



Integrated Upland Vegetation and Soils Monitoring for Mesa Verde National Park

2007 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2009/007



ON THE COVER

Loamy Mesa Top Pinyon-Juniper Ecological Site at Mesa Verde National Park
Photograph courtesy of USGS Southwest Biological Science Center

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The corresponding author and project manager for this project is Jim DeCoster (jim_decoaster@nps.gov). Megan Swan is the botanist and crew leader for the project. Other contributions were made by the SCPN staff. The 2007 field crew consisted of Mare Nazaire and Jeff Organ.

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Introduction and Background

The National Park Service Vital Signs Monitoring Program was designed to monitor the status and trends in the condition of park natural resources, providing a strong scientific foundation for decision-making and resource conservation for park managers. The Southern Colorado Plateau Network (SCPN) has selected upland vegetation and soils as indicators of the overall condition of upland ecosystems.

SCPN and park staff selected the Loamy Mesa Top Pinyon-Juniper ecological site to monitor at Mesa Verde National Park (MEVE). The Mesa Top Pinyon-Juniper woodland is a unique ecosystem containing old-growth pinyon-juniper woodland. It faces numerous threats, including changing fire regimes, climate change, soil erosion, and invasion by non-native species.

In 2007 the SCPN Integrated Upland Monitoring program began upland monitoring at MEVE. The purpose of this report is to document monitoring activities in the 2007 field season and summarize the data that were collected.

Methods

Sampling Frame

The sampling frame was derived from the Loamy Mesa Top Pinyon-Juniper ecological site developed by the US Natural Resources Conservation Service (NRCS) (Figure 1). Ecological sites are based on soil survey data and represent landscapes with characteristic soils, hydrology, plant communities, and disturbance regimes and responses (Butler et al. 2003).

Various modifications were made to the representation of the ecological site using geographic information system (GIS) technology. These modifications were necessary to avoid:

1. areas that were not within the target ecological site (roads, buildings and other infrastructure)
2. areas that were expected to differ substantially from the norm and thus increase ecological variation, making it more difficult to detect trends (burned areas and areas that were mechanically treated)
3. areas where sampling was impractical (slopes $\geq 20\%$)
4. areas containing arthropod monitoring sites.

A set of spatially distributed sampling points was created using the Generalized Random-Tessellation Stratified (GRTS) design (Stevens and Olsen 2004). Park staff reviewed the sampling points and rejected those points that were situated in close proximity to archaeological sites. Before establishing a plot the Integrated Upland crew conducted an ecological site assessment for each sampling point, and rejected the site if it did not fall within the ecological site or contained a major disturbance.

Field Methods

The SCPN Upland Monitoring crew implemented monitoring at MEVE in 2007, establishing 10 plots in the Loamy Mesa Top Pinyon-Juniper ecological site. Plots were installed and read in August.

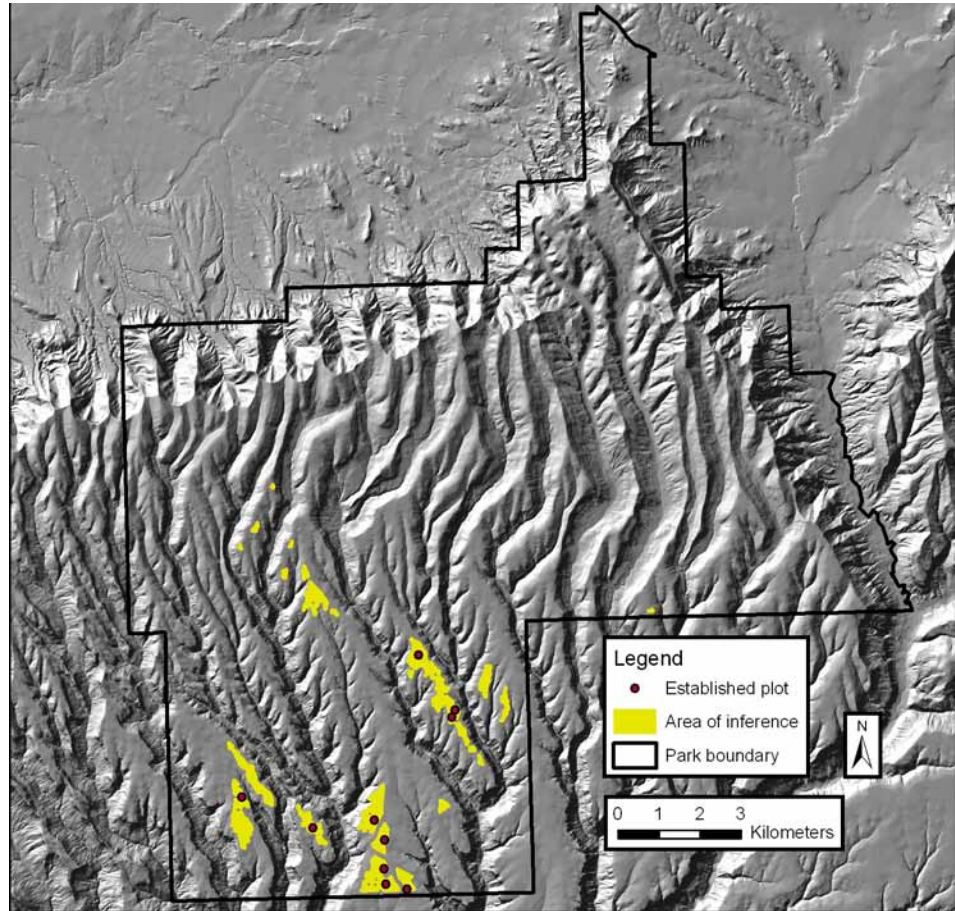


Figure 1. Sampling frame of Loamy Mesatop Pinyon-Juniper ecological site with the 10 plots established in 2007.

Field methodology is described in detail in the SCPN Integrated Upland Protocol (DeCoster et al., in review). Plots are 0.50 ha in size, measuring 71 m x 71 m. Shrub and herbaceous vegetation data and soil data are collected on three 50 m transects, spaced 25 meters apart. Overstory tree and sapling data are collected in nested subplots located between two of the transects.

Shrub and Herbaceous Vegetation

Along each transect, shrub and herbaceous vegetation are sampled at 10 m intervals using five sets of nested quadrats. The largest quadrat size is 10 m² (2 m x 5 m) with three smaller quadrats nested inside (0.01 m², 0.1 m², 1 m²). The presence of individual vascular species is recorded for each nested sub-quadrat. For each individual herbaceous and shrub species, percent cover is estimated in the 10 m² quadrat and recorded as one of 12 cover classes. Percent cover for functional groups (e.g. perennial grasses, forbs, shrubs) is also estimated in the largest quadrat and recorded as one of 12 cover classes.

Tree Overstory and Understory

Overstory trees are those greater than or equal to 15 cm in diameter and are measured within a 20 x 50 m (0.1 ha) subplot between two of the transects. Due to the multi-stemmed growth form

of *Juniperus* spp, diameter at root crown (drc) was used for measuring size. For all other species, diameter at breast height (dbh) was used. For each individual tree, species, diameter, and status (live or dead) are recorded. Saplings (>2.5 and <15 cm dbh) are sampled in a 10 x 25 m subplot, and are tallied by species and size class. Tree seedlings are sampled in the 10 m² quadrats and are tallied by species and size class.

Soil Stability and Hydrologic Function

Basal gaps are measured along each of the transects to provide a measure of the amount of bare soil. A soil aggregate stability test is conducted, using 18 soil samples collected along the transects. Percent cover of soil surface features are estimated in the 1 m² quadrats in conjunction with the shrub and herbaceous data and recorded as one of 12 cover classes.

Data Summary

The sample unit for summary and analysis is the plot, hence, all data are summarized at the level of the plot. In order to calculate summary statistics for the ecological site, means and standard deviations are calculated from the plot means.

For herbaceous and shrub vegetation, cover and frequency are calculated for each species from the cover class midpoints. The mean cover is calculated for each plot, and the mean and standard deviation (SD) and range of cover (where that species occurs) are calculated for the ecological site. The species frequency is calculated for quadrats (mean percentage of quadrats per plot where the species occurs) and for plots (percentage of plots where the species occurs). The mean cover and SD of functional groups and surface features are calculated in a similar fashion.

Four diversity measures are calculated for herbaceous and shrub species (Magurran 1988). Calculations are made for all species in the site, and recalculated for native species only.

1. Species richness (S) is the number of species at a given spatial scale, and is calculated at all spatial scales (i.e. for each nested quadrat size, for the plot, and for the ecological site).
2. The Shannon Diversity Index (H') provides a measure of species diversity that takes into account the relative abundance of each species:

$$- \sum_{i=1}^n p_i \ln p_i \quad (1)$$

where p_i is the mean cover of each species.

3. Species evenness (J') is a measure of the degree to which all species are equal in abundance:

$$H' / \ln(S) \quad (2)$$

4. Beta diversity (β_w) is a measure of within-ecological site heterogeneity:

$$S_e / (S_p - 1) \quad (3)$$

where S_e is the total number of species found in the ecological site and S_p is the mean number of species found per plot.

Tree basal area is calculated for each overstory tree species in terms of m²/ ha. Tree density (stems/ha) is calculated for all species and size classes for overstory, sapling and seedling layers. Mean diameter of overstory trees is also calculated by species.

Five calculations are made for the basal gap data: (1) median basal gap size, (2) percentage of transects comprised of gaps, (3) percentage of transects comprised of gaps $\geq$ 50 cm, (4) number of gaps by size class, and (5) total number of gaps. Mean and SD are calculated for each metric.

The mean soil aggregate stability index is calculated along with the standard deviation. This index ranges between 1 and 6, where 1 indicates low aggregate stability and 6 indicates high stability. The index is also calculated separately for samples with vegetative cover and those without vegetative cover.

Results

Herbaceous and Shrub Vegetation

The herbaceous and shrub vegetation of the MEVE Loamy Mesa Top Pinyon-Juniper ecological site is dominated by a combination of grasses, shrubs, and succulents. Table 1 lists the 15 most abundant species and all non-native species. *Poa fendleriana* (muttongrass) is the species with the greatest cover (4.596%), followed by the shrub *Purshia tridentata* (antelope bitterbrush), and the succulents *Yucca baccata* (banana yucca), and *Opuntia* spp (prickly pear cactus). Despite its relatively high cover, *Artemisia tridentata* (big sagebrush) is locally abundant, only occurring in one plot. Common forbs include *Penstemon linarioides* (toadflax penstemon), *Petradoria pumila* (rock goldenrod), *Cordylanthus wrightii* (Wright's bird's beak) and *Eriogonum racemosum* (redroot buckwheat). Species composition is variable among plots; many species have wide ranges in cover, and standard deviations that exceed their means. A complete species list is found in Appendix A, which includes common names, families, mean foliar cover and plot frequency.

Table 1. Cover and Frequency of Shrub and Herbaceous Species. Foliar cover of the fifteen most abundant vascular species, expressed as a percentage. All non-native species are included, and are indicated by an asterisk. The range in foliar cover is provided for where the species occurs. (Many species do not occur in every plot of an ecological site; for these species, the minimum range of 0% is not provided).

Species	Foliar Cover			Frequency (%)	
	Mean	Standard Deviation	Range	Quadrat	Plot
<i>Poa fendleriana</i>	4.596	3.077	0.080-10.017	96.67	100
<i>Purshia tridentata</i>	1.297	1.306	0.050-3.610	48.00	90
<i>Artemisia tridentata</i>	0.760	2.404	7.603-7.603	10.00	10
<i>Yucca baccata</i>	0.651	0.703	0.003-2.063	32.00	80
<i>Penstemon linarioides</i>	0.462	0.468	0.023-1.520	78.67	100
<i>Cercocarpus montanus</i>	0.104	0.214	0.020-0.510	10.00	30
<i>Arabis fendleri</i>	0.054	0.109	0.003-0.360	20.67	90
<i>Phlox hoodii</i>	0.031	0.062	0.003-0.153	10.67	40

Table 1 *continued...*

Species	Foliar Cover			Frequency (%)	
	Mean	Standard Deviation	Range	Quadrat	Plot
<i>Cordylanthus wrightii</i>	0.029	0.033	0.003-0.100	27.33	80
<i>Comandra umbellata</i>	0.020	0.050	0.003-0.157	10.00	30
<i>Bromus tectorum</i> *	0.007	0.011	0.003-0.030	6.67	50
<i>Ceratocephala testiculata</i> *	0.005	0.009	0.003-0.030	10.00	50
<i>Sisymbrium altissimum</i> *	0.002	0.005	0.017-0.017	3.33	10
<i>Carduus nutans</i> *	0.001	0.002	0.003-0.003	2.00	30
<i>taraxacum officinale</i> *	0.001	0.001	0.003-0.003	1.32	20
<i>Erodium cicutarium</i> *	<0.001	0.001	0.003-0.003	0.67	10

Six non-native species are found in the plots, although none in high abundance. *Bromus tectorum* (cheatgrass) and *Ceratocephala testiculata* (curve-seed butterwort) are present in half of the plots, *Carduus nutans* (nodding thistle) occurs in 30% of the plots, *taraxacum officinale* (dandelion) occurs in two plots, and *Sisymbrium altissimum* (tumble mustard) and *Erodium cicutarium* (stork's bill) each occur in one plot.

The cover of the functional groups confirms the dominance of perennial grass: mean cover of perennial grass is 4.67% (Table 2). Shrubs and cacti/succulents comprise lower cover: 2.30%, and 1.29%, respectively. Standard deviations and ranges are generally lower than those found with individual species, but perennial grass cover exhibits high variability. Cover of standing dead herbaceous and standing dead woody plant material both ranged between 2 and 3%.

A total of 57 species are recorded in this ecological site, with a mean species richness of 19.20 species per plot (Table 3a.). Shannon diversity is 1.346, which is low. Values generally fall between 1.5 and 3.5 (Margalef 1972). Evenness is moderate—0.458. The Evenness Index is bounded by 0 and 1, where a value of 1 indicates that all species are of equal abundance. Beta diversity is 3.132, which is moderate. High values (greater than 5) indicate large differences among plots, whereas low

Table 2. Cover of Functional Groups. The cover of functional groups is expressed as a percentage. Components of total live vegetation are not strictly additive due to several factors: calculations are made from cover class midpoints, various components may overlap, and cover values are estimated independently.

Functional Groups	Foliar Cover		
	Mean	Standard Deviation	Range
Perennial Grass, Graminoids	4.67	3.13	0.08-10.02
Annual Grass	<0.01	0.01	0-0.03
Forbs	0.94	0.77	0.17-2.34
Shrubs, Dwarf Shrubs, Woody Vines	2.30	2.61	0-8.80
Cacti, Succulents	1.29	0.10	0-3.12
Standing Dead Herbaceous	2.28	1.45	0.63-5.77
Standing Dead Woody	2.10	1.02	0.34-3.66

values (less than 1) indicate similar composition (McCune and Grace 2002). When these indices are recalculated using only native species, they change little (Table 3b). The species area curve (Figure 2) illustrates how species accumulate with increased area. The concave shape of the curve seems to indicate low diversity at finer spatial scales.

Trees

Abundance of trees is expressed in terms of density and basal area. Table 4 and Figures 3 and 4 illustrate density and basal area of overstory trees by species and size class. Only two tree species are found in the plots: *Juniperus osteosperma* (Utah juniper) and *Pinus edulis* (two-needle pinyon).

Table 3. Species Diversity. Species diversity is expressed as mean richness per plot, the total richness for the ecological site, Shannon-Weaver Diversity Index, Evenness index and Beta Diversity. Metrics are presented for all species and for native species.

Table 3a. All Species					Table 3b. Native Species				
Metric	Plot		Ecological Site		Metric	Plot		Ecological Site	
	Mean (SD)	Range	Metric			Mean (SD)	Range	Metric	
Richness	19.2 (5.1)	14–29	Richness	57	Richness	17.1 (4.8)	13-27	Richness	55
Shannon Diversity	1.346 (0.347)		β Diversity	3.132	Shannon Diversity	1.324 (0.334)		β Diversity	3.254
Evenness	0.458 (0.101)				Evenness	0.469 (0.101)			

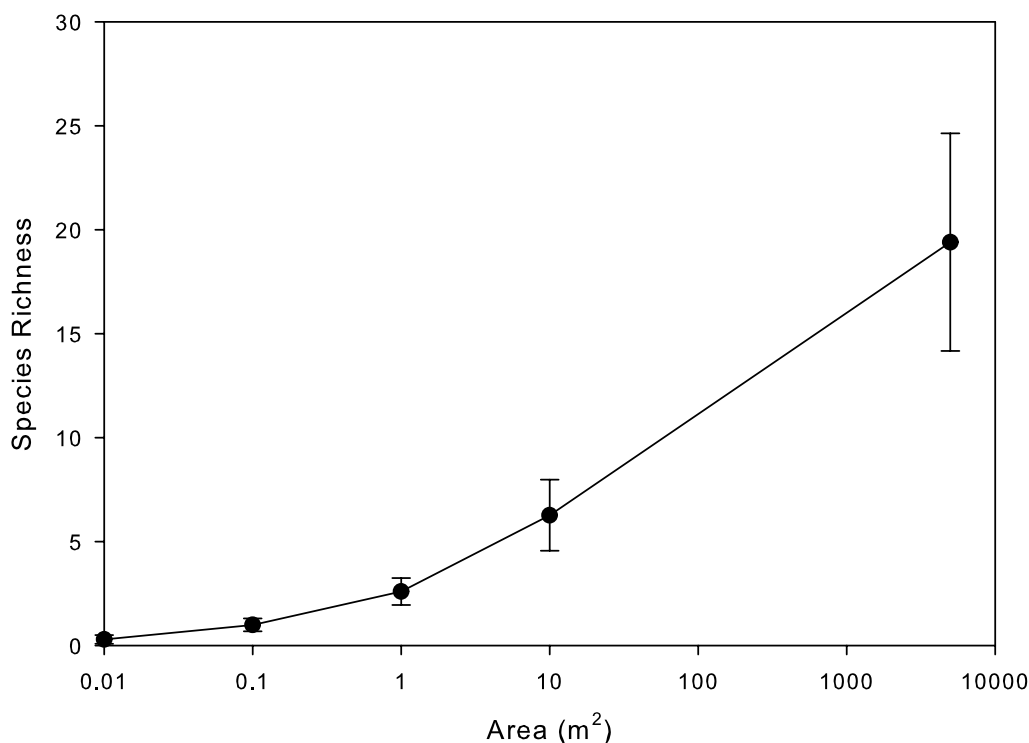


Figure 2. Mean Species Richness at 5 spatial scales. Estimates are based on 10 plots with 15 quadrats each. The point at 5000 m² represents plot species richness. Error bars represent 1 standard deviation.

Juniper is much more abundant than pinyon: its density is 280.0 stems/ha, as opposed to pinyon with a density of 42.0 stems/ha. The basal area for juniper is 27.1 m²/ha., while the basal area for pinyon is 1.21 m²/ha. The standard deviations of basal areas are relatively low, indicating low variability among plots. Snags occur in moderate numbers: 107.0 stems/ha, with a basal area of 6.14 m²/ha. The majority of these snags are *Juniperus osteosperma*; however, the snag density of pinyon exceeds the density of living pinyon trees. The size structure of juniper demonstrates a large number in the smaller size classes, and decreasing number with increasing size. Pinyon, on the other hand, occurs only in the smallest two size classes.

Seedling and sapling densities provide insight into the structure and dynamics of the forest. Both tree species have a moderate number of seedlings and sapling in each of the size classes, with pinyon having higher densities in all size classes. (Table 4, Figures 5 and 6). The large error bars indicate that these densities are variable among plots. Figure 7 shows the density of both overstory and sapling size classes, indicating a typical decline in density with increasing tree diameter.

Soil Stability and Hydrologic Function

The amount of exposed soil is monitored in two ways: estimates of soil surface feature cover in

Table 4. Density and Basal Area of Trees by Species and Size Class. Density is provided for seedlings (< 2.5 cm diameter), saplings (2.5-14.9 cm diameter) and overstory trees (≥15 cm diameter), and is expressed in stems/ha. Basal area is provided for overstory trees and snags, and is expressed as m²/ha. Mean diameter of trees is provided.

Species	Seedling Density	Sapling Density	Overstory Density	Snag Density	Overstory Basal Area	Snag Basal Area	Mean Diameter
<i>Juniperus osteosperma</i>	1040.0	280.0	280.0	60.0	27.1	4.4	31.8
<i>Pinus edulis</i>	1713.3	316.0	42.0	47.0	1.2	1.7	18.5
Total	2753.3	596.0	322.0	107.0	28.3	6.1	30.2

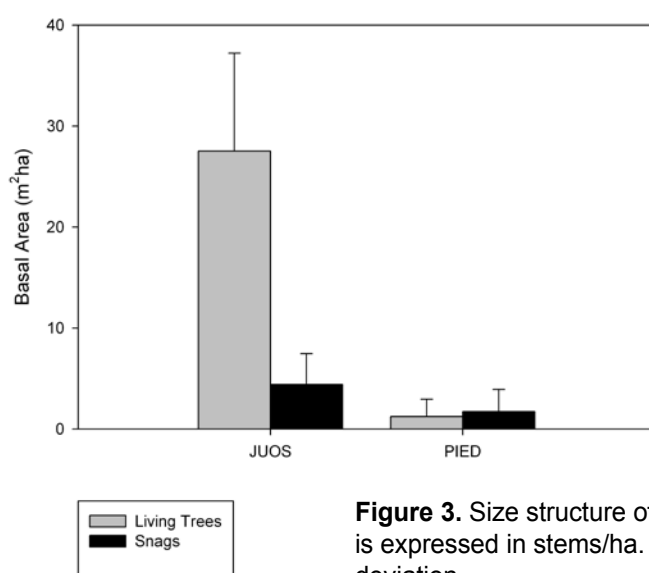


Figure 3. Size structure of the overstory tree species. Density is expressed in stems/ha. Error bars represent 1 standard deviation.

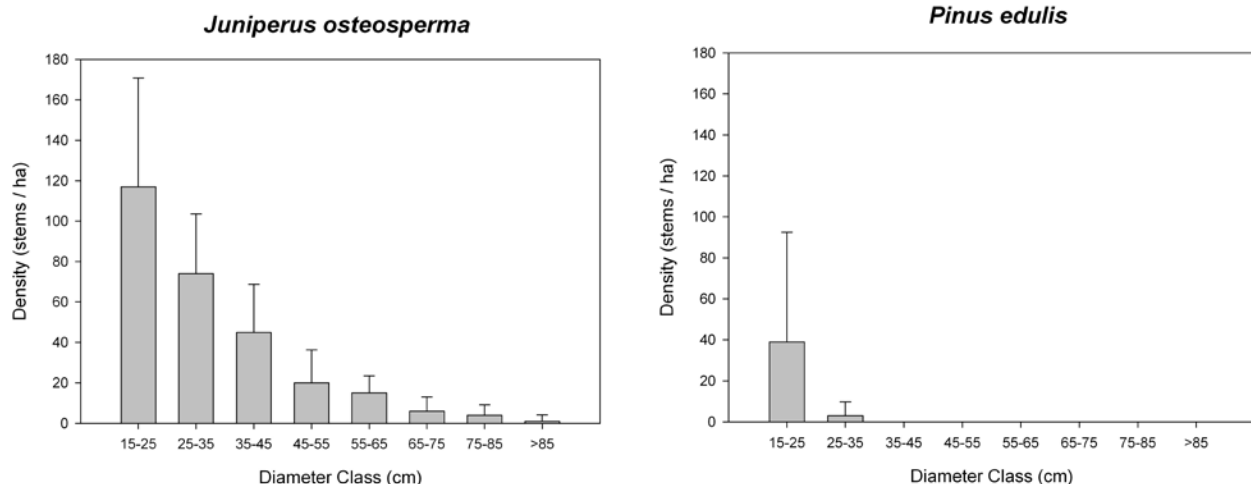


Figure 4. Size structure of the overstory tree species. Density is expressed in stems/ha. Error bars represent 1 standard deviation.

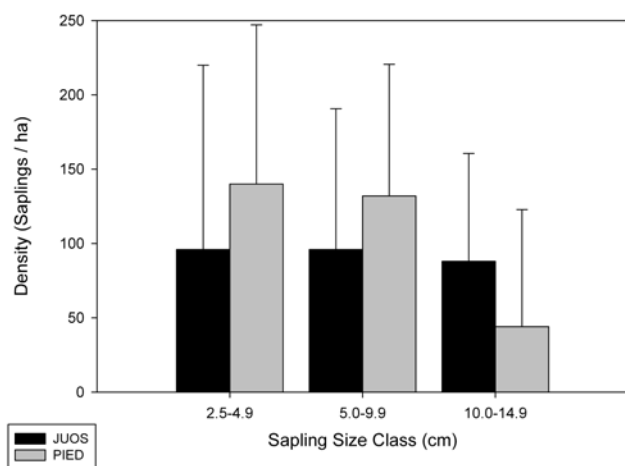


Figure 5. Sapling density. Density is expressed as saplings/ha. Species codes are as follow: JUOS – *Juniperus osteosperma*, PIED- *Pinus edulis*. Error bars represent 1 standard deviation.

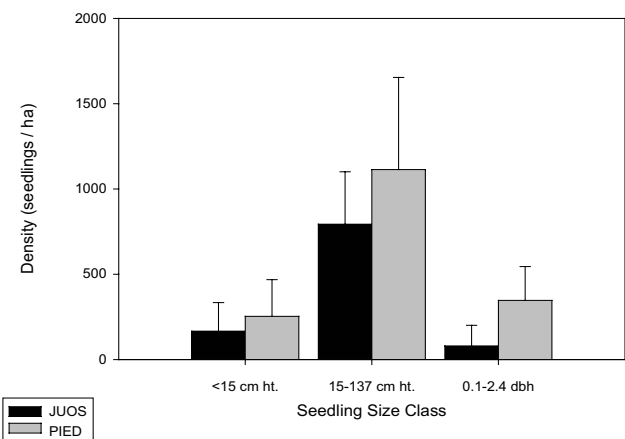


Figure 6. Seedling Density. Density is expressed as seedlings/ha. Species codes are as follows: JUOS – *Juniperus osteosperma*, PIED- *Pinus edulis*. Error bars represent 1 standard deviation.

quadrats, and basal gap intercepts. The cover of surface features (Table 5) shows that the dominant surface features are duff and litter (58.16%), undifferentiated crust (18.46%), and cyanobacterial crust (8.65%)(Figure 8). Cover of live plant bases, woody debris, and moss comprise between 1 and 5%. Rock components, bare soil, dead woody bases, and lichen occupy less than 1%. Variability of the surface features are generally low relative to their means.

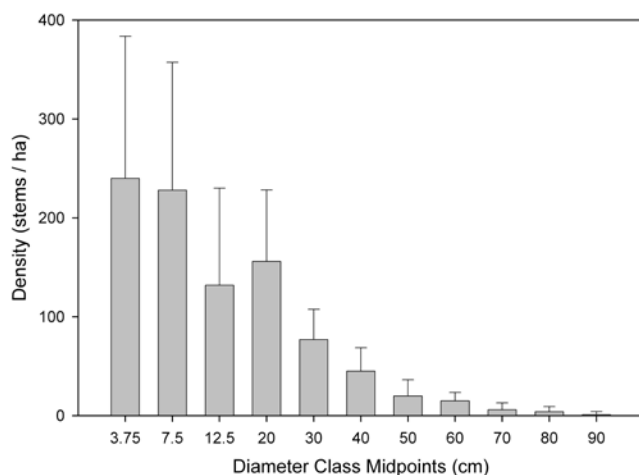


Figure 7. Size structure of overstory trees and saplings. Density is expressed in stems/ha. Error bars represent 1 standard deviation.

Table 5. Surface Features Cover. The cover of surface features is expressed as a percentage. The features do not add up to 100% because the calculations are made from cover class midpoints, and the estimations have observer error.

Surface Features	Cover (%)		
	Mean	SD	Range
Live Plant Base	3.02	1.81	0.95-7.12
Dead Woody Base	0.28	0.39	0-1.19
Bare Soil	0.84	0.74	0.10-2.62
Duff and Litter	58.16	13.62	25.07-72.33
Undifferentiated Crust	18.48	12.86	3.09-50.50
Moss	2.11	1.69	0.31-6.37
Lichen	0.15	0.26	0-0.84
Cyanobacteria	8.65	4.65	3.09-14.90
Fine Gravel (0.2 cm- 2 cm)	0.01	0.01	0-0.03
Coarse Gravel (2 cm – 7.5 cm)	0.06	0.10	0.0-0.30
Cobble (7.5 cm – 25 cm)	0.14	0.42	0-1.33
Stone, Boulder, Bedrock (>25 cm)	0.00	0.00	0
Woody Debris	1.42	0.76	0.35-2.47

Table 6. Basal Gaps. Basal gaps are measured along three 50 m transects in each plot. The mean and standard deviation are calculated for the 10 plots in the ecological site.

Metric	Mean	(SD)
Gap Number	52.8	(21.2)
Median Gap Size (cm)	188.9	(105.6)
% of Transect in Gaps	97.6	(0.1)
% of Transect in Gaps ≥ 50 cm	95.6	(0.2)

Table 7. Soil Stability. Mean soil stability rating by cover. 18 points were measured in each of the 10 plots. Ratings range from 1-6, with 1 being the lowest stability and 6 being the highest.

Soil Stability Rating	Mean	(SD)
Cover	4.51	(0.75)
No Cover	4.27	(0.94)
Total	4.43	(0.71)

The basal gap data (Table 6) show that 97.6% of transect length is gap. Consequently, 2.4% intersect plant bases. (Note the similarity between quadrat estimates and those resulting from basal gap intercept measurements). The gaps are few and large: 52.8 per plot with a median size of 188.9 cm. When only gaps greater than 50 cm are considered in the percentage of transect in gaps, the figure only drops a small amount, from 97.6% to 95.6%. The size distribution of gaps (Figure 9) demonstrates the predominance of large size gaps.

Soil aggregate stability provides a measure of the erodibility of soil (Table 7). The mean rating is 4.43, indicating moderately high stability. Soil occurring under vegetative cover has a slightly higher aggregate stability rating than bare soil without cover: 4.51 compared to 4.27.

Discussion

These data represent the first year baseline of sampling for the Loamy Mesatop Pinyon-Juniper ecological site of MEVE. The data indicate that the understory has a moderate diversity of grasses, shrubs, and succulents. The higher diversity at coarser spatial scales and the moderately high beta diversity suggest high diversity on the landscape scale.

The tree data suggest a healthy size structure, with abundant saplings and seedlings. *Pinus edulis* exhibits a moderately high density of snags, indicating recent mortality event(s). This species, however, is still well represented in the understory, and it appears that regeneration will compensate for this mortality.

Soil aggregate stability and the amount of exposed soil are means by which to quantify the potential for soil erosion. Even though the gap data demonstrate extensive areas occupied by large basal gaps, the potential for soil erosion is buffered by the high cover of biological crusts and duff/litter, coupled with moderately high soil aggregate stability.

Our plan is to sample the quadrats and gap intercept transects annually for the next 3-5 years to determine the range of variability for key metrics. Power analysis will then be used to determine the total number of plots necessary to detect change in the key metrics. A temporal sampling design will then be implemented, with the installation of additional plots in subsequent years. Each year's data will be compared to the previous year's data to demonstrate change in vegetation composition and structure, and change in hydrologic function and soil stability. More thorough trend analyses will be conducted once sufficient data have been collected.



Figure 8. Photopoint from Loamy Mesatop Pinyon Juniper plot. Note the biological soil crusts in the foreground.

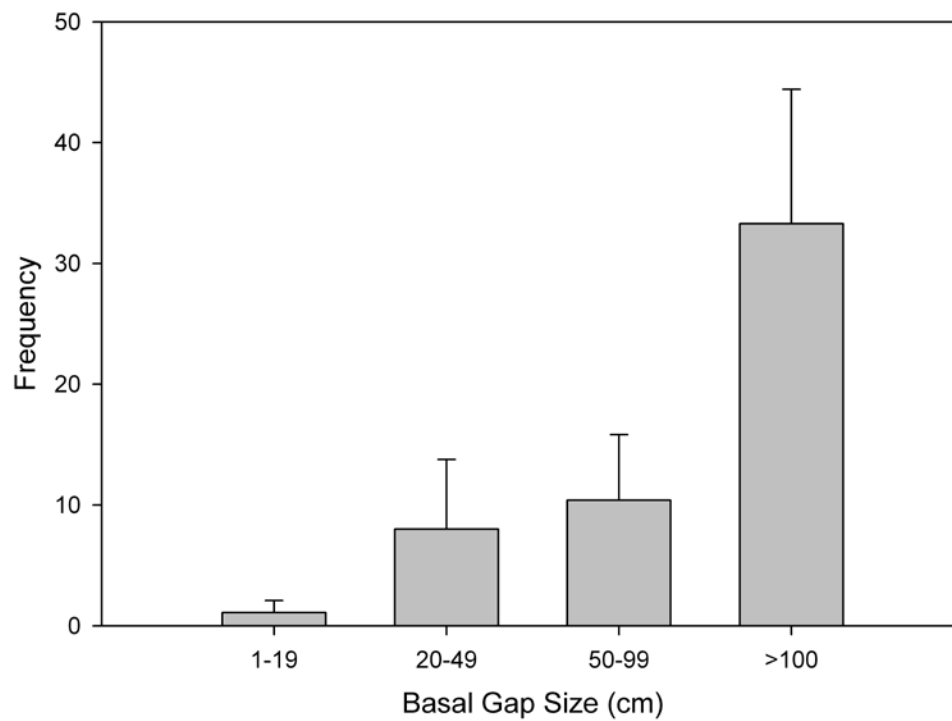


Figure 9. Basal Gap Size Distribution. The frequency of basal gaps is shown for 4 size classes. Error bars represent 1 standard deviation.

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Appendix A

Complete species list with foliar cover and frequency values for herbaceous and shrub species, and overstory basal area and frequency of tree species. Non-native species are indicated by an asterisk.

Species	Common Name	Family	Foliar Cover (%)	Plot Frequency (%)
Herbaceous and Shrub Species				
<i>Achnatherum hymenoides</i>	Indian ricegrass	Poaceae	0.009	10
<i>Amelanchier utahensis</i>	Utah serviceberry	Rosaceae	0.002	10
<i>Androsace septentrionalis</i>	pygmy flower rockjasmine	Primulaceae	0.000	10
<i>Antennaria rosea</i>	rosy pussytoes	Asteraceae	0.000	10
<i>Arabis fendleri</i>	Fendler rockcress	Brassicaceae	0.054	90
<i>Arabis holboellii</i>	Holboell's rockcress	Brassicaceae	<0.001	10
<i>Artemisia tridentata</i>	big sagebrush	Asteraceae	0.760	10
<i>Astragalus spp.</i>	milkvetch	Fabaceae	0.008	50
<i>Bromus tectorum</i> *	cheatgrass	Poaceae	0.007	50
<i>Carduus nutans</i> *	nodding thistle	Asteraceae	0.001	30
<i>Ceratocephala testiculata</i> *	curve-seed butterwort	Ranunculaceae	0.005	50
<i>Cercocarpus montanus</i>	alderleaf mountain mahogany	Rosaceae	0.104	30
<i>Chenopodium album</i>	lambsquarters	Chenopodiaceae	0.004	50
<i>Chrysothamnus depressus</i>	longflower rabbitbrush	Asteraceae	0.119	30
<i>Comandra umbellata</i>	bastard toadflax	Santalaceae	0.020	30
<i>Cordylanthus wrightii</i>	Wright bird's-beak	Scrophulariaceae	0.029	80
<i>Dalea sp.</i>	prairie clover	Fabaceae	0.001	10
<i>Descurainia sophia</i>	herb sophia	Brassicaceae	0.008	40
<i>Draba reptans</i>	Carolina draba	Brassicaceae	0.017	60
<i>Echinocereus sp.</i>	hedgehog cactus	Cactaceae	<0.001	10
<i>Elymus elymoides</i>	squirreltail	Poaceae	0.019	40
<i>Erigeron divergens</i>	spreading fleabane	Asteraceae	0.006	10
<i>Eriogonum racemosum</i>	redroot buckwheat	Polygonaceae	0.028	80
<i>Eriogonum umbellatum</i>	sulfur flower buckwheat	Polygonaceae	0.002	30
<i>Erodium cicutarium</i> *	stork's bill	Geraniaceae	0.000	10
<i>Escobaria vivipara</i>	spiny star	Cactaceae	0.000	10
<i>Gutierrezia sarothrae</i>	broom snakeweed	Asteraceae	0.021	10
<i>Heterotheca villosa</i>	hairy false goldenaster	Asteraceae	0.001	20
<i>Ipomopsis aggregata</i>	skyrocket gilia	Polemoniaceae	<0.001	10
<i>Koeleria macrantha</i>	junegrass	Poaceae	0.013	30
<i>Lepidium montanum</i>	mountain pepperweed	Brassicaceae	0.001	10
<i>Lesquerella rectipes</i>	straight bladderpod	Brassicaceae	0.004	10
<i>Lupinus ammophilus</i>	sand lupine	Fabaceae	0.002	30

Appendix A *continued*

Species	Common Name	Family	Foliar Cover (%)	Plot Frequency (%)
<i>Machaeranthera canescens</i>	hoary tansyaster	Asteraceae	0.009	60
<i>Opuntia</i> spp.	prickly pear	Cactaceae	0.636	90
<i>Packera multilobata</i>	lobeleaf groundsel	Asteraceae	<0.001	10
<i>Pedicularis centranthera</i>	dwarf lousewort	Scrophulariaceae	0.001	20
<i>Penstemon barbatus</i>	beardlip penstemon	Scrophulariaceae	0.017	60
<i>Penstemon linarioides</i>	toadflax penstemon	Scrophulariaceae	0.462	100
<i>Petradoria pumila</i>	rock goldenrod	Asteraceae	0.158	50
<i>Phlox gracilis</i>	slender phlox	Polemoniaceae	0.009	20
<i>Phlox hoodii</i>	Hood's phlox	Polemoniaceae	0.031	40
<i>Phlox longifolia</i>	longleaf phlox	Polemoniaceae	0.002	10
<i>Poa fendleriana</i>	muttongrass	Poaceae	4.596	100
<i>Polygonum douglasii</i>	Johnston's knotweed	Polygonaceae	0.013	100
<i>Purshia tridentata</i>	antelope bitterbrush	Rosaceae	1.297	90
<i>Quercus gambelii</i>	Gambel oak	Fagaceae	0.005	10
<i>Sisymbrium altissimum</i> *	tumble mustard	Brassicaceae	0.002	10
<i>Sphaeralcea coccinea</i>	scarlet globemallow	Malvaceae	0.001	10
<i>Streptanthus cordatus</i>	heartleaf twistflower	Brassicaceae	<0.001	10
<i>Taraxacum officinale</i> *	dandelion	Asteraceae	0.001	20
<i>Yucca baccata</i>	banana yucca	Agavaceae	0.651	80
<i>Unknown MEVE08032007-1</i>			<0.001	10
<i>Unknown MEVE08032007-2</i>			<0.001	10
Tree Species				
Species	Common Name	Family	Basal Area (m ² /ha)	Plot Frequency (%)
<i>Juniperus osteosperma</i>	Utah juniper	Cupressaceae	27.52	100
<i>Pinus edulis</i>	two-needle pinyon	Pinaceae	1.23	100