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Stereo Photo Series for Quantifying Natural Fuels

Volume IX: Oak/Juniper Types in Southern Arizona and New Mexico

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ABSTRACT

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A series of single and stereo photographs display a range of natural conditions and fuel loadings in evergreen and deciduous oak/juniper woodland and savannah ecosystems in southern Arizona and New Mexico. This group of photos includes inventory data summarizing vegetation composition, structure, and loading; woody material loading and density by size class; forest floor coverage and loading; and various site characteristics. The natural fuels photo series is designed to help land managers appraise fuel and vegetation conditions in natural settings.

Keywords: Woody material, biomass, fuel loading, natural fuels, oak/juniper woodlands, Arizona white oak, *Quercus arizonica*, Emory oak, *Quercus emoryi*, alligator juniper, *Juniperus deppeana*, pointleaf manzanita, *Arctostaphylos pungens*, grama, *Bouteloua* spp.

COOPERATORS

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CONTENTS

2	What Is the Natural Fuels Photo Series?
3	Why Is the Photo Series Needed?
3	How Was the Photo Series Developed?
3	Photographs
3	Photograph and Information Arrangement
4	Site and Stand Information
4	Woody Material
5	Forest Floor Information
5	Understory Vegetation
5	Saplings and Trees
6	Selected Shrub Species
6	Using the Photo Series
7	Species List
8	Metric Conversions
8	Literature Cited
10	Oak/Juniper Woodland Photo Series

WHAT IS THE NATURAL FUELS PHOTO SERIES?

The first phase of the natural fuels photo series was a collection of six volumes, each representing a region of the United States. The second phase of the natural fuels photo series included new volumes (volumes VII and VIII) and supplemental series for existing volumes (volumes IIa, Va, and VIa). Volume I included sites in mixed-conifer, western juniper, sagebrush, and grassland ecosystems in the interior Pacific Northwest. Volume II included sites in black and white spruce ecosystems in Alaska, and volume IIa included sites in hardwood ecosystems undergoing succession to spruce. Volume III included sites in lodgepole pine, quaking aspen, and gambel oak ecosystems in the Rocky Mountains. Volume IV included sites in pinyon-juniper, sagebrush, and chaparral ecosystems in the Southwest. Volume V included sites in red and white pine, northern tallgrass prairie, and mixed oak ecosystems in the Midwest, and volume Va included sites in jack pine ecosystems. Volume VI included sites in longleaf pine, pocosin, and marsh grass ecosystems in the Southeast, and volume VIa included sites in sand hill, sand pine scrub, and white pine-invaded hardwood ecosystems. Volume VII included sites in Oregon white oak, California deciduous oak, and mixed-conifer with shrub ecosystems in Washington, Oregon, and California. Volume VIII included sites in hardwood, pitch pine, and red spruce/balsam fir ecosystems in the Northeast.

Generally, sites include wide-angle and stereo-pair photographs supplemented with information on living and dead fuels, vegetation, and stand structure and composition within the area visible in the photographs (fig. 1). This volume (Volume IX) continues the natural fuels photo series and includes sites in oak/juniper ecosystems in southern Arizona and New Mexico. The sites in this volume provide a basis for appraising and describing woody material, vegetation, and stand conditions in many oak/juniper ecosystems throughout Arizona and New Mexico.

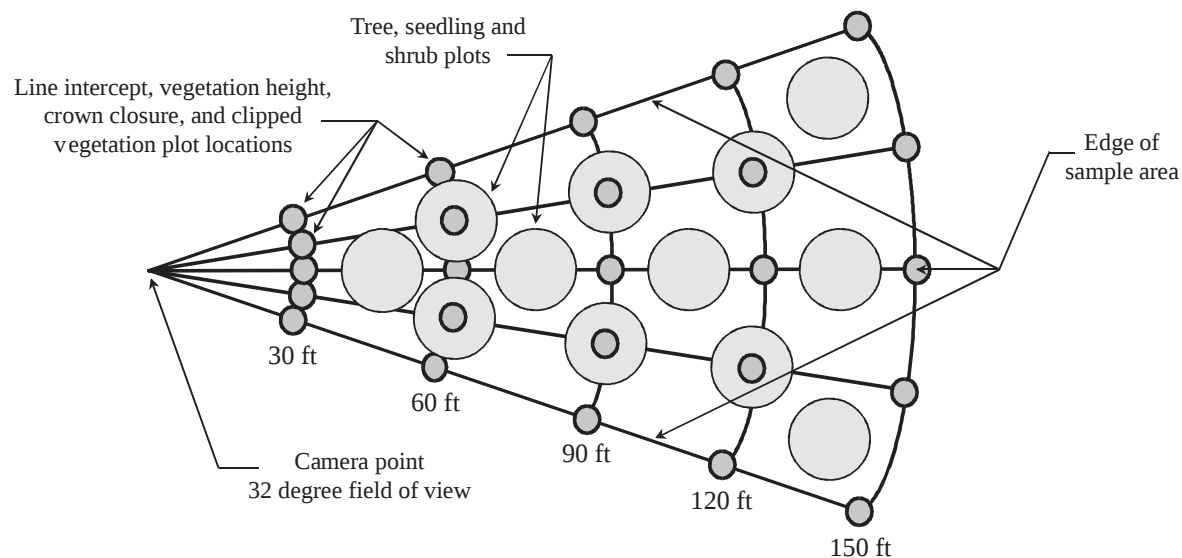


Figure 1--Photo series sample area layout. Forty random azimuth line transects (one at each point on the 30- and 150-foot arcs, and two at each point on the 60-, 90-, and 120-foot arcs) and 12 clipped vegetation plots (two to three per arc) were located within the sample area. Trees, shrubs and seedlings were inventoried on 12 systematically located sample plots, or within the entire sample area if of low density.

WHY IS THE PHOTO SERIES NEEDED?

These photo series are land management tools that can be used to assess landscapes through appraisal of living and dead woody material and vegetation (i.e., fuels) and stand characteristics. Once an assessment has been completed, stand treatment options, such as prescribed fire or harvesting, can be planned and implemented to better achieve desired effects while minimizing negative impacts on other resources.

The photo series has application in several branches of natural resource science and management. Inventory data such as these can be used as inputs for evaluating animal and insect habitat, nutrient cycling, and microclimate, for example. Fire managers will find these data useful for predicting fuel consumption, smoke production, fire behavior, and fire effects during wildfires and prescribed fires. In addition, the photo series can be used to appraise carbon sequestration, an important factor in predictions of future climate, and to link remotely sensed signatures to live and dead fuels on the ground.

Ground inventory procedures that directly measure site conditions (e.g., fuel loading and arrangement, vegetation structure and composition, etc.) exist for most ecosystem types and are useful when a high degree of accuracy is required. Ground inventory is time consuming and expensive, however. Photo series can be used to make quick, easy, and inexpensive determinations of fuel quantities and stand conditions when less precise estimates are acceptable.

HOW WAS THE PHOTO SERIES DEVELOPED?

Sites photographed for the series in this volume were selected to represent a range of conditions in oak/juniper woodland ecosystems in southern Arizona and New Mexico. Photographs were taken, and fuel loading, stand structure, and composition data were collected by using the procedures of Maxwell and Ward (1980) as a guide. The sites in this series are ordered by increasing density of trees greater than 4 inches in diameter at breast height (d.b.h.).¹

PHOTOGRAPHS

Stereo-pair photographs are included in this guide. The three-dimensional image obtained by viewing the photographs with a stereoscope will improve the ability of the land manager to appraise natural fuel, vegetation, and stand structure conditions. A larger wide-angle photograph has been included for additional comparisons. The marker in these photographs is a 1-foot square, and the pole is painted in contrasting colors at 1-foot intervals to provide scale. The pole is 30 feet from the camera. The summary data relate to the field of view of the stereo-pair photographs but are based on measurements taken in the sample area only (see fig. 1). No sampling occurs in the foreground between the camera and the sign.

PHOTOGRAPH AND INFORMATION ARRANGEMENT

The photographs and accompanying data summaries are presented as single sites organized into one series. Each site is arranged to occupy two facing pages. The upper page contains a wide-angle (50mm) photograph, general site and stand, woody material, and forest floor information. The lower page

¹D.b.h. is measured 4.5 feet above the ground.

includes the stereo-pair photographs and summaries of the structure and composition of overstory trees and saplings, understory vegetation, and selected shrub species.

SITE AND STAND INFORMATION

The camera point of each site was located with a global positioning system receiver using the WGS-84 datum. Aspect and slope were measured with a compass and clinometer, respectively. Ecological community classification (to the alliance level; NatureServe 2006), and Society of American Foresters (SAF) cover type (Eyre 1980), two indicators of current vegetation composition, were assigned for all sites.

Tree, seedling, and understory species (shrub, forb, graminoid, and cactus species) present at a site are listed in order of abundance.² The listing of understory species is not a complete vegetation inventory and may represent only a portion of the actual species richness of the sampled areas. Crown closure was measured with a forest densitometer (95 systematically located points). Tree and seedling composition and density were determined either by a total inventory of the sample area, or estimated by using twelve 0.005-acre circular plots. All trees less than 4.5 feet tall were considered seedlings.

WOODY MATERIAL

Woody material data are reported by size classes that correspond to timelag fuel classes used in fire behavior modeling (see, for example, Burgan and Rothermel 1984).³ Dead and down woody material occurs in small amounts in oak/juniper ecosystems. For most sites woody material loading in the 1-hour, 10-hour and 100-hour size classes was determined by collecting, oven drying, and weighing all pieces in twelve 10.76-square-foot plots. When woody material greater than 3 inches in diameter was scarce, a total inventory within the sample area was conducted to determine loading and density estimates. For the total inventory, measurements were taken to determine log volume, and wood specific gravities were applied to the volume to calculate loading. For a few sites with a substantial woody material component, measurement techniques used for inventorying dead and down woody material were patterned after the planar intersect method outlined by Brown (1974) and described by Maxwell and Ward (1980). Forty transects of random azimuth starting at 25 systematically located points within the sample area were used to determine woody material loading and density (fig. 1). Woody material in 1-hour, 10-hour, and 100-hour-and-larger size classes was tallied on transects that were 3, 10, and 30 feet long, respectively. The decay class and the actual diameter at the point of intersection were measured on 30-foot-long transects for all pieces greater than 3 inches in diameter. All woody material less than or equal to 3 inches in diameter was considered sound. Woody material loading and woody material density were calculated from relationships that use number of pieces intersected and transect length (and wood specific gravity for loading) developed by Brown (1974) and Safranyik and Linton (1987), respectively. Region-specific average fuel particle sizes for 1-hour, 10-hour, and 100-hour particles reported by Sackett (1980) were used for oak-dominated sites.

FOREST FLOOR INFORMATION

Where reported, litter and duff depth were calculated as the average of measurements taken every 5 feet between the 30- and 150-foot arcs of the

²A list of scientific and common species names used in this volume appears on page 7.

³1-, 10-, 100- and 1000-hour timelag fuels are defined as woody material ≤ 0.25 inch, 0.26-1.0 inch, 1.1-3.0 inches, and >3.0 inches in diameter, respectively.

three center transects for a total of 75 measurements (fig. 1). The depth of the litter and duff was calculated as an average of the depth only where litter or duff was encountered during sampling (null values, or points where litter or duff were absent, are not included in the average). Therefore, the depths reported for litter and duff are not unit-wide averages, and do not necessarily sum to total depth. Loading was calculated from bulk density values derived from field measurements or, more commonly, through collection of material in twelve 10.76-square-foot plots.⁴ Coverage was estimated by using line intercept transects (Canfield 1941).

UNDERSTORY VEGETATION

Understory species coverage was estimated by using line intercept transects (Canfield 1941). Where species-specific coverage is not reported, understory vegetation coverage was estimated by lifeform category (shrub, forb, or graminoid) by using the line intercept transects. Forb and graminoid heights were measured at 25 points located systematically throughout the sample area. Shrub height was calculated by averaging the height either of all shrubs present in the sample area, or of all shrubs present in twelve 0.005-acre circular plots located systematically throughout the sample area (fig. 1). Herbaceous and small-stature shrub biomass was determined by sampling 12 square, clipped vegetation plots (10.76 square feet each) also located systematically throughout the sample area. All live and dead understory vegetation within each square plot was clipped at ground level, separated, and returned to the laboratory for oven drying. Understory vegetation and other collected materials were oven dried at a minimum of 158 °F for at least 48 hours before weighing and determination of area loading. *Yucca* spp., *Agave* spp., and cactus species were not collected in clipped vegetation plots.

Large-stature shrub biomass was calculated by using individual plant measurements and species- or group-specific allometric equations. Equations for *Arctostaphylos patula*, *Rhamnus alnifolia*, *Chrysothamnus nauseosus*, and *Rhus glabra* were substituted for *Arctostaphylos pungens*/*Arctostaphylos pringlei*, *Frangula californica*, *Artemisia filifolia*, and *Rhus trilobata*/*Rhus microphylla*, respectively (Elliott and Clinton 1993, Grigal and Ohmann 1977, Ross and Walstad 1986, Wright unpublished data). The composite equation for medium-stature shrubs in Brown (1976) was substituted for *Acacia* spp. and *Garrya wrightii*. The biomass of *Quercus turbinella* greater than 0.5-inch basal diameter (b.d.)⁵ was determined by substituting an equation for *Quercus gambelii* (Clary and Tiedemann 1986); biomass of *Quercus turbinella* less than or equal to 0.5 inch b.d. was determined by assuming a typical size of 0.15 inch b.d., and multiplying by the number of plants per acre. Biomass of *Vitis arizonica* was determined by harvesting, oven drying, and weighing four 10.76-square-foot plots, computing the average loading per square foot, and multiplying by the square footage of *Vitis* coverage within the sample area. Shrub biomass is the sum of small- and large-stature shrubs.

SAPLINGS AND TREES

Overstory tree and sapling composition and density were determined either by a total inventory of the sample area, or were estimated by using twelve 0.005-acre circular plots located systematically throughout the sample area (fig. 1). Tree measurement data were summarized by diameter at breast height (d.b.h.) size classes. The two most abundant tree species for each size class are listed with their relative density. Height to crown base (reported as ladder fuel height in previous photo series volumes) was defined as the height of the lowest, continuous live or dead branch material of the tree canopy, and height to live crown was defined as the height of the lowest continuous live branches of the tree canopy. Live

⁴Forest floor bulk density values used for each material type appear under “Notes to Users.”

⁵B.d. is measured above the root collar as near to the ground level as possible.

crown mass (branchwood and foliage) was calculated from species-specific allometric equations, where possible (Grier et al. 1992), and from genus-specific equations for pine (for *Pinus leiophylla*), and from group-specific allometric equations for other woodland species (for *Fraxinus velutina*, *Juniperus deppeana*, *Quercus arizonica*, *Q. emoryi*, *Q. turbinella*, and *Q. oblongifolia*; Jenkins et al. 2003). Live crown mass for *Quercus emoryi* and *Q. arizonica* trees less than 1.0 inch d.b.h. was calculated as a proportion (based on actual d.b.h.) of the crown mass of a 1.0 inch d.b.h. woodland tree (based on Jenkins et al. 2003). A crown mass equation for *Arbutus menziesii* was substituted for *Arbutus arizonica* (Snell and Little 1983).

SELECTED SHRUB SPECIES

Individual plants of all large-stature shrub species were measured in twelve 0.005-acre circular plots, or if shrub density was low, in the entire sample area. The density and percentage of all stems that were dead is based on the number of plants rooted in the sampled area. Crown area was calculated from crown breadth (i.e., the average of the maximum crown diameter, and the widest point perpendicular to the maximum crown diameter). Basal diameter (b.d.) or basal area of multistemmed plants was measured immediately above the root collar. The average and maximum height of all sampled individuals of a given species is also reported. Where they occur, *Quercus turbinella* plants less than or equal to, and greater than 0.5 inch basal diameter are noted separately.

USING THE PHOTO SERIES

The natural fuels photo series is a tool for quickly and inexpensively evaluating a variety of fuel and vegetation conditions. Because of its ease of use, however, care must be taken when evaluating field sites to compare only with photo series sites that are appropriate matches. It is acceptable to use the data from more than one site from the photo series when evaluating a site in the field (e.g., woody material loading from one site in the photo series and tree density from another site in the photo series to best match the conditions of a given field site).

Make a visual inventory of the site by observing fuel and stand conditions within the field of view and comparing them with the stereo-pair photographs as follows, remembering that the data tables relate to the area behind the sign in the stereo-pair photographs:

- Observe each fuel and vegetation characteristic (e.g., 1.1- to 3.0-inch woody material loading).
- Select a photo series site (or sites) that nearly matches (or brackets) the observed characteristics.
- Obtain the quantitative value for the characteristic being estimated from the data summary accompanying the selected photo series site, or interpolate a value between sites.
- Repeat these steps for each characteristic of interest.

The total biomass or stand condition can then be calculated by summing the estimates. If the site being inventoried has areas with obvious differences in composition, structure, or condition, the user should make separate determinations for each area and then weight and sum the characteristics for the whole site.

Characteristics not distinguishable in the photographs are forest floor depth, loading, and bulk density. If values for these characteristics are desired in the inventory, they must be derived from independent sampling or observations.

The 20 National Fire-Danger Rating System fuel models (Burgan 1988, Deeming et al. 1977) and the 13 original (Albini 1976) or 40 new (Scott and Burgan 2005) fire behavior fuel models are general and broadly applied. Each photo series encompasses a wider range of conditions, and individual sites represent fuel characteristics in greater detail and at greater resolution than can be gained by using fuel models; consequently, we chose not to assign one of these existing fuel models to individual sites in this photo series. The photo series was designed to provide sufficient fuel and vegetation data from which managers could generate their own customized fuel models.

SPECIES LIST

Scientific and common species names are from NRCS (2006).

SCIENTIFIC NAME

COMMON NAME

TREES:

<i>Arbutus arizonica</i> (Gray) Sarg.	Arizona madrone
<i>Cercocarpus montanus</i> Raf.	Mountain mahogany
<i>Fraxinus velutina</i> Torr.	Velvet ash
<i>Juniperus deppeana</i> Steud.	Alligator juniper
<i>Pinus discolor</i> D.K. Bailey & Hawksworth	Border pinyon
<i>Pinus edulis</i> Engelm.	Twoneedle pinyon
<i>Pinus engelmannii</i> Carr.	Apache pine
<i>Pinus leiophylla</i> Schiede & Deppe	Chihuahuan pine
<i>Pinus strobiformis</i> Engelm.	Southwestern white pine
<i>Quercus arizonica</i> Sarg.	Arizona white oak
<i>Quercus emoryi</i> Torr.	Emory oak
<i>Quercus hypoleucoides</i> A. Camus	Silverleaf oak
<i>Quercus oblongifolia</i> Torr.	Mexican blue oak

SHRUBS:

<i>Acacia constricta</i> Benth.	Whitethorn acacia
<i>Acacia greggii</i> Gray	Catclaw acacia
<i>Arctostaphylos pringlei</i> Parry	Pringle manzanita
<i>Arctostaphylos pungens</i> Kunth	Pointleaf manzanita
<i>Artemisia filifolia</i> Torr.	Sand sagebrush
<i>Frangula californica</i> (Eschsch.) Gray	California buckthorn
<i>Garrya wrightii</i> Torr.	Wright's silktassel
<i>Lonicera</i> spp.	Honeysuckle
<i>Mahonia repens</i> (Lindl.) G. Don	Creeping barberry
<i>Quercus turbinella</i> Greene	Sonoran scrub oak
<i>Rhus microphylla</i> Engelm. ex Gray	Littleleaf sumac
<i>Rhus trilobata</i> Nutt.	Skunkbush sumac
<i>Vitis arizonica</i> Englem.	Canyon grape

SCIENTIFIC NAME

COMMON NAME

GRAMINOIDS:

<i>Andropogon barbinodis</i> (Lag.) Herter	Cane bluestem
<i>Bouteloua curtipendula</i> (Michx.) Torr.	Sideoats grama
<i>Bouteloua gracilis</i> (Willd. ex Kunth) Lag. ex Griffith	Blue grama
<i>Bouteloua repens</i> (Kunth) Scribn. & Merr.	Slender grama
<i>Deschampsia caespitosa</i> (L.) Beauv.	Tufted hairgrass
<i>Eragrostis intermedia</i> A.S. Hitchc.	Plains lovegrass
<i>Leptochloa dubia</i> (Kunth) Nees	Green sprangletop
<i>Muhlenbergia emersleyi</i> Vasey	Bullgrass
<i>Nolina microcarpa</i> S. Wats.	Sacahuista, beargrass
<i>Phleum pratense</i> L.	Timothy
<i>Pseudoroegneria spicata</i> (Pursh) A. Löve	Bluebunch wheatgrass
<i>Schizachyrium sanguineum</i> (Retz.) Alston	Crimson bluestem
<i>Schizachyrium scoparium</i> (Michx.) Nash	Little bluestem
<i>Sporobolus cryptandrus</i> (Torr.) Gray	Sand dropseed

CACTI, FORBS, AND MISCELLANEOUS:

<i>Agave</i> spp.	Agave
<i>Allium</i> spp.	Onion
<i>Arnica cordifolia</i> Hook.	Heartleaf arnica
<i>Artemisia ludoviciana</i> Nutt.	White sagebrush
<i>Aster</i> spp.	Aster
<i>Gnaphalium</i> spp.	Cudweed
<i>Mentha arvensis</i> L.	Wild mint
<i>Opuntia</i> spp.	Pricklypear
<i>Yucca</i> spp.	Yucca

METRIC CONVERSIONS

1 inch (in) = 2.54 centimeters	1 pound (lb) = 0.4536 kilogram	1 ton/acre = 0.2242 kilogram/square meter
1 foot (ft) = 0.3048 meter	1 ton = 907.2 kilograms	1 ton/acre = 2,241.7023 kilograms/hectare
1 square foot = 0.0929 square meter	(Degrees Fahrenheit - 32) × (5/9) = Degrees Celsius	1 ton·acre ⁻¹ ·inch ⁻¹ = 8.8256 kilograms/cubic meter
1 acre (ac) = 4,046.9 square meters	1 pound/acre (lb/ac) = 1.1209 kilograms/hectare	1 ton·acre ⁻¹ ·inch ⁻¹ = 8825.6 grams/cubic meter
1 acre = 0.4047 hectare	1 pound/acre = 1.1209 E-04 kilograms/square meter	1 ton·acre ⁻¹ ·inch ⁻¹ = 8.8256E-03 grams/cubic centimeter

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OAK/JUNIPER WOODLAND PHOTO SERIES

A SERIES OF 15 SITES
OJW 01 THROUGH OJW 15

NOTES TO USERS:

1. Sites are arranged in order of increasing density of trees greater than 4 inches d.b.h.
2. A list of scientific and common species names can be found on page 7.
3. Photographs were taken in October 2003 and 2004. Sampling was performed in October 2003 and November 2004.
4. The marker in these photographs is a 1-foot square, and the pole is painted in contrasting colors at 1-foot intervals. The pole is 30 feet from the camera.
5. Bulk density values used for calculating forest floor loading from depth:

Forest floor type	Litter bulk density	Duff bulk density
	<i>Tons·acre⁻¹·inch⁻¹</i>	<i>Tons·acre⁻¹·inch⁻¹</i>
Arizona white, silverleaf, or Emory oak	2.81	5.94
Short-needle pine	4.05	10.58

6. Live crown mass includes foliage and branches. For species where live crown mass was calculated by using the woodland group equation presented in Jenkins et al. (2003), the proportion of the total aboveground biomass that is considered branchwood increases dramatically as stem diameter decreases. That is, a substantial portion of the biomass of what some may consider the bole, is shifted to the branchwood category for smaller trees.
7. Where they occur, *Quercus turbinella* plants less than or equal to, and greater than 0.5 inch basal diameter are noted separately.
8. Forest floor loading, woody material loading and live crown mass are reported in tons per acre. Understory biomass is reported in pounds per acre.
9. Trace coverage of understory species is indicated either as “trace” or as “t.” The designation of “na” indicates cases where data are “not available.”
10. Depth values, where reported, for litter, duff, and total forest floor are not unit-wide averages (null values, or points where litter or duff were absent, are not included in average), and, as such, the total forest floor depth is not the sum of surface material and duff depths.



SITE AND STAND INFORMATION

Site location: N 31° 28' 52.8" W 110° 20' 36.9"
 Elevation: 5,284 ft Aspect: E Slope: 5%

Alliance: Emory oak woodland
 SAF cover type: Western live oak

Trees (% of stems): *Quercus emoryi* (95), *Juniperus deppeana* (5)
 Crown Closure: 27%

Seedlings (% of stems): *Quercus emoryi* (95), *Juniperus deppeana* (5)
 Density: 336/ac

Understory (% cover): *Arctostaphylos pungens* (2),
Leptochloa dubia (na)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.09
0.26 - 1.0	0.27
1.1 - 3.0	0.21
> 3.0	0.00 (0)
Total	0.57

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	1.64	71
Duff	na	1.30	na
Total	na	2.94	71
Mineral soil and rock			10



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Quercus emoryi</i> (97)	<i>Quercus emoryi</i> (91)	--	--	<i>Quercus emoryi</i> (91)
Second most common species (percentage of stems)	<i>Juniperus deppeana</i> (3)	<i>Juniperus deppeana</i> (9)	--	--	<i>Juniperus deppeana</i> (9)
Tree density (stems/ac)	1,510	772	0	0	772
Dead (percentage of plants)	14	2	--	--	2
Avg d.b.h. (in)	1.2	2.6	--	--	2.6
Avg height (ft)	8.4	11.7	--	--	11.7
Avg height to crown base (ft)	0.7	0.5	--	--	0.5
Avg height to live crown (ft)	2.5	3.8	--	--	3.8
Live crown mass (tons/ac)	4.13	5.87	0.00	0.00	5.87

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Arctostaphylos pungens</i> (2)	--	<i>Leptochloa dubia</i> (na)
Second most common species (percent cover)	--	--	--
Coverage (percent)	2	7	17
Avg height (ft)	7.1	1.0	1.2
Biomass (lbs/ac)	2,498	136	347

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Arctostaphylos pungens</i>	181	0	6.0	32.0	4.3	7.1	9.1



SITE AND STAND INFORMATION

Site location: N 31° 31' 35.7" W 108° 58' 40.1"
 Elevation: 5,372 ft Aspect: -- Slope: 0%

Alliance: Mexican blue oak shrubland
 SAF cover type: Western live oak

Trees (% of stems): *Quercus oblongifolia* (69), *Juniperus deppeana* (31)
 Crown Closure: 36%

Seedlings (% of stems): *Quercus oblongifolia* (94),
Juniperus deppeana (6)
 Density: 123/ac

Understory (% cover): *Artemisia filifolia* (9), *Vitis arizonica* (7), *Rhus trilobata* (t), *Bouteloua curtipendula* (na), *Bouteloua gracilis* (na)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.09
0.26 - 1.0	0.14
1.1 - 3.0	0.13
> 3.0	0.21 (5)
Total	0.57

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	0.49	35
Duff	na	0.00	0
Total	na	0.49	35
Mineral soil and rock			23



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Juniperus deppeana</i> (75)	<i>Quercus oblongifolia</i> (67)	<i>Quercus oblongifolia</i> (100)	<i>Quercus oblongifolia</i> (100)	<i>Quercus oblongifolia</i> (83)
Second most common species (percentage of stems)	<i>Quercus oblongifolia</i> (25)	<i>Juniperus deppeana</i> (33)	--	--	<i>Juniperus deppeana</i> (17)
Tree density (stems/ac)	29	43	22	22	87
Dead (percentage of plants)	0	17	0	0	8
Avg d.b.h. (in)	1.2	2.8	4.9	27.3	9.5
Avg height (ft)	7.9	10.5	13.2	49.3	20.9
Avg height to crown base (ft)	1.0	1.8	2.0	7.3	3.3
Avg height to live crown (ft)	1.0	2.8	2.3	7.3	3.9
Live crown mass (tons/ac)	0.09	0.32	0.35	3.08	3.75

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Artemisia filifolia</i> (9)	--	<i>Bouteloua gracilis</i> (na)
Second most common species (percent cover)	<i>Vitis arizonica</i> (7)	--	<i>Bouteloua curtipendula</i> (na)
Coverage (percent)	16	1	21
Avg height (ft)	1.9	1.1	1.0
Biomass (lbs/ac)	1,656	17	236

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Artemisia filifolia</i>	390	9	1.2	1.7	0.4	1.8	3.5
<i>Rhus trilobata</i>	22	0	3.6	11.9	0.8	3.7	4.8
<i>Vitis arizonica</i>	na	0	na	na	na	2.9	4.7



SITE AND STAND INFORMATION

Site location: N 31° 29' 17.0" W 110° 19' 48.1"
 Elevation: 5,108 ft Aspect: E Slope: 3%

Alliance: Emory oak woodland
 SAF cover type: Western live oak

Trees (% of stems): *Quercus emoryi* (100)
 Crown Closure: 34%

Seedlings (% of stems): *Quercus emoryi* (94), *Juniperus deppeana* (6)
 Density: 448/ac

Understory (% cover): *Acacia* spp. (t), *Bouteloua curtipendula* (na), *Muhlenbergia emersleyi* (na), *Schizachyrium sanguineum* (na)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.15
0.26 - 1.0	0.12
1.1 - 3.0	0.00
> 3.0	0.00 (0)
Total	0.27

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	1.45	40
Duff	na	0.00	0
Total	na	1.45	40
Mineral soil and rock			27



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Quercus emoryi</i> (100)	--	<i>Quercus emoryi</i> (100)	<i>Quercus emoryi</i> (100)	<i>Quercus emoryi</i> (100)
Second most common species (percentage of stems)	--	--	--	--	--
Tree density (stems/ac)	22	0	14	36	50
Dead (percentage of plants)	0	--	0	0	0
Avg d.b.h. (in)	0.8	--	8.0	15.8	13.6
Avg height (ft)	6.7	--	22.0	26.2	25.0
Avg height to crown base (ft)	1.7	--	4.0	3.8	3.9
Avg height to live crown (ft)	1.7	--	4.0	4.2	4.1
Live crown mass (tons/ac)	0.05	0.00	0.41	2.43	2.84

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Acacia</i> spp. (t)	--	<i>Bouteloua curtipendula</i> (na)
Second most common species (percent cover)	--	--	<i>Schizachyrium sanguineum</i> (na)
Coverage (percent)	trace	1	39
Avg height (ft)	1.9	1.3	1.9
Biomass (lbs/ac)	15	16	2,092

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Acacia</i> spp.	7	0	2.9	6.6	0.2	2.1	2.1



SITE AND STAND INFORMATION

Site location: N 31° 29' 51.2" W 109° 03' 13.6"
 Elevation: 5,220 ft Aspect: NNW Slope: 5%

Alliance: Emory oak woodland
 SAF cover type: Western live oak

Trees (% of stems): *Quercus emoryi* (57), *Juniperus deppeana* (33), *Pinus leiophylla* (10)
 Crown Closure: 25%

Seedlings (% of stems): *Quercus emoryi* (62), *Juniperus deppeana* (34), *Pinus leiophylla* (4)
 Density: 173/ac

Understory (% cover): *Arctostaphylos pungens* (41), *Artemisia ludoviciana* (5), *Nolina microcarpa* (1), *Acacia greggii* (na), *Agave* spp. (na), *Bouteloua curtipendula* (na), *Bouteloua gracilis* (na)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.12
0.26 - 1.0	0.04
1.1 - 3.0	0.00
> 3.0	0.00 (0)
Total	0.16

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	1.37	52
Duff	na	0.65	na
Total	na	2.02	52
Mineral soil and rock			47



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Quercus emoryi</i> (60)	<i>Juniperus deppeana</i> (63)	<i>Quercus emoryi</i> (60)	<i>Quercus emoryi</i> (100)	<i>Quercus emoryi</i> (56)
Second most common species (percentage of stems)	<i>Pinus leiophylla</i> (40)	<i>Quercus emoryi</i> (37)	<i>Juniperus deppeana</i> (40)	--	<i>Juniperus deppeana</i> (44)
Tree density (stems/ac)	36	58	36	22	116
Dead (percentage of plants)	67	12	0	0	6
Avg d.b.h. (in)	0.7	2.8	5.7	10.5	5.2
Avg height (ft)	6.3	13.9	15.2	22.0	15.8
Avg height to crown base (ft)	0.2	2.1	4.0	0.7	2.4
Avg height to live crown (ft)	0.0	3.6	4.0	9.0	4.8
Live crown mass (tons/ac)	0.01	0.43	0.69	0.86	1.98

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Arctostaphylos pungens</i> (41)	<i>Artemisia ludoviciana</i> (5)	<i>Bouteloua gracilis</i> (na)
Second most common species (percent cover)	<i>Acacia greggii</i> (na)	<i>Agave</i> spp. (na)	<i>Bouteloua curtipendula</i> (na)
Coverage (percent)	41	5*	9
Avg height (ft)	3.9	1.2*	0.7
Biomass (lbs/ac)	4,374	6*	266

* Does not include *Agave*

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Arctostaphylos pungens</i>	839	10	4.4	20.9	2.4	3.9	7.4
<i>Acacia greggii</i>	29	0	na	na	2.6	7.4	8.0



SITE AND STAND INFORMATION

Site location: N 31° 31' 01.4" W 108° 58' 41.5"
 Elevation: 5,466 ft Aspect: SW Slope: 20%

Alliance: Arizona white oak woodland
 SAF cover type: Western live oak

Trees (% of stems): *Juniperus deppeana* (56), *Quercus arizonica* (44)
 Crown Closure: 8%

Seedlings (% of stems): *Quercus arizonica* (95),
Juniperus deppeana (5)
 Density: 151/ac

Understory (% cover): *Nolina microcarpa* (16),
Arctostaphylos pungens (8), *Rhus trilobata* (1),
Acacia constricta (1), *Agave* spp. (na), *Bouteloua*
curtipendula (na), *Bouteloua gracilis* (na), *Bouteloua*
repens (na), *Schizachyrium scoparium* (na)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.02
0.26 - 1.0	0.00
1.1 - 3.0	0.00
> 3.0	0.00 (0)
Total	0.02

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	0.41	22
Duff	na	0.00	0
Total	na	0.41	22
Mineral soil and rock			52



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	--	--	<i>Juniperus deppeana</i> (83)	<i>Quercus arizonica</i> (100)	<i>Juniperus deppeana</i> (56)
Second most common species (percentage of stems)	--	--	<i>Quercus arizonica</i> (17)	--	<i>Quercus arizonica</i> (44)
Tree density (stems/ac)	0	0	43	22	65
Dead (percentage of plants)	--	--	0	0	0
Avg d.b.h. (in)	--	--	6.4	10.2	7.6
Avg height (ft)	--	--	16.2	20.8	17.7
Avg height to crown base (ft)	--	--	1.3	3.3	2.0
Avg height to live crown (ft)	--	--	1.7	3.7	2.3
Live crown mass (tons/ac)	0.00	0.00	0.95	0.83	1.78

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Arctostaphylos pungens</i> (8)	<i>Agave</i> spp. (na)	<i>Nolina microcarpa</i> (16)
Second most common species (percent cover)	<i>Rhus trilobata</i> (1)	--	<i>Schizachyrium scoparium</i> (na)
Coverage (percent)	10	1	27
Avg height (ft)	1.3	0.3	1.3
Biomass (lbs/ac)	1,126	2	9,085

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Acacia constricta</i>	303	0	1.0	1.2	0.2	0.7	2.4
<i>Arctostaphylos pungens</i>	87	25	2.7	7.7	1.0	3.5	7.3
<i>Rhus trilobata</i>	22	0	2.4	9.6	0.5	1.7	4.0



SITE AND STAND INFORMATION

Site location: N 31° 30' 56.5" W 109° 01' 33.8"
 Elevation: 5,713 ft Aspect: SSW Slope: 5%

Alliance: Twoneedle pinyon-Juniper spp. woodland
 SAF cover type: Western live oak

Trees (% of stems): *Pinus edulis* (63), *Juniperus deppeana* (29), *Quercus emoryi* (8)
 Crown Closure: 15%

Seedlings (% of stems): *Pinus edulis* (64), *Juniperus deppeana* (22) *Quercus emoryi* (14)
 Density: 260/ac

Understory (% cover): *Quercus turbinella* (21),
Arctostaphylos pungens (17), *Nolina microcarpa* (2),
Arctostaphylos pringlei (2), *Allium* spp. (t), *Agave*
 spp. (na), *Schizachyrium sanguineum* (na), *Sporobolus*
cryptandrus (na), *Yucca* spp. (na)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.09
0.26 - 1.0	0.10
1.1 - 3.0	0.04
> 3.0	0.00 (0)
Total	0.23

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	1.23	44
Duff	na	0.00	0
Total	na	1.23	44
Mineral soil and rock			50



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Pinus edulis</i> (71)	<i>Pinus edulis</i> (86)	<i>Juniperus deppeana</i> (56)	<i>Pinus edulis</i> (100)	<i>Pinus edulis</i> (59)
Second most common species (percentage of stems)	<i>Juniperus deppeana</i> (14)	<i>Juniperus deppeana</i> (14)	<i>Pinus edulis</i> (33)	--	<i>Juniperus deppeana</i> (35)
Tree density (stems/ac)	51	51	65	7	123
Dead (percentage of plants)	0	14	0	0	6
Avg d.b.h. (in)	0.7	3.1	6.5	9.5	5.3
Avg height (ft)	6.2	10.1	12.2	15.0	11.5
Avg height to crown base (ft)	0.9	1.9	3.4	0.0	2.6
Avg height to live crown (ft)	1.6	3.2	5.1	3.0	4.3
Live crown mass (tons/ac)	0.12	1.08	2.28	0.93	4.29

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Quercus turbinella</i> (21)	<i>Allium</i> spp. (t)	<i>Nolina microcarpa</i> (2)
Second most common species (percent cover)	<i>Arctostaphylos pungens</i> (17)	<i>Yucca</i> spp. (na)	<i>Schizachyrium sanguineum</i> (na)
Coverage (percent)	41	trace*	7
Avg height (ft)	3.8	2.0*	0.9
Biomass (lbs/ac)	11,659	trace*	398

* Does not include *Yucca*

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Quercus turbinella</i> ≤0.5" b.d.	4,881	12	na	na	<0.5	na	na
<i>Quercus turbinella</i> >0.5" b.d.	2,063	16	na	na	1.4	4.0	9.0
<i>Arctostaphylos pungens</i>	1,409	20	3.2	9.5	2.1	3.5	5.3
<i>Arctostaphylos pringlei</i>	101	0	5.1	24.6	2.4	4.6	7.0



SITE AND STAND INFORMATION

Site location: N 31° 28' 30.1" W 110° 20' 06.1"
 Elevation: 5,319 ft Aspect: N Slope: 10%

Alliance: Emory oak woodland
 SAF cover type: Western live oak

Trees (% of stems): *Quercus emoryi* (49), *Juniperus deppeana* (40), *Pinus discolor* (6), *Quercus arizonica* (5)
 Crown Closure: 40%

Seedlings (% of stems): *Juniperus deppeana* (58), *Quercus* spp. (42)
 Density: 1,437/ac

Understory (% cover): *Arctostaphylos pungens* (3), *Rhus trilobata* (t), *Acacia* spp. (t), *Bouteloua curtipendula* (na), *Schizachyrium sanguineum* (na)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.29
0.26 - 1.0	1.77
1.1 - 3.0	1.00
> 3.0	0.43 (19)
Total	3.49

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	2.01	82
Duff	na	0.67	na
Total	na	2.68	82
Mineral soil and rock			9



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Juniperus deppeana</i> (51)	<i>Quercus emoryi</i> (63)	<i>Quercus emoryi</i> (100)	<i>Quercus emoryi</i> (50)	<i>Quercus emoryi</i> (70)
Second most common species (percentage of stems)	<i>Quercus emoryi</i> (37)	<i>Juniperus deppeana</i> (30)	--	<i>Quercus arizonica</i> (50)	<i>Juniperus deppeana</i> (20)
Tree density (stems/ac)	491	195	65	29	289
Dead (percentage of plants)	6	19	0	0	13
Avg d.b.h. (in)	0.9	2.8	6.3	10.2	4.3
Avg height (ft)	8.2	13.3	18.2	19.5	15.0
Avg height to crown base (ft)	0.5	0.4	0.7	1.8	0.6
Avg height to live crown (ft)	1.6	3.0	4.3	2.8	3.3
Live crown mass (tons/ac)	0.92	1.30	1.42	1.11	3.83

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Arctostaphylos pungens</i> (3)	--	<i>Bouteloua curtipendula</i> (na)
Second most common species (percent cover)	<i>Rhus trilobata</i> (t)	--	<i>Schizachyrium sanguineum</i> (na)
Coverage (percent)	3	1	39
Avg height (ft)	3.9	1.1	1.1
Biomass (lbs/ac)	438	4	651

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Arctostaphylos pungens</i>	43	0	5.6	30.0	3.2	5.6	7.4
<i>Acacia</i> spp.	22	0	0.6	0.4	0.1	0.8	1.4
<i>Rhus trilobata</i>	7	0	2.1	3.3	0.2	3.2	3.2



SITE AND STAND INFORMATION

Site location: N 31° 29' 09.9" W 110° 19' 44.5"
 Elevation: 5,043 ft Aspect: -- Slope: 0%

Alliance: Alligator juniper woodland
 SAF cover type: Western live oak

Trees (% of stems): *Juniperus deppeana* (100)
 Crown Closure: 16%

Seedlings (% of stems): *Juniperus deppeana* (100)
 Density: 29/ac

Understory (% cover): *Nolina microcarpa* (t), *Bouteloua curtipendula* (na), *Leptochloa dubia* (na)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.11
0.26 - 1.0	0.03
1.1 - 3.0	0.03
> 3.0	0.00 (0)
Total	0.17

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	0.58	21
Duff	na	0.89	na
Total	na	1.47	21
Mineral soil and rock			61



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Juniperus deppeana</i> (100)	<i>Juniperus deppeana</i> (100)	<i>Juniperus deppeana</i> (100)	--	<i>Juniperus deppeana</i> (100)
Second most common species (percentage of stems)	--	--	--	--	--
Tree density (stems/ac)	101	58	116	0	174
Dead (percentage of plants)	0	0	0	--	0
Avg d.b.h. (in)	1.0	3.2	6.4	--	5.3
Avg height (ft)	7.4	12.9	18.4	--	16.6
Avg height to crown base (ft)	0.1	0.4	0.2	--	0.3
Avg height to live crown (ft)	0.3	4.0	2.1	--	2.8
Live crown mass (tons/ac)	0.24	0.58	2.52	0.00	3.10

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	--	--	<i>Bouteloua curtipendula</i> (na)
Second most common species (percent cover)	--	--	<i>Leptochloa dubia</i> (na)
Coverage (percent)	trace	1	26
Avg height (ft)	1.8	1.3	1.4
Biomass (lbs/ac)	39	65	1,017

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
Unknown	43	0	1.7	2.9	0.6	1.8	2.7



SITE AND STAND INFORMATION

Site location: N 31° 21' 54.7" W 110° 18' 53.0"
 Elevation: 5,901 ft Aspect: SW Slope: 10%

Alliance: Arizona white oak woodland
 SAF cover type: Western live oak

Trees (% of stems): *Quercus emoryi* (54), *Quercus arizonica* (46)
 Crown Closure: 38%

Seedlings (% of stems): *Quercus* spp. (97), *Pinus* spp. (3)
 Density: 231/ac

Understory (% cover): *Bouteloua curtipendula* (31),
Eragrostis intermedia (25), *Acacia constricta* (1),
Phleum pratense (1), *Rhus trilobata* (t), *Aster* spp. (t),
Opuntia spp. (t), *Andropogon barbinodis* (na),
Bouteloua gracilis (na)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.17
0.26 - 1.0	0.08
1.1 - 3.0	0.00
> 3.0	0.00 (0)
Total	0.25

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	1.24	76
Duff	na	0.81	na
Total	na	2.05	76
Mineral soil and rock			4



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Quercus arizonica</i> (75)	<i>Quercus emoryi</i> (67)	<i>Quercus emoryi</i> (58)	<i>Quercus arizonica</i> (100)	<i>Quercus emoryi</i> (57)
Second most common species (percentage of stems)	<i>Quercus emoryi</i> (25)	<i>Quercus arizonica</i> (33)	<i>Quercus arizonica</i> (42)	--	<i>Quercus arizonica</i> (43)
Tree density (stems/ac)	29	108	137	22	267
Dead (percentage of plants)	25	7	5	0	5
Avg d.b.h. (in)	0.9	2.8	6.5	12.7	5.5
Avg height (ft)	7.3	11.7	17.1	20.7	15.2
Avg height to crown base (ft)	0.3	1.8	1.7	3.0	1.8
Avg height to live crown (ft)	4.0	3.9	5.6	6.7	5.0
Live crown mass (tons/ac)	0.04	0.86	2.95	1.13	4.94

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Acacia constricta</i> (1)	<i>Aster</i> spp. (t)	<i>Bouteloua curtipendula</i> (31)
Second most common species (percent cover)	<i>Rhus trilobata</i> (t)	<i>Opuntia</i> spp. (t)	<i>Eragrostis intermedia</i> (25)
Coverage (percent)	1	trace	60
Avg height (ft)	3.0	na	1.8
Biomass (lbs/ac)	4	4*	1,163

* Does not include *Opuntia*

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Rhus trilobata</i>	7	0	4.1	13.2	0.8	3.0	3.0



SITE AND STAND INFORMATION

Site location: N 31° 30' 53.5" W 109° 01' 05.3"
 Elevation: 5,573 ft Aspect: W Slope: 2%

Alliance: Chihuahuan pine woodland
 SAF cover type: Western live oak

Trees (% of stems): *Quercus emoryi* (51), *Pinus leiophylla* (20), *Juniperus deppeana* (15), *Quercus arizonica* (8), *Pinus edulis* (6)
 Crown Closure: 50%

Seedlings (% of stems): *Quercus emoryi* (70), *Quercus arizonica* (18), *Pinus edulis* (9), *Juniperus deppeana* (2), *Pinus leiophylla* (1)
 Density: 2,585/ac

Understory (% cover): *Arctostaphylos pungens* (1), *Nolina microcarpa* (1), *Quercus turbinella* (1), *Rhus trilobata* (t), *Pseudoroegneria spicata* (na)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.10
0.26 - 1.0	0.24
1.1 - 3.0	0.17
> 3.0	0.09 (7)
Total	0.60

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	0.92	66
Duff	na	0.89	na
Total	na	1.81	66
Mineral soil and rock			26



SAPLINGS AND TREES

	Size Class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Quercus emoryi</i> (79)	<i>Pinus leiophylla</i> (41)	<i>Juniperus deppeana</i> (36)	<i>Pinus leiophylla</i> (60)	<i>Pinus leiophylla</i> (38)
Second most common species (percentage of stems)	<i>Pinus edulis</i> (9)	<i>Quercus emoryi</i> (32)	<i>Pinus leiophylla</i> (32)	<i>Juniperus deppeana</i> (20)	<i>Juniperus deppeana</i> (27)
Tree density (stems/ac)	419	159	181	36	376
Dead (percentage of plants)	10	14	4	20	10
Avg d.b.h. (in)	0.9	3.1	6.2	11.4	5.4
Avg height (ft)	6.9	12.1	15.1	28.3	15.1
Avg height to crown base (ft)	1.2	2.9	3.3	6.8	3.5
Avg height to live crown (ft)	2.0	3.5	5.5	8.5	4.9
Live crown mass (tons/ac)	0.75	1.05	3.56	1.74	6.35

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Arctostaphylos pungens</i> (1)	--	<i>Pseudoroegneria spicata</i> (na)
Second most common species (percent cover)	<i>Quercus turbinella</i> (1)	--	<i>Nolina microcarpa</i> (1)
Coverage (percent)	2	0	9
Avg height (ft)	2.7	--	1.5
Biomass (lbs/ac)	266	0	528

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Quercus turbinella</i> ≤0.5" b.d.	138	16	na	na	<0.5	na	na
<i>Arctostaphylos pungens</i>	65	0	3.7	24.9	0.9	2.5	4.7
<i>Quercus turbinella</i> >0.5" b.d.	14	0	na	na	1.2	5.1	5.3
<i>Rhus trilobata</i>	7	0	3.0	7.1	0.5	4.8	4.8



SITE AND STAND INFORMATION

Site location: N 31° 27' 18.3" W 110° 22' 38.4"
 Elevation: 6,355 ft Aspect: S Slope: 15%

Alliance: Apache pine woodland
 SAF cover type: Western live oak

Trees (% of stems): *Pinus discolor* (85), *Juniperus deppeana* (12), *Quercus arizonica* (2), *Pinus engelmannii* (1)
 Crown Closure: 40%

Seedlings (% of stems): *Pinus discolor* (68), *Quercus arizonica* (21), *Juniperus deppeana* (9), *Cercocarpus montanus* (2)
 Density: 1,257/ac

Understory (% cover): *Arnica cordifolia* (6), *Nolina microcarpa* (6), *Gnaphalium* spp. (1), *Bouteloua curtipendula* (na), *Eragrostis intermedia* (na), *Muhlenbergia emersleyi* (na), *Schizachyrium sanguineum* (na)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.24
0.26 - 1.0	0.36
1.1 - 3.0	0.85
> 3.0	0.90 (36)
Total	2.35

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	1.54	50
Duff	na	4.06	na
Total	na	5.60	50
Mineral soil and rock			18



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Pinus discolor</i> (97)	<i>Pinus discolor</i> (60)	<i>Juniperus deppeana</i> (80)	<i>Pinus engelmannii</i> (50)	<i>Juniperus deppeana</i> (63)
Second most common species (percentage of stems)	<i>Juniperus deppeana</i> (3)	<i>Juniperus deppeana</i> (40)	<i>Quercus arizonica</i> (16)	<i>Juniperus deppeana</i> (33)	<i>Quercus arizonica</i> (12)
Tree density (stems/ac)	1,761	84	181	43	308
Dead (percentage of plants)	2	40	0	0	11
Avg d.b.h. (in)	0.9	2.6	6.1	13.8	6.3
Avg height (ft)	8.7	12.8	15.9	28.2	16.8
Avg height to crown base (ft)	0.3	1.8	4.0	6.8	3.8
Avg height to live crown (ft)	3.7	5.0	7.1	9.8	6.9
Live crown mass (tons/ac)	1.23	0.19	3.90	3.99	8.08

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	--	<i>Arnica cordifolia</i> (6)	<i>Schizachyrium sanguineum</i> (na)
Second most common species (percent cover)	--	<i>Gnaphalium</i> spp. (1)	<i>Muhlenbergia emersleyi</i> (na)
Coverage (percent)	0	7	31
Avg height (ft)	--	0.7	1.1
Biomass (lbs/ac)	0	60	1,068

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
none							



SITE AND STAND INFORMATION

Site location: N 31° 27' 11.4" W 110° 22' 31.3"
 Elevation: 6,340 ft Aspect: W Slope: 30%

Alliance: Border pinyon woodland
 SAF cover type: Western live oak

Trees (% of stems): *Juniperus deppeana* (45), *Pinus discolor* (45), *Quercus arizonica* (5), *Cercocarpus montanus* (4), *Fraxinus velutina* (1)
 Crown Closure: 50%

Seedlings (% of stems): *Pinus discolor* (55), *Juniperus deppeana* (26), *Cercocarpus montanus* (8), *Quercus arizonica* (8), *Fraxinus velutina* (3)
 Density: 773/ac

Understory (% cover): *Agave* spp. (10), *Rhus trilobata* (t), *Arnica cordifolia* (t), *Opuntia* spp. (t)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.50
0.26 - 1.0	0.67
1.1 - 3.0	0.42
> 3.0	0.37 (20)
Total	1.96

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	0.6	1.95	93
Duff	1.0	6.72	68
Total	1.3	8.67	93
Mineral soil and rock			6



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Pinus discolor</i> (53)	<i>Juniperus deppeana</i> (63)	<i>Pinus discolor</i> (53)	<i>Quercus arizonica</i> (33)	<i>Juniperus deppeana</i> (45)
Second most common species (percentage of stems)	<i>Juniperus deppeana</i> (45)	<i>Pinus discolor</i> (22)	<i>Juniperus deppeana</i> (28)	<i>Pinus discolor</i> (33)	<i>Pinus discolor</i> (37)
Tree density (stems/ac)	657	361	318	22	701
Dead (percentage of plants)	30	28	7	33	19
Avg d.b.h. (in)	1.0	3.0	5.8	25.1	4.9
Avg height (ft)	8.3	12.7	17.6	27.7	15.4
Avg height to crown base (ft)	1.6	3.1	2.1	3.7	2.6
Avg height to live crown (ft)	3.8	6.1	7.0	10.5	6.7
Live crown mass (tons/ac)	0.56	2.05	5.63	1.36	9.04

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Rhus trilobata</i> (t)	<i>Agave</i> spp. (10)	--
Second most common species (percent cover)	--	<i>Arnica cordifolia</i> (t)	--
Coverage (percent)	trace	10	51
Avg height (ft)	2.4	0.4*	1.7
Biomass (lbs/ac)	1	1*	818

* Does not include *Agave*

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Rhus trilobata</i>	7	0	1.5	1.7	0.4	2.4	2.4



SITE AND STAND INFORMATION

Site location: N 31° 24' 13.7" W 110° 14' 48.9"
 Elevation: 5,153 ft Aspect: E Slope: 3%

Alliance: Emory oak woodland
 SAF cover type: Western live oak

Trees (% of stems): *Quercus emoryi* (77), *Quercus arizonica* (22), *Juniperus deppeana* (1)
 Crown Closure: 65%

Seedlings (% of stems): *Quercus emoryi* (69), *Quercus arizonica* (24), *Juniperus deppeana* (7)
 Density: 445/ac

Understory (% cover): *Arctostaphylos pungens* (15),
Deschampsia caespitosa (5), *Rhus microphylla* (1),
Acacia constricta (1)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.47
0.26 - 1.0	0.48
1.1 - 3.0	0.19
> 3.0	0.00 (0)
Total	1.14

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	na	3.05	53
Duff	na	1.74	na
Total	na	4.79	53
Mineral soil and rock			46



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Quercus emoryi</i> (67)	<i>Quercus emoryi</i> (95)	<i>Quercus emoryi</i> (76)	<i>Quercus arizonica</i> (75)	<i>Quercus emoryi</i> (78)
Second most common species (percentage of stems)	<i>Quercus arizonica</i> (33)	<i>Quercus arizonica</i> (5)	<i>Quercus arizonica</i> (24)	<i>Juniperus deppeana</i> (25)	<i>Quercus arizonica</i> (21)
Tree density (stems/ac)	65	159	397	29	585
Dead (percentage of plants)	22	18	0	0	5
Avg d.b.h. (in)	1.4	3.0	6.1	10.0	5.5
Avg height (ft)	7.4	11.0	18.1	24.0	16.5
Avg height to crown base (ft)	2.6	3.3	5.3	2.5	4.6
Avg height to live crown (ft)	3.6	5.7	8.3	9.5	7.8
Live crown mass (tons/ac)	0.21	1.18	8.35	1.08	10.61

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Arctostaphylos pungens</i> (15)	--	<i>Deschampsia caespitosa</i> (5)
Second most common species (percent cover)	<i>Rhus microphylla</i> (1)	--	--
Coverage (percent)	16	trace	9
Avg height (ft)	2.9	0.4	0.8
Biomass (lbs/ac)	2,787	6	41

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Arctostaphylos pungens</i>	1,157	0	2.7	10.7	1.1	3.2	9.2
<i>Rhus microphylla</i>	218	0	1.7	7.7	0.8	2.1	10.3
<i>Acacia constricta</i>	101	0	1.0	1.4	0.2	0.9	1.9



SITE AND STAND INFORMATION

Site location: N 31° 24' 14.9" W 110° 15' 03.7"
 Elevation: 5,200 ft Aspect: E Slope: 3%

Alliance: Arizona white oak woodland
 SAF cover type: Western live oak

Trees (% of stems): *Quercus arizonica* (63), *Quercus emoryi* (31), *Juniperus deppeana* (4), *Pinus discolor* (2)
 Crown Closure: 76%

Seedlings (% of stems): *Quercus* spp. (97), *Pinus discolor* (2), *Juniperus deppeana* (1)
 Density: 2,315/ac

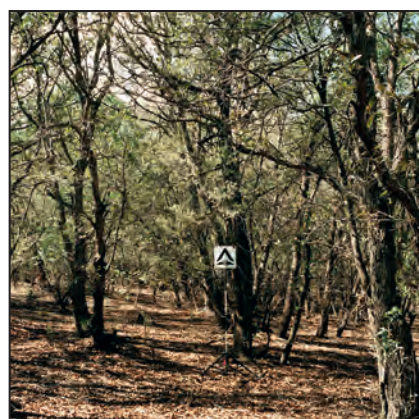
Understory (% cover): *Rhus microphylla* (13), *Arctostaphylos pungens* (3), *Garrya wrightii* (t), *Rhus trilobata* (t), *Mentha arvensis* (t)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.72
0.26 - 1.0	1.16
1.1 - 3.0	0.16
> 3.0	0.00 (0)
Total	2.04

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	1.1	2.89	94
Duff	1.4	7.48	94
Total	2.4	10.37	94
Mineral soil and rock			3



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Quercus arizonica</i> (60)	<i>Quercus arizonica</i> (55)	<i>Quercus arizonica</i> (84)	<i>Quercus emoryi</i> (60)	<i>Quercus arizonica</i> (64)
Second most common species (percentage of stems)	<i>Quercus emoryi</i> (30)	<i>Quercus emoryi</i> (42)	<i>Quercus emoryi</i> (12)	<i>Quercus arizonica</i> (20)	<i>Quercus emoryi</i> (31)
Tree density (stems/ac)	335	520	419	84	1,023
Dead (percentage of plants)	20	0	4	0	2
Avg d.b.h. (in)	1.2	3.1	5.8	10.3	4.8
Avg height (ft)	11.0	18.8	25.2	32.2	22.5
Avg height to crown base (ft)	3.1	5.3	7.6	16.0	6.1
Avg height to live crown (ft)	5.4	9.4	12.3	3.8	11.1
Live crown mass (tons/ac)	0.78	4.89	7.96	3.25	16.10

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Rhus microphylla</i> (13)	<i>Mentha arvensis</i> (t)	--
Second most common species (percent cover)	<i>Arctostaphylos pungens</i> (3)	--	--
Coverage (percent)	16	trace	trace
Avg height (ft)	5.5	0.8	0.7
Biomass (lbs/ac)	3,878	trace	trace

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Rhus microphylla</i>	436	4	5.4	34.8	1.7	6.0	10.3
<i>Arctostaphylos pungens</i>	134	25	2.1	9.3	0.6	3.2	7.8
<i>Garrya wrightii</i>	50	0	4.7	24.0	1.3	9.5	12.1
<i>Rhus trilobata</i>	50	0	3.8	24.3	0.8	3.0	5.5



SITE AND STAND INFORMATION

Site location: N 31° 28' 28.9" W 110° 22' 25.9"
 Elevation: 5,982 ft Aspect: ESE Slope: 15%

Alliance: Arizona white oak woodland
 SAF cover type: Western live oak

Trees (% of stems): *Quercus arizonica* (65), *Quercus hypoleucoides* (21), *Pinus discolor* (7), *Juniperus deppeana* (5), *Arbutus arizonica* (1), *Pinus strobiformis* (1)
 Crown Closure: 82%

Seedlings (% of stems): *Quercus* spp. (93), *Pinus discolor* (4), *Juniperus deppeana* (2), *Arbutus arizonica* (1)
 Density: 1,704/ac

Understory (% cover): *Frangula californica* (2), *Agave* spp. (1), *Rhus trilobata* (t), *Garrya wrightii* (t), *Rhus microphylla* (t), *Mahonia repens* (t), *Lonicera* spp. (t)

WOODY MATERIAL

Diameter (in)	Loading in tons/ac (Density in pieces/ac)
≤ 0.25	0.87
0.26 - 1.0	2.23
1.1 - 3.0	0.93
> 3.0	0.07 (10)
Total	4.10

FOREST FLOOR

	Depth (in)	Loading (tons/ac)	Coverage (%)
Litter	1.1	3.36	95
Duff	2.0	17.69	99
Total	3.1	21.05	99
Mineral soil and rock			1



SAPLINGS AND TREES

	Size class (diameter at breast height)				
	≤ 2 in	2 - 4 in	4 - 9 in	> 9 in	> 2 in
Most common species (percentage of stems)	<i>Quercus hypoleucoides</i> (100)	<i>Pinus discolor</i> (38)	<i>Quercus arizonica</i> (70)	<i>Quercus arizonica</i> (70)	<i>Quercus arizonica</i> (70)
Second most common species (percentage of stems)	--	<i>Quercus hypoleucoides</i> (25)	<i>Quercus hypoleucoides</i> (19)	<i>Quercus hypoleucoides</i> (29)	<i>Quercus hypoleucoides</i> (21)
Tree density (stems/ac)	7	58	607	101	766
Dead (percentage of plants)	0	25	1	0	3
Avg d.b.h. (in)	0.4	3.6	6.3	11.7	6.8
Avg height (ft)	5.0	21.8	29.6	34.5	29.7
Avg height to crown base (ft)	3.0	7.1	12.8	14.4	12.6
Avg height to live crown (ft)	3.0	13.2	17.0	21.2	17.4
Live crown mass (tons/ac)	0.01	0.38	12.97	4.62	17.97

UNDERSTORY VEGETATION

	Lifeform		
	Shrub	Forb	Graminoid
Most common species (percent cover)	<i>Frangula californica</i> (2)	<i>Agave</i> spp. (1)	--
Second most common species (percent cover)	<i>Rhus trilobata</i> (t)	--	--
Coverage (percent)	3	1	trace
Avg height (ft)	1.5	0.7*	0.8
Biomass (lbs/ac)	31	trace*	trace

* Does not include *Agave*

SELECTED SHRUB SPECIES

	Density (plants/ac)	Dead (percentage of plants)	Avg crown breadth (ft)	Avg crown area (ft ²)	Avg basal diameter (in)	Avg height (ft)	Max height (ft)
<i>Frangula californica</i>	209	0	1.1	1.3	0.4	1.8	5.0
<i>Rhus trilobata</i>	65	0	0.3	0.1	0.1	0.8	1.4
<i>Garrya wrightii</i>	22	0	0.2	0.1	0.1	0.2	0.2
<i>Mahonia repens</i>	14	0	1.0	0.8	0.4	2.7	2.8

Ottmar, Roger D.; Vihnanek, Robert E.; Wright, Clinton S.; Seymour, Geoffrey B. 2007. Stereo photo series for quantifying natural fuels. Volume IX: oak/juniper in southern Arizona and New Mexico. Gen. Tech. Rep. PNW-GTR-714. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 41 p.

A series of single and stereo photographs display a range of natural conditions and fuel loadings in evergreen and deciduous oak/juniper woodland and savannah ecosystems in southern Arizona and New Mexico. This group of photos includes inventory data summarizing vegetation composition, structure, and loading; woody material loading and density by size class; forest floor coverage and loading; and various site characteristics. The natural fuels photo series is designed to help land managers appraise fuel and vegetation conditions in natural settings.

Keywords: Woody material, biomass, fuel loading, natural fuels, oak/juniper woodlands, Arizona white oak, *Quercus arizonica*, Emory oak, *Quercus emoryi*, alligator juniper, *Juniperus deppeana*, pointleaf manzanita, *Arctostaphylos pungens*, grama, *Bouteloua* spp.