to 50 percent. This is a transitional area between adjoining Major Land Resource Areas SD-1 and WP-2 as a product of the highly variable soils, slopes, and exposures. Historic plant communities have about 33 percent bare ground, 10 percent litter, and 12 percent grasses and forbs as an average percentage of the surface area. The overstory is about 20 percent shrubs and half-shrubs and 20 percent tree canopy. Under unfavorable growing conditions, the historic potential plant community could produce 375 pounds per acre air dry plant matter while favorable growing conditions raise the site's potential to 750 pounds per acre air dry plant matter.

Historically, the fire regime occurring on the Foothills and Savannah ecological sites was one of frequent mixed severity fires (Fire Regimes I and II). Typically fires occurring on these sites consisted of low intensity surface fires with occasional high intensity stand-replacing fires when higher fuel concentrations were present. The average historic fire return interval is about 28 to 31 years, with a range of 10 to 49 years. These sites are now dominated by piñon-juniper with a grass/forb and shrub understory. The current plant communities fall into the Open and Closed Conifer Woodlands fire regimes. The herbaceous understory is discontinuous and of low productivity; coupled with the small amount of litter, and the number, age and size of trees that are present, the current fire frequency is between 85 and 120 years.

Vegetative response is tied closely to changes in soil structure, function, and productivity. The loss of organic-rich topsoils, decreased plant-available-water (Breshears and Barnes 1999), extreme soil temperatures, and freeze-thaw activity severely impede herbaceous vegetation establishment and productivity (Davenport et al. 1998). Reductions in ground cover cause increased runoff from summer thunderstorms (Reid et al. 1999), with associated increases in erosion (Wilcox et al. 1996a, 1996b, 2003). The processes described above have moved much of the historic natural potential vegetation on the Monument across a plant community threshold that currently favors further establishment and maintenance of oneseed juniper and piñon.

Successful restoration of the rangelands on the Monument to historic natural plant communities

is directly proportional to the site's retention of topsoil. Areas that have experienced severe loss of the organic topsoil would exhibit a slower response to vegetative treatments and prescriptions than similar areas containing higher amounts of topsoil in the system.

Strategies for any vegetative treatments should address the need to minimize any further surface disturbance and/or transport of soils off site. Treatments geared to the reduction of oneseed juniper and piñon pine stems should include lopping and scattering of smaller diameter stems and branches to provide suitable micro-climates for seed germination, establishment, and survival of seedlings. Since the native seed bank is stored in the soil, its presence and abundance is proportional to the degree of soil loss. It is uncertain whether an adequate native seed bank is present to move treated sites toward their natural potential plant community. To encourage the desired restoration of treated areas, vegetative strategies should include re-seeding with native seeds.