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# Plant Associations of Arizona and New Mexico

edition 4

**Volume 2: Woodlands**



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# Acknowledgements

This guide represents the product of the work of many people over many years to develop and improve a vegetation classification system for the forests and woodlands of Arizona and New Mexico.

This is the 4th edition of Forest and Woodland field guides. These guides were revised in 2023 by a working group of forest managers and academic specialists to include knowledge gained over the subsequent quarter century since the 3rd edition was published in 1997, and to update terminology and botanical nomenclature. This effort was organized and co-edited by James Youtz (USDA Forest Service, Regional Silviculturist), Mary Stuever (New Mexico Forestry Division, Chama District Forester), Jack Triepke (USDA Forest Service, Regional Ecologist), and Bruce Buttrey (USDA Forest Service, retired silviculturist). Esteban Muldavin (University of New Mexico, Natural Heritage New Mexico Division Leader, and Ecology Coordinator), Mark Nabel (USDA Forest Service, Silviculturist), and Shawn Martin (USDA Forest Service, Forest Silviculturist) provided input and review. Mariah Stover and Jordan Felt (USDA Forest Service, Terrestrial Ecological Unit Inventory) provided significant assistance with review and editing of plant name updates, and synonymic references with names used in the 3rd edition. Monique Duke and Olivia Diaz of the Southwestern Region provided help with formatting and final editing. This working group also developed Volume 3 as a companion publication to these field guides titled “Ecological Response Units of the Southwestern United States”, which references current science, classification linkages, plant association groupings, and tools for management and project planning and implementation.

The 3rd edition was compiled and edited by Mary Stuever and John Hayden (1996, revised 1997). It is primarily based on three regional guidebooks compiled in the mid 1980’s by editors/authors Will Moir and Milo Larson, with assistance from Dick Bassett, Reggie Fletcher, Esteban Muldavin, Suraj Ahuja, and Maurice Williams. Information for the third edition update was derived from many sources including comments from reviewers-- primarily natural resource professionals who utilize habitat typing information, information from the Fire Effects Information System-- a database maintained by the U.S. Forest Service’s Intermountain Fire Sciences Laboratory in Missoula,

Montana, and a large body of literature on fire history generated by researchers associated with the University of Arizona's Laboratory of Tree Ring Research in Tucson, Arizona, and numerous other research publications. Comments on the third edition plant association descriptions were provided by: Norm Ambos, Jack Carpenter, Francisco Escobedo, Will Moir, Don Moniak, Wayne Robbie, Gregg Sant, John Shafer, and Rita Suminski. Comments on the regional key were provided by: Norm Ambos, Kim Paul, John Shafer, and Charlie Wicklund. Thanks also to the 1997 Habitat Typing Workshop participants who provided additional field review.

The 2nd edition was a three-volume set of Forest and Woodland Habitat Types for three geographic regions within the Southwest (Arizona South of the Mogollon Rim and Southwestern New Mexico -yellow cover, Southern New Mexico and Central Arizona north of the Mogollon Rim -brown cover, and Northern New Mexico and Northern Arizona -green cover) compiled by Moir & Larson in 1987, based on the handouts described below and input from 8 workshops in the mid 1980's.

The 1st edition was the handouts synthesized from the research literature provided during the first round of habitat typing training in this region (taught by Will Moir & Milo Larson). Research to describe habitat types in Arizona and New Mexico was conducted by Billy G. Alexander, Jr., Fairley J. Barnes, Robert L. DeVelice, E. Lee Fitzhugh, Richard E. Francis, Jess P. Hanks, Sharon R. Hanks, Kathryn Kennedy, Earl F. Layser, John A. Ludwig, Will Moir, Esteban Muldavin, Frank Ronco, Jr., Gilbert H. Schubert and Alan S. White. In addition, plant association descriptions from numerous authors and data sources were adapted by Moir and Larson to develop the woodland descriptions.



# Preface

Habitat typing or plant association concepts provide natural resource professionals a way to communicate with peers about specific forest ecology observations without assigning them to broad areas where they may not apply. This ability to separate knowledge by more specific ecosystems allows for rapidly increasing the collective understanding of a wide diversity of forest ecosystems. Habitat typing (referring to forest stands by their plant associations) provides a language for the transmission of ideas and observations and has greatly enhanced our ability to discuss and understand the role of forest vegetation management in many specific situations.

Although foresters (particularly silviculturists) originally pioneered the use of habitat types in this region, this tool is now employed by many types of natural resource professionals, including fuels managers, vegetation ecologists, range conservationists, wildlife biologists, engineers, soil scientists, landscape architects, etc. Every year more natural resource professionals realize the value of using this classification system to provide site specific guidelines based on past experiences in similar plant associations for predicting future responses to management activities.

The management implementation guidelines associated with this classification system are dynamic. As more experience is assembled by many professionals and researchers working in the field, our overall understanding of each plant association increases. When Will Moir compiled the regional habitat typing guides in 1987, he stated that this was just the beginning. As a working professional in the field, it is our responsibility, as well as our colleagues, to collect the information we glean from our experiences to enhance these guides. All users of this guide are challenged to continue to document observations and experiences for Edition 5. Comments on this guide should be sent to the Regional Forester, USFS Southwestern Region, 333 Broadway Blvd. SE, Albuquerque, New Mexico 87102.

# Introduction

Forests and woodlands are naturally complex and diverse ecosystems and, therefore, difficult to thoroughly understand or predict changes which may result from management activities or natural vegetation development over time. This classification of forests and woodlands allows us to make general statements about observations in one site and apply the knowledge learned to other sites of the same plant association. The recognition of plant associations (habitat types) provides one system of classification, based on potential natural vegetation. The core classification level are the plant associations which are nested in sub-series and series levels. Occasionally plant associations are subdivided into phases, particularly when there is a wide geographic distribution.

Plant associations are closely related to other classifications. For example, the National Vegetation Classification System is similar, and share the plant community as the foundational level, but is based on current vegetation, rather than potential natural vegetation. These plant associations are cross walked to the National Vegetation Classification System hierarchy. Since plant associations are quite specific to micro-site changes, mapping plant associations is rarely practical beyond the local area scale. The Terrestrial Ecological Unit Inventory (formerly Terrestrial Ecosystem Survey) references plant associations (Winthers et al. 2005, USFS 1986) but is usually associated with the *subseries* level of potential natural vegetation classification, which is often more practical for mapping. Ecological Response Units (ERUs) are coarser than Terrestrial Ecological Units (TEUs) and reflect broad ecosystem types of similar site potential and fire regime and represent groupings of either TEUs or plant associations. The ERUs are most useful for landscape-scale analysis and management purposes. The finer scale of habitat types (associations) best informs development and implementation of site-specific management treatments.

These habitat type classifications have been in use in Arizona and New Mexico for over three decades; during this time, managers have observed that similar responses to disturbances and vegetation development can be expected on different site locations sharing the same or closely associated habitat type classifications. As a result, this classification system has become a valuable and trusted tool for

management planning and implementation of vegetation treatments in forests and woodlands in the Southwestern United States.

This publication describes the known plant associations for forests and woodlands in Arizona and New Mexico. Many sources were utilized to compile these descriptions, but the primary sources for this edition are updates to edition 3, which was derived from three regional habitat typing guides developed by the Forest Service in 1986 and 1987. This book is divided into three parts. The introductory material will provide background information on interpreting the descriptions, recent nomenclature changes for plants, and a key to the plant associations. The second and largest section is the descriptions for each plant association. The appendices include a bibliography, a synonymy list of plant name changes, and a list of plants mentioned in the descriptions.

A companion document titled “Plant Associations of Arizona and New Mexico Volume 3: Potential Vegetation, Ecological Linkages, and Tools for Management Planning” has been developed as a reference to document ecological linkages to other classification systems, historical conditions, and inferences for management planning.

Plant associations, or habitat types, have been used for classification throughout the west. The concept was first developed in western Washington by R. F. Daubenmire. Habitat types for Arizona and New Mexico were described by many researchers, primarily in the late 1970’s and through the mid 1980’s. Plant associations are still being recognized and described today, and conceivably there will be stands that will not fit any of the descriptions in this guidebook.

Although this classification system of plant association descriptions is based on climax or very late successional stand conditions, frequently the stands being classified are often in early or mid-successional stages. Additionally, one should recognize that there are often different climax conditions for a plant association which are influenced by the stand’s history. The fire exclusion disclimax that many of the plant associations are based on, may not be the historic reference condition, or the desired future condition that the manager is hoping to develop or maintain. It is helpful to think of the plant association as a “name” representing development potential, rather than a goal for stand conditions.

Another important guideline when matching these descriptions to specific forest or woodland stands is to expect variation. The

descriptions are based on the “typic” expression of the associations, although “ecotones” between associations are frequently encountered in the field. Descriptions also cover broad geographic areas, and usually all the plants listed will not actually occur in any given stand. Some habitat types occur on limited or singular soil types, while others occur on a variety of soils; therefore, expressing subtle differences in plant composition. Other factors such as variances in elevation, precipitation, and management history can influence expressed plant composition. The information presented may not be consistent from association to association. For example, stating that one association has high aesthetic value does not imply that others do not. Rather it implies that literature or comments on aesthetic value were not available for associations that omit this information.

### **Notes about Plants and Plant Names**

The names of plants can be confounding. Common names tend to vary by geography and culture and are often applied to more than one plant. Scientific names, though follow specific naming rules, can change for individual plants based on better information and understanding of the species. Since the publishing of Regional Forest and Woodland Habitat Type (Plant Association) guides in 1986 and 1987, and the Plant Associations of Arizona and New Mexico (Volumes 1 & 2) in 1997, many of the scientific names of the plants have since changed. Additionally, new information is emerging on hybridization and evolution, changing our understanding of various species.

The PLANTS database was used during the summer of 2021 as a source for genus and species names, codes, and standardized common names presented here. It is maintained by the USDA Natural Resources Conservation Service and presently considered the appropriate authority recording and abbreviating scientific and common plant names. A synonymy section is included in each Plant Association description to familiarize the user with name changes however these lists are not comprehensive.

Here are some important thoughts on plants and plant names within the context of Southwestern Plant Associations:

- The editors are endorsing the use of PLANTS database for this document to avoid confusion but are **not** discouraging the use of additional and geographically important common names, nor the use

of different naming rules (such as no possessive punctuation for plant names). Users are encouraged to know many names for plants including indigenous and local names where appropriate.

- The scientific name for subalpine fir used in the 1997 version of the guides was *Abies bifolia*. The correct name is now back to the original *Abies lasiocarpa*. Although corkbark fir is the more dominant variety of subalpine fir in the Southwest, the PLANTS database only uses the common name ‘corkbark fir’ when the variety is identified. In keeping with this conformity, we are using the common name “subalpine fir” because the research data list the tree as *Abies lasiocarpa*.
- Although the PLANTS database tends to follow conventions more common in naming animals by giving a possessive voice to a proper name, it was decided to follow this database for consistency, so “Gambel oak” would become “Gambel’s oak”; Thurber fescue – Thurber’s fescue, and so forth. However, the PLANTS database is not consistent on this.
- The single-needle pinyon pine in central Arizona was referred to as *Pinus fallax* in Edition 3 of the guides to avoid confusing plant associations in Arizona with plant associations in Utah. With efforts to develop the National Vegetation Classification System, the name has been corrected to *Pinus monophylla*, and the NVC will insure having unique nomenclature for each plant community. Similarly, the common name has changed from Arizona pinyon to singleleaf pinyon as standardized by the NRCS.
- Kristin Waring, NAU School of Forestry provides the following information: “Southwestern white pine (*Pinus strobiformis*) and limber pine (*Pinus flexilis*) are known to hybridize readily across Region 3. While populations or individual trees of either species may exist, it more likely to encounter hybrids (Menon et al. 2018). The proportion of each parent species varies systematically from south to north across a latitudinal gradient, with pure *P. strobiformis* found near the Mexican border, and pure *P. flexilis* found in trees in southwestern Colorado (Menon et al. 2018). In between, increasing amounts of *P. flexilis* are found in trees moving from south to north, but generally less than 50% in Region 3 (Menon et al. 2018). Hybridization may provide advantages in the future as both species are further challenged by climate change and white pine blister rust

(Menon et al. 2020, 2021).” For the purposes of this plant association classification, *P. strobiformis* refers to trees in the southern areas, while *P. flexilis* refers to the trees in the northern areas.

Use best judgement based on associated plants to determine the appropriate plant association for areas in between.

- Several woodland plant associations reference *Yucca schottii*. PLANTS Database recognizes *Yucca X schottii* and *Yucca madrensis* as formerly being *Yucca schottii*. In this guide, *Y. schottii* was systematically changed to *Y. madrensis*. Bob Sivinski offers this:

Yuccas are taxonomically problematic. The species often grade into one another over large geographic regions and the variations are endless. *Y. madrensis* extends across the Sierra Madre in Chihuahua/Sonora up to the Chiricahua and Peloncino Mts in the US. There is quite a bit of variation in stature, leaf width and color, and solitary vs colonial growth form including spindly understory shade forms in Mexico that haven’t been seen in the US. A recommendation is to call it all *Y. madrensis*. To retain the distinctions of the variations, the solitary, caulescent plants with non-filamentous leaf margins on bluish leaves are *Y. madrensis* and the plants with colonial bunches of stems are *Y. x schottii*.

- The PLANTS Database lists gray oak (*Quercus grisea*) and Arizona white oak (*Q. arizonica*) as different species. Landrum (1994) has combined both as *Q. grisea*, but for the purposes of this plant association classification system, they are treated as separate species.
- There were 39 species with name changes from the 1986-87 edition to the 1997 edition. There are now approximately ~135 species with name changes from the 1986-87 and 1997 editions to this edition. Some changes represent going back and forth between the same two names, while many are novel changes. Spelling corrections and adding possessive name punctuation are generally not listed in the synonymy section. A list highlighting some of key indicator and important plant name changes in this guide can be found on page 17. A more complete list can be found in Appendix A.

### **Some Essential Terms and Concepts**

Vegetation Coverage terms refer to the area covered by the canopy of the plant.

**Scarce** - less than 1% cover, versus common - greater than 1% cover.

**Poorly represented** - less than 5% cover, versus well-represented - greater than 5% cover.

**Abundant** - greater than 25% cover.

**Luxuriant** - greater than 50% cover.

**Absent** - cannot be found in the stand, versus present - can be found in the stand.

**Accidental** - individuals infrequent, occasional, or limited to special microsites.

**Dominant** - Density or cover is as great as, or greater than, any other species of the same life form (two or more species can be dominant, i.e., codominant).

**Regeneration** - understory trees as established seedlings, saplings, or small poles (DBH <10 inches).

**Life History Traits** - indication of trees' role (major or minor component) at most dominant successional stage (seral or climax)

**Seral** - early and mid-stages of succession

**Climax** - late and advanced stages of succession

### **Other related documents**

*Plant Associations of Arizona and New Mexico, Volume 1: Forests.*

*Plant Associations of Arizona and New Mexico, Volume 2: Woodlands.*

*Plant Associations of Arizona and New Mexico, Volume 3: Ecological Response Units of the Southwestern United States*

### **Plant Associations and Future Climate**

The Forest Service acknowledges that seasonal change, warming, and increased aridity (IPCC 2014) will affect both site potential and disturbance regimes, and that plant associations based on potential natural vegetation form a reasonable baseline from which to assess past variation ((Barrett et al. 2010, Comer et al. 2003)), current departure and loss of ecological integrity (Keane et al. 2018), the future range of variation (Somodi et al. 2012), and to consider adaptation options. Plant associations based on potential natural vegetation will remain a valuable concept for understanding basic land capability. The Southwestern Region and partners have developed vulnerability assessments (e.g., Hand et al. 2018) and tools to address changing climate and fire regimes

(e.g., Bagne et al. 2011, Friggens et al. 2019). The Forest Service also understands that shifts in site potential from climate forcing may already be ongoing and should be addressed in an adaptation strategy (Muldavin and Triepke 2019, Triepke et al. 2019).



# Format Notes for Plant Association Descriptions

*Explanations of each of the subheadings found in the plant association descriptions follow.*

## **Plant Association Identification**

Names for each plant association are found at the beginning of each description. Each association is usually named for the most shade tolerant tree successfully regenerating, and for an understory species (shrub or herb) which is most diagnostic of the site. The plant association abbreviation code is found at the top of the page. Plants that occur in the US are assigned this code by the Natural Resources Conservation Service Plants Database. The code is usually the first two letters of the genus and the first two letters of the species. An additional letter may be added to clarify a variety or subspecies. Where different species have the same codes, numbers are assigned to provide a unique abbreviation for each species. The plant association code includes the most shade tolerant tree (NOT the most common tree) and an indicator plant that is most unique to the plant community. Photos of some associations are included in the final section of the handbook.

The common name of the plant association is also in bold at the top, followed by the scientific name. If the plant association was known by a different name in the regional guides mentioned above, this name is also included in the heading as “formerly ....”. Often when plant associations, habitat types, or community types are referred to in publications, the name of the plant community is followed by an abbreviation to indicate the type. We have only included these initials if the plant community is not a habitat type or plant association. For example, PIPO/ARPU c.t. refers to the ponderosa pine/Manzanita community type. If there are no initials, the description of the plant association refers to a reference condition considered to be late successional under fire exclusion within the state-and-transition model for that plant association.

The vegetation code is used by the U.S. Forest Service and other agencies and organizations for data storage. The first digit recognizes the form, the next two digits delineate the series, the following two

digits are for the specific plant association (habitat type), and the last digit, if present, is a phase designator. For example, the code for ponderosa pine/Arizona fescue, Gambel oak phase is 0 11 09 3. The first '0' designates a forest, the '11' ponderosa pine, the '09' identifies the association, and the '3' is the phase indicator.

If the plant association has been labeled by other researchers using different species to name the type, these alternate names have been included in the synonym field, along with a reference to the publication in which these alternate names appear.

### **Ecological Response Unit**

Each association falls within an Ecological Response Unit (ERU), a general ecosystem type representing both site potential and the characteristic disturbance regime that is similar thematically to other landscape stratifications including LANDFIRE Biophysical Settings and Ecological Systems (Barrett et al. 2010, Comer et al. 2003). The ERU framework for the Southwestern Region of the Forest Service represents all major ecosystem types of the region including over 50 terrestrial types and subclasses and over 30 riparian types and subclasses. On Forest Service lands, each ERU is a technical grouping of Terrestrial Ecological Units (Winthers et al. 2005) that are similar in site potential (PNV subseries), ecosystem dynamics and disturbance, and that have similar plant species dominants. Since the ERU construct is one of both site potential and disturbance, two sites with similar site potential but significantly different disturbance regimes would be classified and mapped as different ERUs. By this approach it is possible for a given association to occur within more than one ERU depending on the disparity in historic disturbance regime and/or phase; however, in this guide the primary ERU, the ERU of greatest frequency, is identified by name and code for each association at the beginning of the description and is described in detail in the ERU companion guide. Determining the corresponding ERU for a given association is an interpretation, sometimes resulting in the least objectionable alternative, and subject to reinterpretation with new information and subsequent revisions to this guide or to the ERU framework.

### **National Vegetation Classification Group**

Within this guide each association has a corresponding Group class within the National Vegetation Classification (NVC) (Jennings et al. 2009). Groups are a mid-level unit of the NVC, each Group falling

within a Macrogroup, and each containing one or more Alliances that, in turn, contain one or more NVC Associations. An example of the classification hierarchy using the NVC Association *Ponderosa Pine / Blue Grama Woodland*:

**Formation Class** -Forest & Woodland

**Formation Subclass** - Temperate & Boreal Forest & Woodland

**Formation** - Cool Temperate Forest & Woodland

**Division** - Rocky Mtn Forest & Woodland

**Macrogroup** - Southern Rocky Mtn Lower  
Montane Forest

**Group** - Southern Rocky Mtn Ponderosa Pine  
Open Woodland

**Alliance** - Southern Rocky Mtn Ponderosa  
Pine / Grass Open Woodland

**Association** – Ponderosa Pine / Blue  
Grama Woodland

For the most part, the plant associations of this guide have already been adopted into the NVC as late seral forested expressions and sometimes with nearly identical naming, as with the *Ponderosa Pine / Blue Grama Woodland* Association and the original *Pinus ponderosa/Bouteloua gracilis* habitat type (Hanks et al. 1983). Though only the principal NVC Group is listed with each plant association description, most associations can be represented by more than one NVC Group since potential vegetation types represent all seral conditions and cover types (Arno et al. 1985). For example, the *Pinus ponderosa/Quercus gambelii* habitat type (Alexander et al. 1984a) can be represented by the NVC *Southern Rocky Mountain Ponderosa Pine Forest & Woodland* Group (tree-dominated), the *Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland* Group (shrub-dominated), or the *Southern Rocky Mountain Montane-Subalpine Grassland* Group (herb-dominated). But for purposes here the Group of greatest frequency is the one listed at the beginning of each association.

### Key criteria

The key criteria section is a brief snapshot description of the plant association highlighting features that separate it from similar plant associations. This usually includes a discussion of the overstory—as

well as what is absent from the overstory and may also provide limited geographical information.

### **Structure**

This discussion includes information on tree site indices, forage rating values, and other structure and productivity information when available. In general, tree site index information is sketchy and not very reliable. There is probably a wide variance in site indices within most associations.

Often a stockability factor is given. Stockability is an estimate of the stocking potential of a given site; a fully stocked site has factor of 1.0. For example, a factor of 0.5 indicates that the site is capable of supporting only 50 percent of timber species of “normal” stocking as indicated in yield tables. The stockability factors are subjectively assigned to each association, and not necessarily determined from extensive data.

### **Location**

This section gives geographical information on several scales, but specific to Arizona and New Mexico. General ranges, often including place names, are provided, as well as specific site information such as elevation, slope, aspect and/or soil characteristics. Elevations are given in feet and meters and are determined from research and observational data. Expect these elevational ranges to be narrower than what may actually be encountered throughout the region. Where determined, precipitation and soil temperature data are also included.

### **Adjacent habitat types**

Landscape patterns of plant associations are discussed here.

### **Also see**

This section provides suggested references to check to help clarify this plant association identification, or if the description isn’t quite right, to find a better description.

### **Important and key plants from research plots**

Plant associations are classified by collecting all of the vegetation information in a specific plot design including species and coverage. A cluster analysis on the data suggests similar plots which is then field check by the researchers to verify similarities. The plants that are listed

for this section are organized by trees, shrubs, herbs, and cryptogams. Herbs includes both graminoids (grasses and grass-like plants) and forbs.

### **Trees & life history traits**

For each phase or geographic region, trees are listed by common name (scientific name) and a letter code indicating the general role that species assumes in the plant association. Where capital letters are utilized, the tree species has the potential to be dominant for that successional state. Conversely, for small letters the species is generally a minor part of that successional state. Capital C stands for major climax, a species which is clearly regenerating successfully and surviving to maturity in late and advanced stages of succession. The species is also present in all (or nearly all) stands. Capital S stands for major seral tree, a species which is clearly regenerating successfully and surviving to maturity only in early and mid-stages of succession, although mature trees often persist as overstory in later stages. The species is also present or potential in all (or nearly all) stands. Small c stands for minor climax, and include species that meet the major climax definition, except they may not be present in all stands. Small s stands for minor seral and includes species that meet the major seral definition, except the species may not occur (now or as potential) in all (or most) stands. Trees that are accidental are referred to in the “Key Criteria” section. Only those trees referred to in the research are listed here. Trees not listed or mentioned generally do not occur in the association (however, see notes on aspen in PIPO/MUMO).

### **Shrubs and herbs plant list**

Shrubs and herbs are listed in separate categories. For each category, the typical canopy coverage is given using defined terminology such as common (>1%), scarce (<1%), well (>5%) or poorly (<5%) represented, abundant (>25%), and luxuriant (>50%). Species that are diagnostic to the association are in bold face and indicated with an asterisk (\*). Species are ordered according to overall importance throughout the range of the plant association, but the occurrence of individual species will vary geographically. Usually, individual stands will **not** include all the species in an association species list.

## **Cryptogams**

This section includes notes on mosses and lichens which have been associated with the plant association. If none are listed, this may mean we have no information on cryptogams for that plant association, rather than implying that there are no cryptogams in the association.

## **Brief plant ID notes**

The brief plant identification notes are intended to serve as reminders to key characteristics of indicator plants, and not to be used as a single source for plant identification. A synonymy list includes any recent scientific names and a few other common names for plants mentioned in the description.

## **Terrestrial Ecological Unit attributes**

Three values indicating Terrestrial Ecological Unit climate class are given (formerly Terrestrial Ecosystem Survey). The first value is the life zone class. These codes are:

- 4 (woodlands)
- 5 (ponderosa pine forest)
- 6 (mixed conifer forest)
- 7 (subalpine forest)

The second value indicates a temperature and moisture phase within each life zone class. These codes are:

- 1 = warm-dry;
- 0 = typical or modal;
- +1 = cool-moist.

The third code indicates the climate class which consists of two parts. The first two words refer to the season in which the majority of the precipitation on the site occurs. *High sun* refers to a summer precipitation-dominated climate, and *low sun* refers to an area that is winter precipitation-dominated. The second part of the climate class refers to temperature regime, either *mild* (including warm-temperate and subtropical) or *cold* (cold temperate). Therefore, the four possible climate class codes are *Low Sun Cold* (LSC), *Low Sun Mild* (LSM), *High Sun Cold* (HSC), and *High Sun Mild* (HSM).

## **Phases**

This section includes information on variations between phases and any specific comments related to a phase.

## Fire ecology

Fire ecology information may include known fire regime information such as fire return intervals, severity, etc., or specific plant responses to fire. When possible, we have tried to distinguish between presettlement and current fire conditions. We have tried to include information on fire behavior specific to the habitat type, observations on successional trends following fire, and information on the use of and responses to prescribed fire.

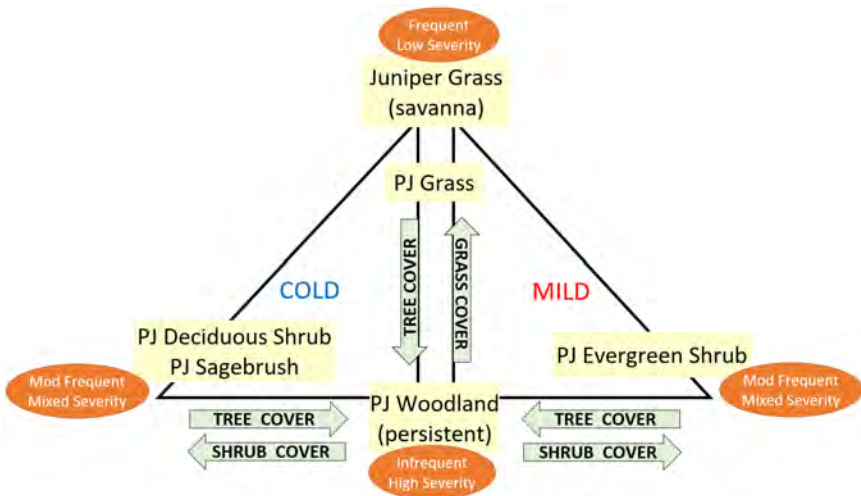


Figure 1. Conceptual diagram showing approximate relationships between historic fire regime (frequent and low severity, moderately frequent and mixed severity, infrequent and high severity) and physiognomic types, either open woodland with a grassy understory (top of the triangle), open and moderately open with a shrubby understory (left and right corners of the triangle), and persistent/closed woodland (bottom center). Adapted from Romme et al. (2009).

## Reforestation

This section includes information on natural regeneration, artificial regeneration, and timber harvesting activities. The focus of this discussion is on the regeneration of timber species.

## Revegetation considerations

This discussion refers to site responses following disturbances of any site component but focuses on early seral species.

**Comments**

This discussion may include specific wildlife, recreation, or range comments, potential opportunities for firewood or other resource products, ecological observations on successional pathways not already mentioned, insect or disease concerns associated with a plant association, or any other comments.

**Reference(s)**

The author and date of documents used to develop the description of this plant association are listed here. For full citations, refer to the bibliography.

Photos of some associations are included in the final section of the handbook.



# Keys to Plant Associations of Southwestern Forests and Woodlands

These keys have been developed to help identify plant associations for forests and woodlands for the Southwestern Region (Arizona and New Mexico). These keys (and the accompanying plant association descriptions) do not cover non-forested environments, including alpine tundra, chaparral, shrublands, grasslands, meadows, etc. In addition, this key does not provide information on mountainous riparian areas at the plant association level, although some series are addressed, nor are lower elevation forests along rivers (i.e., bosque) included. This key primarily has been derived from 3 keys (USFS 1987a, 1987b, 1986) that cover 3 geographic regions of this area.

## Using the Keys

These keys work best in stands where disturbances have been minimal. Stands in early to mid-seral stages of succession generally will not key directly to their association. In young or recently disturbed stands, the association must be inferred from site factors, indicator species, tree successional relationships or from known successional stages.

Fortunately, later successional (near climax) conditions can usually be inferred from the most shade tolerant tree species that is successfully reproducing. When trying to key any early seral stand, look for patterns on the local landscape. Find the most mature stand on a similar site in the local landscape and apply the keys to that stand.

To use the key, determine the combination of potential climax tree species by noting especially the proportions of trees in young, regenerating sizes. This helps determine the series, which is generally based on the most shade tolerant species regenerating in the stand.

**Always start in the first key, the Series Key to Forests and Woodlands.** There are exceptions to every rule which guides this classification system, and only by using the keys can the proper series be determined. Keys A through J are the keys for each series or group of similar series. In these keys, it is necessary to identify certain understory shrubs and herbs (indicator species) and to note their canopy coverage. Coverage classes are defined in the terms below.

Proceed through the key making careful observations required at each decision couplet. When the decision of which part of the couplet to follow is difficult, try both options. Validate the determination against the plant association description which best fits your observations. Check your observations if descriptions do not agree. No stand will fit the description perfectly.

When a site has been disturbed, the keys may not work at that site. To identify the plant association, find a less disturbed site with similar land position, soils, aspect, etc. to key out. Compare the answer with clues within the stand you are working with. Also look for historic documentation if it exists.

If the stand does not key out, consider if the type is unique and has not yet been described. In this case, notify the Regional Silviculturist or Vegetation Ecologist at the Southwest Region Office (USFS).

### Essential Terms

**Scarce** - less than 1% cover, versus common - greater than 1% cover.

**Poorly represented** - less than 5% cover, versus well represented - greater than 5% cover.

**Abundant** - greater than 25% cover.

**Luxuriant** - greater than 50% cover.

**Absent** - cannot be found in the stand, versus present - can be found in the stand.

**Accidental** - individuals infrequent, occasional, or limited to special microsites.

**Dominant** - Density or cover is as great as, or greater than, any other species of the same lifeform (two or more species can be dominant, i.e., codominant).

**Regeneration** - understory trees as established seedlings, saplings, or small poles (DBH <10 inches).

### Important Name Changes

Some of the terminology and many of the plant names have changed since the regional keys were published in the mid-1980's and the mid 1990's. Here is a short list of some of those changes you may encounter in these keys (See Appendix A for a long list).

## Name changes for key indicator plants:

### Trees:

- subalpine fir (*Abies lasiocarpa* = *A. arizonica* = *A. bifolia*) aka corkbark fir
- Arizona cypress (*Hesperocyparis arizonica* = *Cupressus arizonica*)
- redberry juniper (*Juniperus coahuilensis* = *J. erythrocarpa* var. *coahuilensis*)
- border pinyon (*Pinus discolor* = *Pinus cembroides*) = Mexican pinyon
- singleleaf pinyon (*Pinus monophylla* = *Pinus fallax* = *P. californiarum*) aka Arizona pinyon

### Shrubs:

- black sagebrush (*Artemisia nova*) = low sagebrush (*A. arbuscula* var. *nova*)
- alderleaf mountain mahogany (*Cercocarpus montanus*) = true mountain mahoganyrubber rabbitbrush (*Ericameria nauseosa* = *Chrysothamnus nauseosus*)
- creeping barberry (*Mahonia repens* = *Berberis repens*) aka Oregongrape
- wavyleaf oak (*Quercus X pauciloba* = *Q. undulata*)
- Stansbury cliffrose (*Purshia stansburiana* = *Cowania stansburiana* = *C. mexicana*)

### Graminoids:

- Indian ricegrass (*Achnatherum hymenoides* = *Oryzopsis hymenoides*)
- dryspike sedge (*Carex siccata* = *C. foenea*) = fony sedge
- beardless wildrye (*Leymus triticoides* = *Elymus triticoides*)
- screwleaf muhly (*Muhlenbergia straminea* = *M. virescens*)
- tobosagrass (*Pleuraphis mutica* = *Hilaria mutica*)

### Forbs and other herbs:

- sprucefir fleabane (*Erigeron eximius*) = forest fleabane (*E. superbus*)
- Nevada pea (*Lathyrus lanszwertii* var *leucanthus* = *L. lanszwertii* var *arizonica* = *L. arizonica*) aka Arizona peavine
- bittercress ragwort (*Packera cardamine* = *Senecio cardamine*) = cardamine groundsel
- burnet ragwort (*Packera sanguisorboides* = *Senecio sanguisorboides*)

# Series Key to Forests and Woodlands

1. Streamside environments with riparian obligate trees such as cottonwood (*Populus fremontii*, *P. deltoides*, or *P. angustifolia*), alder (*Alnus tenuifolia* or *A. oblongifolia*), willow (*Salix* spp.), sycamore (*Platanus wrightii*), or boxelder (*Acer negundo*). (Note: Arizona walnut (*Juglans major*) does not qualify as a riparian obligate tree since it also occurs in dry or intermittent drainages)...**Key G, Riparian Forests**, page 34.

1. Other environments without riparian obligate plants....2

2. Dominant (density or cover is as great as, or greater than, any other species of the same lifeform) trees species regenerating include subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), bristlecone pine (*Pinus aristata*), blue spruce (*Picea pungens*), white fir (*Abies concolor*), limber pine (*Pinus flexilis*), Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), Apache pine (*Pinus engelmannii*), or Chihuahuah pine (*Pinus leiophylla*)....3

2. Dominant trees species regenerating include species of pinyon pine (*Pinus edulis*, *P. discolor*, or *P. fallax*), juniper (*Juniperus monosperma*, *J. deppeana*, *J. osteosperma*, or *J. coahuilensis*), Arizona cypress (*Cupressus arizonica*), or oak (*Quercus grisea*, *Q. oblongifolia*, *Q. emoryi*, *Q. hypoleucoides*, or *Q. arizonica*)....9

3. Forests of talus or debris slopes with fragmental soils (cobbles or stones >90% of soil volume)....**Scree Forests**, Volume 1, page 427.

3. Forests of other environments....4

4. Subalpine fir (*Abies lasiocarpa*) and/or Engelmann spruce (*Picea engelmannii*) and/or bristlecone pine (*Pinus aristata*) is dominant or reproducing successfully, clearly not accidental....**Key A: Engelmann Spruce, Subalpine Fir & Bristlecone Pine Series**, page 21.

4. Subalpine fir (*Abies lasiocarpa*) and/or Engelmann spruce (*Picea engelmannii*) and/or bristlecone pine (*Pinus aristata*) is absent or accidental (or present in seral stages only)....5

5. Blue spruce (*Picea pungens*), white fir (*Abies concolor*), limber pine (*Pinus flexilis*), or Douglas-fir (*Pseudotsuga menziesii*) dominant or reproducing successfully, clearly not accidental....6

5. Blue spruce (*Picea pungens*), white fir (*Abies concolor*), limber pine (*Pinus flexilis*), or Douglas-fir (*Pseudotsuga menziesii*) absent or accidental....8

6. Blue spruce is common, clearly not accidental...**Key B: Blue Spruce Series**, page 25.
6. Blue spruce is absent or accidental....7
7. White fir is dominant or reproducing successfully, clearly not accidental...**Key C: White Fir Series**, page 26.
7. White fir is absent or accidental...**Key D: Douglas Fir & Limber Pine Series**, page 28.
8. Ponderosa pine dominant without presence of additional Madrean pines.... **Key E: Ponderosa Pine Series**, page 30.
8. Madrean pines including Apache pine (*Pinus engelmannii*), Chihuahuan pine (*Pinus leiophylla*), and Arizona pine (*Pinus arizonica*) are common, clearly not accidental, location SE Arizona or SW New Mexico...**Key F: Apache Pine and Chihuahuan Pine Series**, page 33.
9. Arizona cypress (*Cupressus arizonica*) present, not accidental...13
9. Arizona cypress (*Cupressus arizonica*) absent or accidental ... 10
10. Woodlands of slopes >40% and rocky or bouldery soils with much rock outcrop or bare rock soils...**Scarp Woodland**, page 249.
10. Woodlands of slopes <40% or soils not as described above...11
11. Evergreen oaks (*Quercus grisea*, *Q. oblongifolia*, *Q. emoryi*, *Q. hypoleucoides*, *Q. arizonica*) are well represented (>5% cover) to abundant (>25% cover) in the tallest stratum, geographic locations in southern Arizona or southern New Mexico....**Key H: Madrean Oak Woodlands**, page 35.
11. Evergreen oaks are poorly-represented in the tallest stratum....12
12. Pinyon pine (*Pinus edulis*, *P. discolor*, or *P. fallax*) is dominant or reproducing successfully, clearly not accidental ....**Key I: Pinyon Pine Series**, page 37.
12. Pinyon pine (*Pinus edulis*, *P. discolor*, or *P. fallax*) is absent or accidental, juniper (*Juniperus monosperma*, *J. deppeana*, *J. osteosperma*, or *coahuilensis*) is dominant and reproducing successfully.....**Key J: Juniper Woodlands**, page 42.
13. Silverleaf oak (*Quercus hypoleucoides*) common .....**HEAR22/QUHY**, Vol. 2, page 45.
13. Silverleaf oak (*Quercus hypoleucoides*) absent or accidental .....**HEAR22/QUTU2**, Vol. 2, page 49.

## **Key A: Engelmann Spruce, Subalpine Fir & Bristlecone Pine Series**

(All page numbers refer to Volume 1: Forests)

1. Bristlecone pine (*Pinus aristata*) is dominant at climax (northern NM or northern AZ)....2
1. Bristlecone pine (*Pinus aristata*) is absent or not dominant at climax....4
2. Currants (*Ribes*) common, grasses poorly represented..**PIAR/RIMO2**, page 140.
2. Currants (*Ribes*) scarce, grasses usually well represented...3
3. Thurber's fescue (*Festuca thurberi*) common....**PIAR/FETH**, page 135.
3. Thurber's fescue (*Festuca thurberi*) absent or scarce....**PIAR/FEAR2**, page 77.
4. Herbs and shrubs are scarce.....5
4. Herbs and shrubs are at least common.....6
5. Subalpine fir (*Abies lasiocarpa*) is codominant, reproducing successfully.... **ABLA/moss**, page 111.
5. Subalpine fir (*Abies lasiocarpa*) is absent, or not reproducing successfully... **PIEN/moss**, page 63.
6. Saturated soils.....**ABLA/MECI3**, page 107.
6. Soils otherwise.....7
7. Beardless wildrye (*Leymus triticoides*) is common (known from Capitan Mtns, southern NM).....**PIEN/LETR5**, page 59.
7. Beardless wildrye (*Leymus triticoides*) is scarce or absent, or geographic location is other.....8
8. Regeneration of subalpine fir (*Abies lasiocarpa*) is absent, accidental, or minor....9
8. Regeneration of subalpine fir (*Abies lasiocarpa*) is present, clearly not accidental or minor.....17
9. Nearly pure stands of Engelmann spruce (*Picea engelmannii*) (bristlecone pine (*Pinus aristata*) may be present)....10
9. Engelmann spruce (*Picea engelmannii*) in association other mixed conifer trees such as blue spruce (*Picea pungens*), white fir (*Abies concolor*), or Douglas-fir(*Pseudotsuga menziesii*); but subalpine fir (*Abies lasiocarpa*) is minor, if present.....12

10. Whortleberry (*Vaccinium myrtillus*) is present, often well presented; skunkleaf polemonium (*Polemonium pulcherrimum* ssp. *delicatum*) is also present .....**PIEN/VAMY2-POPUD3, PIEN phase**, page 81.
10. Whortleberry (*Vaccinium myrtillus*) is absent; skunkleaf polemonium (*Polemonium pulcherrimum* ssp. *delicatum*) may be present or absent.....11
11. Ross' avens (*Geum rossii*) dominates herbaceous understory; shrubs are scarce [known from San Francisco Peaks, AZ].....**PIEN/GERO2**, page 55.
11. Gooseberry currant (*Ribes montigenum*) is common, herbs are scarce.....**PIEN/RIMO2**, page 74.
12. Understory essentially shrubby; herbs may be well represented.....13
12. Understory essentially herbaceous; shrubs may be well represented....15
13. Whortleberry (*Vaccinium myrtillus*) is well represented....**PIEN/VAMY2**, page 77.
13. Whortleberry (*Vaccinium myrtillus*) is poorly represented.....14
14. Kinnikinnick (*Arctostaphylos uva-ursi*) is common.....**PIFL/ARUV**, page 265.
14. Kinnikinnick (*Arctostaphylos uva-ursi*) is scarce or absent (known from southern Arizona and New Mexico).....**PIEN/ACGL**, page 45.
15. Bittercress ragwort (*Packera cardamine*) is common (known from White Mountains in Arizona and Mogollon & Blue Mountains in New Mexico).....**PIEN/PACA34, ABCO phase**, page 69.
15. Bittercress ragwort (*Packera cardamine*) is scarce or absent.....16
16. Engelmann spruce (*Picea engelmannii*) is dominant; blue spruce (*Picea pungens*) is minor or absent....**PIEN/EREX4**, page 50.
16. Blue spruce (*Picea pungens*) is dominant, Engelmann spruce (*Picea engelmannii*) is minor....**PIPU/EREX4**, page 159.
17. Whortleberry (*Vaccinium myrtillus*) is common to well represented, clearly a dominant species in the understory....18
17. Whortleberry (*Vaccinium myrtillus*) is absent, or if present, is not a dominant understory species....20
18. Skunkleaf polemonium (*Polemonium pulcherrimum* ssp. *delicatum*) is common.....**PIEN/VAMY2-POPUD3, ABLA phase**, page 47.
18. Skunkleaf polemonium (*Polemonium pulcherrimum* ssp. *delicatum*) is scarce or absent.....19

19. Subalpine fir (*Abies lasiocarpa*) is dominant in regeneration; white fir (*Abies concolor*) is minor or absent.... **ABLA/VAMY2**, page 124.
19. Subalpine fir (*Abies lasiocarpa*) is minor; white fir (*Abies concolor*) regeneration is dominant.....**ABCO/VAMY2**, page 260.
20. Blue spruce (*Picea pungens*) is common, reproducing well even into late succession.....21
20. Blue spruce (*Picea pungens*) is absent or accidental.....22
21. Twinflower (*Linnaea borealis*) is well represented..... **PIPU/LIBO3**, page 170.
21. Twinflower (*Linnaea borealis*) is poorly represented or absent, bittercress ragwort (*Packera cardamine*) is common (known from White Mountains in Arizona and Mogollon & Blue Mountains in New Mexico)..... **PIEN/PACA34**, page 69.
22. Understory essentially shrubby; herbs may be well represented.....23
22. Understory essentially herbaceous.....26
23. Western thimbleberry (*Rubus parviflorus*) is scarce, and common juniper is common.....**ABLA/JUCO6**, page 98.
23. Plants are not as above.....24
24. Western thimbleberry (*Rubus parviflorus*) is well represented..**ABLA/RUPA**, page 119.
24. Western thimbleberry (*Rubus parviflorus*) is absent or poorly represented.....25
25. Fivepetal cliffbush (*Jamesia americana*) is present; location is in SE Arizona...**ABLA/JAAM**, page 95.
25. Fivepetal cliffbush (*Jamesia americana*) is absent or location is otherwise....26
26. Dryspike sedge (*Carex siccata*) is abundant or luxuriant.....**ABLA/CASI12**, page 86.
26. Dryspike sedge (*Carex siccata*) is absent or present, but not abundant....27
27. Bittercress ragwort (*Packera cardamine*) is common (known from White Mountains in Arizona and Mogollon & Blue Mountains in New Mexico).....**PIEN/PACA34**, **ABLA phase**, page 69.
27. Bittercress ragwort (*Packera cardamine*) is absent or scarce....28
28. Burnet ragwort (*Packera sanguisorboides*) is common (known from the Sacramento Mtns., southern NM).....**ABLA/PASA12**, page 115.
28. Burnet ragwort (*Packera sanguisorboides*) is absent or scarce....29



29. Nevada pea (*Lathyrus lanszwertii* var. *arizonica*) is well represented; sprucefir fleabane (*Erigeron eximius*) is scarce or absent...**ABLA/LALAL3**, page 102.

29. Nevada pea (*Lathyrus lanszwertii* var. *arizonica*) is poorly represented; sprucefir fleabane (*Erigeron eximius*) is common...**ABLA/EREX4**, page 90.

## **Key B: Blue Spruce Series**

(All page numbers refer to Volume 1: Forests)

1. Forests of streamsides or streamside terraces with riparian obligate shrubs such as alders (*Alnus*), Bebb willow (*Salix bebbiana*), or redosier dogwood (*Cornus sericea*)....**PIPU/COSES**, page 147.

1. Forests without riparian obligate shrubs...2

2. Bittercress ragwort (*Packera cardamine*) is present, usually in patches (currently known from east central Arizona and adjoining areas in New Mexico)...**PIPU/PACA34**, page 175.

2. Bittercress ragwort (*Packera cardamine*) is absent....3

3. Ponderosa pine (*Pinus ponderosa*) is a common seral tree (often persisting in late succession)....4

3. Ponderosa pine (*Pinus ponderosa*) is absent or accidental, even in early succession....7

4. Understory bunchgrasses, such as Arizona fescue (*Festuca arizonica*) well represented....**PIPU/FEAR2**, page 165.

4. Understory shrubby or herbaceous, but bunchgrasses are poorly represented...5

5. Kinnikinnick (*Arctostaphylos uva-ursi*) well represented (northern New Mexico or Colorado)...**PIPU/ARUV**, page 142.

5. Kinnikinnick (*Arctostaphylos uva-ursi*) poorly represented ....6

6. Grasses and sedges (graminoids) abundant....**PIPU/CASI12**, page 153.

6. Forbs abundant; graminoids common or well represented in small patches....**PIPU/EREX4**, **PIPO phase**, page 159.

7. Twinflower (*Linnaea borealis*) well represented...**PIPU/LIBO3**, page 170.

7. Twinflower (*Linnaea borealis*) absent or poorly represented...**PIPU/EREX4**, page 159.

## **Key C: White Fir Series**

(All page numbers refer to Volume 1: Forests)

1. Herb cover scarce, or no more than 2 species with over 1% canopy coverage; shrubs scarce, except sometimes common juniper is common....**ABCO/MARE11**, page 229.
1. Herbs and/or shrubs at least common....2
2. Location southern New Mexico, particularly in the vicinity of the Lincoln National Forest.....3
2. Location other than southern New Mexico....5
3. Maples (*Acer* spp.) absent; beardless wildrye (*Leymus triticoides*) well represented to abundant....**ABCO/LETR5**, page 225.
3. Maples absent or present; beardless wildrye is poorly represented or absent....4
4. Herb layer is dominated by burnet ragwort (*Packera sanguisorboides*)..... **ABCO/PASA12**, page 247.
4. Herb layer is not dominated by burnet ragwort ..... 5
5. Walnut (*Juglans major*) common; in drainages (central AZ and southern NM) .....**ABCO/JUMA**, page 215.
5. Walnut absent or scarce.....6
6. Soils are derived from volcanic ash or cinders; New Mexico locust is dominant as an understory shrub .....**ABCO/RONE**, page 250.
6. Soils are not derived from volcanic ash or cinders; New Mexico locust may be poorly or well represented .....7
7. Shrub component of the understory is poorly represented .....8
7. Shrub component of the understory is well represented, often abundant .....13
8. Graminoids are well represented to abundant, their coverage considerably more conspicuous than forbs....9
8. Forbs are well represented to luxuriant, their coverage exceeding grasses [although fringed brome (*Bromus ciliatus*) is sometimes abundant].....11
9. Screwleaf muhly (*Muhlenbergia straminea*) is common or well represented.....**ABCO/MUST**, page 235.
9. Screwleaf muhly is scarce or absent....10
10. Dryspike sedge (*Carex siccata*) is often abundant or luxuriant....**ABCO/CASI12**, page 198.

10. Dryspike sedge not abundant or absent; Arizona fescue (*Festuca arizonica*) or mountain muhly (*Muhlenbergia montana*) is present.....**ABCO/FEAR2**, page 209.
11. Nevada pea (*Lathyrus lanszwertii* var. *arizonica*) is well represented.....**ABCO/LALAL3**, page 220.
11. Nevada pea is poorly represented .....12.
12. Sprucefir fleabane (*Erigeron eximius*) is well represented.....**ABCO/EREX4**, page 202.
12. Sprucefir fleabane is poorly represented.....13
13. Maples (*Acer* spp.) or Scouler's willow (*Salix scouleriana*) are common....14
13. Maples or Scouler's willow are scarce or absent....15
14. Bigtooth maple (*Acer grandidentatum*) is common.....**ABCO/ACGR3**, page 188.
14. Bigtooth maple is scarce or absent.....**ABCO/ACGL**, page 180.
15. Gambel oak (*Quercus gambelii*) is well represented....**ABCO/QUGA**, page 240.
15. Gambel oak is poorly represented or absent.....16
16. Whortleberry (*Vaccinium myrtillus*) is well represented to luxuriant.....**ABCO/VAMY2**, page 260.
16. Whortleberry is poorly represented or absent....17
17. Kinnikinnick (*Arctostaphylos uva-ursi*) is well represented.....**ABCO/ARUV**, page 193.
17. Kinnikinnick is poorly represented or absent.....18
18. Mountain snowberry (*Symphoricarpos oreophilus*) is a dominant shrub.....**ABCO/SYOR2**, page 255.
18. Mountain snowberry may be present, but not a dominant shrub...19
19. Nevada pea (*Lathyrus lanszwertii* var. *arizonica*) is well represented.....**ABCO/LALAL3**, page 220.
19. Sprucefir fleabane (*Erigeron eximius*) is well represented.....**ABCO/EREX4**, page 202.

## **Key D: Douglas Fir (& Limber Pine) Series**

(All page numbers refer to Volume 1: Forests)

1. Limber pine (*Pinus flexilis*, not [sw white pine] *Pinus strobiformis*) is a climax tree....2

1. Limber pine is seral or absent...4

2. Kinnikinnick (*Arctostaphylos uva-ursi*) is well represented.....**PIFL2/ARUV**, page 265.

2. Kinnikinnick is poorly represented or absent.....3

3. Arizona fescue (*Festuca arizonica*) is common.....**PSME/FEAR2, PIFL2 phase**, page 278.

3. Arizona fescue is absent, or scarce (but not due to grazing pressure) .....**PSME/MUMO, PIFL2 phase**, page 291.

4. Bigtooth maple common (location generally in southern Arizona or adjoining areas) .....**PSME/ACGR3**, page 268.

4. Bigtooth maple scarce or absent.....5

5. Species of oak well represented ..... 6

5. Species of oak poorly represented ..... 9

6. Wavyleaf oak (*Quercus X pauciloba*) is well represented....**PSME/QUPA4**, page 316.

6. Wavyleaf oak is poorly represented or absent ..... 7

7. Gambel oak (*Quercus gambelii*) is well represented ....**PSME/QUGA**, page 306.

7. Gambel oak is poorly represented or absent ..... 8

8. Silverleaf oak (*Quercus hypoleucoides*) is common .... **PSME/QUHY**, page 311.

8. Silverleaf oak is scarce or absent ..... **PSME/QUAR**, page 302.

9. Kinnikinnick (*Arctostaphylos uva-ursi*) is abundant; other shrubs are poorly represented.....**PSME/ARUV**, page 271.

9. Kinnikinnick is absent or not abundant.....10

10. Herb cover poorly represented, or if well represented, rock spirea (*Holodiscus dumosus*) is common.....11

10. Herb cover well represented to luxuriant....12

11. Rock spirea is common (location southern or central New Mexico).....**PSME/HODU**, page 283.

11. Rock spirea absent or scarce.....**PSME/MARE11**, page 287.

12. Screwleaf muhly (*Muhlenbergia straminea*) is common.....**PSME/MUST**, page 295.

12. Screwleaf muhly is absent or scarce....13

13. Arizona fescue (*Festuca arizonica*) or Kentucky bluegrass (*Poa pratensis*) common; shrubs poorly represented ..... **PSME/FEAR2**, page 278.
13. Grasses not as described above ..... 14
14. Herb cover luxuriant; fringed brome (*Bromus ciliatus*) is usually abundant...**PSME/BRCI**, page 274.
14. Herb cover is not luxuriant, but may be well represented to abundant....15
15. Ponderosa pine (*Pinus ponderosa*) absent or seral ..... 16
15. Ponderosa pine climax; Douglas-fir (*Pseudotsuga menziesii*) is sometimes co-climax ..... 17
16. Quaking aspen (*Populus tremuloides*) is a major seral tree .... **ABCO/ACGL**, page 180.
16. Aspen is absent or scarce even in young stands ..... **PSME/PHMO4**, page 299.
17. Cliffrose (*Purshia stansburyana*) is well represented.....**PIPO/PUST**, page 362.
17. Cliffrose is scarce or absent ..... **PSME/MUMO**, page 291.

## **Key E: Ponderosa Pine Series**

(All page numbers refer to Volume 1: Forests)

1. Very open forests on sanddunes, cinders or rockland.....2
1. Forests and environments otherwise.....4
2. Rockland (soils <4" deep over most of area)..... **PIPO/rockland**, page 396.
2. Sandy or cindery soils .....3
3. Sandy soils; hoary rosemint (*Poliomintha incana*) present...**PIPO/ACHY**, p. 319.
3. Soils of volcanic cinder cones .....**PIPO/BOGR2, ANHA phase**, page 333.
4. Walnut (*Juglans major*) or canyon grape (*Vitis arizonica*) common; on terraces of intermittent washes or streamsides (central & southern AZ, SW NM) .....**PIPO/JUMA**, page 345.
4. Above species scarce or absent .....5
5. Oaks (*Quercus* spp.) and/or New Mexico locust (*Robinia neomexicana*) are well represented .....6
5. Oaks absent or poorly represented.....14
6. Gambel oak (*Quercus gambelii*) and/or New Mexico locust (*Robinia neomexicana*) are well represented as trees or shrubs; and Gambel oak is the dominant oak ..... **PIPO/QUGA**, page 375.
6. Gambel oak is poorly represented or absent, or not the dominant oak.....7
7. Oak species include Arizona white oak (*Quercus arizonica*), Emory oak (*Quercus emoryi*), silverleaf oak (*Quercus hypoleucoides*), or netleaf oak (*Quercus rugosa*) [location is below the Mogollon Rim or adjoining areas of SW NM)]...8
7. Oak species above are not present [may include Gray oak or wavyleaf oak (*Quercus Xpauciloba*) ]...13
8. Species of manzanita (*Arctostaphylos* spp.) usually abundant.... **PIPO/ARPU5**, page 326.
8. Species of manzanita not abundant or absent....9
9. Silverleaf oak (*Quercus hypoleucoides*) is well represented.....**PIPO/QUHY**, page 385.
9. Silverleaf oak is poorly represented or absent...10
10. Emory oak (*Quercus emoryi*) is well represented along drainages with granitic soils....**PIPO/QUEM**, page 371.

10. Emory oak is poorly represented or absent, or environments otherwise...11
11. Netleaf oak (*Quercus rugosa*) at least common, usually well represented or abundant....**PIPO/QURU4**, page 393.
11. Netleaf oak is scarce or absent.....12
12. Mountain muhly (*Muhlenbergia montana*) is well represented....**PIPO/MUMO**, page 349.
12. Mountain muhly is poorly represented or absent.....**PIPO/QUAR**, page 366.
13. Gray oak (*Quercus grisea*) is common.... **PIPO/QUGR3**, page 381.
13. Gray oak is scarce, wavyleaf oak is common....**PIPO/QUPA4**, page 389.
14. Understory essentially grassy, shrubs poorly represented....15
14. Shrubs are well represented in the understory....19
15. Arizona fescue (*Festuca arizonica*) present, or screwleaf muhly (*Muhlenbergia straminea*) common or Kentucky bluegrass (*Poa pratensis*) well represented...16
15. Grasses not as described above....18
16. Arizona fescue is present, usually at least common, or Kentucky bluegrass is well represented; screwleaf muhly is absent to well represented.....17
16. Arizona fescue is absent; screwleaf muhly is common to abundant....**PIPO/MUST**, page 354.
17. Screwleaf muhly (*Muhlenbergia straminea*) is at least common....**PIPO/MUST-FEAR2**, page 358.
17. Screwleaf muhly is scarce or absent.... **PIPO/FEAR2**, page 340.
18. Mountain muhly (*Muhlenbergia montana*) is well represented....**PIPO/MUMO**, page 349.
18. Mountain muhly is poorly represented; blue grama (*Bouteloua gracilis*) is usually well represented (if poorly represented, pinyon or alligator juniper are common).....**PIPO/BOGR2**, page 333.
19. Manzanita (*Arctostaphylos* spp.) is well represented, usually abundant (location is south of Mogollon Rim).....**PIPO/ARPU5**, page 326.
19. Manzanita is poorly represented or absent....20
20. Kinnikinnick (*Arctostaphylos uva-ursi*) is well represented...**PIPO/ARUV**, page 330.
20. Kinnikinnick is poorly represented or absent.....21



21. Cliffrose (*Purshia stansburyana*), bitterbrush (*Purshia tridentata*), or their hybrids are well represented.....**PIPO/PUST**, page 362.
21. Above shrubs are poorly represented or absent....22
22. Black sagebrush (*Artemisia nova*) is well represented (northern NM or northern AZ).....**PIPO/ARNO4**, page 322.
22. Big sagebrush (*Artemisia tridentata*) is well represented.....**PIPO/BOGR2, ARTR2 phase**, page 333.

## **Key F: Apache Pine and Chihuahuan Pine Series**

(All page numbers refer to Volume 1: Forests)

1. Apache pine (*Pinus engelmannii*) present....2

1. Apache pine (*Pinus engelmannii*) absent....3

2. Silverleaf oak (*Quercus hypoleucoides*) or netleaf oak (*Quercus rugosa*) are dominant in the understory....**PIEN2/QUHY**, page 413.

2. Silverleaf oak and/or netleaf oak are poorly represented and subdominant, or absent ....**PIEN2/MULO**, page 410.

3. Pinyon ricegrass (*Piptochaetium fimbriatum*) mostly well represented or abundant .....**PILE/PIFI**, page 399.

3. Pinyon ricegrass usually poorly represented....4

4. Silverleaf oak (*Quercus hypoleucoides*) is the leading oak.....**PILE/QUHY**, page 407.

4. Silverleaf oak is minor among other oaks....**PILE/QUAR**, page 403.

## **Key G: Riparian Forests**

(All page numbers refer to Volume 1: Forests.)

1. Narrowleaf cottonwood (*Populus angustifolia*) well represented.....**POAN series**
1. Narrowleaf cottonwood poorly represented.....2
2. Essentially coniferous forest [aspen may be present].....3
2. Forests not strictly coniferous.....5
3. Subalpine fir (*Abies bifolia*) and /or Engelmann spruce *Picea engelmannii*) dominates the overstory along streams.....**ABLA (riparian) series**
3. Subalpine fir is not dominant in the overstory.....4
4. Blue spruce (*Picea pungens*) dominates the overstory along streams.....**PIPU (riparian) series** ( see **PIPU/COSES** in **PIPU** key), page 147.
4. White fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), and/or quaking aspen (*Populus tremuloides*) codominates the overstory along streams.....**ABCO (riparian) series** (see **ABCO/JUMA** in **ABCO** key), page 215.
5. Alder (*Alnus*) thickets line streamsides.....6
5. Alders not dominant in the overstory.....7
6. Arizona alder (*Alnus oblongifolia*) common.....**POAN3 series**
6. Thinleaf alder (*Alnus incana* ssp. *tenuifolia*) dominant.....**ALINT series**
7. Arizona sycamore (*Platanus wrightii*) common.....**PLWR2 series**
7. Arizona sycamore scarce or absent.....8
8. Rio Grande cottonwood (*Populus deltoides* ssp. *wislizensi*) common....**PODEW series**
8. Rio Grande cottonwood scarce or absent.....in a series not covered in this key.

## **Key H: Madrean Oak Woodlands**

(All page numbers refer to Volume 2: Woodlands.)

1. Mexican blue oak (*Quercus oblongifolia*) common....2
1. Mexican blue oak absent or scarce....3
2. Savannas of gentle slopes or deep, alluvial soils....**QUOB/mixed Bouteloua**, page 86.
2. Savannas usually of moderate or steep colluvial slopes.....**QUOB/DAWH2**, page 76.
3. Gray oak (*Quercus grisea*) is well represented....4
3. Gray oak is poorly represented or absent....5
4. Essentially grassy understory....**QUGR3/BOCU**, page 63.
4. Essentially shrubby understory (chaparral woodland).....**QUGR3/CEMO2**, page 62.
5. Emory oak (*Quercus emoryi*) is well represented....6
5. Emory oak is poorly represented or absent .....12
6. Tall (>30 ft.) Emory oak on dry terraces along drainages.....**QUEM/JUMA**, page 79.
6. Shorter trees in other environments....7
7. Generally open woodlands with grassy understories (savannas)....8
7. Closed woodlands or woodlands with shrubby understories...9
8. Savannas on mostly alluvial soils....**QUEM/BOCU**, page 72.
8. Savannas on mostly moderate or steep colluvial slopes.....**QUEM/DAWH2**, page 76.
9. Shrubs abundant or luxuriant....10
9. Shrubs common or well represented....12
10. Manzanita (*Arctostaphylos pungens*) common to abundant....**QUEM/ARPU5**, page 69.
10. Manzanita scarce or absent....11
11. Shrub live oak (*Quercus turbinella*) well represented....**PIMO/QUTU2** (= **PIFA/QUTU2**), page 157.
11. Shrub live oak poorly represented....**PIED/CEMO2** (= **PIFA/CEMO2**), page 107.
12. Silverleaf oak (*Quercus hypoleucoides*) well represented....13
12. Silverleaf oak poorly represented ....14
13. Longtongue muhly (*Muhlenbergia longiligula*) usually common; mature oaks are trees (not shrubs)....**QUHY/MULO**, page 83.
13. Longtongue muhly scarce; mature oaks are shrubby....**PIDI3/QUHY**, page 170.

- 14. Grasses poorly represented....**QUAR/RHTR**, page 59.
- 14. Grasses well represented to abundant....15
- 15. Savannas mostly of moderate or steep colluvial slopes..**QUAR/MUEM**, page 53.
- 15. Savannas on mostly alluvial soils....16
- 16. Utah juniper (*Juniperus osteosperma*) well represented.....**PIMO/BOGR2** (= PIFA/BOGR2), page 150.
- 16. Utah juniper poorly represented or absent....**QUAR/PIFI**, page 56.

## **Key I: Pinyon Pine Series**

(All page numbers refer to Volume 2: Woodlands.)

1. Herbs are scarce; shrubs scarce or common....2
1. Both herbs and shrubs are at least common....6
2. Open woodlands on rockland (soils < 4" deep)...**PIED/rockland**, page 137.
2. Soils > 4" deep.....3
3. Soils clearly erosional (dissected by active rills and gullies)...4
3. Soils not actively rilled or gullied (sheet erosion may be occurring)[location is central to southern Arizona] ....**PIMO/YUBA** (= PIFA/YUBA), page 160.
4. Pinyon pine is twoneedle pinyon (*Pinus edulis*).....**PIED/sparse**, page 140.
4. Pinyon pine is either singleleaf pinyon (*Pinus monophylla*) or border pinyon (*Pinus discolor*) [geographic location is below the Mogollon Rim in Arizona or adjoining areas of New Mexico]....5
5. Arizona pinyon is the dominant pinyon....**PIMO/sparse** (= PIFA/sparse), page 140.
5. Border pinyon is the dominant pinyon....**PIDI3/sparse**, page 140.
6. Gambel oak (*Quercus gambelii*) is well represented....**PIED/QUGA**, page 131.
6. Gambel oak (*Quercus gambelii*) is poorly represented....7
7. Rubber rabbitbrush (*Ericameria nauseosus*) or Apacheplume (*Fallugia paradoxa*) are common to abundant along washes...8
7. Not as above...9
8. The pinyon is twoneedle pinyon (*Pinus edulis*)....**PIED/ERNA10-FAPA**, page 111.
8. The pinyon is singleleaf pinyon (*Pinus monophylla*).....**PIMO/ERNA10-FAPA** (= PIFA/ERNA10-FAPA), page 111.
8. The pinyon is Mexican pinyon (*Pinus discolor*) [3-needle pinyon].....**PIDI3/ERNA10-FAPA**, page 111.
9. Geographic location is south of the Mogollon Rim and adjoining areas....10
9. Geographic location is other locations in Arizona and New Mexico not described above....22
10. Essentially grassy woodlands; shrubs scarce to well represented....11

10. Essentially shrubby woodlands; shrubs well represented to abundant; grasses poorly represented....14
11. Border pine (*Pinus discolor*) common to well represented....12
11. Arizona pine (*Pinus fallax*) or twoneedle pine (*Pinus edulis*) common to well represented....13
12. Colluvial soils often of moderate to steep slopes....**PIDI3/MUEM**, page 164.
12. Alluvial soils of valleys or gentle lower slopes....**PIDI3/PIFI**, page 167.
13. Utah juniper is the leading juniper.....**PIMO/BOGR2, JUOS phase** (= PIFA/BOGR2, JUOS phase), page 150.
13. Alligator juniper is the leading juniper....**PIMO/BOGR2, JUDE2 phase** (= PIFA/BOGR2, JUDE2 phase), page 150.
14. Crucifixion thorn (*Canotia holacantha*) present.....**PIMO/CAHO3** (= PIFA/CAHO3), page 154.
14. Crucifixion thorn absent.....15
15. Mountain mahogany (*Cercocarpus* spp.) well represented....16
15. Mountain mahogany poorly represented....17
16. Twoneedle pinyon (*Pinus edulis*) well represented....**PIED/CEMO2**, page 107.
16. Border pinyon (*Pinus discolor*) well represented.....**PIDI3/RHVIC**, page 176.
17. Oaks well represented to abundant in understory....18
17. Oaks (as understory) poorly represented or absent...**PIDI3/CHDUA**, page 162.
18. Toumey oak (*Quercus toumeyii*) or its hybrids are present.....**PIDI3/QUTO2**, page 173.
18. Toumey oak or its hybrids are absent....19
19. Silverleaf oak (*Quercus hypoleucoides*) is common.....**PIDI3/QUHY**, page 170.
19. Silverleaf oak is scarce or absent.....20.
20. Manzanita (*Arctostaphylos pungens*) is scarce or absent.....**PIMO/QUTU2** (= PIFA/QUTU2), page 157.
20. Manzanita is at least common....21
21. Arizona pinyon (*Pinus fallax*) is well represented....**PIMO/ARPU5** (= PIFA/ARPU5), page 146.
21. Twoneedle pinyon (*Pinus edulis*) or border pinyon (*Pinus discolor*) or mixtures of these pinyons are well represented....**PIED (PIDI3)/ARPU5**, page 95.

22. Manzanita (*Arctostaphylos pungens*) or blackbrush (*Coleogyne ramosissima*) well represented....23
22. Manzanita or blackbrush scarce or absent....24
23. Manzanita is well represented....**PIED/ARPU5** or **PIMO/ARPU5** (= **PIFA/ARPU5**), page 95.
23. Blackbrush is well represented....**PIED/CORA**, page 114.
24. Oaks are well represented....25
24. Oaks are poorly represented....34
25. Gray oak (*Quercus grisea*) is dominant, twoneedle pinyon is common (mostly in NM)....**PIED/CEMO2**, page 107.
25. Other oaks are dominant [including Arizona white oak (*Quercus arizonica*), Gambel oak (*Quercus gambelii*), and wavyleaf oak (*Quercus Xpauciloba*)].....26
26. Arizona white oak is dominant.....27
26. Other oaks are dominant.....29
27. Border pinyon (*Pinus discolor*) is common....**PIDI3/MUEM**, page 164.
27. Border pinyon is absent or scarce.....28
28. Perennial herbs are scarce....**QUAR/RHTR**, page 59.
28. Perennial herbs (especially grasses) are at least common..**QUAR/PIFI**, page 56.
29. Wavyleaf oak (*Quercus Xpauciloba*) is at least common.....30
29. Wavyleaf oak is absent or scarce.....**PIED/QUGA**, page 131.
30. Understory is essentially shrubby; true mountain mahogany (*Cercocarpus montanus*) or wavyleaf oak is common or well represented.....31
30. Understory is essentially grassy.....32
31. True mountain mahogany is common or well represented.....**PIED/CEMO2**, page 107.
31. True mountain mahogany is scarce; wavyleaf oak is well represented or abundant....**PIED/QUPA4**, page 134.
32. Pine muhly (*Muhlenbergia dubia*) is common.....**PIED/MUDU**, page 118.
32. Pine muhly is absent or scarce.....33
33. Twoneedle pinyon (*Pinus edulis*) is second to oneseed juniper (*Juniperus monosperma*) in cover...**PIED/MUPA2**, page 120.
33. Twoneedle pinyon and oneseed juniper are codominants.....**PIED/ACNED**, page 143.



34. Understory essentially shrubby; shrubs well represented or abundant...35
34. Understory essentially grassy; shrubs scarce to well represented...41
35. True mountain mahogany (*Cercocarpus montanus*) common or well represented....36
35. True mountain mahogany scarce or absent....37
36. Gambel oak (*Quercus gambelii*) common; true mountain mahogany poorly represented....**PIED/QUGA**, page 131.
36. Gambel oak present or absent; true mountain mahogany well represented....**PIED/CEMO2**, page 107.
37. Sandy soils; sand sagebrush (*Artemisia filifolia*) or sand bluestem (*Andropogon hallii*) present to abundant.....**PIED/ANHA**, page 92.
37. Soils otherwise; sand sagebrush or sand bluestem scarce or absent....38
38. Big sagebrush (*Artemisia tridentata*) or antelope bitterbrush (*Purshia tridentata*) common or well represented (northern AZ or northern NM); cliffrose (*Purshia stansburyana*) present or absent....39
38. Big sagebrush or bitterbrush scarce or absent; cliffrose present to abundant.....**PIED/PUST**, page 109.
39. Bitterbrush common....**PIED/PUTR2**, page 128.
39. Bitterbrush scarce or absent....40
40. Cliffrose (*Purshia stansburyana*) common....**PIED/PUST, ARTR2 phase**, page 109.
40. Cliffrose absent or scarce .....**PIED/ARTR2**, page 98.
41. Arizona fescue (*Festuca arizonica*) present.....**PIED/FEAR2**, page 116.
41. Arizona fescue absent....42
42. Sandy soils; sand bluestem (*Andropogon hallii*) or sandhill muhly (*Muhlenbergia pungens*) common to abundant....**PIED/ANHA**, page 192.
42. Soils otherwise; above grasses scarce or absent....43
43. Dore's needlegrass (*Stipa nelsonii* spp. *dorei*) or Schribner needlegrass (*Stipa schribneri*) common to well represented....**PIED/ACNED**, page 143.
43. Above grasses scarce (or poorly represented, if description doesn't fit) ....44
44. Border pinyon (*Pinus discolor*) common (so. AZ or so. NM)...**PIDI3/MUEM**, page 164.
44. Border pinyon absent or scarce....45

45. Herbaceous cover <5% with stony soils and often steep slopes ....  
**PIED/BOGR2, hillslope phase**, page 150.
45. Herbaceous cover well represented....46
46. Muttongrass (*Poa fendleriana*) common.....**PIED/POFE**, page 122.
46. Muttongrass absent or scarce..... 47
47. Alligator juniper (*Juniperus deppeana*) common ..... **PIED/BOGR2, JUDE2 phase**, page 150.
47. Alligator juniper scarce or absent .....48
48. Utah juniper (*Juniperus osteosperma*) common .....**PIED/BOGR2, JUOS phase**, page 150.
48. Utah juniper scarce or absent .....**PIED/BOGR2, JUMO phase**, page 150.

## **Key J: Juniper Woodlands**

(All page numbers refer to Volume 2: Woodlands.)

1. Perennial herbs scarce, soils with high erosion.....**Juniper/sparse**, page 205.
1. Perennial herbs common or soils otherwise....2
2. Geographic location below the Mogollon Rim in Arizona or in adjoining areas of southwestern New Mexico....3
2. Geographic location above the Mogollon Rim in Arizona or in southeastern, central or northern New Mexico.....12
3. Utah juniper (*Juniperus osteosperma*) dominant or codominant with redberry juniper (*Juniperus coahuilensis*) or oneseed juniper (*Juniperus monosperma*) [stringy bark junipers]....4
3. Other junipers dominant ....6
4. Tobosa (*Hilaria mutica*) well represented (sometimes curly mesquite [*H. belangeri*] is well represented or abundant)....**JUOS/PLMU3**, page 201.
4. Tobosa is poorly represented or absent...5
5. Cliffrose (*Purshia stansburiana*) is poorly represented.....**JUOS/BOGR2**, page 197.
5. Cliffrose is well represented....**JUOS/BOGR2**, **PUST phase**, page 197.
6. Alligator juniper (*Juniperus deppeana*) is dominant....7
6. Alligator juniper is secondary to other junipers or absent...8
7. Understory shrubs are abundant .....**JUDE2/ARPU5**, page 179.
7. Understory shrubs are scarce or common....**JUDE2/BOGR2**, page 182.
8. Shrub live oak (*Quercus turbinella*) abundant....**JUCO11/QUTU2**, **QUTU2 phase**, page 242.
8. Shrub live oak not abundant....9
9. Crucifixion thorn (*Canotia holacantha*) present.... **JUCO11/CAHO3**, page 238.
9. Crucifixion thorn absent...10
10. Mesquite at least common....**JUCO11/QUTU2**, **PRVE phase**, page 242.
10. Mesquite absent or scarce....11
11. Oneseed juniper (*Juniperus monosperma*) well represented [SW New Mexico and adjoining AZ]... **JUMO/BOCU**, **NOMI phase**, page 217.

11. Redberry juniper (*Juniperus coahuilensis*) well represented [central and SE AZ]....**JUCO11/QUTU, BOGR2 phase**, page 242.
12. Deep sandy soils with sand bluestem (*Andropogon hallii*), sandhill muhly (*Muhlenbergia pungens*), or broom dalea (*Psoralea scoparius*)....**JUMO/ANHA**, page 210.
12. Soils and vegetation otherwise....13
13. Shrubs well-represented and include Bigelow sagebrush (*Artemisia bigelovii*).... **JUMO/ARBI3**, page 212
13. Vegetation otherwise...14
14. Calcareous soils with winterfat (*Ceratoides lanata*)....**JUMO/KRLA2**, page 229.
14. Soils or vegetation otherwise.....15
15. Sandy or gravelly washes with rubber rabbitbrush (*Chrysothamnus nauseosus*) or Apacheplume (*Fallugia paradoxa*)....**JUMO/ERNA10-FAPA**, page 225.
15. Soils or dominant shrubs otherwise....16
16. Big sagebrush (*Artemisia tridentata*) is well represented [northern NM or northern AZ] ....17.
16. Big sagebrush absent or poorly represented...18
17. Oneseed juniper is dominant.....**JUMO/ARTR2**, page 214.
17. Utah juniper is dominant....**JUOS/ARTR2**, page 194.
18. Alligator juniper well represented....19
18. Alligator juniper absent or scarce....22
19. Gray oak common....20
19. Gray oak scarce....**JUDE2/BOGR2**, page 182.
20. Bullgrass (*Muhlenbergia emersleyi*) well represented; Guadalupe Mountains....**JUDE2/MUEM**, page 189.
20. Bullgrass absent or scarce....21
21. True mountain mahogany (*Cercocarpus montanus*) or desert ceanothus (*Ceanothus greggii*) common [see also scarp woodland]....**JUDE2/CEGR**, page 186.
21. True mountain mahogany or desert ceanothus scarce.....**JUDE2/RHTR**, page 191.
22. Grassy savannas; shrubs poorly represented....23
22. Shrubs well represented; grasses scarce to abundant.....25
23. Oneseed juniper is dominant....24
23. Utah juniper is dominant....**JUOS/BOGR2**, or **JUMO/BOGR2, JUOS phase**, page 197.

24. Sideoats grama (*Bouteloua curtipendula*) is common; often colluvial soils of hillslopes.....**JUMO/BOCU**, page 217.
24. Sideoats grama is scarce; often alluvial soils of valley plains and piedmont fans.....**JUMO/BOGR2**, page 221.
25. Lechuguilla (*Agave lechuguilla*) is common....26
25. Lechuguilla is scarce or absent....27
26. Sacahuista (*Nolina microcarpa*) is common.....**JUMO/NOMI-AGLE**, page 232.
26. Sacahuista is scarce or absent....**JUMO/AGLE**, page 208.
27. Creosote bush (*Larrea tridentata*) is common.....**JUPI/LATR2**, page 246.
27. Creosote bush is absent or scarce.....28
28. Wavyleaf oak (*Quercus X pauciloba*) is well represented.....**JUMO/QUPA4**, page 235.
28. Wavyleaf oak is poorly represented.....20

# Arizona Cypress Series

HEAR22/QUHY

## Arizona cypress/silverleaf oak

### *Hesperocyparis arizonica/Quercus hypoleucoides*

(Formerly: *Cupressus arizonica/Quercus turbinella*)

#### Codes

typic phase 0 31 01

#### Ecological Response Unit

Madrean Pinyon-Oak (MPO)

#### NVC Group

Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

#### Key criteria

Chaparral or woodlands of elevations less than 6,000' (1,830 m) with \***Arizona cypress** mixed with oaks, pinyons and junipers, also lacking significant presence of spruces, firs and Douglas-fir; \***silverleaf oak common**.

#### Location

Slopes and drainages on a wide variety of landforms, parent materials, and soils; often cool north or east slopes, or sites with high subsurface water tables or lateral flows; at elevations from 4,800' to 5,800' (1,460 to 1,770 m); Woods Canyon, Arizona, Dagoon, Santa Catalina, and Chiricahua Mountains of southeastern Arizona.

#### Adjacent plant associations

Arizona cypress is likely to border a wide variety of other woodland and shrub

communities including those dominated by juniper, mesquite, oak, pinyon, or pine.

#### Also see

TES mapping units 714 and 720 and *Hesperocyparis arizonica/Pinus discolor/Quercus hypoleucoides* subseries for Apache National Forest (USFS 1987b); Parker (1980ab).

Moir and Lukens (1976), Wetter habitats containing *Hesperocyparis arizonica* are riparian forests. HEAR22/QUTU2 is a drier h.t. lacking silverleaf oak.

## **Trees**

Luxuriant (>50% cover):

\* **Arizona cypress** (*Hesperocyparis arizonica*)

border pinyon (*Pinus discolor*)

\***silverleaf oak** (*Quercus hypoleucoides*) canyon liveoak (*Quercus chrysolepis*) Arizona white oak (*Quercus arizonica*)

## **Shrubs**

Well represented (>5% cover):

netleaf oak (*Quercus rugosa*)

pointleaf manzanita (*Arctostaphylos pungens*)

alderleaf mountain mahogany (*Cercocarpus montanus*)

cliff fendlerbush (*Fendlera rupicola*)

Wright's silktassel (*Garrya wrightii*)

Fendler ceanothus (*Ceanothus fenderli*)

sacahuista (*Nolina microcarpa*)

singleleaf ash (*Fraxinus anomala*)

common chokecherry (*Prunus virginiana*)

## **Herbs**

Common (>1% cover):

sideoats grama (*Bouteloua curtipendula*)

muttongrass (*Poa fendleriana*)

White Mountain sedge (*Carex geophila*)

prairie junegrass (*Koeleria macrantha*)

Pringle's speargrass (*Piptochaetium pringlei*)

needlegrasse (*Achnatherum* spp.)

bottlebrush squirreltail (*Elymus elymoides*)

little bluestem (*Schizachyrium scoparium*)

longtongue muhly (*Muhlenbergia longiligula*)

mat muhly (*Muhlenbergia richardsonii*)

New Mexico groundsel (*Packera neomexicana* var. *neomexicana*)

## **Brief plant ID notes**

Arizona cypress is a medium sized native, evergreen, scale-leaved tree; mature trees range from 30' to 90' (9 to 19 m) in height. It has a conical or rounded crown, a straight trunk with bark that varies from smooth and reddish to rough, furrowed and fibrous or checkered. Leaves are minute, overlapping, pointed, pale green scales. The fruit is a persistent globe-shaped cone with 6-8 scales, each with a prickle in the center.

## **Synonymy**

Pringle's speargrass (*Piptochaetium pringlei* = *Stipa pringlei*)

bottlebrush squirreltail (*Sitanion hystrix* = *Elymus elymoides*)

little bluestem (*Andropogon scoparius* = *Schizachyrium scoparium*)

Arizona cypress (*Hesperocyparis arizonica* = *Cupressus arizonica*)

New Mexico groundsel (*Packera neomexicana* var. *neomexicana* = *Senecio neomexicanus*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** +1 (cool, moist)

**Climate Class:** HSM (high sun mild)

## **Fire Ecology**

Mosaic patterns of different aged stands of uniform height and density are due to the patchy nature of surface fires which typically kill some but not all trees. Seedlings and saplings (diameters <4 inches (10cm)) have almost no resistance to even low-intensity surface fires. Surface fire may kill all seeds in cones on the ground (Parker 1980). Larger trees exhibit little fire resistance also. Crown fires may open cones on the tree, killing a portion of the seeds in the cone (Vogl et al. 1977). Arizona cypress owes to fire disturbance a tenuous existence. Too frequent fires can wipe out a grove, yet fire is needed sometime in its history to produce conditions for reproduction. Moir (1982) suggested that low-intensity surface fires with a frequency of 50 to 60 years serve to thin out Mexican pinyon thickets which could eventually exclude Arizona cypress. Fire frequencies exceeding 80 years may allow fuel buildup and produce a shift in dominance patterns from those species that are maintained by recurrent fire (Swetnam et al. 1989).

## **Reforestation**

Wood harvesting methods: Clearcutting favors oak. Partial overstory removal such as selection cutting favors Arizona cypress where there is more residual canopy, and favors oak with less dense overstory.

Where soil texture and slopes are suitable, mechanical site prep generally favors oak regeneration. Burning favors oak and cypress. No disturbance favors cypress regeneration.

## **Revegetation Considerations**

See HEAR22/QUTU2.



**Comments**

Natural disturbance such as flooding: favors Arizona cypress.

The forage value rating for cattle in early seral stages is moderate and in late seral is low.

**References**

- Carmichael et al. 1978
- Little 1950
- Moir 1982
- Moir and Lukens 1979
- Parker 1980a
- Smith 1974
- Swetnam et al. 1989
- USFS 1986
- USFS 1987b
- USFS 1986 A-S TES

**Arizona cypress/shrub live oak**  
***Hesperocyparis arizonica/Quercus turbinella***  
(Formerly: *Cupressus arizonica/Quercus turbinella*)

**Codes**

typic phase 0 31 02

**Ecological Response Unit**

PJ Evergreen Shrub (PJC)

**NVC Group**

Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

**Key Criteria**

Chaparral or woodlands of elevations less than 6,000' (1,830 m) with  
\***Arizona cypress** mixed with oaks, pinyons and junipers, also lacking  
significant presence of spruces, firs, and Douglas-fir. Silverleaf oak  
absent or accidental.

**Location**

Moderately steep canyon slopes or alluvial toe slopes with mostly  
northerly aspects; at elevations from 4,800' to 5,800' (1,460 to 1,770 m);  
distribution includes Wood Canyon near Clifton, in vicinity of Sedona,  
local elsewhere in southern and southeastern Arizona; also, north of  
Cooke's Peak, NM.

**Also See**

Arizona cypress-shrub live oak association (Carmichael et al. 1987),  
HEGL4-PIMO- QUTU2-ARPU5 (mapping units 4468, 4469) on the  
Tonto NF (USFS 1986c): Parker 1980b. Information on stand structure  
and productivity and adjacent plant associations are not available.

**Trees**

Luxuriant (>50% cover):

\***Arizona cypress** (*Hesperocyparis arizonica*)  
twoneedle pinyon (*Pinus edulis*) singleleaf pinyon (*Pinus monophylla*)  
Utah juniper (*Juniperus osteosperma*)

**Shrubs**

Well represented (>5% cover): canyon live oak (*Quercus chrysolepis*)  
shrub live oak (*Quercus turbinella*)  
pointleaf manzanita (*Arctostaphylos pungens*)

Pringle manzanita (*Arctostaphylos pringlei*)  
Wright's silktassel (*Garrya wrightii*)  
desert ceanothus (*Ceanothus greggii*)  
sugar sumac (*Rhus ovata*)  
alderleaf mountain mahogany (*Cercocarpus montanus*)  
Stansbury cliffrose (*Purshia stanburiana*)  
cliff fendlerbush (*Fendler rupicola*)  
singleleaf ash (*Fraxinus anomala*)  
catclaw mimosa (*Mimosa aculeallicarpa* var *biuncifera*)  
redberry buckthorn (*Rhamnus crocea*)

## **Herbs**

Scarce (<1% cover): Scarcity of herbs due to strong tree and shrub dominance.

## **Brief plant ID notes**

Arizona cypress is a medium sized native, evergreen, scale-leaved tree; mature trees range from 30' to 90' (9 to 19 meters) in height. It has a conical or rounded crown, a straight trunk with bark that varies from smooth and reddish to rough, furrowed and fibrous or checkered. Leaves are minute, overlapping, pointed, pale green scales. The fruit is a persistent globe-shaped cone with 6 - 8 scales, each with a prickle in the center.

## **Synonymy**

Arizona cypress (*Hesperocyparis arizonica* = *Cupressus arizonica*)  
smooth Arizona cypress (*Hesperocyparis glabra* = *Cupressus glabra*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** 0 (typical)

**Climate Class:** LSM (low sun mild)

## **Phases**

Although no phases are described, the description of this plant association covers elevational subzones ranging from +1 through -1, and phase designations may be needed to distinguish mesic from xeric sites.

## **Fire Ecology**

Arizona cypress tends to occur in mosaics of different aged stands of uniform height and density; a condition due to the patchy nature of surface fires which typically kill some but not all trees. Seedlings and

saplings (diameters <4 inches (10cm)) have almost no resistance to even low-intensity surface fires. Surface fire will kill all seeds in cones on the ground (Parker 1980). Larger trees exhibit little fire resistance also. Crown fires may open cones on the tree, killing a portion of the seeds in the cone (Vogl et al. 1977).

Arizona cypress owes a tenuous existence to fire disturbance. Too frequent fires can wipe out a grove, yet fire is needed sometime in its history to produce conditions for reproduction. Moir (1982) suggested that low-intensity surface fires with a frequency of 50 to 60 years serve to thin out Mexican pinyon thickets which could eventually exclude Arizona cypress. Fire frequencies exceeding 80 years may allow fuel buildup and produce a shift in dominance patterns from those species that are maintained by recurrent fire.

### **Reforestation**

**Wood harvesting methods:** Clearcutting and seedtree harvest methods favor oak. Partial overstory removal such as selection cutting favors Arizona cypress where there is more residual canopy and favors oak with less dense overstory.

Where soil texture and slopes are suitable, mechanical site prep generally favors oak regeneration. Burning favors oak and cypress. No disturbance favors cypress regeneration.

### **Revegetation Considerations**

Community development of Arizona cypress follows various multiple pathways (See Parker 1980ab). Arizona cypress is considered a pioneer species. It is intolerant of litter accumulation, is tolerant of low light levels, and exhibits in-cone seed persistence. It may or may not depend on seed dispersal from distance sources to colonize any given disturbed site. It does, however, require disturbance to reproduce thus, flooding, human-caused activities, or fire at frequencies less than its longevity and at intensities or circumstances that result in removal of litter accumulation, rather than stand replacement, can trigger regeneration (Parker 1980ab).

### **Comments**

Natural disturbance such as flooding favors Arizona cypress.

The forage value rating for cattle in early seral is low and in late seral is none due to paucity of species beneath enclosed crowns.

## **References**

Carmichael et al. 1978

Little 1950

Moir 1982

Parker 1980a, 1980b

USFS 1986

USFS 1987b

USFS 1986 A-S TES

# Evergreen Oak Tree Series

QUAR/MUEM

## Arizona white oak/bullgrass

*Quercus arizonica/Muhlenbergia emersleyi*

### Code(s)

typic phase 6 30 03 0

### Ecological Response Unit

Madrean Pinyon-Oak (MPO)

### NVC Group

Madrean Encinal (G201)

### Key Criteria

Oak savannas on mostly moderate to steep colluvial slopes below 6,200' (1,890 m) with Arizona white oak and other oaks, pinyons, and junipers with grasses well represented (>5% cover).

### Location

Canyon and piedmont hill slopes of highly variable parent materials and soils; at elevations from 4,800' to 6,200' (1,460 to 1,890 m); Animas, Peloncillo, Burro Mountains of southwest New Mexico and adjoining southeastern Arizona; being extensive south of the Mogollon Rim in Arizona and is very local elsewhere.

### Also See

If twoneedle pinyon and alligator juniper (taken together) exceed Arizona white oak in coverage, then see PIED-QUAR/RHTR or PIED-QUAR/PIFI. Along the Arizona- New Mexico border, Arizona white oak and gray oak hybridize, and these oaks and their progeny may not be distinguishable. Open woodland (lower encinal) of Wittaker and Niering (1965) and Wagner (1977); Arizona white oak savanna (Moir 1979, Wallmo 1955). QUGR3/BOCU (USFS 1986a) mostly in southern New Mexico is very similar but lacks some of the Madrean plant species of QUAR/MUEM. In the Glenwood RD, see Terrestrial Ecosystems Survey map units 4836 and 4850 (USFS 1985).

### Trees

Well represented (>5% cover):

Arizona white oak (*Quercus arizonica*)  
Emory oak (*Quercus emoryi*)  
alligator juniper (*Juniperus deppeana*)  
twoneedle pinyon (*Pinus edulis*)  
border pinyon (*Pinus discolor*)  
silverleaf oak (*Quercus hypoleucoides*) at <5% cover when present

## **Shrubs**

Common (>1% cover) to well represented (>5% cover):

sacahuista (*Nolina microcarpa*)  
skunkbush sumac (*Rhus trilobata*)  
turpentine bush (*Ericameria laricifolia*)  
catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*)  
pricklypear cacti (*Opuntia* spp.)  
common sotol (*Dasylirion wheeleri*)  
Wright's silktassel (*Garrya wrightii*)  
pointleaf manzanita (*Arctostaphylos pungens*)  
hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus*)  
Palmer's century plant (*Agave palmeri*)  
Schott yucca (*Yucca madrensis*)  
prairie acacia (*Acaciella angustissima*)  
Arizona Mexican orange (*Choisya Dumosa* var. *arizonica*)  
walkingstick cactus (*Cylindropuntia spinosior*)

## **Herbs**

Well represented (>5% cover) to abundant (>25% cover):

Texas bluestem (*Schizachyrium cirratum*)  
Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*)  
sideoats grama (*Bouteloua curtipendula*)  
bullgrass (*Muhlenbergia emersleyi*)  
plains lovegrass (*Eragrostis intermedia*)  
blue grama (*Bouteloua gracilis*)  
common wolftail (*Lycurus phleoides*)  
pinyon ricegrass (*Piptochaetium fimbriatum*)  
bulb panicgrass (*Panicum bulbosum*)  
bean (*Phaseolus* spp.)  
ticktrefoil (*Desmodium* spp.)

## **Brief Plant ID Notes**

Some additional shrubs and herbs of canyon oak woodlands include:

Apache plume (*Fallugia paradoxa*)  
California brickellbush (*Brickellia californica*)  
western white honeysuckle (*Lonicera albiflora*)  
Thurber desert honeysuckle (*Anisacanthus thurberi*)  
green sprangletop (*Leptochloa dubia*) [occasional on drier slopes].

**Synonymy**

hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus* = *C. breviflorus*)

Catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera* = *M. biuncifera*)

Texas bluestem (*Schizachyrium cirratum* = *Andropogon cirratus*)

yucca (*Yucca madrensis* = *Yucca schottii*)

prairie acacia (*Acaciella angustissima* = *Acacia angustissima*)

walkingstick cactus (*Cylindropuntia spinosior* = *Opuntia spinosior*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)

**Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** 0 (typical)

**Climate Class:** HSM (high sun mild)

**Fire Ecology**

Historically fires probably occurred about every 10 to 20 years in oak woodlands adjacent to semidesert grasslands; and every 1 to 38 years in the Chiricahua National Monument. (Pavek 1994c). Small Arizona white oak are top-killed by fire. Larger trees usually survive low intensity fires. Its foliage is highly flammable. Fires move quickly through oak woodlands that have a continuous grass understory. Surviving stumps sprout vigorously. Acorns not buried in the soil probably do not survive even low intensity fire.

**Comments**

MAP = 19"/yr, MAAT = 55 degrees F; dry season typically May and June. In canyon bottoms, trees often become more dense and taller (cover is abundant or luxuriant). This woodland is sometimes called closed encinal or canyon oak woodland.

**References**

USFS 1986

USFS 1987b

Pavek 1994c



## Arizona white oak/pinyon ricegrass

### *Quercus arizonica*/*Piptochaetium fimbriatum*

#### Synonyms

*Pinus edulis*-*Quercus arizonica*/*Piptochaetium fimbriatum* (USFS 1987b)

#### Code(s)

typic phase 6 30 05 0

#### Ecological Response Unit

Madrean Pinyon-Oak (MPO)

#### NVC Group

Madrean Encinal (G201)

#### Key Criteria

Oak woodland of typically dry soils with Arizona white oak and other oaks, pinyons and junipers. Grasses well represented (>5% cover) with pinyon ricegrass present among abundant herb ground cover. Utah juniper may be poorly represented (<5% cover) or absent.

#### Structure

Both QUAR/PIFI and QUAR/RHTR may be successional related by means of interaction between tree overstory and herbaceous understory, or they may be distinct habitat types. More study is needed.

#### Location

Deep alluvium along dry washes (cumulic and fluventic soils); at elevations from 5,400' to 5,800' (1,645 to 1,770 m); local in southwest New Mexico and south of the Mogollon Rim in Arizona, and is very local elsewhere.

#### Adjacent Plant Associations

Intergrades with QUAR/MUEM on certain sites.

#### Also See

QUEM/JUMA on similar sites at lower elevations; Cumulic Haplustolls component of map unit 4836 in TES for part of the Glenwood RD. If Arizona sycamore is common, see riparian forests.

## Trees

### Luxuriant (>50% cover):

Arizona white oak (*Quercus arizonica*)  
Emory oak (*Quercus emoryi*)  
alligator juniper (*Juniperus deppeana*)  
twoneedle pinyon (*Pinus edulis*)— in some locations  
border pinyon (*Pinus discolor*)  
Arizona walnut (*Juglans major*)

## Shrubs

### Well represented (>5% cover):

rubber rabbitbrush (*Ericameria nauseosus*)  
skunkbush sumac (*Rhus trilobata*)  
canyon grape (*Vitis arizonica*)  
pointleaf manzanita (*Arctostaphylos pungens*)  
Wright's silktassel (*Garrya wrightii*)  
sacahuista (*Nolina microcarpa*)  
broom snakeweed (*Gutierrezia sarothrae*)

## Herbs

### Usually abundant (>25% cover):

pinyon ricegrass (*Piptochaetium fimbriatum*)  
nodding brome (*Bromus anomalus*)  
Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*)  
muttongrass (*Poa fendleriana*)  
longtongue muhly (*Muhlenbergia longiligula*)  
bullgrass (*Muhlenbergia emersleyi*)  
deergrass (*Muhlenbergia rigens*)  
prairie junegrass (*Koeleria macrantha*)  
sideoats grama (*Bouteloua curtipendula*)  
blue grama (*Bouteloua gracilis*)  
Texas bluestem (*Schizachyrium cirratum*)  
Carruth's sagewort (*Artemisia carruthii*)  
white sagebrush (*Artemisia ludoviciana*)  
plains lovegrass (*Eragrostis intermedia*)  
bean (*Phaseolus* spp.)

## Synonymy

Texas bluestem (*Schizachyrium cirratum* = *Andropogon cirratus*)  
rubber rabbitbrush (*Ericameria nauseosa* = *Chrysothamnus nauseosus*)  
Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** 0 (typical)

**Climate Class:** HSM (high sun mild)

**References**

USFS 1987b

**Arizona white oak/skunkbush sumac**  
***Quercus arizonica/Rhus trilobata***

**Synonyms**

*Pinus edulis-Quercus arizonica/Rhus trilobata* (USFS 1986a)

**Code(s)**

alligator juniper (JUDE2) phase 6 30 04 1

oneseed juniper (JUMO) phase 6 30 04 2

pinyon ricegrass (PIFI) phase 6 30 04 3

**Ecological Response Unit**

*typic and pinyon ricegrass phases* - Madrean Pinyon-Oak (MPO)

*oneseed juniper and alligator juniper phases* - Madrean Encinal Woodland (MEW)

**NVC Group**

Madrean Encinal (G201)

**Key Criteria**

Closed oak woodlands with reduced herb ground cover and grasses poorly represented (<5% cover); with Arizona white oak and other oaks, pinyons and junipers.

**Structure**

Arizona white oak is a climax species in Madrean evergreen oak and encinal woodlands (Layser and Schubert 1979, in USFS/FEIS). QUAR/PIFI differs primarily by the well-developed herbaceous understory. Encinal woodlands, Madrean oak woodlands. The pine-oak woodland of Marshall (1957) features emergent pines (*Pinus leiophylla*, *P. engelmannii*, *P. ponderosa*) above the upper oak canopy. The QUAR/MUEM habitat type is a grassy savanna (open encinal), whereas QUAR/RHTR is more a closed woodland with reduced herbaceous understory. The forage value rating for cattle in early seral stage is moderate and in late seral stage is low due to shading of typically closed crown cover.

**Location**

Known from a wide variety of land formslandforms, parent materials, and soils; at elevations from 5,000' to 7,000' (1,540 to 2,130 m); southern

New Mexico and Arizona; being more common south of the Mogollon Rim in Arizona.

### **Adjacent Plant Associations**

QUAR/MUEM; scarp woodlands.

### **Also See**

See also the canyon oak woodlands (e.g., Moir 1979). In the Clifton RD (Apache NF), see TES mapping units 236, 575, 612, 620, 632, 634 of the PIED-JUDE2-JUMO-QUGR3 subseries; MUs 130 and 154 of this subseries can also be regarded as containing scarp woodland (USFS 1987b).

### **Trees**

Abundant (>25% cover) to luxuriant (>50% cover):

Arizona white oak (*Quercus arizonica*)

gray oak (*Quercus grisea*) and its hybrids to *Q. arizonica*

Emory oak (*Quercus emoryi*)

twoneedle pinyon (*Pinus edulis*) (HSM climates)

singleleaf pinyon (*Pinus monophylla*) (LSM)

alligator juniper (*Juniperus deppeana*)

oneseed juniper (*Juniperus monosperma*)

Utah juniper (*Juniperus osteosperma*) (usually associated with PIMO phase)

Arizona madrone (*Arbutus arizonica*) (southeast Arizona)

Texas madrone (*Arbutus xalapensis*) (S. Guadalupe Mountains, New Mexico)

### **Shrubs**

Common (>1% cover) to well represented (>5% cover):

skunkbush sumac (*Rhus trilobata*)

sacahuista (*Nolina microcarpa*)

Wright's silktassel (*Garrya wrightii*)

hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus*)

desert ceanothus (*Ceanothus greggii*)

common sotol (*Dasylirion wheeleri*)

yucca (*Yucca madrensis*)

banana yucca (*Yucca baccata*)

tulip pricklypear (*Opuntia phaeacantha*)

pricklypear cacti (*Opuntia* spp.)

Fendler ceanothus (*Ceanothus fendleri*)

evergreen sumac (*Rhus virens* var. *choriophylla*)

bastardsage (*Eriogonum wrightii*)

Palmer's century plant (*Agave palmeri*)

### **Herbs**

Poorly represented (<5% cover); scarce (<1% cover) to common (>1% cover)

Texas bluestem (*Schizachyrium cirratum*) [Guadalupe Mountains, NM]  
dwarf stickpea (*Calliandra humilis*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*)

Arizona threeawn (*Aristida arizonica*)

threeawn (*Aristida* spp.)

pinyon ricegrass (*Piptochaetium fimbriatum*)

blue grama (*Bouteloua gracilis*)

sideoats grama (*Bouteloua curtipendula*) bullgrass (*Muhlenbergia emersleyi*) plains

lovegrass (*Eragrostis intermedia*) bean (*Phaseolus* spp.)

sage (*Artemisia* spp.)

### **Synonymy**

hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus* = *C. breviflorus*)

evergreen sumac (*Rhus virens* var. *choriophylla* = *Rhus choriophylla*)

Schott yucca (*Yucca madrensis* = *Yucca schottii*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)

singleleaf pinyon (*Pinus monophylla* = *P. fallax*)

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** 0 (typical)

**Climate Class:** HSM (high sun mild) or LSM (low sun mild) for PIMO phase

### **Phases**

Oneseed juniper (JUMO) phase is the typical phase where twoneedle pinyon and oneseed juniper are codominant. In the alligator juniper (JUDE2) phase, twoneedle pinyon and alligator juniper are codominants. Singleleaf pinyon is codominant with Utah juniper in the PIMO phase. Further study may classify this woodland in the Guadalupe Mountains as a distinct plant association.

### **Fire Ecology**

Pavek 1994 indicates that historically, fires probably occurred about every 10 to 20 years in oak woodlands adjacent to semidesert grasslands; and every 1 to 38 years in the Chiricahua National Monument. Intense fires, as a disturbance factor, favor oak species. Small Arizona white oak are top-killed by fire. Larger trees usually survive low intensity fires. Its foliage is highly flammable. Fires move quickly through oak woodlands that have a continuous grass understory.

Surviving stumps sprout vigorously. Acorns not buried in the soil probably do not survive even low intensity fire.

### **Reforestation**

Wood harvesting methods: Partial retention of the overstory, as usually produced by selection and shelterwood harvesting methods, provides microclimates favorable for regeneration of oak. Heavier removal of the overstory as seen in seedtree and clear-cutting favors oak and skunkbush sumac. Planting is not recommended. Mechanical site prep and burning favors oak.

### **Revegetation Considerations**

Revegetation is expected to be rapid due to the sprouting of oak.

### **Comments**

MAP = 19"/yr, MAAT = 54 degrees F.

This plant association is productive for deer browse and offers effective hiding cover.

Arizona white oak acorns are consumed by cattle and wildlife; its foliage is highly palatable to white-tailed and mule deer in all seasons.

### **References**

USFS 1986

USFS 1987b

Pavek, D. S. 1994

**gray oak/sideoats grama**  
***Quercus grisea/Bouteloua curtipendula***

**Code(s)**

typic phase 6 30 01 0

**Ecological Response Unit**

Madrean Pinyon-Oak (MPO)

**NVC Group**

Madrean Encinal (G201)

**Key Criteria**

Oak savannas on foothills and canyons with **\*gray oak** and other oaks, pinyons, and junipers **with a grassy understory**.

**Structure**

The savanna or open woodland begins with about 5 percent canopy of combined oak and juniper. At higher elevations, tree coverage can increase to 40-50 percent and includes mixes of oak, juniper, and pinyon. However, gray oak (as a tree) is always well represented (having >5% cover).

**Location**

Piedmont hills, canyon bottoms and slopes, and coalescent alluvial fans of shallow, rocky, and erosive soils; at elevations from 5,500' to 6,500' (1,676 to 1,980 m) or to 7,500' (2,286 m) on south to west-facing mountain slopes; southern New Mexico; local in southeastern Arizona.

**Adjacent Plant Associations**

At lower elevations, QUGR3/BOCU can grade into desert grassland.

**Also See**

Dick-Peddie and Moir (1970), Gehlbach 1967. TES mapping units 3828, 4835, 4946, 4969, and 4970 on portions of the Glenwood RD, Gila NF indicated as PIED- JUDE2-QUGR3, PIED-JUDE2-JUMO- JUOS-QUGR3, and PIED-JUDE2-QUGR3- QUHY subseries (USFS 1985), QUAR/MUEM and QUAR/RHTR are also similar. Medina (1987) describes a *Quercus grisea* community type at Ft. Bayard, NM, which can perhaps be assigned to QUGR3/BOCU. This complex association needs further study.



## Trees

Well represented (>5% cover) on drier sites to luxuriant (>50% cover) in some canyon bottoms:

gray oak (*Quercus grisea*)  
alligator juniper (*Juniperus deppeana*)  
oneseed juniper (*Juniperus monosperma*)  
twoneedle pinyon (*Pinus edulis*)  
border pinyon (*Pinus discolor*)

## Shrubs

Common (>1% cover) to well represented (>5% cover):

hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus*)  
shrub live oak (*Quercus turbinella*) and hybrids  
gray oak (*Quercus grisea*)  
sacahuista (*Nolina microcarpa*)  
common sotol (*Dasylirion wheeleri*)  
banana yucca (*Yucca baccata*)  
catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*)  
skunkbush sumac (*Rhus trilobata*)  
Wright's silktassel (*Garrya wrightii*)  
tulip pricklypear (*Opuntia phaeacantha*)  
banana yucca (*Yucca baccata*)  
walkingstick cactus (*Cylindropuntia spinosior*)  
turpentine bush (*Ericameria laricifolia*)

Some additional shrubs along washes (Typic Ustifluvents) include:

Apache plume (*Fallugia paradoxa*)  
California brickellbush (*Brickellia californica*)  
western white honeysuckle (*Lonicera albiflora*)

## Herbs

Well represented (>5% cover) to abundant (>25% cover):

sideoats grama (*Bouteloua curtipendula*)  
black grama (*Bouteloua eriopoda*)  
blue grama (*Bouteloua gracilis*)  
bullgrass (*Muhlenbergia emersleyi*)  
plains lovegrass (*Eragrostis intermedia*)  
Texas bluestem (*Schizachyrium cirratum*)  
Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*)  
common wolftail (*Lycurus phleoides*)  
muttongrass (*Poa fendleriana*)  
prairie junegrass (*Koeleria macrantha*)  
bottlebrush squirrel tail (*Elymus elymoides*)  
White Mountain sedge (*Carex geophila*)  
Carruth's sagewort (*Artemisia carruthii*)  
bracted bedstraw (*Galium microphyllum*)

pineywoods geranium (*Geranium caespitosum*)  
bean (*Phaseolus* spp.)

### **Brief Plant ID Notes**

Gray oak is a native small to medium-sized evergreen tree to about 65' (20 m) or a low scrubby shrub. The leaves are thin, firm, elliptic to ovate in shape with few if any teeth; shiny gray-green to blue-green above and pale gray-green, dull with dense stellate hairs; 3/4" to 2" (2 to 5 cm) in length.

### **Synonymy**

hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus* = *C. breviflorus*)  
catclaw mimosa (*Mimosa aculeaticarpa* var  
*biuncifera* = *M. biuncifera*) walkingstick cactus (*Cylindropuntia spinosor* = *Opuntia spinosor*) Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)

### **Terrestrial Ecological Unit attributes**

Life Zone Class: 4 (woodland)

**Elevational Subzone:** 0 (typical) to -1 (warm, dry)

**Climate Class:** HSM (high sun mild)

### **Fire Ecology**

Gray oak is probably top-killed by fire. Survivors having a shrubby growth form may sprout. Acorns on the surface are probably killed by fire, while those buried by soil are likely to be able to survive low intensity fires (Pavek 1994c).

### **Comments**

MAP = 19"/yr, MAAT = 55 degrees F.

### **References**

Pavek. 1994c  
USFS 1986  
USFS 1987b

## gray oak/alderleaf mountain mahogany

*Quercus grisea/Cercocarpus montanus*

### Code(s)

typic phase 6 30 02 0

### Ecological Response Unit

Madrean Encinal Woodland (MEW)

### NVC Group

Madrean Encinal (G201)

### Key Criteria

Oak chaparrals on foothills and canyons with **\*gray oak** and other evergreen and deciduous shrubs, pinyons, and junipers with a shrubby understory.

### Structure

Gray oak is a climax species in evergreen oak and encinal communities.

### Location

Ridgetops, summits, and mountain or hillslopes at elevations from 6,000' to 7,000' (1,840 to 2,149); southern New Mexico and southeastern Arizona.

### Also See

Medina (1987), scarp woodland, mapping unit 4910 for TES in Glenwood RD, Gila NF. If twoneedle pinyon has > 1% cover and is regenerating below other trees and shrubs, PIED/CEMO, QUGR3 phase (204032 in USFS 1986a) very similar, but the oak is generally shrubby (not treelike).

### Trees

Well represented (>5% cover):

**\*Gray oak** (*Quercus grisea*)

alligator juniper (*Juniperus deppeana*)

twoneedle pinyon (*Pinus edulis*)

Utah juniper (*Juniperus osteosperma*)

oneseed juniper (*Juniperus monosperma*)

### Shrubs

Abundant (>25% cover) to luxuriant (>50%):

hairy mountain mahogany

(*Cercocarpus montanus* var. *paucidentatus*)

alderleaf mountain mahogany (*Cercocarpus montanus*)

Wright's silktassel (*Garrya wrightii*)

skunkbush sumac (*Rhus trilobata*)

sacahuista (*Nolina microcarpa*)

Palmer's century plant (*Agave palmeri*)

tulip pricklypear (*Opuntia phaeacantha*)

walkingstick cholla (*Opuntia spinosior*)

banana yucca (*Yucca baccata*)

## Herbs

Typically, scarce (< 1% cover) due to strong tree and shrub dominance:

sideoats grama (*Bouteloua curtipendula*)

three awns (*Aristida* spp.)

muttongrass (*Poa fendleriana*)

blue grama (*Bouteloua gracilis*)

white sagebrush (*Artemisia ludoviciana*)

dwarf lousewort (*Pedicularis centranthera*)

and occasional other forbs.

## Brief Plant ID Notes

Alderleaf mountain mahogany is a small native, evergreen to persistent tree or shrub growing up to 20' (6m) tall. Its leaves are simple, alternate, lanceolate to roundish, and 1 to 1.5 inches (2.5 to 4 cm) long. The grayish- green upper surface is glabrous to pilose while the underside is tomentulose and paler in color. The leaf margin is rounded at the apex, coarsely ovate toothed. This shrub is most often a resident of dry hillslopes.

## Synonymy

hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus* = *C. breviflorus*)

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** 0 (typical) (varies from warm, dry to cool moist)

**Climate Class:** HSM (high sun mild)

## Fire Ecology

Alderleaf mountain mahogany seems to burn less readily than many other shrubs, is damaged usually only temporarily and it sprouts vigorously from the root crown after mostfires. [Ream 1964, Lindenmuth and Glendening 1962, Pase and Lindenmuth 1971, Bradley et al. 1991, and Crane 1982.]

During presettlement times, fires in open, dry habitats where alderleaf mountain mahogany was likely to occur, were probably of low severity because of fuel discontinuity. Today, many formerly open stands are dominated by conifers and decadent shrubs which provide greater fuel loads. When fires occur, they are likely to be more severe—Bradely et al. 1991.

### **Comments**

Gray oak is seldom used by cattle or sheep. Goats may consume it with some adverse effects to their digestive system. Various wildlife species use gray oak: spring browse for pronghorn; partial browse diet component for elk, white-tailed deer, and mule deer; mast (acorns) for Merriam's turkey, thick-billed parrot, Viosca's pigeon, and other birds. The shrubby growth form provides cover for small to medium size mammals and birds.

### **References**

USFS 1986  
USFS 1987b

**Emory oak/pointleaf manzanita**  
***Quercus emoryi*/*Arctostaphylos pungens***

**Code(s)**

typic phase 6 20 01 0

**Ecological Response Unit**

Madrean Encinal Woodland (MEW)

**NVC Group**

Madrean Encinal (G201) Madrean Encinal Woodland

**Key Criteria**

Oak woodlands having scattered trees (usually low i.e., 8-12 feet tall) with **\*Emory oak** attaining < 5 percent cover; abundant shrub layer with **\*pointleaf manzanita** cover exceeding 5 percent, and herbaceous ground cover usually scarce (<1 percent cover).

**Location**

Known from a variety of landforms and mixed parent materials, and soils; at elevations from 4,200' to 5,600' (1,280 to 1,700 m); southwestern New Mexico and southern Arizona; being more common south of the Mogollon Rim in Arizona.

**Adjacent Plant Associations**

Intergrades to QUEM/DAWH2 and QUAR/MUEM as soils become deeper or less erosional and to PIMO/ARPU5 at higher elevations.

**Also See**

On northern portions of the Tonto NF, see map units 3752, 3753, and 4242 of the TES (USFS 1986c); see MUs 4366 and 4439 for the Globe RD (USFS 1984).

**Trees**

Well represented (>5% cover):

**\*Emory oak** (*Quercus emoryi*)

Arizona white oak (*Quercus arizonica*)

alligator juniper (*Juniperus deppeana*) (LSM Climate)

border pinyon (*Pinus discolor*) (HSM climate)

singleleaf pinyon (*Pinus monophylla*) (LSM climate)

Arizona madrone (*Arbutus arizonica*) (SE Arizona)

**Shrubs**

Abundant (>25% cover):

\*Pointleaf manzanita (*Arctostaphylos pungens*)

Pringle manzanita (*Arctostaphylos pringlei*)

Wright's silktassel (*Garrya wrightii*)

alderleaf mountain mahogany (*Cercocarpus montanus*)

shrub live oak (*Quercus turbinella*)

skunkbush sumac (*Rhus trilobata*)

catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera*)

common sotol (*Dasylirion wheeleri*) [a scattering of]

Palmer's century plant (*Agave palmeri*)

yucca (*Yucca madrensis*)

banana yucca (*Yucca baccata*)

sacahuista (*Nolina microcarpa*)

tulip pricklypear (*Opuntia phaeacantha*)

hollyleaf buckthorn (*Rhamnus ilicifolia*)

## Herbs

Scarce (<1% cover) or common (>1% cover):

Texas bluestem (*Schizachyrium cirratum*)

bullgrass (*Muhlenbergia emersleyi*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*)

Arizona threeawn (*Aristida arizonica*) threeawns (*Aristida* spp.)

blue grama (*Bouteloua gracilis*)

sideoats grama (*Bouteloua curtipendula*)

plains lovegrass (*Eragrostis intermedia*)

## Brief Plant ID Notes

Emory oak is a medium-sized native evergreen tree about 50" (15m) tall, but often occurs in shrub form. Its leaves are semi-persistent; broadly lance-shaped, 1" to 2.5" (2.5 to 6 cm) long, with a short spiny tip and a few short spiny teeth. They are thick, stiff, leathery, flat, shiny dark green above, paler below, and are nearly hairless except for dense hairs at base of midrib below. Pointleaf manzanita is a bushy, native, short-lived, evergreen broadleaf shrub, approximately 5' to 7' (1.5 to 2 m) tall. Its leaves are oval-shaped with sharp pointed tips, bright green, leathery, and covered with soft, fine hairs. The stems are shiny red.

## Synonymy

catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera* = *M. biuncifera*)

hollyleaf redberry (*Rhamnus ilicifolia* = *Rhamnus crocea* var. *ilicifolia*)

yucca (*Yucca madrensis* = *Yucca schottii*)

singleleaf pinyon (*Pinus monophylla* = *P. fallax*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** varied.

**Climate Class:** HSM (high sun mild)/LSM (low sun mild)

## **Fire Ecology**

Emory oak is well adapted to recurrent fire. It is a vigorous sprouter from the root crown or stump following fire (Cable 1979, Carmichael et al. 1978). Historically, fires probably occurred every 10 to 20 years in oak woodlands (Baisan and Swetnam 1990). The estimated fire regime for the Madrean oak-pine woodland is probably a fire-tolerant, fire-maintained community (Swetnam et al. 1992). Recent or frequent past fires could reduce the conifers and increase shrub components.

Vegetation would resemble chaparral. Pointleaf manzanita does not sprout from the roots or crown following fire. It is a prolific seeder in response to fire. Such seed crops can be stored in the soil for decades. Pointleaf communities are characteristic of frequently burned areas with dry, coarse soils and are typically found in the transition zone between chaparral and pine or oak woodlands.

## **Reforestation**

**Wood harvesting methods:** Partial retention of the overstory, as usually produced by selection and shelterwood harvesting methods, provides microclimates favorable for regeneration of oak. Heavier removal of the overstory as seen in seedtree and clear-cutting favors oak and manzanita. Planting is not recommended. Mechanical site prep or burning favors oak and manzanita.

## **Revegetation Considerations**

Revegetation is expected to be rapid due to the sprouting of oak.

## **Comments**

MAP = 20-22"/yr. May and June are hot and dry. This plant association is not productive for livestock grazing. Forage value rating (cattle) in early seral stage is low and is none in late seral stage.

## **References**

Baisan and Swetnam 1990

Carmichael et al. 1978

Harris 1988a

Little 1950

Pavek 1994c

Stuever 1995

Swetnam et al. 1992

USFS 1987b



**Emory oak/sideoats grama**  
***Quercus emoryi/Bouteloua curtipendula***

**Code(s)**

typic phase 6 20 02 0

sacahuista phase 6 20 02 1

**Ecological Response Unit**

Madrean Encinal Woodland (MEW)

**NVC Group**

Madrean Encinal (G201)

**Key criteria**

Oak savannas having scattered trees (usually exceeding 12' tall) with \***Emory oak** attaining < 5 percent cover; with grassy understory on alluvial soils.

**Structure**

Emory oak is a climax species in encinal and evergreen oak woodlands and has a seral or climax role in pine-oak woodlands.

**Location**

Deep, well drained alluvial soils of basin fill, depositional soils of ephemeral streams and washes, piedmont alluvial fans, toeslopes of mixed alluvial-colluvial parent materials, hills, and residual soils of rhyolitic pediments and elevated plains; mostly at elevations from 4,500' to 5,500' (1,370 to 1,670 m); southwestern New Mexico and southeast and south-central Arizona; mostly south of the Mogollon Rim in Arizona.

**Adjacent plant associations**

Intergrades to QUAR/PIFI along washes at higher elevations.

**Also See**

Bonham 1972, Moir 1979, Wagner 1977; *Quercus emoryi-Nolina microcarpa- Bouteloua curtipendula* h.t. (Willging 1987); both QUAR/MUEM and QUEM/DAWH2 are also open oak woodland savannas, but these generally occur on colluvial mountain and hill slopes.

**Trees and Life History Traits**

Well represented (>5% cover):

Emory oak (*Quercus emoryi*)C

Arizona white oak (*Quercus arizonica*)C or hybrids of gray oak (*Q. grisea*)

alligator juniper (*Juniperus deppeana*)c

redberry juniper (*Juniperus coahuilensis*) c

border pinyon (*Pinus discolor*) (occasional)c

## Shrubs

Common (>1% cover) in typic phase to well represented (>5% cover) in sacahuista phase:

sacahuista (*Nolina microcarpa*)

Wright's silktassel (*Garrya wrightii*)

skunkbush sumac (*Rhus trilobata*)

turpentine bush (*Ericameria laricifolia*)

catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera*)

whitethorn acacia (*Vachellia constricta*)

pointleaf manzanita (*Arctostaphylos pungens*)

bastardsage (*Eriogonum wrightii*)

yucca (*Yucca madrensis*)

velvet mesquite (*Prosopis velutina*)

## Herbs

Well represented (> 5% cover) to abundant (>25% cover):

Texas bluestem (*Schizachyrium cirratum*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*)

sideoats grama (*Bouteloua curtipendula*)

bullgrass (*Muhlenbergia emersleyi*)

plains lovegrass (*Eragrostis intermedia*)

blue grama (*Bouteloua gracilis*)

common wolftail (*Lycurus phleoides*)

pinyon ricegrass (*Piptochaetium fimbriatum*)

prairie junegrass (*Koeleria macrantha*)

bean (*Phaseolus* spp.)

ticktrefoil (*Desmodium* spp.)

rose heath (*Chaetopappa ericoides*)

Carruth's sagewort (*Artemisia carruthii*)

globemallow (*Sphaeralcea* spp.)

## Brief Plant ID Notes

Sideoats grama is a warm season perennial native grass with scaly rhizomes. The leaf blades are flat, less than 1/4" (3-4 mm) wide, and have short stiff hairs on the surface. The short flower clusters hang mainly from one side of the wavy rachis. Mature leaves take on an orange to purple cast.

## Synonymy

catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera* = *M. biuncifera* )

rose heath (*Chaetopappa ericoides* = *Leucelene ericoides*)

yucca (*Yucca madrensis* = *Yucca schottii*)

whitethorn acacia (*Vachellia constricta* = *Acacia constricta*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)

Redberry juniper (*Juniper coahuilensis* = *J. erythrocarpa*)

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** HSM (high sun mild)

**Phases**

There are two phases: the typic phase is moister and expresses a greater tree/ shrub cover. The sacahuista phase is warmer and drier and expresses greater herbaceous (grassy) cover.

**Fire Ecology**

Oak woodlands having a continuous grass understory experience rapidly spreading fires. Fire effects depend on tree size, fire severity, and drought stress.

Small-sized Emory oak may be top- killed by fire. Large trees survive fires of low severity. Well-developed root systems of mature Emory oak buffer the effects of drought and allow rapid regeneration by sprouting vigorously from root crown and stump after top damage. It recovers quickly from the effects of burning. Unless covered by an insulating layer of soil, acorns are probably killed by fire (Pavek 1994c).

**Comments**

MAP = 17"/yr.; MAAT = 57 degrees F.; severe drought in May and June.

**References**

Pavek 1994c  
USFS 1987b

**Emory oak/common sotol**  
***Quercus emoryi*/*Dasyllirion wheeleri***

**Codes**

typic phase6 20 03 0

**Ecological Response Unit**

Madrean Encinal Woodland (MEW)

**NVC Group**

Madrean Encinal (G201)

**Key Criteria**

Oak savannas having scattered trees (usually 10' - 16' tall) with \***Emory oak** attaining < 5 % cover; with grassy understory on **colluvial soils** (soil materials accumulated through actions of gravity in addition to wind and water).

**Structure**

Emory oak is a climax species in encinal and evergreen oak woodlands and has a seral or climax role in pine-oak woodlands.

**Location**

Mountain and hill slopes, mostly 15-18 percent on colluvial soils; at elevations from 4,300' to 5,800' (1,300 to 1,760 m); southwestern New Mexico and southeast and south-central Arizona; mostly south of the Mogollon Rim in Arizona.

**Adjacent Plant Associations**

Intergrades to QUAR/PIFI along washes at higher elevations.

**Also See**

QUEM/BOCU on generally alluvial soils with greater tree productivity (see TES reports); Wallmo 1955, Wentworth 1981, Shreve 1915; *Quercus emoryi*-*Pinus discolor*/*Mimosa aculeaticarpa* var. *biuncifera* community type (Medina 1987).

**Trees**

Well represented (>5% cover):

\*Emory oak (*Quercus emoryi*)

Arizona white oak (*Quercus arizonica*) or hybrids of gray oak (*Q. grisea*)

alligator juniper (*Juniperus deppeana*)  
border pinyon (*Pinus discolor*) (occasional)

## Shrubs

Common (>1% cover):

sacahuista (*Nolina microcarpa*)  
yucca (*Yucca madrensis*)  
bastardsage (*Eriogonum wrightii*)  
Wright's silktassel (*Garrya wrightii*)  
skunkbush sumac (*Rhus trilobata*)  
turpentine bush (*Ericameria laricifolia*)  
catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera*)  
whitethorn acacia (*Vachellia constricta*)  
pointleaf manzanita (*Arctostaphylos pungens*)  
common sotol (*Dasyllirion wheeleri*)

## Herbs

Well represented (> 5% cover) to abundant (>25% cover):

Texas bluestem (*Schizachyrium cirratum*)  
Orcutt's threeawn (*Aristida shiedeana* var. *orcuttiana*)  
sideoats grama (*Bouteloua curtipendula*)  
bullgrass (*Muhlenbergia emersleyi*)  
plains lovegrass (*Eragrostis intermedia*)  
blue grama (*Bouteloua gracilis*)  
common wolftail (*Lycurus phleoides*)  
pinyon ricegrass (*Piptochaetium fimbriatum*)  
prairie junegrass (*Koeleria macrantha*)  
bean (*Phaseolus* spp.)  
ticktrefoil (*Desmodium* spp.)  
rose heath (*Chaetopappa ericoides*)  
Carruth's sagewort (*Artemisia carruthii*)  
globemallows (*Sphaeralcea* spp.)

## Brief plant ID notes

Common sotol looks similar to its relative's yucca and agave, having leaves concentrated in a basal rosette, with a single flowering stalk extending above. The leaves are narrow (about one inch (2.5 cm) wide) and 3' to 4' (one meter or more) long. They are fiercely armed with stout recurved teeth on the margins.<sup>44</sup>

## Synonymy

catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera* = *M. biuncifera*)  
rose heath (*Chaetopappa ericoides* = *Leucelene ericoides*)  
yucca (*Yucca madrensis* = *Yucca schottii*)  
whitethorn acacia (*Vachellia constricta* = *Acacia constricta*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** HSM (high sun mild)

### **Fire Ecology**

Small-sized Emory oak may be top-killed by fire. Large trees survive fires of low severity. Well-developed root systems of mature Emory oak buffer the effects of drought and allow rapid regeneration by sprouting vigorously from root crown and stump after top damage. It recovers quickly from the effects of burning. Unless covered by an insulating layer of soil, acorns are probably killed by fire (Pavek 1994c).

### **Comments**

MAP = 17"/yr.; MAAT = 56-57 degrees F; about 55% of precipitation occurs from October through March; severe drought in May and June.

### **References**

Medina 198

Pavek 1994c

Shreve 1915

Wallmo 1955

Wentworth 1981

USFS 1987b

## **Emory oak/Arizona walnut** ***Quercus emoryi/Juglans major***

### **Synonyms**

*Quercus emoryi/Vitis arizonica*

(Willging 1987)

### **Code(s)**

typic phase 6 20 04 0

### **Ecological Response Unit**

Arizona Walnut (300)

### **NVC Group**

Western Interior Riparian Forest & Woodland (G797)

### **Key criteria**

Tall (trees >30' height) oak woodland having **\*Emory oak** well represented (>5% cover) on drainage sideslopes and dry terraces along drainages.

### **Structure**

Emory oak is a climax species in encinal and evergreen oak woodlands and has a seral or climax role in pine-oak woodlands.

### **Location**

Wash margins and upper terraces of intermittent drainages; at elevations from 5,000' to 6,000' (1,520 to 1,850 m); southwestern New Mexico; southeast and south-central Arizona; south of the Mogollon Rim in Arizona.

### **Also See**

Riparian forests. QUEM/JUMA differs from other riparian forests by lacking tall, deciduous trees such as cottonwood and sycamores as well as lacking willows and alders (Szaro 1989).

### **Trees**

Abundant (> 25% cover) to luxuriant (> 50% cover):

Emory oak (*Quercus emoryi*) well represented (>5% cover) Arizona white oak (*Quercus arizonica*) gray oak (*Quercus grisea*)

**\*Arizona walnut (*Juglans major*)**

junipers (*Juniperus* spp.) depending on geography.



border pinyon (*Pinus discolor*)  
twoneedle pinyon (*Pinus edulis*)  
singleleaf pinyon (*Pinus monophylla*) (pinyon pines depending on geography)  
netleaf hackberry (*Celtis laevigata* var. *reticulata*)  
chokecherry (*Prunus* spp.)

## **Shrubs**

Well represented (> 5% cover):

skunkbush sumac (*Rhus trilobata*)  
Apache plume (*Fallugia paradoxa*)  
catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera*)  
rubber rabbitbrush (*Ericameria nauseosus*)  
western white honeysuckle (*Lonicera albiflora*)  
eastern poison ivy (*Toxicodendron radicans*)  
red barberry (*Mahonia haematocarpa*)  
Willcox barberry (*Berberis willcoxii*)  
Arizona grape (*Vitis arizonica*)  
Virginia creeper (*Parthenosissus quinquefolia*)

## **Herbs**

Abundant (>25% cover):

sideoats grama (*Bouteloua curtipendula*)  
blue grama (*Bouteloua gracilis*)  
green sprangletop (*Leptochloa dubia*)  
pinyon ricegrass (*Piptochaetium fimbriatum*)  
bullgrass (*Muhlenbergia emersleyi*)  
deergrass (*Muhlenbergia rigens*)  
bulb panicgrass (*Panicum bulbosum*)  
prairie junegrass (*Koeleria macrantha*)  
muttongrass (*Poa fendleriana*)  
Texas bluestem (*Schizachyrium cirratum*)  
cane bluestem (*Bothriochloa barbinodis*)  
Carruth's sagewort (*Artemisia carruthii*)

## **Brief Plant ID Notes**

Arizona walnut is a small to medium tree with pinnately compound leaves and stout branches.

## **Synonymy**

netleaf hackberry (*Celtis laevigata* var. *reticulata* = *Celtis reticulata*)  
catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera* = *M. biuncifera*)  
cane bluestem (*Bothriochloa barbinodis* var. *barbinodis* = *Andropogon barbinodis*)  
Texas bluestem (*Schizachyrium cirratum* = *Andropogon cirratus*)  
Virginia creeper (*Parthenosissus quinquefolia* = *P. inserta*)  
rubber rabbitbrush (*Ericameria nauseosa* = *Chrysothamnus nauseosus*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** 0 (typic) may vary from +1 (cool, moist) to -1 (warm, dry)

**Climate Class:** HSM (high sun mild) and LSM (low sun mild)

### **Reforestation**

Wood harvesting methods: Partial retention of the overstory, as usually produced by selection and shelterwood harvesting methods, provides microclimates favorable for regeneration of oak. Heavier removal of the overstory as seen in seedtree and clear-cutting favors oak. Planting is not recommended. Mechanical site prep or prescribed burning tend to favor oak regeneration.

### **Revegetation Considerations:**

Revegetation is expected to be moderate to rapid due to the sprouting of oak. Walnut management is yet poorly understood.

### **Fire Ecology**

Small-sized Emory oak may be top-killed by fire. Large trees survive fires of low severity. Well-developed root systems of mature Emory oak buffer the effects of drought and allow rapid regeneration by sprouting vigorously from root crown and stump after top damage. Unless covered by an insulating layer of soil, acorns are probably killed by fire (Pavek 1994).

### **Comments**

This plant association is productive for livestock grazing. Forage value rating (cattle) in early seral stage is high and is moderate in late seral stage. Soils may be influenced by overland flow of water but are rarely flooded. Recharge of soil water is by direct precipitation plus some overland flow. Water table, however, is well below rooting depths and is not appreciably elevated by infrequent water drainage in the adjoining channel. Where overland flow produces a greater amount of soil water, the Emory oaks attain great heights (up to 30'-40'). Arizona walnut is a small to medium tree with pinnately compound leaves and stout branches. Dick-Peddie (1993) considers *Juglans major* to be an obligate riparian species. Similarly, other ecologists consider *Vitis arizonica*, an associated vine in this type, as riparian obligate. Fluventic Ustochrepts and Typic Ustifluvents are common soils (See TES reports and verify onsite soils).

## **References**

Dick-Peddie (1993)

Pavek 1994

Szaro (1989)

USFS 1987b

**Silverleaf oak/longtongue muhly**  
***Quercus hypoleucoides/Muhlenbergia longiligula***

**Code(s)**

typic phase 6 50 01 0

**Ecological Response Unit**

Madrean Encinal Woodland (MEW)

**NVC Group**

Madrean Encinal (G201)

**Key Criteria**

Closed woodlands or woodlands with shrubby understories; with  
\***silverleaf oak** well represented (>5% cover) and longtongue muhly  
common (>1% cover). Mature oaks are trees rather than shrubs.

**Location**

Canyons at elevations from 6,000' to 6,500' (1,830 to 1,980 m) often on  
Typic Ustifluvents; and mountain slopes to about 7,500' (2,286 m) on a  
variety of soils on residual or colluvial parent materials; extreme  
southwestern New Mexico (Animas Mountains) with outliers to Bushy  
Mountains and southeastern Arizona.

**Adjacent Plant Associations**

None listed in research material.

**Also See**

TES mapping unit 4970 on the Glenwood RD, Gila NF (USFS 1985);  
Wagner 1977; Moir and Lukens 1979 (plot F5 at Chiricahua National  
Monument, AZ); upper encinal of Lowe 1964; PIDI3/QUHY is a  
chaparral woodland of shallow, rocky soils.

**Trees**

Luxuriant (>50% cover):

\***Silverleaf oak** (*Quercus hypoleucoides*)

Arizona white oak (*Quercus arizonica*)

alligator juniper (*Juniperus deppeana*)

border pinyon (*Pinus discolor*) [occasional]

Arizona madrone (*Arbutus arizonica*)

## Shrubs

Well represented (>5% cover): netleaf oak (*Quercus rugosa*) sacahuista (*Nolina microcarpa*) Wright's silktassel (*Garrya wrightii*) skunkbush sumac (*Rhus trilobata*) turpentine bush (*Ericameria laricifolia*) Parry's agave (*Agave parryi*) Gambel oak (*Quercus gambelii*)

## Herbs

Usually poorly represented (<5% cover): longtongue muhly (*Muhlenbergia longiligula*) Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*) sideoats grama (*Bouteloua curtipendula*) prairie junegrass (*Koeleria macrantha*) Arizona wheatgrass (*Elymus arizonicus*) wooly brome (*Bromus lanatipes*) fringed brome (*Bromus ciliatus*) muttongrass (*Poa fendleriana*) bullgrass (*Muhlenbergia emersleyi*) [lower elevations] aromatic false pennyroyal (*Hedeoma hyssopifolia*) pineywoods geranium (*Geranium caespitosum*) Fendler's meadow-rue (*Thalictrum fendleri*)

## Brief plant ID notes

Longtongue muhly is a large, tufted, native bunchgrass, having long leaf blades (up to 19" (50 cm)) which are slightly in-rolled. The membranous ligule is 1/4" to 3/4" (6 to 20 mm) long, has smooth edges (entire margin), and has a sharp (acute) tip.

## Synonymy

Arizona wheatgrass (*Elymus arizonicus* = *Andropogon arizonicum*) Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** +1(cool, moist)

**Climate Class:** HSM (high sun mild)

## Fire Ecology

QUHY/MULO differs from published descriptions of pine-oak woodland (Marshall 1957, Niering and Lowe 1984, Whittaker and Niering 1965) by absence of taller, emergent pines above the oak-juniper-pinyon canopy level. However, fires within PIPO/QUHY, PILE/QUHY, and PSME/QUHY plant associations can bring about a successional stage resembling QUHY/MULO woodland. Wagner (1977) refers to such a fire in the Animas Mountains, New Mexico.

## **Comments**

Climatic analysis on the north slopes of the Santa Catalina Mountains, Arizona, gives the following gradient (from Unpublished TES notes):

Elevation (Feet): 6,000      6,500

MAP (in/yr):23.225.0

MAST (F):5250

## **References**

Marshall 1957

Stuever 1995

USFS 1987b

Wagner 1977

## QUOB/mixed *Bouteloua*

### Mexican blue oak/mixed grama *Quercus oblongifolia/Bouteloua (mixed)*

#### Codes

typic phase 6 10 01 0

#### Ecological Response Unit

Madrean Encinal Woodland (MEW)

#### NVC Group

Madrean Encinal (G201)

#### Key Criteria

Oak savannas on gentle slopes or deep alluvial soils with Mexican blue oak common (attaining >1% cover).

#### Location

Alluvial soils of valley plains and coalescent piedmont fans, lower slopes and toeslopes of mixed alluvium-colluvium; at elevations from 4,500' - 5,300' (1,480 - 1,610 m); known from southeastern Arizona in portions of the Coronado National Forest.

#### Adjacent Plant Associations

Intergrades to QUAR/PIFI along washes at higher elevations.

#### Also See

Bonham 1972 (association 5), Niering and Lowe 1984, open encinal in Whittaker and Niering (1968).

#### Trees

Well represented (>5% cover): [trees at maturity- 20' - 25' tall]

**\*Mexican blue oak** (*Quercus oblongifolia*)

Emory oak (*Quercus emoryi*)

Arizona white oak (*Quercus arizonica*)

alligator juniper (*Juniperus deppeana*)

border pinyon (*Pinus discolor*) (absent too occasional)

#### Shrubs

Scarce (<1% cover) to Common (>1% cover):

sacahuista (*Nolina microcarpa*)

Wright's silktassel (*Garrya wrightii*)

skunkbush sumac (*Rhus trilobata*)

turpentine bush (*Ericameria laricifolia*)  
catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*)  
whitethorn acacia (*Vachellia constricta*)  
pointleaf manzanita (*Arctostaphylos pungens*)  
bastardsage (*Eriogonum wrightii*)  
yucca (*Yucca madrensis*)  
velvet mesquite (*Prosopis juliflora*)

## Herbs

Abundant (>25% cover):

blue grama (*Bouteloua gracilis*)  
sideoats grama (*Bouteloua curtipendula*)  
hairy grama (*Bouteloua hirsuta*)  
sprucetop grama (*Bouteloua chondrosioides*)  
black grama (*Bouteloua eriopoda*)  
spidergrass (*Aristida ternipes*)  
poverty threeawn (*Aristida divaricata*)  
plains lovegrass (*Eragrostis intermedia*)  
Texas bluestem (*Schizachyrium cirratum*)  
Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*)  
cane bluestem (*Bothriochloa barbinodis*)  
common wolftail (*Lycurus phleoides*)  
birdbill dayflower (*Commelina dianthiifolia*)  
morning-glory (*Evolvulus* spp.)

## Brief Plant ID Notes

Mexican blue oak is a small evergreen tree to 25' (7.6 m) tall. Leaves are oblong, 1" to 2" (2.5 to 5 cm) long, rounded at both ends, or heart shaped at the base; and have smooth (entire) margins, thin, firm, covered with bloom (waxy film) above and are paler beneath (Little 1950).

## Synonymy

cane bluestem (*Bothriochloa barbinodis* var. *barbinodis* = *Andropogon barbinodis*) Texas bluestem (*Schizachyrium cirratum* = *Andropogon cirratus*)  
yucca (*Yucca madrensis* = *Yucca schottii*)  
whitethorn acacia (*Vachellia constricta* = *Acacia constricta*)  
Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*) velvet mesquite (*Prosopis velutina* = *Prosopis juliflora*)



**Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** HSM (high sun mild)

**Comments**

MAP = 17 in/yr.; MAAT = 57 degrees F.

**References**

Bonham (1972)

Lowe (1964)

Little 1950

Niering and Lowe (1984)

USFS 1987b

Whittaker and Niering (1968)

**Mexican blue oak/common sotol**  
***Quercus oblongifolia/Dasyilirion wheeleri***

**Code(s)**

typic phase 6 10 02 0

**Ecological Response Unit**

Madrean Encinal Woodland (MEW)

**NVC Group**

Madrean Encinal (G201)

**Key criteria**

Oak savannas usually of moderate to steep colluvial slopes; with

\*Mexican blue oak attaining >1% cover.

**Location**

Mountain and hill slopes, mostly 15-80 percent on a variety of colluvial soils; at elevations from 4,300' to 5,800' (1,300 to 1,760 m); southeastern Arizona in portions of the Coronado National Forest.

Elevation (feet):	4,250	4,750
MAP (in/yr)	17.2	18.9
MAST	61	59

**Adjacent Plant Associations**

Intergrades to QUAR/PIFI along washes at higher elevations.

**Also See**

Niering and Lowe 1984, Whittaker and Niering 1965.

**Trees**

Well represented (>5% cover): [trees mostly of low stature (10' -16' tall)]

\***Mexican blue oak** (*Quercus oblongifolia*)

Emory oak (*Quercus emoryi*)

alligator juniper (*Juniperus deppeana*) [occasional]

**Shrubs**

Common (>1% cover):

sacahuista (*Nolina microcarpa*)

yucca (*Yucca madrensis*)

bastardsage (*Eriogonum wrightii*)

Wright's silktassel (*Garrya wrightii*)

skunkbush sumac (*Rhus trilobata*)

turpentine bush (*Ericameria laricifolia*)  
catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera*)  
whitethorn acacia (*Vachellia constricta*)  
velvet mesquite (*Prosopis velutina*)  
Palmer's century plant (*Agave palmeri*)  
Schott's agave (*Agave schottii*)

## Herbs

Well represented (> 5% cover) to abundant (>25% cover):

Texas bluestem (*Schizachyrium cirratum*)  
spidergrass (*Aristida ternipes*)  
sideoats grama (*Bouteloua curtipendula*)  
bullgrass (*Muhlenbergia emersleyi*)  
plains lovegrass (*Eragrostis intermedia*)  
blue grama (*Bouteloua gracilis*)  
purple grama (*Bouteloua radicata*)  
black grama (*Bouteloua eriopoda*)  
cane bluestem (*Bothriochloa barbinodis* var. *barbinodis*)  
and numerous forbs.

## Brief plant ID notes

Common sotol looks similar to its relative's yucca and agave, having leaves concentrated in a basal rosette, with a single flowering stalk extending above. These life forms are collectively referred to as evergreen rosette shrubs. The leaves are narrow (about 1 inch (2.5 cm) wide) and 3' to 4' (one meter or more) long. They are fiercely armed with stout recurved teeth on the margins.

## Synonymy

catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera* = *M. biuncifera*)  
cane bluestem (*Bothriochloa barbinodis* var. *barbinodis* = *Andropogon barbinodis*)  
Texas bluestem (*Schizachyrium cirratum* = *Andropogon cirratus*)  
yucca (*Yucca madrensis* = *Yucca schottii*)  
whitethorn acacia (*Vachellia constricta* = *Acacia constricta*)  
velvet mesquite (*Prosopis velutina* = *Prosopis juliflora*)

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** HSM (high sun mild)

MAP = 17"/yr.; MAAT = 56-58 degrees F, about 55% of precipitation occurs from October through March; severe drought in May and June. Climatic analysis on the south slopes of the Santa Catalina Mountains, Arizona, gives the following gradient (from unpublished TES notes)

### **References**

Niering and Lowe 1984

Stuever 1995

USFS 1987b

Whittaker and Niering 1965

# Pinyon Series

PIED/ANHA

## Twoneedle pinyon/sand bluestem *Pinus edulis/Andropogon hallii*

### Code(s)

typic phase2 04 30 0

### Ecological Response Unit

PJ Grass (PJG), subclass PJ Grass - Cold (PJGc)

### NVC Group

Southern Rocky Mountain Pinyon - Juniper Woodland (G253)

### Key Criteria

The pinyon-juniper overstory occurs on sandy soils. The understory may be grassy and \*sand bluestem and/or \*sandhill muhly are common to abundant. Or if the understory is shrubby, a dominant shrub is sand sagebrush.

### Structure

No productivity information is available specifically for this plant association; however, limited plant growth can be expected if sandy soils have low moisture holding capacity and limited fertility.

### Location

Occurs locally in the landscape in central and northern New Mexico on valley plains with deep, sandy soils. Typical soil is a Typic Ustipsamments.

### Also See

See TES mapping unit 153 (Carson NF, Edwards et al. 1987), a sandy woodland environment without sand bluestem, but including sandhill muhly, Indian ricegrass, and sand dropseed.

### Trees

Well represented (>5%):

twoneedle pinyon (*Pinus edulis*)

oneseed juniper (*Juniperus monosperma*)

## Shrubs

Often well represented (>5%):

sand sagebrush (*Artemisia filifolia*)  
big sagebrush (*Artemisia tridentata*) [LSC climate]  
soaptree yucca (*Yucca elata*)  
skunkbush sumac (*Rhus trilobata*)  
rabbitbrush (*Chrysothamnus* spp.)

## Herbs

Well represented (>5%):

\*Sand bluestem (*Andropogon hallii*)  
\*Sandhill muhly (*Muhlenbergia pungens*)  
little bluestem (*Schizachyrium scoparium*)  
blue grama (*Bouteloua gracilis*)  
sand dropseed (*Sporobolus cryptandrus*)  
spike dropseed (*Sporobolus contractus*)  
spreading wallflower (*Erysium repandum*)  
Indian ricegrass (*Achnatherum hymenoides*)

## Brief plant ID notes

Similar to big bluestem (considered the same species by some), sand bluestem has two to five fingerlike racemes with yellowish hairs on the rachis and pedicels.

## Synonymy

sand bluestem (*Andropogon hallii* = *A. gerardii* var. *paucipilus*)  
little bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*)  
Indian ricegrass (*Achnatherum hymenoides* = *Oryzopsis hymenoides*).

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typic)

**Climate Class:** HSC (high sun cold) LSC (low sun cold)

## Fire Ecology

No fire ecology information specific to this plant association is available. However, warm season perennial grasses such as sand bluestem are most susceptible to fire during the growing season, and generally recover very rapidly after fires. Where prescribed burning is considered for unstable sand dune areas, burning may be best in the spring, prior to grass growth, to minimize exposure of bare soils. Unless grasses are abundant, prescribed burning may be difficult due to lack of fine fuels for fire spread.

**Reforestation**

No information available for this plant association. Successful planting of pinyon or juniper may be difficult to achieve due to limited moisture.

**Revegetation Considerations**

Where grasses have been established previously, rhizomes and roots may aid in rapid recovery from surface disturbance such as fire. Due to high erosion potential, reseeding may be necessary for other conditions.

**Comments**

Where sand bluestem grows in large patches, upland birds and small wildlife find good environmental protection. As a “decreaser,” sand bluestem is an indicator of good range conditions. It’s extensive system of roots and rhizomes does a good job of stabilizing sandy soils (Uchytel 1988).

**References**

Edwards et al. 1987  
Moir and Carleton 1987  
Uchytel 1988a  
USFS 1987a

## Twoneedle pinyon/manzanita *Pinus edulis*/*Arctostaphylos pungens*

### Code(s)

typic phase 2 04 40 0

### Ecological Response Unit

Madrean Pinyon-Oak (MPO)

### NVC Group

Colorado Plateau Pinyon - Juniper Woodland (G900)

### Key criteria

This plant association exhibits a chaparral-like expression of shrubs (i.e., dense shrubs), but relatively minor herbs. \***Pointleaf manzanita** is often well represented or abundant.

### Structure

No information on the productivity of this plant association is available.

### Location

Known from Grand Canyon National Park, north of the Colorado River from Shivwits Plateau to Naukoweep Valley. Also on the Globe Ranger District, Tonto National Forest.

### Also See

*Pinus monophylla*/*Arctostaphylos pungens* has singleleaf pinyon as dominant tree, and no big sagebrush; *Pinus edulis*-*Quercus turbinella*-*Arctostaphylos pungens* association (Warren et al. 1982).

### Trees

Well represented (>5%): twoneedle pinyon (*Pinus edulis*)  
Utah juniper (*Juniperus osteosperma*)

### Shrubs

Abundant (>25%):

\*Pointleaf manzanita (*Arctostaphylos pungens*)

shrub live oak (*Quercus turbinella*)

ashy silktassel (*Garrya flavescens*)

big sagebrush (*Artemisia tridentata*)

spiny greaseweed (*Glossopetalon spinescens*)

alderleaf mountain mahogany (*Cercocarpus montanus*)

broom snakeweed (*Gutierrezia sarothrae*)



banana yucca (*Yucca baccata*)  
skunkbush sumac (*Rhus trilobata*)  
Utah agave (*Agave utahensis*)

## **Herbs**

Scarce to common.

## **Brief plant ID notes**

The dark mahogany-colored bark of the manzanita is smooth. The manzanita shrub, which can root from drooping branches and form extensive thickets, has thick, leathery lime-green leaves.

## **Synonymy**

spiny greasewood (*Glossopetalon spinescens* = *G. nevadense*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typical)

**Climate Class:** LSC (low sun cold) LSM (low sun mild)

## **Phases**

No phases have been identified for this type.

## **Fire Ecology**

Although no documented information on fire in the plant association is available, fires are probably a major disturbance factor considering the strong expression of manzanita (Harris 1988a).

## **Reforestation**

Generally, abundant shrubs may inhibit natural and artificial tree seedlings, however, there may be some nurse plant relationships between big sagebrush and pinyon.

## **Revegetation Considerations**

Manzanita re-establishes from seed. Shrub live oak and mountain mahogany often sprout following disturbance.

## **References**

Harris 1988a  
Moir and Carleton 1987  
USFS 1987a  
USFS 1987b  
Warren et al. 1982



## Twoneedle pinyon/big sagebrush

### *Pinus edulis/Artemisia tridentata*

#### Synonyms

*Pinus edulis-Juniperus osteosperma/Artemisia tridentata* (Johnston 1987).

#### Code(s)

Utah juniper (JUOS) phase 2 04 01 0

oneseed juniper (JUMO) phase 2 04 01 1

Rocky Mountain juniper (JUSC) phase 2 04 01 2

#### Ecological Response Unit

PJ Sagebrush (PJS)

#### NVC Group

Colorado Plateau Pinyon - Juniper Woodland (G900)

#### Key criteria

This plant association has **\*big sagebrush** in the understory and a pinyon-juniper overstory.

#### Location

This plant association is found on highly variable soils and topography from 6,000' to 7,400' (1,830 - 2,255 m). The Utah juniper phase occurs from southwest Colorado and southern Utah into northern Arizona and north-central New Mexico. The oneseed and Rocky Mountain juniper phases occur from north-central New Mexico into southern Colorado. Mean annual precipitation (MAP) about 16"/year (Erdman et al. 1969).

#### Also See

Erdman (1970); Erdman, Douglas, and Marr (1969); Jameson et al. (1962); Schmutz et al. (1967); TES mapping units 142, 145, 151, 53, and 194 on Carson National Forest (Edwards 1987); TES mapping units 206, 207, 220, 214, and 643 on Santa Fe National Forest (Gass et al. 1981, Gass et al. 1983); CW2c; *Juniperus osteosperma*-*Pinus edulis*- *Artemisia tridentata* association (Warren et al. 1982).

#### Trees

Well represented (>5%), species of juniper depends on geography and elevation:

twoneedle pinyon (*Pinus edulis*)

oneseed juniper (*Juniperus monosperma*) lower elevation sites

Utah juniper (*Juniperus osteosperma*)

Rocky mountain juniper (*Juniperus scopulorum*)

## **Shrubs**

Common to abundant (>1% to >25%):

\*Big sagebrush (*Artemisia tridentata*) fourwing saltbush (*Atriplex canescens*) pale

wolfberry (*Lycium pallidum*) banana yucca (*Yucca baccata*)

rubber rabbitbrush (*Ericameria nauseosus*)

longflower rabbitbrush (*Chrysothamnus depressus*)

Mormon tea (*Ephedra viridis*)

broom snakeweed (*Gutierrezia sarothrae*)

Whipple cholla (*Cylindropuntia whipplei*)

plains pricklypear (*Opuntia polyacantha*)

## **Herbs**

Well represented (>5%), in addition to the list below, annual grasses, particularly from the genus *Bromus*, are common on grazed sites or disturbed soil:

muttongrass (*Poa fendleriana*)

prairie junegrass (*Koeleria macrantha*)

bottlebrush squirreltail (*Elymus elymoides*)

needle and thread (*Hesperostipa comata*)

New Mexico needlegrass (*Hesperostipa neomexicana*)

desert needlegrass (*Achnatherum speciosa*)

Indian ricegrass (*Achnatherum hymenoides*)

littleseed ricegrass (*Piptatheropsis micrantha*)

western wheatgrass (*Pascopyrum smithii*)

ring muhly (*Muhlenbergia torreyi*)

James' galleta (*Pleuraphis jamesii*)

blue grama (*Bouteloua gracilis*)

phlox (*Phlox* spp.)

## **Brief plant ID notes**

Recognizing the variety of big sagebrush is important for determining the browse value for elk and deer. Basin big sagebrush (A. t. var. *tridentata*) has an uneven top, a single main stem, and gray-green foliage. Mountain big sagebrush (A. t. var. *vaseyana*) has a flat top, multiple main stems, and blue green foliage (often described as resembling "a birthday cake with candles sticking up on it"). Wyoming big sagebrush (A. t. var. *wyomingensis*) has a round top, multiple main stems and gray- green foliage.

## **Synonymy**

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)  
western wheatgrass (*Pascopyrum smithii* = *Agropyron smithii*)  
Whipple cholla (*Cylindropuntia whipplei* = *Opuntia whipplei*)  
rubber rabbitbrush (*Ericameria nauseosa* = *Chrysothamnus nauseosus*)  
Indian ricegrass (*Achnatherum hymenoides* = *Oryzopsis hymenoides*)  
littelseed ricegrass (*Piptatheropsis micrantha* = *Oryzopsis micrantha*)  
needle and thread (*Hesperostipa comata* = *Stipa comata*)  
New Mexico feathergrass (*Hesperostipa neomexicana* = *Stipa neomexicana*)  
desert needlegrass (*Achnatherum speciosum* = *Stipa speciosa*)  
James' galleta (*Pleuraphis jamesia* = *Hilaria jamesii*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typical)

**Climate Class:** LSC (low sun cold)

## **Phases**

Phases are distinguished by the dominant juniper (see “Location” for geography). Rocky Mountain juniper (JUOS) phase occurs at higher elevations than the oneseed juniper (JUMO) phase.

## **Fire Ecology**

Fires are probably infrequent but important to defining the vegetation within this association. Succession is varied, and has been described for Mesa Verde, CO, by Erdman (1970). Big sagebrush is easily killed by fire and does not resprout, but rapidly reinvades a site if soil-stored or offsite seed is available (Bradley 1986a, Bunting 1987). Big sagebrush may be greatly reduced when fire return intervals are less than 10 years (Bunting 1987, Everett 1987). Tree recovery appears to be slow following fire, resulting in plant communities dominated by big sagebrush for many decades (Jameson et al. 1962, Erdman 1970). Where big sagebrush is limited for winter range, prescribed burning may be detrimental to mule deer populations (Suminski 1993).

## **Reforestation**

Pinyon seedlings generally need shade for initial establishment. Natural regeneration may be greater where shrubs are available as nurse plants.

## Revegetation Considerations

Clary and Wagstaff (1987) compared a variety of techniques for revegetating burns following wildfires in central Utah. Springfield (1976) suggests that crested wheatgrass can be successfully seeded in this plant association. Other plants also suggested, but with perhaps broader ecological amplitudes, are western wheatgrass, pubescent wheatgrass, intermediate wheatgrass, blue grama, black grama, sideoats grama, sand dropseed, spike muhly, Indian ricegrass, sweet clover, and four-wing saltbush. Big sagebrush, a good winter forage plant, can be successfully drilled or broadcast seeded. The “Hobble Creek” selection of mountain big sagebrush is available for lower elevations (Welch et al. 1986), and the “Gordon Creek” selection of wyoming big sagebrush is available for higher elevations (Welch et al. 1992). Erdman et al. (1969) describes this association on steep, southwest facing slopes at Mesa Verde, and comments that these sites are least favorable for plant growth in that general location.

## Comments

Schmutz et al. (1967) found twice the diversity of plant species between an isolated ungrazed peninsula and the grazed mainland on the north rim of the Grand Canyon. Determining which variety of big sagebrush is present is important for wildlife management. *A. t. var. tridentata* is generally poor browse, although *A. t. var. wyomingensis* provides good winter browse for elk and deer and *A. t. var. vaseyana* provides good summer browse. Blaisdell, et al. (1982) offers guidelines for assessing range condition and improving forage values on sagebrush and grass ranges, which may also be applicable to this type. This association can provide critical winter range for elk and deer. Firewood potential is usually good for the JUOS and JUSC phases (Jack Carpenter, pers. comm. 1996) (Edwards et al. 1987) (Gass et al. 1981, 1983).

## References

- Blaisdell et al. 1982
- Bradley 1986
- Bunting 1987
- Clary and Wagstaff 1987
- Donart et al. 1978
- Edwards et al. 1987
- Erdman 1970
- Erdman, Douglas, and Marr 1969
- Everett 1987

Gass et al. 1981, 1983  
Jameson et al. 1962  
Johnston 1987  
Moir and Carleton 1987  
Phillips and Yates 1995  
Schmutz et al. 1967  
Springfield 1976  
Suminski 1993  
USFS 1987a  
Warren et al. 1982

## Twoneedle pinyon/blue grama *Pinus edulis/Bouteloua gracilis*

### Synonyms

*Pinus edulis-Juniperus monosperma/Bouteloua gracilis* (Barnes and Cunningham 1987)

### Code(s)

Utah juniper (JUOS) phase2 04 02 1  
oneseed juniper (JUMO) phase2 04 02 2  
alligator juniper (JUDE2) phase2 04 02 3  
hillslope phase2 04 02 4

### Ecological Response Unit

PJ Grass (PJG), subclass PJ Grass - Cold (PJGc)

### NVC Group

Colorado Plateau Pinyon - Juniper Woodland (G900)

### Key criteria

Understory is essentially grassy with **\*blue grama** (*Bouteloua gracilis*) as a dominant grass, and mountain muhly (*Muhlenbergia montana*) is scarce or absent. Generally warm season grasses are more prevalent. Shrubs may be scarce to well represented, but oaks are not common.

### Location

Widespread in New Mexico, Arizona, Colorado, and Utah. Occurs in valleys or on elevated plains, piedmont slopes, and mountain slopes. Elevations range from 5,100' - 7,600' (1,550 - 2,320 m) depending on aspect and soils. Occurs on a wide variety of soil and parent materials. Mean annual precipitation (MAP) is approx. 15- 18"/year.

### Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typic), +1 (cool, moist) for JUDE phase

**Climate Class:** HSC (high sun cold) HSM (high sun mild)

### Trees

Well represented to abundant (>5% to >25%):

twoneedle pinyon (*Pinus edulis*)  
alligator juniper (*Juniperus deppeana*)  
Utah juniper (*Juniperus osteosperma*)  
oneseed juniper (*Juniperus monosperma*)



## Shrubs

Scarce (<1%) or common (>1%): skunkbush sumac (*Rhus trilobata*)  
alderleaf mountain mahogany (*Cercocarpus montanus*)  
broom snakeweed (*Gutierrezia sarothrae*)  
rabbitbrush (*Chrysothamnus* spp.)  
wavyleaf oak (*Quercus* X *pauciloba*)  
tree cholla (*Cylindropuntia imbricata*)  
plains pricklypear (*Opuntia polyacantha*)  
tulip pricklypear (*Opuntia phaeacantha*)  
Stansbury cliffrose (*Purshia stansburyana*) [<1-2% cover]  
big sagebrush (*Artemisia tridentata*) [<1% cover]  
soaptree yucca (*Yucca elata*)  
banana yucca (*Yucca baccata*)  
red barberry (*Mahonia haematocarpa*)  
pale wolfberry (*Lycium pallidum*)

## Herbs

Abundant (>25%), especially grasses:

\***Blue grama** (*Bouteloua gracilis*)  
sideoats grama (*Bouteloua curtipendula*)  
black grama (*Bouteloua eriopoda*)  
pinyon ricegrass (*Piptochaetium fimbriatum*)  
James' galleta (*Pleuraphis jamesii*)  
littleseed ricegrass (*Piptatheropsis micrantha*)  
muttongrass (*Poa fendleriana*)  
prairie junegrass (*Koeleria macrantha*)  
bottlebrush squirrel tail (*Elymus elymoides*)  
needlegrass (*Achnatherum* spp./*Hesperostipa* spp.)  
ring muhly (*Muhlenbergia torreyi*) fringed sagewort (*Artemisia frigida*) common  
wolfstail (*Lycurus phleoides*) threeawn (*Aristida* spp.)  
little bluestem (*Schizachyrium scoparium*)  
western wheatgrass (*Pascopyrum smithii*)

## Cryptogams

The greenish foliose lichen *Xanthoparmelia chlorochroa* can be found on rocks and free living in this plant association. Its abundance can serve as a general indicator of ecological health as per nutrient cycling. Cryptogamic crusts are important in this association but may be damaged or absent due to grazing and/or foot traffic. Cryptogamic communities are varied and may decline as tree canopy cover increases. See Ladyman et al. (1993) for a study of two PIPO/BOGR2 sites in north-central and west-central New Mexico.

## Brief plant ID notes

The inflorescence or “flag” can be used to distinguish blue grama from hairy grama (*Bouteloua hirsuta*). On blue grama, the flag is curved, and the terminal awn is shorter than the width of the flag. This awn is longer on hairy grama, which also has straight flags.

## Synonymy

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)

western wheatgrass (*Pascopyrum smithii* = *Agropyron smithii*)

little bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*)

tree cholla (*Cylindropuntia imbricata* = *Opuntia imbricata*)

littleseed ricegrass (*Piptatheropsis micrantha* = *Oryzopsis micrantha*)

James' galleta (*Pleuraphis jamesia* = *Hilaria jamesii*)

## Phases

The hillslope phase occurs on slopes >15%, and grasses may be poorly represented.

Otherwise, phases are determined by the species of junipers present (alligator juniper is common = JUDE2 phase; Utah juniper common = JUOS phase, otherwise JUMO phase). The JUDE2 phase is the more mesic of these three phases.

## Adjacent Plant Associations

May adjoin PIED/ACNED at higher elevations and more mesic sites. At lower elevations and steeper sites, may adjoin PIED/MUPA2 (Kennedy 1983). The hillslope phase grades into JUMO/BOCU or JUMO/BOGR2 on drier, warmer sites.

## Also See

*Pinus edulis*-*Juniperus monosperma*/*Bouteloua gracilis* and *Pinus edulis*-*Juniperus deppeana*/*Bouteloua gracilis* (Kennedy, 1983); Dick-Peddie, et al. 1984; Francis 1986; Mapping units 118, 159, and 195 (hillslope phase) of Edwards et al. (1987); hillslope phases on the Coyote RD (Santa Fe NF) can be found in TES mapping units 143, 215, and 216 (Gass et al. 1983); See Barnes (1987) and Barnes and Cunningham (1987) for comparisons between PIED/BOGR2, PIED/POFE, and JUMO/BOCU near Los Alamos, NM. PIED/POFE may key to PIED/BOGR2. However, mountain muhly is scarce in PIED/BOGR2, and cool season grasses are less frequent.

## Fire Ecology

Fires are probably infrequent, but important in this plant association. Arnold et al. (1964) compared two sites near Flagstaff, Arizona; one that

did not appear to have experienced any fire in the last 100 years, and one that was burned in 1885 and 1930. On the burned site, blue grama had 35 percent more cover than the unburned site. Kennedy (1983) found that disturbance, including fire, often resulted in thick, brushy understories of wavyleaf oak (*Quercus X pauciloba*) on the Lincoln National Forest in south-central New Mexico.

Arnold et al. (1964) also outlined secondary succession following a fire to include six stages: (1) bare soil and dead standing trees, (2) annual plants, (3) annual and perennial plants, (4) perennial plants, grasses, and half shrubs, (5) shrubs and perennial grasses, and (6) a climax woodland. Tress and Klopatek (1987) further develop complex concepts of succession following fires in this plant association.

### **Comments**

For a review of rooting depths in this plant association, see Foxx and Tierney (1987).

### **References**

- Arnold et al. 1964
- Barnes 1987
- Barnes and Cunningham 1987
- Dick-Peddie et al. 1984
- Edwards et al. 1987
- Everett and Ward 1984
- Foxx and Tierney 1987
- Francis 1986
- Gass et al. 1983
- Kennedy 1983
- Ladyman et al. 1993
- Muldavin et al. 1997
- Moir and Carleton 1987
- Tress and Klopatek 1987
- USFS 1987a
- USFS 1986

## twoneedle pinyon/alderleaf mountain mahogany

### *Pinus edulis/Cercocarpus montanus*

#### Code(s)

wavyleaf oak (QUPA4) phase 2 04 03 01

gray oak (QUGR3) phase 2 04 03 02

Gambel oak (QUGA) phase 2 04 03 03

#### Ecological Response Unit

PJ Deciduous Shrub (PJD)

#### NVC Group

Colorado Plateau Pinyon - Juniper Woodland (G900)

#### Key criteria

This plant association exhibits a chaparral-like expression of shrubs (i.e., dense shrubs), but relatively minor herbs. **Alderleaf mountain mahogany** is common, often well represented or abundant. Gray oak may be well represented, but other oaks are poorly represented. Tree cover is generally light to moderate.

#### Stand Structure and Productivity

This association can maintain a high volume of woody mass in shrubs and woodland trees. Medina (1987) suggests that past disturbance greatly influences stand characteristics, and tree species may recover very slowly under highly eroding conditions. One measured site index for pinyon for this association is 25. Where this association occurs on steep, rocky sites, expect slow growth, which is unable to sustain much grazing.

#### Location

Found from southeastern Arizona and south- central New Mexico, north to southern Colorado. Generally, occurs on steep to gentle slopes from 5,200' to 7,600' (1,585 - 2,315 m). Soils are often Udic or Lithic Ustochrepts, and surface is usually rocky (30-70% surface cover with cobbles). Mean annual precipitation (MAP) = about 18"/year. Mean annual air temperature (MAAT) = 53 degrees Fahrenheit. Alderleaf mountain mahogany may occur in numerous woodlands, including PIED/QUGA, PIED/QUPA4, PIED/BOGR2, etc., but generally, shrubs are not as dense. *Pinus edulis-Juniperus osteosperma/Amelanchier utahensis-Cercocarpus montanus* (Johnson 1987). *Pinus edulis-Juniperus monosperma/Cercocarpus montanus-Andropogon gerardi*

(Kennedy 1983). TES mapping unit 105 in Cuba and Coyote Ranger Districts, Santa Fe National Forest (Gass et al. 1981, Gass et al. 1983). May be very similar to gray oak/alderleaf mountain mahogany (QUGR3/CEMO2).

### **Trees**

Well represented (>5%), species of juniper depends on geography and elevation:

twoneedle pinyon (*Pinus edulis*)

alligator juniper (*Juniperus deppeana*) [not in northern NM]

oneseed juniper (*Juniperus monosperma*) [lower elevation sites]

Utah juniper (*Juniperus osteosperma*)

Rocky mountain juniper (*Juniperus scopulorum*)

### **Shrubs**

Often abundant (>25%):

\*Alderleaf mountain mahogany (*Cercocarpus montanus*)

skunkbush sumac (*Rhus trilobata*)

serviceberry (*Amelanchier* spp.)

red barberry (*Mahonia haematocarpa*)

wavyleaf oak (*Quercus* X *pauciloba*)

Gambel oak (*Quercus gambelii*)

gray oak (*Quercus grisea*)

cliff fendlerbush (*Fendlera rupicola*)

banana yucca (*Yucca baccata*)

eggleaf silktassel (*Garrya ovata*)

broom snakeweed (*Gutierrezia sarothrae*)

sacahuista (*Nolina microcarpa*)

gumhead (*Gymnosperma glutinosum*)

tulip pricklypear (*Opuntia phaeacantha*)

### **Herbs**

Common (>1%) or well represented (>5%), but much less important than shrubs:

sideoats grama (*Bouteloua curtipendula*)

blue grama (*Bouteloua gracilis*)

hairy grama (*Bouteloua hirsuta*)

little bluestem (*Schizachyrium scoparium*)

big bluestem (*Andropogon gerardii*)

New Mexico muhly (*Muhlenbergia pauciflora*)

common wolfstail (*Lycurus pheloides*)

## **Brief Plant ID Notes**

Where wavyleaf and Gambel oak ranges overlap, oaks cross easily and are difficult to distinguish by species.

## **Synonymy**

wavyleaf oak (*Quercus* X *pauciloba* = *Quercus undulata*)

red barberry (*Mahonia haematocarpa* = *Berberis haematocarpa*)

little bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typical), +1 (wet, cool) [QUGA phase]

**Climate Class:** LSC (low sun cold) HSC (high sun cold) HSM (high sun mild)

## **Phases**

Phases are distinguished by the dominant oak. If Gambel oak or wavyleaf oak exceed 5 percent canopy cover, see PIED/QUGA or PIED/QUPA4. PIED/CEMO2 can have over 5 percent canopy of gray oak, if alderleaf mountain mahogany is common.

## **Fire Ecology**

Expect dense shrubs to establish from root sprouting following fire.

## **Reforestation**

Firewood may be reasonable to harvest by a selection method or shelterwood method, but opening the stand through clearcuts or seed tree cuts would result in shrub fields difficult to regenerate in trees.

## **Revegetation Considerations**

Natural revegetation is moderately rapid due to resprouting of shrubs.

## **Comments**

Good potential for palatable deer browses. The wavyleaf oak (QUPA4) phase is an excellent winter habitat for deer (USFS 1987b). Hiding cover can be excellent with dense shrubs. Often, alderleaf mountain mahogany is associated with limestone bearing rocks. Planting alderleaf mountain mahogany can be done by caching seeds (burying a handful of seeds in one hole). Drilling, where feasible, is also a reasonable way to establish mahogany seedlings (Suminski, pers. comm. 1996).

## **References**

Erdman 1970

Gass et al. 1981, 1983

Johnston 1987

Kennedy 1983  
Medina 1987  
Moir 1963  
Moir and Carleton 1987  
Muldavin et al. 1997  
USFS 1987a  
USFS 1987b USFS 1986

**PIED/ERNA10-FAPA**

**twoneedle pinyon/rabbitbrush-Apache plume**  
***Pinus edulis/Ericameria nauseosus-Fallugia paradoxa***  
(Formerly: *Pinus edulis/Chrysothamhus nauseosus-Fallugia paradoxa*)

**Code(s)**

PIED/ERNA10-FAPA 2 04 33 0

PIMO/ERNA10-FAPA 2 33 33 0

PIDI3/ERNA10-FAPA 2 32 33 0

TES mapping unit 71 for the Carson National Forest (Edwards et al. 1987).

TES mapping unit 58 for the Apache-Sitgreaves National Forests (USFS 1987).

**Ecological Response Unit**

PJ Woodland (persistent) (PJO), all subclasses

**NVC Group**

Colorado Plateau Pinyon - Juniper Woodland (G900)

**Key Criteria**

Rubber rabbitbrush and/or Apache plume are abundant along washes.

Trees present include pinyon and juniper.

**Structure**

Disturbances such as periodic flooding, arroyo cutting, and sustained livestock grazing can weaken the tree and perennial grass components and increase the importance of shrubs and annuals. One measured site index for twoneedle pinyon is 25. Several years after disturbance, forage values are generally high due to abundance of palatable shrubs. Stands approaching late succession have low forage values as trees dominate over shrubs.

**Location**

Widespread geographically, but often occurs very locally in the landscape in intermittent washes and river terraces. Often between 6,300' and 7,500' (1,920 and 2,290 m). Common soils include Typic Ustifluvents, Fluventic Haplustolls, and Fluventic Ustocherpts. These are often incised with arroyos or gullies. Also found on deep cindery soils. Site specific determination of soils may be required.

**Adjacent Plant Associations**

May be adjacent to a wide variety of upland pinyon-juniper plant associations.



See also Dick-Peddie's arroyo riparian for considering rubber rabbitbrush, Apache plume, and desert willow as riparian species.

## **Trees**

Common (>1%) or well represented (>5%):

**Depending on geography:** twoneedle pinyon (*Pinus edulis*) singleleaf pinyon (*Pinus monophylla*) border pinyon (*Pinus discolor*) juniper (*Juniperus* spp.) narrowleaf cottonwood (*Populus angustifolia*) [infrequent and only in some areas]

## **Shrubs**

Abundant (>25%):

rubber rabbitbrush (*Ericameria nauseosus* ssp. *nauseosa* var. *glabrata*)  
Apache plume (*Fallugia paradoxa*)  
fourwing saltbush (*Atriplex canescens*)  
California brickellbush (*Brickellia californica*)  
broom snakeweed (*Gutierrezia sarothrae*)

## **Depending on geography:**

big sagebrush (*Artemisia tridentata*) desert willow (*Chilopsis linearis*)  
skunkbush sumac (*Rhus trilobata*)  
red barberry (*Mahonia haematocarpa*)

## **Herbs**

Well represented (>5%):

blue grama (*Bouteloua gracilis*)  
sideoats grama (*Bouteloua curtipendula*) western wheatgrass (*Pascopyrum smithii*)  
numerous other grasses and forbs

## **Brief plant ID notes**

Apache plume is easy to confuse with cliffrose (*Purshia stansburiana*), which has sticky leaves and fewer achenes (feathery plumes) per seed head. Apache plume is usually in drainages and cliffrose grows on the upland site. For identifying the pinyons, see PIED/sparse.

## **Synonymy**

red barberry (*Mahonia haematocarpa* = *Berberis haematocarpa*)  
western wheatgrass (*Pascopyrum smithii* = *Agropyron smithii*)  
rubber rabbitbrush (*Ericameria nauseosa* = *Chrysothamnus nauseosus*)  
rubber rabbitbrush (*Ericameria nauseosa* ssp. *nauseosa* var. *glabrata* = *Chrysothamnus nauseosus* ssp. *gravolens*)  
singleleaf pinyon (*Pinus monophylla* = *P. fallax*)

**Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typic), +1 (cool, moist)

**Climate Class:** varies with geography.

**Fire Ecology**

No specific fire ecology information for this association is available. Fire behavior in this type is probably largely dependent on density of the shrubs. Fires are probably not widespread if stream beds are present to provide fuelbreaks. Rubber rabbitbrush is usually killed by fire but may sprout if fire intensity was not too hot (Bradley 1986b). Apache plume resprouts vigorously after a fire (Harris 1988b).

**Reforestation**

For natural regeneration of tree species, wood harvesting should generally be light, either utilizing a shelterwood or selection cutting method. Clearcutting and seed tree cutting are likely to encourage shrubs.

Planting trees is not a usual or recommended practice. Mechanical site prep or prescribed burning is likely to encourage rabbitbrush and Apache plume. No disturbance is more conducive to pinyon pine regeneration.

**Revegetation Considerations**

Natural revegetation following disturbance is usually rapid due to the resprouting of shrubs and grasses.

**Comments**

Good potential for palatable deer browse if Apache plume is present.

**References**

Bradley 1986b

Dick-Peddie (1993, p152 ff.)

Harris 1988b

Moir and Carleton 1987

USFS 1987a

USFS 1987b

USFS 1986

## Twoneedle pinyon/blackbrush *Pinus edulis*/*Coleogyne ramosissima*

### Code(s)

typic phase2 04 41

### Ecological Response Unit

PJ Sagebrush (PJS)

### NVC Group

Colorado Plateau Pinyon - Juniper Woodland (G900)

### Key Criteria

**\*Blackbrush** is well represented as a shrub. Pinyon and Utah juniper make up the overstory. Grasses and forbs are common.

### Location

Known from the Grand Canyon National Park in northern Arizona where it occurs on elevated plains and benches, 3,500' to 6,200' (1,070 - 1,890 m). Soils are generally shallow (lithic) and stony and may develop from a wide variety of parent materials.

### Also See

*Coleogyne ramosissima*-*Pinus edulis*- *Juniperus osteosperma* and *Mortonia scabrella*-*Pinus edulis*-*Gutierrezia* associations of Warren et al. (1982)

### Trees

Well represented (>5%): twoneedle pinyon (*Pinus edulis*)  
Utah juniper (*Juniperus osteosperma*)

### Shrubs

Well represented (>5%) to abundant (>25%):

\*Blackbrush (*Coleogyne ramosissima*)

\*Rio Grande saddlebush (*Mortonia scabrella*)

spiny greasebush (*Glossopetalon spinescens*)

alderleaf mountain mahogany (*Cercocarpus montanus*)

shrub live oak (*Quercus turbinella*) broom snakeweed (*Gutierrezia sarothrae*) fourwing saltbush (*Atriplex canescens*)

Stansbury cliffrose (*Purshia stansburyana*) [McArthur et al. 1983]

turpentinebroom (*Thamnosma montana*)

Utah agave (*Agave utahensis*)  
banana yucca (*Yucca baccata*)

### **Herbs**

Common (>1%):

desert needlegrass (*Achnatherum speciosa*) bottlebrush squirrel tail  
(*Elymus elymoides*) muttongrass (*Poa fendleriana*)  
prairie junegrass (*Koeleria macrantha*)  
western wheatgrass (*Pascopyrum smithii*)  
sideoats grama (*Bouteloua curtipendula*)  
black grama (*Bouteloua eriopoda*) threeawn (*Aristida* spp.)  
red brome (*Bromus rubens*)  
greenstem paperflower

### **Fire Ecology**

Limited information indicates that blackbrush is “almost entirely destroyed by fire.”

### **References**

McArthur et al. 1983  
USFS 1987a  
Warren et al. 1982

**Twoneedle pinyon/*Arizona fescue***  
***Pinus edulis/Festuca arizonica***

**Code(s)**

typic phase 2 04 31

**Ecological Response Unit**

PJ Grass (PJG), subclass PJ Grass - Cold (PJGc)

**NVC Group**

Southern Rocky Mountain Pinyon - Juniper Woodland (G253)

**Key criteria**

This grassy woodland often has an overstory of tall twoneedle pinyon and juniper.

\**Arizona fescue (Festuca arizonica)* is present and usually at least common.

**Structure**

As with other more mesic plant associations in this series, the potential for high site indices for pinyon is good. The understory is especially luxuriant for a pinyon-juniper type.

**Location**

Occurs in northern Arizona and west-central New Mexico (Mt. Taylor RD, Cibola NF and Quemado RD, Gila NF). Mean annual precipitation (MAP) = 18"/yr.

**Also See**

PIED/POFE and PIED/ACNED are very similar. For description in Grand Canyon National Park, AZ, see Merkle (1952).

**Trees**

Abundant (>25%):

twoneedle pinyon (*Pinus edulis*)C

Utah juniper (*Juniperus osteosperma*) c

oneseed juniper (*Juniperus monosperma*) c

**Shrubs**

Scarce (<1%)

**Herbs**

Well represented (>5%), but forbs are minor:

\*Arizona fescue (*Festuca arizonica*)  
mountain muhly (*Muhlenbergia montana*)  
prairie junegrass (*Koeleria macrantha*)  
muttongrass (*Poa fendleriana*)  
pine dropseed (*Blepharoneuron tricholepis*)  
blue grama (*Bouteloua gracilis*)

### **Brief Plant ID Notes**

Arizona fescue is a bunchgrass with finely rolled leaves. The seedhead consists of a panicle with flattened spikelets of several flowers.

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** +1 (cool, moist)

**Climate Class:** mostly LSC (low suncold)

### **Fire Ecology**

Low intensity fires may be important for maintaining open stands with grassy understories. However, the grass cover may be more extensive under tree canopies, and sparse in openings which may inhibit the spread of fires. Following harvesting operations, prescribed fire can remove woody material which could otherwise provide shading for pinyon regeneration.

### **Reforestation**

Pinyon seedlings need shade to survive. In this association, pinyon seedlings can also face fierce competition from Arizona fescue and other grasses.

### **Comments**

Excessive grazing can stimulate erosion.

### **References**

Merkle 1952

Moir and Carleton 198

USFS 1987a

**twoneedle pinyon/pine muhly**

***Pinus edulis/Muhlenbergia dubia***

**Synonyms**

*Pinus edulis-Juniperus deppeana/Muhlenbergia dubia* (Kennedy 1983)

**Code(s)**

typic phase2 04 10

**Ecological Response Unit**

PJ Grass (PJG), subclass PJ Grass - Cold (PJGc)

**NVC Group**

Madrean Pinyon - Juniper Woodland (G200)

**Key Criteria**

A savanna (grassy) woodland with an overstory dominated by alligator juniper and two needle pinyon. \***Pine muhly** dominates the grass understory, but other grasses are present. There is a sparse shrub understory, primarily of wavyleaf oak.

**Structure**

There is very little documented information about this type.

**Location**

Presently known from the Sacramento and Guadalupe Mountains of south-central New Mexico where it occurs on moderate slopes of predominately southeastern exposures from 6,000' - 7,300' (1,830 - 2,225 m). Often found on slightly to moderately rocky sites.

**Adjacent Plant Associations**

This plant association occurs at higher elevations than most of the PIED series. On north-facing slopes, ponderosa pine may be common. It may adjoin with PIED/BOGR2, JUDE2 phase at lower elevations and on flat landforms.

**Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** +1 (cool, mesic)

**Climate Class:** HSC (high sun cold)

**Trees**

Abundant (>25%):

twoneedle pinyon (*Pinus edulis*)C  
alligator juniper (*Juniperus deppeana*) S  
oneseed juniper (*Juniperus monosperma*) s

## Shrubs

Well represented (>5%): skunkbush sumac (*Rhus trilobata*)  
wavyleaf oak (*Quercus X pauciloba*)

## Herbs

Abundant (>25%):

\***Pine muhly** (*Muhlenbergia dubia*)  
bullgrass (*Muhlenbergia emersleyi*)  
pinyon ricegrass (*Piptochaetium fimbriatum*)  
blue grama (*Bouteloua gracilis*)  
sideoats grama (*Bouteloua curtipendula*)  
little bluestem (*Schizachyrium scoparium*)  
manyflowered stoneseed (*Lithospermum multiflorum*)  
big bluestem (*Andropogon gerardii*)

## Brief Plant ID Notes

Pine muhly is a large, tussock-forming bunchgrass. The rough, green-gray blades are rolled in and have prominent white veins on the upper surface.

## Synonymy

little bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*)

## Fire Ecology

Fire is probably a major disturbance factor. Recent burns in the Mayhill area may include this plant association.

## Comments

In the Guadalupe Mountains of southern New Mexico, Kennedy (1983) reported PIED/MUDU stands that contain madrone (*Arbutus xalapensis*). She reported that the madrone was endangered from heavy grazing by cattle, and present only in remote, protected sites.

## References

Kennedy 1983  
Moir and Carleton 1987  
USFS 1986



**twoneedle pinyon/New Mexico muhly**  
***Pinus edulis/Muhlenbergia pauciflora***

**Synonyms**

*Pinus edulis-Juniperus monosperma/Muhlenbergia pauciflora* (Kennedy 1983).

**Code(s)**

typic phase2 04 11

**Ecological Response Unit**

PJ Grass (PJG), subclass PJ Grass - Cold (PJGc)

**NVC Group**

Madrean Pinyon - Juniper Woodland (G200)

**Key Criteria**

A savanna (grassy) woodland with an overstory of two-needle pinyon and one-seed juniper. New Mexico muhly is usually part of the grass understory, but not necessarily the dominant grass. This may be one of the drier pinyon/grass plant associations.

**Structure**

The crown dominance is usually by oneseed juniper, although two-needle pinyon may dominate the regeneration. Wavyleaf oak can greatly increase in canopy cover as a response to disturbance, particularly if soil erosion is high.

**Location**

Presently known from the Sacramento and Capitan Mountains, and White Sands Missile Range, New Mexico. On upper slopes and ridges, gentle to moderate, south slopes, and on steep north to west slopes. 6,200' - 7,300' (1,890 - 2,225 m).

**Adjacent Plant Associations**

May adjoin PIED/BOGR2, JUMO phase on more mesic sites.

**Also See**

A similar savanna (grassy) woodland is PIED/ACNED.

**Trees and Life History Traits**

Well represented to abundant (>5% to >25%):

Two-needle pinyon (*Pinus edulis*)C  
oneseed juniper (*Juniperus monosperma*)S or C

### **Shrubs**

Well represented (>5%):

wavyleaf oak (*Quercus X pauciloba*)

skunkbush sumac (*Rhus trilobata*)

red barberry (*Mahonia haematocarpa*)

alderleaf mountain mahogany (*Cercocarpus montanus*)

### **Herbs**

Well represented (>5%) to luxuriant:

blue grama (*Bouteloua gracilis*)

sideoats grama (*Bouteloua curtipendula*)

plains lovegrass (*Eragrostis intermedia*)

New Mexico muhly (*Muhlenbergia pauciflora*)

common wolfstail (*Lycurus pheloides*)

### **Brief Plant ID Notes**

New Mexico muhly is a whitish perennial bunchgrass with a firm, knotty base. The branch culms give the bunch a bushy appearance. As with most muhlys, getting familiar with the key for this genus is essential for making accurate grass identification.

### **Synonymy**

red barberry = (*Mahonia haematocarpa* = *Berberis haematocarpa*)

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typic)

**Climate Class:** HSC (high sun cold)

### **References**

Kennedy 1983

Moir and Carleton 1987

Muldavin et al. 1997

USFS 1986

## Twoneedle pinyon/muttongrass *Pinus edulis/Poa fendleriana*

### Code(s)

typic phase2 04 06

### Synonyms

*Pinus edulis-Juniperus osteosperma/Poa fendleriana* (Johnston 1987);  
*Pinus*

*edulis-Juniperus monosperma/mixed shrub/Muhlenbergia montana*  
(Barnes 1987).

### Ecological Response Unit

PJ Grass (PJG), subclass PJ Grass - Cold (PJGc)

### NVC Group

Colorado Plateau Pinyon - Juniper Woodland (G900)

### Key Criteria

This woodland often has an overstory of tall two-needle pinyon and juniper, with a grassy understory. \***Muttongrass** (*Poa fendleriana*) is common, but Arizona fescue (*Festuca arizonica*) is absent.

### Structure

This plant association may provide near optimum growing conditions for both pinyon and juniper (Erdman et al. 1969). The tallest pinyon trees (35' tall) for the Mesa Verde area were reported in this association.

### Location

Occurs in northern Arizona, southern Utah, southern Colorado, and central and northern New Mexico (including the Sandia, Jemez, and Chuska Mountains, and White Sands Missile Range). In the Jemez Mountains, elevations range from 6,500' - 7,100' (1,980 - 2,165 m) on north and east slopes. In the Sandia Mountains, this type can be found up to 8,400' (2,560 m) on south-facing slopes. Loamy soils are generally noncalcareous with high silt and clay content. Mean annual precipitation (MAP) = 18"/yr and mean annual air temperature (MAAT) = 47 deg. F.

### Also See

If Arizona fescue is common, see PIED/FEAR2. If big sagebrush is common, see PIED/ARTR2. PIED/POFE is closely related to

PIED/ACNED. In Colorado, see Johnston (1987) and Erdman, Douglas, and Marr (1969). In NM, see TES mapping units 194 (Edwards et al. 1987), 203, 204 205 (Gass et al. 1983) and 78, 208 (Gass et al. 1981). For a comparison between PIED/POFE, PIED/BOGR2, and JUMO/BOCU in the Jemez Mountains (Los Alamos), see Barnes (1987).

### **Trees and Life History Traits**

Abundant to luxuriant (>25% to >50%):

twoneedle pinyon (*Pinus edulis*)C

Utah juniper (*Juniperus osteosperma*)C

depending on geography:

One-seed juniper (*Juniperus monosperma*) c

Rocky mountain juniper (*Juniperus scopulorum*)c

### **Shrubs**

Scarce to common (< or > 1%):

narrowleaf yucca (*Yucca angustissima*)

banana yucca (*Yucca baccata*)

plains pricklypear (*Opuntia polyacantha*)

big sagebrush (*Artemisia tridentata*) [<1% cover]

alderleaf mountain mahogany (*Cercocarpus montanus*)

Apache plume (*Fallugia paradoxa*) [granitic soils]

### **Herbs**

Well represented (>5%) to abundant (>25%) especially grasses:

muttongrass (*Poa fendleriana*)

prairie junegrass (*Koeleria macrantha*)

mountain muhly (*Muhlenbergia montana*)

Fendler threeawn (*Aristida purpurea* var. *longiseta*)

littleseed ricegrass (*Piptatheropsis micrantha*)

pine dropseed (*Blepharoneuron tricholepis*)

western wheatgrass (*Pascopyrum smithii*)

blue grama (*Bouteloua gracilis*)

needlegrass (*Achnatherum* spp./*Hesperostipa* spp.)

Forbs is minor, but can increase on disturbed sites:

Macdougal's bluebells (*Mertensia macdougalii*)

white sagebrush (*Artemisia ludoviciana*)

Wright's deervetch (*Lotus wrightii*)

phlox (*Phlox* spp.) fineleaf hymenopappus (*Hymenopappus filifolius* var. *lugens*)

Colorado four o'clock (*Mirabelis multiflora*)

### **Brief plant ID notes**

Muttongrass, a perennial bunchgrass, has leaves which are rolled, but can be unfolded to see two lines running up and down the leaf midrib. Muttongrass lacks the cobwebby hairs of Kentucky Bluegrass in the floret, and the spikelets are rounder than Arizona fescue.

### **Synonymy**

Fendler threeawn = red threeawn (*Aristida purpurea* var. *longiseta* = *A. longiseta*)

western wheatgrass (*Pascopyrum smithii* = *Agropyron smithii*)

fineleaf hymenopappus (*Hymenopappus filifolius* var. *lugens* = *H. lugens*)

littleseed ricegrass (*Piptatheropsis micrantha* = *Oryzopsis micrantha*)

Needlegrass spp. (*Achnatherum* spp./*Hesperostipa* spp. = *Stipa* spp.)

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** +1 (cool, moist) 0 (typic)

**Climate Class:** mostly LSC (low sun cold)

### **Fire Ecology**

Where fire is excluded, the decaying needle layer may inhibit grasses and forbs from growing. With regular fire occurrences (probably on a 15-to-20-year interval), ground cover should be well represented to abundant under trees and sparse to well represented in open spaces (Jack Carpenter, pers. comm. 1996).

### **Comments**

Overgrazed sites of PIED/POFE can lack cool season grasses and may resemble PIED/BOGR2.

### **References**

Barnes 1987

Erdman, Douglas, and Marr 1969

Edwards et al. 1987

Gass et al. 1981, 1983

Johnston 1984

Moir and Carleton 1987

USFS 1987a

## Twoneedle pinyon/Stansbury cliffrose

(Formerly: *pinyon pine/cliffrose*)

### ***Pinus edulis/Purshia stansburiana***

(Formerly: *Pinus edulis/Cowania mexicana*)

#### **Synonyms**

Pinyon Pine/Cliffrose (*Pinus edulis/Cowania mexicana*) (USFS 1986, 1987a).

#### **Code(s)**

Stansbury cliffrose (PUST phase) 2 04 32 0  
big sagebrush (ARTR2) phase2 04 32 1

#### **Ecological Response Unit**

PJ Woodland (persistent) (PJO), subclass PJ Woodland - Mild (PJOm)

#### **NVC Group**

Colorado Plateau Pinyon - Juniper Woodland (G900)

#### **Key criteria**

The overstory consists of pinyon pine and Utah juniper, and occasionally Gambel oak. The shrubby understory includes \*Stansbury cliffrose. Antelope bitterbrush and usually mountain mahogany are scarce or absent. Oaks are poorly represented.

#### **Location**

Occurs on plains and hillslopes from central Arizona to southern Utah and southwestern Colorado and locally in western New Mexico. General elevation range is 6,000' to 6,800' (1,825 - 2,075 m). Soils are frequently Lithic Haplustolls or Lithic Ustochrepts on calcareous parent materials.

MAP (mean annual precipitation) = 14-16"/year.

#### **Also See**

Pinyon/blue grama (PIED/BOGR2) if shrubs are poorly represented;  
Pinyon/Gambel oak (PIED/QUGA) if Gambel oak exceeds 5 percent cover; mapping unit 52 in Nelson and Redders (1982).

#### **Trees and Life History Traits**

Well represented (>5%):

twoneedle pinyon (*Pinus edulis*)C

Utah juniper (*Juniperus osteosperma*) C

## Shrubs

Well represented (>5%):

\*Stansbury cliffrose (*Purshia stansburiana*)

desert sweet (*Chamaebatiaria millefolium*)

Gambel oak (*Quercus gambelii*)

algerita (*Mahonia trifoliata*)

alderleaf mountain mahogany (*Cercocarpus montanus*) [usually <1%]

banana yucca (*Yucca baccata*)

big sagebrush (*Artemisia tridentata*) [ARTR phase]

Mormon tea (*Ephedra viridis*)

cholla (*Cylindropuntia* spp.)

pricklypear (*Opuntia* spp.)

prairie sagewort (*Artemisia frigida*)

## Herbs

Well represented (>5%):

blue grama (*Bouteloua gracilis*)

sideoats grama (*Bouteloua curtipendula*)

needleandthread (*Hesperostipa comata*)

New Mexico needlegrass (*Hesperostipa neomexicana*)

little bluestem (*Schizachyrium scoparium*)

muttongrass (*Poa fendleriana*)

prairie junegrass (*Koeleria macrantha*)

bottlebrush squirreltail (*Elymus elymoides*)

white milkwort (*Polygala alba*)

toadflax penstemon (*Penstemon linarioides*)

white sagebrush (*Artemisia ludoviciana*) drawf stickpea (*Calliandra humilis*)

## Brief Plant ID Notes

Cliffrose can be confused with Apache plume, but has sticky leaves and fewer achenes per seedhead.

## Synonymy

Stansbury cliffrose (*Purshia stansburiana* = *Cowania stansburiana* = *C. mexicana*)

algerita (*Mahonia trifoliata* = *Berberis trifoliata*)

little bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*)

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)

needle and thread (*Hesperostipa comata* = *Stipa comata*)

New Mexico feathergrass (*Hesperostipa neomexicana* = *Stipa neomexicana*)

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** +1 (cool, mesic)

**Climate Class:** HSM (high sun mild) [PUST phase] LSC (low sun cold) [ARTR2 phase]

### **Phases**

In the big sagebrush (ARTR2) phase, big sagebrush and cliffrose are common. This phase occurs in southern Utah, Colorado, and northern Arizona and New Mexico where winter moisture exceeds summer moisture. In the cliffrose (PUST) phase, big sagebrush is usually absent, and cliffrose is present. This phase generally occurs further south where summer moisture exceeds winter moisture.

### **Fire Ecology**

Research literature indicates that Stansbury cliffrose is usually killed by fire (Howard and Holifred 1995). The sprouting ability of cliffrose is variable. Prescribed burning or wildfires in this type can be detrimental for mule deer winter range by reducing cliffrose and big sagebrush which do not survive or respond well to fires, but are critical browse plants (Suminski 1993).

### **Revegetation Considerations**

Stansbury cliffrose can be established on disturbed seedbeds by broadcast seeding, drilled seeding and transplants (Howard and Holifred 1995).

### **Comments**

Stansbury cliffrose can withstand moderate browsing and is considered to provide good forage and cover for mule deer and other wildlife.

### **References**

Howard and Holifred 1995

Johnston 1987

Moir and Carleton 1987

Suminski 1993

USFS 1987a

USFS 1986



## **twoneedle pinyon/antelope bitterbrush**

***Pinus edulis/Purshia tridentata***

### **Synonyms**

*Pinus edulis-Juniperus osteosperma/Purshia tridentata* (Johnston 1987).

### **Code(s)**

typic phase2 04 05 0

### **Ecological Response Unit**

PJ Deciduous Shrub (PJD)

### **NVC Group**

Colorado Plateau Pinyon - Juniper Woodland (G900)

### **Key criteria**

The overstory consists of pinyon pine, Utah juniper, and occasionally Gambel oak. The shrubby understory includes \*antelope bitterbrush. Big sagebrush is scarce or absent. Usually has a sparse cover of grasses and forbs.

### **Structure**

As with other more mesic plant associations in this series, the potential for high site indices for pinyon is good.

### **Location**

Known from northwestern New Mexico and southwestern Colorado where it occurs on mesa and scarps, 6,900' - 7,500' (2,100 - 2,290 m). Soils are fine sandy loams to sandy loams, with shales and sandstones as parent rock. This plant association is often associated with the "San Jose Formation." Annual precipitation 9-14"/year.

### **Adjacent Plant Associations**

PIED/PUTR2 on steep mesa scarps intergrades to scarp woodland.

### **Also See**

Twoneedle pinyon/big sagebrush (*Pinus edulis/Artemisia tridentata*) if big sagebrush is well represented; Erdman, Douglas, and Marr (1969). TES mapping unit 769 in Jicarilla Ranger District, Carson National Forest (Edwards et al. 1987).

## **Trees and Life History Traits**

Well represented (>5%) or abundant (>25%):

Two-needle pinyon (*Pinus edulis*)C

Utah juniper (*Juniperus osteosperma*)C

Gambel oak (*Quercus gambelii*)s

## **Shrubs**

Well represented (>5%):

\*Antelope bitterbrush (*Purshia tridentata*)

Utah serviceberry (*Amelanchier utahensis*)

banana yucca (*Yucca baccata*)

wax currant (*Ribes cereum*)

alderleaf mountain mahogany (*Cercocarpus montanus*)

big sagebrush (*Artemisia tridentata*) [<1% cover]

Mormon tea (*Ephedra viridis*)

## **Herbs**

Scarce (<1%) or common (>1%):

muttongrass (*Poa fendleriana*)

prairie junegrass (*Koeleria macrantha*)

Ross' sedge (*Carex rossii*)

littelseed ricegrass (*Piptatheropsis micrantha*)

James' buckwheat (*Eriogonum jamesii*) phlox (*Phlox* spp.)

## **Brief Plant ID Notes**

Antelope bitterbrush is a low, many branched, spreading shrub with small, three-tipped, wedge-shaped leaves.

## **Synonymy**

littelseed ricegrass (*Piptatheropsis micrantha* = *Oryzopsis micrantha*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** +1 (wet, cool)

**Climate Class:** LSC

## **Fire Ecology**

Bunting (1987) reports that antelope bitterbrush has limited resprouting capabilities and appears dependent on rodent caching for reestablishment. Bradley (1986c) considers sprouting a major regeneration strategy, particularly for shrubs with a decumbent growth form. Bitterbrush may take up to 20 years to become re-established after a fire (Bunting 1987). Eventually, antelope bitterbrush dominates root

sprouting species if fire return intervals are greater than 10-15 years, but it appears to decline 50-100 years after establishment (Everett 1987).

### **Reforestation**

Pinyon seedlings generally need shade for initial establishment. Natural regeneration may be greater where shrubs are available as nurse plants.

### **Revegetation Considerations**

Bitterbrush seed or seedling stock should be chosen carefully for compatibility with site and purpose as there is wide variability in different accessions (Bradley 1986c).

### **Comments**

This plant association is important winter range for deer and elk. Bitterbrush is often considered good browse forage for cattle, sheep, horses, pronghorn, elk, and mule deer (Bradley 1986c). Wildfires or prescribed burning can be detrimental to browse availability (Suminski 1993). Where sandstone rock outcrops occur frequently, management activities such as road construction or revegetation may be limited (Edwards et al. 1987).

### **References**

- Bradley 1986c
- Bunting 1987
- Edwards et al. 1987
- Erdman, Douglas, and Marr 1969
- Everett 1987
- Johnston 1987
- Moir and Carleton 1987
- Suminski 1993
- USFS 1987a

**Twoneedle pinyon/Gambel oak**  
***Pinus edulis/Quercus gambelii***

**Code(s)**

typic phase2 04 04

**Ecological Response Unit**

PJ Deciduous Shrub (PJD)

**NVC Group**

Colorado Plateau Pinyon - Juniper Woodland (G900)

**Key criteria**

Must have at least 5 percent cover of **\*Gambel oak**. Ponderosa pine may be accidental.

**Structure**

This woodland can form a closed canopy (luxuriant tree cover) in prolonged cessation of disturbances such as fire (postclimax).

**Location**

Local in southern New Mexico, becoming more widespread in central and northern New Mexico, and north of the Mogollon Rim in Arizona. Usually occurs on moderate and steep mountain slopes, 6,300' - 8,000' (1,920 - 2,400 m) on cool, moist sites such as draws of north slopes. Mean annual precipitation (MAP) is about 18 in/yr. Mean annual temperature is about 48 deg. F.

**Also See**

TES mapping units 119, 140, 157, and 195 in Carson NF (Edwards et al. 1987); also, Johnston (1984) in Colorado and Warren et al. (1982) *Pinus edulis-Amelanchier utahensis-Quercus gambelii* association in Grand Canyon National Park; *Pinus edulis- Juniperus deppeana-Juniperus monosperma- Quercus gambelii* subseries in Dancker (1985).

**Trees and Life History Traits**

Abundant (>25%):

twoneedle pinyon (*Pinus edulis*)C

Gambel oak (*Quercus gambelii*)S

Rocky Mountain juniper (*Juniperus scopulorum*)c

oneseed juniper (*Juniperus monosperma*) s

#### Shrubs

Well represented (>5%):

Gambel oak (*Quercus gambellii*)

mountain snowberry (*Symphoricarpos oreophillus*)

alderleaf mountain mahogany (*Cercocarpus montanus*)

wavyleaf oak (*Quercus X pauciloba*)

cliff fendlerbush (*Fendlera rupicola*)

plum (*Prunus* spp.)

wild rose (*Rosa* spp.)

big sagebrush (*Artemisia tridentata*) [northern NM]

Utah serviceberry (*Amelanchier utahensis*) [northern NM]

banana yucca (*Yucca baccata*)

common hoptree (*Ptelea trifoliata*) [southern NM]

#### Herbs

Common (>1%) or well represented (>5%):

muttongrass (*Poa fendleriana*)

prairie junegrass (*Koeleria macrantha*)

mountain muhly (*Muhlenbergia montana*)

Ross' sedge (*Carex rossii*)

bottlebrush squirrel tail (*Elymus elymoides*)

blue grama (*Bouteloua gracilis*)

pinewoods geranium (*Geranium caespitosum*)

American vetch (*Vicia americana*)

common yarrow (*Achillea millefolium*)

New Mexico groundsel (*Packera neomexicana* var. *neomexicana*)

Fendler's meadow-rue (*Thalictrum fendleri*)

#### Cryptogams

The greenish foliose lichen *Xanthoparmelia chlorochroa* is common in this plant association. Its abundance is generally proportional to healthy nutrient cycling (Sharnof, 1995, pers. comm. w/ Rita Suminski). Other lichen species have also been identified in this plant association, including an orange lichen, *Xanthoria fallax*, which is found on oak bark (Suminski, 1996, pers. comm.).

#### Brief plant ID notes

Gambel oak is a deciduous oak with deeply lobed, prickly "free" leaves. At lower elevations, it may cross with other oaks, making definitive identification difficult.

## Synonymy

wavyleaf oak (*Quercus X pauciloba* = *Quercus undulata*)

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)

New Mexico groundsel (*Packera neomexicana* var. *neomexicana* = *Senecio neomexicanus*)

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** +1 (cool, moist)

**Climate Class:** low sun cold (LSC), high sun cold (HSC)

## Fire Ecology

Following a single fire, Gambel oak forms dense thickets by extensive root sprouting. Repeated, relatively high severity fires may reduce Gambel oak (Tirmenstein 1988b). Erdman (1970) noted that at Mesa Verde, Colorado, in addition to prolific shrub sprouting, two annuals, sunflower (*Helianthus annuus*) and pigweed (*Chenopodium pratericola*), dominated the site during the first two post-fire years.

## Reforestation

Erdman (1970) reported poor results from pinyon seeding and planting following a summer wildfire at Mesa Verde in southern Colorado. Of 240,000 seedlings planted in the 1940s, only a few stands of pinyon were present in the late 1960s. Likewise, a seeding project on a 1959 burn in the same area had poor results. Pinyon seedlings need shade to survive and can persist in the “grass” stage for 5+ years.

## Revegetation Consideration

Natural revegetation is rapid due to oak regeneration.

## Comments

Phillips and Yates (1995) describe in detail an ecosystem management project in this association on the Santa Fe National Forest that involves firewood harvest, heritage site protection, watershed objectives in an integrated, community-based approach.

## References

Edwards et al. 1987

Erdman 1970

Johnston 1987

Muldavin et al. 1997

Phillips and Yates 1995

USFS 1987a

USFS 1986

**Twoneedle pinyon/wavyleaf oak**  
***Pinus edulis/Quercus X pauciloba***

(Formerly: *Pinus edulis/Quercus undulata*)

**Code(s)**

typic phase2 04 36 0

**Synonyms**

*Pinus edulis/Quercus undulata* (USFS 1986, USFS 1987a)

**Ecological Response Unit**

Madrean Pinyon-Oak (MPO)

**NVC Group**

Southern Rocky Mountain Pinyon - Juniper Woodland (G253)

**Key criteria**

\***Wavyleaf oak** is generally abundant (>25%). Pinyon is in the tallest stratum. Herbs are usually poorly represented.

**Structure**

This association may be a community type for plant associations that have undergone severe disturbance from fire, mining, overgrazing, or other erosion-inducing activity (Kennedy 1983). Pieper and Lymbery (1987) observed highest densities of wavyleaf oak on slopes greater than 20 percent.

**Location**

Found in southern (Sacramento Mountains, Lincoln NF and Mescalero Apache Reservation) and central New Mexico, and locally in northern New Mexico (including northeastern mesas); 6,000' - 8,000' (1,830 - 2,440 m) on moderate to steep mountain slopes, often on lithic skeletal soils.

**Also See**

PIED/MUDU, PIED/ACNE, and PIED/MUPA2 all contain wavyleaf oak, but this oak seldom exceeds 15 percent cover in mature stands. Wavyleaf oak is a vigorous sprouter after fire or clearing, and early successional stages of these different plant associations may be difficult

to separate. See Naumann's (1987) *Pinus edulis*- *Juniperus monosperma*/*Quercus undulata*, *Schizachyrium scoparium* phase.

### **Trees**

Well represented (>5%) or abundant (>25%): twoneedle pinyon (*Pinus edulis*)

alligator juniper (*Juniperus deppeana*) [not in northern NM]

oneseed juniper (*Juniperus monosperma*)

### **Shrubs**

Abundant (>25%):

**\*Wavyleaf oak (*Quercus X pauciloba*)**

red barberry (*Mahonia haematocarpa*)

cliff fendlerbush (*Fendlera rupicola*)

Wright's silktassel (*Garrya wrightii*)

eggleaf silktassel (*Garrya ovata*)

skunkbush sumac (*Rhus trilobata*)

alderleaf mountain mahogany (*Cercocarpus montanus*)

banana yucca (*Yucca baccata*)

plum (*Prunus* spp.)

### **Herbs**

Common (>1%):

Numerous species of grasses and forbs, but none are more than 5 percent cover.

### **Brief Plant ID Notes**

Where wavyleaf and Gambel oak ranges overlap, oaks cross easily and are difficult to distinguish by species.

### **Synonymy**

wavyleaf oak (*Quercus X pauciloba* = *Quercus undulata*)

red barberry (*Mahonia haematocarpa* = *Berberis haematocarpa*)

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typical)

**Climate Class:** LSC (low sun cold), HSC (high sun cold), HSM (high sun mild)

### **Fire Ecology**

With ample fuel ladders from oak understory, expect high fire intensity under dry conditions. Oak quickly resprouts following fires.



**Reforestation**

Planting opportunity may be limited by shallow soils. Pinyon seedlings should be planted in shady microsites.

**Revegetation Considerations**

Natural revegetation is rapid due to oak sprouting.

**Comments**

Livestock grazing in this association can be hampered by lack of surface water, impenetrable oak thickets, and typically low forage production.

Naumann (1987) reported heavy soil erosion in this association on relatively undisturbed sites where surface runoff from bare rock occasionally washed-out large amounts of soil.

**References**

- Kennedy 1983
- Muldavin et al. 1997
- Naumann 1987
- Pieper and Lymbery 1987
- USFS 1987a
- USFS 1986

**Twoneedle pinyon/rockland**  
***Pinus edulis*/rockland**

**Synonyms**

*Pinus edulis*-*Juniperus monosperma*/rockland (USFS 1986).

**Code(s)**

typic phase2 04 35 0

**Ecological Response Unit**

PJ Grass (PJG), all subclasses

**NVC Group**

Southern Rocky Mountain Pinyon - Juniper Woodland (G253)

**Key criteria**

Pinyon trees growing on rock with very little soil.

**Structure**

Tree roots often grow in cracks and fissures. Trees may be stunted where moisture is limited. Stocking is often light. Wood production is typically very low.

**Location**

Scattered locations throughout New Mexico and Arizona, including the malpais area near the Zuni Mountains, NM, and the Peloncillo Mountains of southwestern New Mexico.

Occurs on lava flows (malpais) or soils that are <4" to bedrock.

**Adjacent plant associations**

May adjoin ponderosa pine/rockland plant association on more mesic, but still rock- dominated sites. Lindsey (1951) reported the pinyon/rockland to be an ecotone between ponderosa pine and apache plume dominated plant communities.

**Also See**

Lindsey (1951); Moir (1979); *Pinus edulis*- *Juniperus osteosperma*-*Quercus turbinella*- *Cercocarpus intricatus* association in Grand Canyon NP (Warren et al. 1982).

## **Trees**

Well represented (>5%), often rooted in fissures:

twoneedle pinyon (*Pinus edulis*)

alligator juniper (*Juniperus deppeana*)

oneseed juniper (*Juniperus monosperma*)

## **Shrubs**

Common (>1%) to well represented (>5%): Apache plume (*Fallugia paradoxa*) fourwing saltbush (*Atriplex canescens*) cholla (*Cylindropuntia* spp.) pricklypear (*Opuntia* spp.) skunkbush sumac (*Rhus trilobata*)

Mormon tea (*Ephedra viridis*)

shrub live oak (*Quercus turbinella*)

spiny greasebush (*Glossopetalon spinescens*) [in Arizona]

## **Herbs**

Scarce or common. Composition is highly variable.

## **Cryptogams**

Lindsey (1951) reported the densest lichen growth on rocks in the P-J type of the Malpais near Grants, New Mexico, as compared with other life zones.

## **Synonymy**

spiny greasebush (*Glossopetalon spinescens* = *G. nevadense*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (Woodlands)

**Elevational Subzone:** 0 (typic)

**Climate Class:** varies.

## **Fire Ecology**

Many sites may be protected from frequent fire regimes, although fires are rather common in areas such as the malpais.

## **Reforestation**

Natural regeneration is spotty and hard to predict. Artificial regeneration is usually impractical due to the absence of plantable sites.

## **Revegetation Considerations**

Revegetation may be slow and spotty.

## **Comments**

Water in ice caves and sinks may provide for diverse wildlife populations in this plant association, particularly in the malpais.

## **References**

Lindsey 1951

Moir 1979

USFS 1987a

USFS 1986

Warren et al. 1982

## Pinyon/sparse

### **pinyon/sparse c.t.**

#### ***Pinus edulis/sparse***

#### ***Pinus monophylla/sparse***

#### ***Pinus discolor/sparse***

Pinyon/sparse is a community type that may be locally dominated by either twoneedle pinyon (*Pinus edulis*), singleleaf pinyon (*Pinus monophylla*), or border pinyon (*Pinus discolor*).

#### **Code(s)**

typic phase2 04 50 0

#### **Ecological Response Unit**

PJ Woodland (persistent) (PJO), all subclasses

#### **NVC Group**

Colorado Plateau Pinyon - Juniper Woodland (G900)

#### **Key Criteria**

Understory is sparse, although annual plants may be well represented. Tree covers of pinyon and juniper is usually dense, often forming a closed canopy.

#### **Structure**

Kennedy (1983) noted a well-developed litter layer and considered these sites to occur with more mesic conditions, perhaps necessary to support the closed tree canopy. Decreases in site productivity can be expected with extended exposure to wind and water erosion (Baker et al. 1995).

#### **Location**

Widespread geographically, but often occurs locally in the landscape (i.e., not usually extensive). Often between 6,500' and 7,300' (1,980 and 2,225 m) on basaltic mesas or hillslopes; soils are widely variable.

#### **Also See**

PIED/Rockland. Arnold, Jameson, and Reid (1964); Dalen and Snyder (1986); and on soils derived from sandstone and gypsum, see TES mapping unit 106 (Santa Fe NF, Gass et al. 1981, Price 1983).

## **Trees**

Abundant (>25%):

Depending on geography:

twoneedle pinyon (*Pinus edulis*)

singleleaf pinyon (*Pinus monophylla*)

border pinyon (*Pinus discolor*)

Utah juniper (*Juniperus osteosperma*)

alligator juniper (*Juniperus deppeana*)

oneseed juniper (*Juniperus monosperma*)

redberry juniper (*Juniperus coahuilensis*)

## **Shrubs**

Scarce (<1%) or common (>1%):

skunkbush sumac (*Rhus trilobata*)

cholla (*Cylindropuntia* spp.)

pricklypear (*Opuntia* spp.)

## **Herbs**

Perennial herbs are scarce, annuals may be common to well represented or even abundant.

## **Brief plant ID notes**

The easiest way to distinguish the three pinyons in this region is by counting the number of needles per fascicle (the sheath at the base of the needles). Twoneedle pinyon (*Pinus edulis*), commonly called Rocky Mountain pinyon has two needles/fascicle; border pinyon (*Pinus discolor*) has three needles/fascicle; singleleaf pinyon (*Pinus monophylla*) usually has one needle/fascicle, but occasionally has two, with ones and twos on the same tree.

## **Synonymy**

redberry juniper (*Juniper coahuilensis* = *J. erythrocarpa*)

singleleaf pinyon (*Pinus monophylla* = *P. fallax*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typic)

**Climate Class:** varies.

## **Fire Ecology**

The closed-canopy, sparse understory conditions may be a relic of extended fire exclusion. These stands generally only burn under extreme fire conditions, and then fire intensity is high, increasing mortality

among the already sparse understory. These sites are more susceptible to establishment of annuals like cheatgrass (*Bromus tectorum*) [Bunting 1987].

### **Reforestation**

Pinyons are most often naturally re-established from seed stored in caches by birds and small mammals.

### **Revegetation Considerations**

Artificial seeding may be necessary to re-establish understory species where sparse understory conditions have persisted, reducing naturally available seed sources.

### **Comments**

This community type is derived from woodlands with a history of livestock grazing, soil erosion, and fire cessation. It may be a derived successional stage (disclimax) from several plant associations, as well as a prolonged successional stage (disclimax) under current soil and management conditions. Erosional “badlands” represent PIED/sparse as a natural plant association.

### **References**

- Bunting 1987
- Kennedy 1983
- McMurray 1986b
- USFS 1987a
- USFS 1987b
- USFS 1986

## **Twoneedle pinyon/Dore's needlegrass**

(Formerly: *pinyon pine*/western needlegrass)

### ***Pinus edulis/Achnatherum nelsoni* var. *dorei***

(Formerly: *Pinus edulis/Stipa columbiana*; *Pinus edulis/Stipa nelson* var. *dorei*)

#### **Synonyms**

*Pinus edulis-Juniperus monosperma/Stipa columbiana* (Kennedy 1983).

#### **Code(s)**

typic phase2 04 37 0

#### **Ecological Response Unit**

PJ Grass (PJG), subclass PJ Grass - Cold (PJGc)

#### **NVC Group**

Southern Rocky Mountain Pinyon - Juniper Woodland (G253)

#### **Key criteria**

Pinyon dominates the overstory and grasses dominant the understory. Arizona fescue is absent. Dore's needlegrass or Schribner needlegrass are common to well represented. Alligator juniper may be accidental. A distinct litter layer is also usually present.

#### **Structure**

Although junipers can dominate the canopy in early succession, pinyon trees are conspicuously dominant in late successional stands. The site quality for pinyon appears to be good (Kennedy 1983).

#### **Location**

Known in New Mexico from the Sacramento Mountains, Jicarilla Mountains, and White Sands Missile Range, and Rowe Mesa (Pecos Ranger District, Santa Fe NF). Occurs on moderate to gentle slopes, 6,200' to 7,300' (1,890 - 2,225 m). Generally, not found on rocky sites.

#### **Adjacent Plant Associations**

On drier sites, may adjoin PIED/BOGR2, JUMO phase.



## Also See

PIED/MUPA2 and PIED/ACNED are very similar and may be related successionally (see Kennedy 1983).

## Trees and Life History Traits

Well represented to abundant (>5% to >25%):

twoneedle pinyon (*Pinus edulis*)C

oneseed juniper (*Juniperus monosperma*) S

## Shrubs

Scarce to common (< or > 1%):

wavyleaf oak (*Quercus X pauciloba*)

skunkbush sumac (*Rhus trilobata*)

## Herbs

Well represented (>5%) to abundant (>25%) especially grasses:

blue grama (*Bouteloua gracilis*)

sideoats grama (*Bouteloua curtipendula*)

mountain muhly (*Muhlenbergia montana*)

Dore's needlegrass (*Achnatherum nelsonii* spp. *dorei*)

Scribner needlegrass (*Achnatherum scribneri*)

bottlebrush squirrel tail (*Elymus elymoides*)

little bluestem (*Schizachyrium scoparium*)

littleseed ricegrass (*Piptatheropsis micrantha*)

big bluestem (*Andropogon gerardii*)

manyflowered stoneseed (*Lithospermum multiflorum*)

## Brief plant ID notes

The moderately tall (1-3') culms of Dore's needlegrass, also known as Columbia needlegrass, are stout with only a few culms per tuft. Leaves are flat when green and rolled when mature. As with most grasses, specific grass keys should be used to identify grass species.

## Synonymy

Dore's needlegrass (*Achnatherum nelsonii* ssp. *dorei* = *Stipa nelsonii* spp. *Dorei* = western needlegrass (*S. columbiana*)

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)

little bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*)

Scribner needlegrass (*Achnatherum scribneri* = *Stipa schribneri*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:**0 (typic)

**Climate Class:** HSC (high sun cold)

## **Fire Ecology**

Relatively frequent, light surface fires may maintain the needlegrass understory (Kennedy 1983). Where grasses are abundant, fine fuels are capable of supporting rapid fire spread. Dore's needlegrass is generally more resistant to fires than other needlegrasses (*Achnatherum*, *Hesperostipa*), and may be only slightly or moderately damaged by fire. Midsummer fires may be more damaging to the needlegrass in the understory than early spring or late fall fires. Recovery of the needlegrass following a burn may be slow, up to 3-5 years. (Tirmenstein 1987c). Annual grasses may also dominate following burns (Arnold et al. 1964).

## **Reforestation**

Provide shading for pinyon seedlings.

## **References**

Arnold et al. 1964

Barnes 1987

Erdman, Douglas, and Marr 1969

Edwards et al. 1987

Gass et al. 1981, 1983

Johnston 1987

Kennedy 1983

Tirmenstein 1987c

USFS 1987a

## Singleleaf pinyon/manzanita

### *Pinus monophylla*/*Arctostaphylos pungens*

(Formerly: *Pinus fallax*/*Arctostaphylos pugnens*)

#### Synonyms

*Pinus monophylla*/*Quercus turbinella*- *Arctostaphylos pungens* (Moir and Carleton 1987). Formerly *Pinus fallax*/*Arctostaphylos pungens* (PIFA/ARPU5).

#### Code(s)

typic phase2 33 01 0

#### Ecological Response Unit

PJ Evergreen Shrub (PJC)

#### NVC Group

Great Basin Pinyon - Juniper Woodland (G899)

#### Key Criteria

This central Arizona plant association exhibits a chaparral-like expression of shrubs (i.e., dense shrubs), but relatively minor herbs.

\***Pointleaf manzanita** and shrub live oak are at least common, often well represented or abundant. Crucifixion thorn is absent.

#### Structure

One site index for single leaf pinyon measured in this plant association was 25. Cattle forage rating value is moderate for early seral conditions, to none for late seral conditions.

#### Location

Known from central Arizona below the Mogollon Rim, north in Oak Creek Canyon to Sedona. Elevations are mostly between 4,800' and 6,000' (1,470 and 1,830 m) on a wide variety of slopes, aspects, landforms, and soils. Mean annual precipitation (MAP) = 20"/yr; with a hot, dry season during May and June.

#### Adjacent Plant Associations

Warmer, drier sites may feature PIMO/QUTU2 (manzanita scarce or absent), juniper woodlands, or chaparral. Colder or wetter sites may have ponderosa pine or Arizona cypress plant associations.

## Also see

PIED/ARPU5 is similar and may occur in southern portions of the Gila, Apache-Sitgreaves, and Coconino National Forests. TES subseries PIMO/JUOS/QUTU2/ARPU5 on the northern portion of Tonto NF (USFS 1986); the modal mapping unit (MU) is MU 3730 (erosional soils on diabase). Other MUs include 3731, 3710 (Typic Haplustalfs, deep gravelly loam, 15-40% slopes), 3752 and 3753 (Typic Ustochrepts), very deep gravelly loams on mixed parent materials and granitics). This subseries was also described in the TES report for Globe RD, MUs 3705, 3765, 4038, 4768, and 4820.

## Trees

Well represented (>5%) or abundant (>25%):

singleleaf pinyon (*Pinus monophylla*)

Utah juniper (*Juniperus osteosperma*)

alligator juniper (*Juniperus deppeana*)

Emory oak (*Quercus emoryi*) [<5% cover when present]

## Shrubs

Abundant (>25%) or luxuriant (>50%):

**\*Pointleaf manzanita** (*Arctostaphylos pungens*)

shrub live oak (*Quercus turbinella*)

catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*)

sacahuista (*Nolina microcarpa*)

skunkbush sumac (*Rhus trilobata*)

sugar sumac (*Rhus ovata*)

Wright's silktassel (*Garrya wrightii*)

ashy silktassel (*Garrya flavescens*)

red barberry (*Mahonia haematocarpa*)

rough mendora (*Mendora scabra*)

desert ceanothus (*Ceanothus greggii*)

Stansbury cliffrose (*Purshia stansburyana*) [calcareous soils]

alderleaf mountain mahogany (*Cercocarpus montanus*)

broom snakeweed (*Gutierrezia sarothrae*)

## Herbs

Scarce to well represented (<1 to >5% cover):

sideoats grama (*Bouteloua curtipendula*)

hairy grama (*Bouteloua hirsuta*)

curlymesquite (*Hilaria belangeri*)

prairie junegrass (*Koeleria macrantha*)

muttongrass (*Poa fendleriana*)  
New Mexico needlegrass (*Hesperostipa neomexicana*)  
desert needlegrass (*Achnatherum speciosa*)  
Indian ricegrass (*Achnatherum hymenoides*)  
bottlebrush squirrel tail (*Elymus elymoides*)  
plains blackfoot (*Melampodium leucanthum*)  
dwarf lousewort (*Pedicularis centranthera*)  
bastardsage (*Eriogonum wrightii*)

### **Brief Plant ID Notes**

The scientific name for singleleaf pinyon has been variable. The most current accurate name is *Pinus monophylla*. Formerly *Pinus fallax* or *Pinus edulis* var. *fallax* or *Pinus californiarum* var. *fallax*. The dark mahogany-colored bark of the manzanita is smooth. The manzanita shrub, which can root from drooping branches and form extensive thickets, has thick, leathery lime-green leaves.

### **Synonymy**

catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera* = *M. biuncifera*)  
red barberry (*Mahonia haematocarpa* = *Berberis haematocarpa*)  
Stansbury cliffrose (*Purshia stansburyana* = *Cowania stansburyana* = *C. mexicana*)  
rose heath (*Chaetopappa ericoides* = *Leucelene ericoides*)  
bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)  
Indian ricegrass (*Achnatherum hymenoides* = *Oryzopsis hymenoides*)  
New Mexico feathergrass (*Hesperostipa neomexicana* = *Stipa neomexicana*)  
desert needlegrass (*Achnatherum speciosum* = *Stipa speciosa*)  
singleleaf pinyon (*Pinus monophylla* = *P. fallax*)

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)  
**Elevational Subzone:** 0 (typical), +1 (cool, mesic)  
**Climate Class:** LSM (low sun mild)

### **Phases**

No phases are described here for this type, however, Moir and Carleton (1987) list: *Pinus monophylla*/*Arctostaphylos pungens*/*Quercus turbinella* and *Pinus monophylla*/*Arctostaphylos pungens*/*Quercus turbinella*, *Quercus emoryi* phase.

**Fire ecology**

Although not documented, fires are probably a major disturbance factor considering the strong expression of manzanita.

**Reforestation**

Generally, abundant shrubs may inhibit natural and artificial tree seedlings. Seed tree and clear-cut firewood harvesting will favor grasses, shrubs, and possibly encourage alligator juniper (if present) sprouting. A study in central Arizona (Soeth et al. 1995) showed firewood harvest increased forage and reduced soil loss. Selective and light shelterwood harvesting can maintain singleleaf pinyon presence in stands. Shading is critical to pinyon seedling survival.

**Revegetation Considerations**

A rapid revegetation of shrubs can be expected following disturbances. Manzanita re-establishes from seed. Shrub live oak, mountain mahogany, and many other shrubs often resprout following disturbance.

**Comments**

This plant association has potential for browse production and for hiding cover.

**References**

- Harris 1988
- Moir and Carleton 1987
- Soeth et al. 1995
- TES - Northern Tonto (1986)
- TES - Globe RD (1984)
- USFS 1987b

## singleleaf pinyon/blue grama

### *Pinus monophylla/Bouteloua gracilis*

#### Synonyms

Formerly *Pinus fallax/Bouteloua gracilis* (PIFA/BOGR2).

#### Code(s)

alligator juniper (JUDE2) phase2 33 02 0

Utah juniper (JUOS) phase2 33 02 1

cliffrose (PUST) phase2 33 02 2

#### Ecological Response Unit

PJ Grass (PJG), subclass low sun mild (PJGlsm)

#### NVC Group

Great Basin Pinyon - Juniper Woodland (G899)

#### Key Criteria

A pinyon-juniper woodland with a rich understory of grasses, usually including blue grama (*Bouteloua gracilis*). \***Singleleaf pinyon** is the dominant tree, along with either alligator juniper (JUDE2 phase) or Utah juniper (JUOS phase).

#### Structure

This type can produce considerable forage in terms of grass, particularly when tree densities are minor. Trees can also be productive on this site; one estimate of site index is 30 for singleleaf pinyon. There is a relatively broad range of productivity potential for firewood. The forage value rating for cattle is high in early seral conditions and moderate in late seral conditions. A study in central Arizona (Soeth et al. 1995) showed firewood harvest increased forage and reduced soil loss.

#### Location

Primarily known from central Arizona south of the Mogollon Rim (Prescott and Tonto National Forests and Ft. Apache Reservation).

Occurs on elevated plains and alluvial valley plains. Elevations range from 4,900' - 5,600' (1,495 - 1,705 m). Mean annual precipitation (MAP) is around 22"/yr; mean annual air temperature (MAAT) = 52-56 degrees F.

## Also See

PIED/BOGR2 is generally centered in HSC climates. See TES mapping unit 4170 on north portion of the Tonto NF (USFS 1986). PIMO/BOGR2 appears to be similar to JUDE2/BOGR2. PIMO/BOGR2 may historically have been an open woodland, while JUDE2/BOGR2 was a juniper savanna. With fire suppression and livestock grazing, these types are developing thick overstories of trees (Norm Ambos, pers. comm. 1996).

## Trees

Abundant (>25%):

singleleaf pinyon (*Pinus monophylla*)

Utah juniper (*Juniperus osteosperma*)

alligator juniper (*Juniperus deppeana*)

Emory oak (*Quercus emoryi*) [occasional, <5% cover when present]

Arizona white oak (*Quercus arizonica*) [occasional, <5% cover when present]

## Shrubs

Scarce (<1%) to common (>1%):

shrub live oak (*Quercus turbinella*)

sacahuista (*Nolina microcarpa*)

red barberry (*Mahonia haematocarpa*)

Fremont's mahonia (*Mahonia fremontii*)

Stansbury cliffrose (*Purshia stansburyana*)

cholla (*Cylindropuntia* spp.)

pricklypear (*Opuntia* spp.)

broom snakeweed (*Gutierrezia sarothrae*)

bastardsage (*Eriogonum wrightii*)

## Herbs

Abundant (>25%):

blue grama (*Bouteloua gracilis*)

sideoats grama (*Bouteloua curtipendula*)

hairy grama (*Bouteloua hirsuta*)

black grama (*Bouteloua eriopoda*)

Fendler threeawn (*Aristida purpurea* var. *longiseta*)

threeawn (*Aristida* spp.)

sand dropseed (*Sporobolus cryptandrus*)

common wolfstail (*Lycurus phleoides*)

cane bluestem (*Bothriochloa barbinodis*)

little bluestem (*Schizachyrium scoparium*)



curlymesquite (*Hilaria belangeri*)  
prairie junegrass (*Koeleria macrantha*)  
muttongrass (*Poa fendleriana*)  
bottlebrush squirrel tail (*Elymus elymoides*)  
needlegrass (*Achnatherum* spp./*Hesperstipa* spp.)  
western wheatgrass (*Pascopyrum smithii*)

## **Cryptogams**

Cryptogamic crusts may be important for erosion control and may be damaged by increased foot traffic, grazing, and tree canopy cover. See Ladyman, Muldavin, and Fletcher (1993) for a study of cryptogamic crusts in a similar PIED/BOGR2 plant association.

## **Brief Plant ID Notes**

The inflorescence or “flag” can be used to distinguish blue grama from hairy grama (*Bouteloua hirsuta*). On blue grama, the flag is curved, and the terminal awn is shorter than the width of the flag. This awn is longer on hairy grama which also has straight flags.

## **Synonymy**

red barberry (*Mahonia haematocarpa* = *Berberis haematocarpa*)  
Stansbury cliffrose (*Purshia stansburyana* = *Cowania stansburyana* = *C. mexicana*)  
bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)  
western wheatgrass (*Pascopyrum smithii* = *Agropyron smithii*)  
needlegrass spp. (*Achnatherum* spp./*Hesperstipa* spp. = *Stipa* spp.)  
singleleaf pinyon (*Pinus monophylla* = *P. fallax*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** +1 (cool, mesic) [JUDE2 phase] 0 (typical) [JUOS phase]

**Climate Class:** LSM (low sun mild)

## **Phases**

PIMO/BOGR2 has three phases. The Utah juniper phase is more mesic than the Alligator juniper phase. The cliffrose phase has a strong expression of cliffrose.

## **Fire Ecology**

Burning in this site usually encourages grasses. Check the “Fire Ecology” section for a review of research on fire in the similar PIED/BOGR2 plant association description. When blue grama is dormant (early spring, driest part of summer), it is less likely to be

damaged by fires. Re-establishment of blue grama occurs through rhizomes (Tirmenstein 1987b). A 3-to-4-month rest from grazing is recommended for burned sites (Tirmenstein 1987b).

### **Reforestation**

On some sites, junipers or tall shrubs serve as nurse plants for natural regeneration of singleleaf pinyon. Shading is critical for the first 8 to 10 years for pinyon seedling survival. Mechanical site preparation may encourage juniper and oak regeneration. Burning encourages non-woody vegetation.

### **Revegetation Considerations**

When oak is present, revegetation can be rapid. Without a prolific sprouter, revegetation is slow to moderate.

### **Comments**

This plant association can be important for livestock grazing. Yearlong or cool season grazing has often reduced or eliminated cool season grasses while favoring shrubs and short statured warm season grasses. There is fair potential for big game hiding cover in late seral stages.

### **References**

Ladyman, Muldavin and Fletcher 1993  
Soeth et al. 1995  
TES northern portion of the Tonto NF Tirmenstein 1987b  
USFS 1987b

**Singleleaf pinyon/crucifixion thorn**  
***Pinus monophylla/Canotia holacantha***

**Synonyms**

Formerly *Pinus fallax/Canotia holacantha*) (PIFA/CAHO3)

**Code(s)**

typic phase2 33 03 0

**Ecological Response Unit**

PJ Evergreen Shrub (PJC)

**NVC Group**

Madrean Juniper Open Woodland (G487)

**Key Criteria**

A pinyon-juniper woodland amid a shrubby and grassy matrix containing \***crucifixion thorn**.

**Structure**

This type is subject to soil erosion. A reported site index for pinyon is 25. The forage value rating for cattle is low to none.

**Location**

Found in central Arizona south of the Mogollon Rim (including Prescott and Tonto National Forests, Fort Apache and San Carlos Apache Reservations), this association occurs on dissected, erosional escarpments and hills from 3,500' to 4,000' (1,075 - 1,225 m). Mean annual precipitation (MAP) = 20"/yr. Mean annual air temperature (MAAT) = 59-61 degrees F.

**Adjacent Habitat Types**

On elevated plains in the Prescott National Forest, PIMO/CAHO3 adjoins mesquite grasslands.

**Also See**

TES Mapping Unit 3770 in northern portion of the Tonto NF consists of a PIMO/JUOS/QUTU2/ARPU5/CAHO3 subseries on a loamy-skeletal, calcareous Typic Ustochrept.

**Trees**

Well represented (>5%):

singleleaf pinyon (*Pinus monophylla*)  
Utah juniper (*Juniperus osteosperma*)  
redberry juniper (*Juniperus coahuilensis*)

### **Shrubs**

Well represented (>5%):

\*Crucifixion thorn (*Canotia holacantha*)  
shrub live oak (*Quercus turbinella*)  
banana yucca (*Yucca baccata*)  
soaptree yucca (*Yucca elata*)  
common sotol (*Dasylirion wheeleri*)  
red barberry (*Mahonia haematocarpa*)  
featherplume (*Dalea formosa*)  
catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*)  
pointleaf manzanita (*Arctostaphylos pungens*)  
redberry buckthorn (*Rhamnus crocea*)  
Stansbury cliffrose (*Purshia stansburyana*)  
broom snakeweed (*Gutierrezia sarothrae*)

### **Herbs**

Common (>1%) or well represented (>5%):

sideoats grama (*Bouteloua curtipendula*)  
hairy grama (*Bouteloua hirsuta*)  
slim tridens (*Tridens muticus* var. *elongatus*)  
threeawn (*Aristida* spp.)  
New Mexico needlegrass (*Hesperostipa neomexicana*)  
muttongrass (*Poa fendleriana*)  
bottlebrush squirreltail (*Elymus elymoides*)  
plains blackfoot (*Melampodium leucanthum*)

### **Brief Plant ID Notes**

Singleleaf pinyon usually has one needle per fascicle, but occasionally has ones and twos on the same tree. Redberry juniper generally occurs below the Mogollon Rim, while oneseed juniper occurs above the Mogollon Rim. See JUCO11/CAHO3 for notes on sorting these out in the vicinity of the Mogollon Rim. Crucifixion thorn is a distinctive shrub or small tree. Often dominated by stems, as the leaves are drought deciduous. The woody, oval fruit stays on the stem through spring and splits into five parts.

## **Synonymy**

redberry juniper (*Juniperus erythrocarpa* = *coahuilensis*)

red barberry (*Mahonia haematocarpa* = *Berberis haematocarpa*)

Stansbury cliffrose (*Purshia stansburyana* = *Cowania stansburyana* = *C. mexicana*)

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystris*)

slim tridens (*Tridens muticus* var. *elongatus* = *Tridens elongatus*)

New Mexico feathergrass (*Hesperostipa neomexicana* = *Stipa neomexicana*)

singleleaf pinyon (*Pinus monophylla* = *P. fallax*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typical)

**Climate Class:** LSM (low sun mild)

## **Reforestation**

Shading is essential for pinyon seedling survival. Planting projects may have poor survival rates.

## **Revegetation Considerations**

Natural revegetation is slow.

## **Comments**

High erosion potential must be considered in any activity.

## **References**

Fletcher 1985

Stuever 199

USFS 1987b

# singleleaf pinyon/shrub live oak

## *Pinus monophylla*/*Quercus turbinella*

(Formerly: *Pinus fallax*/*Quercus turbinella*)

### Code(s)

Vegetation 2 33 04 0

typic phase 2 33 04 1

cliffrose (PUST) phase 2 33 04 2

### Ecological Response Unit

PJ Evergreen Shrub (PJC)

### NVC Group

Madrean Juniper Open Woodland (G487)

### Key Criteria

**\*Singleleaf pinyon**, Utah juniper, and oneseed juniper are found in the overstory of this shrubby woodland. **\*Shrub live oak** is well represented and often abundant. Crucifixion thorn is absent, mountain mahogany is poorly represented, and manzanita is scarce or absent. The cliffrose phase is on calcareous soils.

### Location

Primarily found in central Arizona mostly south of the Mogollon Rim tapering to occasional stands near the NM border, this association occurs on a wide variety of soils and landforms. This association may represent the lowest elevational limits of singleleaf pinyon.

### Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typical)

**Climate Class:** LSM (high sun mild)

### Trees

Abundant (>25%):

**\*Singleleaf pinyon** (*Pinus monophylla*)

Utah juniper (*Juniperus osteosperma*)

oneseed juniper (*Juniperus monosperma*)

Emory oak (*Quercus emoryi*) [occasional]

### Shrubs

Well represented (>5%) or abundant (>25%):

**\*Shrub live oak** (*Quercus turbinella*)

skunkbush sumac (*Rhus trilobata*)

catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*)  
Alderleaf mountain mahogany (*Cercocarpus montanus*)  
red barberry (*Mahonia haematocarpa*)  
banana yucca (*Yucca baccata*)  
sacahuista (*Nolina microcarpa*)  
fourwing saltbush (*Atriplex canescens*)  
tulip pricklypear (*Opuntia phaeacantha*)  
walkingstick cactus (*Cylindropuntia spinosior*)

**on calcareous soils (PUST phase):**

Stansbury cliffrose (*Purshia stansburyana*)  
desert ceanothus (*Ceanothus greggii*)  
rough mendora (*Mendora scabra*)  
bastardsage (*Eriogonum wrightii*)  
broom snakeweed (*Gutierrezia sarothrae*)

**Herbs**

Well represented (>5%):

blue grama (*Bouteloua gracilis*)  
sideoats grama (*Bouteloua curtipendula*)  
hairy grama (*Bouteloua hirsuta*)  
Fendler threeawn (*Aristida purpurea* var. *longiseta*)  
threeawn (*Aristida* spp.)  
sand dropseed (*Sporobolus cryptandrus*)  
common wolfstail (*Lycurus pheloides*)  
cane bluestem (*Bothriochloa barbinodis*)  
little bluestem (*Schizachyrium scoparium*)  
curlymesquite (*Hilaria belangeri*)  
prairie junegrass (*Koeleria macrantha*)  
muttongrass (*Poa fendleriana*)  
bottlebrush squirreltail (*Elymus elymoides*)  
needlegrass (*Achnatherum* spp./*Hesperostipa* spp.)  
numerous forbs

**Brief Plant ID Notes**

Singleleaf pinyon (*Pinus monophylla*) usually has one needle/fascicle, but occasionally has two, with ones and twos on the same tree. Shrub live oak has thick, stiff, evergreen leaves with spine-tipped teeth. The upper leaf surface is blue-green, and yellow-green beneath. Leaves are small for oaks, approx. 1/2" to 1-1/4" long.

## **Synonymy**

red barberry (*Mahonia haematocarpa* = *Berberis haematocarpa*)  
catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera* = *M. biuncifera*)  
Stansbury cliffrose (*Purshia stansburyana* = *Cowania stansburyana* = *C. mexicana*)  
little bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*)  
bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)  
walkingstick cactus (*Cylindropuntia spinosior* = *Opuntia spinosior*)  
singleleaf pinyon (*Pinus monophylla* = *P. fallax*)

## **Also See**

Common occurrence of singleleaf pine separate PIMO/QUTU2 from JUCO11/QUTU2. Manzanita may be accidental in PIMO/QUTU2 but becomes common or well- represented in PIMO/ARPU5.

## **Structure**

The understory can appear as a patchy mosaic of shrubs amid corridors of grasses and half shrubs. This relationship between shrub live oak, grasses, and conifer densities can be dynamic. This type generally has a low forage value rating for cattle in early succession, and no forage value for cattle at late succession. A recorded site index for pinyon = 20.

## **Fire Ecology**

Frequent fire can favor oak dominance and slow succession to a conifer woodland, producing chaparral vegetation. (Johnson et al. 1962)

## **Reforestation**

Firewood harvest by clearcut or seedtree methods will favor oak and shrub species rather than pinyon and juniper. Conifer regeneration can be encouraged through selection and shelterwood harvesting. Plant pinyon seedlings among woody debris to provide shading for 8 to 10 years. Planting is not a common practice.

## **Revegetation Considerations**

Can be rapid due to oak resprouting.

## **Comments**

This plant association may provide browse cover for deer.

## **References**

Johnson et al. 1962  
Moir and Carleton 1987  
USFS 1987b



**singleleaf pinyon/banana yucca**  
***Pinus monophylla/Yucca baccata***

(Formerly: *Pinus fallax/Yucca baccata*)

**Code(s)**

typic phase2 33 05 0

**Ecological Response Unit**

PJ Evergreen Shrub (PJC)

**NVC Group**

Madrean Juniper Open Woodland (G487)

**Key Criteria**

Tree cover is luxuriant with an overstory of singleleaf pinyon, Utah juniper, and possibly oneseed juniper. Herbs are scarce, primarily annuals, and shrubs are common.

**Structure**

This association has a moderate potential for firewood production. One measured site index for pinyon for this association is 25. There is little to no potential for livestock grazing. Where this association occurs on steep, rocky sites, expect slow growth, which is unable to sustain grazing, and prone to erosion upon disturbance. There is potential for wildlife hiding cover.

**Location**

Presently known from Ft. Apache Reservation where it occurs on steep south or west slopes around 6,200' (1,890 m).

**Also See**

PIMO/sparse community type is perhaps indistinguishable.

**Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typical)

**Climate Class:**LSM (low sun mild)

**Trees**

Luxuriant (>50%):

singleleaf pinyon (*Pinus monophylla*)C

Utah juniper (*Juniperus osteosperma*) S

oneseed juniper (*Juniperus monosperma*)c  
gray oak (*Quercus X grisea*) [occasional]

### **Shrubs**

Common (>1%):

shrubby forms of gray oak (*Quercus x grisea*)  
hybrids of shrub live oak (*Quercus x turbinella*)  
banana yucca (*Yucca baccata*) skunkbush  
sumac (*Rhus trilobata*)  
alderleaf mountain mahogany (*Cercocarpus montanus*)  
broom snakeweed (*Gutierrezia sarothrae*)

### **Synonymy**

singleleaf pinyon (*Pinus monophylla* = *P. fallax*)

### **Herbs**

Scarce (<1%):

buckwheat (*Eriogonum* spp.) annuals

### **Brief Plant ID Notes**

At Fort Apache Reservation, singleleaf pinyon and twoneedle pinyon (*Pinus edulis*) may hybridize at sites within this association.

### **Fire Ecology**

No fire ecology information specifically for this plant association is available. Banana yucca generally survives fires by sprouting from underground rhizomes (Tirmenstein 1989b).

### **Reforestation**

Firewood harvest using a selection method or shelterwood method may be sustainable, but opening the stand through clearcuts or seed tree cuts would favor shrubs and junipers. No information on planting success is available; however, shading is probably essential to pinyon seedling survival.

### **Revegetation Considerations**

Natural revegetation is slow.

### **Comments**

Steep slopes are prone to erosion, particularly when disturbed.

### **References**

Tirmenstein 1989b  
USFS 1987b

## Border pinyon/Mexican orange

(Formerly: border pinyon/star-leaf)

### *Pinus discolor/Choisya dumosa* var. *arizonica*

(Formerly: *Pinus discolor/Choisya arizonica*)

#### Synonyms

*Pinus discolor/Choisya arizonica* USFS 1987b.

*Pinus discolor-Quercus arizonica/Nolina microcarpa* (Moir and Carleton 1987 [ed. 1])

#### Code(s)

typic phase2 32 02 0

#### Ecological Response Unit

PJ Woodland (persistent) (PJO), subclass mild (PJOm)

#### NVC Group

Madrean Pinyon-Juniper Woodland (G200)

#### Key Criteria

This woodland is usually well stocked with **\*border pinyon**, alligator juniper, and occasional Arizona white oak in the canopy. The shrub dominated understory includes **\*Mexican orange**, but oaks or mountain mahogany are poorly represented (<5%).

#### Location

Known from the Dragoon Mountains in southeastern Arizona, this type has been found on steep, north-facing slopes around 6,500' (1,980 m).

Parent materials are limestone and altered limestone. Mean annual precipitation (MAP) = 20" per year.

#### Trees

Luxuriant (>50%):

border pinyon (*Pinus discolor*)

Calligator juniper (*Juniperus deppeana*) c

Arizona white oak (*Quercus arizonica*) s

#### Shrubs

Common (>1%) to well represented (>5%):

\*Mexican orange (*Choisya dumosa* var. *arizonica*)

Wright's silktassel (*Garrya wrightii*)

skunkbush sumac (*Rhus trilobata*)  
cliff fendlerbush (*Fendlera rupicola*)  
hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus*)  
sacahuista (*Nolina microcarpa*)  
common hoptree (*Ptelea trifoliata*)  
walkingstick cactus (*Cylindropuntia spinosior*)

## Herbs

Scarce to common (< or > 1%):

blue grama (*Bouteloua gracilis*)  
sideoats grama (*Bouteloua curtipendula*)  
prairie junegrass (*Koeleria macrantha*)  
Fendler's lipfern (*Cheilanthes fendleri*)  
alpine pennycress (*Thlaspi montanum*)

## Brief Plant ID Notes

Border pinyon has two to three needles/fascicle. Needles have a distinct white or silver line. Mexican orange, also known as star-leaf, has whorls of eight, narrow, wavy margin leaflets. Flowers are five-petaled.

## Synonymy

Mexican orange (*Choisya dumosa* var. *arizonica* = *C. arizonica*)  
alpine pennycress (*Thlaspi montanum* var. *montanum* = *T. alpestre*)  
walkingstick cactus (*Cylindropuntia spinosor* = *Opuntia spinosor*)

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** +1 (cool, moist)

**Climate Class:** HSM (high sun mild)

## References

Moir and Carleton 1987  
USFS 1987b

## Border pinyon/bullgrass

*Pinus discolor/Muhlenbergia emersleyi*

### Code(s)

typic phase2 32 03 0

### Ecological Response Unit

PJ Grass (PJG), subclass high sun mild (PJGhsm)

### NVC Group

Madrean Pinyon-Juniper Woodland (G200)

### Key Criteria

A grassy woodland on moderate to steep slopes occurring in southeastern Arizona and southwestern New Mexico. Bullgrass is usually present, although it may be lacking in some locations. **\*Border pinyon** and Alligator juniper dominate the overstory, and oaks are present but scarce in the overstory.

### Structure

There is very little documented information about this type.

### Location

Presently known from southeastern Arizona, and southwestern New Mexico, but probably occurs in northern Mexico also. Usually on moderate to steep, north-facing colluvial slopes from 5,800' - 6,600' (1,770 - 2,010 m). Soils are erosional and may be very shallow (<5") and interrupted by exposed bedrock. Mean annual precipitation (MAP) =18-19"/yr.

### Adjacent Habitat Types

On shallow rocky soils of the southern Peloncillos, NM, PIDI3/MUEM and QUEM/ARPU form complicated mosaics and gradational associations.

### Also See

Moir (1979); *Pinus discolor-Nolina microcarpa-Muhlenbergia emersleyi* h.t. of Willging (1987).

### Trees

Well represented (>5%), total oak tree cover is <1%:

**\*Border pinyon** (*Pinus discolor*)

alligator juniper (*Juniperus deppeana*)  
Arizona white oak (*Quercus arizonica*)  
Arizona white oak-gray oak hybrids (*Quercus arizonica* X *grisea*)  
Emory oak (*Quercus emoryi*)

## **Shrubs**

Common (>1%):

Toumey oak (*Quercus toumeyi*)  
Toumey oak hybrids with gray oak (*Quercus toumeyi* X *grisea*)  
gray oak (*Quercus grisea*) [shrubby]  
Wright's silktassel (*Garrya wrightii*)  
skunkbush sumac (*Rhus trilobata*)  
cliff fendlerbush (*Fendlera rupicola*)  
hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus*)  
sacahuista (*Nolina microcarpa*)  
common sotol (*Dasyilirion wheeleri*)  
gumhead (*Gymnosperma glutinosum*)  
yucca (*Yucca madrensis*)  
banana yucca (*Yucca baccata*)  
broom snakeweed (*Gutierrezia sarothrae*)  
pointleaf manzanita (*Arctostaphylos pungens*)

## **Herbs**

Well represented (>5%):

blue grama (*Bouteloua gracilis*)  
sideoats grama (*Bouteloua curtipendula*)  
slender grama (*Bouteloua repens*)  
plains lovegrass (*Eragrostis intermedia*)  
bullgrass (*Muhlenbergia emersleyi*)  
slimflower muhly (*Muhlenbergia tenuifolia*)  
prairie junegrass (*Koeleria macrantha*)  
nodding brome (*Bromus anomalus*)  
bottlebrush squirreltail (*Elymus elymoides*)  
Texas bluestem (*Schizachyrium cirratum*)  
ferns (*Cheilanthes*, *Bommeria*, *Pellaea*)

## **Brief Plant ID Notes**

Bullgrass is similar to some other large bunchgrasses in the *Muhlenbergia* genus. Longtongue muhly (*M. longiligula*) has more rounded sheaths at the base, where bullgrass is flattened. There are deciduous awns on the lemmas of bullgrass, but no awns on longtongue

muhly (i.e., if you see awns, it could be bullgrass; if you don't see awns, it could be either). Deergrass (*M. rigens*) looks similar but is found in draws and drainages (Stuever 1995).

**Synonymy**

slimflower muhly (*Muhlenbergia tenuifolia* = *M. monticola*)  
yucca (*Yucca madrensis* = *Yucca schottii*)

**Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typic), +1 (cool, mesic)

**Climate Class:** HSM (high sun mild)

**Comments**

Important habitat for Gould's turkey (Willging 1987).

**References**

Moir 1979

Moir 1982

Moir and Carleton 1987

Stuever 1995

USFS 1986

Willging 1987

# **Border pinyon/pinyon ricegrass** *Pinus discolor/Piptochaetium fimbriatum*

## **Code(s)**

typic phase2 32 04

## **Ecological Response Unit**

PJ Grass (PJG), subclass high sun mild (PJGhsm)

## **NVC Group**

Madrean Pinyon-Juniper Woodland (G200)

## **Key Criteria**

This woodland is found in washes, drainages, and other alluvial settings.

**\*Border pinyon** is the dominant tree species. The understory is dominated by grasses and may include pinyon ricegrass, although it is not always present. The shrub layer may be minor or significant and includes oaks and yuccas.

## **Location**

Occurs in southeastern Arizona and central and southwestern New Mexico. Elevations range from 5,500' - 6,000' (1,680-1,830 m) often on north slopes. Soils may be Typic Ustifluvents and Cumulic and Typic Ustochrepts. Mean annual precipitation (MAP) = 18-19"/yr.

## **Also See**

PIDI3/MUEM is mostly on colluvial slopes and pinyon ricegrass is poorly represented in the grass assemblage. There is very little description of PIDI3/PIFI at present. The importance of PIDI3/PIFI to Gould's turkey habitat is discussed by Willging (1987).

## **Trees**

Abundant (>25%):

border pinyon (*Pinus discolor*)

alligator juniper (*Juniperus deppeana*)

gray oak (*Quercus grisea*) gray oak hybrids to Arizona white oak (*Quercus grisea X arizonica*)

## **Shrubs**

Common (>1%):

Toumey oak (*Quercus toumeyii*)



Toumey oak hybrids with gray oak (*Quercus toumeyi* X *grisea*)  
gray oak (*Quercus grisea*) [shrubby]  
Wright's silktassel (*Garrya wrightii*)  
skunkbush sumac (*Rhus trilobata*)  
cliff fendlerbush (*Fendlera rupicola*)  
hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus*)  
sacahuista (*Nolina microcarpa*)  
yucca (*Yucca madrensis*)  
banana yucca (*Yucca baccata*)  
broom snakeweed (*Gutierrezia sarothrae*)  
tulip pricklypear (*Opuntia phaeacantha*)  
pointleaf manzanita (*Arctostaphylos pungens*)

## Herbs

Well represented (>5%):

blue grama (*Bouteloua gracilis*)  
sideoats grama (*Bouteloua curtipendula*)  
pinyon ricegrass (*Piptochaetium fimbriatum*)  
plains lovegrass (*Eragrostis intermedia*)  
bullgrass (*Muhlenbergia emersleyi*)  
prairie junegrass (*Koeleria macrantha*)  
nodding brome (*Bromus anomalus*)  
bottlebrush squirreltail (*Elymus elymoides*)  
Texas bluestem (*Schizachyrium cirratum*)  
Kunth's onion (*Allium kunthii*)  
New Mexico groundsel (*Packera neomexicana* var. *neomexicana*)  
wild beans (*Phaseolus* spp.)

## Brief Plant ID Notes

When the seedheads are on the plant, pinyon ricegrass is hard to miss as the seeds are large for grasses and the open panicle and long awns give the plant a distinctive appearance. Most of the narrow leaves originate at the base, and there are woolly hairs just below the nodes of the culm. (Stuever 1995.)

## Synonymy

hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus* = *C. breviflorus*)  
bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)  
New Mexico groundsel (*Packera neomexicana* var. *neomexicana* = *Senecio neomexicanus*)  
yucca (*Yucca madrensis* = *Yucca schottii*)

**Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** +1 (cool, moist), 0 (typic)

**Climate Class:** HSM (high sun mild)

**Reforestation**

Like other pinyons, border pinyon seedlings do best with shade.

**References**

Stuever 1995

USFS 1987b

Willging 1987

## Borderpinyon/silverleaf oak

### *Pinus discolor/Quercus hypoleucoides*

#### Code(s)

typic phase2 32 06 0

#### Ecological Response Unit

Madrean Pinyon-Oak (MPO)

#### NVC Group

Madrean Pinyon-Juniper Woodland (G200)

#### Key Criteria

A shrub-dominated woodland on moderate to steep slopes occurring in southeastern Arizona and southwestern New Mexico. Shrubs include a mix of oaks, manzanita, and others, but \*silverleaf oak is at least common. \*Border pinyon and Alligator juniper dominate the overstory, and ponderosa pine (*Pinus ponderosa*) and Chihuahua pine (*Pinus leiophylla*) may be occasional on microsites.

#### Structure

There is very little documented information about this type.

#### Location

Presently known from southeastern Arizona in the Chiricahua and Santa Catalina Mountains and on the Clifton Ranger District near the New Mexico border, and in extreme southwestern New Mexico in the Animas Mountains. Often on steep, upper slopes and ridgetops, and elevated plains from 6,200' - 7,000' (1,890 -2,130 m). Soils are extremely rocky, or shallow and rocky, often broken by rock outcrops. Mean annual precipitation (MAP) = 20-21"/yr; mean annual air temperature (MAAT) = 53 degrees F with relatively mild winters.

#### Also See

Pygmy conifer, oak scrub described by Niering and Lowe (1984); Wagner (1977). TES mapping unit 691 on the Clifton Ranger District. Otherwise, a poorly described association.

#### Trees

Well represented (>5%):

\*Border pinyon (*Pinus discolor*)

alligator juniper (*Juniperus deppeana*)

### **Shrubs**

Abundant (>25%):

\*Silverleaf oak (*Quercus hypoleucoides*)

netleaf oak (*Quercus rugosa*)

sacahuista (*Nolina microcarpa*)

Pringle manzanita (*Arctostaphylos pringlei*)

pointleaf manzanita (*Arctostaphylos pungens*)

Wright's silktassel (*Garrya wrightii*)

Parry's agave (*Agave parryi*)

skunkbush sumac (*Rhus trilobata*)

Gambel oak (*Quercus gambelii*)

### **Herbs**

Scarce (<1%), might include:

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*) sideoats grama (*Bouteloua curtipendula*) prairie junegrass (*Koeleria macrantha*)

Arizona wheatgrass (*Elymus arizonicus*) woolly brome (*Bromus lanatipes*) fringed brome (*Bromus ciliatus*) muttongrass (*Poa fendleriana*)

bullgrass (*Muhlenbergia emersleyi*)

[lower elevations]

falsepennyroyal (*Hedeoma hyssopifolia*)

pineywoods geranium

(*Geranium caespitosum*)

Fendler's meadow-rue (*Thalictrum fendleri*)

### **Brief Plant ID Notes**

The distinctive lance-shaped bicolor leaf of silverleaf oak is hard to mistake. The undersides have a woolly white pubescence that contrasts sharply with dark green, smooth upper leaf surface. Leaf margins are entire and rolled in.

### **Synonymy**

Arizona wheatgrass (*Elymus arizonicus* = *Andropogon arizonicum*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** +1 (cool, mesic)

**Climate Class:** HSM (high sun mild)

## **Reforestation**

Shading may be important to pinyon seedling survival.

## **References**

Niering and Lowe 1984

USFS 1987b

Wagner 1977

**Border pinyon/Toumey oak**  
***Pinus discolor/Quercus toumeyi***

**Code(s)**

typic phase2 32 05 0

**Ecological Response Unit**

Madrean Pinyon-Oak (MPO)

**NVC Group**

Madrean Pinyon-Juniper Woodland (G200)

**Key Criteria**

A shrubby woodland on rhyolite parent materials occurring in southeastern Arizona and southwestern New Mexico. \*Toumey oak or its hybrids are present. \*Border pinyon, Alligator juniper, and redberry juniper dominate the overstory.

**Structure**

There is very little documented information about this type.

**Location**

Presently known from southeastern Arizona and extreme southwestern New Mexico (Animas Mountains), but probably occurs in northern Mexico also. On rhyolite parent materials, usually from 5,900' - 6,100' (1,800 -1,860 m). Mean annual precipitation (MAP) = 19"/yr; mean annual air temperature (MAAT) = 58 degrees F.

**Also See**

Smith (1974); chaparral woodland in Moir (1979); the shrubby element of *Pinus discolor-Quercus toumeyi-Muhlenbergia emersleyi* h.t. of Willging (1987). PIMO/ARPU5 occurs in LSM climates elsewhere south of the Mogollon Rim.

**Trees**

Well represented (>5%):

\*Border pinyon (*Pinus discolor*) alligator juniper (*Juniperus deppeana*) redberry juniper (*Juniperus coahuilensis*) Emory oak (*Quercus emoryi*) [occasional]

## **Shrubs**

Abundant (>25%):

\*Toumey oak (*Quercus toumeyi*)

Toumey oak hybrids with gray oak (*Quercus toumeyi* X *grisea*)  
pointleaf manzanita (*Arctostaphylos pungens*) Wright's silktassel  
(*Garrya wrightii*)

skunkbush sumac (*Rhus trilobata*)

leatherleaf sumac (*Rhus coriophylla*)

sacahuista (*Nolina microcarpa*)

yucca (*Yucca madrensis*)

Palmer's century plant (*Agave palmeri*)

common sotol (*Dasyllirion wheeleri*)

## **Herbs**

Scarce to common (< or > 1%), might include: Texas bluestem  
(*Schizachyrium cirratum*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*)

sideoats grama (*Bouteloua curtipendula*)

bullgrass (*Muhlenbergia emersleyi*)

plains lovegrass (*Eragrostis intermedia*)

blue grama (*Bouteloua gracilis*)

common wolftail (*Lycurus phleoides*)

pinyon ricegrass (*Piptochaetium fimbriatum*)

bulb panicgrass (*Panicum bulbosum*)

bean (*Phaseolus* spp.)

ticktrefoil (*Desmodium* spp.)

## **Brief Plant ID Notes**

The oval to elliptic, small (1/2" to 3/4" long) leaves of the Toumey oak are numerous and crowded on this shrubby oak. The yellow-green leaves are shiny on the upper surfaces, and slightly hairy beneath. (Stuever 1995).

## **Synonymy**

Texas bluestem (*Schizachyrium cirratum* = *Andropogon cirratus*)

yucca (*Yucca madrensis* = *Yucca schottii*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)

Redberry juniper (*Juniper coahuilensis* = *J. erythrocarpa*)

## **Terrestrial Ecological Unit attributes**

**Life Zone Class: 4 (woodlands)**

**Elevational Subzone: 0 (typic)**

**Climate Class: HSM (high sun mild)**

## **Reforestation**

**Shading may be important to pinyon seedling survival.**

## **References**

Moir 1979

Moir and Carleton 1987

Smith 1974

Stuever 1995

USFS 1987b

Willging 1987



## Border pinyon/evergreen sumac

(Formerly: border pinyon/leatherleaf sumac)

### *Pinus discolor/Rhus virens var. coriophylla*

(Formerly: *Pinus discolor/Rhus coriophylla*)

#### Synonyms

*Pinus discolor/Cercocarpus breviflorus- Rhus coriophylla* (Moir and Carleton 1987) *Pinus discolor/Rhus coriophylla* (USFS 1987b)

#### Code(s)

typic phase2 32 07 0

#### Ecological Response Unit

PJ Evergreen Shrub (PJC)

#### NVC Group

Madrean Pinyon-Juniper Woodland (G200)

#### Key Criteria

A shrubby pinyon-juniper woodland occurring in southeastern Arizona.

\*Mountain mahogany is well represented, and leatherleaf sumac is usually present to well represented; oaks are not a significant part of the shrub mix. \*Border pinyon and redberry juniper dominate the overstory.

#### Structure

There is very little documented information about this type.

#### Location

Presently known from southeastern Arizona (Mule and Huachuca Mountains). Found on limestone parent materials from around 5,500' (1,675 m) on north slopes to 6,500' (1,980 m) on south slopes. Mean annual precipitation (MAP) = 19"/yr; mean annual air temperature (MAAT) = 55 degrees F; mean January air temperature = 46 degrees F (Fort Huachuca).

#### Also See

Wentworth (1981, 1985).

#### Trees

Well represented (>5%):  
border pinyon (*Pinus discolor*)

redberry juniper (*Juniperus coahuilensis*)

### **Shrubs**

Well represented (>5%) to abundant (25%):

\*Hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus*)

evergreen sumac (*Rhus virens* var. *choriophylla*)

common sotol (*Dasyilirion wheeleri*)

Utah fendlerbush (*Fendlera utahensis*)

Wright's silktassel (*Garrya wrightii*)

### **Herbs**

Well represented (>5%):

blue grama (*Bouteloua gracilis*)

sideoats grama (*Bouteloua curtipendula*)

slender grama (*Bouteloua repens*)

plains lovegrass (*Eragrostis intermedia*)

bullgrass (*Muhlenbergia emersleyi*)

needlegrass (*Achnatherum* spp./*Hesperostipa* spp.)

ferns (*Cheilanthes*, *Bommeria*, *Pellaea*, *Notholaena*)

### **Brief Plant ID Notes**

Evergreen sumac, also known as leatherleaf sumac, has shiny green upper leaf surfaces with a yellowish green lower leaf surface. Leaflets usually occur in groups of three or may be single. The gray-red bark has reddish bumps.

### **Synonymy**

hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus* = *C. breviflorus*) evergreen sumac = leatherleaf sumac (*Rhus virens* var. *choriophylla* = *R. coriophylla*)

needlegrass spp. (*Achnatherum* spp./*Hesperostipa* spp. = *Stipa* spp.)

redberry juniper (*Juniper coahuilensis* = *J. erythrocarpa*)

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** 0 (typic)

**Climate Class:** HSM (high sun mild)

### **Reforestation**

Select microsites for planting pinyon seedlings which provide shade and needle litter for mulch.

**Comments**

Wentworth (1981) felt this association had more affinity with the Chihuahuan Desert rather than the Sonoran Desert than nearby plant associations on granite-derived soils. He credits a drier environment, cooler winter temperatures, and tolerance for calcareous soils as reasons the Chihuahuan flora prevails.

**References**

Moir and Carleton 1987

USFS 1987b

Wentworth 1985

Wentworth 1981

# Juniper Series

JUDE2/ARPU5

## Alligator juniper/pointleaf manzanita

*Juniperus deppeana*/*Arctostaphylos pungens*

### Code(s)

typic phase2 31 01 0

### Ecological Response Unit

PJ Evergreen Shrub (PJC)

### NVC Group

Madrean Juniper Open Woodland (G487)

### Key Criteria

A juniper woodland wherein \*alligator juniper is dominant with an abundant (>25% cover) shrubby understory.

### Structure

Alligator juniper is the overstory dominant.

### Location

Known from a single location at the foot of the Bradshaw Mountains, Arizona (T11- 1/2 N, R1W, Sec. 24; G&SRB&M); at approximately 5,300 feet (1,610 m) on Typic Haplustalfs on a variety of slopes.

### Also See

PIMO/ARPU5. The absence of *Pinus monophylla* distinguishes JUDE/ARPU5.

### Trees

Well represented (>5% cover):

\*Alligator juniper (*Juniperus deppeana*)

Emory oak (*Quercus emoryi*)

redberry juniper (*Juniperus coahuilensis*)

### Shrubs

Abundant (>25% cover):

\*Pointleaf manzanita (*Arctostaphylos pungens*)

Pringle manzanita (*Arctostaphylos pringlei*)

shrub live oak (*Quercus turbinella*)

alderleaf mountain mahogany (*Cercocarpus montanus*)

skunkbush sumac (*Rhus trilobata*)  
catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera*)  
desert ceanothus (*Ceanothus greggii*)  
sugar sumac (*Rhus ovata*)  
Wright's silktassel (*Garrya wrightii*)  
broom snakeweed (*Gutierrezia sarothrae*)

## **Herbs**

Scarce (<1% cover):

sideoats grama (*Bouteloua curtipendula*)  
hairy grama (*Bouteloua hirsuta*)  
threeawns (*Aristida* spp.)

## **Brief Plant ID Notes**

Alligator juniper is a native evergreen, scale- leaved tree with heavy primary branches, distinctive checkered or fissured bark, and a massive trunk capable of growing to diameters approaching 5 feet.

Pointleaf manzanita is a bushy, native, short-lived, evergreen, broadleaf shrub, approximately 5 to 7 feet (1.5 to 2 m) tall. Its leaves are oval shaped with sharp pointed tips, bright green, leathery, and covered with soft, fine hairs. The stems are shiny red.

## **Synonymy**

catclaw mimosa (*Mimosa aculeallicarpa* var. *biuncifera* = *M. biuncifera* )

## **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** 0 (typical)

**Climate Class:** LSM (low sun mild)

## **Fire Ecology**

This may be a fire-edaphic climax plant community. Pointleaf manzanita does not sprout from the roots or crown following fire (Harris 1988a). It is a prolific seeder in response to fire. Such seed crops can be stored in the soil for decades. Pointleaf communities are characteristic of frequently burned areas with dry, coarse soils, and are typically found in the transition zone between chaparral and pine or oak woodlands.

Alligator juniper is well adapted to survive most fires. It is capable of producing prolific sprouts/suckers even after significant consumption of the aboveground portions of the plants. This allows alligator juniper to

quickly regain dominance on most sites. Mortality of this juniper is quite low following many severe fires.

### **Reforestation**

Wood harvesting methods: partial retention of the overstory, as usually produced by selection and shelterwood harvesting methods, provides microclimates favorable for regeneration of alligator juniper. Heavier removal of the overstory as seen in seed tree and clear-cutting favors alligator juniper, manzanita and oak.

Site preparation techniques: alligator juniper and manzanita respond to a variety of techniques including mechanical and burning. Review TES reports for limitations due to shallow or rocky soils or high erosion potentials.

### **Revegetation Considerations**

Revegetation is expected to be rapid due to the sprouting characteristics of alligator juniper and oak (Gottfried and Ffolliott. 1994).

### **Comments**

Forage value rating for cattle in early seral stage is low and none in the late seral.

### **References**

- Harris 1988a
- Little 1950
- Moir and Carleton 1987
- Tirmenstein 1988
- USFS 1986
- USFS 1987b

**alligator juniper/blue grama**

***Juniperus deppeana/Boutelous gracilis***

**Codes**

Typic phase2 31 02 0

Mesquite (PRGL2) phase2 31 02 1

**Ecological Response Unit**

PJ Grass (PJG), subclass high sun mild (hsm)

**NVC Group**

Madrean Juniper Open Woodland (G487)

**Key Criteria**

A juniper woodland wherein alligator juniper is dominant with a scarce (<1% cover) or common (>1% cover) shrubby understory. Gray oak is scarce (< 1% cover).

**Structure**

Alligator juniper is the overstory dominant. One average site index for pinyon is 25, indicating a low productivity for timber species.

**Location**

Known from southern New Mexico and Arizona south of the Mogollon Rim; at approximately 5,200' (1,600 m) on north aspects and to 6,600' (2,610 m) on south aspects. JUDE2/BOGR2, PRGL2 Phase is presently known only from the New Mexico- Arizona border between Glenwood, NM, and Clifton, AZ.

**Also See**

Souders (1985) mapping unit 3914. TES report for Apache-Sitgreaves NFs (USFS 1987b) has mapping units 587 and 589 within a JUDE2-NOMI subseries (mostly on the Clifton RD); MUs 512 and 582 within this subseries have very steep slopes and appear to intergrade to scarp woodland. For Globe RD, see MU 3914 and local sites of JUDE2/BOGR2 in MU 3828.

**Trees**

Well represented (>5% cover):

alligator juniper (*Juniperus deppeana*) [often 5-10% cover]

twoneedle pinyon (*Pinus edulis*) [usually scarce (<1% cover) but sometimes common (>1% cover)].

oneseed juniper (*Juniperus monosperma*) [scarce]

gray oak (*Quercus grisea*)

[scarce; a low tree or shrub] Emory oak (*Quercus emoryi*) [scarce; a low tree or shrub]

Utah juniper (*Juniperus osteosperma*) [sometimes common]

## **Shrubs**

Scarce (<1% cover) or common (>1% cover):

bastardsage (*Eriogonum wrightii*)

broom snakeweed (*Gutierrezia sarothrae*)

sacahuista (*Nolina microcarpa*)

common sotol (*Dasylirion wheeleri*)

banana yucca (*Yucca baccata*)

desert ceanothus (*Ceanothus greggii*)

tulip pricklypear (*Opuntia phaeacantha*)

dollarjoint pricklypear (*Opuntia chlorotica*)

walkingstick cactus (*Cylindropuntia spinosior*)

fairyduster (*Calliandra eriophylla*)

honey mesquite (*Prosopis glandulosa*) [common in mesquite phase]

yerba de pasmo (*Baccharis pterioinoides*)

bastardsage (*Eriogonum wrightii*)

## **Herbs**

Abundant (>25% cover):

Typic Phase and Mesquite Phase: sidecoats grama (*Bouteloua curtipendula*)

blue grama (*Bouteloua gracilis*)

hairy grama (*Bouteloua hirsuta*)

Carruth's sagewort (*Artemisia carruthii*) vine mesquite (*Panicum obtusum*)

Typic Phase also includes:

bullgrass (*Muhlenbergia emersleyi*)

curlymesquite (*Bouteloua belangeri*)

plains lovegrass (*Eragrostis intermedia*)

poverty threeawn (*Aristida divaricata*)

needle and thread (*Hesperostipa comata*)

dwarf stickpea (*Calliandra humilis*)

Mesquite Phase also includes:



large-spike bristlegrass (*Setaria macrostachya*)

black grama (*Bouteloua eriopoda*)

### **Brief Plant ID Notes**

Alligator juniper is a native evergreen, scale-leaved tree with heavy primary branches, distinctive checkered or fissured bark, and a massive trunk capable of growing to diameters approaching 5 feet. Blue grama is a warm season, tufted perennial grass often with short, stout rhizomes. Its leaves have rounded sheaths with occasional to sparse long hairs. The most recognizable character is the softly to strongly curved terminal flowerhead, called a spike or a flag.

### **Synonymy**

needle and thread (*Hesperostipa comata* = *Stipa comata*)

### **Terrestrial Ecological Unit attributesTypic Phase**

**Life Zone Class:** 4 (Woodland)

**Elevational Subzone:** 0 (typical)

**Climate Class:** HSM (High Sun Mild)

### **Mesquite Phase**

**Life Zone Class:** 4

**Elevational Subzone:** -1

**Climate Class:** HSM (High Sun Mild)

### **Phases**

Two phases are recognized. The typic phase is slightly moister and cooler and tends to support more pinyon and Utah juniper than the mesquite phase. The mesquite phase is warmer and drier and supports a higher percent cover of mesquite.

### **Fire Ecology**

Alligator juniper is well adapted to survive most fires. It produces prolific sprouts/suckers even after significant consumption of the above ground portions of the plants. This allows alligator juniper to quickly regain dominance on most sites. Mortality of this juniper is quite low following many severe fires. Blue grama is generally top-killed by fires. The rhizomes are usually unharmed. Blue grama is usually unharmed by fire during years with above normal winter and spring precipitation. Its response to fire varies from being harmed to almost unaffected to being increased by fire. Season of burning, soil moisture, temperature, plant community composition and fire severity are some of the factors affecting blue grama responses. Recovery time ranges from 1 to 4 years or more depending on conditions. White and Currie, 1981.

### **Reforestation**

Wood harvesting methods: Partial retention of the overstory, as usually produced by selection and shelterwood harvesting methods, provides microclimates favorable for

regeneration of alligator juniper. Heavier removal of the overstory as seen in seed tree and clear-cutting favors alligator juniper, oak, and grass.

Site preparation techniques: Alligator juniper and manzanita respond to a variety of techniques including mechanical and burning. Review TES reports for limitations due to shallow or rocky soils, or high erosion potentials.

### **Revegetation Considerations**

Revegetation is expected to be rapid due to the sprouting characteristics of alligator juniper and oak (Gottfried and Ffolliott, 1995).

### **Comments**

Typic phase: MAP = 19"/yr; MAAT = 55 deg. F; often heavy clay soils (see TES reports); mesquite phase: MAP = 16-18"/yr; MAAT = 54-56 deg. F; on elevated plains and gently sloping upper slopes and ridges, often of basaltic rock; Vertic or Typic Argiustolls with heavy clay horizon. See TES reports for limitations on heavy clay soils and for other textural limitations.

### **References**

- Gottfried and Ffolliott 1995
- Moir and Carleton 1987
- Tirmenstein 1987b
- Tirmenstein 1988a
- USFS 1986
- USFS 1987b

## Alligator juniper/desert ceanothus *Juniperus deppeana/Ceanothus greggii*

### Synonyms

mixed juniper/mountain mahogany-desert ceanothus; *Juniperus deppeana*-*Juniperus monosperma*/*Cercocarpus montanus*- *Ceanothus greggii*; JUDE2-JUMO/CEMO2- CEGR; also known as mixed juniper/mountain mahogany-deerbrush (USFS 1987b).

### Code(s)

typic phase2 31 03 0

### Ecological Response Unit

Juniper Grass (JUG), cold (JUGc)

### NVC Group

Madrean Juniper Open Woodland (G487)

### Key Criteria

A juniper woodland wherein alligator juniper and oneseed juniper are codominant with a well-represented (>5% cover) shrubby understory and \*alderleaf mountain mahogany or \*desert ceanothus is common (>1% cover). Twoneedle pinyon (*Pinus edulis*) may occur as an accidental tree.

### Structure

Oneseed juniper is the overstory dominant and major climax species. Alligator juniper is a minor climax species. Twoneedle pinyon may exist as an accidental.

### Location

Sacramento and Guadalupe Mountains, NM; at elevations of 6,000' to 6,500' (1,824 to 1,975 m) on south slopes with limestone parent materials.

### Also See

Woodin and Lindsey (1954) stations 19 and 20. Otherwise a poorly known plant association.

### Trees

Well represented (>5% cover) often of low stature (<16 feet [4.9 m] tall): oneseed juniper (*Juniperus monosperma*)  
alligator juniper (*Juniperus deppeana*)

## Shrubs

Well represented (>5% cover):

\*Hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentata*)

\*Desert ceanothus (*Ceanothus greggii*)

skunkbush sumac (*Rhus trilobata*)

wavyleaf oak (*Quercus* X *pauciloba*)

pricklyleaf dogweed (*Thymophylla acerosa*)

broom snakeweed (*Gutierrezia sarothrae*)

crown of thorns (*Koeberlinia spinosa*)

ocotillo (*Fouquieria splendens*)

tulip pricklypear (*Opuntia phaeacantha*)

soaptree yucca (*Yucca elata*)

## Herbs

Well represented (>5% cover):

blue grama (*Bouteloua gracilis*)

hairy grama (*Bouteloua hirsuta*)

black grama (*Bouteloua eriopoda*)

sideoats grama (*Bouteloua curtipendula*)

Peruvian muhly (*Muhlenbergia pauciflora*)

curlyleaf muhly (*Muhlenbergia setifolia*)

plains lovegrass (*Eragrostis intermedia*)

slim tridens (*Tridens muticus*)

common wolftail (*Lycurus phleoides*)

## Brief Plant ID Notes

Alligator juniper is a native evergreen, scale-leaved tree with heavy primary branches, distinctive checkered or fissured bark, and a massive trunk capable of growing to diameters approaching 5 feet. Desert ceanothus is multi-branched, evergreen, native shrub growing to about 5 feet (1.5 m) in height. The leaves are small (1 inch (>2.5 cm) long), opposite, pinnately veined, elliptic to oblanceolate, thick with a smooth (entire) margin, grayish-green on the upper surface and paler on the lower surface. While there are no spines, the rigid branchlets end in a sharp point.

## Synonymy

hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentata* = *C. breviflorus*)

pricklyleaf dogweed (*Thymophylla acerosa* = *Dyssodia acerosa*)

**Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** HSC (high sun cold)

**References**

Moir and Carleton 1987

Stuever 1995

Tirmenstein 1988a

USFS 1986

Woodin and Lindsey 1954

## Alligator juniper/Bullgrass

*Juniperus deppeana*/*Muhlenbergia emersleyi*

### Codes

typic phase2 31 05 0

### Ecological Response Unit

Juniper Grass (JUG), high sun mild (JUGhsm)

### NVC Group

Madrean Juniper Open Woodland (G487)

### Key Criteria

A juniper woodland wherein alligator juniper is dominant with a well-represented (>5% cover) shrubby understory; gray oak is common (> 1% cover) and bull grass with its associates produce abundant (>25%) cover.

### Structure

Alligator juniper is the overstory dominant.

### Location

Known only from Guadalupe Mountains, NM.

### Trees

Well represented (>5% cover):

alligator juniper (*Juniperus deppeana*)

#### Shrubs

Well represented (>5% cover):

oaks (*Quercus* spp.)

sacahuista (*Nolina microcarpa*)

green sotol (*Dasyllirion leiophyllum*) century plant (*Agave* spp.)

### Herbs

Abundant (>25% cover):

bullgrass (*Muhlenbergia emersleyi*) and associated grasses

### Brief Plant ID Notes

Alligator juniper is a native evergreen, scale-leaved tree with heavy primary branches, distinctive checkered or fissured bark, and a massive trunk capable of growing to diameters approaching 5 feet. Bullgrass is a large, native, warm season, perennial bunchgrass, growing to 2' to 3' (60 to 90 cm) in height. The leaves are long blades 6" to 14" (15 to 35 cm)

long, are folded and have stiff, short hair on the lower surface. The sheath is conspicuously keeled, especially near the base. The membranous ligule is 3/8" to 1" (10 to 25 mm) long and has a narrow, thin, often frayed tip.

**Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** HSM (high sun mild)

**References**

Allred 1993

Gould 1951

Moir and Carleton 1987

Stuever 1995

Tirmenstein 1988a

USFS 1986

**Alligator juniper/skunkbush sumac**  
***Juniperus deppeana/Rhus trilobata***

**Synonyms**

alligator juniper-oneseed juniper-gray oak/skunkbush sumac (*Juniperus deppeana*- *Juniperus monosperma*-*Quercus grisea*/*Rhus trilobata* JUDE2-JUMO-QUGR3/RHTR).

**Codes**

typic phase2 31 04 0

**Ecological Response Unit**

Juniper Grass (JUG), high sun mild (JUGhsm)

**NVC Group**

Madrean Juniper Open Woodland (G487)

**Key Criteria**

A juniper woodland wherein alligator juniper and oneseed juniper are codominant with a well-represented (>5% cover) shrubby understory and alderleaf mountain mahogany or desert ceanothus is scarce (<1% cover).

**Structure**

Alligator juniper and oneseed juniper are the overstory dominants and major climax species. Gray oak may be a codominant and major or minor climax species. Utah juniper is a minor climax species.

**Location**

Moderately steep and steep hill and mountain slopes; at elevations of 4,600' to 6,900' (1,400 to 2,100 m) on gravelly or cobbly soils; southern New Mexico in winter-mild climates; Guadalupe Mountains, in the vicinity of Glenwood, NM, and adjoining Arizona.

**Also See**

Gehlbach 1967, Souders (1985) mapping unit 3967. JUDE2/CEGR is considerably more shrubby and less grassy, but neither habitat type has been well described synecologically. The absence (or accidental occurrence) of twoneedle pinyon helps distinguish JUDE/RHTR.

**Trees**

Well represented (>5% cover) or abundant (> 25% cover):  
alligator juniper (*Juniperus deppeana*)



oneseed juniper (*Juniperus monosperma*)

gray oak (*Quercus grisea*)

Utah juniper (*Juniperus osteosperma*)

### **Shrubs**

Common (>1% cover) or well represented (>5% cover):

skunkbush sumac (*Rhus trilobata*)

fragrant mimosa (*Mimosa borealis*)

featherplume (*Dalea formosa*)

sacahuista (*Nolina microcarpa*)

honey mesquite (*Prosopis glandulosa*)

walkingstick cactus (*Cylindropuntia spinosior*)

tulip pricklypear (*Opuntia phaeacantha*)

common sotol (*Dasyllirion wheeleri*)

green sotol (*Dasyllirion leiophyllum*) [Guadalupe Mountains]

bastardsage (*Eriogonum wrightii*)

### **Herbs**

Well represented (>5% cover):

sideoats grama (*Bouteloua curtipendula*)

blue grama (*Bouteloua gracilis*)

hairy grama (*Bouteloua hirsuta*)

black grama (*Bouteloua eriopoda*)

bottlebrush squirrel tail (*Elymus elymoides*)

bluestems (*Schizachyrium* spp.)

muhlys (*Muhlenbergia* spp.)

### **Brief Plant ID Notes**

Alligator juniper is a native evergreen, scale- leaved tree with heavy primary branches, distinctive checkered or fissured bark, and a massive trunk capable of growing to diameters approaching 5 feet. Skunkbush sumac is a native deciduous shrub growing to about 7' (2 m) in height. It has leaflets of three (3/8" to 1-1/4" (10 to 30 mm) long), green and no hairs on upper surface, minutely pubescent on the lower surface; the margin lobed and the terminal leaflet much longer than wide. The small red to orange fruits are covered with short, glandular hairs. When crushed, the leaves give off a pungent (some say ill-smelling) somewhat "skunky" odor.

### **Synonymy**

bottlebrush squirrel tail (*Elymus elymoides* = *Sitation hystrix*)

walkingstick cactus (*Cylindropuntia spinosor* = *Opuntia spinosor*)

**Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodland)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** HSM (high sun mild)

**References**

Gehlbach 1967

Moir and Carleton 1986

Souders 1985

Tirmenstein 1988a

## Utah juniper/big sagebrush

### *Juniperus osteosperma*/*Artemisia tridentata*

#### Code(s)

typic phase2 02 02 0

#### Ecological Response Unit

PJ Sagebrush (PJS)

#### NVC Group

Colorado Plateau Pinyon - Juniper Woodland (G900)

#### Key criteria

This plant association has \*big sagebrush in the understory, and a \*Utah juniper and oneseed juniper overstory which seldom exceeds 15 percent canopy cover.

#### Location

This plant association occurs from northern Arizona and northern New Mexico to southwest Colorado, Utah, Nevada, and Wyoming. Typically found at elevations between 5,700' and 7,000' (1,740 and 2,130 m) on a wide range of slopes from level to steeply sloping piedmont plains. Mean annual precipitation (MAP) = 10-14"/year, much of this as winter snow. Soils often on gullied alluvium.

#### Also See

JUMO/ARTR2 is very similar; some of the JUOS communities described in southern Nevada by Blackburn, Tueller, and Eckert (1969) can probably be assigned to this association. TES mapping unit 111 on Santa Fe National Forest (Gass et al. 1983).

#### Trees

Well represented (>5%), to about 15% cover:

\*Utah juniper (*Juniperus osteosperma*)

oneseed juniper (*Juniperus monosperma*) [occasionally mixed in]

#### Shrubs

Well represented (>5%):

\*Big sagebrush (*Artemisia tridentata*)

black sagebrush (*Artemisia nova*)

fourwing saltbush (*Atriplex canescens*)  
Stansbury cliffrose (*Purshia stansburyana*)  
broom snakeweed (*Gutierrezia sarothrae*)  
cholla (*Cylindropuntia* spp.)  
pricklypear (*Opuntia* spp.)  
pingue rubberweed (*Hymenoxys richardsonii*)

## Herbs

Well represented (>5%) to abundant (>25%), especially grasses:  
blue grama (*Bouteloua gracilis*)  
hairy grama (*Bouteloua hirsuta*)  
sideoats grama (*Bouteloua curtipendula*)  
James' galleta (*Pleuraphis jamesii*)  
western wheatgrass (*Pascopyrum smithii*)  
bottlebrush squirreltail (*Elymus elymoides*)  
Indian ricegrass (*Achnatherum hymenoides*)  
threeawn (*Aristida* spp.)

## Brief Plant ID Notes

Recognizing the variety of big sagebrush is important for determining the browse value for elk and deer. Basin big sagebrush (*A. t.* var. *tridentata*) has an uneven top, a single main stem, and gray-green foliage. Mountain big sagebrush (*A. t.* var. *vaseyana*) has a flat top, multiple main stems, and blue green foliage. Wyoming big sagebrush (*A. t.* var. *wyomingensis*) has a round top, multiple main stems, and gray- green foliage.

## Synonymy

black sagebrush (*Artemisia nova*) = low sagebrush (*A. arbuscula* var. *nova*)  
Stansbury cliffrose (*Purshia stansburyana* = *Cowania stansburyana* = *C. mexicana*)  
bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)  
western wheatgrass (*Pascopyrum smithii* = *Agropyron smithii*)  
Indian ricegrass (*Achnatherum hymenoides* = *Oryzopsis hymenoides*)  
James' galleta (*Pleuraphis jamesia* = *Hilaria jamesii*)

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** LSC (low sun cold)

### **Fire Ecology**

Big sagebrush is easily killed by fire and does not resprout; however, it does rapidly invade a site if soil stored or offsite seed is available (Tirmenstein 1986). Mountain big sagebrush is the most flammable and Wyoming big sagebrush is the least flammable of the subspecies discussed above.

### **Revegetation Considerations**

Big sagebrush, a good winter forage plant, can be successfully drilled or broadcast seeded. The “Hobble Creek” selection of mountain big sagebrush is available for lower elevations (Welch et al. 1986). Black sagebrush can be a nutritious winter browse for game. The “Pine Valley Ridge” superior strain (Welch et al. 1994) can be strip seeded with a grass/forb mixture (Rita Suminski, 1996, personal communication).

### **Comments**

Livestock grazing can result in higher density or cover of broom snakeweed, pingue, blue grama, big sagebrush, or rubber rabbitbrush. At these lower elevations where range conditions are overgrazed or in poor ecological health, big sagebrush can invade mesic areas and act as a pheatophyte, drying up smaller springs, seeps, and creeks in a relatively short time (Blaisdell et al. 1982; Rita Suminski, 1996, personal communication). Determining which variety of big sagebrush is present is important for wildlife management. *A. t.* var. *tridentata* is generally poor browse, although *A. t.* var. *wyomingensis* provides good winter browse for elk and deer and *A. t.* var. *vaseyana* provides good summer browse.

### **References**

- Blackburn, Tueller, and Eckert 1969
- Blaisdell et al. 1982
- Bradley 1986a
- Gass et al. 1983
- Tirmenstein 1986
- USFS 1987a
- Welch et al. 1986, 1994

## Utah juniper/blue grama

### *Juniperus osteosperma/Bouteloua gracilis*

#### Synonyms

*Juniperus monosperma/Bouteloua gracilis*, *Juniperus osteosperma* phase (USFS 1986).

#### Code(s)

typic phase2 02 32 0

cliffrose (PUST) phase2 02 32 1

#### Ecological Response Unit

Juniper Grass (JUG), subclass cold (JUGc)

#### NVC Group

Colorado Plateau Pinyon - Juniper Woodland (G900)

#### Key Criteria

A juniper savanna with a rich understory of grasses, usually including blue grama (*Bouteloua gracilis*). Utah juniper is the dominant tree, although pinyon pine may be present, but is usually confined to microsites.

#### Structure

This type can support a heavy cover of juniper trees to the near exclusion of herbaceous understory. Likewise, this type can support grass, particularly in absence or weak expression of trees. Early seral situations should provide moderate amounts of forage for cattle, while late seral stages offer low amounts of forage for cattle.

#### Location

Primarily known from central and northern Arizona. Occurs in valleys and on elevated plains and piedmont alluvial fans. Elevations range from 5,000' - 6,000' (1,525 - 1,825 m).

#### Adjacent Plant Associations

On more mesic toe slopes, JUOS/BOGR2 may adjoin the PIED/BOGR2 hillslope phase.

#### Also See

JUMO/BOGR2 is very similar to JUOS/BOGR2, from USFS 1987a.

Much data is needed before the two habitat types are better distinguished.

At present, separation of JUMO/BOGR2 and JUOS/BOGR2 is mostly geographical. JUMO/BOGR2 is generally centered in HSC climates. Also, Baxter 1977.

### **Trees and Life History Trait**

Well represented (>5%):

Utah juniper (*Juniperus osteosperma*)C

### **Shrubs**

Scarce (<1%) [typic phase] or well represented (>5%)

[PUST phase]: small soapweed (*Yucca glauca*)

Stansbury cliffrose (*Purshia stansburyana*)

red barberry (*Mahonia haematocarpa*)

pale wolfberry (*Lycium pallidum*) bastardsage (*Eriogonum wrightii*)

### **Herbs**

Well represented (>5%) to abundant (>25%), especially grasses:

blue grama (*Bouteloua gracilis*)

black grama (*Bouteloua eriopoda*)

sideoats grama (*Bouteloua curtipendula*)

Fendler threeawn (*Aristida purpurea* var. *longiseta*)

threeawn (*Aristida* spp.)

common wolfstail (*Lycurus pheloides*)

ring muhly (*Muhlenbergia torreyi*)

bottlebrush squirrel tail (*Elymus elymoides*)

New Mexico needlegrass (*Hesperostipa neomexicana*)

prairie junegrass (*Koeleria macrantha*)

western wheatgrass (*Pascopyrum smithii*)

### **Brief Plant ID Notes**

Utah juniper usually has both male and female cones on the same tree, unlike other junipers in the area. The twisted trunk of the Utah juniper is usually a single stem, but oneseed juniper has multiple stems. The inflorescence or “flag” can be used to distinguish blue grama from hairy grama (*Bouteloua hirsuta*). On blue grama, the flag is curved, and the terminal awn is shorter than the width of the flag. This awn is longer on hairy grama, which also has straight flags.

### **Synonymy**

red barberry (*Mahonia haematocarpa* = *Berberis haematocarpa*)

Stansbury cliffrose (*Purshia stansburyana* = *Cowania stansburyana* = *C. mexicana*)

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)  
western wheatgrass (*Pascopyrum smithii* = *Agropyron smithii*)  
New Mexico feathergrass (*Hesperostipa neomexicana* = *Stipa neomexicana*)

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** HSC (high sun cold)

### **Phases**

JUOS/BOGR2 has two phases, the typic phase and the shrubbier cliffrose phase. The JUMO/BOGR2, JUOS phase (mentioned in USFS 1986) is treated as JUOS/BOGR2, typic phase in this publication.

### **Fire Ecology**

Burning in this site usually encourages grasses, although the lack of continuous fine fuels may limit the spread of fires except under extreme conditions. When blue grama is dormant (early spring, driest part of summer) it is less likely to be damaged by fire. Re-establishment of blue grama occurs through rhizomes (Tirmenstein 1987b). A 3-to-4-month rest from grazing is recommended for burned sites (Tirmenstein 1987b).

### **Reforestation**

No information on reforestation is available in this type. Most forest management activities have been focused toward reducing existing trees, rather than planting them. Due to fire exclusion and grazing practices of at least the past century, many sites now support more trees than they did prior to European settlement. Mechanical site preparation may encourage juniper regeneration by providing seed beds and reducing grass competition.

### **Revegetation Considerations**

Following disturbance, revegetation on this site can be slow.

### **Comments**

The cool season component of this association is often absent or weakly expressed as a result of yearlong or winter livestock grazing over many years. Well represented populations of broom snakeweed often indicate such grazing history.



## **References**

Baxter 1977

Tirmenstein 1986

Tirmenstein 1987b

USFS 1987b

USFS 1986

## Utah juniper/tobosagrass

### *Juniperus osteosperma/Pleuraphis mutica*

(Formerly: *Juniperus osteosperma/Hilaria mutica*)

#### Code(s)

mesquite (PRVE) phase2 02 33 0

singleleaf pinyon (PIMO) phase2 02 33 1

#### Ecological Response Unit

Juniper Grass (JUG), subclass high sun mild and low sun mild (JUGhsm, JUGlsm)

#### NVC Group

Colorado Plateau Pinyon - Juniper Woodland (G900)

#### Key Criteria

A juniper savannah, often on heavy clay soils. \*Tobosagrass, \*curlymesquite, and/or \*panic grass are present among an abundant cover of herbs. Juniper trees dominate the overstory, but rarely reach over 10 percent cover. Singleleaf pinyon may be present in the PIMO phase but is usually only occasional or a minor climax species.

#### Structure

Grasses and shrubs generally increase as tree cover is removed. Tree covers rarely exceeds 10 percent and opportunities for firewood are limited.

#### Location

Widespread south of the Mogollon Rim, this plant association is typically found on elevated or valley plains, from 4,300' - 5,900' (1,315 - 1,800 m). Soils generally have a heavy clay content. Mean annual precipitation (MAP) is approx. 17-18"/year (to 20"/yr in the PIMO phase). Mean annual air temperature (MAAT) is 55-61 degrees F.

#### Also See

TES mapping units 3181, 3187, & 3700 (PIMO phase) on the Globe Ranger District (1984); 3832 on the Glenwood Ranger District (1985). The various subseries of these TES mapping units includes JUMO-PRGLT-HIBE-HEAN, JUOS-JUMO-PRVE- BOHI-HIBE, JUOS-HIBE-PAOB, and JUMO-JUOS-PRGLG. singleleaf pinyon (*Pinus monophylla*) [PIMO phase]

## Trees

Well represented (5-10% canopy cover):

Utah juniper (*Juniperus osteosperma*)

redberry juniper (*Juniperus coahuilensis*)

## Shrubs

Common (>1%) or well represented (>5%) [especially on heavily grazed sites]:

mesquite (*Prosopis* spp.) [varieties depend on geography]

catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*)

broom snakeweed (*Gutierrezia sarothrae*)

sacahuista (*Nolina microcarpa*)

catclaw acacia (*Senegalia greggii*)

tulip pricklypear (*Opuntia phaeacantha*)

walkingstick cactus (*Cylindropuntia spinosior*)

Whipple cholla (*Cylindropuntia whipplei*)

littleleaf ratany (*Krameria erecta*)

## Herbs

Abundant (>25%) to luxuriant (>50%):

\*Tobosagrass (*Pleuraphis mutica*)

\*Curlymesquite (*Hilaria belangeri*)

\*Vine mesquite (*Panicum obtusum*)

sideoats grama (*Bouteloua curtipendula*)

blue grama (*Bouteloua gracilis*)

hairy grama (*Bouteloua hirsuta*)

threeawn (*Aristida* spp.)

and numerous annuals including common sunflower (*Helianthus annuus*)

red brome (*Bromus rubens*)

mucronate sprangletop (*Leptochloa panicea* ssp. *mucronata*)

witchgrass (*Panicum capillare*)

slender goldenweed (*Machaeranthera gracilis*)

## Brief Plant ID Notes

Most of the leaves of the tobosagrass are basal, stiff, harsh, and hairless, and are up to 6 inches long. Flowering spikes are erect and straw to purplish in color. This native, warm season grass has rhizomes and forms sod (Uchytel 1988b)

## Synonymy

littleleaf ratany (*Krameria erecta* = *parvifolia*)

slender goldenweed (*Machaeranthera gracilis* = *Haplopappus gracilis*)  
Whipple cholla (*Cylindropuntia whipplei* = *Opuntia whipplei*)  
walkingstick cactus (*Cylindropuntia spinosior* = *Opuntia spinosior*)  
catclaw acacia (*Senegalia greggii* = *Acacia greggii*)  
tobosagrass (*Pleuraphis mutica* = *Hilaria mutica*)  
mucronate sprangletop (*Leptochloa panicea* ssp. *Mucronata* = *Leptochloa mucronata*)

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** -1 (warm, dry), 0 (typic) [PIMO phase]

**Climate Class:** LSM (low sun mild), HSM (high sun mild)

### **Phases**

There are two phases, the singleleaf pinyon phase occurs in low sun mild (LSM) climates and has singleleaf pinyon in the overstory. The mesquite phase is drier.

### **Fire Ecology**

No specific information was available for this plant association. For tobosagrass, fires generally rejuvenate the grass, especially when followed by precipitation. In this upland, relatively dry setting, tobosagrass may not form dense sod capable of carrying a fire (Uchytel 1988b).

### **Reforestation**

Selective cutting tends to favor juniper regeneration, but seed tree or clear cuts favor grass and shrubs.

### **Revegetation Considerations**

Natural revegetation is slow to moderate following disturbance.

### **Comments**

Historical photos suggest that valleys and mesa tops were once steppic and free of junipers or strong shrub cover. Since about 1880, a combination of livestock grazing, fire suppression, and soil erosion are among the factors producing shrub and juniper increases. Herbs most tolerant of heavy grazing include curly mesquite, tobosagrass, and annuals. Soils supporting this plant association tend to be subject to severe erosion if grazing levels are too high (USFS 1987b).

## **References**

Souders 1985

TES Apache-Sitgreaves NFs, 1987

Uchytel 1988b

USFS 1987b

## Juniper/sparse

### juniper/sparse c.t.

***Juniperus coahuilensis/sparse***

***Juniperus deppeana/sparse***

***Juniperus monosperma/sparse***

***Juniperus oteosperma***

***Juniperus pinchotii***

***Juniperus scopulorum***

Juniper/sparse is a community type that may be locally dominated by either redberry juniper (*Juniperus coahuilensis*), alligator juniper (*Juniperus deppeana*), oneseed juniper (*Juniperus monosperma*), Utah juniper (*Juniperus oteosperma*), Pinchot's juniper (*Juniperus pinchotii*), or Rocky Mountain juniper (*Juniperus scopulorum*).

### Code(s)

typic phase2 02 50 0

### Ecological Response Unit

PJ Woodland (persistent) (PJO), subclass cold (JUGc)

### NVC Group

Colorado Plateau Pinyon - Juniper Woodland (G900)

### Key Criteria

Understory is sparse, although annual plants may be well represented. Juniper overstory is well represented to abundant. Existing plants may be on pedestals, providing evidence of recent erosion.

### Structure

This community type may be an advanced successional stage from several plant associations, as well as a prolonged successional stage (disclimax) under current soil and management conditions.

Juniper/sparse may be a "badland" plant association, as well as on special parent materials such as gypsum. Soil and landform features are critical in helping distinguish seral or climax (potential) expressions of this association. Herbage production rapidly increases as tree cover decreases below 10 square feet/acre. As tree cover increases, herbage production is significantly reduced. Decreases in site productivity can be

expected with extended exposure to wind and water erosion (Baker et al. 1995).

### **Location**

Widespread in New Mexico and Arizona. Commonly occurs between 5,000' and 6,400' (1,525 and 1,950 m) on a wide variety of soils and parent materials, often adjoining grasslands of valley plains or piedmont slopes. Can occur on special sites such as erosional badlands or gypsum soils. Mean annual precipitation (MAP) = 12-16"/yr.

### **Trees**

Juniper species are well represented (>5%) to abundant (>25%).

### **Shrubs**

Scarce (<1%).

### **Herbs**

Perennial herbs are scarce, annuals may be common to well represented or even abundant. Herbaceous composition varies by location and vegetation type.

### **Brief Plant ID Notes**

Utah juniper usually has both male and female cones on the same tree, although this trait is uncommon for other junipers in the area. The twisted trunk of the Utah juniper is usually a single stem, unlike oneseed juniper with multiple stems.

### **Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** varies

### **Fire Ecology**

Fires are infrequent due to the lack of surface fuels to enable most fire spread. Under extreme conditions (drought and wind), crown fires are possible. Prescribed burning is extremely difficult due to the very narrow window for these conditions, and then the difficulty of control during these conditions. Utah juniper is usually killed when 60 percent or more of the tree crown is scorched. Low-intensity fires tend to kill trees under 3-4 feet tall (Tirmenstein 1986). Likewise, oneseed juniper is also susceptible to fire and is not considered a climax species in grasslands subject to frequent fires (Tirmenstein 1989).

### **Reforestation**

Both junipers naturally regenerate from seed. Sprouting is not an important regeneration method.

### **Revegetation Considerations**

In many cases, removal of juniper alone does little to increase long term forage potential. Control of grazing with seeding may be necessary for sites to develop a grass component.

**Comments**

Utah and oneseed juniper “berries” are important food sources for many birds and small mammals (Tirmenstein 1989a, 1986). The foliage of oneseed juniper can be significant for mule deer and pronghorn diets (Tirmenstein 1989a).

**References**

- Baker et al. 1995
- Baxter 1977
- Clary et al. 1974
- Dalen and Snyder 1987
- Johnsen 1962
- Tirmenstein 1986, 1989a
- USFS 1987a
- USFS 1987b
- USFS 1986



## Oneseed juniper/lecheguilla

*Juniperus monosperma/Agave lechuguilla*

### Code(s)

typic phase2 01 42 0

### Ecological Response Unit

Semi-Desert Grassland (SDG), subclass high sun mild (SDGhsm)

### NVC Group

Madrean Juniper Open Woodland (G487)

### Key Criteria

An open cover of oneseed juniper with a shrubby understory, consisting primarily of lecheguilla.

### Structure

Gelbach (1967) observed that oneseed juniper was most important in the shrub stratum, and does not attain prominence in the tree stratum.

### Location

Known from the Guadalupe Mountains in southern New Mexico, this association occurs on hot, dry limestone slopes along draws and gullies, 4,000' - 4,600' (1,225 - 1,400 m).

### Also See

Similar to JUMO/NOMI-AGLE, but shrubbier (dominated by lecheguilla) and less grassy. The *Dasyllirion-Agave* formation (Gelbach 1967) is similar, but lacks juniper.

### Trees

Open cover (3 - 10%):

oneseed juniper (*Juniperus monosperma*)

### Shrubs

Well represented (>5%), dominated by evergreen rosette species:

\*Lecheguilla (*Agave lechuguilla*) green sotol (*Dasyllirion leiophyllum*)  
sacahuista (*Nolina microcarpa*) yucca (*Yucca* spp.)

other species may include:

tree cholla (*Cylindropuntia imbricata*)

resinbush (*Viguiera stenoloba*)

## Herbs

Usually poorly represented (<5%):

sideoats grama (*Bouteloua curtipendula*)

black grama (*Bouteloua eriopoda*)

hairy woollygrass (*Erioneuron pilosum*)

slim tridens (*Tridens muticus*)

bush muhly (*Muhlenbergia porteri*)

curlyleaf muhly (*Muhlenbergia setifolia*)

large-spike bristlegrass (*Setaria macrostachya*)

## Brief Plant ID Notes

The lecheguilla primarily consists of a basal rosette of semisucculent, banana-shaped leaves, generally less than 16" long, with spines along the leaf margin that point to the base of the plant. The terminal spine is often longer than 1 inch. It grows in colonies, often forming dense mats.

## Synonymy

hairy woollygrass (*Erioneuron pilosum* = *Tridens pilosus*)

tree cholla (*Cylindropuntia imbricata* = *Opuntia imbricata*)

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 3 (grasslands)

**Elevational Subzone:** +1 (cool, moist)

**Climate Class:** HSM (high sun mild)

## Comments

Possibly derived from JUMO/NOMI-AGLE plant association or desert grassland as a result of livestock grazing, soil erosion, or climatic change.

## References

Gehlbach 1967

Moir and Carleton 1987

Stuever 1995

USFS 1986

Van Devender et al. 1984

## Oneseed juniper/sand bluestem

### *Juniperus monosperma/Andropogon hallii*

#### Code(s)

typic phase2 01 34 0

#### Ecological Response Unit

Juniper Grass (JUG), subclass cold (JUGc)

#### NVC Group

Southern Rocky Mountain Juniper Open Woodland (G252)

#### Key Criteria

This juniper woodland has a grassy understory which includes \*sand bluestem and/or \*sandhill muhly. The shrub \*broom dalea (*Psoralea scoparius*) is also present.

#### Structure

**Plant growth may be limited if sandy soils have low moisture holding capacity and limited fertility. Little documentation is available for structure and productivity of this association.**

#### Location

Occurs locally in the landscape in central and northern New Mexico on valley plains with deep, sandy soils. Typical soil is Typic Ustipsamments.

#### Also See

See TES mapping unit 143 and 144 (Carson NF, Edwards et al. 1987). If pinyon is regenerating, see PIED/ANHA. This association may be similar to JUMO/MUPU mentioned in Moir and Carleton (1987).

#### Trees

Well represented (>5%):  
oneseed juniper (*Juniperus monosperma*)

#### Shrubs

Usually scarce (<1%), but sometimes well represented (>5%):

sand sagebrush (*Artemisia filifolia*)

big sagebrush (*Artemisia tridentata*)

[LSC climate]

soaptree yucca (*Yucca elata*)

\*Broom dalea (*Psoralea scoparius*) skunkbush sumac (*Rhus trilobata*) rabbitbrush (*Chrysothamnus* spp.)

## Herbs

Well represented (>5%):

\*Sand bluestem (*Andropogon hallii*)

\*Sandhill muhly (*Muhlenbergia pungens*) little bluestem (*Schizachyrium scoparium*) blue grama (*Bouteloua gracilis*)

sand dropseed (*Sporobolus cryptandrus*) spike dropseed (*Sporobolus contractus*) spreading wallflower (*Erysium repandum*) Indian ricegrass (*Achnatherum hymenoides*)

## Brief Plant ID Notes

Similar to big bluestem (considered the same species by some), sand bluestem has two to five finger-like racemes with yellowish hairs on the rachis and pedicels.

## Synonymy

little bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*)

broom dalea (*Psoralea scoparius* = *Dalea scoparia*)

Indian ricegrass (*Achnatherum hymenoides* = *Oryzopsis hymenoides*)

## Terrestrial Ecological Unit attributes

Life Zone Class: 4 (woodlands)

Elevational Subzone: -1 (warm, dry)

Climate Class: HSC (high sun cold), LSC (low sun cold)

## Fire Ecology

No fire ecology information specific to this plant association is available. However, warm season perennial grasses such as sand bluestem are most susceptible to fire during the growing season, and generally recover very rapidly after fires. Where prescribed burning is considered for unstable sand dune areas, burning may be best in the spring, prior to grass growth, to minimize exposure of bare soils. Unless grasses are abundant, prescribed burning may be difficult due to lack of fine fuels for fire spread.

## References

Edwards et al. 1987

Moir and Carleton 198

Stuever 1995

Uchytel 1988a

USFS 1987a

USFS 1986

**Oneseed juniper/Bigelow sagebrush**  
*Juniperus monosperma/Artemisia bigelovii*

**Code(s)**

typic phase2 01 35 0

**Ecological Response Unit**

Juniper Grass (JUG), subclass cold (JUGc)

**NVC Group**

Southern Rocky Mountain Juniper Open Woodland (G252)

**Key Criteria**

This plant association has \*Bigelow sagebrush in the understory, and a\*oneseed juniper overstory which seldom exceeds 10 percent canopy cover. Twoneedle pinyon may be accidental.

**Structure**

Very limited information is available for this plant association.

**Location**

This plant association occurs locally in northern Arizona and possibly northern New Mexico, southern Utah, and southwestern Colorado. Found on limestone mesas and hillslopes, on very shallow rocky soils (Lithic Ustochrepts and Lithic Ustorthents) from 5,000' to 7,000' (1,520 - 2,130 m).

Mean annual precipitation (MAP) is about 14"/year.

**Also See**

PIED/rockland.

**Trees**

Well represented (>5%), but <10%: oneseed juniper.  
(*Juniperus monosperma*)C

**Shrubs**

Well represented (>5%):

\*Bigelow sagebrush (*Artemisia bigelovii*) fourwing saltbush (*Atriplex canescens*) winterfat (*Krascheninnikovia lanata*) Fremont's mahonia (*Mahonia fremontii*) Mormon tea (*Ephedra* spp.)

## Herbs

Well represented (>5%):

blue grama (*Bouteloua gracilis*) black grama (*Bouteloua eriopoda*)

threeawn (*Aristida* spp.)

common wolfstail (*Lycurus pheloides*)

needleandthread (*Hesperostipa comata*)

New Mexico needlegrass (*Hesperostipa neomexicana*)

Rocky Mountain zinnia (*Zinnia grandiflora*)

## Brief Plant ID Notes

Bigelow sagebrush is a spreading shrub generally about a foot tall. The center lobe of the three-lobed, wedge-shaped leaf is larger than the side lobes. Hairs on the leaves gives this sagebrush a silvery appearance.

## Synonymy

winterfat (*Krascheninnikovia lanata* = *Ceratoides lanata* = *Eurotia lanata*)

Fremont's mahonia (*Mahonia fremontii* = *Berberis fremontii*) New Mexico feathergrass (*Hesperostipa neomexicana* = *Stipa neomexicana*)

needle and thread (*Hesperostipa comata* = *Stipa comata*)

## Terrestrial Ecological Unit attributes

Life Zone Class: 4 (woodlands)

Elevational Subzone: -1 (warm, dry)

Climate Class: LSC (low sun cold)

## Revegetation Considerations

Winterfat is difficult to cultivate. Many seed sources available for winterfat are from other regions where a lower elevation variety occurs and may not be suitable for this plant association (Suminski, 1996, personal communication). If planting winterfat, try to use local seed.

## Comments

Good winter range for elk and deer. Winterfat is a key livestock and elk forage plant but is difficult to plant or seed successfully.

## References

USFS 1987a

## **Oneseed juniper/big sagebrush** *Juniperus monosperma/Artemisia tridentata*

### **Code(s)**

typic phase2 01 04 0

### **Ecological Response Unit**

Juniper Grass (JUG), subclass cold (JUGc)

### **NVC Group**

Southern Rocky Mountain Juniper Open Woodland (G252)

### **Key Criteria**

This plant association has \*big sagebrush in the understory, and a \*oneseed juniper overstory which seldom exceeds 10 percent canopy cover.

### **Location**

This plant association is found in northern New Mexico on elevated and piedmont plains from 6,600' to 6,800' (2,010 - 2,070 m). It may occur on a wide variety of soils including calcareous Typic Ustochrepts and Typic Haplustalfs (consult TES reports and verify onsite soils). Mean annual precipitation (MAP) is about 14"/year.

### **Adjacent Plant Associations**

May adjoin PIED/ARTR2 on more mesic sites, and grasslands on more xeric sites.

### **Also See**

JUOS/ARTR2; *Juniperus monosperma/Artemisia tridentata/Pleuraphis jamesii- Sporobolus cryptandrus* plant community (Francis 1986); TES mapping units 143 on Carson National Forest (Edwards et al. 1987); TES mapping unit 111 on Santa Fe National Forest (Gass et al. 1983); *Juniperus osteosperma-Pinus edulis- Artemisia tridentata* association (Warren et al. 1982).

### **Trees**

Well represented (>5%) to about 10% cover:  
oneseed juniper (*Juniperus monosperma*)

### **Shrubs**

Well represented (>5%):  
\*Big sagebrush (*Artemisia tridentata*)

broom snakeweed (*Gutierrezia sarothrae*)  
plains pricklypear (*Opuntia polyacantha*)  
fourwing saltbush (*Atriplex canescens*)  
pingue rubberweed (*Hymenoxys richardsonii*)  
rubber rabbitbrush (*Ericameria nauseosus*)

## Herbs

Well represented (>5%):

James' galleta (*Pleuraphis jamesii*)  
sand dropseed (*Sporobolus cryptandrus*)  
alkali sacaton (*Sporobolus airoides*)  
Indian ricegrass (*Achnatherum hymenoides*)  
bottlebrush squirreltail (*Elymus elymoides*)  
western wheatgrass (*Pascopyrum smithii*)  
Fendler threeawn (*Aristida purpurea* var. *longiseta*)  
Fendler's threeawn (*Aristida purpurea* var. *fendleriana*)  
blue grama (*Bouteloua gracilis*)  
hairy grama (*Bouteloua hirsuta*)  
sideoats grama (*Bouteloua curtipendula*)  
James' buckwheat (*Eriogonum jamesii*)  
New Mexico needlegrass (*Heterostipa neomexicana*)

## Brief Plant ID Notes

Recognizing the variety of big sagebrush is important for determining the browse value for elk and deer. Basin big sagebrush (*A. t.* var. *tridentata*) has an uneven top, a single main stem, and gray-green foliage. Mountain big sagebrush (*A. t.* var. *vaseyana*) has a flat top, multiple main stems, and blue green foliage. Wyoming big sagebrush (*A. t.* var. *wyomingensis*) has a round top, multiple main stems, and gray-green foliage.

## Synonymy

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)  
western wheatgrass (*Pascopyrum smithii* = *Agropyron smithii*)  
rose heath (*Chaetopappa ericoides* = *Leucelene ericoides*)  
Fendler threeawn = red threeawn (*Aristida purpurea* var. *longiseta* = *A. longiseta*)  
Fendler's threeawn (*Aristida purpurea* var. *fendleriana* = *Aristida fendleriana*)  
rubber rabbitbrush (*Ericameria nauseosa* = *Chrysothamnus nauseosus*)  
Indian ricegrass (*Achnatherum hymenoides* = *Oryzopsis hymenoides*)  
James' galleta (*Pleuraphis jamesii* = *Hilaria jamesii*)



New Mexico feathergrass (*Hesperostipa neomexicana* = *Stipa neomexicana*)

**Terrestrial Ecological Unit attributes**

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** LSC (low sun cold)

**Fire Ecology**

Big sagebrush is easily killed by fire and does not resprout; however, it could reinvade a site if soil stored or offsite seed is available. Mountain big sagebrush is the most flammable and Wyoming big sagebrush is the least flammable of the subspecies discussed above. Wildfire or prescribed burning can be detrimental to mule deer winter range by reducing big sagebrush which is a prime browse species (Suminski 1993).

**Comments**

Alkali sacaton and western wheatgrass may be indicative of clayey soils (Alfisols), whereas sideoats grama and other grasses may suggest non-clayey soils (Inceptisols or Entisols). Livestock grazing can result in higher density or cover of broom snakeweed, pinque, blue grama, or rubber rabbitbrush.

**References**

Bradley 1986a

Edwards et al. 1987

Francis 1986

Gass et al. 1983

Moir and Carleton 1987

Suminski 1993

USFS 1987a

## Oneseed juniper/sideoats grama

*Juniperus monosperma/Bouteloua curtipendula*

### Code(s)

typic phase2 01 01 0

sacahuista (NOMI) phase2 01 01 1

### Ecological Response Unit

Juniper Grass (JUG), subclass high sun mild (JUGhsm)

### NVC Group

Southern Rocky Mountain Juniper Open Woodland (G252)

### Key Criteria

A juniper woodland, often on steep, rocky slopes. \*Oneseed juniper is the dominant tree, although pinyon pine may be present, but is usually only occasional or minor climax species. \*Sideoats grama (*Bouteloua curtipendula*) is common.

### Location

From southern New Mexico and southeastern Arizona (NOMI phase) into southern Colorado (typic phase). Typically, on steep, colluvial slopes of escarpments, and hill or mountainsides with > 15% slope. Soils, from a wide variety of parent materials, are often stony or rocky, and may be interrupted by rock outcrops. Elevations range from 4,900' - 6,400' (1,500 - 1,950 m). Mean annual precipitation (MAP) is approx. 15-19"/year. Mean annual air temperature (MAAT) is 55-57 degrees F.

### Also See

Scarp woodland on steep, rocky slopes; JUMO/BOGR2 on gentle slopes where sedimentation tends to be despositional; TES mapping units 224, 412, and 432 for Apache-Sitgreaves National Forests (1987).

### Trees and Life History Traits

Well represented (>5%):

oneseed juniper (*Juniperus monosperma*)C

gray oak (*Quercus grisea*) [southeren AZ, southern NM]c

two-needle pinyon (*Pinus edulis*) [regen is minor]c

## Shrubs

Common (>1%) to well represented (>5%):

typic phase:

skunkbush sumac (*Rhus trilobata*)

big sagebrush (*Artemisia tridentata*) [<1%]

alderleaf mountain mahogany (*Cercocarpus montanus*)

wavyleaf oak (*Quercus X pauciloba*)

broom snakeweed (*Gutierrezia sarothrae*)

tree cholla (*Cylindropuntia imbricata*)

sacahuista (NOMI) phase:

skunkbush sumac (*Rhus trilobata*)

sacahuista (*Nolina microcarpa*)

desert ceanothus (*Ceanothus greggii*)

common sotol (*Dasyllirion wheeleri*)

banana yucca (*Yucca baccata*)

tulip pricklypear (*Opuntia phaeacantha*)

walkingstick cactus (*Cylindropuntia spinosior*)

broom snakeweed (*Gutierrezia sarothrae*)

bastardsage (*Eriogonum wrightii*)

gray oak (*Quercus grisea*) gray oak intergrades with shrub live oak (*Quercus grisea X turbinella*)

## Herbs

Common (>1%) to abundant (>25%):

blue grama (*Bouteloua gracilis*)

sideoats grama (*Bouteloua curtipendula*)

hairy grama (*Bouteloua hirsuta*)

black grama (*Bouteloua eriopoda*)

muttongrass (*Poa fendleriana*)

prairie junegrass (*Koeleria macrantha*)

bottlebrush squirrel tail (*Elymus elymoides*)

common wolfstail (*Lycurus pheloides*)

needlegrass (*Achnatherum* spp./*Hesperostipa* spp.)

typic phase:

James' galleta (*Pleuraphis jamesii*)

New Mexico muhly (*Muhlenbergia pauciflora*)

little bluestem (*Schizachyrium scoparium*)

Colorado four o'clock (*Mirabilis multiflora*)

James' buckwheat (*Eriogonum jamesii*)

trailing fleabane (*Erigeron flagellaris*)  
sacahuista (NOMI) phase:  
bullgrass (*Muhlenbergia emersleyi*)  
cane bluestem (*Bothriochloa barbinodis*)  
Texas bluestem (*Schizachyrium cirratum*)  
Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*)  
plains lovegrass (*Eragrostis intermedia*)  
green sprangletop (*Leptochloa dubia*)  
purple grama (*Bouteloua radicata*) numerous forbs

### **Brief Plant ID Notes**

Sideoats grama is easy to recognize by its slender, zig-zag flower stalk or rachis which supports 20-60 small spikes, usually all hanging down on the same side. When the spikes have dropped, sideoats grama can be confused with tobosa (*Pleuraphis mutica*) which also has a wavy rachis, but it is less robust and forms short mats.

### **Synonymy**

wavyleaf oak (*Quercus X pauciloba* = *Quercus undulata*)  
bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)  
little bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*)  
trailing fleabane (*Erigeron flagellaris* = *E. nudiflorus*)  
tree cholla (*Cylindropuntia imbricata* = *Opuntia imbricata*)  
walkingstick cactus (*Cylindropuntia spinosior* = *Opuntia spinosior*)  
Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)  
James' galleta (*Pleuraphis jamesii* = *Hilaria jamesii*)

### **Terrestrial Ecological Unit attributes**

Life Zone Class: 4 (woodlands)  
Elevational Subzone: -1 (warm, dry)  
Climate Class: HSM (high sun mild)

### **Phases**

The JUMO/BOCU, NOMI phase has been identified on the Clifton RD and in southwestern New Mexico. The JUMO/BOCU, typic phase is known from the Jemez Mountains and southern Colorado but is probably widespread.

### **Fire Ecology**

Although no documentation was available for fire response specific to this plant association, responses to fire by sideoats grama appear to be

varied and involve many variables (for more information, see Tirmenstein 1987b).

### **Comments**

Management activities may be limited by high erosion potential on colluvial slopes.

### **References**

- Barnes 1987
- Johnston 1987
- Stuever 1995
- Tirmenstein 1987b
- TES Apache-Sitgreaves NFs, 1987
- USFS 1987a
- USFS 1987b

**Oneseed juniper/blue grama**  
*Juniperus monosperma/Bouteloua gracilis*

**Code(s)**

typic phase2 01 02 0

**Ecological Response Unit**

Juniper Grass (JUG), subclass cold (JUGc)

**NVC Group**

Southern Rocky Mountain Juniper Open Woodland (G252)

**Key Criteria**

A juniper savanna with a rich understory of grasses, usually including blue grama (*Bouteloua gracilis*). \*Oneseed juniper is the dominant tree, although pinyon pine may be present, but is usually confined to microsites. Sideoats grama (*Bouteloua curtipendula*) is scarce or absent. Twoneedle pinyon (*Pinus edulis*) is accidental.

**Structure**

Stand conditions can vary from open savannas to dense tree cover. Grasses decrease with an increase in tree density.

**Location**

Widespread in New Mexico, Arizona, and southern Colorado. Occurs in valley plains, piedmont alluvial fans. Elevations range from 5,500' - 7,000' (1,675 - 2,130 m). Occurs on a wide variety of soil and parent materials. Mean annual precipitation (MAP) is approx. 14-16"/year.

**Also See**

JUMO/BOGR2 is very similar to JUOS/BOGR2, from USFS 1987a. Much data are needed before the two habitat types are better distinguished. At present, separation of JUMO/BOGR2 and JUOS/BOGR2 is mostly geographical. JUMO/BOGR2 and JUMO/BOCU may be hard to differentiate. Location on the slope may be more reliable than dominance of sideoats grama which can be altered under various grazing pressures. JUMO/BOGR2 occurs on alluvial settings where soil is being deposited (i.e., lower slopes, toe slopes) while JUMOBUCU occurs on more colluvial upper slopes. Dick-Peddie, et al. 1984; Francis 1986; Johnsen 1962; TES mapping units 143 and 168 on the Carson National Forest (Edwards et al. 1987), 112 on the Santa Fe

National Forest (Gass et al. 1983), 14 on the Smokey Bear Ranger District (USFS 1985), and 41, 43, and 44 on the Heber Ranger District (Nelson and Redders 1982).

### **Trees**

Well represented (>5%):

oneseed juniper (*Juniperus monosperma*)

### **Shrubs**

Scarce (<1%); however on grazed ranges shrubs may be well represented and may include:

broom snakeweed (*Gutierrezia sarothrae*)

rabbitbrush (*Chrysothamnus* spp.)

cholla (*Cylindropuntia* spp.)

pricklypear (*Opuntia* spp.)

catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*) [depending on geography] on relict sites (Baxter 1977)

sacahuista (*Nolina microcarpa*)

### **Herbs**

Abundant (>25%) or luxuriant (>50%):

blue grama (*Bouteloua gracilis*)

black grama (*Bouteloua eriopoda*)

James' galleta (*Pleuraphis jamesii*)

Fendler's threeawn (*Aristida purpurea* var. *longiseta*)

Fendler's threeawn (*Aristida purpurea* var. *fendleriana*)

sand dropseed (*Sporobolus cryptandrus*)

bottlebrush squirrel tail (*Elymus elymoides*)

muttongrass (*Poa fendleriana*)

prairie junegrass (*Koeleria macrantha*)

needlegrass (*Achnatherum* spp./*Hesperostipa* spp.)

ring muhly (*Muhlenbergia torreyi*)

bastardsage (*Eriogonum wrightii*)

prairie sagewort (*Artemisia frigida*)

globemallow (*Sphaeralcea* spp.)

rose heath (*Chaetopappa ericoides*)

pingue rubberweed (*Hymenoxys richardsonii*)

slimflower scurfpea (*Psoralidium tenuiflorum*)

## Brief Plant ID Notes

The inflorescence or “flag” can be used to distinguish blue grama from hairy grama (*Bouteloua hirsuta*). On blue grama, the flag is curved and the terminal awn is shorter than the width of the flag. This awn is longer on hairy grama, which also has straight flags.

## Synonymy

catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera* = *M. biuncifera*)

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)

rose heath (*Chaetopappa ericoides* = *Leucelene ericoides*)

slimflower scurfpea (*Psoralidium tenuiflorum* = *Psoralea tenuiflora*)

James' galleta (*Pleuraphis jamesii* = *Hilaria jamesii*)

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** LSC (low sun cold) HSC (high sun cold), HSM (high sun mild)

## Phases

The JUMO/BOGR2, JUOS phase (mentioned in USFS 1986) is treated as JUOS/BOGR2 in this publication. This leaves one phase, the typic phase, for this association at this time. Moir and Carleton (1987), however, place a JUMO/BOGR2, QUTU2 phase in the HSM climate and cite

TES mapping unit 120 on the Alma Mesa and Strayhorse (Clifton RD) allotments TES report as a reference. Below the Mogollon Rim, this association is probably more correctly called JUCO11/BOGR2 to reflect the dominance of redberry juniper rather than oneseed juniper.

## Fire Ecology

The lack of continuous fine fuels may limit the spread of fires except under extreme conditions. Francis (1986) reported 75 percent bare soils in stands he inventoried. When blue grama is dormant (early spring, driest part of summer), it is less likely to be damaged by fires.

Reestablishment of blue grama occurs through rhizomes (Tirmenstein 1987b). A 3 to 4 month rest from grazing is recommended for burned sites (Tirmenstein 1987b).



## **Comments**

On some sites, tree densities may have increased in this century due to fire exclusion. Johnsen (1962) suggests a combination of grass fires and competition from grasses are necessary to inhibit juniper establishment. Blue grama may be more resistant to this juniper “invasion” than other grass species.

## **References**

- Dick-Peddie et al. 1984
- Donart et al. 1978 (GG4a)
- Edwards et al. 1987
- Francis 1986
- Gass et al. 1983
- Johnsen 1962
- Moir and Carleton 1987
- Nelson and Redders 1982
- New Mexico Environ. Inst. 1971
- Tirmenstein 1987b
- USFS 1987a
- USFS 1986
- USFS 1985,
- TES Smokey Bear RD

**Oneseed juniper/Rabbitbrush-Apache plume**  
***Juniperus monosperma/Ericameria nauseosus-***  
***Fallugia paradoxa***

(Formerly: *Juniperus monosperma/Chrysothamnus nauseosus-Apache plume*)

**Code(s)**

typic phase2 01 33 1

big sagebrush (ARTR2) phase2 01 33 2

gray oak (QUGR3) phase2 01 33 3

**Ecological Response Unit**

Juniper Grass (JUG), subclass cold (JUGc)

**NVC Group**

Southern Rocky Mountain Juniper Open Woodland (G252)

**Key Criteria**

\*Rubber rabbitbrush and/or

\*Apache plume are abundant along washes, streamsides, and terraces. Trees present include \*oneseed juniper, rocky mountain juniper, and in northern Arizona, Utah juniper. An infrequent or occasional narrowleaf cottonwood may be present. In HSM (mild with summer moisture) climates, gray oak may also be occasional.

**Structure**

Disturbances such as periodic flooding, arroyo cutting, and sustained livestock grazing can weaken the tree and perennial grass components and increase the importance of shrubs and annuals. Several years after disturbance, forage values are generally high due to abundance of palatable shrubs.

**Location**

Widespread geographically, but often occurs very locally in the landscape in steamsides and river terraces of intermittent washes. Often between 4,300' and 6,500' (1,315 and 1,980 m). Common soils include Typic Ustifluvents, Fluventic Haplustolls, and Fluventic Ustochrepts (site specific determination of soils may be required). The soils are often cut by gullies and arroyos.

## Adjacent Plant Associations

May be adjacent to a wide variety of upland pinyon-juniper plant associations.

## Also See

Shrub riparian in Dick-Peddie et al. (1984); *Ericameria nauseous* series if trees are scarce (Moir 1983). TES mapping units 34 and 23 (LSC) for the Carson National Forest (Edwards et al. 1987) and TES mapping unit 3040 for Glenwood Ranger District (Souders 1985); TES mapping unit 58 for the Apache-Sitgreaves National Forests (USFS 1987). If cottonwood are common, see riparian forests. If pinyon is common, see PIED/ERNA10-FAPA.

## Trees

Common (>1%) or well represented (>5%):

\*oneseed juniper (*Juniperus monosperma*)

Rocky mountain juniper (*Juniperus scopulorum*)

Utah juniper (*Juniperus osteosperma*) [northern Arizona usually]

narrowleaf cottonwood (*Populus angustifolia*) [infrequent and only in some areas] gray oak (*Quercus grisea*) [occasional, HSM climate]

## Shrubs

Abundant (>25%):

\*rubber rabbitbrush (*Ericameria nauseosus* ssp. *Nauseosa* var. *glabrata*)

\*Apache plume (*Fallugia paradoxa*)

fourwing saltbush (*Atriplex canescens*)

California brickellbush (*Brickellia californica*)

broom snakeweed (*Gutierrezia sarothrae*)

depending on geography:

big sagebrush (*Artemisia tridentata*)

catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*)

desert willow (*Chilopsis linearis*)

honey mesquite (*Prosopis glandulosa*) [HSM climate]

## Herbs

Well represented (>5%), numerous species of grasses and forbs including:

blue grama (*Bouteloua gracilis*)

sideoats grama (*Bouteloua curtipendula*)

bush muhly (*Muhlenbergia porteri*)

western wheatgrass (*Pascopyrum smithii*)

yellow milkvetch (*Astragalus flavus*)

### **Brief Plant ID Notes**

Apache plume is easy to confuse with cliffrose (*Purshia stansburiana*), which has sticky leaves and fewer achenes (feathery plumes) per seedhead. Apache plume is usually in drainages and cliffrose grows on the upland sites.

### **Synonymy**

broom snakeweed (*Gutierrezia sarothrae* = *Xanthocephalum sarothrae*)  
catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera* = *M. biuncifera*)  
western wheatgrass (*Pascopyrum smithii* = *Agropyron smithii*)  
rubber rabbitbrush (*Ericameria nauseosa* = *Chrysothamnus nauseosus*)  
rubber rabbitbrush (*Ericameria nauseosa* ssp. *nauseosa* var. *glabrata* = *Chrysothamnus nauseosus* ssp. *gravolens*)

### **Terrestrial Ecological Unit attributes**

Life Zone Class: 4 (woodlands)

Elevational Subzone: -1 (dry, warm)

**Climate Cass:** HSC (high sun cold), typic phase LSC (low sun cold) big sagebrush phase HSM (high sun cold) gray oak phase

### **Phases**

The big sagebrush (ARTR2) phase is in the LSC climate class; the gray oak (QUGR3) phase is in the HSM climate class; and the typic phase has neither gray oak or big sagebrush and is in the HSC climate class.

### **Fire Ecology**

No specific fire ecology information for this association is available. Fire behavior in this type is probably largely dependent on density of the shrubs. Fires are probably not widespread if streambeds are present to provide firebreaks. Rubber rabbitbrush is usually killed by fire, but may sprout if fire intensity was not too hot (Bradley 1986b). Apache plume resprouts vigorously after a fire (Harris 1988b).

### **Reforestation**

Mechanical site prep or prescribed burning is likely to encourage rabbitbrush and Apache plume. No disturbance is more conducive to juniper regeneration. Many species need shady microsites to regenerate. Lop and scattering of firewood slash can often create such microsites.

### **Revegetation Considerations**

Natural revegetation following disturbances is usually rapid due to the resprouting of shrubs and grasses.

### **Comments**

Arroyo cutting and lowered water tables can reduce or eliminate the potential for cottonwoods. Apache plume is an indicator of excessive drainage (e.g., deep, gravelly soils). Good potential for palatable deer browse if Apache plume is present.

### **References**

- Bradley 1986b
- Dick-Peddie et al. 1984
- Edwards et al. 1987
- Harris 1988b
- Souders 1985
- USFS 1987a
- USFS 1986

**Oneseed juniper/winterfat*****Juniperus monosperma*/Krascheninnikovia lanata***(Formerly: Juniperus monosperma/Ceratoides lanata)***Synonyms***Juniperus monosperma*/Ceratoides lanata  
(USFS 1986, 1987a)**Code(s)**

typic phase2 01 40

**Ecological Response Unit**

Juniper Grass (JUG), subclass cold (JUGc)

**NVC Group**

Southern Rocky Mountain Juniper Open Woodland (G252)

**Key Criteria**

The soils are calcareous and the plant association has \*winterfat (*Krascheninnikovia lanata*) present. The overstory consists of \*oneseed juniper.

**Location**

This plant association is known from western and central New Mexico where it occurs in localized settings (i.e., not extensive). Found on valley plains from 6,000' to 6,500' (1,830 - 1,980 m). Soils are calcareous.

**Trees**

Well represented (>5%):  
oneseed juniper (*Juniperus monosperma*)

**Shrubs**

Well represented (>5%):  
\*winterfat (*Krascheninnikovia lanata*)  
fourwing saltbush (*Atriplex canescens*)  
tree cholla (*Cylindropuntia imbricata*)  
skunkbush sumac (*Rhus trilobata*)  
soaptree yucca (*Yucca elata*)  
broom snakeweed (*Gutierrezia sarothrae*)

## Herbs

Well represented (>5%) or abundant (>25%):

blue grama (*Bouteloua gracilis*)

sand dropseed (*Sporobolus cryptandrus*)

spike dropseed (*Sporobolus contractus*)

Indian ricegrass (*Achnatherum hymenoides*)

bottlebrush squirreltail (*Elymus elymoides*)

James' galleta (*Pleuraphis jamesii*)

New Mexico needlegrass (*Heterostipa neomexicana*)

globemallow (*Sphaeralcea* spp.)

ring muhly (*Muhlenbergia torreyi*)

rose heath (*Chaetopappa ericoides*)

## Brief Plant ID Notes

Winterfat is a shrub or spreading subshrub with erect branches sporting tufts of seeds, each enclosed by two papery bracts covered in white silky hairs.

## Synonymy

broom snakeweed (*Gutierrezia sarothrae* = *Xanthocephalum sarothrae*)

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)

rose heath (*Chaetopappa*)*ericoides* = *Leucelene ericoides*)

tree cholla (*Cylindropuntia imbricata* = *Opuntia imbricata*)

James' galleta (*Pleuraphis jamesii* = *Hilaria jamesii*)

Indian ricegrass (*Achnatherum hymenoides* = *Oryzopsis hymenoides*)

New Mexico feathergrass (*Hesperostipa neomexicana* = *Stipa neomexicana*)

## Terrestrial Ecological Unit attributes

Life Zone Class: 4 (woodlands)

Elevational Subzone: -1 (warm, dry)

Climate Class: HSC (high sun cold)

## Fire Ecology

Although no information is available on fire response in this plant association, in general winterfat is known to resprout vigorously from the surviving root crown or caudex after most fires. Early fall fire can be most damaging to winterfat (Holifield 1987).

### **Revegetation Considerations**

Winterfat is often seeded and planted on disturbed sites including mine spoils, drilling pad sites, etc. (Holifield 1987). Winterfat is difficult to cultivate. Many seed sources available for winterfat are from other regions where a lower elevation variety occurs, and may not be suitable for this plant association (Suminski, 1996, personal communication). If planting winterfat, try to use local seed.

### **Comments**

Winterfat is evergreen and provides nutritious, palatable forage year round. It is especially important in winter when forage is limited. It is used by cattle, sheep, pronghorn, bighorn sheep, elk, deer, and a number of small mammals. Winterfat is intolerant of shading and will decrease as tree density increases (Holifield 1987).

### **References**

Holifield 1987  
USFS 1986  
USFS 1987a



## JUMO/NOMI-AGLE

### Oneseed juniper/sacahuista-lecheguilla

(Formerly: one-seed juniper/beargrass-lechuguilla)

### *Juniperus monosperma*/*Nolina microcarpa*- *Agave lechuguilla*

#### Code(s)

typic phase 2 01 41 0

#### Ecological Response Unit

Juniper Grass (JUG), subclass low sun mild (JUGlsm)

#### NVC Group

Madrean Juniper Open Woodland (G487)

#### Key Criteria

An open cover of \*oneseed juniper with a strong shrubby component, consisting primarily of \*sacahuista (beargrass) and \*lecheguilla, with a grassy understory.

#### Location

Known from the Guadalupe Mountains and the southern portion of the Sacramento Mountains in southern New Mexico, this association occurs on limestone slopes, 4,300' - 4,600' (1,315 - 1,400 m).

#### Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** HSM (high sun mild)

#### Trees

Open cover (3 - 10%):

oneseed juniper (*Juniperus monosperma*)

#### Shrubs

Well represented (>5%), dominated by evergreen rosette species:

\*sacahuista (*Nolina microcarpa*)

\*lecheguilla (*Agave lechuguilla*)

green sotol (*Dasyllirion leiophyllum*)

yucca (*Yucca* spp.)

other species may include:

tree cholla (*Cylindropuntia imbricata*)

resinbush (*Viguiera stenoloba*)

### Herbs

Well represented (>5%), especially grasses:

sideoats grama (*Bouteloua curtipendula*)

black grama (*Bouteloua eriopoda*)

hairy woollygrass (*Erioneuron pilosum*)

slim tridens (*Tridens muticus*)

bush muhly (*Muhlenbergia porteri*)

curlyleaf muhly (*Muhlenbergia setifolia*)

large-spike bristlegrass (*Setaria macrostachya*)

### Brief Plant ID Notes

Sacahuista is also known as beargrass. Although a basal rosette species from the lily family (like yucca, sotol, and agave), the bunch of relatively narrow leaves resembles a very large bunch grass in form. The lecheguilla is also a basal rosette species from the lily family. Lecheguilla has semisucculent, banana-shaped leaves, generally less than 16" long, with spines along the leaf margin that point to the base of the plant. The terminal spine is often longer than 1 inch. It grows in colonies, often forming dense mats.

### Synonymy

hairy woollygrass (*Erioneuron pilosum* = *Tridens pilosus*)

tree cholla (*Cylindropuntia imbricata* = *Opuntia imbricata*)

### Also See

Similar to JUMO/AGLE, but more grassy, and sacahuista and lecheguilla codominate the shrub layer; Gehlbach 1967.

### Fire Ecology

Little is known about fire in this plant association. Sacahuista resprouts from the woody, underground caudex after a fire, but recovery to pre-burn canopy cover should be reduced (Griffith 1991, Johnsen 1962).

### Comments

The degree of utilization of sacahuista may indicate range condition: good = flower stalks selectively browsed and foliage exhibits no cropping; fair = no flower stalks and foliage shows signs of cropping; and poor = pure stands of sacahuista are noticeably hedged (from Darrow, quoted by Griffith 1991). This utilization can be from wildlife

or livestock. In some areas, sacahuista is harvested under special permit for broom material. In this case, sacahuista utilization would be a poor indication of range conditions.

### **References**

Gehlbach 1967

Griffith 1991

Johnsen 1962

Moir and Carleton 1987

USFS 1986

## Oneseed juniper/wavyleaf oak

### *Juniperus monosperma/Quercus X pauciloba*

(Formerly: *Juniperus monosperma/Quercus undulata*)

#### Synonyms

*Juniperus monosperma/Quercus undulata* (USFS 1986, USFS 1987a)

#### Code(s)

typic phase2 01 40 0

#### Ecological Response Unit

Juniper Grass (JUG), subclass cold and high sun mild (JUGc, JUGhsm)

#### NVC Group

Southern Rocky Mountain Juniper Open Woodland (G252)

#### Key Criteria

A chaparral woodland association where shrubs are generally abundant (>25%), and dominated by \*wavyleaf oak. Junipers are of low stature (<16' or 5 m).

#### Location

Found in southern and central New Mexico, and locally in northern New Mexico. Occurs on rocky slopes between 15 and 40 percent slopes, intergrading to scarp woodland with increasing steepness and rocky outcrop terrain, 6,000' -6,500' (1,830 - 1,980 m).

#### Also See

New Mexico Environmental Institute (1971), associations 3 and 4; Juniper-oak breaks and juniper associations: Martin, Fletcher, and Knight (1981); Naumann (1987); Pettit et al. (1980): JUNI-QUPA4-BOCU.

Otherwise a poorly described chaparral woodland association.

#### Trees

Well represented (>5%) and of low stature (<16' or 5 m):

oneseed juniper (*Juniperus monosperma*)

gray oak (*Quercus grisea*) [occasional, HSM climate]

#### Shrubs

Abundant (>25%):

\*wavyleaf oak (*Quercus X pauciloba*)

shrub live oak (*Quercus turbinella*)

Apache plume (*Fallugia paradoxa*)  
fourwing saltbush (*Atriplex canescens*)  
sacahuista (*Nolina microcarpa*)  
featherplume (*Dalea formosa*)  
tree cholla (*Cylindropuntia imbricata*)  
pricklypear (*Opuntia* spp.)  
hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus*)  
yucca (*Yucca* spp.)  
pale wolfberry (*Lycium pallidum*)  
Mormon tea (*Ephedra viridis*)

## Herbs

Common (>1%):

sideoats grama (*Bouteloua curtipendula*)  
grama (*Bouteloua* spp.)  
bush muhly (*Muhlenbergia porteri*)  
curlyleaf muhly (*Muhlenbergia setifolia*)  
needlegrass (*Achnatherum* spp./*Hesperostipa* spp.)  
bottlebrush squirrel tail (*Elymus elymoides*)  
plains lovegrass (*Eragrostis intermedia*)  
sagebrush (*Artemisia* spp.)

## Brief Plant ID Notes

Wavyleaf oak is by definition a hybrid oak, usually between Gambel oak and another oak. Leaves are smaller than Gambel oak and wavy to coarsely toothed. This oak may be either deciduous or evergreen, and usually occurs as a shrub.

## Synonymy

wavyleaf oak (*Quercus* X *pauciloba* = *Quercus undulata*)  
hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus* = *C. breviflorus*)  
bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)  
tree cholla (*Cylindropuntia imbricata* = *Opuntia imbricata*)

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 4 (woodlands)

**Elevational Subzone:** -1 (warm, dry)

**Climate Class:** HSC (high sun cold) HSM (high sun mild)

## **Phases**

No phases are recognized here for this plant association, however, Naumann (1987) describes five plant communities in northeastern New Mexico that contain oneseed juniper and wavyleaf oak: JUMO/QUPA4-RHTR, PAIN phase; JUMO/QUPA4-RHTR; JUMO/QUPA4-CEMO; JUMO/QUPA4-NOTE; and JUMO/QUPA4- PRGL2. The HSM climate JUMO/QUPA4 would include gray oak and shrub live oak, not found in the HSC climate stands.

## **Fire Ecology**

Within the Great Plains Province, juniper- wavyleaf oak woodlands may occur on prominent escarpments and topographic breaks which serve as refugia from grass fires for formerly widespread woodlands from the late Pleistocene and early Holocene (Naumann 1987).

## **Revegetation Considerations**

Natural revegetation is rapid due to oak sprouting.

## **Comments**

Livestock grazing in this association is generally hampered by lack of surface water, impenetrable oak thickets, and typically low forage production.

## **References**

- Martin, Fletcher, and Knight 1981
- Moir and Carleton 1987
- Naumann 1987
- New Mexico Environmental Institute 1971 Pettit et al. 1980
- Stuever 1995
- USFS 1987a
- USFS 1986

## **Redberry juniper/crucifixion thorn**

### ***Juniperus coahuilensis*/Canotia holacantha**

*Formerly: (Juniperus erthyocarpa/Canotia holacantha)*

#### **Code(s)**

typic phase2 30 03 0

#### **Ecological Response Unit**

PJ Evergreen Shrub (PJC)

#### **NVC Group**

Madrean Juniper Open Woodland (G487)

#### **Key Criteria**

A juniper woodland of \*redberry juniper and Utah juniper amid a shrubby and grassy matrix containing \*crucifixion thorn.

#### **Structure**

This type is subject to soil erosion and has low firewood productivity. The site index for juniper is low.

#### **Location**

Found in central Arizona south of the Mogollon Rim (including Prescott and Tonto National Forests, Fort Apache and San Carlos Apache Reservations), this association occurs on dissected elevated plains, eroding breaks of valley fill alluvia, and steep, erosional hills. Soils are of calcareous parent materials, and in the thermic (mean annual soil temperature = 59-72 degrees F) soil temperature regime. Mean annual precipitation (MAP) = 16-20"/yr. Mean annual air temperature (MAAT) = 59-63 degrees F.

#### **Also See**

JUCO11/QUTU2. TES Mapping Units 3350- 52, 3359-60 in northern portion of the Tonto NF.

#### **Trees**

Well represented (5-10% cover):  
redberry juniper (*Juniperus coahuilensis*)  
Utah juniper (*Juniperus osteosperma*)

## **Shrubs**

Well represented (>5%):

\*crucifixion thorn (*Canotia holacantha*)  
shrub live oak (*Quercus turbinella*)  
sacahuista (*Nolina microcarpa*)  
red barberry (*Mahonia haematocarpa*)  
Fremont's mahonia (*Mahonia fremontii*)  
cholla (*Cylindropuntia* spp.)  
pricklypear (*Opuntia* spp.)  
common sotol (*Dasylirion wheeleri*)  
velvet mesquite (*Prosopis velutina*)  
broom snakeweed (*Gutierrezia sarothrae*)  
bastardsage (*Eriogonum wrightii*)  
banana yucca (*Yucca baccata*)  
soaptree yucca (*Yucca elata*)

## **Herbs**

Scarce (<1%) or common (>1%):

sideoats grama (*Bouteloua curtipendula*)  
hairy grama (*Bouteloua hirsuta*)  
black grama (*Bouteloua eriopoda*)  
Fendler threeawn (*Aristida purpurea* var. *longiseta*)  
threeawn (*Aristida* spp.)  
sand dropseed (*Sporobolus cryptandrus*)  
New Mexico needlegrass (*Hesperostipa neomexicana*)  
cane bluestem (*Bothriochloa barbinodis*)  
little bluestem (*Schizachyrium scoparium*)  
curlymesquite (*Hilaria belangeri*)  
prairie junegrass (*Koeleria macrantha*)  
muttongrass (*Poa fendleriana*)  
bottlebrush squirreltail (*Elymus elymoides*)  
bush muhly (*Muhlenbergia porteri*)  
slim tridens (*Tridens muticus*)  
and scattered forbs

## **Brief Plant ID Notes**

Generally, in Arizona, oneseed juniper and redberry juniper are separated geographically with oneseed occurring above the Mogollon Rim and redberry occurring below the Mogollon Rim. There is a slight overlap in ranges below and adjacent to the Mogollon Rim. Here are a few



characteristics to try to separate these junipers: (1) Redberry juniper produces pollen in the late fall and early winter, while oneseed juniper produces pollen in the late winter and early spring; (2) Redberry juniper is more likely to have a single, straight trunk, rather than the multi-stemmed oneseed juniper; (3) The shreddy bark of redberry juniper is tighter than the shreddy, stringy bark of oneseed juniper; (4) The mature “berry” of redberry juniper is reddish-brown, rather than the blueish-brown “berry” of the oneseed juniper (Fletcher 1985). The scientific name of redberry juniper is now back to *Juniperus coahuilensis* according to the new “Flora of Arizona” currently in preparation. This name was published in 1993 in the Journal of the Arizona-Nevada Academy of Science, but at this printing, has not changed in the “PLANTS” database which is the official reference for this publication. Crucifixion thorn is a distinctive shrub or small tree. Often dominated by stems, as the leaves are drought deciduous. The woody, oval fruit stays on the stem through spring and splits into five parts.

### **Synonymy**

redberry juniper (*Juniperus erythrocarpa* = *J. coahuilensis*)

Fremont’s mahonia (*Mahonia fremontii* = *Berberis fremontii*)

red barberry (*Mahonia haematocarpa* = *Berberis haematocarpa*)

Fendler threeawn = red threeawn (*Aristida purpurea* var. *longiseta* = *A. longiseta*)

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)

little bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*)

New Mexico feathergrass (*Hesperostipa neomexicana* = *Stipa neomexicana*)

### **Terrestrial Ecological Unit attributes**

Life Zone Class: 4 (woodlands)

Elevational Subzone: -1 (warm, dry)

Climate Class: LSM (low sun mild)

### **Fire Ecology**

JUCO11/CAHO3 plant associations today may have had more of an herbaceous component prior to widespread fire exclusion associated with heavy grazing and, much later, effective fire suppression. Fires may have maintained more savanna-like conditions, where large junipers were generally not killed by fires, but regeneration was limited (Sullivan 1993).

**Revegetation Considerations**

Natural revegetation is very slow.

**Comments**

See TES reports for extreme soil limitations.

**References**

Fletcher 1985

Stuever 1995

Sullivan 1993

USFS 1987b

**Redberry juniper/shrub live oak*****Juniperus coahuilensis/Quercus turbinella****(Formerly: Juniperus erythrocarpa/Quercus turbinella)***Code(s)**

shrub live oak (QUTU2) phase 2 30 04 0

mesquite (Prosopsis) phase 2 30 04 1

blue grama (BOGR2) phase 2 30 04 2

**Ecological Response Unit**

PJ Evergreen Shrub (PJC)

**NVC Group**

Madrean Juniper Open Woodland (G487)

**Key Criteria**

\*Redberry juniper dominates this shrubby woodland, where \*shrub live oak is well represented and often abundant. Crucifixion thorn is absent.

**Structure**

This type generally provides moderate forage for cattle in early succession, although if shrub live oak is abundant, forage value rating will be low. Forage for cattle decreases as tree cover increases.

**Location**

Found below the Mogollon Rim to southeast Arizona, this association occurs on complex hillslopes, dissected pediments and toeslopes, elevated plains and alluvial fans, and eroding breaks of old valley fill alluvium. Often occurring on moderately steep and steep slopes, elevations range around 3,600' - 4,800' (1,100 - 1,460 m). Soils are in the thermic (mean annual soil temperature = 59-72 degrees F) soil temperature regime. Mean annual precipitation (MAP) = 16-20"/yr. Mean annual air temperature (MAAT) = 59-63 degrees F.

**Also See**

JUCO11/CAHO3 also has shrub live oak and is usually found on eroding breaks with calcareous soils. In southwest New Mexico (HSM climate), see the honey mesquite (PRGL2) phase of JUMO/BOGR2 occurring, for example, on TES mapping units 3828, 3829, 3945, 3947, and 3971 in the Glenwood RD (Souders 1985). On heavy clay soils (elevated and valley

plains), see JUOS/PLMU3. For this association, see TES mapping units 2055, 3053, 3181, 3313, and 3809 on

the Globe Ranger District 3050, 3060, 3231, 3236, 3261, 3333, 3339, 3371, 3469, 3521, 3760, and 3761 for northern portions of the Tonto NF.

### **Terrestrial Ecological Unit attributes**

Life Zone Class: 4 (woodlands)

Elevational Subzone: -1 (warm, dry)

Climate Class: LSM (low sun mild)

### **Trees**

Well represented (5 - 15% canopy cover):

redberry juniper (*Juniperus coahuilensis*)

Utah juniper (*Juniperus osteosperma*) [not always present]

yellow paloverde (*Parkinsonia microphylla*) [occasional, Globe RD]

### **Shrubs**

Well represented (>5%) or abundant (>25%):

\*shrub live oak (*Quercus turbinella*)

velvet mesquite (*Prosopis velutina*)

red barberry (*Mahonia haematocarpa*)

Fremont's mahonia (*Mahonia fremontii*)

catclaw acacia (*Senegalia greggii*)

fairyduster (*Calliandra eriophylla*)

desert ceanothus (*Ceanothus greggii*)

squawbush (*Condalia spathulata*)

skunkbush sumac (*Rhus trilobata*)

catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*)

sacahuista (*Nolina microcarpa*)

broom snakeweed (*Gutierrezia sarothrae*)

bastardsage (*Eriogonum wrightii*)

littleleaf ratany (*Krameria erecta*)

tulip pricklypear (*Opuntia phaeacantha*)

### **Herbs**

Common (>1%) to abundant (>25%), depending on shrub cover:

blue grama (*Bouteloua gracilis*)

hairy grama (*Bouteloua hirsuta*)

black grama (*Bouteloua eriopoda*)

sideoats grama (*Bouteloua curtipendula*)

threeawn (*Aristida* spp.)

sand dropseed (*Sporobolus cryptandrus*)  
 curlymesquite (*Hilaria belangeri*) [heavy clay soils]  
 ring muhly (*Muhlenbergia torreyi*)  
 cane bluestem (*Bothriochloa barbinodis*)  
 little bluestem (*Schizachyrium scoparium*)  
 bush muhly (*Muhlenbergia porteri*)  
 prairie junegrass (*Koeleria macrantha*)  
 muttongrass (*Poa fendleriana*)  
 bottlebrush squirrel tail (*Elymus elymoides*)  
 needlegrass (*Achnatherum* spp./*Hesperostipa* spp.)  
 slim tridens (*Tridens muticus*)  
 globemallow (*Sphaeralcea* spp.)  
 red brome (*Bromus rubens*)  
 lacy tansyaster (*Machaeranthera pinnatifida*)  
 redstem stork's bill (*Erodium cicutarium*) and other annuals

### Brief Plant ID Notes

See JUCO11/CAHO3 for separating redberry juniper and oneseed juniper. Also note that a new scientific name for redberry juniper is *Juniperus coahuilensis* according to the revised Flora of Arizona (in preparation). Shrub live oak has thick, stiff, evergreen leaves with spine-tipped teeth. The upper leaf surface is blue-green, and yellow-green beneath. Leaves are small for oaks, approx. 1/2" to 1-1/4" long.

### Synonymy

redberry juniper (*Juniperus erythrocarpa* = *J. coahuilensis*)  
 yellow paloverde (*Parkinsonia microphylla* = *Cercidium microphyllum*)  
 Fremont's mahonia (*Mahonia fremontii* = *Berberis fremontii*)  
 red barberry (*Mahonia haematocarpa* = *Berberis haematocarpa*)  
 catclaw acacia (*Senegalia greggii* = *Acacia greggii*)  
 catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera* = *M. biuncifera*)  
 littleleaf ratany (*Krameria erecta* = *K. parvifolia*)  
 bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystris*)  
 lacy tansyaster (*Machaeranthera pinnatifida* = *Haplopappus spinulosus*)

### Phases

The shrub live oak phase has >25% cover of shrub live oak. In the mesquite (PRVE phase), mesquite is at least common (>1%). If shrub live oak is <25% cover, and mesquite is scarce, then the phase is blue grama (BOGR2).

### Fire Ecology

Burning usually favors oaks and shrubs. Fires may produce chaparral vegetation which can be an undesirable fire hazard in urban interface settings.

### Reforestation

Firewood harvest by clearcut or seedtree methods will favor oak and shrub species rather than juniper. Juniper regeneration can be encouraged through selection and shelterwood harvesting. Planting is not a common practice and no information on planting success is available.

**Revegetation Considerations**

Revegetation can be rapid due to oak resprouting.

**Comments**

Photographic records indicate that shrub live oak and mesquite have increased in geographic extent and coverage since about 1900 (USFS 1987b). This association can be subject to high erosion if overgrazed.

**References**

Fletcher 1985  
Moir & Carleton 198  
Souders 1985  
Sullivan 1993  
TES Globe RD1984  
USFS 1987b

## Pinchot juniper/creosote bush

### *Juniperus pinchotii/Larrea tridentata*

(Formerly: oneseed juniper/creosote bush)

#### Synonyms

*Juniperus monosperma/Larrea divaricate* (USFS 1987b).

#### Code(s)

typic phase2 01 43 0

#### Ecological Response Unit

Semi-Desert Grassland (SDG), subclass high sun mild (SDGhsm)

#### NVC Group

Madrean Juniper Open Woodland (G487)

#### Key Criteria

A wide scattering of low stature (<16')

\*Pinchot juniper amid a shrubby matrix containing \*creosote bush.

#### Location

Known from the Guadalupe Mountains in southern New Mexico, this association occurs on plains and piedmonts, 3,500' - 4,500' (1,075 - 1,375 m).

#### Also See

Similar to JUMO/AGLE, but with creosote bush. TES - South La Luz Grazing Allotment 1981, mapping units 274 and 278.

#### Trees

Scattered: Pinchot juniper (*Juniperus pinchotii*)

#### Shrubs

Well represented (>5%):

\*creosote bush (*Larrea tridentata*)

lecheguilla (*Agave lechuguilla*)

green sotol (*Dasyllirion leiophyllum*)

sacahuista (*Nolina microcarpa*)

yucca (*Yucca* spp.)

tree cholla (*Cylindropuntia imbricata*)

resinbush (*Viguiera stenoloba*)

## Herbs

Scarce (<1%) or common (>1%):

sideoats grama (*Bouteloua curtipendula*)

black grama (*Bouteloua eriopoda*)

hairy woollygrass (*Erioneuron pilosum*)

slim tridens (*Tridens muticus*)

bush muhly (*Muhlenbergia porteri*)

curlyleaf muhly (*Muhlenbergia setifolia*)

large-spike bristlegrass (*Setaria macrostachya*)

## Brief Plant ID Notes

Pinchot juniper is similar to redberry juniper (*J. coahuilensis*) vegetatively, but grows in southeastern New Mexico and Texas. Unlike oneseed juniper (*J. monosperma*), the red berry of the Pinchot juniper does not have a waxy bloom (Fletcher 1985). The small, bright green leaves of the creosote bush are thick, resinous and strongly scented. The many branches are brittle, and leaves are clumped at the ends of the branches.

## Synonymy

Creosote bush (*Larrea tridentata* = *divaricata*)

hairy woollygrass (*Erioneuron pilosum* = *Tridens pilosus*)

tree cholla (*Cylindropuntia imbricata* = *Opuntia imbricata*)

## Terrestrial Ecological Unit attributes

**Life Zone Class:** 3 (grasslands)

**Elevational Subzone:** 0 (typic)

**Climate Class:** HSM (high sun mild)

## Fire Ecology

For many areas, fire exclusion has contributed to creosote bush range expansion (Marshall and Korthius 1995). Creosote bush is poorly adapted to fire, and only survives fires that burn in patches or are of low severity. Season of burning, fuel quantity, fire temperature, and age of existing plants affect the ability of creosote bush to sprout. Marshall and Korthius (1995) suggests conducting prescribed burns for creosote bush control in spring or early fall, after 2 years of above average plant growth.



## **Revegetation Considerations**

Revegetating creosote bush-inhabited sites with other plant species is exceedingly difficult (Marshall and Korthuis 1995). Creosote bush is susceptible to severe drought during short-term climate changes such as those associated with the El Niño- Southern Oscillation phenomena. The success of creosote bush control projects may be enhanced by timing activities with expected drought conditions (i.e., predicted La Nina conditions).

## **Comments**

Possibly derived from JUMO/NOMI-AGLE plant association or desert grassland because of livestock grazing, soil erosion, or climatic change. Creosote bush has expanded into many areas of this plant association within the last 100 years, and once established, is difficult to control. (Gardiner 1951)

## **References**

- Fletcher 1985
- Gardiner 1951
- Marshall and Korthuis 1995
- Moir and Carleton 1987
- New Mexico Environmental Institute 1971
- USFS 1986
- VanDevender et al. 1984

# Scarp Woodland

## Code(s)

typic phase2 50 00 0

## Ecological Response Unit

various

## NVC Group

various

## Key Criteria

Woodland sites with slopes exceeding 40 percent with cobbly, bouldery soils having much discontinuity because of rock outcrop or bare rock exposure.

## Structure

Tree roots often grow in cracks and fissures. Trees may be stunted where moisture is limited. Stocking is often light. Wood production is typically very low. Steep, rough topography limits commodity- oriented use and vegetation management opportunities.

## Location

Widespread in the Southwest and Great Plains. Often occurs on upper slopes as mesa caprock, although other landforms may also qualify as “scarp.”

## Adjacent Plant Associations

May adjoin a variety of woodland types.

## Also See

QUGR3/CEMO,PIED/CEMO, JUMO/QUTU2,JUMO/QUPA4, JUDE/QUGR3; Wells (1970); TES mapping units with very steep slopes and rock outcrop components, such as Mapping Unit 278 (Edwards et al. 1987), Mapping Units 105, 113, 117, 127, 133, and 208 (Gass et al. 1983), and Mapping Unit 74 (Gass et al. 1981); Naumann (1987) divides scarp woodlands into local plant associations.

## Trees

Well represented (>5%), often rooted in fissures. Woodland species composition varies with geography and elevation.

## Shrubs

Well represented (>5%), usually numerous species are found. Composition varies with geography and topography.

**Herbs**

Well represented (>5%). Numerous species of both grasses and forbs.

**Cryptogams**

Lichen growth on rocks can be dense.

**Terrestrial Ecological Unit attributes**

**Life Zone Class:**4 (Woodlands)

**Elevational Subzone:** -1 (warm, dry), 0 (typic), +1 (cool, moist)

**Climate Class:** varies

**Fire Ecology**

Most sites may be protected from frequent fire regimes and may contain important dendrochronology woody material.

**Reforestation**

Natural regeneration is spotty and hard to predict. Artificial regeneration is usually impractical due to the absence of plantable sites.

**Revegetation Considerations**

Revegetation may be slow and spotty.

**Comments**

Scarp woodlands can provide important wildlife habitat, visual quality, and dispersed recreational opportunities.

**References**

Edwards et al. 1987

Naumann 1987

USFS 1987a

USFS 1986

Wells 1970

# Synonymy

Listed here are most of the major changes in plant names mentioned in the plant association descriptions. Except as mentioned in the introduction, the following are the “accepted” synonyms as appeared in the 5/21/95 version of USDA, NRCS 1995, “The PLANTS Database.” Listed for each taxon treated are the accepted common name and its accepted scientific name. The former common name(s) and/or the former scientific names follow depending on the nature of the change involved. Occasionally, more than one change is shown.

This list is separated into three main categories—trees, shrubs, and herbs—each category is organized alphabetically by scientific name.

## Trees

corkbark fir (*Abies lasiocarpa* var. *arizonica* = *A. arizonica* = *A. bifolia*)

thinleaf alder (*Alnus incana* ssp. *tenuifolia* = *A. tenuifolia*)

velvet ash (*Fraxinus velutina* = *F. v. ssp. pennsylvanica*)

Arizona cypress (*Hesperocyparis arizonica* = *Cupressus arizonica*)

redberry juniper (*Juniperus coahuilensis* = *J. erythrocarpa* var. *coahuilensis*) or redberry juniper (*Juniper coahuilensis* = *J. erythrocarpa*)

Rocky Mountain juniper (*Juniperus scopulorum* = *J. s. var. columnaris*)

yellow paloverde (*Parkinsonia microphylla* = *Cercidium microphyllus*)

Arizona pine (*Pinus arizonica* = *P. ponderosa* var. *arizonica*)

border pinyon (*Pinus discolor* = *Pinus cembroides* = Mexican pinyon)

singleleaf pinyon (*Pinus monophylla* = *P. fallax*) aka Arizona pinyon

Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni* = *P. fremontii*)

## Shrubs

Utah serviceberry (*Amelanchier utahensis* ssp. *utahensis* = *A. alnifolia*)

black sagebrush (*Artemisia nova*) = low sagebrush (*A. arbuscula* var.

*nova*) dwarf stickpea (*Calliandra humilis* var. *reticulata* = *C. reticulata*)

hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus* = *C. breviflorus*)

Mexican orange (*Choisya dumosa* var. *arizonica*) = star-leaf (*C. arizonica*)

redosier dogwood (*Cornus sericea* ssp. *sericea* = *C. stolonifera*)

Cholla (*Cylindropuntia* = *Opuntia*)

tree cholla (*Cylindropuntia imbricata* = *Opuntia imbricata*)

walkingstick cactus (*Cylindropuntia spinosor* = *Opuntia spinosor*)  
 Whipple cholla (*Cylindropuntia whipplei* = *Opuntia whipplei*)  
 rubber rabbitbrush (*Ericameria nauseosa* = *Chrysothamnus nauseosus*)  
 rubber rabbitbrush (*Ericameria nauseosa* ssp. *nauseosa* var. *glabrata* = *Chrysothamnus nauseosus* ssp. *gravolens*)  
 Utah fendlerbush (*Fendlerella utahensis* = *Fendlera utahensis*)  
 velvet ash (*Fraxinus velutina* = *F. v.* ssp. *pennsylvanica*)  
 spiny greasebush (*Glossopetalon spinescens* = *G. nevadense*)  
 broom snakeweed (*Gutierrezia sarothrae* = *Xanthocephalum sarothrae*)  
 fivepetal cliffbush = waxflower = (*Jamesia americana*)  
 littleleaf ratany (*Krameria erecta* = *K. parvifolia*)  
 winterfat (*Krascheninnikovia lanata* = *Ceratoides lanata* = *Eurotia lanata*)  
 creosote bush (*Larrea tridentata* = *L. divaricata*)  
 Fremont's mahonia (*Mahonia fremontii* = *Berberis fremontii*)  
 red barberry (*Mahonia haematocarpa* = *Berberis haematocarpa*)  
 algerita (*Mahonia trifoliata* = *Berberis trifoliata*)  
 creeping barberry = Oregon grape (*Mahonia repens* = *Berberis repens*)  
 catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera* = *M. biuncifera*)  
 Rio Grande saddlebush (*Mortonia scabrella* = *M. sempervirens* ssp. *scabrella*)  
 velvet mesquite (*Prosopis velutina* = *Prosopis juliflora*)  
 broom dalea (*Psoralea scoparius* = *Dalea scoparia*)  
 Stansbury cliffrose (*Purshia stansburiana* = *Cowania stansburiana* = *C. mexicana*)  
 wavyleaf oak (*Quercus* X *pauciloba* = *Q. undulata*)  
 evergreen sumac = leatherleaf sumac (*Rhus virens* var. *choriophylla* = *R. coriophylla*)  
 hollyleaf redberry (*Rhamnus ilicifolia* = *Rhamnus crocea* var. *ilicifolia*)  
 whitethorn acacia (*Vachellia constricta* = *Acacia constricta*)  
 resinbush = skeletonleaf goldeneye (*Viguiera stenoloba*)  
 yucca (*Yucca madrensis* = *Yucca schottii*)

## Herbs

prairie acacia (*Acaciella angustissima* = *Acacia angustissima*)  
 needlegrass spp. (*Achnatherum* spp./*Hesperostipa* spp.) = *Stipa* spp.)  
 Indian ricegrass (*Achnatherum hymenoides* = *Oryzopsis hymenoides*)  
 Dore's needlegrass (*Achnatherum nelsonii* ssp. *dorei* = *Stipa nelsonii* ssp. *dorei* = western needlegrass (*S. columbiana*)  
 Fendler's threeawn (*Aristida purpurea* var. *fendleriana* = *A. fendleriana*) Fendler threeawn (*Aristida purpurea* var. *longiseta*) = red threeawn (*A.*

*longiseta*)

Orcutt's threawn (*Aristida schiedeana* var. *orcuttiana* = *Aristida orcuttiana*)

nodding brome (*Bromus anomalus* = *B. porteri*)

fringed brome (*Bromus ciliatus*) = Canadian brome (*Bromus canadensis* = *B. richarsonii*)

dryspike sedge (*Carex siccata* = *C. foenea*) = fony sedge

fireweed (*Chamerion angustifolium* spp. *angustifolium* = *Epilobium angustifolium* ssp. *angustifolium*)

rose heath (*Chaetopappa ericoides* = *Leucelene ericoides*)

tufted hairgrass (*Deschampsia cepitosa* = *D. caespitosa*)

needle and thread (*Hesperostipa comata* = *Stipa comata*)

Dore's needlegrass (*Achnatherum nelsonii* ssp. *dorei* = *Stipa nelsonii* spp. *Dorei* = western needlegrass (*S. columbiana*))

Scribner needlegrass (*Achnatherum scribneri* = *Stipa schribneri*)

desert needlegrass (*Achnatherum speciosum* = *Stipa speciosa*)

Arizona wheatgrass (*Elymus arizonicus* = *Andropogon arizonicum*)

bottlebrush squirreltail (*Elymus elymoides* = *Sitanion hystrix*)

sprucefir fleabane (*Erigeron eximius*) = forest fleabane (*E. superbus*)

trailing fleabane (*Erigeron flagellaris* = *E. nudiflorus*)

hairy woollygrass (*Erioneuron pilosum* = *Tridens pilosus*)

hairy goldenaster (*Heterotheca villosa* var. *villosa* = *Chrysopsis villosa*)

fineleaf hymenopappus (*Hymenopappus filifolius* var. *lugens* = *H. lugens*) prairie junegrass (*Koeleria macrantha* = *K. pyramidalis* = *K. cryptandrus*)

Arizona peavine (*Lathyrus lanszwertii* var. *leucanthus* = *L. lanszwertii* var. *arizonica* = *L. arizonica*)

beardless wildrye (*Leymus triticoides* = *Elymus triticoides*)

mucronate sprangletop (*Leptochloa panicea* ssp. *mucronata* = *Leptochloa mucronata*)

slender goldenweed (*Machaeranthera gracilis* = *Haplopappus gracilis*)

lacy tansyaster (*Machaeranthera pinnatifida* = *Haplopappus spinulosus*)

slimflower muhly (*Muhlenbergia tenuifolia* = *M. monticola*)

screwleaf muhly (*Muhlenbergia straminea* = *M. virescens*)

Parry's goldenrod (*Oreochrysum parryi* = *Haplopappus parryi* = *Solidago parryi*)

bittercress ragwort (*Packera cardamine* = *Senecio cardamine* = *cardamine groundsel*)

New Mexico groundsel (*Packera neomexicana* = *Senecio neomexicana*)

burnet ragwort (*Packera sanguisorboides* = *Senecio sanguisorboides*)

western wheatgrass (*Pascopyrum smithii* = *Agropyron smithii*)

littleseed ricegrass (*Piptatheropsis micrantha* = *Oryzopsis micrantha*)  
Pringle's speargrass (*Piptochaetium pringlei* = *Stipa pringlei*)  
James' galleta (*Pleuraphis jamesii* = *Hilaria jamesii*)  
tobosagrass (*Pleuraphis mutica* = *Hilaria mutica*)  
Jacob's-ladder (*Polemonium pulcherrimum* ssp. *delicatum*) = Jacob's  
ladder *P. delicatum*)  
Texas bluestem (*Schizachyrium cirratum* = *Andropogon cirratus*) little  
bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*)  
bittercress ragwort = cardamine groundsel (*Packera cardamine*)  
threenerve goldenrod (*Solidago velutina* = *S. sparsifolia*)  
slim tridens (*Tridens muticus* var. *elongatus* = *T. elongatus*)  
sharpleaf valerian (*Valeriana acutiloba* var. *acutiloba* = *V. capitata* var.  
*acutiloba* = *V. capitata*)

# Plant Reference List

This reference list compiles the plant names which appear in the plant association descriptions. It is not necessary to be familiar with all of these plants in order to be able to accurately identify plant associations in the Southwest. For most geographic areas, you will need to be familiar with about 75 to 100 different species to be able to accurately identify plant associations. Plants with a \* are key indicator plants or frequently appear in association descriptions. This list is separated into three main categories—trees, shrubs, and herbs—and is then organized alphabetically.

## Trees

- \*corkbark fir (*Abies bifolia*)
- \*white fir (*Abies concolor*)
- \*thinleaf alder (*Alnus incana* ssp. *tenuifolia*)
- \*Arizona alder (*Alnus oblongifolia*)
- Arizona madrone (*Arbutus arizonica*)
- velvet ash (*Fraxinus velutina*)
- \*Arizona walnut (*Juglans major*)
- \*redberry juniper (*Juniperus coahuilensis*)
- \*alligator juniper (*Juniperus deppeana*)
- \*oneseed juniper (*Juniperus monosperma*)
- \*Utah juniper (*Juniperus osteosperma*)
- \*Pinchot juniper (*Juniperus pinchotii*)
- \*Rocky Mountain juniper (*Juniperus scopulorum*)c
- yellow paloverde (*Parkinsonia microphylla*)
- \*Engelmann spruce (*Picea engelmannii*)C
- \*blue spruce (*Picea pungens*)
- \*bristlecone pine (*Pinus aristata*)C
- Arizona pine (*Pinus arizonica*) C
- \*border pinyon (*Pinus discolor*)c



- \*twoneedle pinyon (*Pinus edulis*)c
- \*Apache pine (*Pinus engelmannii*)C
- \*limber pine (*Pinus flexilis*)C
- \*Chihuahuan pine (*Pinus leiophylla*)c
- \*singleleaf pinyon (*Pinus monophylla*)
- \*ponderosa pine (*Pinus ponderosa*)C
- \*southwestern white pine (*Pinus strobiformis*)C
- \*Arizona sycamore (*Platanus wrightii*)a
- narrowleaf cottonwood (*Populus angustifolia*)s
- Rio Grande cottonwood (*Populus deltoides* ssp. *wislizensi*)s
- \*quaking aspen (*Populus tremuloides*)s
- black cherry (*Prunus serotina*)a
- \*Douglas-fir (*Pseudotsuga menziesii*)c
- \*Arizona white oak (*Quercus arizonica*)s
- \*Emory oak (*Quercus emoryi*)s
- \*silverleaf oak (*Quercus hypoleucoides*)S
- \*Gambel oak (*Quercus gambelii*)s
- \*gray oak (*Quercus grisea*)s
- \*netleaf oak (*Quercus rugosa*)S

## **Shrubs**

- \*Rocky Mountain maple (*Acer glabrum*)
- \*bigtooth maple (*Acer grandidentatum*)
- \*lecheguilla (*Agave lechuguilla*) Palmer's century plant (*Agave palmeri*)
- Parry's agave (*Agave parryi*)
- Utah agave (*Agave utahensis*)
- serviceberry (*Amelanchier* spp.)
- Utah serviceberry (*Amelanchier utahensis*)
- manzanita (*Arctostaphylos* spp.)

Pringle manzanita (*Arctostaphylos pringlei*)

\*pointleaf manzanita (*Arctostaphylos pungens*)

\*kinnikinnick (*Arctostaphylos uva-ursi*)

\*Bigelow sagebrush (*Artemisia bigelovii*)

sand sagebrush (*Artemisia filifolia*)

\*black sagebrush (*Artemisia nova*)

\*big sagebrush (*Artemisia tridentata*) fourwing saltbush (*Atriplex canescens*) California brickellbush (*Brickellia californica*) fairyduster (*Calliandra eriophylla*)

\*crucifixion thorn (*Canotia holacantha*)

\*Fendler ceanothus (*Ceanothus fendleri*)

\*desert ceanothus (*Ceanothus greggii*)

\*alderleaf mountain mahogany (*Cercocarpus montanus*)

hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus*)

mountain mahogany (*Cercocarpus* spp.) desert sweet (*Chamaebatiaria millefolium*)

desert willow (*Chilopsis linearis*)

\*Mexican orange (*Choisya dumosa* var. *arizonica*) rabbitbrush (*Chrysothamnus* spp.)

longflower rabbitbrush (*Chrysothamnus depressus*)

\*blackbrush (*Coleogyne ramosissima*) squawbush (*Condalia spathulata*) cholla (*Cylindropuntia* spp.)

tree cholla (*Cylindropuntia imbricata*)

tulip pricklypear (*Opuntia phaeacantha*) plains pricklypear (*Opuntia polyacantha*) walkingstick cactus (*Cylindropuntia spinosior*)

Whipple cholla (*Cylindropuntia whipplei*)

featherplume (*Dalea formosa*)

green sotol (*Dasyllirion leiophyllum*)

common sotol (*Dasyllirion wheeleri*)

Mormon tea (*Ephedra viridis*)

\*rubber rabbitbrush (*Ericameria nauseosus*)  
 bastardsage (*Eriogonum wrightii*)  
 \*Apache plume (*Fallugia paradoxa*) cliff fendlerbush (*Fendlera  
 rupicola*) Utah fendlerbush (*Fendlera utahensis*)  
 ashy silktassel (*Garrrya flavescens*)  
 eggleaf silktassel (*Garrrya ovata*)  
 \*Wright's silktassel (*Garrrya wrightii*)  
 spiny greasebush (*Glossopetalon spinescens*) broom snakeweed  
 (*Gutierrezia sarothrae*) gumhead (*Gymnosperma glutinosum*)  
 \*rockspirea (*Holodiscus dumosus*)  
 pingue rubberweed (*Hymenoxys richardsonii*)  
 \*cliffbush (*Jamesia americana*)  
 \*common juniper (*Juniperus communis*)  
 littleleaf ratany (*Krameria erecta*)  
 \*winterfat (*Krascheninnikovia lanata*)  
 \*creosote bush (*Larrea tridentata*)  
 \*twinflor (*Linnaea borealis*)  
 pale wolfberry (*Lycium pallidum*) Fremont's mahonia (*Mahonia  
 fremontii*)  
 red barberry (*Mahonia haematocarpa*)  
 \*creeping barberry (*Mahonia repens*)  
 algerita (*Mahonia trifoliata*) rough mendora (*Mendora scabra*)  
 catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*)  
 Rio Grande saddlebush (*Mortonia scabrella*)  
 \*sacahuista (*Nolina microcarpa*)  
 pricklypear (*Opuntia* spp.)  
 mountain ninebark (*Physocarpus monogynus*)  
 honey mesquite (*Prosopis glandulosa*) velvet mesquite (*Prosopis  
 velutina*) common chokecherry (*Prunus virginiana*) broom dalea  
 (*Psoralea scoparius*) common hoptree (*Ptelea trifoliata*)

\*Stansbury cliffrose (*Purshia stansburyiana*)  
 \*antelope bitterbrush (*Purshia tridentata*) shrubby forms oaks (*Quercus* spp.) canyon live oak (*Quercus chrysolepis*)  
 \*Gambel oak (*Quercus gambelii*)  
 \*gray oak (*Quercus grisea*)  
 \*silverleaf oak (*Quercus hypoleucoides*)  
 \*netleaf oak (*Quercus rugosa*)  
 \*wavyleaf oak (*Quercus X pauciloba*)  
 \*Toumey oak (*Quercus toumeyi*)  
 \*shrub live oak (*Quercus turbinella*)  
 redberry buckthorn (*Rhamnus crocea*)  
 sugar sumac (*Rhus ovata*)  
 \*skunkbush sumac (*Rhus trilobata*)  
 \*evergreen sumac (*Rhus virens* var. *choriophylla*)  
 wax currant (*Ribes cereum*)  
 \*gooseberry currant (*Ribes montigenum*) currant (*Ribes* spp.)  
 \*New Mexico locust (*Robinia neomexicana*)  
 rose (*Rosa* spp.)  
 \*thimbleberry (*Rubus parviflorus*)  
 \*Scouler's willow (*Salix scouleriana*)  
 catclaw acacia (*Senegalia greggii*)  
 \*mountain snowberry (*Symphoricarpos oreophilus*)  
 turpentinebroom (*Thamnosma montana*)  
 \*whortleberry (*Vaccinium myrtillus*)  
 resinbush (*Viguiera stenoloba*)  
 \*canyon grape (*Vitis arizonica*)  
 yucca (*Yucca* spp.)  
 narrowleaf yucca (*Yucca angustissima*)

\*banana yucca (*Yucca baccata*) soaptree yucca (*Yucca elata*) yucca (*Yucca madrensis*)

## Herbs

common yarrow (*Achillea millefolium*)

needlegrass (*Achnatherum* spp.)

\*Indian ricegrass (*Achnatherum hymenoides*)

\*Dore's needlegrass (*Achnatherum nelsonii* spp. dorei)

Scribner needlegrass (*Achnatherum scribneri*)

desert needlegrass (*Achnatherum speciosa*)

Kunth's onion (*Allium kunthii*)

big bluestem (*Andropogon gerardii*)

\*sand bluestem (*Andropogon hallii*)

threeawns (*Aristida* spp.)

Arizona threeawn (*Aristida arizonica*)

Fendler's threeawn (*Aristida purpurea* var. *fendleriana*)

Fendler threeawn (*Aristida purpurea* var. *longiseta*)

Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*)

sagebrush (*Artemisia* spp.)

prairie sagewort (*Artemisia frigida*)

white sagebrush (*Artemisia ludoviciana*)

yellow milkvetch (*Astragalus flavus*)

pine dropseed (*Blepharoneuron tricholepis*)

cane bluestem (*Bothriochloa barbinodis*)

\*sideoats grama (*Bouteloua curtipendula*)

\*black grama (*Bouteloua eriopoda*)

\*blue grama (*Bouteloua gracilis*)

\*hairy grama (*Bouteloua hirsuta*) purple grama (*Bouteloua radicata*)

slender grama (*Bouteloua repens*)

brickellbush (*Brickellia* spp.)

brome (*Bromus* spp.)

nodding brome (*Bromus anomalus*)

\*fringed brome (*Bromus ciliatus*) woolly brome (*Bromus lanatipes*) red brome (*Bromus rubens*)

drawf stickpea (*Calliandra humilis*)

drawf stickpea (*Calliandra humilis* var. *reticulata*)

sedges (*Carex* spp.)

White Mountain sedge (*Carex geophila*)

Ross' sedge (*Carex rossii*)

\*dryspike sedge (*Carex siccata*)

rose heath (*Chaetopappa ericoides*) Fendler's lipfern (*Cheilanthes fendleri*) ticktrefoil (*Desmodium* spp.)

Arizona wheatgrass (*Elymus arizonicus*) bottlebrush squirreltail (*Elymus elymoides*) plains lovegrass (*Eragrostis intermedia*)

spreading fleabane (*Erigeron divergens*)

\*sprucefir fleabane (*Erigeron eximius*) trailing fleabane (*Erigeron flagellaris*)

James' buckwheat (*Eriogonum jamesii*) hairy woollygrass (*Erioneuron pilosum*) redstem stork's bill (*Erodium cicutarium*) spreading wallflower (*Erysium repandum*)

\*Arizona fescue (*Festuca arizonica*)

\*Thurber's fescue (*Festuca thurberi*) bedstraw (*Galium* spp.)

bracted bedstraw (*Galium microphyllum*) pineywoods geranium (*Geranium caespitosum*)

Ross' avens (*Geum rossii*)

falsepennyroyal (*Hedeoma hyssopifolia*) common sunflower (*Helianthus annuus*)

needle and thread (*Hesperostipa* spp.)

\*needle and thread (*Hesperostipa comata*)

New Mexico needlegrass (*Hesperostipa neomexicana*)

hairy false goldenaster (*Heterotheca villosa* var. *villosa*)

yellow hawkweed (*Hieracium fendleri*)

\*curlymesquite (*Hilaria belangeri*)

fineleaf hymenopappus (*Hymenopappus filifolius* var. *lugens*)

prairie junegrass (*Koeleria macrantha*)

\*Arizona peavine (*Lathyrus lanszwertii* var. *leucanthus*)

green sprangletop (*Leptochloa dubia*)

mucronate sprangletop (*Leptochloa panicea* ssp. *mucronata*)

\*beardless wildrye (*Leymus triticoides*)

manyflowered stoneseed (*Lithospermum multiflorum*)

Wright's deervetch (*Lotus wrightii*)

common wolfstail (*Lycurus pheloides*)

slender goldenweed (*Machaeranthera gracilis*) starry false lily of the valley (*Maianthemum stellatum*)

plains blackfoot (*Melampodium leucanthum*)

tall fringed bluebells (*Mertensia ciliata*)

Macdougal's bluebells (*Mertensia macdougalii*) Colorado four o'clock (*Mirabelis multiflora*)

\*pine muhly (*Muhlenbergia dubia*)

\*bullgrass (*Muhlenbergia emersleyi*)

\*longtongue muhly (*Muhlenbergia longiligula*)

\*mountain muhly (*Muhlenbergia montana*)

\*New Mexico muhly (*Muhlenbergia pauciflora*)

bush muhly (*Muhlenbergia porteri*)

\*sandhill muhly (*Muhlenbergia pungens*) curlyleaf muhly (*Muhlenbergia setifolia*)

\*screwleaf muhly (*Muhlenbergia straminea*)

slimflower muhly (*Muhlenbergia tenuifolia*) ring muhly (*Muhlenbergia torreyi*) alpine pennycress (*Noccaea fendleri* ssp. *Glauca*)

Parry's goldenrod (*Oreochrysum parryi*)

bulb panicgrass (*Panicum bulbosum*) witchgrass (*Panicum capillare*)  
vine mesquite (*Panicum obtusum*) western wheatgrass (*Pascopyrum smithii*) dwarf lousewort (*Pedicularis centranthera*) toadflax penstemon (*Penstemon linarioides*) wild beans (*Phaseolus* spp.)  
phlox (*Phlox* spp.)  
littleseed ricegrass (*Piptatheropsis micrantha*)  
\*pinon ricegrass (*Piptochaetium fimbriatum*)  
Pringle's speargrass (*Piptochaetium pringlei*)  
\*James' galleta (*Pleuraphis jamesii*)  
\*tobosagrass (*Pleuraphis mutica*)  
\*muttongrass (*Poa fendleriana*)  
\*Kentucky bluegrass (*Poa pratensis*)  
\*jacob's-ladder (*Polemonium pulcherrimum* ssp. *delicatum*)  
white milkwort (*Polygala alba*)  
greenstem paperflower (*Psilotrophe sparsiflora*) slimflower scurfpea (*Psoralidium tenuiflorum*) western brackenfern (*Pteridium aquilinum*)  
Texas bluestem (*Schizachyrium cirratum*)  
\*little bluestem (*Schizachyrium scoparium*)  
\*bittercress ragwort (*Packera cardamine*)  
New Mexico groundsel (*Packera neomexicana* var. *neomexicana*)  
\*burnet ragwort (*Packera sanguisorboides*)  
large-spike bristlegrass (*Setaria macrostachya*)  
goldenrod (*Solidago* spp.)  
threenerve goldenrod (*Solidago velutina*)  
globemallow (*Sphaeralcea* spp.)  
\*alkali sacaton (*Sporobolus airoides*) spike dropseed (*Sporobolus contractus*) sand dropseed (*Sporobolus cryptandrus*)  
Fendler's meadow-rue (*Thalictrum fendleri*)  
mountain goldenbanner (*Thermopsis montana* var. *montana*)  
spike trisetum (*Trisetum spicatum*)



slim tridens (*Tridens muticus*)

slim tridens (*Tridens muticus* var. *elongatus*)

sharpleaf valerian (*Valeriana acutiloba*) American vetch (*Vicia americana*)

sweetclover vetch (*Vicia pulchella*)

Rocky Mountain zinnia (*Zinnia grandiflora*)

# Bibliography

- Abolt, R.P., Baisan, C.H., & Swetnam, T.W. (1995, April). Fire history along an elevation transect in the Mogollon Mountains, Gila National Forest (Progress Report Coop. Agreement 28-C4-858). Silver City, NM: Gila National Forest.
- Ahleslager, K.E. (1986). *Pinus aristata*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Ahleslager, K.E. (1987). *Pinus flexilis*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Alexander, B.G., Fitzhugh, E.L., Ronco, F., & Ludwig, J.A. (1984d). A classification of forest habitat types on the Lincoln National Forest, New Mexico (General Technical Report RM-104). Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.
- Alexander, B.G., Fitzhugh, E.L., Ronco, F., & Ludwig, J.A. (1987). A classification of forest habitats of the northern portion of the Cibola National Forest, New Mexico (General Technical Report RM-143). Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.
- Alexander, B.G., Ronco, F., White, A.S., & Ludwig, J.A. (1984b). Douglas-fir habitat types of northern Arizona (General Technical Report RM-108). Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.
- Alexander, R.R. (1988, July). Forest vegetation on national forests in the Rocky Mountain and Intermountain Regions: habitat types and community types (GTR-RM-162). Ft.

Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Alexander, R.R. (1985, November). Major habitat types, community types, and plant communities in the Rocky Mountains (GTR-RM-123). Ft. Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Alexander, R.R., Hoffman, G.R., & Wirsing, J.M. (1986, August). Forest vegetation of the Medicine Bow National Forest in southeastern Wyoming: A habitat type classification (Research Paper RM-271). Ft. Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Alexander, R.R., & Ronco, F.J. (1987, June). Classification of the forest vegetation on the national forests of Arizona and New Mexico (Research Note RM-469). Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.

Allen, C.D., Touchan, R., & Swetnam, T.W. (1995). Landscape-scale fire history studies support fire management activities at Bandelier. *Park Science*, Summer, 18-19.

Allred, K. (1993). *A Field Guide to the Grasses of New Mexico*. Las Cruces, NM: New Mexico Cooperative Extension Service.

Andariese, S.W., & W. Wallace Covington. (1986, September). Biomass estimation for four common grass species in northern Arizona ponderosa pine. *Journal of Range Management*, 39(5), 472-473.

Andariese, S.W., & W. Wallace Covington. (1986). Changes in understory production for three prescribed burns of different ages in ponderosa pine. *Forest Ecology and Management*, 14, 193-203.

Anderson, R.S. Development of the southwestern ponderosa pine forests: what do we really know? *Multiresource Management of Ponderosa Pine Forest Symposium*, Northern Arizona University, Flagstaff, AZ, 1989, November 14.

- Archibold, O.W. (1980). Seed input into a postfire forest site in northern Saskatchewan. *Canadian Journal of Forest Research*, 10, 129-134.
- Arno, S.F., & Fischer, W.C. (1989, February). Using vegetation classifications to guide fire management. In: D.E. Ferguson, P. Morgan, & F.D. Johnson (compilers), *Proceedings-Land Classifications Based on Vegetation: Applications for Resource Management Vol. General Technical Report INT-257*, Moscow, ID, 1987, November 17 (pp. 81-86). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Arno, S.F., Simmerman, D.G., & Keane, R.E. (1985). Forest succession on four habitat types in western Montana (General Technical Report INT-GTR-177). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Arnold, J.F., Jameson, D.A., & Reid, E.H. (1964). The pinyon/juniper type of Arizona: effects of grazing, fire, and tree control (Production Research Report No. 84). USDA Forest Service.
- Bahre, C.J. (1991). *A legacy of change: historic human impact on vegetation of the Arizona borderlands*. Tucson, AZ: University of Arizona Press.
- Bahre, C.J. (1985). Wildfire in Southeastern Arizona between 1859 and 1890. *Desert Plants*, 7(4), 190-194.
- Bagne, K.E., M.M. Friggens, and D.M. Finch. 2011. *A System for Assessing Vulnerability of Species (SAVS) to Climate Change*. USDA Forest Service Gen. Tech. Rep. RMRS-GTR-257. Rocky Mountain Research Station, Fort Collins, CO. 28 pp.
- Bailey, D.K. (1987). A study of *Pinus subsection cembroides* I: the single needle pinyon of California and the Great Basin. *Notes from the Royal Botanical Gardens, Edinburgh*, 44, 275-310.

- Baisan, C.H., & Swetnam, T.W. (1990). Fire history on a desert mountain range: Rincon Mountain Wilderness, Arizona, U.S.A. *Can. J. For. Res.*, 20, 1559- 1569.
- Baisan, C.H., & Swetnam, T.W. (University of Arizona, Laboratory of Tree-Ring Research) (1995, January). Sandia/Manzano fire history (Final Report to Cibola National Forest). Albuquerque, NM: Cibola National Forest.
- Baker, M.B.J., DeBano, L.F., & Ffolliott, P.F. (1995). Soil loss in piñon-juniper ecosystems and its influence on site productivity and desired future condition. In D.W. Shaw, E.F. Aldon, & C. LoSapio (technical coordinators), *Desired Future Conditions for Piñon-Juniper Ecosystems Vol. General Technical Report RM-258*, Flagstaff, AZ, 1994, August 8 (pp. p. 9-15).
- Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Baker, M.B.J., DeBano, L.F., & Ffolliott, P.F. (1995). Soil loss in piñon- juniper ecosystems and its influence on site productivity and desired future condition. In D.W. Shaw, E.F. Aldon, & C. LoSapio (technical coordinators), *Desired Future Conditions for Piñon-Juniper Ecosystems Vol. General Technical Report RM-258*, Flagstaff, AZ, 1994, August 8 (pp. 9-15). Fort Collins, CO: USDA Forest Service. Rocky Mountain Forest and Range Experiment Station.
- Baker, W.L. (1983). Alpine vegetation of Wheeler Peak, New Mexico, USA: gradient analysis, classification, and biogeography. *Arctic & Alpine Res.* 15: 223-240,
- Baker, W.L. (1989). Classification of the riparian vegetation of the montane and subalpine zones in western Colorado. *Great Basin Nat.* 49: 214-228,
- Barnes, F.J. (1987). Carbon and water relations across a pinyon-juniper habitat gradient. Unpublished doctoral dissertation, New Mexico State University, Las Cruces, NM.

- Barnes, F.J., & Cunningham, G.L. (1987). Water relations and productivity in pinyon-juniper habitat types. In R.L. Everett (compiler), *Proceedings— Pinyon-Juniper Conference Vol. General Technical Report INT-215*, Reno, NV, 1986, January 13 (pp. 406-411). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Barrett, S., D. Havlina, J. Jones, W. Hann, C. Frame, D. Hamilton, K. Schon, T. DeMeo, L. Hutter, and J. Menakis. 2010. *Interagency Fire Regime Condition Class guidebook. Version 3.0. Technical guide available online* <<http://www.frcc.gov/>>. USDA Forest Service, US Department of the Interior, and The Nature Conservancy.
- Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. *Ecological Systems of the United States: A working classification of US Terrestrial Systems. NatureServe technical guide available online* <<http://www.natureserve.org/>>. Home Office, Arlington, VA. 83 pp.
- Baxter, C. (1977). In *Ecology, Uses, and Management of Pinyon-Juniper Woodlands* (General Technical Report RM-39). Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Biswell, H.H., Kallander, H.R., Komarek, R., Vogl, R.J., & Weaver, H. (1973). *A ponderosa fire management: a task force evaluation of controlled burning in ponderosa pine forests of central Arizona*. Tall Timbers Research Station, Miscellaneous Publications(2), 49 numbered p.
- Blackburn, W.H., Tueller, P.T., & Eckert, R.E. (1969, April). *Vegetation and soils of the Pine and Mathews Canyon watersheds (R46)*. University of Nevada Agriculture Experiment Station.
- Blaisdell, J.P., Murray, R.B., & McArthur, E.D. (1982). *Managing intermountain rangelands—sagebrush-grass ranges* (General Technical Report INT-

- 34). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Bonham, C.D. (1972). Ecological inventory information storage-retrieval system for the Research Ranch, Elgin, Arizona. (Science Series 14). Fort Collins, CO: Colorado State University Range Dept.
- Bradley, A.F. (1986a). *Artemisia tridentata* var. *tridentata*. In: W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Bradley, A.F. (1986b). *Chrysothamnus nauseosus*. In: W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Bradley, A.F. (1986c). *Purshia tridentata*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Bradley, A.F., Fischer, W.C., & Noste, N.V. (1992, September). Fire ecology of the forest habitat types of Eastern Idaho and Western Wyoming. (General Technical Report INT-290). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Brown, D.E., Lowe, C.P., & Pase, C.P. (1980). A digitized systematic classification for ecosystems with an illustrated summary of the natural vegetation of North America. USDA Forest Service General Technical Report, RM-73, 91 p,
- Brown, T.C. (1987). Production and cost of scenic beauty: examples for a ponderosa pine forest. *Forest Science*, 33(2), 392-410.
- Bunting, S.C. (1987). Use of prescribed burning in juniper and pinyon-juniper woodlands. In R.L. Everett, Proceedings—Pinyon-Juniper Conference Vol. General Technical Report INT-215, Reno, NV, 1986, January 13 (pp. 141- 144).

Ogden, Utah: USDA Forest Service Intermountain Forest and Range Experiment Station.

Carleton, O., Shaw, D., Robison, T., Gass, J., Moir, W., Brown III, H.G., Potter, D., Spann, C., Fletcher, R., Robertson, G., Galeano-Popp, R., Robbie, W., & Miller, G. (1991). General Ecosystem Survey. Albuquerque, NM: USDA Forest Service Southwestern Region.

Carmichael, R.S., Knipe, O.S., Pase, C.P., & Brady, W.W. (1978, July). Arizona chaparral: plant associations and ecology. Research Paper RM-202. Ft.

Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Clagg, H.B. (1975). Fire ecology in high-elevation forests in Colorado. Unpublished doctoral dissertation, Colorado State University, Fort Collins, CO.

Clagg, H.B., & Stevens, D.R. (1976). Fire management in Rocky Mountain National Park. Part II: Current fire research. Proceedings, Montana Tall Timbers Fire Ecology Conference and Intermountain Fire Research Council Fire and Land Management Symposium Vol. No. 14, Missoula, MT, 1974, October 8 (pp. 77-86). Tallahassee, FL: Tall Timbers Research Station.

Clary, W.P. (1987). Biological and economic effectiveness of several revegetation techniques in the pinyon-juniper-sagebrush zone. In R.L. Everett (compiler), Proceedings—Pinyon-Juniper Conference Vol. General Technical Report INT-215, Reno, NV, 1986, January 13 (pp. p. 305-312). Ogden, UT: USDA

Forest Service Intermountain Forest and Range Experiment Station.

Collins, W.B., & Urness, P.J. (1983). Feeding behavior and habitat selection of mule deer and elk on northern Utah summer range. *Journal of Wildlife Management*, 47(3), 646-663.

Cooper, C.F. (1960, April). Changes in vegetation, structure, and growth of southwestern ponderosa



- pine since white settlement. *Ecological Monographs*, 30(2), 129-164.
- Cooper, C.F. (1961, July). Pattern in ponderosa pine forests. *Ecology*, 42(3), 493- 499.
- Cooper, S.V., Neimann, K.E., Steele, R., & Roberts, D.W. (1987). Forest habitat types of northern Idaho: a second approximation. USDA Forest Service General Technical Report INT-236, iii, 135 pp.,
- Cooper, W.S. (1928). Seventeen years of successional change upon Isle Royale, Lake Superior. *Ecology*, 9(1), 1-5.
- Costello, D.F. (1944). Important species of the major forage types in Colorado and Wyoming. *Ecological Monographs* 14: 107-134,
- Covington, W.W., & Sackett, S.S. (1984). The effect of a prescribed burn in southwestern ponderosa pine on organic matter and nutrients in woody debris and forest floor. *Forest Science*, 30(1), 183-192.
- Covington, W.W., & Sackett, S.S. (1986). Effects of periodic burning on soil nitrogen concentrations in ponderosa pine. *Soil Sci. Soc. Am. J.*, 50, 452- 457.
- Crane, M.F. (1991). *Arctostaphylos uva-ursi*. In: W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Crane, M.F. (1989). *Cornus sericea*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Crane, M.F., & Fischer, W.C. (1986). Fire ecology of the forest habitat types of central Idaho: USDA Forest Service General Technical Report INT-218, 86 pp.
- Crouch, G.L. (1986). Aspen regeneration in 6 to 10 year old clearcuts in southwestern Colorado (Research Note RM-467). Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.

- Curry, P.O. (1975). Grazing management of ponderosa pine-bunchgrass ranges of the central Rocky Mountains: the status of our knowledge (Research Paper RM-159). Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Dalen, R.S., & Snyder, W.R. Economic and social aspects of pinyon-juniper treatment - then and now. In Proceedings of the Pinyon-Juniper Conference, Reno, NV, 1987.
- Dancker, R.C. (1985). Terrestrial Ecosystem Report for Smokey Bear Ranger District, Lincoln National Forest. Albuquerque, NM: USDA Forest Service Southwestern Region.
- Daubenmire, R.F. (1952). Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. *Ecological Monographs*, 22(4), 301-330.
- Daubenmire, R.F. (1943). Vegetational zonation in the Rocky Mountains. *Botanical Review*, 9, 325-393.
- Deitschman, G.H., Jorgensen, K.R., & Plummer, A. P. *Fallugia paradoxa* (Don) Endl. *Apacheplume*. *Agricultural Handbook* 450. Washington, DC: U.S. Department of Agriculture.
- Despain, D.W. (1987). History and results of prescribed burning of pinyon- juniper woodland on the Hualapai Indian Reservation in Arizona. In R.L. Everett (compiler), *Proceedings—Pinyon-Juniper Conference Vol. General Technical Report INT-215*, Reno, NV, 1986, January 13 (pp. 145-151).
- Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- DeVelle, R.L., Ludwig, J.A., Moir, W.H., & Ronco, F. (1986). A classification of forest habitat types of northern New Mexico and southern Colorado (General Technical Report RM-131). Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station, USDA Forest Service.

- Dick-Peddie, W.A. (1993). New Mexico vegetation, past, present and future. Albuquerque, NM, XXii, 244 pp: University of New Mexico Press.
- Dick-Peddie, W.A., Meents, J.K., & Spellenberg, R. (1984). Vegetation resource analysis for the Velarde Ditch Project, Rio Arriba and Santa Fe Counties, New Mexico (Final Rept. Contr. 4-CS-50-02400). Amarillo, TX: U.S. Bureau of Reclamation, Southwest Region.
- Dick-Peddie, W.A., & Moir, W.H. (1970). Vegetation of the Organ Mountains, New Mexico (Series 4). Fort Collins, CO: Range Science Dept., Colo. State. Univ.
- Dieterich, J.H., & Hibbert, A.R. (1990). Fire history in a small ponderosa pine stand surrounded by chaparral. In J.S. Knowles (tech. coordinator), Effects of fire management of Southwestern Natural Resources, Proceedings of the Symposium Vol. General Technical Report RM-191, Tucson, AZ, 1988, November 15 (pp. 168-173). Ft. Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Dieterich, J.H. (1983). Fire history of southwestern mixed conifer: a case study. *Forest ecology and management*, 6, 13-31.
- Dobyns, H.E. (1981). From fire to flood: historic human destruction of Sonoran Desert Riverine Oases. Socorro, NM: Ballena Press, Anthropology Papers No. 20.
- P. Durkin, M. Bradley, S.E. Carr, E. Muldavin, & P. Melhop Riparian/ Wetland vegetation communities of the Rio Grande: A classification and site evaluation (Final Report submitted to New Mexico Environment Department). Santa Fe, New Mexico: New Mexico Natural Heritage Program.
- Dye, A.J., & Moir, W.H. (1977). Spruce-fir forest at its southern distribution in the Rocky Mountains, New Mexico. *Amer. Midl. Nat.*, 97, 133-146.
- Edwards, M., Miller, G., Redders, J., Stein, R., & Dunstan, K. (1987). Terrestrial ecosystems survey of the Carson

- National Forest. Albuquerque, NM: USDA Forest Service Southwestern Region, 552 p.
- Erdman, J.A. (1970). Pinyon-juniper succession after natural fires on residual soils of Mesa Verde, Colorado. Brigham Young University Science Bulletin Biological Series 11: 122-138,
- Erdman, J.A., Douglas, C.L., & Marr, J.W. (1969). Environment of Mesa Verde, Colorado (Archaeological Res. Ser. No. 7-B) (Wetherill Mesa Studies ). Washington DC: USDI National Park Service.
- Escobedo, F. (1995). Dark Canyon EMA: Terrestrial Ecosystem Survey. USDA Forest Service Southwestern Region, Lincoln National Forest.
- Esser, L.L. (1994). *Bromus ciliatus*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Evans, R.A. (1988, July). Management of Pinyon-Juniper Woodlands. (General Technical Report INT-249). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Everett, R.L. (1987). Plant response to fire in the pinyon-juniper zone. In R.L. Everett (compiler), Proceedings—Pinyon-Juniper Conference Vol. General Technical Report INT-215, Reno, NV, 1986, January 13 (pp. 152-157).
- Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Ferguson, C.W. (1968). Bristlecone pine: science and esthetics. Science 159: 839-846,
- Fischer, W.C., & Bradley, A.F. (1987, April). Fire ecology of western Montana forest habitat types (General Technical Report INT-223). Ogden, UT: USDA Forest Service, Intermountain Research Station.
- Fischer, W.C., & Clayton, B.D. (1983). Fire ecology of Montana habitat types east of the Continental Divide.

USDA Forest Service General Technical Report INT-141,  
83 pp.

Fitzhugh, L.E., Moir, W.H., Ludwig, J.A., & Ronco, F. (1987).  
Forest habitat types in the Apache, Gila, and part of the  
Cibola National Forests in Arizona and New Mexico  
(General Technical Report RM-145). Fort Collins, CO:  
Rocky Mountain Forest and Range Experiment Station,  
USDA Forest Service.

Fletcher, R.A. (1985). Differentiation of *Juniperus erythrocarpa* and  
*Juniperus monosperma* (Range Notes 3). Albuquerque, NM: USDA  
Forest Service Southwestern Region.

Floyd-Hanna, L., Romme, W., Kendall, D., Loy, A., & Colyer, M.  
(1993). Succession and biological invasion at Mesa Verde NP. *Park  
Science*, 4 (Fall), 16-18.

Forman, R.T.T., & Dowden, D.L. (1977). Nitrogen fixing lichen  
roles from desert to alpine in the Sangre de Cristo  
Mountains, New Mexico. *The Bryologist*, 80(4), 561-570.

Fosberg, M.A., & Hironaka, M. (1964). Soil properties  
affecting the distribution of big and low sagebrush  
communities in southern Idaho. *Amer. Soc. Agronomy  
Special Publ.* 5: 230-236,

Foxx, T.S., & Tierney, G.D. (1987). Rooting patterns in the  
pinyon-juniper woodland. In R.L. Everett (compiler),  
*Proceedings—Pinyon-Juniper Conference Vol. General  
Technical Report INT-215*, Reno, NV, 1986, January 13  
(pp. 69-79). Ogden, UT: USDA Forest Service  
Intermountain Forest and Range Experiment Station.

Francis, R.E. (1986). Phyto-edaphic communities of the  
Upper Rio Puerco watershed, New Mexico (Research  
Paper RM-272). Fort Collins, CO: USDA Forest  
Service Rocky Mountain Forest and Range  
Experiment Station.

Francis, R.E., & Williams, T.B. (1989, February). Plant  
community classification of El Malpais, New Mexico. In  
D.E. Ferguson, P. Morgan, & F.D. Johnson (compilers),  
*Proceedings-Land Classifications Based on Vegetation:*

Applications for Resource Management Vol. General Technical Report INT- 257, Moscow, ID, 1987, November 17 (pp. 282-284). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.

Franklin, J.F., & Halpern, C.B. (1989, February). Influence of biological legacies on succession. In D.E. Ferguson, P. Morgan, & F.D. Johnson (compilers), *Proceedings-Land Classifications Based on Vegetation: Applications for Resource Management Vol. General Technical Report INT-257*, Moscow, ID, 1987, November 17 (pp. 54-55). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.

Friggens, M. M., K. E. Bagne, D. M. Finch, D. Falk, F. J. Triepke, and A. Lynch. 2013. Review and recommendations for climate change vulnerability assessment approaches with examples from the Southwest. USDA Forest Service General Technical Report RMRS-GTR-309. Rocky Mountain Research Station, Fort Collins, Colorado, USA.

Gardiner, J.L. (1951). Vegetation of the creosotebush area of the Rio Grande Valley in New Mexico. *Ecol. Monogr* 21: 379-403.

Gass, J.M., Lucas, W.M., & Price, P.A. (1981). Terrestrial ecosystems report for Cuba Ranger District: USDA Forest Service Southwestern Region, Albuquerque, NM.

Gass, J.M., Price, Penny A; Stephen L. Sebring. February 1983. Terrestrial ecosystems report for Coyote Ranger District. USDA Forest Service, Southwestern Region, Albuquerque, NM, 437 p. + insert + maps + air photos.

Gehlbach, F.R. (1967). Vegetation of the Guadalupe Escarpment, New Mexico- Texas. *Ecology*, 48, 404-419.

Gifford, G.F. (1987). Myths and fables of the pinyon-juniper type. In: R.L. Everett (compiler), *Proceedings—Pinyon-Juniper Conference Vol. General Technical Report INT-215*, Reno, NV, 1986, January 13 (pp. p. 34-37).

Ogden, Utah: USDA Forest Service Intermountain Forest and Range Experiment Station.

- Gottfried, G.J., & Ffolliott, P.F. (1995). Stand dynamics on upper elevation piñon- juniper watersheds at Beaver Creek, Arizona. In D.W. Shaw, E.F. Aldon, & C. LoSapio (technical coordinators), *Desired Future Conditions for Piñon- Juniper Ecosystems Vol. General Technical Report RM-258*, Flagstaff, AZ, 1994, August 8 (pp. 38-45). Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Gould, F.W. (1951). *Grasses of the Southwestern United States*. Tucson, AZ: University of Arizona Press.
- Griffith, R.S. (1991). *Nolina microcarpa*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Grissino-Mayer, H.D., & Swetnam, T.W. (1992). Dendroecological research on Mt. Graham: development of tree-ring chronologies for the Pinaleño Mountains. Laboratory of Tree Ring Research, University of Arizona.
- Grissino-Mayer, H.D., & Swetnam, T.W. (1995, September). Effects of habitat diversity on fire regimes in El Malpais National Monument, New Mexico. In J.K. Brown, R.W. Mutch, C.W. Spoon, & R.H. Wakimoto (technical coordinators), *Proceedings: Symposium on Fire in Wilderness and Park Management Vol. General Technical Report INT-GTR-320*, Missoula, MT, 1993, March 30 (pp. p. 195-200). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Gruell, G.E. (1983, December). Fire and vegetative trends in the northern Rockies: interpretations from 1871-1982 photographs (General Technical Report INT-158). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Hall, F.C. (1989, February). Plant community classification: from concept to application. In D.E. Ferguson, P. Morgan, & F.D. Johnson (compilers), *Proceedings-Land Classifications Based on Vegetation: Applications for*

Resource Management Vol. General Technical Report INT-257, Moscow, ID, 1987, November 17 (pp. 41-48). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.

- Hand, M. S., H. Eichman, F. J. Triepke, and D. Jaworski. 2018. Socioeconomic vulnerability to ecological changes to National Forests and Grasslands in the Southwest. USDA Forest Service General Technical Report RMRS-GTR-383. Rocky Mountain Research Station, Fort Collins, Colorado, USA.
- Hanks, J.P., Fitzhugh, E.L., & Hanks, S.R. (1983). A habitat type classification system for ponderosa pine forests of northern Arizona (General Technical Report RM-97). Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station, USDA Forest Service.
- Hanks, J.P. (1966). Vegetation of the mixed conifer zone; White Mountains, New Mexico (Thesis). University Park, NM: New Mexico State University.
- Hanks, J.P., & Dick-Peddie, W.A. (1974). Vegetation patterns of the White Mountains, New Mexico. The Southwestern Naturalist, 18, 371-382.
- Hansen, P.L., Hoffman, G.R., & Bjugsted, A.J. (1984). The vegetation of Theodore Roosevelt National Park, North Dakota: a habitat type classification. USDA Forest Service General Technical Report (RM-113), 35 pp.
- Hansen, P.L., & Hoffman, G.R. (1988). The vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest: a habitat type classification. USDA Forest Service General Technical Report (RM- 157), 68 pp.
- Harper, K.T., Wagstaff, F.J., & Kunzler, L.M. (1985). Biology and management of the gambel oak vegetative type: a literature review. USDA Forest Service General Technical Report (INT-179), 31 p.



- Harris, H.T. (1988a). *Arctostaphylos pungens*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Harris, H.T. (1988b). *Fallugia paradoxa*. In: W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Hess, K., & Alexander, R.R. (1986). Forest vegetation of the Arapahoe and Roosevelt National Forests in central Colorado: a habitat type classification. USDA Forest Service General Technical Report RM-266, i, 48 pp.
- Hess, K., & Wasser, C.H. (1982). Grassland, shrubland, and forestland habitat types of the White River-Arapahoe National Forests. Final Report to Rocky Mountain Forest & Range Exp. Station, Ft Collins CO, v1, 335 pp.
- Hickerson, J. (1986). *Oryzopsis hymenoides*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Hironaka, M. (1987). Classification of the pinyon-juniper vegetation type. In R.L. Everett (compiler), *Proceedings—Pinyon-Juniper Conference Vol. General Technical Report INT-215*, Reno, NV, 1986, January 13 (pp. 199- 201). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Hironaka, M. (1989, February). Primary succession theories. In D.E. Ferguson, P. Morgan, & F.D. Johnson (compilers), *Proceedings—Land Classifications Based on Vegetation: Applications for Resource Management Vol. General Technical Report INT-257*, Moscow, ID, 1987, November 17 (pp. 29-31). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Hoffman, G.R., & Alexander, R.R. (1980). Forest vegetation of the Routt National Forest in northwestern Colorado: a habitat type classification. USDA Forest Service General Technical Report RM-221, i, 41 pp.

- Hoffman, G.R., & Alexander, R.R. (1987). Forest vegetation of the Black Hills National Forest of South Dakota and Wyoming: a habitat type classification. USDA Forest Service General Technical Report RM-276, 48 pp.
- Holifield, J.L. (1987). *Krascheninnikovia lanata*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Howard, J.L. (1993). *Linnaea borealis*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Howard, J.L., & Holifred, J.L. (1995). *Purshia mexicana* var. *stansburiana*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Huckaby, L.S., & Brown, P.M. (1995). Fire history in mixed-conifer forests of the Sacramento Mountains, southern New Mexico (Final Report (WHM file 441)). Ft. Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Huckaby, L.S., & Brown, P.M. (1996, January 19). Fire history in mixed-conifer forests of the Sacramento Mountains, southern New Mexico. (Progress Report). Fort Collins, CO: Rocky Mountain Station Tree-Ring Laboratory, USDA Forest Service.
- Humphrey, L.D. (1984). Patterns and mechanisms of plant succession after fire on *Artemisia*-grass sites in southeastern Idaho. *Vegetation*, 57, 91-101.
- IPCC (Intergovernmental Panel on Climate Change). 2014. Climate change 2014: impacts, adaptation, and vulnerability. In C. B. Field and V. R. Barros, editors. Fifth Assessment Report of the Intergovernmental Panel

on Climate Change. Cambridge University Press,  
Cambridge, UK.

Jameson, D.A., Williams, J.A., & Wilton, E.W. (1962).  
Vegetation and soils of Fishtail Mesa, Arizona. *Ecol.*, 43,  
403-410.

Johnsen, T.N. . (1962). One-seed juniper invasion of northern Arizona  
grasslands. *Ecological Monographs*, 32, 187-207.

Johnson, D.E., Mukhtar, H.A.M., Mapston, R., & Humphrey,  
R.R. (1962). The mortality of oak-juniper woodland species  
following a wildfire. *J. Range Management*, 15, 201-204.

Johnston, B.C. (1995, March). Key to plant  
subformations of the Rocky Mountain Region  
(manuscript).

Johnston, B.C. (1987). Plant associations of Region 2, edition 4. USDA  
Forest Service Rocky Mountain Region, R2-ECOL-87-2, 429 pp.

Johnston, B.C. (1989, February). Woodland classification: the  
pinyon-juniper formation. In D.E. Ferguson, P. Morgan, &  
F.D. Johnson (compilers), *Proceedings-Land  
Classifications Based on Vegetation: Applications for  
Resource Management Vol. General Technical Report  
INT-257*, Moscow, ID, 1987, November 17 (pp. 160-166).  
Ogden, UT: USDA Forest Service Intermountain Forest  
and Range Experiment Station.

Johnston, B.C., & Hendzel, L. (1985). Examples of aspen  
treatment, succession and management in western  
Colorado. USDA Forest Service Rocky Mountain Region,  
164 pp.

Jones, J.R. (1974, May). Silviculture of Southwestern mixed  
conifers and aspen: the status of our knowledge (Research  
Paper RM-122). Ft. Collins, CO: USDA Forest Service  
Rocky Mountain Forest and Range Experiment Station.

Keane, R.E. (1989, February). Classification and prediction of  
successional plant communities. In D.E. Ferguson, P.  
Morgan, & F.D. Johnson (compilers), *Proceedings-Land  
Classifications Based on Vegetation: Applications for*

Resource Management Vol. General Technical Report INT-257, Moscow, ID, 1987, November 17 (pp. 56-62). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.

- Keane, R.E., R.A Loehman, L.M. Holsinger, D.A. Falk, P. Higuera, S.M. Hood, and P.F. Hessburg. 2018. Use of landscape simulation modeling to quantify resilience for ecological applications. *Ecosphere*  
<https://doi.org/10.1002/ecs2.2414>
- Kelsey, J. (1986). Terrestrial ecosystem survey of Tonto National Forest(northern portion). Albuquerque, NM: USDA Forest Service, Southwestern Region.
- Kennedy, K.L. (1983). A habitat type classification of the pinyon-juniper woodlands of the Lincoln National Forest, New Mexico. In W.H. Moir, & L. Hendzel (Tech. Coord.), Proceedings of the workshop on Southwestern habitat types, Albuquerque, NM, 1983, April 6 (pp. 54-61). Albuquerque, NM: USDA Forest Service, Southwestern Region.
- Kessell, S.R., & Fischer, W.C. (1981). Predicting postfire plant succession for fire management planning (General Technical Report INT-94). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Kilgore, B.M., & Curtis, G.A. (1987, September). Guide to understory burning in ponderosa pine/larch/fir forests in the Intermountain West (General Technical Report INT-233). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Kittel, G.M., & Lederer, N.D. (1993). A preliminary classification of the riparian vegetation of the Yampa and San Miguel/Dolores River basins (Final Report to Colo. Dept. Health & Environmental Protection Agency). The Nature Conservancy, Colorado Program.
- Kittel, G., Rondeau, R., Lederer, N., & Randolph, D. (1994). A classification of the riparian vegetation of the White and Colorado River Basins, Colorado (Final Report submitted to

the Colorado Department of Natural Resources and the Environmental Protection Agency). Boulder, CO: The Colorado Natural Heritage Program.

- Komarkova, V., Alexander, R.R., & Johnston, B.C. (1988). Forest vegetation of the Gunnison and parts of the Uncompahgre National Forests: a preliminary habitat type classification. USDA Forest Service General Technical Report RM-163. Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Koniak, S. (1985). Succession in pinyon-juniper woodlands following wildfire in the Great Basin. *Great Basin Naturalist*, 45(3), p. 556-566. (1990, May). J.S. Krammes (Technical Coordinator), Effects of fire management of Southwestern natural resources Vol. General Technical Report RM-191, Tucson, AZ, 1988, November 15 Ft. Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Ladyman, J.L.R., Muldavin, E., & Fletcher, R. (1993). Pattern and relationships of terrestrial cryptogam cover in two piñon-juniper communities in New Mexico. In E.F. Aldon, & D.W. Shaw (tech. coordinators), *Managing Piñon-Juniper Ecosystems for Sustainability and Social Needs* Vol. General Technical Report RM-236, Santa Fe, NM, 1993, April 26 (pp. 97-104). Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Ladyman, J.A.R., & Muldavin, E. (1996). Terrestrial cryptogams of pinyon- juniper woodlands in the Southwestern United States: a review (General Technical Report RM-GTR-28-). Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Larson, M.J. (1989, February). Habitat types are a tool for prescribing stand treatment. In D.E. Ferguson, P. Morgan, & F.D. Johnson (Ferguson, D. E./ Morgan, P./Johnson, F. D.), *Proceedings-Land Classifications Based on Vegetation: Applications for Resource Management* Vol. General

Technical Report INT-257, Moscow, ID, 1987, November 17 (pp. 120-122). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.

- Laurenzi, A.W., Ohmart, R.D., & Hink, V.C. (1983). Classification of mixed broadleaf riparian forest in Tonto National Forest in W.H. Moir, & L. Hendzel (Tech. Coord.), Proceedings of the workshop on southwestern habitat types, Albuquerque, NM, 1983, April 6 (pp. 72-81). Albuquerque, NM: USDA Forest Service Southwestern Region.
- Layser, E.F., & Schubert, G.H. (1979). Preliminary classification of the coniferous forest and woodland series of Arizona and New Mexico. USDA Forest Service General Technical Report, RM-208, 27 pp.
- Lindsey, A.A. (1951). Vegetation and habitats in a southwestern volcanic area. *Ecological Monographs*, 21, 227-253.
- Little, E.L.J. (1950). *Southwestern Trees*, Agricultural Handbook 9. Washington, DC: USDA.
- Mallik, A.U., & Gimingham, C.H. (1985). Ecological effects of heather burning. II. Effects on seed germination and vegetative regeneration. *Journal of Ecology*, 73, 633-644.
- Marr, J.W. (1961). *Ecosystems of the east slope of the Front Range in Colorado*. (Univ. Colo. Series in Biology No. 8). Boulder, CO: Univ. Colo. Press.
- Marshall, J.T.J. (1957). Birds of the pine-oak woodland in southern Arizona and adjacent Mexico. *Pacific Coast Avifauna*, 32, 1-125.
- Marshall, K.A., & Korthuis, S.L. (1995). *Larrea tridentata*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Martin, P.A.E. (1979). Productivity and taxonomy of the *Vaccinium globulare*, *V. membranaceum* complex in western Montana. Unpublished doctoral dissertation, University of Montana, Missoula, MT.

- Martin, W., Fletcher, R., & Knight, P. (1981). An analysis of the flora of the Canadian River Canyon, Mills Canyon Section. Albuquerque, NM: USDA Forest Service Southwestern Region, Range Management.
- Mathiasen, R.L., Blake, E.A., & Edminster, C.B. (1986). Estimates of site potential for Douglas-fir based on site index for several southwestern habitat types. *Great Basin Naturalist*, 46(2), 277 - 280.
- Mathiasen, R.L., Blake, E.A., & Edminster, C.B. (1987, July). Estimates of site potential for ponderosa pine based on site index for several southwestern habitat types. *Great Basin Naturalist*, 47(3), 467-472.
- Mauk, R.L., & Henderson, J.A. (1984, July). Coniferous forest habitat types of northern Utah (General Technical Report INT-170). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- McArthur, E.D., Stutz, H.C., & Sanderson, S.C. (1983). Taxonomy, distribution, and cytogenetics of *Purshia*, *Cowania*, and *Fallugia* (Rosoideae, Rosaceae). In Proceedings—research and management of bitterbrush and cliffrose in western North America (General Technical Report INT-152). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- McMurray, N.E. (1986a). *Artemisia nova*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- McMurray, N.E. (1987). *Holodiscus dumosus*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- McMurray, N. (1986b). *Pinus edulis*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula,

MT: USDA Forest Service, Intermountain Research Station,  
Intermountain Fire Sciences Laboratory.

- Medina, A.L. (1986). Riparian plant communities of the Fort Bayard watershed in southwestern New Mexico. *Southw. Nat.*, 31, 345-359.
- Medina, A.L. (1987). Woodland communities and soils of Fort Bayard, Southwestern New Mexico. *J. Ariz.-Nev. Acad. Sci.*, 21, 99-122.
- Merkle, J. (1952). An analysis of a pinyon-juniper community at Grand Canyon, Arizona. *Ecology*, 33, 375-384.
- Merrill, L.M., Hawksworth, F.G., & Jacobi, W.R. (1987). Frequency and severity of ponderosa pine dwarf mistletoe in relation to habitat type and topography in Colorado. *Plant disease*, 71(4), 342-344.
- Moir, W.H. (1993). Alpine tundra and coniferous forest (Dick-Peddie, William A.). *New Mexico vegetation, past, present and future* (pp. Chap 5 (pp 47- 84)). Albuquerque, NM: University of New Mexico Press.
- Moir, W.H. (1963). Vegetational analyses of three southern New Mexico mountain ranges. Unpublished ms. thesis, New Mexico State University, Las Cruces, NM.
- Moir, W.H., & Carleton, J.O. (1987). Classification of pinyon-juniper (P-J) sites on national forests in the Southwest. R.L. Everett (Compiler), *Proceedings - Pinyon-Juniper conference Vol. General Technical Report INT-215*, 581 p, Reno, NV, 1986, January 13 (pp. 216-226). Ogden, UT: USDA Forest Service Intermountain Station.
- Moir, W.H., & Dieterich, J.H. (1988). Old-growth ponderosa pine from succession on pine-bunchgrass habitat types in Arizona and New Mexico. *Natural Areas J.* 8: 17-24.
- Moir, W.H., Elson, J., Allen, C.D., DuBuys, W., & Tatschl, P. (1995). A photo history of the southern portion of the Pecos Wilderness, NM, Ft. Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Moir, W.H., & Ludwig, J.A. (1979). A classification of spruce-fir and mixed conifer habitat types of Arizona and New



- Mexico. USDA Forest Service Research Paper, RM-207, 1-47.
- Moir, W.H. (1982). A fire history of the high Chisos, Big Bend National Park, Texas. *Southwest Naturalist*, 27, 87-98.
- Moir, W.H. (1983). A series vegetation classification for Region 3. In W.H. Moir, & L. Hendzel (Tech. Coors.), *Proceedings of the Workshop on Southwestern Habitat Types*, Albuquerque, NM, 1983, April 6 (pp. 91-95). Albuquerque, NM: USDA Forest Service Southwestern Region.
- Moir, W.H. (1979). Soil-vegetation patterns in the central Peloncillo Mountains, New Mexico. *Amer. Midl. Nat.*, 102, 317-331.
- Moir, W.H., & Ludwig, J.A. (1983). Methods of forest habitat type classification. In W.H. Moir, & L. Hendzel (Tech. Coords.), *Proceedings of the workshop on southwestern habitat types*, Albuquerque, NM, 1983, April 6 (pp. 5-10). Albuquerque, NM: USDA Forest Service Southwestern Region.
- Moir, W.H., & Lukens, W.M. (1979). Resource monitoring system, Chiricahua National Monument, Arizona. Pp 1189-1199 in: Robert M. Linn [Ed.] *Proc. of the first conference on scientific research in the National Parks*, Rpt. NPS/ST-80/02-7, NPS Transactions and Proceedings Series 5.
- Monsen, S.B., & Christensen, D.R. (1975). Woody plants for rehabilitating rangelands in the Intermountain Region. In H.C. Stutz (editor), *Wildland Shrubs: Proceedings—symposium and workshop*, Provo, UT, 1975, November 5 (pp. 72-119). Provo, UT: Brigham Young University.
- Moody, R., Buchanan, L., Melcher, R., & Wistrand, H. (1992). *Fire and forest health: Southwestern Region*. Albuquerque, NM: USDA Forest Service Southwestern Region.
- Mueggler, W.F. (1988). *Aspen community types of the Intermountain Region*. USDA Forest Service General Technical Report INT-250, ii, 135 p,

- Mueggler, W.F., & Campbell, R.B. . (1986, April). Aspen community types of Utah (Research Paper INT-362). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Muldavin, E.H., Harper, G., Chauvin, Y., Melhop, P., (1997). Vegetation Classification and Map for White Sands Missile Range including San Andres National Wildlife Refuge. Vol 1 Vegetation Communities. Final report to the Environmental Services Division, White Sands Missile Range.
- Muldavin, E.H., DeVelice, R.L., & Ronco, F. (1996, November). A classification of forest habitat types: Southern Arizona and portions of the Colorado Plateau (General Technical Report RM-287). Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station, USDA Forest Service.
- Muldavin, E., Ronco, F.J., & Aldon, E.F. (1990). Consolidated stand tables and biodiversity database for Southwestern Forest habitat types. USDA Forest Service General Technical Report, RM-190, 51 p + computer diskettes.
- Muldavin, E., and F.J. Triepke. 2019. North American pinyon–juniper woodlands: Ecological composition, dynamics, and future trends. *Encyclopedia of the World's Biomes* <<https://doi.org/10.1016/B978-0-12-409548-9.12113-X>>.
- Naumann, T.S. (1987). Cañon Blanco Mesa, NM: a natural history and nature preserve proposal (Rpt. to the Nature Conservancy). Albuquerque, NM: TNC, NM Field Office.
- Nelson, C.A., & Redders, J.S. (1982). Terrestrial Ecosystem Survey, Heber Ranger District, Apache-Sitgreaves National Forests. USDA Forest Service Southwestern Region, Springerville, AZ.
- New Mexico Environmental Institute. (1971). A socio-ecological survey of the Sevilleta Land Grant. Las Cruces, NM: unpublished report to: The Nature Conservancy, Arlington, VA.
- Niering, W.A., & Lowe, C.H. (1984). Vegetation of the Santa Catalina Mountains: community types and dynamics. *Vegetation*, 58, 3-28.

- Noste, N.V., & Bushey, C.L. (1987). Fire response of shrubs of dry forest habitat types in Montana and Idaho (General Technical Report INT-239). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Padgett, W.G., Andrew P. Youngblood, & Alma H. Winward. (1989). Riparian community type classification of Utah and southeastern Colorado. USDA Forest Service Intermountain Region, R4-ECOL-89-01, 191 p + photographic insert.
- Parker, A.J. (1980). Site preferences and community characteristics of *Cupressus arizonica* Greene (Cupressaceae) in southeastern Arizona. Southwest Naturalist.
- Parker, A.J. (1980). The successional status of *Cupressus arizonica*. Great Basin Nat., 40, 254-264.
- Pavek, D.S. (1993). *Picea pungens*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Pavek, D.S. (1994a). *Pinus engelmanni*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Pavek, D.S. (1994b). *Pinus leiophylla* var. *chihuahuana*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Pavek, D.S. (1994c). *Quercus arizonica*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Pavek, D.S. (1993). *Robinia neomexicana*. In W.C. Fischer (compiler), The Fire Effects Information System

[Database], Missoula, MT: USDA Forest Service,  
Intermountain Research Station, Intermountain Fire  
Sciences Laboratory.

Pearson, G.A. (1950). Management of ponderosa pine in the southwest.  
U.S. Department of Agriculture, Monograph 6.

Peet, R.K. (1981). Forest vegetation of the Colorado  
Front Range, USA composition and dynamics.  
*Vegetation*, 45(1), 3-75.

Pettit, R., Sosebee, R., & Dahl, W. (1980). Vegetation support document.  
McGregor Range Grazing Environmental Impact Statement. Las  
Cruces, NM: Bureau of Land Management.

Pfister, R.D. (1989, February). Basic concepts of using  
vegetation to build a site classification system. In D.E.  
Ferguson, P. Morgan, & F.D. Johnson (compilers),  
*Proceedings-Land Classifications Based on Vegetation:  
Applications for Resource Management*, Moscow, ID,  
1987, November 17 (pp. 22-31). Ogden, UT: USDA  
Forest Service Intermountain Forest and Range  
Experiment Station.

Pfister, R.D., Kovalchik, B.L., Arno, S.F., & Presby, R.C.  
(1977). Forest habitat types of Montana (General  
Technical Report INT-34). Ogden, UT: USDA Forest  
Service Intermountain Forest and Range Experiment  
Station.

Phillips, J.C., & Yates, M.D. (1995). The Capulin piñon-  
juniper ecosystem management project: the  
archaeological and ecological components. In  
D.W. Shaw, E.F. Aldon, & C. LoSapio (technical  
coordinators), *Desired Future Conditions for Piñon-Juniper  
Ecosystems Vol. General Technical Report RM-258*,  
Flagstaff, AZ, 1994, August 8 (pp. 153-159). Fort Collins,  
CO: USDA Forest Service Rocky Mountain Forest and  
Range Experiment Station.

Phillips, J. (1987). *Southwestern Landscaping with Native Plants*.  
Albuquerque, NM: Museum of New Mexico Press.

- Pieper, R.D., & Lymbery, G.A. (1987). Influence of topographic features on pinyon-juniper vegetation in south-central New Mexico. In R.L. Everett (compiler), Proceedings—Pinyon-Juniper Conference Vol. General Technical Report INT-215, Reno, NV, 1986, January 13 (pp. 53-57). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Plummer, A.P., Christensen, D.R., & Monsen, S.B. (1968). Restoring big game range in Utah (Utah Publication No. 68-3). Ephraim, UT: Utah Division of Game & Fish.
- Potential natural vegetation, New Mexico. (1978). Portland, OR: USDA Soil Conservation Service.
- Potential natural vegetation, New Mexico. (1978). Portland, OR: USDA Soil Conservation Service.
- Powell, D.C. (1988). Aspen community types of the Pike and San Isabel National Forests in Colorado. USDA Forest Service Rocky Mountain Region, R2- ECOL-88-01, viii, 254 p,
- Richardson, N. (1980). Species-specific above ground shrub biomass in seral communities in three habitat types in west-central Montana (Final Report). Missoula, MT: USDA Forest Service Intermountain Forest and Range Experiment Station, Forest Sciences Laboratory.
- Ritchie, J.C. (1956). Biological flora of the British Isles: *Vaccinium myrtillus* L. *Journal of Ecology*, 44(1), 290-298.
- Roberts, D.W., & Morgan, P. (1989, February). Classification and Models of Succession. In D.E. Ferguson, P. Morgan, & F.D. Johnson (compilers), Proceedings—Land Classifications Based on Vegetation: Applications for Resource Management Vol. General Technical Report INT-257, Moscow, ID, 1987, November 17 (pp. 49-53). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Rominger, J.M., & Paulik, L.A. (1983). A floristic inventory of the plant communities of the San Francisco Peaks Research

Natural Area (General Technical Report RM-96). Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.

- Romme, W.H., C.D. Allen, J.D. Bailey, W.L. Baker, B.T. Bestelmeyer, P.M. Brown, K.S. Eisenhart, L.M. Floyd, D.W. Huffman, B.F. Jacobs, R.F. Miller, E.H. Muldavin, T.W. Swetnam, R.J. Tausch, and P.J. Weisberg. 2009. Historical and modern disturbance regimes, stand structures, and landscape dynamics in pinyon-juniper vegetation of the Western U.S. *Rangeland Ecology and Management* 62: 203-222.
- Ronco, F.J. (1987). Stand structure and function of Pinyon-Juniper woodlands. In: R.L. Everett (compiler), *Proceedings—Pinyon-Juniper Conference* Vol. General Technical Report INT-215, Reno, NV, 1986, January 13 (pp. 14-22). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Savage, M., & Swetnam, T.W. (1990, December). Early 19th century fire decline following sheep pasturing in a Navajo ponderosa pine forest. *Ecology*, 71(6), 2374-2378.
- Schmutz, E.M., Michaels, C.C., & Judd, B.I. (1967). Boysag Point: A relict area on the North Rim of the Grand Canyon in Arizona. *Journal of Range Management*, 20, 363-369.
- Severson, K.E., & Medina, A.L. (1983, May). Deer and elk management in the Southwest. *Journal of Range Management*, Monograph No. 2, Shepherd, H.R. (1975). Vegetation of two dissimilar bighorn sheep ranges in Colorado (Division Report 4). Denver, CO: Colorado Division Wildlife.
- Shreve, F. (1915). The vegetation of a desert mountain range as conditioned by climatic factors : Carnegie Inst. Washington Publ.
- Smith, E.L. (1974). Established natural areas in Arizona, a guidebook for scientists and educators. Arizona: Planning Div. Office Economic Planning and Development, Office of the Governor.

- Soeth, J.R., Tubb, D., & Parker, P. (1995). Adaptive Management in Pinyon- Juniper. Young, AZ: USDA Forest Service, Pleasant Valley Ranger District, Tonto National Forest.
- Soil and Water West, I. (1995). TES of the Southern Guadalupe Mountains. Soil Survey Staff. (1990). Keys to soil taxonomy, fourth edition. Soil Management Support Services Tech. Monograph 6, Ithaca, NY, (iv, 423 p),
- Somodi, I., Molnár, Z. and Ewald, J., 2012. Towards a more transparent use of the potential natural vegetation concept– an answer to Chiarucci et al. *Journal of Vegetation Science*, 23(3), pp.590-595.
- Souders, C.E. (1985). Terrestrial Ecosystem Report, western portion of the Glenwood Ranger District, Gila National Forest, Catron and Grant Counties, New Mexico. Silver City, NM: USDA Forest Service Southwestern Region.
- Springfield, H.W. (1976). Characteristics and management of Southwestern pinyon-juniper ranges: the status of our knowledge (Research Paper RM- 160). Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Stanton, F. (1974). Wildlife guidelines for range fire rehabilitation (Technical Note 6712). Denver, CO: U.S. Department of Interior, Bureau of Land Management.
- Steele, R., Cooper, S.V., Ondov D.M., Roberts, D.W., & Pfister, R.D. (1983). Forest habitat types of eastern Idaho-western Wyoming. USDA Forest Service General Technical Report INT-144, iii, 122 pp + inserts,
- Steele, R., & Geier-Hayes, K. (1989). The Douglas-fir/mountain maple habitat type in Central Idaho: succession and management (Preliminary draft). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.

- Steele, R., & Geier-Hays, K. (1993). The Douglas-fir/pinegrass habitat type in central Idaho: succession and management: USDA Forest Service General Technical Report INT-298, 83 pp + inserts.
- Steele, R., & Geier-Hays, K. (1994, April). The Douglas-fir/white spirea habitat type in central Idaho: succession and management (General Technical Report INT-305). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Steele, R., & Geier-Hays, K. (1987, December). The Grand fir/blue huckleberry habitat type in central Idaho: succession and management (General Technical Report INT-228). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Steele, R., & Geier-Hays, K. (1992, March). The grand fir/mountain maple habitat type in central Idaho: succession and management (General Technical Report INT-284). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Steele, R., Pfister, R.D., Ryker, R.A., & Kittams, J.A. (1981). Forest habitat types of central Idaho (General Technical Report INT-114). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Stein, S.J. (1988). Explanations of the imbalanced age structure and scattered distribution of ponderosa pine within a high-elevation mixed coniferous forest. *Forest Ecology and Management*, 25, 139-153.
- Stevens, R., Jorgensen, K.R., & Davis, J.N. (1981). Viability of seed from 32 shrub and forb species through 15 years of warehouse storage. *Great Basin Naturalist*, 41(3), 274-277.
- Stickney, P.F. (1980). Database for post-fire succession, first 6 to 9 years, in Montana larch-fir forests (General Technical Report INT-62). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.



- Stromberg, J.C., & Patten, D.T. (1991). Dynamics of the spruce-fir forest on the Pinaleno Mountains, Graham County, Arizona. *The Southwestern Naturalist*, 36(1), 37-48.
- Stuever, M.C. (1995). Indicator Plants of Southwest Forest and Woodland Habitat Types. Placitas, NM: Seldom Seen Expeditions, Inc.
- Sullivan, J. (1993). *Juniperus erythrocarpa*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Sullivan, J. (1993). *Pinus ponderosa* var. *arizonica*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Suminski, R. (1993). Management implications for mule deer winter range in northern piñon-juniper in E.F. Aldon, & D.W. Shaw (technical coordinators), *Managing Piñon-Juniper Ecosystems for Sustainability and Social Needs* (General Technical Report RM-236). Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Swetnam, T.W. (1990). Fire history and climate in southwestern United States. J.S. Krammes (Technical Coordinator), *Proceedings - effects of fire management of Southeastern natural resources* (pp. 6-17): USDA Forest Service General Technical Report RM-191.
- Swetnam, T.W., & Dieterich, J.H. (1985). Fire history of ponderosa pine forests in the Gila Wilderness, New Mexico in J.E. Lotan, B.M. Kilgor, W.C. Fischer, & R.W. Mutch (technical coordinators), *Proceedings: Symposium and workshop on wilderness fire* Vol. General Technical Report INT-182, Missoula, MT, 1983, November 15 (pp. 390-397). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.

- Swetnam, T.W., Baisan, C.H., Brown, P.M.C., & Caprio, A. (1989). Fire history of Rhyolite Canyon, Chiricahua National Monument (USDI National Park Service, Cooperative Studies Unit Technical Report No. 32). Tucson, AZ: University of Arizona.
- Swetnam, T.W., Baisan, C.H., Caprio, A.M., & Brown, P.M. (1992). Fire history in a Mexican oak-pine woodland and adjacent montane conifer gallery forest in southeastern Arizona. In P. Ffolliott, G.J. Gottfried, D.A. Bennett, V.M. Hernandez, A. Ortega-Rubio, & R.H. Hamre (technical coordinators), *Ecology and Management of Oak and Associated Woodlands: Perspectives in the Southwestern United States and Northern Mexico* Vol. General Technical Report RM-218, Sierra Vista, AZ, 1992, April 27 (pp. 165-173). Ft. Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Swetnam, T.W., & Baisan, C.H. (1995). Historical fire regime patterns in Southwestern United States since AD 1700. In C.D. Allen (editor), *Proceedings of the 2nd La Mesa fire symposium* Vol. NPS Technical Report, Los Alamos, NM, 1994, March 29: National Park Service.
- Swetnam, T.W., & Lynch, A.M. (1993). Multicentury, regional-scale patterns of western spruce budworm outbreaks. *Ecological Monographs*, 63(4), 399- 424.
- Szaro, R.C. (1989). Riparian forest and scrubland community types of Arizona and New Mexico. *Desert Plants*, 9(3-4), 69-138.
- Teale, A., & Covington, W.W. (1991, July). *Multiresource Management of Southwestern Ponderosa Pine Forests: The Status of Our Knowledge*. Flagstaff, AZ: Southwestern Region, USDA Forest Service.
- Terwilliger, C.J., & Tiedeman, J.A. (1978). Habitat types of the mule deer critical winter range and adjacent steppe vegetation of Middle Park, Colorado. Final Report Coop Agreement 16-739-CA, Rocky Mountain Forest & Range Experiment Station, Ft. Collins, CO, vii, 103 p.,

- Thomas, J.W., & Toweill, D.E. Elk of North America and Management: A Wildlife Management Institute.
- Tirmenstein, D.A. (1987a). *Bouteloua curtipendula*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Tirmenstein, D.A. (1987b). *Bouteloua gracilis*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Tirmenstein, D.A. (1986). *Juniperus osteosperma*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Tirmenstein, D. (1988a). *Juniperus deppeana*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Tirmenstein, D.A. (1989a). *Juniperus monosperma*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Tirmenstein, D. (1988b). *Quercus gambelii*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Tirmenstein, D. (1987c). *Stipa columbiana*. In: W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.

- Tirmenstein, D.A. (1990). *Vaccinium myrtillus*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Tirmenstein, D.A. (1989b). *Yucca baccata*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Touchan, R., Allen, C.D., & Swetnam, T.W. (1995). Fire history and climatic patterns in ponderosa and mixed-conifer forests of the Jemez Mountains, New Mexico. In C.D. Allen (ed.), *Proceedings of the 2nd La Mesa Fire Symposium Vol. General Technical Report RM-* , Los Alamos, NM, 1994, March 29 Ft. Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.
- Touchan, R., & Swetnam, T.W. (1992, June 25). Fire history of the Jemez Mountains (Final Report submitted to Santa Fe National Forest & Bandelier National Monument, Cooperative Agreement No. PX7120-0-0164 & 40- 8379-0-0633). Tucson, AZ: Laboratory of Tree-Ring Research.
- Touchan, R., Swetnam, T.W., & Allen, C.D. (1995). Fire history and climatic patterns in ponderosa pine and mixed-conifer forests of the Jemez Mountains, northern New Mexico. In C.D. Allen (editor), *Proceedings of the 2nd La Mesa fire symposium*, Los Alamos, NM, 1994, March 29 : National Park Service Technical Report.
- Tress, J.A. Jr., and J.M. Klopatek (1987). Successional changes in community structure of pinyon-juniper woodlands in north-central Arizona. In R.L. Everett (compiler), *Proceedings—Pinyon-Juniper Conference Vol. General Technical Report INT-215*, Reno, NV, 1986, January 13 (pp. 80-85). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.

- Triepke, F.J., E.H. Muldavin, and M.M. Wahlberg. 2019. Using climate projections to assess ecosystem vulnerability at scales relevant to managers. *Ecosphere* 10(9):e02854
- Twit, S.J., & Houston, K.E. (1980). Grassland and shrubland habitat types of the Shoshone National Forest. USDA Forest Service Shoshone National Forest, Cody, WY, 143 pp.
- USDA. (1989). Identification characteristics of major sagebrush taxa and species adapted to areas inhabited by each. Habitat Express.
- USFS. (1984). A Riparian Area Handbook (Forest Service Handbook 2905.23). Albuquerque, NM: Forest Service Southwestern Region.
- USFS. (1984). Terrestrial ecosystem survey, Globe Ranger District (eastern portion), Tonto National Forest. Albuquerque, NM: Forest Service Southwestern Region.
- USFS. (1986). Terrestrial Ecosystem Survey Handbook. Albuquerque, NM: Forest Service Southwestern Region.
- USFS. (1995). Terrestrial Ecosystem Survey of the Coconino National Forest. Albuquerque, NM: Forest Service Southwestern Region.
- USFS. (1986). Forest and woodland habitat types (plant associations) of southern New Mexico and central Arizona (north of the Mogollon Rim). USDA Forest Service Southwestern Region, Albuquerque, NM, 2nd edition, 140 pp. + insert.
- USFS. (1987 a). Forest and woodland habitat types (plant associations) of northern New Mexico and northern Arizona. USDA Forest Service Southwestern Region, Albuquerque, NM, 2nd edition, 170 pp. + insert.
- USFS. (1987 b). Forest and woodland habitat types (plant associations) of Arizona south of the Mogollon Rim and southwestern New Mexico. USDA Forest Service Southwestern Region, Albuquerque, NM, 2nd edition, 168 pp. + insert.
- Uchytel, R.J. (1991). *Abies concolor*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula,

MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.

Uchytil, R.J. (1991). *Abies lasiocarpa*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.

Uchytil, R.J. (1990). *Acer grandidentatum*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.

Uchytil, R.J. (1988a). *Andropogon gerardii* var. *paucipilus*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.

Uchytil, R.J. (1988b). *Hilaria mutica*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.

Uchytil, R.J. (1991). *Picea engelmannii*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.

Uchytil, R.J., & Crane, M. (1991). *Pseudotsuga menziesii* var. *glauca*. In W.C. Fischer (compiler), The Fire Effects Information System [Database], Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.

USNVC [United States National Vegetation Classification]. 2019. United States National Vegetation Classification Database, V2.03. Federal Geographic Data Committee, Vegetation Subcommittee, Washington DC. [usnvc.org]

- Van Devender, T.R., Betancourt, J.L., & Wimberly, M. (1984). Biogeographic implications of a packrat midden sequence from the Sacramento Mountains, south-central New Mexico. *Quaternary Res.*, 22, 344-360.
- Vander Kloet, S.P., & Hall, I.V. (1981). The biological flora of Canada. 2. *Vaccinium myrtilloides* Michx., velvet-leaf blueberry. *Canadian Field Naturalist*, 95, 329-345.
- Volland, L.A. (1989, February). Development of forage rating guides for monitoring rangeland condition and trend. In D.E. Ferguson, P. Morgan, & F.D. Johnson (compilers), *Proceedings-Land Classifications Based on Vegetation: Applications for Resource Management Vol. General Technical Report INT-257*, Moscow, ID, 1987, November 17 (pp. 154-159). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Wagner, W.L. (1977). Floristic affinities of Animas Mountain, Southwestern New Mexico. Unpublished doctoral dissertation, Univ. of New Mexico, Albuquerque, NM.
- Walkup, C.J. (1991). *Mahonia repens*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Wallmo, O.C. (1955). Vegetation of the Huachuca Mountains, Arizona. *Amer. Midl. Nat.*, 54, 466-480.
- Walsh, R.A. (1995). *Muhlenbergia montana*. In W.C. Fischer (compiler), *The Fire Effects Information System [Database]*, Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory.
- Warren, P.L., Reichhardt, K.L., Mouat, D.A., Brown, B.T., & Johnson, R.R. (1982). Vegetation of Grand Canyon National Park (Technical Report 9, iv) (Coop. National Park Resource Studies Unit). Tucson, AZ: Univ. of Arizona.

- Weaver, H. (1951, February). Fire as an ecological factor in the southwestern ponderosa pine forests. *Journal of Forestry*, 93-98.
- Welch, B., Briggs, S., & Young, S. (1994). Pine Valley Ridge source - a superior selected germplasm of black sagebrush (Research Paper INT-RP-474).  
Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Welch, B.L., McArthur, E.D., Nelson, D.L., Pederson, J.C., & Davis, J.N. (1986). "Hobble Creek"—a superior selection of low-elevation mountain big sagebrush (Research Paper INT-370). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Welch, B.L., Nelson, E.D., Young, S.A., Sands, A.R., Wagstaff, F.J., & Nelson, D.L. (1992). "Gordon Creek"—a superior tested germplasm of Wyoming big sagebrush (Research Paper INT-461). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Wellner, C.A. (1989, February). Classification of habitat types in the Western United States. In D.E. Ferguson, P. Morgan, & F.D. Johnson (compilers), *Proceedings-Land Classifications Based on Vegetation: Applications for Resource Management Vol. General Technical Report INT-257*, Moscow, ID, 1987, November 17 (pp. 7-21). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Wells, P.V. (1970). Post glacial vegetation history of the Great Plains. *Science*, 167, 1574-1584.
- Wentworth, T.R. (1981). Vegetation on limestone and granite in the Mule Mountains, Arizona. *Ecology*, 62, 469-482.
- Wentworth, T.R. (1985). Vegetation on limestone in the Huachuca Mountains, Arizona. *Southwest Naturalist*, 30, 385-395.
- West, N.E., & Van Pelt, N.S. (1987). Successional patterns in pinyon-juniper woodlands. In: R.L. Everett (compiler),



Proceedings—Pinyon-Juniper Conference Vol. General  
Technical Report INT-215, Reno, NV, 1986, January 13  
(pp. 43-52). Ogden, UT: USDA Forest Service  
Intermountain Forest and Range Experiment Station.

White, R.S., & Currie, P.O. (1981). Prescribed burning in  
northern mixed-grass prairies. In Field Day Proceedings  
(pp. 40-43). Miles City, MT: Livestock and Research  
Station.

Whittaker, R.H., & Niering, W.A. (1965). Vegetation of the  
Santa Catalina Mountains, Arizona: a gradient analysis  
of the south slope. *Ecology*, 46, 429-452.

Whittaker, R.H., & Niering, W.A. (1968). Vegetation of the  
Santa Catalina Mountains, Arizona. IV. Limestone and  
acid soils. *J. Ecol.*, 56, 523-544.

Whittaker, R.H., & Niering, W.A. (1975). Vegetation of  
the Santa Catalina Mountains, Arizona. V. Biomass,  
production, and diversity along the elevation gradient.  
*Ecology*, 56, 771-790.

Willing, R.C. (1987). Status, distribution, and habitat use of  
Gould's turkey in the Peloncillo Mountains, New Mexico.  
Unpublished masters thesis, New Mexico State Univ., Las  
Cruces, NM.

Windell, J.T., Willard, B.E., Cooper, D.J., Foster, S.Q., Knud-Hansen,  
C.F. et al. (1986). An ecological characterization of Rocky Mountain  
montane and subalpine wetlands. U.S. Government Printing Office,  
Washington, DC: USDI Fish & Wildlife Service Biological Report  
86, xxi, 298 pp.

Winward, A.H., McArthur, E.D., Kaffer, D.A., Plummer, C.A.,  
& Brackley, G.A. (1986). Another sagebrush in Nevada  
(Technical Notes TN-RANGE NV- 44). USDA, Nevada  
Soil Conservation Service.

Winward, A.H., & Padgett, W.G. (1989, February). Special  
considerations when classifying riparian areas. In D.E.  
Ferguson, P. Morgan, & F.D. Johnson (compilers),  
Proceedings-Land Classifications Based on Vegetation:  
Applications for Resource Management Vol. General

- Technical Report INT- 257, Moscow, ID, 1987, November 17 (pp. 176-179). Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Winthers, E., D. Fallon, J. Haglund, T. DeMeo, G. Nowacki, D. Tart, M. Ferwerda, G. Robertson, A. Gallegos, A. Rorick, D.T. Cleland, and W. Robbie. 2005. Terrestrial Ecological Unit Inventory technical guide: Landscape and land unit scales. USDA Forest Service Gen. Tech. Report W0-68. Washington Office, Ecosystem Management Coordination Staff, Washington DC. 245 pp.
- Wood, M.K., & LaFayette, R.A. (1993). New Mexico's riparian areas. *New Mexico Wildlife*, 38(2), 20-26.
- Woodin, H.E., & Lindsey, A.A. (1954). Juniper-Pinyon east of Continental Divide, as analysed by the line-step method. *Ecology*, 35, 473-489.
- Wright, H.A., & Bailey, A.W. (1980). Fire ecology and prescribed burning in the Great Plains: a research review. Vol. General Technical Report INT- 77, Ogden, UT: USDA Forest Service Intermountain Forest and Range Experiment Station.
- Youngblood, A.P., & Mauk, R.L. (1985). Coniferous forest habitat types of central and southern Utah (General Technical Report INT-187). Ogden, UT: Intermountain Forest and Range Experiment Station, USDA Forest Service.
- Youngblood, A.P., Padgett, W.G., & Winward, A.H. (1985). Riparian community type classification of eastern Idaho-western Wyoming. USDA Forest Service Intermountain Region, R4-EC01-85-01.

# Photos (some associations)

Oneseed Juniper/Blue Grama (Juniper Grass ERU)



Emory Oak/Sideoats Grama (Madrean Encinal Woodland ERU)



Twoneedle Pinyon/Alderleaf Mountain Mahogany (Madrean Pinyon-Oak ERU)



Twoneedle Pinyon /Pointleaf Manzanita (PJ Evergreen Shrub)





Twoneedle Pinyon/Gambel Oak (PJ Deciduous Shrub ERU)



Twoneedle Pinyon /Blue Grama (PJ Grass ERU)



Emory Oak/Sideoats Grama (Madrean Encinal Woodland ERU)

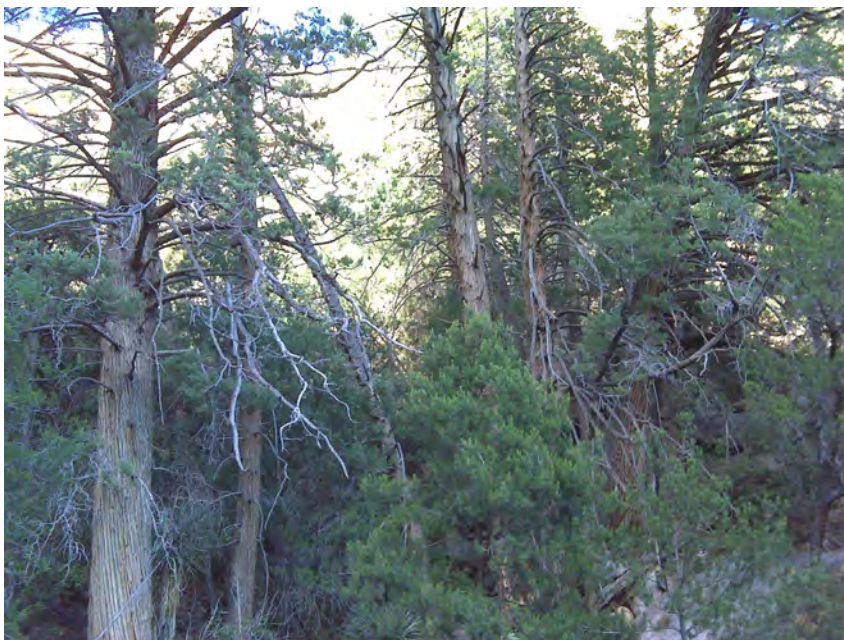


Border Pinyon/Toumey Oak (Madrean Pinyon-Oak ERU)





Arizona Cypress/Silverleaf Oak (Madrean Pinyon-Oak ERU)



Twoneedle Pinyon/Big Sagebrush (PJ Sagebrush ERU)

