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STORAGE

HABITAT TYPES IN PIÑON-JUNIPER  
WOODLAND ON THE PAJARITO PLATEAU  
AND  
RANGE CONDITIONS IN BANDELIER  
NATIONAL MONUMENT

Final Report  
Purchase Order No. PX7029-0-0694  
Southwest Region  
National Park Service

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June 15, 1983

B&W Scans  
5-16-2005

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# ABSTRACT

Forty stands of piñon-juniper woodland in Los Alamos County and vicinity were selected on the basis of minimal impact with respect to logging, grazing or recreational use. These stands were sampled using standard vegetative techniques based on Daubenmire's methods, and the data analysed using association tables and principal component analyses. Three habitat types were defined in the study area: (1) Juniperus monosperma/Bouteloua curtipendula habitat type at lower elevations and more xeric sites, (2) Pinus edulis - Juniperus monosperma/Bouteloua gracilis habitat type at mid-elevations and moderate sites, (3) Pinus edulis-Juniperus monosperma/Muhlenbergia montana at higher elevations, and more mesic sites.

Ten sites were sampled in Bandelier National Monument in areas judged to be moderately to heavily impacted by grazing by feral burros. The data from these sites was compared with baseline data obtained from sampling for the habitat type analysis. Canopy cover of snakeweed (Gutierrezia microcephala) was significantly higher in Bandelier than on baseline sites (17% relative cover compared to 0.2 to 5% relative cover). Relative cover of cool season grasses was lower, as was total grass cover, total understory cover, and total shrub cover. Forb cover was higher on the Bandelier sites than on the baseline sites. Given protection from grazing, recovery trends in Bandelier over the next 40 years should show a dramatic decrease in snakeweed cover, a general increase in grass and total understory cover, and an increase in relative cover of cool season grasses.

## INTRODUCTION

### Habitat Type Classification

The habitat type system of land classification has developed from the site index and site quality classifications that began to be utilized in forestry in the early 1800's (Daubenmire 1976). Site indices rely on growth rate tables of important tree species, and site quality classifications usually depend heavily on non-biotic factors such as topography and soil type. In contrast to these two systems, habitat typing relies on the use of plant communities as indicators of site quality, using the characteristic climax plant community on a site as an indication of the integrated effects of all biotic and environmental factors that contribute to site quality. Daubenmire (1976) has stated that, "habitat types are the basic ecologic units of landscapes," and that "it is the pattern of the land units having approximately the same capacity to produce vegetation (e.g. habitat type), rather than the pattern of vegetation existing at a particular time, that is the permanent feature of a landscape."

The use of these methods and the mapping of economically important forests has been increasing rapidly, and over 20 habitat type classifications of western U.S. forested areas have been developed (Pfister 1981). The importance of this effort has been emphasized by several authors (Layser 1974, Daubenmire 1976, Bailey et al. 1978, Kessell 1979, Steele et al. 1981). Resource management depends heavily on accurate mapping, and the mapping system is only as accurate as the classification it is based on and the ease of using the key to the classification when performing reconnaissance surveys. The advantage of using a habitat type system in the field is partly due to the use of highly visible plants rather than soil type, which often requires digging pits to identify, and

the fact that relatively few of the plant species in a community need be used as indicators.

Management of a complex pattern of communities is greatly facilitated by an assessment of the ecology and potential of each community. In particular, the problems of estimating the course of secondary succession over a wide area is greatly facilitated by a habitat type analysis (Crane 1982). This is equally true for planning the grazing utilization of a range, or for predicting the course of range recovery after a period of overgrazing.

#### Piñon-Juniper Woodland

The piñon-juniper woodland is a major vegetation type in the United States, with estimates of its range varying from 43 to 76 million acres (Clary 1975, Lanner 1975, West et al. 1975, Tueller et al. 1979). The area of woodland derived from planimetering Kuchler's (1964) map of potential vegetation was 324,600 km<sup>2</sup> (125,328 m<sup>2</sup>) with almost 80% of this area being in the states of Arizona, New Mexico, Nevada and Utah (West et al. 1975). This area extends from northern Mexico to the Snake River in Idaho, and from eastern New Mexico to the Sierra Nevada in California (Daubenmire 1943, West et al. 1975). Of the total area of piñon-juniper woodland, 26% is in New Mexico, with 26% of the state having this vegetation type (West et al. 1975).

Any particular piñon-juniper woodland is usually dominated by one of three species of Pinus and one of six species of Juniperus. The ranges of these nine dominant species have been well documented (West et al. 1975, Lanner 1975) but the characterization of many of the communities is incomplete and little is known of the autecology of the dominant species or their associate understory

species (Tueller and Clark 1975, West et al. 1975). The common dominants in southern Colorado, New Mexico, Arizona and eastern Utah are Pinus edulis, and Juniperus osteosperma or J. monosperma; in western Utah and Nevada, P. monophylla and J. osteosperma; and in California, P. monophylla, J. californica and J. occidentalis. J. deppeana overlaps portions of both P. edulis and P. monophylla types in Arizona and New Mexico (Barger and Ffoliott 1972, Lanner 1975, West et al. 1975).

Historic invasion of grassland and sagebrush flats by piñons and junipers has been documented by many workers (Emerson 1932, Cottom and Stewart 1940, Woodbury 1947, Plummer 1958, Johnsen 1962, Jameson 1965, Blackburn and Tueller 1970, Burkhardt and Tisdale 1976, West et al. 1979, Tausch et al. 1981). This invasion is followed by a decline in grass productivity and has resulted in many attempts by land managers to eradicate the trees by various "conversion" projects - usually by chaining or cabling the land, and more recently, by using prescribed burns (Aro circa 1965, Blackburn and Bruner 1975, Springfield 1976, Wright et al. 1979). Most of the research into various aspects of piñon-juniper woodland ecology have resulted from concern over the spread of the woodland into grassland. The aims of such studies have frequently been to evaluate the reasons for the extreme variability of success of the conversion projects, or to investigate the causes and results of the spread of the woodland. There are three general theories for this invasive spread of the woodland (Cottom and Stewart 1940, Plummer 1958, Johnsen 1962, Jameson 1965, Burkhardt and Tisdale 1976): overgrazing, fire suppression, and climatic changes. Most authorities consider that some combination of overgrazing and fire suppression are the major factors in the spread of piñon-juniper woodland observed in the last 100 years.

Attempts to classify sites for their suitability for conversion projects have resulted in useful information on the correlation between site productivity and soil type (Aro circa 1965, Jameson and Dodd 1969, Aldon and Brown 1971, Sauerwain 1981). Trees prevail on the coarser, rockier sites, and it has been stated that the most consistent indicator of original piñon-juniper sites is the stoniness of the soil (Aro circa 1965, Sauerwain 1981). Such sites have more rapid infiltration rates and deeper penetration of precipitation, and favor dominance of woodland over grassland. Woodbury (1947) noted discontinuities in low elevation woodland that corresponded to changes in soil type. The woodland tends to be confined to ridges, canyons, rough slopes and coarse soils, while the sagebrush-grassland association was found in valleys, on mesas and gentle slopes with fine, deep soils.

In studying species diversity on sites in central Utah and northern New Mexico, Harner and Harper (1976) found that site heterogeneity and site favorability accounted for 74% of the observed variation in species diversity in Utah and 84% in New Mexico. In New Mexico, species diversity was largely controlled by the number of soil types in the site, with precipitation and solar irradiation also making significant but minor contributions to species diversity.

Twenty-nine percent of the piñon-juniper type is on highly unstable geologic formations that contribute to high sediment yields (Gifford 1973, Aldon and Brown 1971). This is an especially important factor to consider in designing conversion projects. Loope and Gifford (1972) noted that a high cryptogamic cover significantly increases water infiltration, and that disturbance of the microfloral crust (such as occurs with chaining) dramatically increases sediment yields.

Jameson and Dodd (1969) have reported interesting relationships between herbage productivity on three different soil types in northern Arizona and the presence or absence of a J. osteosperma canopy. Springerville soils had very poor grass cover in an open woodland, but quite high productivity when trees were absent. Two other soil types showed very little disparity in productivity between grassland and woodland sites. These differences were not due to moisture or nutrient levels. A mycological survey of these soils (Story 1968) showed very low fungal content of Springerville soils under a J. osteosperma canopy. There may be an allelopathic factor under J. osteosperma canopies that inhibits mycorrhizal growth.

Several studies have documented woodland succession after fire (Erdman 1970, Barney and Frischknecht 1974), with fire suppression (Clay 1975, Tausch et al. 1981), after conversion projects (Rippel et al. 1980, Aro 1965, Tausch and Tueller 1977) and after construction of transmission lines (Ludwig et al. 1977, Kruse et al. 1979). Despite the generally acknowledged poor condition of the woodland due to severe overgrazing (Springfield 1976), there are relatively few studies on succession with protection from grazing. Pieper (1968) documented increased production of blue grama after 12 years protection in southern New Mexico, and Potter and Krenetsky (1967) showed total grass cover increased on six sites that had been protected for 25 years. In general, under grazing pressure, palatable grasses decrease and unpalatable subshrubs increase (Springfield 1976).

Studies of relict areas in northern Arizona have provided a unique view of the productivity and species composition of piñon-juniper woodland. These areas, ranging from 10 to 1430 acres in extent, are mesa tops inaccessible to domestic grazing (Jameson et al. 1962, Thatcher and Hart 1974, Baxter 1977). In

general, B. gracilis is present only in trace amounts on these relict areas, with the dominant grass species being Poa fendleriana (Jameson et al. 1962), P. fendleriana and Sitanion hystrix (Baxter 1977), or Stipa speciosa and Hilaria jamesii (Thatcher and Hart 1974). It is notable that cover of cool season grasses is dramatically higher than that of warm season grasses in these areas. This is in contrast to similar areas in adjoining piñon-juniper woodland that are open to grazing. Discontinuities in community species composition on these mesas were noted to correspond with changes in soil type (Thatcher and Hart 1974, Jameson et al. 1962). Soils with platy surface layers (and thus with poor water infiltration) had little or no grass cover. Soils with granular sandy loam surfaces had high grass productivity at all stages of succession after fire (Thatcher and Hart 1974).

It has been noted that although the study of relict areas can indicate the productivity of pristine woodland, it probably does not indicate the potential of the surrounding woodland. Historical use of the woodland has reduced site potential through soil degradation to the point where only partial recovery may be possible (Baxter 1977).

#### Classification of Piñon-Juniper Woodland

The most extensive attempt to classify piñon-juniper woodland was started by Meeuwig and associates in the Great Basin (Meeuwig and Murray 1977). Initial fieldwork convinced them that a habitat type analysis would be extremely difficult because of the considerable disturbance throughout the type. The goals of the project were adjusted to developing models to predict annual biomass increments of piñon-juniper stands, to determine resource potentials in relation of site factors, and to relate potential forage productivity to

potential tree growth. This research effort has yielded valuable information on biomass and growth of P. monophylla and J. osteosperma in the Great Basin (Meeuwig 1979, Meeuwig and Budy 1979, Meeuwig et al. 1979, Miller et al. 1981, Meeuwig and Cooper 1981, Meeuwig and Budy 1981).

Also in the Great Basin, West and associates have had a cooperative effort to study patterns and rates of piñon-juniper woodland invasion and succession (Meeuwig and Murray 1977). This project has resulted in detailed information on synecological stratification of these woodlands (West et al. 1974, West et al. 1975, West et al. 1978, West et al. 1979, Tueller et al. 1979) and on growth, biomass, and dominance patterns of P. monophylla, J. osteosperma and understory species (Tausch 1980, Tausch et al. 1981). The woodland on 55 mountain ranges was sampled using small study plots arrayed on slopes facing the cardinal directions. Although several sets of subtype groupings have been suggested by West and associates, the subtypes all tend to be at the higher levels of a classification hierarchy and relationships between the sets of subtypes are not clearly defined. In unpublished progress reports (and hence not citable) West and associates described their classifications as based on land types and on three vegetative belts of piñon and juniper dominance (high P. monophylla, equal P. monophylla and J. osteosperma, high J. osteosperma). They noted that although the landtype unit has similarity to the habitat type of Daubenmire (1952), it "describes the existing vegetation-soil-landform unit," and not the potential vegetation of the type. In the Great Basin, West et al. (1978) concluded that Artemisia spp. could be used as a set of understory indicators to predict site favorableness in piñon-juniper woodland.

Jameson (unpublished, quoted in Springfield 1976) recognized four subtypes of piñon-juniper woodland in northern Arizona and New Mexico, west of the Continental Divide. The subtypes were categorized by both understory and overstory species, and corresponded with general climatic divisions.

East of the Continental Divide, Woodin and Lindsay (1954) analysed piñon-juniper woodland using the line strip method on 24 sites. They suggested three wide, geographic subdivisions of the woodland based on the time of onset of the rainy season. They noted that in central New Mexico, density of piñon and junipers are approximately equal at 7200 ft or its latitudinal equivalent. Below 5000 ft, the woodland becomes a J. monosperma consociation, and above 7500 ft it intergrades with Pinus ponderosa forest.

The relative dominance of piñon versus juniper on a site is the most commonly used type discriminator in the woodland (Tueller et al. 1981, Woodin and Lindsay 1954). Sauerwain (1981) noted that the "apparent moisture requirement of piñon compared with juniper provides a useful, and sometimes very sensitive ecologic tool for determining dynamic vegetative patterns." Several authors have documented that the relative importance of piñon and juniper changes with elevation (Merkle 1952, Barger and Ffolliott 1972, Tueller et al. 1981). At low elevations, where the woodland intergrades with grassland in an open savannah, juniper is dominant. At mid-elevations, piñon and juniper have equal dominance, while at high elevations, piñon becomes more dominant until the woodland intergrades with ponderosa pine forest (Woodin and Lindsay 1954).

Greenwood and Brotherson (1978) defined a Cercocarpus montanus subtype and a piñon-juniper subtype in the woodland in Utah. In the former, C. montanus density was 1,225 plants/ha, in contrast to only 62 plants/ha on the piñon-juniper subtype. These two subtypes corresponded to several environmental factors measured, with soil depth being the most significant factor influencing annual productivity in the C. montanus subtype.

Cryptograms might be useful for distinguishing between seral and climax stands (Burkhardt and Tisdale 1973). Brinkman (1929,1931) has reported correlations between lichen and moss species and site productivity. Given the usually low vascular plant species diversity in piñon-juniper woodlands, it may be advantageous to include microfloral species in a habitat analysis of these woodlands.

### Problem Statement

Bandelier National Monument currently has a severe problem of overgrazing by feral burros particularly in the piñon-juniper woodland (National Park Service 1979). By studying similar woodland areas that have been protected from grazing by feral burros, we aimed to assess the extent of the impact, and to predict the recovery trends. Our choice was to complete a habitat type analysis of woodland areas adjacent to Bandelier, to sample impacted areas in Bandelier, and to compare baseline and impacted sites with respect to vegetative cover and composition.

## METHODS

### Habitat Type Classification

#### Study Area

The study area was primarily in the Los Alamos National Environmental Research Park (LA/NERP), with some study plots on adjacent US Forest Service and US National Park Service lands. The LA/NERP lands have been closed to disruptive management and public access for over 30 years, and a variety of range conditions can be found, from apparently pristine areas to those in various stages of recovery after grazing or logging. The range of the piñon-juniper woodland in the LA/NERP and Bandelier falls into two major elevation units - one from approximately 5300' (at the Rio Grande) to 6300' on the upper edge of the Pajarito Plateau escarpment, and the other from 6300' up to the ecotone with Ponderosa pine forest, which varies with exposure and slope from 7000' to 7300'. Slopes vary from level mesas to extremely steep canyon walls. The canyons dissecting the Pajarito Plateau run generally east-west, and the slope aspects are usually north or south.

#### Vegetative Sampling

Sampling was aimed at obtaining unbiased data from stands representing the full range of environmental conditions in the study area. Choice of stands was restricted only by the preconditions that they showed minimal impact (with respect to evidence of logging, grazing and recreational use) and were located reasonably close to roads. Our major emphasis was on recognizing stands representative of all aspects of frequency and distribution of piñon and juniper, and selecting stands without a preconceived bias about their position in a classification array.

After a stand had been selected, a study plot was located to represent the stand in terms of undergrowth and tree composition, density of species, and topography. Plots were 25 by 15 m (375 m<sup>2</sup>) to facilitate comparison with other studies (Moir and Ludwig 1983). Plot boundaries were always aligned with the cardinal directions. To reduce bias, one corner stake was placed, and plot placement determined by flipping a coin to decide which plot axis would be the longer. Plot orientation, location, per cent slope, aspect and type were recorded. Site locations and physical characteristics are given in Appendix AI.

Trees were tallied by species and 5 cm basal diameter (DAB) classes. Basal diameters were measured above the swell at ground level, approximately 15 cm above ground level. Seedlings less than 5 cm DAB were recorded by two height classes (less than and greater than 1 m). Seedlings less than 10 cm high were noted but not used in any analysis. Since junipers branch extensively from the base, all basal branches of this species were tallied by 2.5 cm diameter classes and an equivalent DAB estimated using the formula,  $DAB = (d_1^2 + d_2^2 + \dots + d_n^2)^{1/2}$ , where  $d_n$  is the diameter of the  $n^{th}$  branch.

On each site, three trees judged to be relatively free growing, were cored for age determination, and measured for height and DAB. Increment cores were generally counted in the field using a 10X lens, although some were also taken to the laboratory, sanded, and counted using a binocular microscope.

A series of 50 quadrats (20 x 50cm) were superimposed on each study plot following Daubenmire's technique (Moir and Ludwig 1983), and cover of all shrubs and herbaceous understory species tallied by visual estimation using coverage classes (Table I). Canopy coverage was considered to be the percentage of the ground covered by a vertical projection of a polygon drawn around the natural

spread of the foliage of an individual (Daubenmire 1968). Percent cover of total plant basal area, bare soil, litter, rock and cryptograms were also recorded for each quadrat. Raw vegetation data for each site are given in Appendix A2.

Table 1. Cover classes for visual estimation of canopy cover  
(adapted from Moir and Ludwig, 1983).

| <u>Cover Class</u> | <u>% Cover</u> | <u>Midpoint Value (%)</u> |
|--------------------|----------------|---------------------------|
| T                  | 0-1            | .5                        |
| 1                  | 1-5            | 2.5                       |
| 2                  | 5-25           | 15.0                      |
| 3                  | 25-50          | 37.5                      |
| 4                  | 50-75          | 62.5                      |
| 5                  | 75-95          | 85.0                      |
| 6                  | 95-100         | 97.5                      |

Field measurements of basal diameter, height and crown diameters were made on open growing piñons and junipers. The maximum crown diameter was determined ( $C_1$ ) and the longest diameter perpendicular to  $C_1$  then measured ( $C_2$ ). The average crown diameter ( $C$ ) was calculated as the geometric mean,  $C = (C_1 \cdot C_2)^{1/2}$ . Height was measured at 10 m distance with a relaskop. Linear regression relationships between average crown diameter and DAB were determined for each species, and these relationships used to estimate tree canopy cover on each plot (Table 2 and Appendix A4).

Table 2. Regression relationships between diameter at base (D) and mean crown diameter (C) for Pinus edulis and Juniperus monosperma.

| <u>Species</u>       | <u>Equation</u>      | <u>n</u> | <u>t</u> |
|----------------------|----------------------|----------|----------|
| <u>J. monosperma</u> | $C = 0.758 + 0.113D$ | 20       | 0.853    |
| <u>p. edulis</u>     | $C = 0.155 + 0.200D$ | 15       | 0.974    |

### Data Analysis

Nomenclature for plants species follows Martin and Hutchins (1980) except for graminoids treated by Cronquist et al.1972). Voucher specimens were deposited either at New Mexico State University herbarium or with the LA/NERP. Data from a habitat type analysis on ponderosa pine forests (DeVelice 1983) was added to the data base obtained in this study, and the analysis performed on the total data base. The sites contributed by DeVelice and associates all had P. edulis or J. monosperma in the overstory, although P. ponderosa was dominant. These data were obtained using comparable methods of site selection and determination of canopy coverage, and only data from sites sampled within our study area were used.

Data were analysed using association tables and principal component analyses (PCA) using the strategy of Moir and Ludwig (1983). Plot ordinations from the PCA were used to refine the association tables, although in some cases ecological judgements took precedence over the objective groupings. Species ordinations as well as diagnostic features observed from the association tables

contributed to the identification of diagnostic vegetation used to construct a key to the habitat types.

### Range Conditions in Bandelier National Monument

Ten sites in Bandelier were selected in areas judged previously to be in poor condition with a deteriorating trend (Earth Environmental Consultants 1974), and to be moderately to heavily impacted by feral burros (Koehler 1974). Sites were selected to sample a variety of soil types and aspects and without reference to sites in the baseline study. This was to simulate the process that would be used when evaluating range conditions by reference to a habitat analysis performed by another agency. Site locations and physical characteristics are given in Appendix B1.

Plots were established and vegetative data recorded exactly as stated for the baseline study. Raw data for the plots are listed in Appendix B2.

Habitat type for each plot was determined using the descriptive key developed for the habitat type classification. Vegetative data was compared with data from baseline plots, and statistically significant differences ascertained using t-tests.

### HABITAT TYPE CLASSIFICATION

Three woodland habitat types were defined in the study area (Table 3). We had anticipated more habitat types to be defined, but the generally low species diversity of woodland understory, and the low understory cover typical of this semi-arid woodland suggested that a conservative approach to the problem would be the most appropriate.

Table 3. Piñon-juniper woodland habitat types  
in Los Alamos County and vicinity.

| <u>Habitat type</u>                                                                     | <u>Abbreviation</u> | <u>No. of plots</u> |
|-----------------------------------------------------------------------------------------|---------------------|---------------------|
| 1. <u>Juniperus monosperma/</u><br><u>Bouteloua curtipendula</u> HT                     | JUMO/BOCU           | 10                  |
| 2. <u>Pinus edulis-Juniperus</u><br><u>monosperma/Bouteloua</u><br><u>gracilis</u> HT   | PIED-JUMO/BOGR      | 17                  |
| 3. <u>Pinus edulis-Juniperus</u><br><u>monosperma/Muhlenbergia</u><br><u>montana</u> HT | PIED-JUMO/MUMO      | 10                  |

Principal component analysis showed clear separation along the first axis between stands judged to be in the P. ponderosa series, and woodland stands dominated by either P. edulis or J. monosperma (Figure 1). The second and third axis apparently represented site quality within the woodland series, with good separation between stands dominated by J. monosperma and those with co-dominance of the two tree species. The stands with mature P. edulis were separated into two habitat types using both association tables (vegetative criteria) and two dimensional ordinations of principal component scores from analyses performed only on woodland plots (Figure 2). The raw data on species cover values are given in Appendix A2. Combined cover values and calculated cover values are

# PLOT ORDINATION

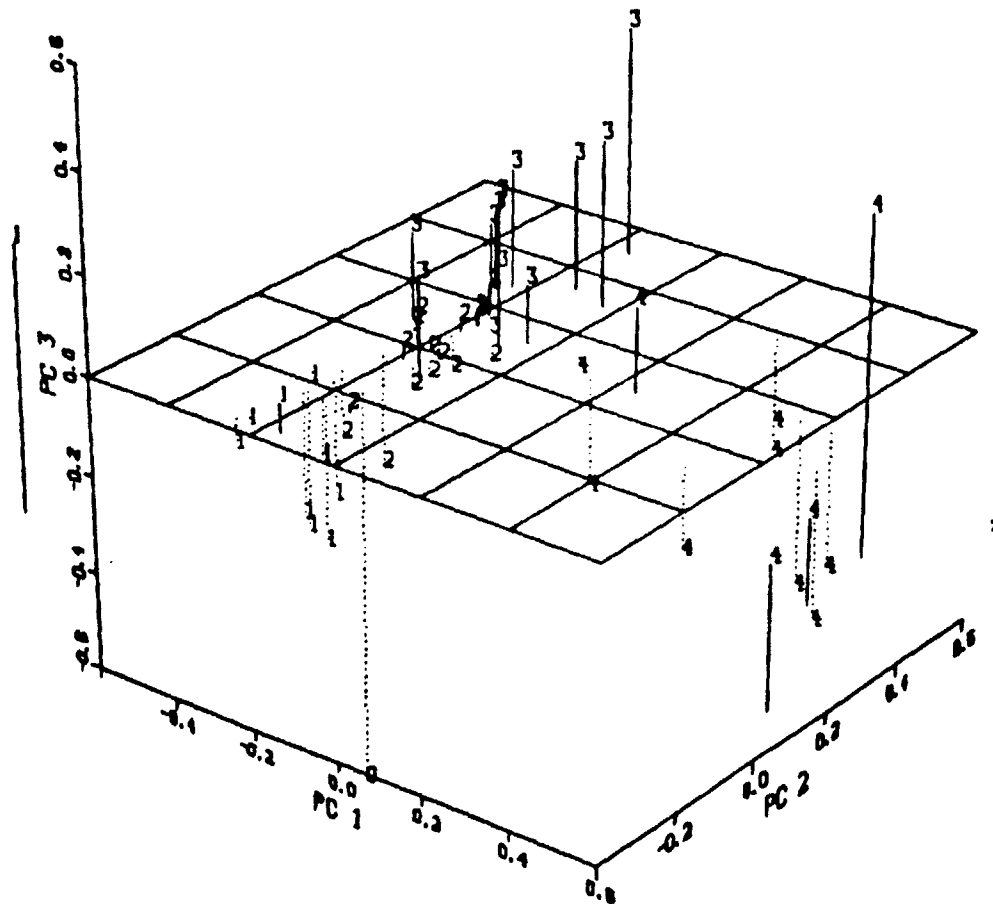


Figure 1. Ordination of sites using the first three principal scores from a principal components analysis. 1, *J. monosperma*/*B. curtispindula* HT; 2, *P. edulis* - *J. monosperma*/*B. gracilis* HT; 3, *P. edulis*-*J. monosperma*/*M. montana* HT; 4, *P. ponderosa* series; 0, site not classified.

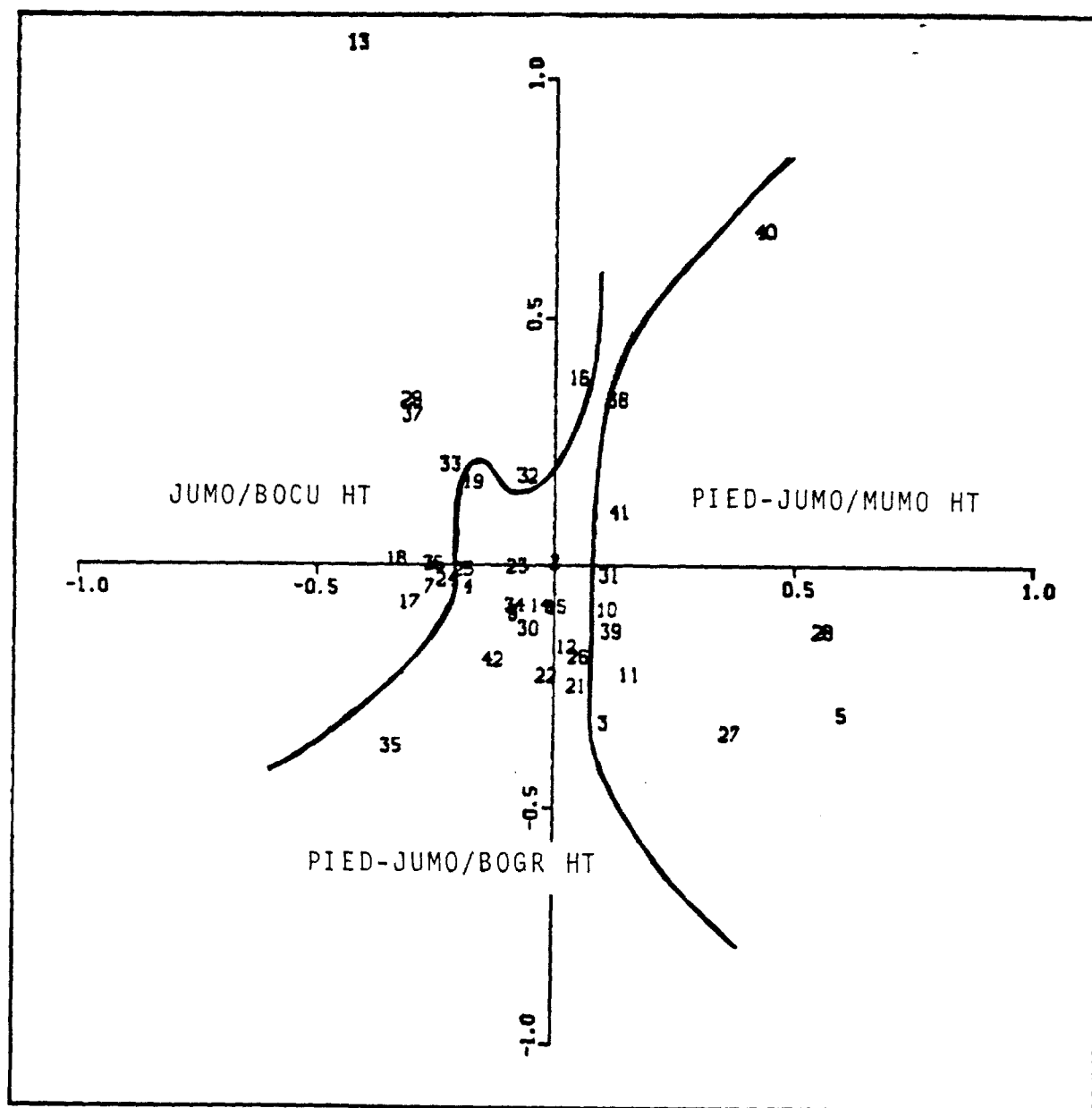


Figure 2. Ordination of piñon-juniper woodland sites using the first and third component scores from a principal components analysis.

Appendix A3. A descriptive key to the habitat types is followed by a description of each habitat type.

Descriptive Key To The Habitat Types

1. P. ponderosa present and dominant P. ponderosa Series
1. P. edulis or J. monosperma dominant.....2.
  2. Mature P. edulis (>25 cm diameter at base) present.....3.
  2. Mature P. edulis absent or widely scattered, J. monosperma present and dominant; one or more of Bouteloua curtipendula, B. eriopoda, Hilaria jamesii, Lycurus phleoides well represented.....Juniperus monosperma/Bouteloua curtipendula HT
3. Mature J. monosperma (>25 cm diameter at base) uncommon; Mature P. edulis dominant; one or more of Poa fendleriana, Muhlenbergia montana, Koeleria cristata, Oryzopsis micrantha well represented.....Pinus edulis, Juniperus monosperma/Muhlenbergia montana HT
3. Both mature P. edulis and mature J. monosperma common; understory dominated by B. gracilis.....Pinus edulis, J. monosperma/Bouteloua gracilis HT

Juniperus monosperma/Bouteloua curtipendula HT

(JUMO/BOCU; One-seed juniper/side oats grama)

Vegetation: The primary features of this HT are the absence of mature P. edulis, the low regeneration rate of this species (Table 4), and the high density and crown dominance of mature J. monosperma. Secondly, a high

incidence of B. curtispindula, B. eriopoda, Lycurus phleoides, and Hilaria jamesii is diagnostic, with these four species having a combined canopy cover from 1 to 6%, averaging 50% of the total grass cover. B. gracilis or B. hirsuta is likely to be the most abundant grass species. Combined cover values for C4 (warm season) grasses range from 2-11%, averaging 85% of the total grass cover. Artemesia tridentata, Rhus trilobata, Quercus undulata, Fallugia paradoxa, Fendlera rupicola, and Forrestiera neomexicana each had 30 to 40% frequency.

Table 4. Average tree densities (individuals/hectare) on the three piñon-juniper habitat types; regeneration individuals less than 25 cm diameter at base; mature: individuals greater than 25 cm diameter at base.

| Habitat        | <u>Juniperus monosperma</u> |        | <u>Pinus edulis</u> |        |
|----------------|-----------------------------|--------|---------------------|--------|
|                | regeneration                | mature | regeneration        | mature |
| JUMO/BOCU      | 136                         | 624    | 128                 | 0      |
| PIED-JUMO/BOGR | 50                          | 734    | 386                 | 33     |
| PIED-JUMO/MUMO | 22                          | 1337   | 691                 | 70     |

Soils and Topography: Most of the sites were on basaltic soils, with a few sites having stony, colluvial soils or soils derived from rhyolite tuff. All sites had boulders or bed rock on the soil surface (mean 47% rock cover). Slopes were steep (20 - 60%). Litter cover averaged 24% of the soil surface. Elevations ranged from 1675 m to 1965 m (5500' to 6450'), the higher elevations all being on steep slopes with a southerly or southeasterly exposure.

The JUMO/BOCU HT has ecotones with the PIED-JUMO/BOGR HT at higher elevations, with a Juniper-grassland type (Grieve, Ludwig and Berger 1979) at lower elevations, and with riparian HT's at all elevations. In the study area, there were no sites similar to this Juniper savanna, although this type is readily apparent to the south and east of the study area. No sites were sampled between 1805 m and 1900 m (5920' - 6280'). This omission was because the precipitous escarpment at the edge of the Pajarito Plateau occupies this elevation range, with very low vegetative cover and difficult access.

Pinus edulis, Juniperus monosperma/Bouteloua gracilis HT  
(PIED-JUMO/BOGR; piñon, one seed juniper/blue grama)

Vegetation: Both mature P. edulis and J. monosperma are commonly present in this HT, with crown dominance varying according to the site quality. There is moderate regeneration of both species (Table 4). Stand age ranged from 120 to 290 years. The understory is dominated by B. gracilis, averaging 64% of the total grass cover. C3 (cool season) grasses averaged only 11% of the grass cover. Q. undulata, Cercocarpus montanus, R. trilobata were all of approximately equal occurrence (35 to 50 % frequency), predominantly on rocky sites.

Soils and Topography: This HT at mid-elevations, from 1950 to 2100 m (6400' to 6800'), mainly on mesas and mid-slopes. Soils were primarily from rhyolite tuff parent body, and included coarse soils with a high amount of rock outcrop, as well as fine, deeper soils with no exposed bedrock. A few sites were on pumice deposits. Litter cover averaged 35% of the ground surface.

This HT had ecotones with the JUMO/BOCU HT at lower elevations, with the PIED-JUMO/MUMO HT at higher elevations, and with riparian types in washes and stream beds.

It is possible that this HT may have phases that separate by vegetative criteria of shrub frequency and abundance. These phases might well correlate with edaphic factors.

Pinus edulis, Juniperus monosperma/Muhlenbergia montana HT  
(PIED-JUMO/MUMO; piñon, one seed juniper/mountain mahly)

Vegetation: This HT is characterized primarily by high regeneration rates of both P. edulis and J. monosperma, overall high density of trees, and low incidence of large J. monosperma (Table 4.) Overstory crown dominance is attributable to P. edulis. Secondly, the diagnostic feature is a high incidence of M. montana, Poa fendleriana, Koeleria cristata and Oryzopsis micrantha. These four grasses constitute from 20 to 80% of the total grass cover (mean 45%). C3 grass cover ranges from 0.3 to 12% cover, averaging 34% of the total grass cover. B. gracilis is likely to be the most abundant single grass species. C. montanus had the highest shrub frequency (82%) with Q. undulata also common (55% frequency).

Soils and Topography: The sites were at higher elevations from 1970 to 2175 m (6460' to 7130'), predominantly on soils derived from rhyolite tuff parent body. Some stands were on pumice soils. Slopes were from 3 to 55%, the steeper ones being rocky and with northern aspects. Litter cover averaged 50% of the soil surface, rock outcrop only 12%.

This HT had a gradual ecotone with the PIED-JUMO/BOGR HT at lower elevations, and a more gradual ecotone with Pinus ponderosa HT at higher elevations. P. ponderosa was present on two sites, but did not make a large contribution to overstory canopy cover.

## DISCUSSION

Tree densities (Table 4) were comparable with densities reported by Meeuwig (1979) for Great Basin woodland, (366-733 stems/ha) and Garcia (1977) for woodland analysed in northern New Mexico (480-666 stem/ha).

Garcia (1977) presented a regression relationship for P. edulis between DAB and crown diameter,  $C = 17.85 + 18.54 D$ , where C is crown diameter (cm) and D, basal diameter (cm). For a given DAB, this equation predicts a crown diameter 90-95% of that predicted by the relationship we developed for P. edulis (Table 2). Total canopy coverage calculated using equations for P. edulis and J. monosperma (Appendix A3) ranged from 20 to 100%. These are high compared to some other reports. Clary and Jameson (1981) reported tree cover to range from 2 to 43%, and Tausch, West and Nabi (1981) reported cover to range from 12 to 80% on Great Basin sites. However, in New Mexico, Garcia (1977) calculated just P. edulis canopy coverage as ranging from 20 to 114%, higher than reported here, without accounting for coverage by J. monosperma. It is possible that the use of regression relationships overestimates canopy cover since the data supporting these equations were obtained from free growing individuals, while usually individuals of these species have a clumped distribution, and hence are likely to exhibit some suppression of crown development.

The key to habitat types depends heavily on the decision as to which tree species dominates the crown cover, and whether old mature specimens of each species are relatively common. These criteria are similar to those noted in the Great Basin by Tueller et al. (1981) for P. monophylla and J. osteosperma, and by Woodin and Lindsay in northern New Mexico (1954). This shift in canopy dominance is most dramatically seen when the sites in the PIED-JUMO/BOGR HT are ranked by relative cover of P. edulis (Figure 3).

Mean size class distributions (Figure 4) show this shift in dominance from the drier JUMO/BOCU HT to the most moist PIED-JUMO/MUMO HT. The high regeneration rates of both P. edulis and J. monosperma in the PIED-JUMO/MUMO HT is in marked contrast to the shape of the distribution in the other two habitat types.

#### RANGE CONDITIONS IN BANDELIER NATIONAL MONUMENT

##### Habitat Types

The ten stands sampled in Bandelier areas that were open to grazing by burros ("Frijoles" stands) were judged to be of the J. monosperma/B. curtispindula HT. The canopy cover values for species on these plots is presented in Appendix B2, soil surface cover values in Appendix B1. All of the Frijoles stands had overstory canopy dominance by J. monosperma, and there was no occurrence of mature P. edulis. However, there was low frequency and abundance of the four grass species considered secondarily diagnostic of the JUMO/BOCU HT. This discrepancy could be the result of overgrazing and subsequent deterioration of the understory on the Frijoles stands. Alternatively, it could be because the soils and topography of the baseline stands in this HT differ in several respects from those of the Frijoles stands.

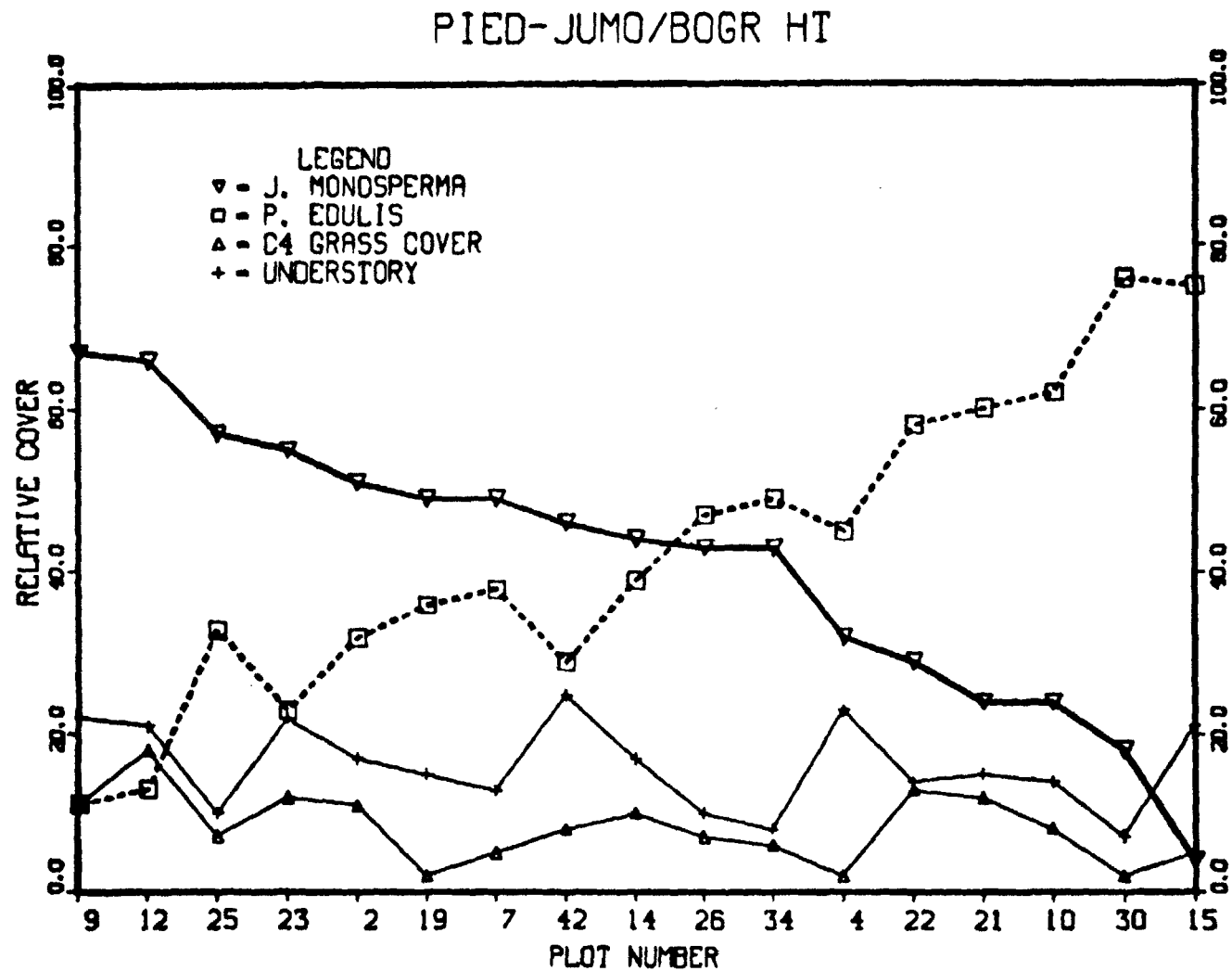


Figure 3. Pinus edulis - Juniperus monosperma/Bouteloua gracilis habitat types: sites valued by relative cover of J. monosperma.

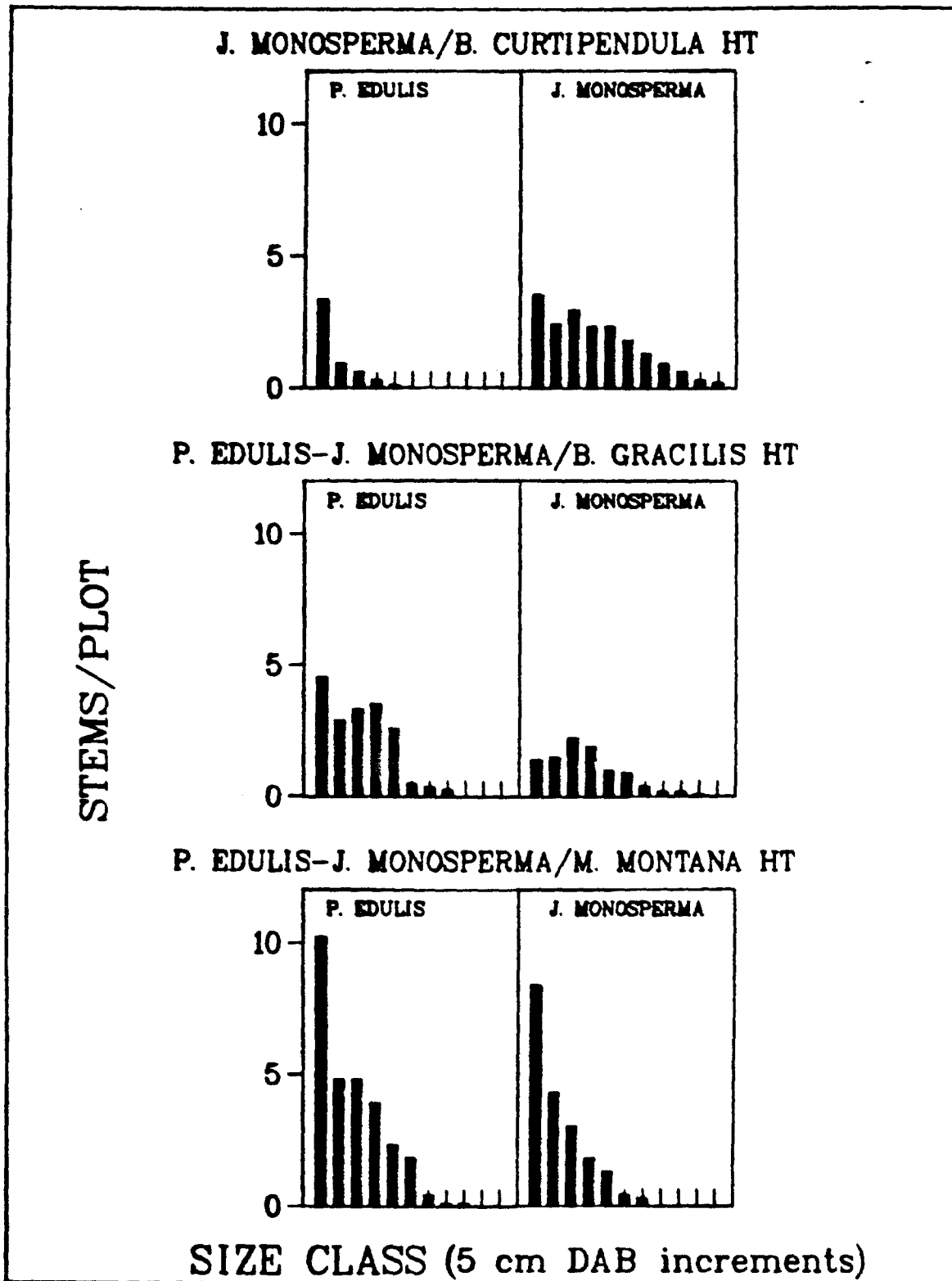


Figure 4. Mean size class distributions of Pinus edulis and Juniperus monosperma in each habitat type.

The baseline stands were mostly on steep slopes and basaltic soils (Appendix A1) while the Frijoles stands were on more gentle slopes and on either soils derived from rhyolite tuff, or on pumice soils (Appendix B1). In addition, the elevation range of the Frijoles plots (1880 m to 1950 m, 6180' to 6400') overlaps the elevations not sampled in the baseline study (see p. 24). The soils and topography of the P. edulis, J. monosperma/B. gracilis HT approximate those of the Frijoles stands while the vegetative characteristics and elevations of the J. monosperma/B. curtispindula HT are more closely diagnostic. For those reasons, the vegetative parameters from the Frijoles stands were averaged and compared with each of these habitat types.

#### Evaluation of Range Condition

The parameters chosen for evaluating range conditions are listed in Table 5. To establish whether a significant deterioration of the range existed, two parameters were judged to be the most valuable: relative cover of Gutierrezia microcephala (percent of total understory cover), and relative cover of C3 grasses (percent of total grass cover). G. microcephala is generally held to be an undesirable weed indicative of overgrazing (Potter and Foxx 1979, Jameson 1966). Jameson 1966 reports although cover of Gutierrezia ssp. will decrease as the range recovers from overgrazing, it will stabilize at a level above that of pristine areas. Much of the Pajarito Plateau was subjected to overgrazing by domestic livestock until the 1940's and has been protected since then. Hence the comparison of the Frijoles plots with the baseline plots is likely to show the vegetative response to protection from feral burros.

Table 5. Canopy and relative canopy cover values for sites impacted by feral burros ("Frijoles" sites) compared with data from baseline sites.

|                                     | <u>Frijoles</u>                                  | <u>JUMO/BOCO HT</u> | <u>PIED-JUMO/BOGR HT</u> |
|-------------------------------------|--------------------------------------------------|---------------------|--------------------------|
|                                     | <u>(n = 10)</u>                                  | <u>(n = 10)</u>     | <u>(n = 17)</u>          |
| <u>% Canopy Cover</u>               |                                                  |                     |                          |
| understory                          | 8.59                                             | 12.08               | 9.08                     |
| shrubs                              | 2.23                                             | 3.36                | 2.65                     |
| forbs                               | 1.63                                             | 0.92                | 0.72                     |
| grasses                             | 4.73                                             | 7.80                | 5.70                     |
| C3 grasses                          | 0.31                                             | 0.97                | 0.69                     |
| <u>B. gracilis</u>                  | 2.42                                             | 2.38                | 4.02                     |
| <u>G. microcephala</u>              | 1.52                                             | 0.51                | 0.26                     |
| <u>Relative Cover</u>               |                                                  |                     |                          |
| C3 grasses <sup>1</sup>             | 7.2                                              | 12.4                | 10.6                     |
| <u>G. microcephala</u> <sup>2</sup> | 17.1 ( <sup>a</sup> <sub>bb</sub> ) <sup>3</sup> | 4.9 (a)             | 0.19 (bb)                |
| forbs <sup>2</sup>                  | 21.3% ( <sup>c</sup> <sub>dd</sub> )             | 7.1% (c)            | 7.2% (dd)                |
| grasses <sup>2</sup>                | 55.4%                                            | 67.3%               | 61.7%                    |
| <u>B. gracilis</u> <sup>1</sup>     | 52.0% (d)                                        | 25.0% (d)           | 67.4%                    |

1. Expressed as a percent of total grass cover.
2. Expressed as percent of total understory cover.
3. Quantities in different columns followed by single letters are significantly different as shown by t-test  $P < 0.05$ ; double letters signify  $P < 0.01$ .

The use of relative cover of C3 grasses is suggested by studies on relict areas in piñon-juniper woodland showing that in pristine areas, C3 grasses constituted a very high percentage of the grass cover compared to cover values measured on adjoining or similar stands of woodland subjected to grazing by domestic livestock (Jameson et al. 1962, Mason et al. 1967, Thatcher and Hart 1974).

The Frijoles stands had C3 grass relative cover of 7.2% compared to 12.4% for the JUMO/BOCU HT and 10.6% for the PIED-JUMO/BOGR HT. These differences were not significantly different (Table 5). Mean relative cover of G. microcephala (17%) is significantly higher than in the JUMO/BOCU HT (5%) or the PIED-JUMO/BOGR HT (0.2%) (Table 5).

We conclude that continued grazing by feral burros has significantly altered the understory species composition in the woodland, with a large increase the subshrub G. microcephala. In addition, the total understory cover on the Frijoles stands was only 71% to 94% of the understory cover on baseline plots, and the total grass cover was 61% to 83% of the total grass cover on the baseline plots. There was a significant increase in forb cover under grazing pressure of 177% to 226% of the baseline plots, or expressed as a percent of the total understory, forb relative cover was 19% on the Frijoles plots, compared to 8% on the baseline plots. Relative cover of B. gracilis was significantly higher on the Frijoles plots compared to the JUMO/BOCU plots, suggesting that the more palatable grasses (e.g. B. eriopoda and B. curtispindula) had been overgrazed.

## Discussion

Several studies have documented general trends in range conditions in Bandelier National Monument. Koehler (1974), Earth Environmental Consultants (1974), and Potter and Berger (1977) considered the areas west and south of Frijoles Canyon to be in poor condition, the trends to be deteriorating, and there to be overlap in dietary habits between feral burros and deer. Potter and Foxx (1979) quantified understory basal and foliage cover in three experimental range exclosures three years after the exclosures had been established. Of the three locations, the Stone Lions and San Miguel sites most closely approximate the Frijoles sites in soil types and topography. The San Miguel site was wooded with both P. edulis and J. monosperma. This site averaged (over three treatments) 7.3% herbaceous canopy cover and 21.5% woody canopy cover; 23.5% relative cover B. gracilis and 55% relative cover G. microcephala. The Stone Lions site averaged 23% herbaceous cover; 47.5% relative cover B. gracilis and 20.4% relative cover G. microcephala. It was noted that litter was very sparse at both sites.

G. microcephala in these exclosures had dramatically higher values than on the baseline sites reported here, the Stone Lions site average (20.4%) being very close to the average for the Frijoles sites (17.1%). Several of the Frijoles sites were in the vicinity of the Stone Lions exclosure. Relative cover of forbs and B. gracilis were also very comparable between these sites. The San Miguel site had a total herbaceous understory cover (7.3%) very close to that reported here for the Frijoles sites (8.6%). The Stone Lions site had a total herbaceous understory canopy cover of 23%, quite higher than figures for the Frijoles, the JUMO/BOCU HT, or the PIED-JUMO/BOGR HT sites. However, this

is not unexpected, as wooded sites have a much lower understory canopy cover than sites without trees (Jameson 1967, Tausch 1980).

An increase in relative cover of B. gracilis under grazing pressure has been noted by Pieper (1968) in piñon-juniper woodland in southern New Mexico, although the increase he noted (2%) was not nearly as high as the average increase observed in this study (Table 5). Data from Potter and Foxx (1979) also showed an increase in B. gracilis canopy cover with protection from grazing on exclosures at the two unwooded sites, but not at the wooded site. Such an increase is possibly dependent on the intensity of the grazing pressure.

The use of the habitat type classifications to evaluate range conditions would seem to be a most useful adjunct to the established exclosures for following trends in range conditions. Understory on wooded sites is much more sparse than on unwooded areas, and it is difficult to use the unwooded exclosure data to give estimates for wooded sites. In addition, the exclosures can follow trends, but cannot predict them. The current study focused on just one of the woodland habitats in Bandelier. It would seem most appropriate to sample sites in the other two habitat types in order to get quantitative data on range conditions while the burro impact is at its highest.

### CONCLUSIONS

With protection from feral burros, it could be expected that in those areas of Bandelier that have the J. monosperma/B. curtispindula HT, the total understory cover would increase, with the main change being an increase in grass cover from 120% to 160% over current levels. Shrub cover is likely to increase 120% to 150%, and forb cover to decrease to 45% to 60% of current conditions.

Species composition should change, the major differences being a decrease in the relative cover of G. microcephala from its current value of 17% to a level between 0.2% and 5%, and an increase in the relative cover of C3 grasses.

The habitat type classification of piñon-juniper woodland that has been protected for 40 years has resulted in basic data on species composition, frequency and abundance that will be useful for assessing future range conditions in Bandelier. It is recommended that additional study sites be established in other habitat types in Bandelier to provide current reference data against which future conditions can be compared.

#### ACKNOWLEDGMENTS

This study was also supported by the Los Alamos National Environmental Research Park, Contract No's. 4-L10-8123R, 9-L42-6556X, awarded to Gary L. Cunningham and myself. Computer programs for association table and principal component analyses were provided by Dr. John L. Ludwig, who also gave generously of his advice and encouragement. Field assistance was cheerfully provided by Lani Moore, Greg Brown and Bette Brandt. Cindy Gamble was very helpful in typing and editing this report.

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Appendix A1. Location and characteristics of baseline sites sampled for the habitat type analysis of piñon-juniper woodland.

Table 6. Location of baseline sites sampled for habitat type analysis of pinon-juniper woodland.

| PLOT NO. |    | UTM-EAST | UTM-NORTH | LOCALITY         |                      |
|----------|----|----------|-----------|------------------|----------------------|
| B        | 2  | 38995    | 396863    | LA/NERP          | SANDIA CANYON        |
| B        | 3  | 38437    | 396822    | LA/NERP          | PUYE DRIVE           |
| B        | 4  | 38768    | 396886    | LA/NERP          | PUYE DR              |
| B        | 5  | 38908    | 397718    | SANTA FE NTL FOR | CAN.DE LAS LATAS     |
| B        | 7  | 39016    | 397018    | LA/NERP          | PUEBLO CANYON        |
| B        | 9  | 38735    | 395965    | LA/NERP          | TA-33                |
| B        | 10 | 38745    | 395920    | LA/NERP          | TA-33                |
| B        | 11 | 38835    | 396180    | LA/NERP          | EAST OF ST.RT.4      |
| B        | 12 | 38735    | 396293    | SANTE FE NTL FOR | EAST OF ST.RT.4      |
| B        | 13 | 38944    | 397493    | SANTA FE NTL FOR | GUAJE CANYON         |
| B        | 14 | 39034    | 397811    | SANTA FE NTL FOR | CHUPADEROS CANYON    |
| B        | 15 | 39049    | 397820    | SANTA FE NTL FOR | CHUPADEROA CANYON    |
| B        | 16 | 39080    | 397454    | SANTA FE NTL FOR | GUAJE CANYON         |
| B        | 17 | 38931    | 395996    | LA/NERP          | WHITE ROCK CANYON    |
| B        | 18 | 38975    | 395950    | LA/NERP          | WHITE ROCK ANYON     |
| B        | 19 | 38770    | 396080    | LA/NERP          | EAST OF ST.RT. 4     |
| B        | 20 | 38642    | 397854    | LA COUNTY        | CHUPADEROS CANYON    |
| B        | 21 | 38920    | 396400    | LA/NERP          | LOWER PAJARITO RD    |
| B        | 22 | 38881    | 396432    | LA/NERP          | LOWER PAJARITO RD    |
| B        | 23 | 38874    | 396092    | LA/NERP          | EAST OF ST.RT.4      |
| B        | 24 | 38881    | 396095    | LA/NERP          | EAST OF ST.RT.4      |
| B        | 25 | 38667    | 395865    | BNM              | LOWER FRIJOLLES MESA |
| B        | 26 | 38659    | 395878    | BNM              | LOWER FRIJOLLES MESA |
| B        | 27 | 38924    | 397130    | LA/NERP          | BAYO CANYON          |
| B        | 28 | 38935    | 397139    | LA/NERP          | BAYO CANYON          |
| B        | 29 | 39188    | 396263    | LA/NERP          | WHITE ROCK CANYON    |
| B        | 30 | 39114    | 396859    | BNM              | TSANKAWI             |
| B        | 31 | 39141    | 397038    | LA/NERP          | PUEBLO-LA CANYON X   |
| B        | 32 | 39217    | 396262    | LA/NERP          | WHITE ROCK CANYON    |
| B        | 33 | 39200    | 396325    | LA/NERP          | WHITE ROCK CANYON    |
| B        | 34 | 39048    | 397041    | LA/NERP          | PUEBLO-LA CANYON X   |
| B        | 35 | 39081    | 397035    | LA/NERP          | PUEBLO-LA CANYON X   |
| B        | 36 | 38999    | 395931    | LA/NERP          | WHITE ROCK CANYON    |
| B        | 37 | 39009    | 395950    | LA/NERP          | WHITE ROCK CANYON    |
| B        | 38 | 38184    | 396420    | BNM              | FRIJOLLES MESA       |
| B        | 39 | 38203    | 396392    | BNM              | FRIJOLLES MESA       |
| B        | 40 | 38369    | 396227    | BNM              | FRIJOLLES MESA       |
| B        | 41 | 38249    | 396283    | BNM              | FRIJOLLES            |
| B        | 42 | 38900    | 397065    | LA/NERP          | LOWER PUEBLO CANYON  |

Table 7. Characteristics of baseline sites sampled for habitat type analysis of pinon-juniper woodland.

|                   | PLOT NO. | ELEVATION |      | SLOPE (%) | ASPECT |      | LANDFORM CODE | SOIL NO. | PER CENT GROUND COVER |      |      |      |        |
|-------------------|----------|-----------|------|-----------|--------|------|---------------|----------|-----------------------|------|------|------|--------|
|                   |          | (M)       | (FT) |           | DEG    | CDS  |               |          | SOIL                  | ROCK | MOSS | VASC | LITTER |
| JUMO/BOCU HT      | B 32     | 1691      | 5550 | 40        | 130    | 1.09 | 4             | 68       | 23                    | 41   | T    | 2    | 34     |
|                   | B 29     | 1700      | 5580 | 15        | 140    | .91  | 5             | 8        | 22                    | 55   | T    | 3    | 17     |
|                   | B 17     | 1804      | 5920 | 16        | 255    | .13  | 1             | 8        | 18                    | 45   | 2    | 5    | 30     |
|                   | B 33     | 1767      | 5800 | 10        | 115    | 1.34 | 3             | 68       | 10                    | 51   | 1    | 3    | 34     |
|                   | B 18     | 1691      | 5550 | 42        | 80     | 1.82 | 3             | 10       | 11                    | 53   | T    | 3    | 32     |
|                   | B 37     | 1676      | 5500 | 42        | 125    | 1.17 | 4             | 10       | 51                    | 34   | 1    | 2    | 13     |
|                   | B 16     | 1914      | 6280 | 56        | 255    | .13  | 3             | 6        | 29                    | 54   | 1    | 5    | 13     |
|                   | B 36     | 1670      | 5480 | 29        | 308    | .88  | 54            | 8        | 6                     | 55   | 2    | 2    | 30     |
|                   | B 24     | 1950      | 6400 | 19        | 120    | 1.26 | 1             | 4        | 30                    | 47   | 0    | 4    | 17     |
|                   | B 13     | 1965      | 6450 | 58        | 200    | .09  | 3             | 10       | 33                    | 35   | 1    | 4    | 23     |
| PIED-JUMO/BOGR    | B 9      | 1956      | 6420 | 9         | 110    | 1.42 | 2             | 13       | 42                    | 5    | 1    | 3    | 42     |
|                   | B 12     | 1969      | 6460 | 9         | 180    | .29  | 1             | 8        | 39                    | 22   | 1    | 8    | 18     |
|                   | B 25     | 1956      | 6420 | 17        | 95     | 1.64 | 2             | 3        | 60                    | 0    | T    | 4    | 36     |
|                   | B 23     | 1950      | 6400 | 7         | 192    | .16  | 1             | 4        | 24                    | 44   | T    | 2    | 30     |
|                   | B 2      | 1996      | 6550 | 2         | 10     | 1.82 | 4             | 1        | 50                    | T    | 10   | 3    | 35     |
|                   | B 19     | 1962      | 6440 | 12        | 280    | .43  | 3             | 4        | 38                    | 19   | T    | 4    | 40     |
|                   | B 7      | 1950      | 6400 | 47        | 190    | .18  | 3             | 5        | 43                    | 36   | 0    | 2    | 14     |
|                   | B 42     | 1975      | 6480 | 7         | 155    | .66  | 3             | 1        | 66                    | 0    | 7    | 5    | 12     |
|                   | B 14     | 2097      | 6880 | 2         | 200    | .09  | 1             | 4        | 38                    | 0    | T    | 4    | 54     |
|                   | B 26     | 1956      | 6420 | 19        | 22     | 1.92 | 2             | 3        | 55                    | 0    | T    | 2    | 43     |
| PIED-JUMO/MUMO HT | B 34     | 2042      | 6700 | 5         | 180    | .29  | 1             | 4        | 63                    | 5    | T    | 2    | 30     |
|                   | B 4      | 2072      | 6800 | 27        | 210    | .03  | 35            | 4        | 19                    | 67   | 0    | 1    | 12     |
|                   | B 22     | 2011      | 6600 | 5         | 190    | .18  | 1             | 1        | 43                    | 0    | 7    | 4    | 42     |
|                   | B 21     | 1981      | 6500 | 8         | 90     | 1.71 | 1             | 1        | 56                    | 0    | 2    | 3    | 39     |
|                   | B 10     | 1944      | 6380 | 16        | 315    | 1.00 | 3             | 34       | 37                    | 1    | T    | 2    | 58     |
|                   | B 30     | 1999      | 6560 | 8         | 130    | 1.09 | 1             | 4        | 32                    | 36   | T    | 1    | 28     |
|                   | B 15     | 2097      | 6880 | 12        | 350    | 1.57 | 1             | 1        | 39                    | 1    | T    | 2    | 55     |
|                   | B 3      | 2173      | 7130 | 3         | 180    | .29  | 1             | 4        | 20                    | 4    | 3    | 4    | 64     |
|                   | B 38     | 2164      | 7100 | 13        | 148    | .78  | 1             | 4        | 54                    | 8    | T    | 6    | 30     |
|                   | B 40     | 2084      | 6840 | 4         | 175    | .36  | 1             | 3        | 43                    | 0    | 0    | 3    | 52     |
|                   | B 41     | 2066      | 6780 | 55        | 235    | .02  | 2             | 5        | 16                    | 42   | T    | 8    | 31     |
|                   | B 11     | 1969      | 6460 | 9         | 0      | 1.71 | 1             | 1        | 38                    | 8    | 3    | 2    | 47     |
|                   | B 39     | 2164      | 7100 | 12        | 182    | .27  | 1             | 4        | 32                    | 2    | T    | 4    | 61     |
|                   | B 28     | 1981      | 6500 | 49        | 25     | 1.94 | 4             | 65       | 26                    | 21   | 3    | 5    | 42     |
|                   | B 20     | 2139      | 7020 | 12        | 35     | 1.98 | 2             | 4        | 21                    | 7    | 7    | 7    | 51     |
|                   | B 5      | 2072      | 6800 | 27        | 30     | 1.97 | 3             |          | 30                    | 7    | 4    | 4    | 52     |
|                   | B 27     | 2005      | 6580 | 27        | 20     | 1.91 | 3             | 4        | 35                    | 6    | T    | 4    | 51     |
|                   | B 31     | 2017      | 6620 | 9         | 98     | 1.60 | 1             | 4        | 29                    | 27   | T    | 3    | 38     |

Table 7. Continued

LANDFORM CODES 1=RIDGE,2=UPPER SIDE SLOPE,3=MIDESLOPE,4=LOWER SLOPE,  
5=BENCH,6=STREAMSIDE,&7=OTHER AND TWO NUMBERS IMPLY TRANSITIONS.

ASPECT COSINE TRANSFORM AFTER BEERS, ET AL.(1966), WHERE NE=2 & SW=0

SOIL NO.S CORRESPOND TO THE FOLLOWING SOIL TYPES (BNM REPORT, 1974):

1. RHYOLITE TUFF PARENT; SANDY LOAM, SHALLOW(3 INCHES).
2. RHYOLITE TUFF PARENT; SANDY LOAM(>4 INCHES)
3. PUMICE DEPOSITS.
4. TUFF OUTCROP, 5-30% SLOPES
5. VERY STEEP TUFF OUTCROP; > 30% slopes
6. STONY COLLUVIAL, FOOT OF CLIFFS; 15-75% SLOPES.
8. BASALT ROCK OUTCROP; 3-15% SLOPES.
10. BASALT ROCK OUTCROP; VERY STEEP SLOPES, >30%.

## Appendix A2. Canopy coverage of species present on baseline sites.

Table 8. Canopy coverage of species present on sites of the Juniperus monosperma/Bouteloua curtipendula habitat type.

|                             | -NO: | 32    | 29    | 17    | 33   | 18   | 37   | 16    | 35   | 24   | 13   | FREQ  | ABUND |
|-----------------------------|------|-------|-------|-------|------|------|------|-------|------|------|------|-------|-------|
| JUNIPERUS MONOSPERMA YNG R  |      | 9.00  | 8.00  | 1.00  | 3.00 | 4.00 | 0.00 | 4.00  | 4.00 | 0.00 | 2.00 | 80.0  | 3.50  |
| JUNIPERUS MONOSPERMA ADV R  |      | 20.00 | 15.00 | 12.00 | 2.00 | 9.00 | 3.00 | 14.00 | 6.00 | 9.00 | 9.00 | 100.0 | 9.90  |
| JUNIPERUS MONOSPERMA MATURE |      | 7.00  | 6.00  | 6.00  | 7.00 | 6.00 | 5.00 | 4.00  | 3.00 | 3.00 | 4.00 | 100.0 | 5.10  |
| PINUS EDULIS YNG REGEN      |      | 4.00  | 3.00  | 2.00  | 2.00 | 1.00 | 6.00 | 5.00  | 1.00 | 4.00 | 5.00 | 100.0 | 3.30  |
| PINUS EDULIS ADV REGEN      |      | 2.00  | 0.00  | 0.00  | 0.00 | 0.00 | 2.00 | 4.00  | 1.00 | 5.00 | 7.00 | 60.0  | 2.10  |
| PINUS EDULIS MATURE         |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| PINUS PONDEROSA - YNG REGEN |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 1.00  | 0.00 | 0.00 | 0.00 | 10.0  | .10   |
| PINUS PONDEROSA - ADV REGEN |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| PINUS PONDEROSA - MATURE    |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| ARTEMESIA TRIDENTATA        |      | 0.00  | 0.00  | 1.30  | 0.00 | .01  | .01  | 0.00  | 3.10 | 0.00 | 0.00 | 40.0  | .44   |
| ARTEMESIA BIGELOVII         |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | .33  | 0.00 | 10.0  | .03   |
| CERCOCARPUS MONTANUS        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | .01   | 0.00 | 0.00 | 7.80 | 20.0  | .78   |
| CHRYSOTHAMNUS NAUSEOSUS     |      | 0.00  | 0.00  | 0.00  | .75  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 10.0  | .08   |
| CHRYSOPSIS VILLOS           |      | 0.00  | 0.00  | 0.00  | 2.00 | 0.00 | 0.00 | 0.00  | 0.00 | .05  | 0.00 | 20.0  | .21   |
| FALLUGIA PARADOXA           |      | .01   | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | .01  | 0.00 | .76  | 30.0  | .08   |
| FENDLERIA RUPICOLA          |      | 0.00  | .03   | 0.00  | .01  | 0.00 | 0.00 | 0.00  | 1.60 | 0.00 | 0.00 | 30.0  | .16   |
| FORRESTIERIA NEOMEXICANA    |      | .01   | 0.00  | 0.00  | 0.00 | .01  | 0.00 | 0.00  | .30  | 0.00 | 0.00 | 30.0  | .03   |
| GUTIERREZIA MICROCEPHALA    |      | .38   | 0.00  | 1.10  | .31  | 1.60 | .01  | .01   | 0.00 | 1.70 | .01  | 80.0  | .51   |
| GUTIERREZIA SAROTHRAE       |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| GUTIERIZIA SPP              |      | 0.00  | .65   | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | .70  | 0.00 | 0.00 | 20.0  | .14   |
| HYMENOXYS RICHARDSONII      |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| PTELEA TRIFOLIATA           |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | .01  | 0.00 | 0.00 | 10.0  | .00   |
| QUERCUS UNDULATA            |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| QUERCUS SP.                 |      | 0.00  | 0.00  | 0.00  | 5.90 | 0.00 | 0.00 | 0.00  | 1.70 | .01  | .01  | 40.0  | .76   |
| QUERCUS GAMBELLII-GRISEA    |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| QUERCUS GRISEA-GAMBELLII    |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | .01  | 0.00 | 10.0  | .00   |
| RHUS TRILOBATA              |      | 0.00  | .01   | 0.00  | 0.00 | 0.00 | .75  | 0.00  | .30  | .01  | 0.00 | 40.0  | .11   |
| RIBES CEREUM                |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| YUCCA ANGUSTISSIMA          |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | .01  | 0.00 | 10.0  | .00   |
| YUCCA BACCATA               |      | 0.00  | 0.00  | 0.00  | 0.00 | .01  | 0.00 | 0.00  | 0.00 | .30  | 0.00 | 20.0  | .03   |
| ANDROPOGON SACCHAROIDES     |      | 1.50  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 10.0  | .15   |
| ANDROPOGON SCOPARIUS        |      | 0.00  | 0.00  | 0.00  | 1.10 | 0.00 | 0.00 | 1.60  | .05  | 0.00 | .01  | 40.0  | .28   |
| ARISTIDA PURPUREA GLAUCA    |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | .01  | 0.00 | 10.0  | .00   |
| ARISTIDA PURPUREA LONGISETA |      | 0.00  | 0.00  | .05   | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 10.0  | .01   |
| ARISTIDA PURPUREA PURPUREA  |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | .05   | 0.00 | 0.00 | 0.00 | 10.0  | .01   |
| ARISTIDA PURPUREA ROBUSTA   |      | .35   | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 10.0  | .04   |
| ARISTIDA PURPUREA LONGISETA |      | 0.00  | 0.00  | .05   | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 10.0  | .01   |
| ARISTIDA SP.                |      | .35   | 0.00  | .05   | 0.00 | 0.00 | 0.00 | .05   | 0.00 | .01  | 0.00 | 40.0  | .05   |
| BOUTELOUA CURTIPENDULA      |      | 1.50  | 1.40  | .06   | .03  | 1.80 | 5.10 | 1.80  | .20  | 1.40 | 1.70 | 100.0 | 1.50  |
| BOUTELOUA ERIPODA           |      | .01   | .08   | .05   | .02  | .37  | .39  | .68   | .01  | .16  | 5.80 | 100.0 | .76   |
| BOUTELOUA GRACILIS          |      | 0.00  | .50   | 9.50  | .30  | 4.50 | .10  | 3.00  | .41  | 1.90 | 3.60 | 90.0  | 2.38  |
| BOUTELOUA HIRSUTA           |      | .52   | 3.20  | .15   | 1.80 | .01  | 1.10 | 1.90  | .63  | 0.00 | .42  | 90.0  | .97   |
| BROMUS SPP.                 |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| CAREX SPP.                  |      | .01   | 0.00  | 0.00  | .35  | 0.00 | 0.00 | 0.00  | 0.00 | .01  | 0.00 | 30.0  | .04   |
| CAREX GEOPHILA              |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | .33   | 0.00 | 0.00 | .30  | 20.0  | .06   |
| CYPERUS FENDLERIANUS        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | .48  | 0.00 | 0.00 | 10.0  | .05   |
| HILARIA JAMESII             |      | 0.00  | 0.00  | .65   | 0.00 | .31  | .05  | 0.00  | 0.00 | 1.50 | 0.00 | 40.0  | .25   |
| KOLERIA CRISTATA            |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| LYCURUS PHLEOIDES           |      | 0.00  | .05   | .32   | .01  | 0.00 | 0.00 | .01   | .01  | 0.00 | 1.80 | 60.0  | .22   |
| MUHLENBERGIA ARSENEI        |      | 0.00  | 0.00  | 0.00  | 0.00 | .01  | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 10.0  | .00   |
| MUHLENBERGIA MONTANA        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| MUHLENBERGIA TORREYI        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | .01  | 0.00  | 0.00 | 0.00 | 0.00 | 10.0  | .00   |
| MUHLENBERGIA WRIGHTII       |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| ORYZOPSIS HYMENOIDES        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | .33  | 0.00 | 10.0  | .03   |
| ORYZOPSIS MICRANTHA         |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | .01  | 0.00 | 10.0  | .00   |
| POA FENDLERIANA             |      | .34   | .01   | 0.00  | .06  | 1.30 | .01  | 4.40  | .83  | 0.00 | .33  | 80.0  | .73   |
| SCHEDONNARDUS PANICULATUS   |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| SITANION HYSTRIX            |      | .01   | .40   | .03   | 0.00 | .04  | 0.00 | .01   | .01  | .07  | .38  | 80.0  | .10   |
| SPOROBOLUS CRYPTANDRUS      |      | .02   | .02   | 0.00  | 0.00 | .17  | .01  | .32   | .75  | .06  | .02  | 80.0  | .14   |
| SPOROBOLUS CONTRACTUS       |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| SPOROBOLUS NEALLYI          |      | 0.00  | 0.00  | .30   | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 10.0  | .03   |
| STIPA COLUMBIANA            |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | .01  | 0.00 | 10.0  | .00   |
| STIPA COMATA                |      | .31   | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 10.0  | .03   |
| STIPA NEOMEXICANA           |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | .31  | 0.00  | 0.00 | .09  | 0.00 | 20.0  | .04   |
| ALLIUM CERNUUM              |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| ANTENNARIA SPP.             |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 0.0   | 0.00  |
| ARABIS PORPHYREA            |      | 0.00  | 0.00  | 0.00  | 0.00 | .03  | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 10.0  | .00   |
| ARTEMESIA CARRUTHII         |      | 0.00  | 0.00  | 0.00  | 0.00 | .01  | 0.00 | 0.00  | 0.00 | 0.00 | 0.00 | 10.0  | .00   |
| ARTEMISIA DRACUNCULOIDES    |      | 0.00  | .05   | .01   | .01  | .67  | .01  | 0.00  | 0.00 | 0.00 | 0.00 | 50.0  | .08   |
| ARTEMISIA FRIGIDA           |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | .01   | 0.00 | .01  | 0.00 | 20.0  | .00   |
| ARTEMISIA LUDOVICIANA       |      | .02   | 0.00  | .02   | 0.00 | 0.00 | 0.00 | 1.50  | 0.00 | 0.00 | .36  | 40.0  | .19   |



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|                             | -NO: | 9     | 12    | 25    | 23   | 2    | 19    | 7    | 42    | 14   | 26    | 34    | 4    | 22    | 21    | 10    | 30   | 15    | FREQ  | ABUND |
|-----------------------------|------|-------|-------|-------|------|------|-------|------|-------|------|-------|-------|------|-------|-------|-------|------|-------|-------|-------|
| JUNIPERUS MONOSPERMA YNG R  |      | 6.00  | 7.00  | 1.00  | 2.00 | 0.00 | 2.00  | 0.00 | 2.00  | 0.00 | 2.00  | 1.00  | 1.00 | 1.00  | 2.00  | 0.00  | 0.00 | 0.00  | 64.7  | 1.59  |
| JUNIPERUS MONOSPERMA ADV R  |      | 18.00 | 32.00 | 3.00  | 8.00 | 6.00 | 14.00 | 2.00 | 9.00  | 6.00 | 11.00 | 2.00  | 1.00 | 8.00  | 13.00 | 2.00  | 5.00 | 2.00  | 100.0 | 8.35  |
| JUNIPERUS MONOSPERMA MATURE |      | 3.00  | 0.00  | 6.00  | 1.00 | 2.00 | 3.00  | 5.00 | 1.00  | 3.00 | 1.00  | 3.00  | 2.00 | 1.00  | 0.00  | 2.00  | 0.00 | 0.00  | 76.5  | 1.94  |
| PINUS EDULIS YNG REGEN      |      | 6.00  | 3.00  | 7.00  | 9.00 | 7.00 | 3.00  | 0.00 | 7.00  | 2.00 | 3.00  | 5.00  | 2.00 | 6.00  | 6.00  | 0.00  | 1.00 | 6.00  | 88.2  | 4.29  |
| PINUS EDULIS ADV REGEN      |      | 7.00  | 2.00  | 15.00 | 4.00 | 6.00 | 15.00 | 4.00 | 10.00 | 5.00 | 5.00  | 15.00 | 3.00 | 20.00 | 24.00 | 16.00 | 7.00 | 15.00 | 100.0 | 10.24 |
| PINUS EDULIS MATURE         |      | 0.00  | 1.00  | 0.00  | 0.00 | 1.00 | 0.00  | 3.00 | 0.00  | 3.00 | 4.00  | 1.00  | 1.00 | 0.00  | 0.00  | 2.00  | 4.00 | 1.00  | 58.8  | 1.24  |
| PINUS PONDEROSA - YNG REGEN |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| PINUS PONDEROSA - ADV REGEN |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| PINUS PONDEROSA - MATURE    |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| ARTEMESIA TRIDENTATA        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 6.40  | 0.00 | 0.00  | .01   | 0.00 | .01   | 0.00  | 0.00  | 0.00 | 0.00  | 17.6  | .38   |
| ARTEMESIA BIGELOVII         |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | .01   | 0.00 | .01   | 0.00  | 0.00  | .01  | 0.00  | 11.8  | .00   |
| CERCOCARPUS MONTANUS        |      | .01   | 0.00  | 0.00  | .30  | 0.00 | .01   | 0.00 | 0.00  | 0.00 | 0.00  | 1.10  | .75  | 0.00  | 0.00  | 0.00  | 1.60 | 0.00  | 35.3  | .22   |
| CHRYSOTHAMNUS NAUSEOSUS     |      | .01   | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | .01  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 11.8  | .00   |
| CHRYSOPSIS VILLOS           |      | 3.00  | 0.00  | .01   | 0.00 | 0.00 | 2.60  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | .01  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 23.5  | .33   |
| FALLUGIA PARADOXA           |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | .01   | 0.00 | 0.00  | 5.9   | .00   |
| FENDLERIA RUPICOLA          |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| FORRESTIERIA NEOMEXICANA    |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| GUTIERREZIA MICROCEPHALA    |      | 0.00  | .72   | .01   | .01  | .01  | .75   | .87  | 1.70  | 0.00 | 0.00  | .01   | .02  | .01   | 0.00  | 0.00  | .30  | .05   | 70.6  | .26   |
| GUTIERREZIA SAROTHRÆ        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| GUTIERREZIA SPP             |      | 2.70  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 5.9   | .16   |
| HYMENOXYS RICHARDSONII      |      | 0.00  | .13   | 0.00  | 0.00 | 2.30 | 0.00  | 0.00 | .01   | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | .02   | 0.00  | 0.00 | .01   | 29.4  | .15   |
| PTELEA TRIFOLIATA           |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | .01  | 0.00  | .01   | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | .32   | 17.6  | .02   |
| QUERCUS UNDULATA            |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 4.80 | 0.00  | 5.9   | .28   |
| QUERCUS SP.                 |      | 0.00  | 0.00  | 0.00  | .01  | 0.00 | .30   | 4.70 | 0.00  | .75  | 0.00  | 0.00  | 3.60 | 0.00  | 0.00  | .01   | 0.00 | 4.80  | 41.2  | .83   |
| QUERCUS GAMBELLII-GRISEA    |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 1.30 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 5.9   | .08   |
| QUERCUS GRISEA-GAMBELLII    |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 4.70 | 0.00  | 0.00 | 0.00  | 0.00  | 2.30 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 11.8  | .41   |
| RHUS TRILOBATA              |      | 0.00  | 0.00  | 0.00  | .01  | 0.00 | 0.00  | .01  | 0.00  | .75  | 0.00  | .01   | .01  | 0.00  | .01   | .01   | 0.00 | .65   | 47.1  | .09   |
| RIBES CEREUM                |      | 0.00  | 0.00  | .01   | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 1.60  | 0.00  | 0.00  | .30  | 0.00  | 17.6  | .11   |
| YUCCA ANGUSTISSIMA          |      | 0.00  | 0.00  | 0.00  | 1.30 | 0.00 | 0.00  | 0.00 | 0.00  | .01  | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 11.8  | .08   |
| YUCCA BACCATA               |      | .01   | .35   | .01   | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | .01  | 0.00  | 0.00  | .01   | .01  | 0.00  | 35.3  | .02   |
| ANDROPOGON SACCHAROIDES     |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| ANDROPOGON SCOPARIUS        |      | 0.00  | 0.00  | 0.00  | 0.00 | 1.30 | 0.00  | .05  | 0.00  | 0.00 | 0.00  | 0.00  | .01  | 0.00  | 0.00  | 0.00  | 0.00 | .30   | 23.5  | .10   |
| ARISTIDA PURPUREA GLAUCA    |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | .01   | 1.00 | 0.00  | .30   | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 17.6  | .08   |
| ARISTIDA PURPUREA LONGISETA |      | 0.00  | .30   | 0.00  | .35  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | .01  | 0.00  | 17.6  | .04   |
| ARISTIDA PURPUREA PURPUREA  |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| ARISTIDA PURPUREA ROBUSTA   |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| ARISTIDA PURPUREA LONGISETA |      | 0.00  | .30   | 0.00  | .35  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | .01   | 0.00 | 0.00  | 23.5  | .04   |
| ARISTIDA SP.                |      | 0.00  | .30   | 0.00  | .35  | .01  | 0.00  | 0.00 | .01   | 1.00 | 0.00  | .30   | .01  | 0.00  | 0.00  | 0.00  | .01  | 0.00  | 47.1  | .12   |
| BOUTELOUA CURTIPENDULA      |      | 0.00  | 0.00  | 0.00  | .73  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | .30   | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 11.8  | .06   |
| BOUTELOUA ERIOPODA          |      | .70   | 0.00  | 0.00  | .60  | 0.00 | 0.00  | 1.10 | 0.00  | 0.00 | 0.00  | .05   | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 23.5  | .14   |
| BOUTELOUA GRACILIS          |      | 7.40  | 10.00 | 6.30  | .60  | 4.10 | 1.20  | 1.70 | 3.40  | 3.50 | 5.20  | 2.50  | .39  | 7.40  | 7.60  | 4.50  | .01  | 2.50  | 100.0 | 4.02  |
| BOUTELOUA HIRSUTA *         |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 1.60 | 0.00  | .05   | 0.00 | 0.00  | .01   | 0.00  | 0.00 | 0.00  | 17.6  | .10   |
| BROMUS SPP.                 |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| CAREX SPP.                  |      | 0.00  | 0.00  | 0.00  | .01  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 5.9   | .00   |
| CAREX GEOPHILA              |      | 0.00  | .05   | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 5.9   | .00   |
| CYPERUS FENDLERIANUS        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| HILARIA JAMESII             |      | 0.00  | .51   | .01   | .41  | 0.00 | 0.00  | .82  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 1.00  | 0.00 | 0.00  | 29.4  | .16   |
| KOLERIA CRISTATA            |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| LYCURIUS PHELOIDES          |      | 0.00  | .01   | 0.00  | .01  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | .05  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 17.6  | .00   |
| MUHLenbergia ARSENEI        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | .01   | 0.00 | 0.00  | 0.00  | 0.00  | .01  | 0.00  | 11.8  | .00   |
| MUHLenbergia MONTANA        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 1.10 | 0.00  | 0.00  | .05  | 0.00  | 0.00  | 1.40  | 0.00 | .01   | 23.5  | .15   |
| MUHLenbergia TORREYI        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | .01   | 0.00  | 0.00  | 0.00 | 0.00  | 5.9   | .00   |
| MUHLenbergia WRIGHTII       |      | 0.00  | 1.30  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 5.9   | .08   |
| ORYZOPSIS HYMENOIDES        |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | .01  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | .01  | 0.00  | 11.8  | .00   |
| ORYZOPSIS MICRANTHA         |      | 0.00  | .60   | .01   | 0.00 | 0.00 | 0.00  | 0.00 | .01   | .47  | .37   | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 1.10  | 35.3  | .15   |
| POA FENDLERIANA             |      | 1.10  | .05   | .30   | .02  | .31  | .36   | 0.00 | .01   | .31  | 1.90  | 0.00  | 0.00 | 0.00  | .01   | 3.80  | 0.00 | 0.00  | 64.7  | .48   |
| SCHEDONNARDUS PANICULATUS   |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | .50   | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 5.9   | .03   |
| SITANION HYSTRIX            |      | .03   | .01   | .53   | 0.00 | .01  | .06   | 0.00 | .01   | 0.00 | .01   | 0.00  | 0.00 | 0.00  | 0.00  | .01   | 0.00 | 0.00  | 47.1  | .04   |
| SPOROBOLUS CRYPTANDRUS      |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | .40   | .01  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | .00   | 0.00 | 0.00  | 11.8  | .02   |
| SPOROBOLUS CONTRACTUS       |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| SPOROBOLUS NEALLYI          |      | 0.00  | 0.00  | 0.00  | .06  | 0.00 | 0.00  | 0.00 | .30   | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 11.8  | .02   |
| STIPA COLUMBIANA            |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | .01   | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 5.9   | .00   |
| STIPA COMATA                |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | .01  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 5.9   | .00   |
| STIPA NEOMEXICANA           |      | 0.00  | 0.00  | 0.00  | .31  | 0.00 | 0.00  | 0.00 | 0.00  | .01  | 0.00  | 0.00  | .01  | 0.00  | 0.00  | 0.00  | .01  | 0.00  | 23.5  | .02   |
| ALLIUM CERNUUM              |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00 | 0.00  | 0.0   | 0.00  |
| ANTENNARIA SPP.             |      | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  |      |       |       |       |

| DATE   | TIME  | STATUS | NAME | PHONE    | ADDRESS   | CITY     | STATE | ZIP   | AGE | SEX | REL | EDUC | EMP | IND | REMARKS | REMARKS | REMARKS | REMARKS | REMARKS |  |
|--------|-------|--------|------|----------|-----------|----------|-------|-------|-----|-----|-----|------|-----|-----|---------|---------|---------|---------|---------|--|
| 1970   | 10:00 | OK     | JOHN | 555-1234 | 123 MAIN  | NEW YORK | NY    | 10001 | 35  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 11:00 | OK     | JANE | 555-5678 | 456 MAIN  | NEW YORK | NY    | 10001 | 32  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 12:00 | OK     | JOHN | 555-9012 | 789 MAIN  | NEW YORK | NY    | 10001 | 38  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 13:00 | OK     | JANE | 555-3456 | 101 MAIN  | NEW YORK | NY    | 10001 | 31  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 14:00 | OK     | JOHN | 555-7890 | 202 MAIN  | NEW YORK | NY    | 10001 | 36  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 15:00 | OK     | JANE | 555-2345 | 303 MAIN  | NEW YORK | NY    | 10001 | 33  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 16:00 | OK     | JOHN | 555-6789 | 404 MAIN  | NEW YORK | NY    | 10001 | 37  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 17:00 | OK     | JANE | 555-0123 | 505 MAIN  | NEW YORK | NY    | 10001 | 34  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 18:00 | OK     | JOHN | 555-4567 | 606 MAIN  | NEW YORK | NY    | 10001 | 39  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 19:00 | OK     | JANE | 555-8901 | 707 MAIN  | NEW YORK | NY    | 10001 | 30  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 20:00 | OK     | JOHN | 555-2345 | 808 MAIN  | NEW YORK | NY    | 10001 | 36  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 21:00 | OK     | JANE | 555-6789 | 909 MAIN  | NEW YORK | NY    | 10001 | 32  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 22:00 | OK     | JOHN | 555-0123 | 1010 MAIN | NEW YORK | NY    | 10001 | 37  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 23:00 | OK     | JANE | 555-4567 | 1111 MAIN | NEW YORK | NY    | 10001 | 33  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 24:00 | OK     | JOHN | 555-8901 | 1212 MAIN | NEW YORK | NY    | 10001 | 38  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 25:00 | OK     | JANE | 555-2345 | 1313 MAIN | NEW YORK | NY    | 10001 | 31  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 26:00 | OK     | JOHN | 555-6789 | 1414 MAIN | NEW YORK | NY    | 10001 | 36  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 27:00 | OK     | JANE | 555-0123 | 1515 MAIN | NEW YORK | NY    | 10001 | 32  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 28:00 | OK     | JOHN | 555-4567 | 1616 MAIN | NEW YORK | NY    | 10001 | 37  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 29:00 | OK     | JANE | 555-8901 | 1717 MAIN | NEW YORK | NY    | 10001 | 33  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 30:00 | OK     | JOHN | 555-2345 | 1818 MAIN | NEW YORK | NY    | 10001 | 38  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 31:00 | OK     | JANE | 555-6789 | 1919 MAIN | NEW YORK | NY    | 10001 | 31  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 32:00 | OK     | JOHN | 555-0123 | 2020 MAIN | NEW YORK | NY    | 10001 | 36  | M   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970   | 33:00 | OK     | JANE | 555-4567 | 2121 MAIN | NEW YORK | NY    | 10001 | 32  | F   | F   | H    | Y   | 1   |         |         |         |         |         |  |
| 1970</ |       |        |      |          |           |          |       |       |     |     |     |      |     |     |         |         |         |         |         |  |

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Table 10. Canopy coverage of species present on sites of the  
Pinus edulis - Juniperus monosperma/Muhlenbergia montana  
 habitat type.

| -NO:                        | 3     | 38   | 40    | 41    | 11    | 39    | 28    | 20    | 5     | 27    | FREQ  | ABUND |
|-----------------------------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| JUNIPERUS MONOSPERMA YNG R  | 2.00  | 6.00 | 2.00  | 2.00  | 7.00  | 5.00  | 17.00 | 68.00 | 16.00 | 10.00 | 100.0 | 13.50 |
| JUNIPERUS MONOSPERMA ADV R  | 3.00  | 2.00 | 4.00  | 8.00  | 15.00 | 11.00 | 21.00 | 30.00 | 11.00 | 8.00  | 100.0 | 11.30 |
| JUNIPERUS MONOSPERMA MATURE | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 1.00  | 0.00  | 0.00  | 2.00  | 20.0  | .30   |
| PINUS EDULIS YNG REGEN      | 4.00  | 6.00 | 7.00  | 7.00  | 8.00  | 8.00  | 10.00 | 12.00 | 14.00 | 15.00 | 100.0 | 9.10  |
| PINUS EDULIS ADV REGEN      | 13.00 | 5.00 | 14.00 | 5.00  | 21.00 | 14.00 | 22.00 | 16.00 | 26.00 | 16.00 | 100.0 | 15.20 |
| PINUS EDULIS MATURE         | 4.00  | 2.00 | 1.00  | 0.00  | 2.00  | 4.00  | 1.00  | 4.00  | 3.00  | 6.00  | 90.0  | 2.70  |
| PINUS PONDEROSA - YNG REGEN | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 1.00  | 0.00  | 0.00  | 10.0  | .10   |
| PINUS PONDEROSA - ADV REGEN | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 2.00  | 0.00  | 0.00  | 10.0  | .20   |
| PINUS PONDEROSA - MATURE    | 0.00  | 0.00 | 1.00  | 0.00  | 0.00  | 0.00  | 0.00  | 1.00  | 0.00  | 0.00  | 20.0  | .20   |
| ARTEMESIA TRIDENTATA        | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| ARTEMESIA BIGELOVII         | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| CERCOCARPUS MONTANUS        | .06   | 3.70 | 3.00  | 0.00  | .30   | .95   | 1.10  | .01   | 0.00  | .01   | 80.0  | .91   |
| CHRYSOTHAMNUS NAUSEOSUS     | 0.00  | 0.00 | 0.00  | 0.00  | .01   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 10.0  | .00   |
| CHRYSOPTIS VILLOS           | 0.00  | .01  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 10.0  | .00   |
| FALLUGIA PARADOXA           | 0.00  | 0.00 | .01   | 0.00  | 0.00  | 0.00  | .01   | 0.00  | 0.00  | 0.00  | 20.0  | .00   |
| FENDLERIA RUPICOLA          | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| FORRESTIERIA NEOMEXICANA    | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| GUTIERREZIA MICROCEPHALA    | .01   | .11  | .01   | .14   | .01   | 0.00  | 0.00  | 0.00  | 0.00  | .32   | 60.0  | .06   |
| GUTIERREZIA SAROTHRAE       | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| GUTIERREZIA SPP             | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | .01   | .01   | 0.00  | 0.00  | 0.00  | 20.0  | .00   |
| HYMENOXYS RICHARDSONII      | .01   | 1.70 | 0.00  | 0.00  | .67   | .01   | .01   | .01   | .01   | 0.00  | 70.0  | .24   |
| PTOLEA TRIFOLIATA           | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | .01   | 0.00  | 0.00  | .01   | 20.0  | .00   |
| QUERCUS UNDULATA            | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| QUERCUS SP.                 | 13.00 | 6.40 | 0.00  | 16.00 | 0.00  | 3.20  | 0.00  | 2.10  | .01   | 0.00  | 60.0  | 4.07  |
| QUERCUS GAMBELLII-GRISEA    | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| QUERCUS GRISEA-GAMBELLII    | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| RHUS TRILOBATA              | 0.00  | .01  | 3.70  | 0.00  | 0.00  | .01   | 0.00  | 0.00  | 0.00  | .01   | 40.0  | .37   |
| RIBES CEREUM                | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | .01   | 0.00  | 0.00  | 0.00  | 10.0  | .00   |
| YUCCA ANGUSTISSIMA          | 0.00  | .01  | 0.00  | 0.00  | 0.00  | 0.00  | .01   | .01   | .01   | 0.00  | 40.0  | .00   |
| YUCCA BACCATA               | .30   | 0.00 | 0.00  | 0.00  | .75   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 20.0  | .11   |
| ANDROPOGON SACCHAROIDES     | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| ANDROPOGON SCOPARIUS        | 0.00  | .75  | 1.50  | .03   | 0.00  | 0.00  | 0.00  | .75   | 0.00  | 0.00  | 40.0  | .30   |
| ARISTIDA PURPUREA GLAUCA    | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| ARISTIDA PURPUREA LONGISETA | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| ARISTIDA PURPUREA PURPUREA  | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| ARISTIDA PURPUREA ROBUSTA   | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| ARISTIDA PURPUREA LONGISETA | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| ARISTIDA SP.                | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| BOUTELOUA CURTIPENDULA      | 0.00  | 0.00 | 0.00  | .05   | 0.00  | 0.00  | 0.00  | .05   | .01   | 0.00  | 30.0  | .01   |
| BOUTELOUA ERIOPODA          | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| BOUTELOUA GRACILIS          | 4.90  | 4.10 | .01   | 1.50  | 3.50  | 3.50  | 2.20  | .25   | 5.40  | 3.80  | 100.0 | 2.92  |
| BOUTELOUA HIRSUTA           | 0.00  | .05  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | .14   | 0.00  | 0.00  | 20.0  | .02   |
| BROMUS SPP.                 | 0.00  | .01  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | .02   | 0.00  | 0.00  | 20.0  | .00   |
| CAREX SPP.                  | .02   | 0.00 | 0.00  | .70   | 0.00  | 0.00  | .10   | 0.00  | 0.00  | 0.00  | 30.0  | .08   |
| CAREX GEOPHILA              | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 2.90  | 0.00  | 10.0  | .29   |
| CYPERUS FENDLERIANUS        | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 1.60  | 0.00  | 0.00  | 10.0  | .16   |
| HILARIA JAMESII             | 0.00  | 0.00 | 0.00  | 0.00  | .47   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 10.0  | .05   |
| KOLERIA CRISTATA            | 0.00  | .01  | .01   | 0.00  | 0.00  | 0.00  | 3.90  | 1.20  | .09   | 0.00  | 50.0  | .52   |
| LYCURUS PHLEOIDES           | 0.00  | .03  | 0.00  | .70   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 20.0  | .07   |
| MUHLENBERGIA ARSENEI        | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| MUHLENBERGIA MONTANA        | .90   | .02  | .21   | 2.70  | 0.00  | .05   | 0.00  | 4.70  | 3.10  | 1.10  | 80.0  | 1.28  |
| MUHLENBERGIA TORREYI        | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| MUHLENBERGIA WRIGHTII       | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| ORYZOPSIS HYMENOIDES        | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | .05   | 0.00  | 0.00  | .33   | 20.0  | .04   |
| ORYZOPSIS MICRANTHA         | 0.00  | .91  | 1.10  | 0.00  | 0.00  | .40   | .02   | 0.00  | 0.00  | 0.00  | 40.0  | .24   |
| POA FENDLERIANA             | .31   | .30  | .01   | .60   | .81   | .42   | 7.70  | 2.90  | 2.30  | .53   | 100.0 | 1.59  |
| SCHEDONNARDUS PANICULATUS   | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| SITANION HYSTRIX            | 0.00  | .01  | .01   | 0.00  | .01   | .31   | 0.00  | 0.00  | 0.00  | .02   | 50.0  | .04   |
| SPOROBOLUS CRYPTANDRUS      | 0.00  | 0.00 | 0.00  | .01   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | .11   | 20.0  | .01   |
| SPOROBOLUS CONTRACTUS       | 0.00  | 0.00 | 0.00  | .05   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 10.0  | .01   |
| SPOROBOLUS NEALLYI          | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| STIPA COLUMBIANA            | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | .71   | .15   | 20.0  | .09   |
| STIPA COMATA                | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 1.30  | 10.0  | .13   |
| STIPA NEOMEXICANA           | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| ALLIUM CERNUUM              | .01   | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | .01   | 0.00  | 0.00  | 20.0  | .00   |
| ANTENNARIA SPP.             | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | .15   | .01   | 0.00  | 20.0  | .02   |
| ARABIS PORPHYREA            | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | .03   | 10.0  | .00   |
| ARTEMESIA CARRUTHII         | 0.00  | 1.50 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 10.0  | .15   |
| ARTEMISIA DRACUNCULOIDES    | 0.00  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.0   | 0.00  |
| ARTEMISIA FRIGIDA           | .01   | 0.00 | 0.00  | .01   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 20.0  | .00   |
| ARTEMISIA LUDOVICIANA       | .01   | .01  | 0.00  | 1.20  | 0.00  | 0.00  | .05   | 0.00  | 0.00  | 0.00  | 40.0  | .13   |

Table 10. Continued

|                              | -NO: | 3    | 38   | 40   | 41   | 11   | 39   | 28   | 20   | 5    | 27   | FREQ | ABUND |
|------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
| ASCLEPIAS SP.                |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| ASTER HIRTIFOLIUS            |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| ASTRAGALUS SPP.              |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| BAHIA DISSECTA               |      | .06  | .01  | .07  | 0.00 | .31  | .05  | .01  | 0.00 | .01  | .01  | 80.0 | .05   |
| BRICKELLIA BRACHYPHYLLA      |      | 0.00 | 0.00 | 0.00 | .40  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .04   |
| BRICKELLIA FENDLERI          |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .01  | 10.0 | .00   |
| BRICKELLIA CALIFORNICA       |      | 0.00 | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 20.0 | .00   |
| CASTILLEJA SPP.              |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 10.0 | .00   |
| CHEILANTHES EATONII          |      | 0.00 | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| CHRYSOOPSIS VILLOS           |      | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| CORYPHANTHA VIVIPARA         |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| CRYPTANTHA JAMESII           |      | 0.00 | 0.00 | .47  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .05   |
| ECHINOCEREUS TRIGLOCHIDIATUS |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| ECHINOCEREUS VIRIDIFLORUS    |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| ECHINOCEREUS FENDLERI        |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| ECHINOCEREUS SP.             |      | 0.00 | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| ERIGERON SPP.                |      | 0.00 | 0.00 | 0.00 | .05  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .01   |
| ERIGERON DIVERGENS           |      | 0.00 | .02  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| ERIGERON FLAGELLARIS         |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .14  | .07  | 0.00 | 0.00 | 20.0 | .02   |
| ERIGERON NUDIFLORUS          |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| ERIOGONUM JAMESII            |      | 0.00 | .01  | .30  | .41  | .01  | .01  | 0.00 | 0.00 | .01  | .01  | 70.0 | .08   |
| ERIOGONUM RACEMOSUM          |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| ERYSIMUM CAPITATUM           |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .01  | 0.00 | 10.0 | .00   |
| EUPHORBIA GEYERI             |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| EUPHORBIA REVOLUTA           |      | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| EUPHORBIA SP.                |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| GILIA AGGREGATA              |      | 0.00 | .08  | .07  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .01  | 30.0 | .02   |
| HAPLOPAPPUS SPINULOSUS       |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| HAPLOPAPPUS GRACILIS         |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| HEDEOMA DRUMMONDII           |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| HYMENOPAPPUS FILIFOLIUS      |      | 0.00 | .08  | 0.00 | 0.00 | .12  | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 30.0 | .02   |
| HYMENOXYS ARGENTEA           |      | .03  | 0.00 | 0.00 | 0.00 | .01  | 0.00 | .01  | .42  | .43  | 0.00 | 50.0 | .09   |
| HYMENOXYS ACAULIS            |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| IPOMOPSIS LONGIFLORA         |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| KUHNSIA CHLOROLEPIS          |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| LESQUERELLA RECTIPES         |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| LIATRIS PUNCTATA             |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .05  | 0.00 | 0.00 | 10.0 | .01   |
| LITHOSPERMUM SP.             |      | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| LONICERA SPP.                |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| LOTUS WRIGHTII               |      | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| LUPINUS SPP.                 |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| MAMMALLARIA SP.              |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| MAMMALLARIA WRIGHTII         |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| MAMMILLARIA VIVIPARA         |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| MELILOTUS OFFICINALIS        |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| MENTZELIA PUMILA             |      | 0.00 | 0.00 | .81  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .30  | 20.0 | .11   |
| MIRABILIS MULTIFLORA         |      | 0.00 | 0.00 | 0.00 | .30  | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 20.0 | .03   |
| MONARDA PECTINATA            |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .01  | 10.0 | .00   |
| NOTHOLAENA SPP.              |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| OPUNTIA PHAEACANTHA          |      | 0.00 | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| OPUNTIA POLYACANTHA          |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| OPUNTIA ERINACEA             |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| OPUNTIA IMBRICATA            |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| OPUNTIA SPP. (PRICKLY PEARS) |      | 2.00 | .10  | 0.00 | 0.00 | .37  | .95  | .01  | 0.00 | .01  | .01  | 70.0 | .35   |
| OXYBAPHUS LINEARIS           |      | 0.00 | 0.00 | 0.00 | .01  | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 20.0 | .00   |
| PELLAEA FENDLERI             |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 10.0 | .00   |
| PELLAEA LONGIMUCRONNATA      |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| PENSTEMON BARBATUS           |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| PENSTEMON SECUNDIFLORUS      |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| PENSTEMON VIRGATUS           |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| PHYSALIS HEDERAEFOLIA        |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| SENECIO FENDLERI             |      | 0.00 | 0.00 | 0.00 | .07  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .01   |
| SENECIO MULTILOBATUS         |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| SENECIO MULTICAPITATUS       |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| SENECIO NEOMEXICANUS         |      | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| SISYMBRIUM LINEARIFOLIUM     |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .01  | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| STEPHANOMERIA                |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| THELESPERMA FILIFOLIUM       |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| THELYPODIUM INTEGRIFOLIUM    |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| TOWNSENDIA ESCAPA            |      | 0.00 | .01  | 0.00 | 0.00 | 0.00 | .05  | 0.00 | 0.00 | 0.00 | 0.00 | 20.0 | .01   |
| TOWNSENDIA EXIMIA            |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| VERBASCUM THAPSUS            |      | 0.00 | 0.00 | .40  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | .04   |
| VERBENA WRIGHTII             |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0  | 0.00  |
| WOODSIA OREGANA              |      | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .04  | 0.00 | 0.00 | 0.00 | 10.0 | .00   |
| WOODSIA SP.                  |      | 0.00 | 0.00 | 0.00 | .01  | 0.00 | 0.00 | .04  | 0.00 | .01  | 0.00 | 30.0 | .01   |

Appendix A3. Relative and summed cover values of selected species on baseline sites.

Tree cover was calculated using regression equations in Table 2; JUMO/BOCU HT grasses are Bouteloua curtipendula, B. eripoda, Hilaria jamesii, and Lycurus phleoides; PIED-JUMO/MUMO HT grasses are Muhlenbergia montana, Poa fendleriana, Koeleria cristata and Oryzopsis micrantha; relative C3 grass cover calculated as a fraction of total grass cover; relative cover of Gutierrezia microcephala ("GUMI") was calculated as a fraction of total understory cover.

Table 11. Relative and summed values of selected species on sites of the Juniperus monosperma/Bouteloua curtipendula habitat type.

|                           | -NO: | 32    | 29    | 17    | 33    | 18    | 37    | 16    | 36    | 24    | 13    | FREQ  | ABUND |
|---------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| P. EDULIS COVER           |      | 1.50  | .30   | .20   | .20   | .10   | 1.70  | 6.00  | .70   | 9.30  | 12.00 | 100.0 | 3.20  |
| J. MONOSPERMA COVER       |      | 70.00 | 48.00 | 44.00 | 36.00 | 40.00 | 25.00 | 39.00 | 22.00 | 23.00 | 29.00 | 100.0 | 37.60 |
| TOTAL UNDERSTORY COVER    |      | 5.31  | 6.43  | 13.69 | 12.80 | 13.85 | 8.19  | 15.97 | 11.88 | 8.53  | 24.14 | 100.0 | 12.08 |
| TOTAL SHRUB COVER         |      | .40   | .69   | 2.40  | 8.97  | 1.63  | .77   | .02   | 7.72  | 2.41  | 8.58  | 100.0 | 3.36  |
| TOTAL FORB COVER          |      | .34   | .08   | .18   | .16   | 3.71  | .34   | 1.85  | .78   | .57   | 1.20  | 100.0 | .92   |
| TOTAL GRASS COVER         |      | 4.57  | 5.66  | 11.11 | 3.67  | 8.51  | 7.08  | 14.10 | 3.38  | 5.55  | 14.36 | 100.0 | 7.80  |
| JUMO/BOCU GRASSES         |      | 2.03  | 4.73  | 1.23  | 1.86  | 2.49  | 6.64  | 4.39  | .85   | 3.06  | 9.72  | 100.0 | 3.70  |
| PIED-JUMO/MUMO GRASSES    |      | .34   | .01   | 0.00  | .06   | 1.30  | .01   | 4.40  | .83   | .01   | .33   | 90.0  | .73   |
| C3 GRASS COVER            |      | .67   | .41   | .03   | .41   | 1.34  | .32   | 4.41  | .84   | .52   | .71   | 100.0 | .97   |
| C4 GRASS COVER            |      | 3.90  | 5.25  | 11.08 | 3.26  | 7.17  | 6.76  | 9.36  | 2.06  | 5.03  | 13.35 | 100.0 | 6.72  |
| RELATIVE COVER C3 GRASSES |      | .15   | .07   | .00   | .11   | .16   | .05   | .31   | .25   | .09   | .05   | 100.0 | .12   |
| RELATIVE COVER GUMI       |      | .07   | 0.00  | .08   | .02   | .12   | .00   | .00   | 0.00  | .20   | .00   | 80.0  | .05   |

Table 12. Relative and summed cover values of selected species on sites of the Pinus edulis - Juniperus monosperma/Bouteloua gracilis habitat type.

|                           | -NO: | 9     | 12    | 25    | 23    | 2     | 19    | 7     | 42    | 14    | 26    |
|---------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| P. EDULIS COVER           |      | 13.00 | 12.00 | 43.00 | 8.20  | 23.00 | 37.00 | 39.00 | 22.00 | 40.00 | 51.00 |
| J. MONOSPERMA COVER       |      | 39.00 | 41.00 | 32.00 | 11.00 | 18.00 | 27.00 | 23.00 | 14.00 | 21.00 | 0.00  |
| TOTAL UNDERSTORY COVER    |      | 16.38 | 14.19 | 8.32  | 4.96  | 8.18  | 10.48 | 9.41  | 12.48 | 11.44 | 7.56  |
| TOTAL SHRUB COVER         |      | 5.73  | 1.20  | .04   | 1.63  | 2.31  | 3.66  | 5.59  | 8.11  | 1.52  | 0.00  |
| TOTAL FORB COVER          |      | 1.42  | .16   | 1.13  | .23   | .14   | 4.79  | .13   | .13   | 1.93  | .08   |
| TOTAL GRASS COVER         |      | 9.23  | 12.83 | 7.15  | 3.10  | 5.73  | 2.03  | 3.69  | 4.24  | 7.99  | 7.48  |
| JUMO/BOCU GRASSES         |      | .70   | .52   | .01   | 1.75  | 0.00  | 0.00  | 1.92  | 0.00  | 1.60  | 0.00  |
| PIED-JUMO/MUMO GRASSES    |      | 1.10  | .65   | .31   | .02   | .31   | .36   | 0.00  | .02   | 1.88  | 2.27  |
| C3 GRASS COVER            |      | 1.13  | .66   | .84   | .34   | .32   | .43   | .01   | .03   | .79   | 2.28  |
| C4 GRASS COVER            |      | 8.10  | 12.12 | 6.31  | 2.76  | 5.41  | 1.60  | 3.68  | 3.71  | 7.20  | 5.20  |
| RELATIVE COVER C3 GRASSES |      | .12   | .05   | .12   | .11   | .06   | .21   | .00   | .01   | .10   | .30   |
| RELATIVE COVER GUMI       |      | 0.00  | .05   | .00   | .00   | .00   | .07   | .09   | .14   | 0.00  | 0.00  |

|                           | -NO: | 34    | 4     | 22    | 21    | 10    | 30    | 15    |  | FREQ  | ABUND |
|---------------------------|------|-------|-------|-------|-------|-------|-------|-------|--|-------|-------|
| P. EDULIS COVER           |      | 43.00 | 15.00 | 49.00 | 56.00 | 66.00 | 50.00 | 60.00 |  | 100.0 | 36.89 |
| J. MONOSPERMA COVER       |      | 17.00 | 5.00  | 14.00 | 15.00 | 12.00 | 7.00  | 2.10  |  | 94.1  | 17.54 |
| TOTAL UNDERSTORY COVER    |      | 4.75  | 5.03  | 7.49  | 9.26  | 10.43 | 3.02  | 10.91 |  | 100.0 | 9.08  |
| TOTAL SHRUB COVER         |      | 1.15  | 4.40  | .02   | 1.63  | .04   | 1.92  | 6.13  |  | 94.1  | 2.65  |
| TOTAL FORB COVER          |      | .38   | .11   | .06   | .01   | .68   | .05   | .87   |  | 100.0 | .72   |
| TOTAL GRASS COVER         |      | 3.22  | .52   | 7.41  | 7.62  | 9.71  | 1.05  | 3.91  |  | 100.0 | 5.70  |
| JUMO/BOCU GRASSES         |      | .40   | .05   | 0.00  | .01   | 0.00  | 1.00  | 0.00  |  | 58.8  | .47   |
| PIED-JUMO/MUMO GRASSES    |      | 0.00  | .05   | 0.00  | .01   | 5.20  | 0.00  | 1.11  |  | 76.5  | .78   |
| C3 GRASS COVER            |      | .01   | .01   | 0.00  | .01   | 3.81  | .02   | 1.10  |  | 94.1  | .69   |
| C4 GRASS COVER            |      | 3.21  | .51   | 7.41  | 7.61  | 5.90  | 1.03  | 2.81  |  | 100.0 | 4.97  |
| RELATIVE COVER C3 GRASSES |      | .00   | .02   | 0.00  | .00   | .39   | .02   | .28   |  | 94.1  | .11   |
| RELATIVE COVER GUMI       |      | .00   | .00   | .00   | 0.00  | 0.00  | .10   | .00   |  | 70.6  | .03   |

Table 13. Relative and summed cover values of selected species of the Pinus edulis - Juniperus monosperma/Muhlenbergia montana habitat type.

|                           | -NO: | 3     | 38    | 40    | 41    | 11    | 39    | 28    | 20    | 5     | 27    | FREQ  | ABUND |
|---------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| P. EDULIS COVER           |      | 54.00 | 25.00 | 27.00 | 5.40  | 64.00 | 56.00 | 45.00 | 69.00 | 79.00 | 83.00 | 100.0 | 50.74 |
| J. MONOSPERMA COVER       |      | 3.60  | 4.30  | 5.00  | 8.60  | 16.00 | 13.00 | 21.00 | 44.00 | 16.00 | 21.00 | 100.0 | 15.25 |
| TOTAL UNDERSTORY COVER    |      | 21.63 | 19.96 | 11.72 | 24.97 | 7.35  | 9.97  | 15.40 | 14.47 | 15.02 | 8.08  | 100.0 | 14.86 |
| TOTAL SHRUB COVER         |      | 13.38 | 11.94 | 6.72  | 16.14 | 1.74  | 4.18  | 1.16  | 2.13  | .03   | .35   | 100.0 | 5.78  |
| TOTAL FORB COVER          |      | 2.12  | 1.83  | 2.15  | 2.49  | .82   | 1.11  | .27   | .73   | .48   | .39   | 100.0 | 1.24  |
| TOTAL GRASS COVER         |      | 6.13  | 6.19  | 2.85  | 6.34  | 4.79  | 4.68  | 13.97 | 11.61 | 14.51 | 7.34  | 100.0 | 7.84  |
| JUMO/BOCU GRASSES         |      | 0.00  | .08   | 0.00  | .75   | .47   | 0.00  | 0.00  | .19   | .01   | 0.00  | 50.0  | .15   |
| PIED-JUMO/MUMO GRASSES    |      | 1.21  | 1.24  | 1.33  | 3.30  | .81   | .87   | 11.62 | 8.80  | 5.49  | 1.63  | 100.0 | 3.63  |
| C3 GRASS COVER            |      | .33   | 1.23  | 1.13  | 1.30  | .82   | 1.13  | 11.77 | 4.10  | 3.10  | 2.33  | 100.0 | 2.72  |
| C4 GRASS COVER            |      | 5.80  | 4.95  | 1.72  | 5.04  | 3.97  | 3.55  | 2.20  | 5.89  | 8.51  | 5.01  | 100.0 | 4.66  |
| RELATIVE COVER C3 GRASSES |      | .05   | .20   | .40   | .21   | .17   | .24   | .84   | .35   | .21   | .32   | 100.0 | .30   |
| RELATIVE COVER GUMI       |      | .00   | .01   | .00   | .01   | .00   | 0.00  | 0.00  | 0.00  | 0.00  | .04   | 60.0  | .01   |

Appendix A4. Regression relationships between diameter at base and mean crown diameter of Pinus edulis and Juniperus monosperma.

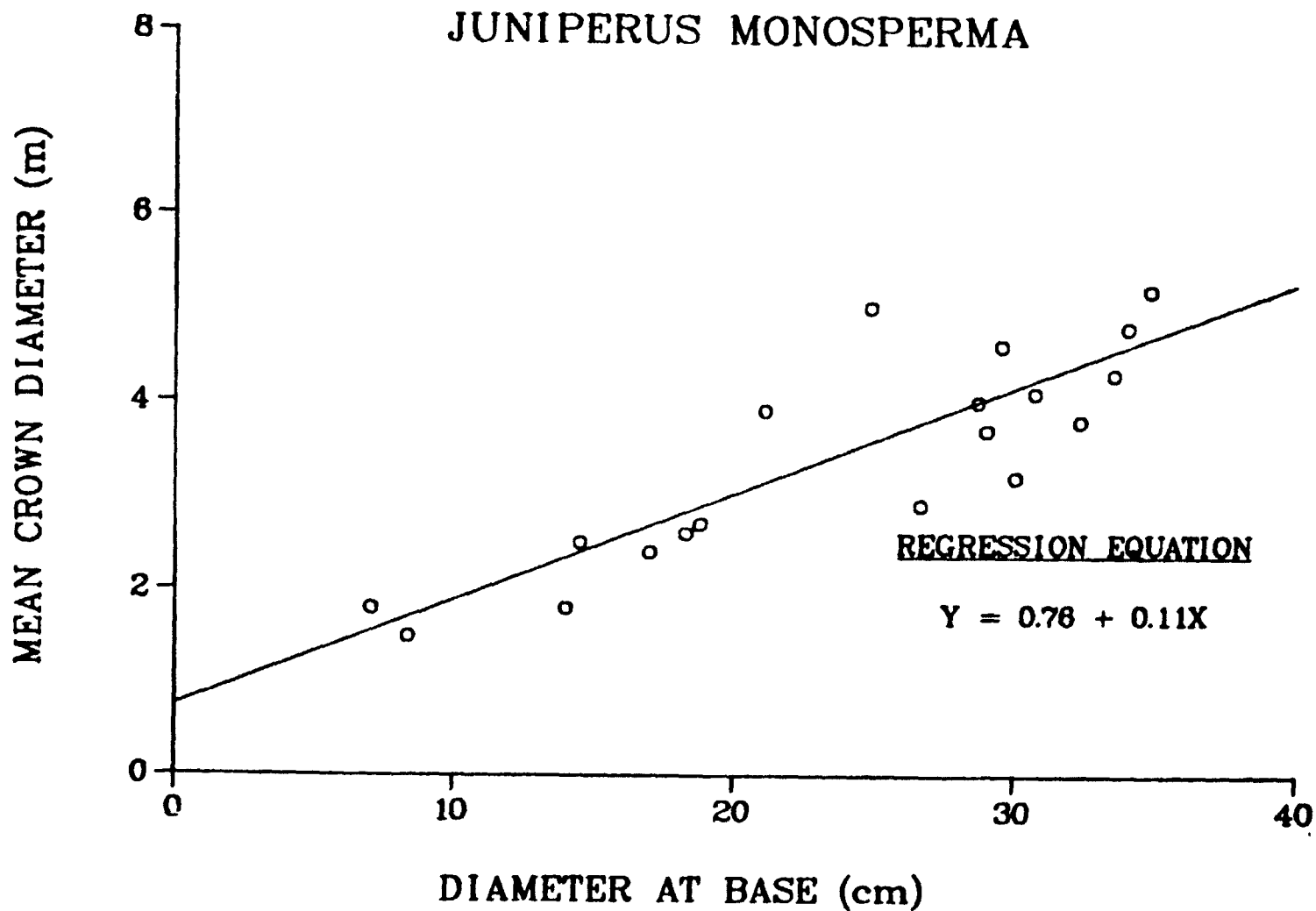


Figure 5. Regression relationships between diameter at base and mean crown diameter of Juniperus monosperma.

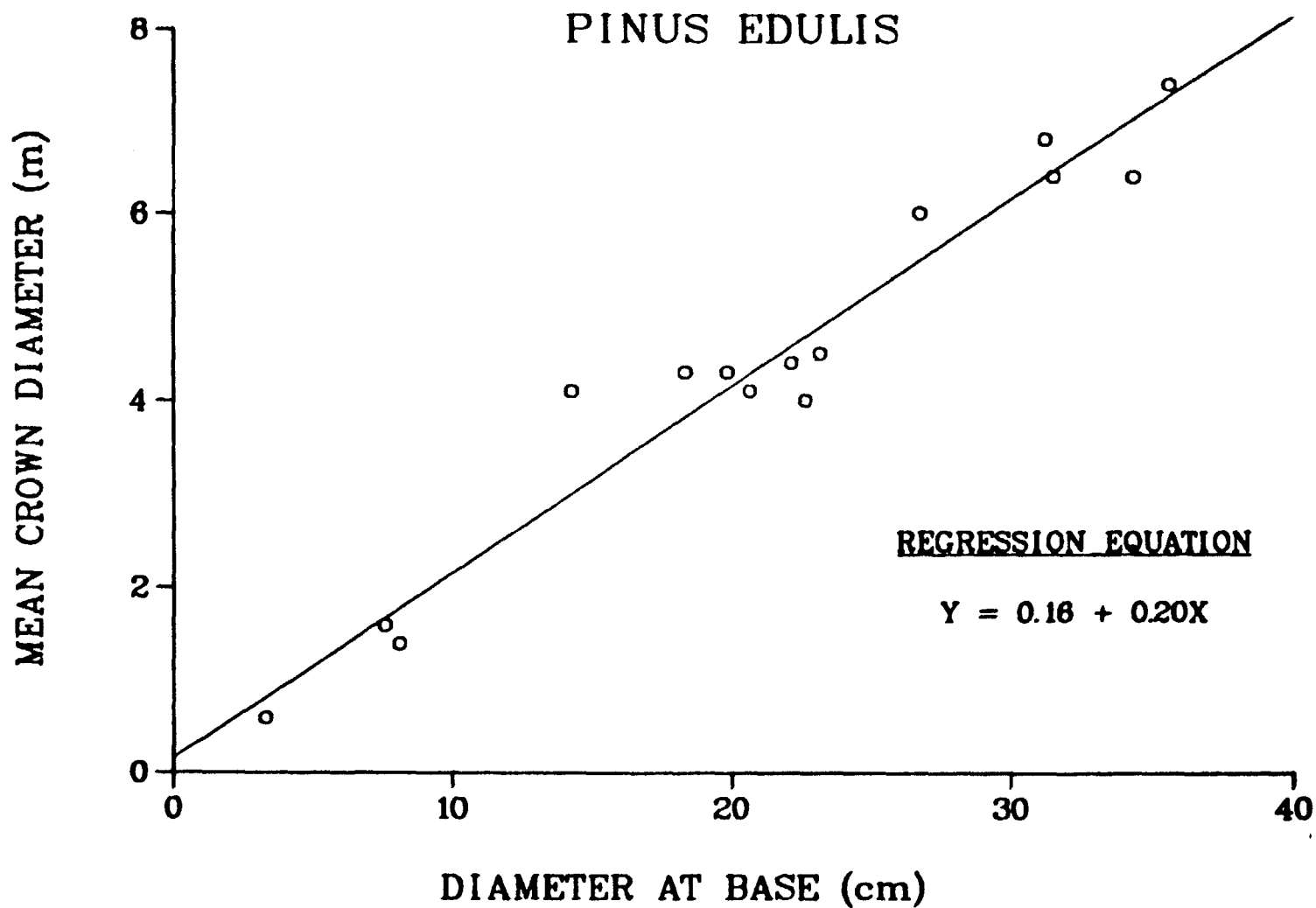


Figure 6. Regression relationship between diameter at base and mean crown diameter of Pinus edulis.

Appendix B1. Locations and characteristics of Frijoles sites sampled for evaluation of range condition in Bandelier National Monument.

Table 14. Location of Frijoles sties for evaluation of range conditions in Bandelier National Monument.

| PLOT NO. |    | UTM-EAST | UTM-NORTH | LOCALITY  |                  |
|----------|----|----------|-----------|-----------|------------------|
| F        | 1  | 38587    | 395715    | BANDELIER | WEST OF FRIJOLES |
| F        | 2  | 38587    | 395715    | BANDELIER | WEST OF FRIJOLES |
| F        | 3  | 38484    | 395582    | BANDELIER | WEST OF FRIJOLES |
| F        | 4  | 38480    | 395723    | BANDELIER | WEST OF FRIJOLES |
| F        | 5  | 38200    | 395723    | BANDELIER | WEST OF ALAMO    |
| F        | 6  | 38233    | 395580    | BANDELIER | WEST OF ALAMO    |
| F        | 7  | 38236    | 395637    | BANDELIER | WEST OF ALAMO    |
| F        | 8  | 38205    | 395620    | BANDELIER | WEST OF ALAMO    |
| F        | 9  | 38099    | 395732    | BANDELIER | WEST OF ALAMO    |
| F        | 10 | 38141    | 395703    | BANDELIER | WEST OF ALAMO    |

Table 15. Characteristics of Frijoles sites sampled for evaluation of range conditions in Bandelier National Monument.

| PLOT NO. |    | ELEVATION |      | SLOPE (%) | ASPECT |      | LANDFORM CODE | SOIL NO. | PER CENT GROUND COVER |      |      |      |        |
|----------|----|-----------|------|-----------|--------|------|---------------|----------|-----------------------|------|------|------|--------|
|          |    | (M)       | (FT) |           | DEG    | CDS  |               |          | SOIL                  | ROCK | MOSS | VASC | LITTER |
| F        | 1  | 1944      | 6380 | 5         | 160    | .58  | 1             | 3        | 84                    | 0    | 0    | 3    | 13     |
| F        | 2  | 1944      | 6380 | 4         | 215    | .02  | 1             | 1        | 43                    | 0    | 0    | 5    | 48     |
| F        | 3  | 1901      | 6240 | 11        | 60     | 1.97 | 2             | 4        | 48                    | 22   | 0    | 3    | 23     |
| F        | 4  | 1920      | 6300 | 12        | 265    | .23  | 2             | 4        | 60                    | 6    | 0    | 7    | 25     |
| F        | 5  | 1911      | 6270 | 4         | 135    | 1.00 | 3             | 1        | 77                    | T    | 2    | 1    | 18     |
| F        | 6  | 1883      | 6180 | 9         | 160    | .58  | 3             | 3        | 51                    | 0    | T    | 1    | 47     |
| F        | 7  | 1895      | 6220 | 11        | 265    | .23  | 2             | 4        | 48                    | 8    | T    | 11   | 29     |
| F        | 8  | 1883      | 6180 | 9         | 265    | .23  | 2             | 4        | 36                    | 29   | T    | 8    | 23     |
| F        | 9  | 1935      | 6350 | 25        | 200    | .09  | 3             | 4        | 44                    | 41   | 0    | 4    | 9      |
| F        | 10 | 1914      | 6280 | 9         | 30     | 1.97 | 4             | 1        | 45                    | 5    | T    | 5    | 40     |

LANDFORM CODES 1=RIDGE, 2=UPPER SIDE SLOPE, 3=MIDESLOPE, 4=LOWER SLOPE, 5=BENCH, 6=STREAMSIDE, & 7=OTHER AND TWO NUMBERS IMPLY TRANSITIONS.

ASPECT COSINE TRANSFORM AFTER BEERS, ET AL. (1966), WHERE NE=2 & SW=0

SOIL NO.'S CORRESPOND TO THE FOLLOWING SOIL TYPES (BNM REPORT, 1974):

1. RHYOLITE TUFF PARENT; SANDY LOAM, SHALLOW(3 INCHES).
2. RHYOLITE TUFF PARENT; SANDY LOAM(>4 INCHES)
3. PUMICE DEPOSITS.
4. TUFF OUTCROP, 5-30% SLOPES.
5. VERY STEEP TUFF OUTCROP; >30% slopes
6. STONY COLLUVIAL, FOOT OF CLIFFS; 15-75% SLOPES.
8. BASALT ROCK OUTCROP; 3-15% SLOPES.
10. BASALT ROCK OUTCROP; VERY STEEP SLOPES, >30%.

## Appendix B2. Canopy coverage of species present on Frijoles sites.

Table 16. Canopy coverage of species present on Frijoles sites sampled for evaluation of range conditions in Bandelier National Monument.

| -NO:                        | 1    | 2     | 3     | 4     | 5     | 6     | 7    | 8    | 9    | 10    | FREQ  | ABUND |
|-----------------------------|------|-------|-------|-------|-------|-------|------|------|------|-------|-------|-------|
| JUNIPERUS MONOSPERMA YNG R  | 3.00 | 9.00  | 7.00  | 2.00  | 5.00  | 3.00  | 1.00 | 2.00 | 0.00 | 7.00  | 90.0  | 3.90  |
| JUNIPERUS MONOSPERMA ADV R  | 8.00 | 20.00 | 10.00 | 21.00 | 11.00 | 5.00  | 7.00 | 8.00 | 4.00 | 8.00  | 100.0 | 10.20 |
| JUNIPERUS MONOSPERMA MATURE | 5.00 | 5.00  | 5.00  | 3.00  | 3.00  | 12.00 | 5.00 | 3.00 | 1.00 | 5.00  | 100.0 | 4.70  |
| PINUS EDULIS YNG REGEN      | 1.00 | 2.00  | 4.00  | 2.00  | 1.00  | 1.00  | 1.00 | 3.00 | 0.00 | 5.00  | 90.0  | 2.00  |
| PINUS EDULIS ADV REGEN      | 2.00 | 1.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 1.00 | 12.00 | 40.0  | 1.60  |
| PINUS EDULIS MATURE         | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| PINUS PONDEROSA - YNG REGEN | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| PINUS PONDEROSA - ADV REGEN | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| PINUS PONDEROSA - MATURE    | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| ARTEMESIA TRIDENTATA        | 0.00 | .01   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 10.0  | .00   |
| ARTEMESIA BIGELOVII         | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| CEROCARPUS MONTANUS         | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | .01  | .05  | .05   | 30.0  | .01   |
| CHRYSOETHAMNUS NAUSEOSUS    | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| CHRYSOETHAMNUS VILLOS       | .01  | 0.00  | 0.00  | 2.30  | 0.00  | 0.00  | .01  | 0.00 | 0.00 | 0.00  | 30.0  | .23   |
| FALLUGIA PARADOXA           | .01  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 2.10 | 0.00  | 20.0  | .21   |
| FENDLERIA RUPICOLA          | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| FORRESTIERIA NEOMEXICANA    | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| GUTIERREZIA MICROCEPHALA    | 0.00 | 3.90  | 2.60  | .01   | .36   | .20   | 3.10 | 2.20 | 1.60 | 1.20  | 90.0  | 1.52  |
| GUTIERREZIA SAROTHRAE       | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| GUTIERREZIA SPP             | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| HYMENOXYS RICHARDSONII      | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| PTILEA TRIFOLIATA           | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| QUERCUS UNDULATA            | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| QUERCUS SP.                 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| QUERCUS GAMBELLII-GRISEA    | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| QUERCUS GRISEA-GAMBELLII    | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | .01   | .01  | 2.60 | 1.80 | .05   | 50.0  | .45   |
| RHUS TRILOBATA              | .01  | 0.00  | 0.00  | .01   | 0.00  | .40   | 0.00 | 0.00 | .01  | .01   | 50.0  | .04   |
| RIBES CEREUM                | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| YUCCA ANGUSTISSIMA          | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | .01  | 0.00 | 0.00 | 0.00  | 10.0  | .00   |
| YUCCA BACCATA               | 0.00 | 0.00  | .01   | .01   | 0.00  | 0.00  | 2.00 | .05  | .05  | 0.00  | 50.0  | .21   |
| ANDROPOGON SACCHAROIDES     | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| ANDROPOGON SCOPARIUS        | 4.00 | 0.00  | 0.00  | .80   | 0.00  | 0.00  | .01  | .75  | 0.00 | 0.00  | 40.0  | .56   |
| ARISTIDA PURPUREA GLAUCA    | 0.00 | 0.00  | .02   | .01   | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 20.0  | .00   |
| ARISTIDA PURPUREA LONGISETA | .01  | 0.00  | 0.00  | 0.00  | 0.00  | .35   | 0.00 | 0.00 | 0.00 | .06   | 30.0  | .04   |
| ARISTIDA PURPUREA PURPUREA  | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| ARISTIDA PURPUREA ROBUSTA   | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| ARISTIDA PURPUREA LONGISETA | .01  | 0.00  | 0.00  | 0.00  | 0.00  | .35   | 0.00 | 0.00 | 0.00 | .06   | 30.0  | .04   |
| ARISTIDA SP.                | .01  | .20   | .02   | 0.00  | .32   | .35   | 2.40 | .08  | 0.00 | .06   | 80.0  | .34   |
| BOUTELOUA CURTIPENDULA      | 0.00 | 0.00  | .01   | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 10.0  | .00   |
| BOUTELOUA ERIOPODA          | 0.00 | 0.00  | .01   | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | .85  | 0.00  | 20.0  | .09   |
| BOUTELOUA GRACILIS          | .01  | 1.90  | 2.90  | 8.40  | .70   | 1.10  | 2.30 | 2.00 | 1.90 | 3.00  | 100.0 | 2.42  |
| BOUTELOUA HIRSUTA           | 0.00 | 0.00  | 0.00  | .01   | 0.00  | .40   | 3.80 | 2.90 | 0.00 | 0.00  | 40.0  | .71   |
| BROMUS SPP.                 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| CAREX SPP.                  | 0.00 | 0.00  | 0.00  | 0.00  | .01   | 0.00  | 0.00 | .05  | 0.00 | 0.00  | 20.0  | .01   |
| CAREX GEOPHILA              | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | .05  | 0.00 | 0.00  | 10.0  | .01   |
| CYPERUS FENDLERIANUS        | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| HILARIA JAMESII             | 0.00 | 0.00  | 1.00  | 0.00  | 0.00  | 0.00  | .40  | .01  | 0.00 | .05   | 40.0  | .15   |
| KOLERIA CRISTATA            | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | .05   | 10.0  | .01   |
| LYCURUS PHLEOIDES           | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | .96  | 0.00  | 10.0  | .10   |
| MUHLENBERGIA ARSENEI        | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| MUHLENBERGIA MONTANA        | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | .10   | 10.0  | .01   |
| MUHLENBERGIA TORREYI        | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | .01  | 0.00 | 0.00  | 10.0  | .00   |
| MUHLENBERGIA WRIGHTII       | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| ORYZOPSIS HYMENOIDES        | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| ORYZOPSIS MICRANTHA         | .01  | 0.00  | .01   | .01   | .01   | .01   | .01  | .30  | .01  | .01   | 90.0  | .04   |
| POA FENDLERIANA             | 0.00 | .90   | 0.00  | 0.00  | .01   | 0.00  | .60  | .30  | 0.00 | .30   | 50.0  | .21   |
| SCHEDONNARDUS PANICULATUS   | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| SITANION HYSTRIX            | .02  | .10   | 0.00  | .06   | .02   | .03   | .02  | .10  | .05  | 0.00  | 80.0  | .04   |
| SPOROBOLUS CRYPTANDRUS      | 0.00 | 0.00  | 0.00  | .01   | .35   | .01   | 0.00 | 0.00 | 0.00 | 0.00  | 30.0  | .04   |
| SPOROBOLUS CONTRACTUS       | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| SPOROBOLUS NEALLYI          | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| STIPA COLUMBIANA            | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| STIPA COMATA                | 0.00 | .06   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 10.0  | .01   |
| STIPA NEOMEXICANA           | 0.00 | 0.00  | .05   | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 10.0  | .01   |
| ALLIUM CERNUUM              | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| ANTENNARIA SPP.             | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | .90   | 10.0  | .09   |
| ARABIS PORPHYREA            | 0.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 0.0   | 0.00  |
| ARTEMESIA CARRUTHII         | .06  | 0.00  | 0.00  | .30   | 0.00  | .01   | 0.00 | 0.00 | .01  | .16   | 50.0  | .05   |
| ARTEMISIA DRACUNCULOIDES    | 0.00 | 0.00  | .01   | 0.00  | 0.00  | 0.00  | .30  | 0.00 | .01  | 0.00  | 30.0  | .03   |
| ARTEMISIA FRIGIDA           | 0.00 | 0.00  | .01   | 0.00  | 0.00  | 0.00  | 0.00 | 0.00 | 0.00 | 0.00  | 10.0  | .00   |
| ARTEMISIA LUDOVICIANA       | 0.00 | 0.00  | .01   | 0.00  | 0.00  | 0.00  | .01  | 0.00 | 0.00 | 0.00  | 20.0  | .00   |

Table 16. Continued

[illegible]

Appendix B3. Relative and summed values of selected species on Frijoles sites.

Table 17. Relative and summed cover values of selected species on site sampled for evaluation of range condition in Bandelier National Monument.

Tree cover was calculated using regression equations in Table 2; JUMO/BOCU HT grasses are Bouteloua curtipendula, B. eripoda, Hilaria jamesii, and Lycurus phleoides; PIED-JUMO/MUMO HT grasses are Muhlenbergia montana, Poa fendleriana, Koeleria cristata and Oryzopsis micrantha; relative C3 grass cover calculated as a fraction of total grass cover; relative cover of Gutierrezia microcephala ("GUMI") was calculated as a fraction of total understory cover.

|                           | -NO: | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | FREQ  | ABUND |
|---------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| P. EDULIS COVER           |      | 7.70  | .80   | .40   | .20   | .10   | .10   | .10   | .30   | 1.50  | 15.00 | 100.0 | 2.62  |
| J. MONOSPERMA COVER       |      | 35.00 | 5.30  | 41.00 | 39.00 | 29.00 | 56.00 | 32.00 | 21.00 | 10.00 | 36.00 | 100.0 | 30.43 |
| TOTAL UNDERSTORY COVER    |      | 5.25  | 10.34 | 6.91  | 12.68 | 2.82  | 4.72  | 17.54 | 9.72  | 10.59 | 6.21  | 100.0 | 8.68  |
| TOTAL SHRUB COVER         |      | .03   | 3.91  | 2.61  | 2.33  | .36   | .60   | 5.12  | 2.26  | 3.81  | 1.26  | 100.0 | 2.23  |
| TOTAL FORB COVER          |      | 1.17  | 3.27  | .30   | 1.06  | 1.04  | 2.22  | 2.88  | .91   | 3.01  | 1.38  | 100.0 | 1.72  |
| TOTAL GRASS COVER         |      | 4.05  | 3.16  | 4.00  | 9.29  | 1.42  | 1.90  | 9.54  | 6.55  | 3.77  | 3.57  | 100.0 | 4.73  |
| JUMO/BOCU GRASSES         |      | 0.00  | 0.00  | 1.02  | .01   | 0.00  | .40   | 4.20  | 2.91  | 1.81  | .05   | 70.0  | 1.04  |
| PIED-JUMO/MUMO GRASSES    |      | .01   | .90   | .01   | .01   | .02   | .01   | .61   | .60   | .01   | .46   | 100.0 | .26   |
| C3 GRASS COVER            |      | .03   | 1.06  | .06   | .07   | .05   | .04   | .63   | .75   | .06   | .36   | 100.0 | .31   |
| C4 GRASS COVER            |      | 4.02  | 2.10  | 3.94  | 9.22  | 1.37  | 1.86  | 8.91  | 5.75  | 3.71  | 3.21  | 100.0 | 4.41  |
| RELATIVE COVER C3 GRASSES |      | .01   | .34   | .02   | .01   | .04   | .02   | .07   | .11   | .02   | .10   | 100.0 | .07   |
| RELATIVE COVER GUMI       |      | 0.00  | .38   | .38   | .00   | .13   | .04   | .18   | .23   | .15   | .19   | 90.0  | .17   |