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Plant Associations of Arizona and New Mexico

Edition 4

Volume 1: Forests

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Contents

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 monophyla*, 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, caulesent 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 27 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 Terretrial 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 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 (*). Spe-

cies are ordered according to overall importance throughout the range of the plant association, but the occurence 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 the typical TES climate class are given. 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.

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. *coahulensis*)
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 Chihuahua 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. emoryii, 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,** Vol. 2 page 249.
10. Woodlands of slopes <40% or soils not as described above...11
11. Evergreen oaks (Quercus grisea, Q. oblongifolia, Q. emoryii, 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 131.
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 menzensii); but subalpine fir (Abies lasiocarpa) is minor, if present.....12

10. Whortleberry (Vaccinium myrtillus) is present, often well presented; skunkleaf poleminum (Polemonium pulcherrimum ssp. delicatum) is also present .....**PIEN/VAMY2-POPUD3, PIEN phase**, page 81.
10. Whortleberry (Vaccinium myrtillus) is absent; skunkleaf poleminum (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 81.
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 <u>not</u> 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 menzensii) 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 stansburyiana) 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 stansburyiana), 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 menzensii), 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 xx.
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 toumeyi) 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. Manzantia 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 104.
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 stansburyiana) 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 stansburyiana) 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 (Psorothamnus 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; Guadelupe Mountains....**JUDE2/MUEM**, page 189.
20. Bullgrass absent or scarce....21
21. True mountain mahoghany (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

Engelmann Spruce Series

PIEN/ACGL

Engelmann spruce/Rocky Mountain maple
Picea engelmannii/Acer glabrum

Code(S)
typic phase 0 04 30 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Lower (SFM)

National Vegetation Classification Group
Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland (G218)

Key criteria
***Engelmann spruce** present, with Douglas-fir as the most important codominant. Rocky Mountain maple is usually present in the understory. Ponderosa pine is an accidental tree in early seral stages of succession.

Structure
Scattered to moderately dense overstory containing Engelmann spruce, Douglas-fir, white fir, southwestern white pine and aspen; principally co-dominated by spruce and Douglas-fir. Stockability = 1. The understory is commonly moderately stocked with young and advanced regeneration of spruce, Douglas-fir and white pine.

Productivity is low to moderate. No site index data available.

Location

Disjunct outliers of Engelmann spruce found on sheltered, cold lower slopes in Hubbell and Sacramento Canyons of the Sacramento Mountains of New Mexico and on the high north and east-facing slopes on the Chiricahua Mountains of Arizona; at elevations ranging from 8,900 to 9,500’ (2,710 to 2,900 m); also may occur on wetter sites in the Pinaleno Mountains, Arizona. May also occur in the White Mountains

of eastern Arizona. Mean annual precipitation (MAP) = 33-34”/year; mean annual soil temperature (MAST) = 40-41 degrees F.

Adjacent plant associations

Borders ABCO/ACGL, ABCO/MARE on warmer sites and PIEN/Moss on cooler upper slopes.

Also see
PIEN/Moss (USFS 1986a) if herbs and shrubs become sparse on drier sites. Closely resembles ABLA/Moss except for absence of subalpine fir. ABLA/ACGL of the central and northern Rocky Mountains and Basin and Range is very distinctive and not to be confused with these southern outlier PIEN/ACGL stands. PIEN/ACGL is on wetter sites in the Pinaleno Mountains, Arizona (Stromberg and Patten 1991).

Important and key plants from research plots
Trees & life history traits
Engelmann spruce *(Picea engelmannii) C
quaking aspen *(Populus tremuloides)* Early to Mid-seral S
Douglas-fir *(Pseudotsuga menziesii)* c
white fir *(Abies concolor)* c
southwestern white pine *(Pinus strobiformis)* s

Shrubs
Well represented (>5% cover)**:**
Rocky Mountain maple *(Acer glabrum)*
mountain ninebark *(Physocarpus monogynus)*
thimbleberry *(Rubus parviflorus)*
rockspirea *(Holodiscus dumosus)*
fivepetal cliffbush *(Jamesia americana*)
sidebells wintergreen *(Orthilia secunda)*
Arizona honeysuckle *(Lonicera arizonica)*

Herbs
Well represented (>5% coverage)**:**
fringed brome *(Bromus ciliatus)*
ravine fescue *(Festuca sororia)*
Canadian white violet *(Viola canadensis)*
starry false lily of the valley *(Maianthemum stellatum)*
Porter’s licorice-root *(Ligusticum porteri)*

western brackenfern *(Pteridium aquilinum)*
spike trisetum (*Trisetum spicatum*)
sprucefir fleabane *(Erigeron eximius)*
nodding ragwort *(Senecio bigelovii)*
Parry's goldenrod *(Oreochrysum parryi)*
Virginia strawberry (*Fragaria virginiana* var *virginiana)*
ragweed sagebrush *(Artemisia franserioides)*
woodland strawberry *(Fragaria vesca)*
burnet ragwort *(Packera sanguisorboides)*
Fendler's meadow-rue *(Thalictrum fendleri)*
Nevada pea (Lathyrus lanszwertii var leucanthus)

Brief plant ID notes
Rocky Mountain maple is a shrub or small tree with reddish brown twigs and leaves that are opposite, 3-5" long with long, red leafstalks. The leaf blades are 3- or 5- lobed, lobes sharply short-pointed, edges doubly saw-toothed, or some or all deeply divided into 3 lance-shaped leaflets: shiny dark green above and paler beneath.

Synonymy
sidebells wintergreen *(Orthilia secunda = Ramischia secunda = Pyrola secunda)*
Nevada pea *(Lathyrus lanszwertii* var *leucanthus = L. lanszwertii var arizonica = L. arizonica* aka Arizona peavine*)*
starry false lily of the valley *(Maianthemum stellatum = Smilacina stellata),* aka starry false Solomon's seal
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
Parry's goldenrod *(Oreochrysum parryi = Haplopappus parryi = Oreochrysum parryi)*
Virginia strawberry *(Fragaria virginiana var virginiana)* = wild strawberry *(F. ovalis)*
burnet ragwort *(Packera sanguisorboides = Senecio sanguisorboides)*
woodland strawberry *(Fragaria vesca = Fragaria americana)*
fringed brome *(Bromus ciliata var. ciliata = B. canadensis* = Canadian brome)
fringed brome and Canadian brome are now both considered to be the same species
spike trisetum (*Trisetum spicatum = T. montanum* = Rocky Mountain *trisetum)*

spike trisetum and Rocky Mountain trisetum are now both considered to be one species
fivepetal cliffbush = waxflower = *(Jamesia americana)*
Porter's licorice-root *(Ligusticum porteri) = oshá*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: -1 (warm, dry)
Climate Class: LSC (low sun cold)

Reforestation
This minor plant association is of interest primarily due to low elevation occurrence of Engelmann spruce at its southernmost limit in North America. Engelmann spruce is more likely to regenerate than true fir following clearcutting and group selection because of the former's ability to withstand more severe environmental conditions. Rocky Mountain maple and aspen may sprout/sucker following overstory removal. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance. Shelterwood and individual tree selection generally favor more shade tolerant associates such as subalpine fir. Seed tree method is not usually successful for tree regeneration due to the susceptibility of Engelmann spruce and subalpine fir to windthrow.

Engelmann spruce and Douglas-fir can be planted in this association with a high probability for survival. Tree planting success can be enhanced by mechanical site preparation. Burning at high and moderate intensities initially favors natural aspen regeneration.

Thinning of younger individuals and selected species may be used to reduce stocking and improve species composition.

Revegetation considerations
Natural revegetation is usually rapid due to sprouting of aspen and shrubs.

Comments
These sites are excellent snow catchment areas for regulated water flow at lower elevations; moderate winter snowpack; important for snow retention.

Localized stands in valleys and road corridors add to landscape diversity. Some stands have potential for aspen management.

The resource value rating for cattle is moderate for early seral stages and none for late seral.

This plant association provides effective thermal and hiding cover and a good mix of browse plants for wildlife.

Often many management options are available for this plant association, so clear objectives should be defined prior to any management activity including timber harvest.

Muldavin found soils in southeastern Arizona were commonly Dystric Cryochrepts. (Muldavin *et al*. 1996).

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)

Alexander *et al.* 1984a
Alexander 1988
Muldavin *et al*. 1996
Stromberg and Patten 1991
USFS 1986, USFS 1987a, Uchytil 1991

Engelmann spruce/sprucefir fleabane

(Formerly: Engelmann spruce/Forest fleabane PIEN/EREX)

Picea engelmannii/Erigeron eximius

Synonyms
Picea pungens-P. Engelmannii/Erigeron superbus (Moir and Ludwig 1979).

Code(S)
typic phase 0 04 31 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Lower (SFM)

National Vegetation Classification Group
Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland (G218)

Key criteria
***Engelmann spruce** and Douglas-fir are climax dominants. Other mixed conifer species are present as minor climax and/or seral trees. Herbage coverage ranges from 19 to 102%. Sprucefir fleabane is present along with other dominant forbs. Ponderosa pine and subalpine fir may be accidental species.

Structure
The overstory is a moderate to dense cover of mixed coniferous trees. Engelmann spruce and Douglas-fir co-dominate. White fir and southwestern white pine are sometimes abundant as reproduction but never in larger size classes. Subalpine fir is also present as reproduction, but rarely as a mature tree. Blue spruce can be present throughout the elevation range of most slopes and aspects. Stands without blue spruce mostly occur on steep northeast-facing mid to upper slopes above 9,000 feet (2743 m). Where blue spruce is absent, graminoids cover = <14%, forb cover = <30%, and total herb cover = <45%. Also, on gentle slopes sprucefir fleabane increases to 20% cover. Where blue spruce is a minor climax tree, herbaceous cover is greater in all three categories. (Fitzhugh *et al.* 1987).

Mathiasen *et al.* (1986) reported a mean site index for Douglas-fir of 76.2 +/-17.0 (N = 28 stands). Stockability = 1.

Location
This type occurs on gentle to steep slopes on all aspects; also lower slopes of canyon drainages; elevations range from 8,850 [>8,100' in canyons] to 10,000' (2,655 to 3,000 m); widespread throughout mountains from central Arizona to southwestern and central New Mexico into the Jemez Mountains of northern New Mexico and into southern Colorado.

Adjacent plant associations
In White Mountains, moister sites support PIEN/SECA while PSME/BRCI may be intermixed. Other stands at lower elevations and drier sites may support ABCO/MUVI, PIPU/FEAR, ABCO/Sparse or PIPU/EREX4.

Also see
ABLA/EREX4 if subalpine fir has common reproduction and is surviving. ABCO/EREX4 or ABCO/ACGL if blue spruce is minor as regeneration relative to white fir and Douglas-fir in mature stands. PIPU/EREX4 .

Important and key plants from research plots
Trees & life history traits
***Engelmann spruce** C Douglas-fir *(Pseudotsuga menziesii)* C
quaking aspen *(Populus tremuloides)*
[early to mid-seral] S white fir (*Abies concolor)* c
blue spruce *(Picea pungens)* s
southwestern white pine *(Pinus strobiformis)* [south] s
limber pine *(Pinus flexilis)* [north] s

Shrubs
Poorly represented (<5% cover)**:**
thimbleberry *(Rubus parviflorus)*
Rocky Mountain maple *(Acer glabrum)*
mountain ninebark *(Physocarpus monogynus)*

Herbs
Abundant (>25% cover) to luxuriant (>50% cover)**:**
fringed brome *(Bromus ciliatus)*

dryspike sedge *(Carex siccata)*
spike trisetum (*Trisetum spicatum*)
Richardson's geranium *(Geranium richardsonii)*
Nevada pea *(Lathyrus lanszwertii* var *leucanthus*)
sprucefir fleabane *(Erigeron eximius)*
nodding ragwort *(Senecio biglovii)*
starry false lily of the valley *(Maianthemum stellatum)*
Fendler's meadow-rue *(Thalictrum fendleri)*
mountain goldenbanner*(Thermopsis montana)*
Parry's goldenrod *(Oreochrysum parryi)*
bluntseed sweetroot *(Osmorhiza depauperata)*
Porter's licorice-root *(Ligusticum porteri)*
American vetch *(Vicia americana)*
Virginia strawberry (*Fragaria viginiana* var *virginiana)*
alpine false springparsley *(Pseudocymopterus montanus)*
Canadian white violet *(Viola canadensis)*
western brackenfern *(Pteridium aquilinum)*

Brief plant ID notes
Sprucefir fleabane is often difficult to identify in the field because of its short flowering season and close resemblance (basal leaves) to other species. The mix of forbs may be the most useful in recognizing this plant association.

Synonymy
sprucefir fleabane (*Erigeron eximius*) = forest fleabane (*E. superbus*)
dryspike sedge (*Carex siccata*) = fony sedge
Nevada pea (*Lathyrus lanszwertii* var *leucanthus = L. lanszwertii* var *arizonica = L. arizonica* aka Arizona peavine)
starry false lily of the valley (*Maianthemum stellatum = Smilacina stellata*), aka starry false Solomon's seal
mountain goldenbanner (*Thermopsis montana = Thermopsis rhombifolia* var. *montana*), aka mountain thermopsis
Parry's goldenrod (*Oreochrysum parryi = Haplopappus parryi = Oreochrysum parryi*)
bluntseed sweetroot *(Osmorhiza depauperata)* = sweetcicily *(O. obtusa)*
Virginia strawberry (*Fragaria virginiana* var *virginiana)* = wild strawberry *(F. ovalis)*

spike trisetum (*Trisetum spicatum* = *T. montanum* = Rocky Mountain trisetum
spike trisetum and Rocky Mountain trisetum are now both considered to be one species
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
Porter's licorice-root *(Ligusticum porteri) = oshá*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: 0 (typical)
Climate Class: LSC (low sun cold)

Fire ecology
Fire scars at bases of some trees indicated ground fires have occurred in some stands. Extensive aspen stands are probably the results of past "stand replacement" fires.

Reforestation
Cutting will probably favor Douglas-fir at the expense of both spruces (Muldavin *et al.* 1996). Heavy removal of overstory will first favor aspen followed by in-seeding of Douglas-fir and spruce. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance. Engelmann spruce regenerates readily under cover. Experience has demonstrated that logging has resulted in establishment of white fir, western brackenfern and dryspike sedge (Fitzhugh *et al*. 1987.)

Engelmann spruce and Douglas-fir seedlings have a high probability for survival. Most site preparation can enhance tree survival; however, high intensity mechanical methods are usually detrimental because of establishment of sod forming sedges and western brackenfern.

Revegetation considerations
Natural revegetation is usually rapid due to rich herbaceous cover and presence of aspen.

Comments
Forage resource value rating for cattle in early seral conditions is high, and in late seral is medium to low.

High cover and forage values make this excellent habitat for wildlife.

This type can have high scenic potential when adjoining meadows, trails, or roads. It has potential for aspen management and is important for snow retention. Locations along drainages enhance the importance of this plant association for watershed and fisheries management.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)

Fitzhugh *et al.* 1987
Mathiasen *et al.* 1986
Muldavin *et al.* 1996
USFS 1986
USFS 1987a

Engelmann spruce/Ross' avens

(Formerly: Engelmann spruce/Alpine avens PIEN/GERO2)

Picea engelmannii/Geum rossii

Code(s)
typic phase 0 04 33 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Lower (SFM)

National Vegetation Classification Group
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

Key criteria
Characterized by nearly pure stands of ***Engelmann spruce**. Where present, the herbaceous cover is dominated by ***Ross' avens.** Subalpine fir may be an accidental species.

Structure
Overstory is nearly pure Engelmann spruce. No site index information is available. Stockability = 1.

Location
This type occurs on north-facing high mountain slopes where moist soils often remain snow-covered until June. Elevations range from 10,500' to timberline (3,150 to 3,420 m). Known from San Francisco Peaks, near Flagstaff, Arizona.

Adjacent plant associations
Adjoining type below is PIEN/Moss; above are Krummholtz communities; windswept PIEN, PIAR.

Also see
PIEN/RIMO (Youngblood and Mauk, 1985) if herbs are poorly represented (<5% cover). PIEN/GERO is below and distinct from Krummholz where Engelmann spruce is shrubby because of tundra climate.

Important and key plants from research plots
Trees & life history traits
***Engelmann spruce** (*Picea engelmannii)* C
bristlecone pine *(Pinus aristata)* s

Shrubs
Scarce (<1% cover) to common (>1% cover)**:** gooseberry currant *(Ribes montigenum)*
twinberry honeysuckle (Lonicera involucrata)

Herbs
Well represented (>5%)**:**

***Ross' avens** *(Geum rossii* var. *turbinatum)*
skunkweed polemonium
(Polemonium pulcherrimum var *delicatum)*
spike trisetum (*Trisetum spicatum)*
golden columbine *(Aquilegia chrysantha)*
alpine fescue *(Festuca brachyphylla* ssp *brachyphylla)*
Franciscan bluebells (*Mertensia franciscana)*
single delight *(Monesis uniflora)*

Cryptogams
Well represented (>5% coverage) especially lichens and minute mosses.

Brief plant ID notes
Ross' avens occurs in dense clumps having many pinnately-divided basal leaves. One to four yellow flowers bloom in June and July on simple stems reaching from 8-20 cm high. This species is easily confused with the similar yellow-flowered cinquefoils (*Potentilla* ssp.); however, most high elevation cinquefoils, except sheep cinquefoil *(Potentilla ovina*), have palmately compound leaves. Sheep cinquefoil is prostrate (5 - 15cm tall), has pinnate leaves and an open inflorescence of 3 to 7 flowers.

Synonymy
Ross' avens (*Geum rossii* var. *turbinatum = Acomastylis rossii*)
skunkweed polemonium (Polemonium pulcherrimum ssp delicatum) = Jacob's ladder (Polemonium delicatum)
spike trisetum *(Trisetum spicatum = T. montanum = Rocky Mountain trisetum)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: +1 (cool, moist)
Climate Class: LSC (low sun cold)

Fire ecology
No information on fire ecology was available for this type.

Reforestation
PIEN/GERO4 plant association is within the San Francisco Peaks Research Natural Area (SFPRNA). The SFPRNA is reserved for research. Road access and logging are not permitted.

Revegetation considerations
PIEN/GERO2 is at upper elevational forest limit which coincides with 12-degree Centigrade June isotherm; thus, providing a very short growing season for trees. (USFS 1987a). Natural revegetation following disturbance was found to be slow to moderate.

Comments
Areas supporting this plant association typically receive heavy snow accumulations. These areas are some of the most productive watersheds and are very important for snow retention.

The association adjoins the forest-alpine tundra ecotone, where recreation values are likely to be very high.

Resource value rating for cattle in the early seral stages is low, and in late seral stages is none.

The location of forest near the high summits of the San Francisco Peaks also confers spiritual significance to Native Americans.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)
USFS 1987a
Rominger and Paulik 1983

Engelmann spruce/beardless wildrye
Picea engelmannii/Leymus triticoides

(Formerly: Picea engelmannii/Elymus triticoides)

Code(S)
typic phase 0 04 32 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Lower (SFM)

National Vegetation Classification Group
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

Key criteria
***Engelmann spruce** present with Douglas-fir as the most important codominant. Subalpine fir varies from absent to codominant. Shrubby undergrowth provides varying densities from 2 to 23%. ***Beardless wildrye** may provide up to 20% of canopy cover within the stand.

Structure
The overstory is moderately dense with Engelmann spruce and Douglas-fir being codominant. Subalpine fir may or may not be present in the overstory but is represented as young and advanced regeneration. Productivity is moderate; stockability is 1. Reported site index for Engelmann spruce is 72 and for Douglas-fir is 63. The resource value rating for cattle in early seral is moderate; late seral is none due to low density forb cover.

Location
This minor plant association is known from the uppermost elevations (>9,900'; 2,970 m) of the Capitan Mountains, New Mexico. Soils are very cobbly. Mean annual precipitation (MAP) = 29 inches per year.

Adjacent plant associations
Ecotones with ABCO/ACGL.

Also see
Scree forests.

Important and key plants from research plots
Trees & life history traits
***Engelmann spruce** *(Picea engelmannii)* C
Douglas-fir (*Pseudotsuga menziesii*) S
subalpine fir (*Abies lasiocarpa*) c
quaking aspen (*Populus tremuloides*) [early to mid-seral] s
southwestern white pine *(Pinus strobiformis)* s

Shrubs
Common (>1% cover) to abundant (>25% cover)**:**
fivepetal cliffbush *(Jamesia americana*)
rockspirea *(Holodiscus dumosus)*
Rocky Mountain maple *(Acer glabrum)*
Wolf's currant *(Ribes wolfii)*
orange gooseberry *(Ribes pinetorum)*
sidebells wintergreen *(Orthilia secunda)*

Herbs
Scarce (<1% cover) to common (>1% cover)**:**
***beardless wildrye** *(Leymus triticoides)*
fringed brome *(Bromus ciliatus)*
spike trisetum *(Trisetum spicatum*)
sprucefir fleabane *(Erigeron eximius)*
woodland strawberry *(Fragaria vesca)*

Cryptogams
Common (>1% cover) to abundant (>25% cover), especially on sites without litter; also as epiphytes on conifers.

Brief plant ID notes
Beardless wildrye is a native perennial grass with slender, creeping rhizomes and leaf blades with clasping auricles (extensions of the leaf blade which wrap around the culm at the node).

Synonymy
subalpine fir (*Abies lasiocarpa* var. *arizonica = A. arizonica*)
beardless wildrye (*Leymus triticoides = Elymus triticoides*)
sprucefir fleabane (*Erigeron eximius*) = forest fleabane (*E. superbus*)
woodland strawberry (*Fragaria vesca = Fragaria americana*)

spike trisetum (*Trisetum spicatum = T. montanum* = Rocky Mountain trisetum)
spike trisetum and Rocky Mountain trisetum are now both considered to be one species
sidebells wintergreen (*Orthilia secunda = Ramischia secunda = Pyrola secunda*)
fivepetal cliffbush = waxflower = (*Jamesia americana*)
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: -1 (warm, dry)
Climate Class: LSC (low sun cold)

Fire ecology
If burned, stands are likely to regenerate in aspen with Engelmann spruce remnants (Jack Carpenter, pers. comm.).

Reforestation considerations
Severe overstory removal (such as clearcuts and seedtree cuts) results in microenvironments too dry and exposed for establishment of Engelmann spruce. Aspen (a minor seral species) may become established in clumps or patches where sufficient healthy rootstocks exist prior to disturbance. Further, seed trees often blow down before providing seed to regenerate the stand. Shelterwood and selection cutting methods are more often successful for natural tree regeneration.

Success probability for planting of Engelmann spruce is moderate to low. Site preparation using burning is detrimental for Engelmann spruce, although moderate to low intensity mechanical methods may improve spruce survival.

Measures to reduce stocking levels or improve species mix are usually not necessary.

Revegetation
Natural revegetation is slow.

Comments
Many stands in Capitan Wilderness are in old-growth condition although recent fires have changed much of this landscape.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References

Alexander *et al*. 1984a
USFS 1986

Engelmann spruce/Moss
Picea engelmannii/Moss

Synonyms
Abies lasiocarpa-Picea engelmannii/Moss (Johnston 1987)

Code(s)
typic phase 0 04 06 0
typical or Engelmann spruce
(PIEN) phase 0 04 06 1
interior Douglas-fir
(PSME) phase 0 04 06 2

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Lower (SFM)

National Vegetation Classification Group
Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland (G218) (primary)
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

Key criteria
***Engelmann spruce** dominates overstory. Douglas-fir may or may not have a codominant role. Subalpine fir is minor or absent. The prominent feature is the sparse undergrowth and the ***moss** cover.

Structure
Overstory provides dense cover often to the exclusion of herbaceous cover beneath. In openings forbs/shrubs are expected to increase. Engelmann spruce is the climax dominant. In the typical phase, subalpine fir may or may not be a codominant and is usually absent in the interior Douglas-fir phase. Aspen is a seral tree being sporadically scattered throughout the overstory. Spruce and occasionally subalpine fir regeneration densities range from moderate to heavy.
Stockability = 1.

The forest floor is very sparsely covered by shrubs and herbs. Cryptogams dominate; highly variable cover is dependent on distribution of exposed rocky soil verses litter accumulation. Site quality for Engelmann spruce is poor to very poor. In the interior Douglas-fir phase, site productivity is low.

Location
Mountain summits, ridges, or upper slopes on any aspect. Slopes vary from gentle to steep; cold, dry sites. Elevations range from 9,800' to 11,500' (2,990 to 3,500 m) on Mount Taylor and San Francisco Peaks and the San Mateo, Mogollon, Sangre de Cristo, San Juan, Pinaleno, Chiricahua Mountains.

Adjacent plant associations
PIEN/Moss is bordered by ABLA/VAMY on more sheltered, wetter sites; by PSME/FEAR2 on ridgetops; and by ABCO/ACGL on lower slopes. In northern NM, other ecotones occur with PIEN/VAMY/POPU and dry meadows. On San Francisco Peaks, look for association with PIEN/GERO2 and ABLA/LALA; in the Pinaleno Mountains are ecotones with ABLA/VAMY2, PIEN/CAFO and dry meadows; on Mount Taylor PIEN/Moss occurs above ABLA/VAMY and is often adjacent to dry meadows.

Also see
ABLA/Moss has subalpine fir. If whortleberry is common, see PIEN/VAMY or PIEN/VAMY-POPU.

Important and key plants from research plots
Trees & life history traits
Typical phase: San Juan, Pinaleno, and Sangre de Cristo Mountains, Mount Taylor and San Francisco Peaks; 10,000 -11,500 feet:
Engelmann spruce *(Picea engelmannii)* C
subalpine fir *(Abies lasiocarpa* var. *arizonica)* c
quaking aspen *(Populus tremuloides)* s
Douglas-fir *(Pseudotsuga menziesii)* s
southwestern white pine *(Pinus strobiformis)* s
Interior Douglas-fir phase: Black Mountain (Mogollons) and San Mateo Mountains; 9,500 - 10,000 feet (2,895 - 3,050 m); Chiricahua Mountains >9300 feet (>2,835 m)
Engelmann spruce *(Picea engelmannii*) C

subalpine fir *(Abies lasiocarpa* var. *arizonica)* c
Douglas-fir *(Pseudotsuga menziesii)* s
southwestern white pine *(Pinus strobiformis)* s
quaking aspen *(Populus tremuloides)* s
white fir *(Abies concolor)* s

Shrubs
Scarce (<1% cover)**:**
grouse whortleberry *(Vaccinium scoparium)*
whortleberry *(Vaccinium myrtillus)*
dwarf bilberry *(Vaccinium cespitosum)*
twinberry honeysuckle *(Lonicera involucrata)*
orange gooseberry *(Ribes pinetorum)*
gooseberry currant *(Ribes montigenum)*
Utah honeysuckle *(Lonicera utahensis)*
Rocky Mountain maple *(Acer glabrum)*
fivepetal cliffbush *(Jamesia americana)*
sidebells wintergreen *(Orthilia secunda)*

Herbs
Scarce (<1% cover), but may include**:**
fireweed *(Epilobium angustifolium* ssp *angustifolium)*
alpine false spirngparsley *(Pseudocymopterus montanus)*
Virginia strawberry *(Frageria virginiana* ssp *virginiana)*
sprucefir fleabane *(Erigeron eximius)*
American vetch *(Vicia americana)*
Nevada pea *(Lathyrus lanszwertii* var. *leucanthus*)
thistle *(Circium* spp.)
starry false lily of the valley *(Maianthemum stellatum)*
golden columbine *(Aquilegia chrysantha)*
owl's-claws *(Hymenoxys hoopesii)*
elkweed *(Frasera speciosa)*

Cryptogams
Well represented (>5% cover) on microsites without litter.

Brief plant ID notes
Moss cover is the only prominent feature of the undergrowth.

Synonymy
subalpine fir (*Abies lasiocarpa* var. *arizonica = A. arizonica = A. bifolia*)
sidebells wintergreen (*Orthilia secunda = Ramischia secunda = Pyrola secunda*)
Nevada pea (*Lathyrus lanszwertii* var *arizonicus = Lathyrus arizonica*)
owl's-claws (*Hymenoxys hoopesii*) = owl's-claws (*Dugaldia hoopesii*) = orange sneezeweed (*Helenium hoopesii*)
sprucefir fleabane (*Erigeron eximius*) = forest fleabane (*E. superbus*)
Virginia strawberry (*Fragaria virginiana var virginiana*) = wild strawberry (*F. ovalis*)
starry false lily of the valley (*Maianthemum stellatum = Smilacina stellata*), aka starry false Solomon's seal
elkweed (*Frasera speciosa*) = green gentian (*Swertia radiata*)
fivepetal cliffbush = waxflower = (*Jamesia americana*)
fireweed (*Chamerion angustifolium* spp. *angustifolium = Epilobium angustifolium* ssp *angustifolium*)

Terrestrial Ecological Unit attributes
Life zone class: 7 (subalpine forest)
Elevation Subzone: 0 (typical) typical and Douglas-fir phases
-1 (warm, dry) Douglas-fir phase
Climate class: LSC (low sun cold)

Phases
Two phases are recognized: typical and interior Douglas-fir. These are geographic variations rather than actual phases. The following "phases" are based on compilations from available references:

Typical Phase: High elevation (> 10,000 feet [>3,048 m]), cold slopes with Engelmann spruce occurring in all sizes and dominating overstory; moderate to heavy regeneration of subalpine fir, but mature sizes less frequent. Douglas-fir is of minor importance as a seral tree. This phase is known from San Francisco Peaks and the Pinaleno Mountains in Arizona, and Sangre de Cristo and San Juan Mountains of New Mexico and Colorado, respectively.

Interior Douglas-fir Phase: comparatively warmer, dry slopes at slightly lower elevations [>9,500 feet (>2896 m)]; Engelmann spruce as climax dominant and subalpine fir usually absent except on Mount

Taylor; Douglas-fir being an important seral tree. This phase is known to exist on Mount Taylor, Black Mountain (Mogollons), and San Mateo Mountains, NM; and the White and Chiricahua Mountains in Arizona.

Fire ecology
One successional pathway (See Alexander *et al.* 1987) suggests that following complete overstory removal, shrubs and graminoids would become established. At some unknown amount of time and sets of factors later, overstory colonization by aspen could occur. Later establishment of Douglas-fir beneath the aspen would provide the cooler microsite conditions needed for establishment of Engelmann spruce and subalpine fir. At lower elevations, PIEN/Moss post disturbance succession begins with an aspen-Douglas-fir community converting to a stand containing only Douglas-fir and then to late seral mixed codominance stage.

Regeneration methods
Revegetation after disturbance is slow.

Reforestation considerations
Silvicultural Cutting methods: heavy overstory removal may favor aspen if present, otherwise regeneration may be unsuccessful without extraordinary planting measures. Lesser degrees of overstory removal may be only somewhat more successful and can be expected to favor Engelmann spruce especially at higher elevations. Windthrow susceptibility may increase once a stand is opened through cutting. Selection cutting favors Engelmann spruce. **Planting**: recommended species is Engelmann spruce. Site preparation methods including burning are usually harmful or ineffective due to the severely dry nature of the habitat and particular requirements of the target species. Planting success probability is moderate to poor in large openings. In the Typical phase, where aspen is minor seral, regeneration of aspen may be patchy or clumpy following disturbance, where healthy root stock exists. It is unlikely to form a dominant cover type. In the Interior Douglas Fir phase, where aspen in a major seral species, has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance.

Revegetation Considerations

Natural revegetation is slow. Very early seral conditions may be difficult to identify due to the temporary greater cover of shrubs and forbs.

Comments

Herbage production for livestock is very limited therefore, the forage value rating for cattle is low to none.

These warm, dry sites provide bedding and shelter areas for wildlife.

References

Alexander *et al.* 1987
Fitzhugh *et al*. 1987
Moir and Ludwig 1979
Muldavin *et al*. 1996
Rominger and Paulik 1983
USFS1987a
USFS 1987b

Engelmann spruce/bittercress ragwort

(Formerly: Engelmann spruce/Cardamine groundsel——PIEN/SECA6)

Picea engelmannii/Packera cardamine

(Formerly: Picea engelmannii/Senecio cardamine——PIEN/SECA)

Code(s)
subalpine (ABLA) phase 0 04 35 0
white fir (ABCO) phase 0 04 35 1

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Lower (SFM)

National Vegetation Classification Group
Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland (G218)

Key criteria
Tree regeneration is mostly ***Engelmann spruce** and/or Subalpine fir or white fir. The combined number of stems less than 10 inches (25.4 cm) d.b.h. of Engelmann spruce and subalpine fir usually exceeds that of combined white fir and Douglas-fir by a ratio greater than 2:1. Shrubs are minor. The herbaceous layer is dominated by conspicuous patches of ***bittercress ragwort.** Subalpine fir, blue spruce and ponderosa pine may be accidental trees in this type.

Structure
The overstory is often a varied mixture of Douglas-fir and Engelmann spruce along with blue spruce, white fir and subalpine fir. Regeneration is mostly Engelmann spruce and subalpine fir or white fir. Stockability is 1. Herbaceous undergrowth is characterized by patches of bittercress ragwort or Oregon boxleaf. These sites have the highest tree diversity of all southwestern plant associations. This site is a productive environment capable of growing attractive stands of large diameter trees. Some reported site indices for Engelmann spruce average SI = 100 and Douglas-fir is 81. Mathiasen *et al.* (1986) reported a mean site

index for Douglas-fir of 91.3 +/-9.6 (N = 39 stands). PIEN/PACA34 is a very productive site for timber (John Shafer, pers. comm

Location
This type occurs on gentle to moderate slopes; subalpine fir phase occurs on north and east aspects of upper slopes and ridges; white fir phase on warmer (often lower) northerly aspects of slopes. Elevations range from 8,500' to 9,400' (2,590 to 2,865 m). Known from the vicinity of Hannagan and Thomas Creek drainages of the White Mountains and the Blue Mountains of Arizona; Bearwallow and Mogollon Mountains of New Mexico.

Adjacent plant associations
At lower elevations: ABCO/QUGA, ABCO/Sparse; at higher elevations: ABLA/EREX; also some stands may intergrade with PIPU/PACA34.

Important and key plants from research plots
Trees & life history traits
subalpine phase:
subalpine fir *(Abies lasiocarpa* var. *arizonica)* C
Engelmann spruce *(Picea engelmannii)* C
quaking aspen *(Populus tremuloides)* Early to Mid-seral S
Douglas-fir (*Pseudotsuga menziesii*) Late Seral S
southwestern white pine (*Pinus strobiformis*) s
white fir *(Abies concolor)* s
white fir phase:
Engelmann spruce *(Picea engelmannii)* C
quaking aspen *(Populus tremuloides)* Early to Mid-seral S
Douglas-fir *(Pseudotsuga menziesii)* Late Seral S
white fir *(Abies concolor)* Southwestern white pine *(Pinus strobiformis)*s
ponderosa pine *(Pinus ponderosa)* s
blue spruce *(Picea pungens)* s

Shrubs
Scarce (<1% cover) sometimes common (>1% cover)**:**
Utah honeysuckle *(Lonicera utahensis)*
thimbleberry *(Rubus parviflorus)*
sidebells wintergreen *(Orthilia secunda)*

greenflowered wintergreen *(Pyrola chlorantha)*
Oregon boxleaf *(Paxistima myrsinites)*

Herbs
Abundant (>25% coverage)**:**
***bittercress ragwort** *(Packera cardamine)*
fringed brome *(Bromus ciliatus)*
Richardson's geranium *(Geranium richardsonii)*
sprucefir fleabane (*Erigeron eximius)*
Canadian white violet *(Viola canadensis)*
Virginia strawberry *(Fragaria virginiana* ssp *virginiana)*
Wooton's ragwort *(Senecio wootonii)*
owl's-claws *(Hymenoxys hoopesii)*
western brackenfern *(Pteridium aquilinum)*
dryspike sedge *(Carex siccata)*
Nevada pea *(Lathyrus lanszwertii* var *leucanthus)*
mountain goldenbanner *(Thermopsis montana)*

Brief plant ID notes
Bittercress ragwort is a yellow flowered composite, with a clump of mostly basal, egg-shaped to circular leaves that have wavy margins. The lowest leaf is usually a small leaf with a purple underside.

Synonymy
bittercress ragwort (*Packera cardamine = Senecio cardamine* = cardamine groundsel)
sprucefir fleabane (*Erigeron eximius*) = forest fleabane (*E. superbus*)
Virginia strawberry (*Fragaria virginiana ssp virginiana = F. ovalis*)
Wooton's ragwort = Wooton's groundsel
owl's-claws (*Hymenoxys hoopesii*) = owl's-claws (*Dugaldia hoopesii*) = orange sneezeweed (*Helenium hoopesii*)
mountain goldenbanner (*Thermopsis rhombifolia var montana= Thermopsis montana*)
Nevada pea (*Lathyrus lanszwertii* var *leucanthus = L. lanszwertii* var *arizonica = L. arizonica* aka Arizona peavine)
sidebells wintergreen (*Orthilia secunda = Ramischia secunda = Pyrola secunda*)
dryspike sedge (*Carex siccata*) = fony sedge

Oregon boxleaf (*Paxistima myrsinites*) = mountain lover (*Pachystima myrsin-ites*)
fringed brome *(Bromus ciliata* var. *ciliata* = *B. canadensis* = Canadian brome *(aka B. richardsonii)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: -1 (warm, dry)
Climate Class: LSC (low sun cold)

Phases
Subalpine fir (ABLA) phase: subalpine fir has light to moderate regeneration. Utah honeysuckle occurs most often in this phase.

White fir (ABCO) phase: subalpine fir is absent or sparse, while white fir has light to moderate regeneration. Oregon boxleaf, Franciscan bluebells, and woodland strawberry are often present in the ABCO phase.

Fire ecology
Fire history is characterized by frequent, low intensity fires interspersed by larger, higher intensity surface fires. Mean annual fire interval is estimated at 22 years (Dieterich 1983). The long-term history (centuries) of such fires may be responsible for the mixture of such seral species as ponderosa pine, aspen, southwestern white pine and western brackenfern. Forest habitat type study site data indicated increased numbers of shade tolerant species i.e., Engelmann spruce and subalpine fir, as a result of the cessation of fire over past 50 years. (Fitzhugh *et al* 1987).

Reforestation
Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance. Heavy overstory removal favors aspen and Douglas-fir. Lesser or staged removal of overstory (shelterwood cutting) is usually successful with light shelter favoring Douglas-fir and ponderosa pine, heavier shelter favoring more shade tolerant species. Selection harvest method favors Engelmann spruce over other species. Potential of windthrow is high as demonstrated by blowdown occurrence in otherwise undisturbed stands; therefore, seed tree cutting is often unsuccessful because of blowdown.

Douglas-fir, Engelmann spruce, and ponderosa pine seedlings have been highly successful. Site preparation can enhance planting success. Moderate to low intensity mechanical methods and low intensity burning are usually beneficial. Silvicultural treatments in regeneration can improve stocking levels and species composition.

Revegetation considerations
Natural revegetation is rapid.

Comments
Abundance of the herbaceous layers (forbs) indicates a greater utility for foraging/browsing by sheep and/or deer than for cattle. The resource value rating for cattle in early seral stages is high and in late seral is low due to decrease of herbaceous cover under increasing overstory canopy.

This plant association has very high values for esthetics because of excellent species diversity and ease of access at relatively low elevations. There are opportunities for aspen management along roadways. This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
Dieterich 1983
Fitzhugh *et al*. 1987
Mathiasen *et al.* 1986
USFS 1986

Engelmann spruce/gooseberry currant

(Formerly: Engelmann spruce/Mountain gooseberry——PIEN/RIMO)

Picea engelmannii/Ribes montigenum

Code(s)
typic phase 0 04 34 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Lower (SFM)

National Vegetation Classification Group
Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland (G218)

Key Criteria
Characterized by nearly pure stands of Engelmann spruce. Where present, the shrub cover is dominated by gooseberry currant. subalpine fir may be an accidental tree in this type.

Structure
Stands are dense and continuous to patchy with subalpine meadows interspersed. Engelmann spruce is the only conifer present. The depauperate undergrowth is characterized by scattered gooseberry currant shrubs often growing at the bases of Engelmann spruce trees. Forbs are scarce especially under the tree canopy but may create small patches in openings. Timber potentials are low due to the low site index for Engelmann spruce, the short growing seasons and rocky soils. Canopy removal by cutting, blowdown, or fire may increase forb cover. Wind-firmness of stands varies and potential to windfall is often high.

Location
This type occurs on north-facing high mountain slopes with extremely rocky soils. Elevations range from 10,000' to 11,400' (3,000 to 3,420 m); known from San Francisco Peaks, Arizona, and generally the higher mountains of northern New Mexico, and southern Utah. Mean annual

precipitation (MAP) is 31"/yr.; mean annual air temperature (MAAT) is 34 degrees F (1.2 C).

Adjacent plant associations
Adjoining type is PIEN/Moss.

Also see
Scree forest; PIEN/GERO if herbs are well represented (>5% cover).

Important and key plants from research plots
Trees & life history traits
Engelmann spruce (*Picea engelmannii)* C
quaking aspen *(Populus tremuloides)* [early to late seral] s

Shrubs
Common (>1% cover)**:**

gooseberry currant *(Ribes montigenum)

Herbs
Scarce (<1%)**:**
Ross' avens *(Geum rossii)*
skunkweed polemonium *(Polemonium pulcherrimum* var. *delicatum)*
spike trisetum *(Trisetum spicatum)*
golden columbine *(Aquilegia chrysantha)*
alpine fescue *(Festuca brachyphylla* ssp*. brachyphylla)*
Franciscan bluebells *(Mertensia franciscana)*
single delight *(Monesis uniflora)*

Cryptogams
Well represented (>5% coverage) especially lichens on rocks.

Brief plant ID notes
Gooseberry currant has reddish flowers and berries, and thorny stems. The genus *Ribes* is commonly split into two main groups: gooseberries, which have thorns, and currants, which don't. This *Ribes* does not have thorny fruit (so it is a currant), but does have thorny stems, thus the common name gooseberry currant.

Synonymy
Ross' avens (*Geum rossii* var. *turbinatum = Acomastylis rossii*)
skunkweed polemonium (*Polemonium pulcherrimum ssp delicatum*) = Jacob's ladder (*Polemonium delicatum*)

spike trisetum *(Trisetum spicatum = T. montanum = Rocky Mountain trisetum)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: +1 (cool, moist)
Climate Class: LSC (low sun cold)

Fire ecology
No information was available for fire ecology, although fires may be stand replacing events with long fire return intervals.

Reforestation
Soil and climatic limitations generally preclude silviculture. In general, regeneration of Engelmann spruce is by seed and layering.

Revegetation considerations
Where aspen is present, revegetation can be rapid. Where aspen is minor seral, regeneration of aspen may be patchy or clumpy following disturbance, where healthy root stock exists. It is unlikely to form a dominant cover type.

Comments
Heavy winter snowpack remains until early July. Because of late snowmelt on most sites, watershed protection becomes very important.

Forage production is low, however; deer and elk may prefer some sites for summer/fall hiding and thermal cover. Adjacent meadows provide forage.

Reference(s)
USFS 1987a
Youngblood and Mauk 198541

PIEN/VAMY2

Engelmann spruce/Whortleberry

(Formerly: Engelmann spruce/Myrtle huckleberry)

Picea engelmannii/Vaccinium myrtillus

Code(s)
typic phase 0 04 36 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Lower (SFM)

National Vegetation Classification Group
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

Key criteria
***Engelmann spruce** is dominant and strongly competitive. Subalpine fir is absent. Douglas-fir is present and may dominate seral stands. ***Whortleberry** is always present in the low shrub layer that dominates undergrowth and is diagnostic for this type. Herb cover is sparse.

Structure
Engelmann spruce is competitive and the dominant species, usually producing vigorous regeneration. Douglas-fir is present as a seral tree and may even co-dominate, however regeneration is much less vigorous than that of spruce. The overstory is well stocked (stockability = 1) and usually relatively continuous. The undergrowth is dominated by low shrubs. Whortleberry is always present; often accompanied by other low shrub species. Tall shrubs may also be present. Herb cover is sparse.

Timber productivity is low to moderate. No site index data are available.

Location
This type occurs on steep, upper, north and northeast-facing slopes and draws. Soils are very cobbly. These are cold sites where snowpack persists into late spring. Elevations range from 9,400 to 10,150 feet (2,865 to 3,093 m). It is found in the San Mateo Mountains, local in the

Jemez Mountains, New Mexico and into the San Juan Mountains in Colorado.

Adjacent plant associations
Adjoining types: ridgetops support PIEN/Moss or PSME/FEAR2; cobble-scree soils below support the ABCO/ACGL. Warmer sites support mixed conifer plant associations which adjoin PIEN/VAMY2.

Also see
PIEN/Moss, ABLA/VAMY, RUPA and LIBO3 phases, and PIPU/LIBO3. PIEN/VAMY2 is easy to distinguish from PIEN/VAMY2/POPUD3 – they typically will not be adjacent but separated by a plant association in the ABLA series, often ABLA/VAMY2. PIEN/VAMY2 is a lower elevation, rich shrubby mixed conifer type; PIEN/VAMY2/POPUD3 is a high elevation type, often adjacent to alpine, that occurs to high for abundant subalpine fir.

Important and key plants from research plots
Trees & life history traits
***Engelmann spruce** (*Picea engelmannii*) C
quaking aspen (*Populus tremuloides*) [early to mid-seral] S
Douglas-fir (*Pseudotsuga menziesii*) [late seral] S
limber pine (*Pinus flexilis*) S
white fir *(Abies concolor)* s

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

***whortleberry (*Vaccinium myrtillus*)**
common juniper (*Juniperus communis*)
fivepetal cliffbush (*Jamesia americana*)
Utah honeysuckle (*Lonicera utahensis*)
orange gooseberry (*Ribes pinetorum*)
Oregon boxleaf (*Paxistima myrsinites*)
Rocky Mountain maple (*Acer glabrum*)
Scouler's willow (*Salix scouleriana*)
mountain ninebark (*Physocarpus monogynus*)
sidebells wintergreen (*Orthilia secunda*)
greenflowered wintergreen *(Pyrola chlorantha)*

Herbs
Poorly represented (<5% cover)**:**
fringed brome *(Bromus ciliatus)*
sprucefir fleabane (*Erigeron eximius*)
lesser rattlesnake plantain *(Goodyera repens)*

Cryptogams
Well represented (>5% cover) on microsites without litter.

Brief plant ID notes
Vaccinium myrtillus and *V. scoparium* may be found occurring in the same plant communities. Since *V. myrtillus* seems to be the more common of the two species in northern New Mexico and southern Colorado, it was chosen to name the type.

Synonymy
sidebells wintergreen (*Orthilia secunda = Ramischia secunda = Pyrola secunda*)

sprucefir fleabane (*Erigeron eximius*) = forest fleabane (*E. superbus*)

Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*

fivepetal cliffbush = waxflower = *(Jamesia americana)*

fringed brome (*Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome (aka *B. richardsonii*)

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: 0 (typical)
Climate Class: LSC (Low Sun Cold)

Fire ecology
Crown fires result in successional stages dominated by aspen and a dense herbaceous layer.

Reforestation
Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance. Heavy overstory removal may favor aspen if present. Small clearcuts which are promptly planted have been successful. Lesser degrees of overstory removal may be successful and tend to favor Douglas-fir. Windthrow

susceptibility may increase once a stand is opened through cutting. Selection cutting usually favors Engelmann spruce. Selection methods can be used to modify species composition especially in early to mid-seral stages. Artificial planting of conifers with appropriate site preparation can have a high degree of success. Site preparation techniques must create microsite conditions required by species to be planted, for example, burning usually favors natural aspen regeneration, if present in original stand. Moderate to low intensity mechanical methods may give satisfactory conditions for planting Engelmann spruce or Douglas-fir.

Revegetation considerations
Natural revegetation is moderately rapid after disturbance.

Comments
Livestock seldom use this plant association due to little available forage (especially in late seral stages). Resource value rating for cattle in early seral stage is low and for late seral is none.

This plant association does provide cover/shelter and important browse production for wildlife summer range. The browse component increases in seral stages.

These sites have potential for water yield and aspen management. Increased water production and quality are possible through proper grazing and timber harvesting techniques.

Reference(s)
Fitzhugh *et al*. 1987
USFS 1986
USFS 1987a

Engelmann spruce/ Whortleberry-Skunkweed polemonium

(Formerly: Engelmann spruce/Myrtle blueberry-Jacob's-ladder)

Picea engelmannii/Vaccinium myrtillus-Polemonium pulcherrimum ssp delicatum

(Formerly: Picea engelmannii/Vaccinium myrtillus-Polemonium pulcherrimum)

Synonyms
Engelmann spruce/Littleleaf whortleberry/Skunkleaf Jacob's-ladder

Picea engelmannii/Vaccinium scoparium/Polemonium delicatum

Code(s)
PIEN/VAMY2/POPUD3 0 04 15
Engelmann spruce (PIEN) phase 0 04 15 1
subalpine fir (ABLA) phase 0 04 15 2

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Lower (SFM)

National Vegetation Classification Group
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

Key criteria
***Engelmann spruce** is the dominant tree species; spruce regeneration should be evident. No Douglas-fir present. The undergrowth is characterized by ***whortleberry**. Other cold indicator species are: ***skunkweed polemonium** and showy alpine groundsel or smallflowered woodrush.

Structure
Occupies the forest-alpine tundra ecotone, where timber productivity is severely limited by rigorous subalpine environment. Site productivity:

low to moderate as evidenced by the site index of 52 for Engelmann spruce. The overstory at the highest elevations is dominated by Engelmann spruce (all sizes) with bristlecone pine (Sangre de Cristo Mountains) as a seral tree near forest-tundra ecotone. At lower elevations, Engelmann spruce and subalpine fir both are present. Subalpine fir has moderate to heavy regeneration but usually fewer mature individuals in the overstory. Whortleberry is the dominant shrub. The well-developed herbaceous layer is well developed and is dominated by herb species, such as skunkweed polemonium and showy alpine groundsel.

Location
This type is found at the coldest extremes of forest growth; elevations ranging from 9,800 to 11,800' (2990 to 3600 m). It occurs on cold sites that retain snow cover well into the summer, on all aspects, and on moderate to steep slopes. Very limited growing season for trees. Distribution: Sangre de Cristo and San Juan Mountains north into southern Colorado. Note: May also occur in other mountain ranges of northern New Mexico and southern Colorado exceeding 10,500' (3200 m).

Adjacent plant associations
PIEN/VAMY/POPU typically borders alpine tundra at its upper limits and adjoins PIAR/FETH or ABLA/Moss. Its lower limit in most locations borders the ABLA/VAMY.

Also see
Krummholz refers to a forest-tundra border vegetation characterized by stunted, shrubby stature of Engelmann spruce and subalpine fir. See also *Picea engelmannii/Trifolium dasyphyllum* in central Colorado (Hess and Alexander 1986). PIEN/VAMY2/POPUD3 is easy to distinguish from PIEN/VAMY2– they typically will not be adjacent but separated by a plant association in the ABLA series, often ABLA/VAMY2. PIEN/VAMY2/POPUD3 is a high elevation type, often adjacent to alpine, that occurs too high for abundant subalpine fir; PIEN/VAMY2 is a lower elevation, rich shrubby mixed conifer type.

Important and key plants from research plots
Trees & life history traits
Engelmann spruce phase:

Engelmann spruce (*Picea engelmannii*) C
subalpine fir (*Abies lasiocarpa*) c
bristlecone pine (*Pinus aristata*) s
Subalpine fir phase:
Engelmann spruce (*Picea engelmannii*) C
subalpine fir (*Abies lasiocarpa*) C
quaking aspen *(Populus tremuloides)* s

Shrubs
Well represented (>5% canopy cover)**:**
***whortleberry** *(Vaccinium myrtillus)*
grouse whortleberry (*Vaccinium scoparium)*
gooseberry currant *(Ribes montigenum)*
twinberry honeysuckle (*Lonicera involucrata)*
sidebells wintergreen *(*Orthilia *secunda)*

Herbs
Well represented (>5%cover):
*skunkweed polemonium (*Polemonium pulcherrimum spp delicatum*)
showy alpine groundsel (*Senecio amplectens*)
single delight (*Moneses uniflora*)
creeping sibbaldia (*Sibbaldia procumbens*)
Whipple's penstemon (*Penstemon whippleanus*)
Cryptogams
Well represented (>5%) including both lichens and mosses.

Brief plant ID notes
Tundra species may be found at upper limits, including:
Ross' avens *(Geum rossii)*
alpine bistort *(Polygonum viviparum)*
tufted hairgrass *(Deschampsia caespitosa)*
creeping Sibbalia *(Sibbaldia procumbens)*
alpine clover *(Trifolium dasyphyllum)*

Synonymy
subalpine fir (*Abies lasiocarpa* var. *arizonica = A. arizonica = A. bifolia*)
sidebells wintergreen (*Orthilia secunda = Ramischia secunda = Pyrola secunda*)

skunkweed polemonium (*Polemonium pulcherrimum ssp delicatum*) = Jacob's ladder (*Polemonium delicatum*)
Ross' avens (*Geum rossii = Acomastylis rossii*)
tufted hairgrass *(Deschampsia cepitosa = D. caespitosa)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: +1 (cool, moist)
Climate Class: LSC (low sun cold)

Phases
There are two phases recognized: Engelmann spruce (PIEN) phase, in which Engelmann spruce is climax; and subalpine fir(ABLA) phase, with subalpine fir climax or co-climax. PIEN phase is usually higher than 11,200 feet. ABLA phase is generally lower than 11,500 feet.

Fire ecology
Many stands have not been significantly disturbed by fire for centuries. Recovery from fire can span centuries.

Reforestation
Complete overstory removal tends to favor tundra plants; clearcutting is seldom, if ever, successful for regenerating trees. Trees can regenerate with partial overstory removal/retention (e.g., shelterwood and selection methods) if enough time is allowed for seedlings to become established. Under some stand conditions, partial overstory removals may increase potential for windthrow. (Alexander 1973) To prevent windthrow, retain a sufficient overstory structure.

Engelmann spruce and subalpine fir seedlings planted in this type may have a low probability for success. Site preparation can be expected to enhance planting. Reestablishment of Engelmann spruce regeneration following removal of overstory requires shading to prevent insolation damage.

Revegetation considerations
Natural revegetation following disturbance has been found to be slow to moderate. These sites are very difficult to reforest once cleared or burned. Aspen (a minor seral species) may become established in clumps or patches where sufficient healthy rootstocks exist prior to disturbance.

Comments
Areas supporting this plant association typically receive heavy snow accumulations and can be very important for snow retention especially in ski areas. These areas are some of the most productive watersheds. Esthetic values for recreational pursuits are likely to be very high.

Forage resource value rating for cattle in early seral stage is low; late seral is none. This plant association is valuable habitat for wildlife living in the forest-tundra ecotone, e.g., ptarmigan and bighorn sheep.

Reference(s)
DeVelice *et al.* 1986
Ludwig and Moir 1979
Ronco 1970
USFS 1987a

Subalpine Fir Series

ABLA/CASI12

Subalpine fir/dryspike sedge

(Formerly: Subalpine fir/Fony sedge ABLA/CAFO)

Abies lasiocarpa/Carex siccata

(Formerly: Abies bifolia/Carex siccata)

Synonyms
Picea engelmannii/Carex siccata (PIEN/CAFO) (Moir and Ludwig 1979).

Common name updated as per USDA Plants database.

Code(s)
typic phase 0 03 37 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Upper (SFP)

National Vegetation Classification Group
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

Key criteria
Engelmann spruce and ***subalpine fir** are present in the overstory. Graminoids dominate the understory with ***dryspike sedge** forming up to 70% cover in small patches.

Structure
The overstory is dominated by Engelmann spruce which is more drought tolerant than subalpine fir. The presence of subalpine fir, especially reproduction, influenced this plant association being assigned to the subalpine (ABLA) series.

Soils are cobbly and skeletal. Where finer textured microsites exist, dryspike sedge may provide up 70% cover. (Moir and Ludwig 1979)

Site index data were not available. However, judging by conditions in adjoining timbered plant associations, it can be surmised that timber

productivity is moderate to low at best. Forage for cattle may be moderate to low in the early to mid-seral stages, as well.

Location
Above 10,000' (3,050 m) in elevation on south-facing slopes and ridgetops; borders of cienegas. Known only from the Pinaleno (Graham) Mountains in Arizona.

Adjacent plant associations
Adjoining types: ABLA/Moss on drier exposures; ABLA/VAMY.

Also see
Intergrades to ABLA/VAMY2 and ABLA/Moss on gentle slopes (Stromberg and Patten, March 1991).

Important and key plants from research plots
Trees & life history traits
***Engelmann spruce** (*Picea engelmannii*) C
subalpine fir (*Abies lasiocarpa*) c
quaking aspen (*Populus tremuloides*) [early to mid-seral] s
Douglas-fir *(Pseudotsuga menziesii)* s

Shrubs
Scarce (<1% cover)**:**
whortleberry *(Vaccinium myrtillus* var *oreophilum)*
snowberry *(Symphoricarpos* spp)
fivepetal cliffbush *(Jamesia americana)*

Herbs
Abundant (>25% cover) to luxuriant (>50%cover)**:**
Kentucky bluegrass *(Poa pratensis)*
Sedge *(Carex siccata)*
mountain muhly *(Muhlenbergia montana)*
fringed brome *(Bromus ciliatus)*
Richardson's geranium
(Geranium richardsonii)
owl's-claws *(Dugaldia hoopsii)*
Wooton's ragwort *(Senecio wootoni)*
whiteflower cinquefoil *(Potentilla albiflora)*
Brief plant ID notes

Sedges are difficult to tell apart, but easy to distinguish from other graminoids by the combination of leaves and culms originating from the base (no sheaths), solid triangle-shaped culms, and one flower with a single scale below it per spike or spikelet. Dryspike sedge has flat, bright green leaves and four to twelve spikes in the linear, oblong flower head.

Synonymy

owl's-claws *(Dugaldia hoopsii)* = orange sneezeweed *(Helenium hoopsii)*
dryspike sedge = fony sedge
fivepetal cliffbush = waxflower = *(Jamesia americana)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*

Terrestrial Ecological Unit attributes

Life Zone Class: 7 (subalpine forest)
Elevational Subzone: 0 (typical or modal)
Climate Class: LSC (low sun cold)

Fire ecology

Fire history suggested by abundance of old-growth stands is one of long return intervals of stand replacing fires (Grissino-Mayer and Swetnam 1992). For the Pinaleno Mountains at elevations exceeding 9,200 feet (2,800 m), Stromberg and Patten (1991) present the following model for a successional pathway following disturbance: (1) spruce colonization; (2) reduction in further recruitment of all species; and (3) abundant recruitment of subalpine fir and spruce 80 to 150 years after initial colonization. This sequence which is recovery to old growth status requires more than 300 years on gentle slopes. On steeper, lower elevation sites recovery time would be longer and colonizing species would be spruce and Douglas-fir.

Reforestation

Moderate overstory removal favors Douglas-fir. Where viable roots are present and intact, aspen can be expected to re-establish fairly rapidly, followed in time by Douglas-fir and ultimately by Engelmann spruce and subalpine fir. Seed tree harvesting method featuring subalpine fir or Engelmann spruce is usually not successful because the microclimate is too severe to allow regeneration of the target species.

Some stands support dense subalpine fir reproduction. Where present, Engelmann spruce reproduction is less dense. Mid-seral closed pole stands of this type can resemble ABLA/Moss with scarce understory. Clearings are strongly dominated by graminoid turf, resulting in conditions that are often too dry and exposed to solar radiation and wind. Regeneration by spruce in such clearings is difficult (Ronco 1970).

Revegetation considerations
Natural revegetation by graminoids is moderately rapid following removal of overstory. Meadows adjoining ABLA/CASI12 areas have limiting soil/vegetations characteristics which support some tree invasion along the margins only.

Reference(s)
Grissino-Mayer and Swetnam 1992
Ronco 1970
Stromberg and Patten 1991
USFS 1987a

Subalpine fir/sprucefir fleabane

(Formerly: Subalpine fir/Forest fleabane ABLA/EREX)

Abies lasiocarpa/Erigeron eximius

(Formerly: Abies bifolia/Erigeron eximius)

Synonyms
Abies lasiocarpa/Erigeron superbus (Moir and Ludwig 1979). ABLA-PIEN1/EREX4 (Johnston 1987).

Code(s)
typic phase 0 03 08 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Upper (SFP)

National Vegetation Classification Group
Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland (G218)

Key criteria
Engelmann spruce and ***subalpine fir** co-dominate overstory. Douglas-fir, aspen, and white fir generally occur as seral trees. Whortleberry (*Vaccinium* spp.) when present is minor relative to ***sprucefir fleabane** which is common (>1% cover). Nevada pea is poorly represented (< 5% cover). Undergrowth of rich shrub and herb cover is typical except beneath closed canopy. Ponderosa pine may occur as an accidental tree in Arizona south of the Mogollon Rim and in southwestern New Mexico.

Structure
The overstory is dominated by Engelmann spruce and subalpine fir. Occurring as seral species are Douglas-fir, aspen and white fir. Conifer stands of varying mixes of species, densities and age classes are interspersed with stands of aspen (stockability = 1). Timber productivity ranges from moderate to high. Some reported site indices for Engelmann spruce average 64 +/-16, and for Douglas-fir average 82. Mathiasen *et al.* (1986) reported a mean site index for Douglas fir of 73.6 +/-10.7 (N = 12 stands).

Forage value for cattle is rated at high in early seral stages and moderate to low in later seral stages, as tree cover inhibits undergrowth.

Large volumes of deer and elk browse are produced. Abundant undergrowth combined with thermal protection afforded by the dense overstory make this an important wildlife habitat for wide variety of game and non-game species.

Location
This type occurs on all aspects and slopes, except for ridgetops and the driest south-facing aspects; 9,200' to 10,500' (2,800 to 3,200 m) elevation. Widespread throughout the mountains from southwestern New Mexico into southern Colorado; White, Pinaleno and Escudilla Mountains, in Arizona; Mogollon Mountains and the Black Range in New Mexico; also locally in northern Arizona.

Adjacent plant associations
Intergrades with ABCO/EREX at lower elevations; adjoins *Vaccinium* dominated types in cooler, drier sites; often occurs in frost pockets within ABCO series.

Also see
ABLA/ LALAL3, PIEN1/EREX4, and ABLA/ACGL (Alexander *et al* 1987, Youngblood and Mauk 1985), the latter on sites with shrubs well represented.

Important and key plants from research plots
Trees & life history traits
Engelmann spruce (*Picea engelmannii*) C
***subalpine fir** (*Abies lasiocarpa*) C
quaking aspen (*Populus tremuloides*) [early to mid-seral] S
Douglas-fir (*Pseudotsuga menziesii*) [late seral] S
limber pine (*Pinus flexilis*) [north] s
southwestern white pine (*Pinus strobiformis*) [south] s
white fir *(Abies concolor)* s

Shrubs
Poorly represented (<5% cover) or
well represented (>5 % cover):
orange gooseberry *(Ribes pinetorum)*
thimbleberry *(Rubus parviflorus)*

Scouler's willow *(Salix scouleriana)*
Rocky Mountain maple *(Acer glabrum)*
twinberry honeysuckle *(Lonicera involucrata)*
Utah honeysuckle *(Lonicera utahensis)*
russet buffaloberry *(Shepherdia canadensis)*
fivepetal cliffbush *(Jamesia americana*)
rockspirea *(Holodiscus dumosus)*
mountain snowberry (Symphoricarpos oreophilus)

Herbs
Luxuriant (>50% coverage):
***sprucefir fleabane** *(Erigeron eximius)*
ragweed sagebrush *(Artemisia franserioides)*
Richardson's geranium *(Geranium richardsonii)*
bluntseed sweetroot *(Osmorhiza depauperata)*
Canadian white violet *(Viola canadensis)*
sidebells wintergreen *(Orthilia secunda)*
starry false lily of the valley *(Maianthemum stellatum)*
Spike trisetum (*Trisetum spicatum*)
fringed brome *(Bromus ciliatus)*
Kentucky bluegrass *(Poa pratensis)*
dryspike sedge *(Carex siccata)*

Cryptogams
Well represented (>5% cover).

Brief plant ID notes
Sprucefir fleabane is a perennial; over 20 cm tall; with involucral bracts, not thickened; in 1-2 series of about equal length; leaves glabrous, basal leaves usually obovate-spatulate, entire to minutely toothed and somewhat three-nerved, lengths to 15 cm. Flower heads 7-9 mm tall with 1-6 per stem, blue to purplish-pink, 40-80 rays, about 12-20 mm in length.

Synonymy
sprucefir fleabane (*Erigeron eximius)* = forest fleabane (*E. superbus)*
sidebells wintergreen *(Orthilia secunda = Ramshia secunda)*
starry false lily of the valley *(Maianthemum stellatum = Smilacina stellata)*
bluntseed sweetroot *(Osmorhiza depauperata)* = sweetcicily *(Osmorhiza obtusa)*

fivepetal cliffbush = waxflower = *(Jamesia americana)*
fringed *brome (Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
dryspike sedge *(Carex siccata)* = fony sedge
starry false lily of the valley (*Maianthemum stellatum = Smilacina stellata*), aka starry false Solomon seal
spike trisetum *(Trisetum spicatum = T. montanum* = Rocky Mountain trisetum*)*
russet buffaloberry *(Shepherdia canadensis = Elaeagnus canadensis)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: -1 (warm, dry)
Climate Class: LSC (low sun cold)

Fire ecology
Mosaic patterns of interspersed aspen are probably created by surface fires. The relative presence of Douglas-fir in the overstory seems to be determined by fire occurrence and elevation, where increased fire frequency favors establishment of the more fire tolerant Douglas-fir while increased elevation and lower temperatures favor spruce and fir.

Reforestation
Because of the presence of Douglas-fir as a major seral (or in some locations, a minor climax species) and aspen as a major seral tree, a degree of flexibility for overstory management including opportunities for developing mixed, as well as single species stands is possible. Heavy overstory removal favors establishment of aspen. With lesser degrees of overstory removal, shade tolerance will favor spruce and fir; that is, more shade favoring fir. Seed tree type harvest methods for spruce and fir are likely to be unsuccessful due to increased potential for blowdown. Selective removal of species can be used to improve species composition especially in early to mid-seral stands. Artificial planting of conifers with appropriate site preparation can result in a high degree of success probability. Site preparation techniques must create microsite conditions required by species to be planted, e.g., burning usually favors natural aspen regeneration and may give satisfactory condition for planting of Douglas-fir or even white fir at lower elevations, but

conditions for planting spruce or fir would be too dry and too exposed to sunlight.

Revegetation considerations
Natural revegetation is rapid following disturbances due to sprouting of aspen and rapid seeding sprouting shrubs and herbs.

Comments
The mean annual precipitation (MAP) = 29 to 31 in/yr., with much of this precipitation in the form of snow resulting in moderate to deep winter snowpack.

It has been reported that heavy grazing of livestock and wildlife can result in development of Kentucky bluegrass sod.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)
DeVelice *et al.* 1986
Mathiasen *et al.* 1986
USDA 1986
USDA 1987a
USDA 1987b

Subalpine fir/fivepetal cliffbush

(Formerly: Subalpine fir/waxflower ABLA/JAAM)

Abies lasiocarpa/Jamesia americana

(Formerly: Abies bifolia/Jamesia americana)

Codes
typic phase 0 03 32 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Upper (SFP)

National Vegetation Classification Group
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

Key criteria
***Subalpine fir** dominates overstory. Shrubs include ***fivepetal cliffbush** and others. Understory has scattered patches of forbs.

Structure
Overstory is dominated by subalpine fir and occurs in association with aspen, Douglas-fir and white fir. Tree canopy is relatively continuous with firs making up 60-70% of the cover. Undergrowth is scarce; fivepetal cliffbush is the principal shrub. Site index data are unavailable. Mortality is high in subalpine reproduction; seedlings are rare.

Location
This type occurs on north-facing slopes above 8,700' (2,650m). Known distribution is limited to Mount Lemon, Santa Catalina Mountains, AZ.

Also see
Niering and Lowe (1984).

Important and key plants from research plots
Trees & life history traits
***Subalpine fir** (*Abies lasiocarpa*) C
quaking aspen (*Populus tremuloides*) [early to mid-seral] S
Douglas-fir (*Pseudotsuga menziesii*) [late seral] S
white fir *(Abies concolor)* [late seral] S

Shrubs
Common (< 5%)**:**
orange gooseberry *(Ribes pinetorum)*
***fivepetal cliffbush** *(Jamesia americana*)
grayleaf red raspberry *(Rubus idaeus* ssp*. strigosus)*
mountain snowberry *(Symphoricarpos oreophilius)*
black elderberry *(Sambucus racemosa* ssp *pubens* var *melanocarpa)*

Herbs
Well represented (>5%)**:**
fringed brome *(Bromus ciliatus)*,
Canadian white violet *(Viola canadensis)*,
red baneberry *(Actaea rubra)*,
roughfruit fairybells
(Disporum trachycarpus),
brittle bladderfern *(Cystopteris fragilis),*
sidebells wintergreen *(Orthilia secunda),*
ravine fescue *(Festuca sororia),*
western brackenfern *(Pteridium aquilinum),*
American vetch *(Vicia americana*).

Synonymy
grayleaf red raspberry (Rubus idaeus ssp. strigosus = R. strigosus)

Brief plant ID notes
fivepetal cliffbush = waxflower

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: -1 (warm, dry)
Climate Class: LSC (low sun cold)

Fire ecology
This plant association may be fire disturbed, probably with long periods between major fire events; however, specific information was not available.

Comments
A unique, insular habitat in a desert region.

Mean annual precipitation (MAP) = 33 to 34"/yr. and the mean annual soil temperature (MAST) = 40-41 degrees F. Moderate winter snowpack is characteristic.

Reference(s)

Niering and Lowe 1986
USFS 1987b

Subalpine fir/Common juniper
Abies Lasiocarpa/Juniperus Communis

(Formerly: Abies bifolia/Juniperus communis)

Synonyms
Abies lasiocarpa-Picea engelmannii/Juniperus communis (Johnson 1987).

Code(s)
typic phase 0 03 09 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Upper (SFP)

National Vegetation Classification Group
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

Key criteria
Engelmann spruce and subalpine fir dominate overstory and regeneration. Common juniper and sidebells wintergreen are most prevalent in sparse cover for understory and are diagnostic for this type. Ponderosa pine may be an accidental species in this plant association.

Structure
Engelmann spruce and subalpine fir are often codominant in the overstory. In some stands the fir is the major climax tree species. Both species may layer in the understory. Douglas-fir and white fir are seral but regeneration is usually sparse. The patchy undergrowth is dominated by common juniper, accompanied by sidebells wintergreen. Herb cover is usually less than 1%. Site productivity is moderate to low, representing the lowest potential yields (timber) for the ABLA series. Site quality for Engelmann spruce is moderate; site index = 80-95. Stockability is 1. The sparse understory provides little volume and diversity for livestock forage. Cattle resource value ratings are moderate for early seral stages and none for late seral. Common juniper can provide much needed cover for ground nesting birds. The ABLA/JUCO plant association is important to many wildlife species, especially as used in connection with adjoining plant communities.

Location
This type occurs on mostly gentle north- or east-facing draws and upland slopes on the North Kaibab Plateau and hot dry slopes in the Sangre de Cristo Mountains; 8,700' to 9,200' (2,650 to 2,800 m) on the North Kaibab Plateau, Arizona; and about 10,500' (3,200 m) elevation in mountains of northern New Mexico; into Colorado, Utah, Idaho, and Wyoming.

Adjacent plant associations
Adjoining types— ABCO/BERE (MARE11) on ridges and west-facing slopes; PIPU/CASI12 on lower slopes and adjoining parks.

Also see
Youngblood and Mauk (1985) describe ABLA/JUCO in south and central Utah: ABLA/MOSS

Important and key plants from research plots
Trees & life history traits
subalpine fir (*Abies lasiocarpa*) * C
Engelmann spruce (*Picea engelmannii*) C
quaking aspen (*Populus tremuloides*) [early to mid-seral] S
Douglas-fir (*Pseudotsuga menziesii*) [late seral] S
white fir *(Abies concolor)* s

Shrubs
Common (<5% coverage):
***common juniper** *(Juniperus communis)*
New Mexico locust *(Robina neomexicana*)
Utah honeysuckle *(Lonicera utahensis)*
creeping barberry *(Mahonia repens)* 60

Herbs
Usually common (<5%):
***sidebells wintergreen** *(Orthilia secunda)*
fringed brome *(Bromus ciliatus)*
Virginia strawberry *(Fragaria virginiana* ssp *virginiana)*
sprucefir fleabane (*Erigeron eximius*)
dryspike sedge *(Carex siccata)*
Ross' sedge *(Carex rossii)*

Synonymy

sidebells wintergreen (*Orthilia secunda = Ramischia secunda*)
sprucefir fleabane (*Erigeron eximius*) = forest fleabane (*E. superbus*)
Virginia strawberry (*Fragaria ovalis = F. virginiana* ssp *virginiana*)
creeping barberry (*Mahonia repens = Berberis repens*)
dryspike sedge *(Carex siccata)* = fony sedge

Terrestrial Ecological Unit Attributes

Life Zone Class: 7 (subalpine forest)
Elevational Subzone: -1 (warm, dry)
Climate Class: LSC (low sun cold)

Fire ecology
Light to moderate disturbance (fire or logging) favors re-establishment of aspen through root suckering or natural regeneration of Douglas-fir on the wetter microsites. Heavy disturbance by fire may result in dry meadows that revegetate slowly.

Reforestation
Standard procedures of manipulating the overstory for silvicultural purposes will usually be unsuccessful (Youngblood & Mauk 1985.) Seed tree harvest is usually not successful due to blowdown and can be expected to favor aspen. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance. Shelterwood and selection harvesting methods are more likely to withstand blowdown and regenerate conifers. Heavier shelterwood cuts favor fir over spruce because of decreased shade. Leaving less shelter favors the spruce. At lower elevations, Douglas-fir and white fir regeneration may become established in early to mid-seral stages. Recommended species for tree planting are Engelmann spruce and Douglas-fir, although the probability for success is moderate to low due to cold, dry conditions.

Site preparation methods: Burning is usually detrimental to most species except aspen where fire will stimulate resprouting from viable roots. Moderate to low intensity site preparation may increase seedling survival.

Revegetation considerations
Natural regeneration appears to be sporadic and limited to only the most mesic microsites.

Comments
Mean annual precipitation (MAP) = 29”/yr., moderate snowpack, little precipitation in May and June.

This plant association may be of the driest habitats within the spruce-fir region of Arizona and New Mexico.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings. However; low level budworm infestation may be a chronic problem in this plant association. Dr. David Fellin suggested low intensity defoliation by western spruce budworm may be evidenced by epicormic branching in crowns of host trees (Will Moir, pers. comm. 1996).

Reference(s)

Moir and Ludwig 1979.
USFS 1987a
Youngblood and Mauk 1985

Subalpine fir/Nevada pea

(Formerly: Subalpine fir/Arizona peavine ABLA/LAAR)

Abies lasiocarpa/Lathyrus Lanszwertii Var Arizonicus

(Formerly: Abies bifolia/Lathyrus arizonica)

Code(s)
typic phase 0 03 31 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Upper (SFP)

National Vegetation Classification Group
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

Key criteria
Stand contains ***subalpine fir** and sometimes Engelmann spruce, but may be dominated by white fir or southwestern white pine. Shrub and forb layers in understory with ***Nevada pea** and other forbs dominating.

Structure
In the overstory, subalpine fir is the dominant species. Aspen is major seral tree and may form a mixture with subalpine fir to make up the dominant overstory. Engelmann spruce is present often as scattered mature trees. In some areas, such as the Mogollon Mountains, Douglas-fir and southwestern white pine may actually dominate a stand. Subalpine fir usually dominates the regeneration. The stockability rating is 1. Understory has a luxuriant herbaceous cover which is dominated by Nevada pea in openings. Moderate shrub layers are present as well.

Although no site index data are available, productivity has been rated as high.

Forage for livestock is variable. The forage value rating for cattle is high in clearings and stands in early seral stage of development; decreasing to low as forested cover begins to increase.

Location
Moderate-steep mountain slopes, southeast- and west-facing aspects; deep well-watered soils; moderate snowpack. Elevation 10,200' (3108 m) Mt. Taylor, Whitewater Baldy, Mogollon Mountains in New Mexico and 9,500' to 10,000' (2,895 to 3048 m) in the San Francisco Peaks, Arizona. Gentle slopes in the San Juan Mts.

Adjacent plant associations
Occurs at lower edge of *Picea-Abies* zone.

Also see
Abies lasiocarpa/Carex geyeri in Colorado and Utah (Youngblood and Mauk 1985); Rominger and Paulik, (1983) for description in San Francisco Peaks, AZ. This plant association is closely related to ABLA/EREX4.

Important and key plants from research plots
Trees & life history traits
subalpine fir (*Abies lasiocarpa*) C
Engelmann spruce (*Picea engelmannii*) C
quaking aspen (*Populus tremuloides*) [early to mid-seral] S
Douglas-fir (*Pseudotsuga menziesii*) [early to mid-seral] S
Southwestern white pine (*Pinus strobiformis*) S
white fir *(Abies concolor)* S

Shrubs
Scarce (<1% cover).
Mogollon Mountains:
wintergreen (*Orthilia* spp. and *Pyrola* spp.)
Rocky Mountain maple *(Acer glabrum)*
mountain snowberry *(Symphoricarpos oreophilus)*
San Francisco Peaks:
gooseberry currant *(Ribes montigenum)*
orange gooseberry *(Ribes pinetorum)*
twinberry honeysuckle (*Lonicera involucrata*)

Herbs

Luxuriant (>50% cover):
Both Mogollon Mountains and San Francisco Peaks:
***Nevada pea** *(Lathyrus lanszwertii* var. *arizonicus)*

San Juan Mountains:
Geyer sedge *(Carex geyeri)*
Mogollon Mountains:
aspen pea *(Lathyrus laetivirens)*
American vetch *(Vicia americana)*
Parry's goldenrod *(Oreochrysum parryii)*
western brackenfern *(Pteridium aquilinum)*
starry false lily of the valley *(Maianthemum stellatum)*
Richardson's geranium *(Geranium richardsonii)*
dryspike sedge *(Carex siccata)*
fringed brome *(Bromus ciliatus)*
San Francisco Peaks:
Virginia strawberry *(Fragaria virginiana* ssp *virginiana)*
fireweed *(Epilobium angustifolium)*
alpine false springparsley *(Pseudocymopterus montanus)*
owl's-claws *(Dugaldia hoopsii)*
elkweed *(Frasera speciosa)*

Cryptogams
Under closed canopy, the herbaceous vegetation may become sparse and be replaced with cryptogamic cover.

Brief plant ID notes
Since they often grow together, Nevada pea is often confused with another legume, American vetch. This particular peavine lacks tendrils and the larger leaflet is more heavily veined. There are few leaflets on the peavine, which has white and pink flowers while the vetch has reddish to lavender flowers.

Synonymy
Virginia strawberry (*Fragaria ovalis = F. virginiana* ssp *virginiana*)
starry false lily of the valley (*Maianthemum stellatum = Smilacina stellata*), aka starry false Solomon seal
Nevada pea (*Lathyrus lanszwertii var arizonicus = L. arizonicus*)
elkweed (*Frasera speciosa*) = green gentian (*Swertia radiata*)
owl's-claws (*Dugaldia hoopsii*) = orange sneezeweed (*Helenium hoopsii*).
fringed brome (*Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome (aka B. richardsonii)

dryspike sedge (*Carex siccata*) = fony sedge
fireweed (*Chamerion angustifolium* spp. *angustifolium = Epilobium angustifolium* ssp *angustifolium*)
Parry's goldenrod *(Oreochrysum parryi = Haplopappus parryi = Solidago parryi)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: 0 (typical or modal)
Climate Class: LSC (low sun cold)

Fire ecology
Natural fires are a part of this plant community and, although infrequent, ground fires seem to influence the nature of the herbaceous vegetation.

Reforestation
Complete overstory removal regardless of the method will strongly favor aspen. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance. Seed tree harvest methods usually render these sites too dry and exposed for reestablishment of fir or spruce. Windthrow potential is high. Various forms of shelterwood harvesting are more appropriate if the species to be featured are spruce, fir, Douglas-fir or southwestern white pine. The greater the overstory cover, the better are the microsite conditions for the more shade tolerant species.

Site preparation methods can be designed to favor a particular species. For example, most forms of burning and high to moderate intensity mechanical treatments that remove the protective layers of medium and heavy woody debris from the forest floor favor aspen and perhaps Douglas-fir. Planting projects are usually successful and can be used to increase the presence of one or more species.

Revegetation considerations
Natural revegetation is rapid following disturbances due to aspen suckering/sprouting and re-establishment of herbaceous cover.

Comments
ABLA/LALA3 is important for water yield and as a summer range for big game. Tall aspen can have scenic value.

References

Fitzhugh *et al* 1987
Moir and Ludwig 1979
Rominger and Paulik 1983
USFS 1987a

Subalpine fir/tall fringed bluebells

(Formerly: Subalpine fir/bluebells ABLA/MECI)

Abies lasiocarpa/Mertensia ciliata

(Formerly : Abies bifolia/Mertensia ciliata)

Synonyms
Abies lasiocarpa-Picea engelmannii/Mertensia ciliata (Johnston 1987)

Code(s)
typic phase 0 03 06 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Upper (SFP)

National Vegetation Classification Group
Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland (G218)

Key criteria
Engelmann spruce and subalpine fir codominate the overstory. The luxuriant understory is a key feature; total herb cover may be in excess of 100%.

Soils are characteristically deep with high water tables, supporting water-indicating plants such as tall fringed bluebells, Fendler's cowbane, and heartleaf bittercress.

Structure
This plant association represents the wettest riparian and nonriparian conditions found in the southern Rocky Mountains. Soils are aquic intergrades. Engelmann spruce and subalpine fir co-dominate the overstory. Stands near timberline may have little subalpine fir. The remarkable feature of the vegetation is the luxuriant herbaceous undergrowth. Total herb cover often exceeds 100% because of multiple layers. These sites are rich in species kinds and numbers, many of which are water obligate species. Productivity is rated moderate. The site index for Engelmann spruce is 62. Stockability is 1. This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged

in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Location
Gentle to moderate mid and lower slopes; generally northerly aspects; elevations from 9,000' to 11,200' (2,800 to 3,410 m); wet seep slopes high in San Juan and Sangre de Cristo Mountains of northern New Mexico and southern Colorado.

Adjacent plant associations
In seep areas, the seep itself may be occupied by ABLA/MECI3. Wet meadows dominated by *Carex spp.* and *Juncus* spp. adjoin the type in some areas.

Also see
Steele *et al*. (1981). Peet (1981). Pfister *et al*. (1977).

Important and key plants from research plots
Trees & life history traits
Engelmann spruce (*Picea engelmannii*) C
***subalpine fir** (*Abies lasiocarpa*) C
quaking aspen *(Populus tremuloides)* s

Shrubs
Mostly confined to hummocks where myrtle blueberry *(Vaccinium)* or currant *(Ribes)* can occur. Also, in extreme northern New Mexico, elderberry *(Sambucus)* may occur along transitions to other plant associations.

Herbs
Luxuriant (canopy coverage greater than 50%; even exceeding 100% in some locations.)
***tall fringed bluebells** *(Mertensia ciliata)*
Fendler's cowbane *(Oxypolis fendleri)*
heartleaf bittercress *(Cardimine cordifolia)*
white marsh marigold *(Caltha leptosepala)*
brook saxifrage *(Saxifraga odontoloma)*
arrowleaf ragwort *(Senecio triangularis)*

southwestern showy sedge *(Carex bella)*
large mountain fleabane *(Erigeron coulteri)*
Porter's licorice-root *(Ligusticum porteri)*
fivestamen miterwort *(Mitella pentandra)*
Richardson's geranium *(Geranium richardsonii)*

Cryptogams
Mosses and liverworts may cover hummocks and mineral soils near rivulets.

Brief plant ID notes
Dry hummocks support blueberry *(Vaccinium)* spp. and Jacob's ladder

Synonymy

brook saxifrage (*Saxifraga odontoloma = Micranthes odontoloma*)
arrowleaf ragwort (Senecio triangularis) = arrowleaf groundsel
southwestern showy sedge (*Carex bella = C. uncompahgre*)
large mountain fleabane (*Erigeron coulteri*) = Coulter daisy
fivestamen miterwort *(Mitella pentandra = Pectiantia pentandra)*

Terrestrial Ecological Unit attributes
Life zone class: 7 (subalpine forest),
Elevation Subzone: 0 (typic or modal), +1 (cool, moist)
Climate class: LSC (low sun cold)

Fire ecology
Though this association may not always have sufficient cover of wetland obligates to be considered riparian, it represents the wettest of subalpine forest conditions of the southern Rocky Mountains. This association is often sheltered from factors causing windthrow, and is associated with long fire intervals and late successional (climax) conditions.

Reforestation
Harvesting methods that remove most or all of the overstory often result in formation of dense *Carex* communities. Without special site preparation, conifer establishment is unlikely due to raising of water table (Steele *et al*. 1981). Methods that remove limited amounts of the overstory may be more successful. Potential for blowdown is high in exposed sites. Tree planting in this type is not well known and the success probability has been rated low. Light shelterwood harvest may

be successful in regenerating stands. Where aspen is minor seral, regeneration of aspen may be patchy or clumpy following disturbance, where healthy root stock exists. It is unlikely to form a dominant cover type.

Revegetation considerations
Natural regeneration is usually rapid after disturbance due to lush regrowth of graminoids and tall forbs. Artificial re-establishment of trees (i.e. planting) is very difficult once cleared or burned. Soils are easily damaged by heavy equipment.

Comments
Livestock: The forage value rating for cattle in early seral is high to none in late seral.

Wildlife: This plant association supports abundant forage and is near water, making it attractive to livestock and wildlife. Deer, elk, and black bear may find these sites particularly attractive for food and cover. The wet spots serve as wallows for black bear and elk. Overuse can lead to compaction of the wet soil and loss of plant cover.

This plant association usually covers small areas that can be avoided by most management activities. The concern is that high elevation areas occupied by extensive steep slopes exhibit fragile aquic intergrade soils. Disturbance from heavy equipment can be especially damaging in spring and early summer when water tables are highest. If tree removal is necessary, cable yarding or entry while frozen and snow covered should be used. Watershed: Important natural water producer.

Reference(s)
DeVelice *et al*. 1986
USFS 1987a

Subalpine fir/moss
Abies lasiocarpa/moss

(Formerly: Abies bifolia/Moss)

Synonyms
Abies lasiocarpa-Picea engelmannii/Moss (Johnston 1987)

Code(s)
subalpine fir (ABLA) phase 0 03 11 0

Engelmann spruce (PIEN) phase 0 03 11 1

Douglas-fir (PSME) phase 0 03 11 2

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Upper (SFP)

National Vegetation Classification Group
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219) (primary)

Key criteria
Engelmann spruce and ***subalpine fir** codominate the overstory. The prominent feature is the sparse undergrowth and the ***moss** cover.

Structure
Subalpine fir and Engelmann spruce codominate the overstory with aspen and occasionally, bristlecone pine appearing in minor seral roles. The overstory is well stocked (stockability = 1) with most age and size classes represented. At lower elevations Douglas-fir is a seral tree and is associated with Rocky Mountain maple. In the understory, herbaceous cover is sparse with the most prominent feature being the moss cover. In this dry habitat, the shrub layer occasionally attains up to 10% cover. Timber productivity is low to moderate. The average site index for Engelmann spruce is 54 (N=11).

Location
Mountain summits, ridges or upper slopes on any aspect. Slopes vary from gentle to steep; cold, dry sites. Elevations range from 9,800’ to 11,500’ (2,990 to 3,505 m) primarily restricted to the Sangre de Cristo,

San Pedro, and Jemez Mountains of northern New Mexico and extensive in the Pinaleno Mountains of southern Arizona.

Adjacent plant associations
ABLA/Moss lies within the elevational range of the PIEN/VAMY/POPU and ABLA/VAMY sites and adjoins them in less exposed situations.

Also see
At lower elevations, ABLA/JUCO herb cover is common, and Douglas-fir is a more important seral tree. At higher elevations or more exposed sites where subalpine fir becomes a minor tree, see PIEN/Moss. PIEN/ACGL has better expressions of shrubs and herbs, but grades to ABLA/Moss: PIEN/Moss (USFS 1986a) altogether lacks subalpine fir and occurs on dry high elevation sites in the Chiricahua Mountains. The PIEN phase of ABLA/Moss may be called PIEN/Moss.

Important and key plants from research plots
Trees & life history traits
subalpine fir phase:
***subalpine fir** (*Abies lasiocarpa*) C
Engelmann spruce (*Picea engelmannii*) c
quaking aspen (*Populus tremuloides*) [early] s
Engelmann spruce phase:
Engelmann spruce (*Picea engelmannii*) C
***subalpine fir** (*Abies lasiocarpa*) c
quaking aspen (*Populus tremuloides*) [early] s
bristlecone pine (*Pinus aristata*) [late] s
Douglas-fir (*Pseudotsuga menziesii*) [mid to late (lower elev.)] s
Douglas-fir phase:
Engelmann spruce (*Picea engelmannii*) C
white fir (*Abies concolor*) S
Douglas-fir (*Pseudotsuga menziesii*) S
***subalpine fir** (*Abies lasiocarpa*) c
southwestern white pine (*Pinus strobiformis*) s
quaking aspen *(Populus tremuloides)* [early] s

Shrubs
Scarce (<1% cover) to common (>1% cover) occasionally to 10% cover:

common juniper *(Juniperus communis)*
gooseberry currant *(Ribes montigenum)*
whortleberry *(Vaccinium* spp.)
lower elevations:
rock spirea *(Holodiscus dumosus)*
Rocky Mountain maple *(Acer glabrum)*

Herbs
Scarce (<1% cover).

Cryptogams
Well represented (>5% cover) on microsites without litter.

Brief plant ID notes
Moss cover is the only prominent feature of the undergrowth.

Terrestrial Ecological Unit attributes
Life zone class: 7 (subalpine forest)
Elev. Subzone: 0 (typical) subalpine fir/Engelmann spruce phases
-1(warm, dry) Douglas-fir phase
Climate class: LSC (low sun cold)

Phases
Three phases are recognized:

Subalpine fir phase: High elevation, cold, dry slopes of Northern New Mexico and Southern Colorado; containing varying percentages of Engelmann spruce.

Engelmann spruce phase: High elevation, cold, dry slopes of Arizona south of the Mogollon Rim and Southwestern New Mexico.

Douglas-fir phase: Elevations lower than the other phases; also warmer, dryer.

Fire ecology
No information on fire ecology was available for this plant association.

Reforestation
Silvicultural cutting methods: Heavy overstory removal may favor aspen if present, otherwise regeneration of trees may be unsuccessful without extraordinary planting measures. Where aspen is minor seral, regeneration of aspen may be patchy or clumpy following disturbance,

where healthy root stock exists. It is unlikely to form a dominant cover type.

Lesser degrees of overstory removal may encourage tree regeneration and can be expected to favor Engelmann spruce especially at higher elevations. Windthrow susceptibility increases once a stand is opened through cutting. Selection cutting favors subalpine fir by leaving larger amounts of shade. Engelmann spruce may be planted, but survival can be difficult. Site preparation methods including burning are usually ineffective for increasing tree survival due to the severely dry nature of the habitat.

Revegetation considerations
Natural revegetation is slow to moderate after disturbance.

Comments
Livestock find little forage and seldom use these areas. Deer and elk find cover in these stands.

Compared with many other high elevation plant associations, this one is dry; typically occurring near ridges and upper slopes; usually a poor site for aspen.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)
DeVelice *et al*.1986
USFS 1987a
USFS 1987b

Subalpine fir/burnet ragwort

(Formerly: Subalpine fir/Burnet groundsel ABLA/SESA6)

Abies lasiocarpa/packera sanguisorboides

(Formerly: Abies bifolia/Senecio sanguisorboides)

Code(s)
burnet ragwort (PASA12) phase 0 03 30 0
Douglas-fir (PSME) phase 0 03 30 1

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Upper (SFP)

National Vegetation Classification Group
Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland (G218)

Key criteria
***Subalpine fir** is most often dominant in the overstory while Engelmann spruce is either less or is co-dominate. No white fir is present; Douglas-fir is seral only at lower elevations. The shrub layer is dominated by *Ribes* spp. while the rich herbaceous layer is dominated by ***burnet ragwort.** Southwestern white pine may be an accidental species in the Douglas-fir phase.

Structure
Subalpine fir is present in all sizes and classes; some individuals exceed 275 years old and hold North American records for size and growth rate. Engelmann spruce often shares crown dominance. White fir is absent. At lower elevations, Douglas-fir is present as a seral tree.

Site quality for subalpine fir is high. Productivity is moderate to high; increasing toward lower elevations of type. Average site index for Engelmann spruce in the Douglas-fir phase is 80.

Location
The known distribution of this plant association is the Sacramento Mountains in the vicinity of Sierra Blanca Peak, NM, where it occurs on all aspects and slopes over 10,000 feet (3,000 m).

Adjacent plant associations
Adjoining types: tundra and *Festuca thurberi* meadows adjoin on high windswept ridges; ABCO-PSME/ACGL Hodu phase at lower elevations.

Also see
Alexander *et al.* 1984a; Dye and Moir 1977.

Important and key plants from research plots
Trees & life history traits
<u>*burnet ragwort phase:*</u>
***subalpine fir** (*Abies lasiocarpa* var. *arizonica)* C
Engelmann Spruce (*Picea engelmannii*) C
<u>*Douglas-fir phase:*</u>
subalpine fir (*Abies lasiocarpa* var. *arizonica)* C
Engelmann spruce (*Picea engelmannii)* C
quaking aspen *(Populus tremuloides)* early/mid-seral S
Douglas-fir *(Pseudotsuga menziesii)* late seral S
Shrubs
Well represented (>5%):
twinberry honeysuckle *(Lonicera involucrata)*
Wolf's currant *(Ribes wolfii)*
gooseberry currant *(Ribes montigenum)*
Rocky Mountain maple *(Acer glabrum)*
sidebells wintergreen *(Orthilia secunda)*

Herbs
Abundant (>25% coverage):
*burnet ragwort (*Packera sanguisorboides*)
fringed brome (*Bromus ciliatus*)
Richardson's geranium (*Geranium richardsonii*)
sprucefir fleabane (*Erigeron eximius*)
Canadian white violet (*Viola canadensis*)
bluntseed sweetroot (*Osmorhiza depauperata*)

red baneberry (*Actaea rubra*)
ravine fescue (*Festuca sororia*)
spike trisetum (*Trisetum spicatum*)
alpine false springparsley (*Pseudocymopterus montanus*)
Porter's licorice-root (*Ligusticum porteri*)

Brief plant ID notes
Burnet ragwort is a multi-headed, yellow-flowered composite, with pinnately lobed leaves.

Synonymy
bluntseed sweetroot (*Osmorhiza depauperata*) = sweetcicily (*Osmorhiza obtusa*)
sprucefir fleabane (*Erigeron eximius*) =
forest fleabane (*E. superbus*)
subalpine fir (*Abies lasiocarpa* var *arizonica*)
sidebells wintergreen (*Orthilia secunda = Ramischia secunda*)
Oregon boxleaf (*Paxistima myrsinites= Pachistima myrsinites*)
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
Porter's licorice-root *(Ligusticum porteri) = osha*
burnet ragwort *(Packera sanguisorboides = Senecio sanguisorboides)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: 0 (typical) [SESA phase], -1 (warm, dry) [PSME phase]
Climate Class: LSC (Low Sun Cold)

Phases
ABLA/PASA12, typic phase lacks Douglas-fir and *Ribes* spp. dominate shrub layer. In the ABLA/PASA12, PSME phase, Douglas-fir is an important seral tree on warmer sites and lower elevations, *Ribes* spp. has minimal coverage, and aspen forms seral communities.

Fire ecology
Fires severe enough to create large forest openings (often along upper slopes and ridges) result in shrub dominated communities. Fires may bring about seral communities suggestive of ABCO-PSME/ACGL at lower elevations. Intervals between stand replacement fires is on the

order of hundreds of years. Dye and Moir (1977) discuss this plant association in depth. Stands in the range of 140 to 212 years reflect a fire or fires that were extensive around Sierra Blanca. A small old-growth stand escaped burning during that time.

Reforestation
Silvicultural cutting methods: Clearcutting favors aspen in the Douglas-fir phase. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance.

Shelterwood and selection methods favor subalpine fir. Seed tree cutting methods often result in blowdown. Tree planting is likely to be successful for Engelmann spruce and subalpine fir.

Revegetation considerations
Natural revegetation is very rapid. Burning will cause resprouting of aspen in the lower portions of the site, and establishment of *Ribes* spp. following fire is evident on the higher areas.

Comments
In the Sacramento Mountains, this association serves as the principal watershed for Ruidoso and Capitan, NM. Important for snow retention and ski recreation.

Mean annual precipitation (MAP) = 30-31"/yr., deep winter snowpack.

Livestock: Forage value rating for cattle in the early seral stage is high; late seral is none.

Reference(s)
Alexander et al.1984
Dye and Moir 1977
Moir and Ludwig 1979
USFS 1986
Uchytil 1991

(Formerly: ABBI/RUPA)

Subalpine fir/Thimbleberry
Abies lasiocarpa/Rubus Parviflorus

(Formerly: Abies bifolia/Rubus parviflorus)

Synonyms
ABLA-PIEN1/RUPA (Johnston 1987)

Code(s)
whortleberry Phase 0 03 24 0
Rocky Mountain maple Phase 0 03 23 1

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Upper (SFP)

National Vegetation Classification Group
Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland (G218)

Key criteria
***Subalpine fir** dominates the overstory; Engelmann spruce usually subordinate. Douglas-fir and aspen are major seral trees. Undergrowth is rich in species diversity. Except for the VAMY phase, *Vaccinium* spp. are lacking; ***thimbleberry** is an indicator species for the undergrowth.

Structure
ABLA/RUPA plant association is found in moist, protected sites. Stand structure typically demonstrates a dense and varied overstory with a tall and low shrub layer having cover ranging from 15-55% and rich, diverse herbaceous cover having many species represented in trace amounts. Subalpine fir is present, usually in all sizes; with moderate to heavy regeneration. Engelmann spruce is codominant or sometimes subordinate with light to moderate regeneration. Douglas-fir is a major seral species and may dominate having abundant regeneration in successional aspen stands.

Site quality for spruce and fir are moderate to good and moderate for Douglas-fir.

Site indices are 67 +/- 7 for Douglas-fir and 55 +/- 12 for Engelmann spruce. Stockability = 1.

The forage value rating for cattle is moderate in early seral stages. Late seral stage in most stands have such dense crown growth, little herbaceous cover is available. A wealth of forage and browse species make this an outstanding wildlife habitat.

Location
Steep, northerly, mid and lower slopes and draws with soils often extremely cobbly; 8,800' to 9,200' [2,640 to 2,990 m] (but as low as 8,200' [2,460 m] in sheltered draws); known distribution is San Juan Mountains of northern New Mexico and southern Colorado, and local in the White Mountains of Arizona and the Mogollon Mountains of southern New Mexico.

Adjacent plant associations
ABLA/EREX3 (colder/wetter sites) or ABLA/VAMY, RUPA phase; ABCO/QUGA, ABCO/ACGL, or ABCO/Sparse (on less moist sites).

ABLA/RUPA, VAMY2 phase ecotones with ABLA/VAMY2 on cooler, more moist sites.

On warmer drier sites at lower elevations, the VAMY and ACGL phases adjoin. Look for ecotones with PIST/FEAR2 plant associations.

Also see
ABLA/ACGL (Alexander *et al*. 1987; Youngblood and Mauk, 1985).

Important and key plants from research plots
Trees & life history traits
whortleberry phase:
***subalpine fir** (*Abies lasiocarpa*) C
Engelmann spruce (*Picea engelmannii*) C
quaking aspen (*Populus tremuloides*) [early to late] S
Douglas-fir (*Pseudotsuga menziesii*) [mid to late] S
white fir (*Abies concolor*) s
Rocky Mountain maple phase:
***subalpine fir** (*Abies lasiocarpa*) C
quaking aspen (*Populus tremuloides*) [early to late] S
Douglas-fir (*Pseudotsuga menziesii*) [mid to late] S
white fir (*Abies concolor*) S

Engelmann spruce (*Picea engelmannii*) c
southwestern white pine (*Pinus strobiformis*) [so. NM] s
limber pine *(Pinus flexilis)* [northern NM, Colo.] s

Shrubs
Abundant (>25% cover):
***thimbleberry** *(Rubus parviflorus)* whortleberry *(Vaccinium myrtillus)* [VAMY phase only]
Rocky Mountain maple *(Acer glabrum)* [ACGL phase]
rockspirea *(Holodiscus dumosus)*
Scouler's willow *(Salix scouleriana)*
New Mexico locust *(Robinia neomexicana)*
orange gooseberry *(Ribes pinetorum)*
Utah honeysuckle *(Lonicera utahensis)*
Oregon boxleaf *(Paxistima myrsinites)*

Herbs
Well represented (>5%) sometimes abundant (>25%) cover:
fringed brome *(Bromus ciliatus)*
Richardson's geranium *(Geranium richardsonii)*
western rattlesnake plantain *(Goodyera oblongifolia)*
sidebells wintergreen *(Orthilia secunda)*
ragweed sagebrush *(Artemisia franserioides)*
rock clematis *(Clematis columbiana* var. *columbiana)*
western bracken fern *(Pteridium aquilinum)*
roughfruit fairybells *(Prosartes trachycarpum)*
fireweed *(Epilobium angustifolium)*
bluntseed sweetroot *(Osmorhiza depauperata)*
bittercress ragwort *(Packera cardamine)*
feathery false lily of the valley *(Maiathemum racemosum)*
Canadian white violet *(Viola canadensis)*
red baneberry *(Actaea rubra)*
mountain deathcamas *(Zigadenus elegans)*

Brief plant ID notes
Thimbleberry is generally a low shrub with large, palmately-lobed, simple leaves.

Synonymy
whortleberry = myrtle huckleberry

subalpine fir *(Abies lasiocarpa* var *arizonica)*
feathery false liliy of the valley *(Maianthemum racemosum = Smilacina racemosa)*
sidebells wintergreen *(Orthilia secunda = Ramischia secunda)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
bluntseed sweetroot *(Osmorhiza depauperata)* = sweet cicily *(Osmorhiza obtusa)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
rock clematis *(Clematis columbiana* var. *columbiana = C. pseudoalpina)*
fireweed *(Chamerion angustifolium* spp. *angustifolium = Epilobium angustifolium* ssp *angustifolium)*
bittercress ragwort (*Packera cardamine = Senecio cardamine = cardamine groundsel)*
roughfruit ferrybells *(Porsartes trachycarpum = Disporum trachycarpum)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: -1 (warm, dry)
Climate Class: LSC (low sun cold)

Phases
Two phases are recognized (Moir and Ludwig 1979). In the **whortleberry** (VAMY2) **phase,** the low shrub whortleberry is codominant with thimbleberry. The **Rocky Mountain maple** (ACGL) **phase** is characterized with Rocky Mountain maple in the tall shrub stratum, and the absence of whortleberry in the low shrub stratum. In the VAMY2 phase, white fir is a minor or accidental, whereas in the ACGL phase, white fir is a major seral species.

Fire ecology
Primeval wildfires were probably light intensity, burning irregularly in patches and at long intervals between events within this and related wet habitats (Jones 1974).

Reforestation
Because of the presence of Douglas-fir as a major seral, or in some locations a minor climax species, and aspen as a major seral tree, a

degree of flexibility for overstory management including opportunities for developing mixed as well as single species stands is possible. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance. Heavy overstory removal favors establishment of aspen. With lesser degrees of overstory removal, shade tolerance will favor spruce and fir; that is, more shade favoring fir. Seed tree type harvest methods for spruce and fir are likely to be unsuccessful due to increased potential for blowdown. Selective removal of species can be used to improve species composition especially in early to mid-seral stands. Artificial planting of conifers with appropriate site preparation can result in a high degree of success probability. Site preparation techniques must create microsite conditions required by species to be planted, e.g., burning usually favors natural aspen regeneration and may give satisfactory condition for planting of Douglas-fir or even white fir at lower elevations, but conditions for planting spruce or fir would be too dry and too exposed to sunlight. Some slopes are too steep for conventional timber harvest methods.

Revegetation considerations
Stands with young Douglas-fir and subalpine fir regeneration exhibited the ground characteristics of the plant association indicating rapid recovery after fairly recent burning.

Comments
Sites in this type are characteristically moist. They are important for snow retention; and important big game feeding and cover.

References
DeVelice *et al*. 1986
Fitzhugh *et al*. 1987
Jones 1974
Moir and Ludwig 1979
Tirmenstein 1990 (Vaccinium)
Uchytil 1991
USFS 1987a
USFS 1987b

Subalpine fir/whortleberry

(Formerly*: Subalpine fir/myrtle huckleberry ABLA/VAMY)*

Abies lasiocarpa/Vaccinium myrtillus

(Formerly*: Abies bifolia/Vaccinium myrtillus*)

Synonyms
Abies lasiocarpa/ Vaccinium scoparium (ABLA/VASC) Moir and Ludwig 1979; ABLA-PIEN/VAMY Johnston 1987.

Code(s)
whortleberry (VAMY2) phase 0 03 20 0
twinflower (LIBO3) phase 0 03 20 1
thimbleberry (RUPA) phase 0 03 20 2
fivepetal cliffbush (JAAM) phase 0 03 20 3

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Upper (SFP)

National Vegetation Classification Group
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

Location
This type occurs on all aspects (north-northeast in RUPA phase) and on moderate to steep, lower, middle and upper slopes (lower draws and streamside in RUPA phase). Elevations range from 8,500 to 11,200' (2,90 to 3,13 m); north slopes to 9,000 feet (2,56m). Distribution is widespread from Fort Apache Reservation, White and Pinaleno Mountains in Arizona, Mogollon Mountains and the Black Range in New Mexico, also generally the higher mountains of northern New Mexico, southern Colorado and southern Utah (La Sal Mountains).

Adjacent plant associations
Adjoining types are: ABLA/Moss on drier exposures; ABLA/EREX4 at lower elevations; and PIEN/VAMY/POPU at upper elevations.

Also see
ABLA-PIEN/VASC (Johnston 1987) is closely related but has lodgepole pine as a major seral tree. ABLA/VAMY2-RUPA (DeVelice

et al. 1986) appears to be identical to RUPA phase and their ABLA/VAMY2-LIBO3 is identical to the LIBO3 phase. See ABLA/CASI12 when whortleberry <5% cover; scree forest on talus slopes where whortleberry is patchy; also closely related to ABLA/EREX (Moir and Ludwig 1979).

Important and key plants from research plots
Trees & life history traits
whortleberry (VAMY or typic) phase:
Engelmann spruce (*Picea engelmannii*) C
*subalpine fir (*Abies lasiocarpa* var. *arizonica*) C
quaking aspen (*Populus tremuloides*) [early to mid] S
twinflower (LIBO3) phase:
Engelmann spruce (*Picea engelmannii*) C
*subalpine fir (*Abies lasiocarpa* var. *arizonica*) C
quaking aspen (*Populus tremuloides*) [early to mid] S
Douglas-fir (*Pseudotsuga menziesii*) [late] S
white fir (*Abies concolor*) S
blue spruce (*Picea pungens*) s
white fir (*Abies concolor*) s
thimbleberry (RUPA) phase:
Engelmann spruce (*Picea engelmannii*) C
*subalpine fir (*Abies lasiocarpa* var. *arizonica*) C
quaking aspen (*Populus tremuloides*) [early to mid] S
Douglas-fir (*Pseudotsuga menziesii*) [late] S
southwestern white pine (*Pinus strobiformis*) s
white fir (*Abies concolor*) s
fivepetal cliffbush (JAAM) phase:
Engelmann spruce (*Picea engelmannii*) C
*subalpine fir (*Abies lasiocarpa* var. *arizonica*) C
quaking aspen (*Populus tremuloides*) [early to mid] S

Shrubs
Well represented (>5%) to luxuriant (>50%) coverage:
grouse whortleberry (*Vaccinium scoparium*)
*whortleberry (*Vaccinium myrtillus*)
Utah honeysuckle (*Lonicera utahensis*)
twinberry honeysuckle (*Lonicera involucrata*)
Wolf's currant (*Ribies wolfii*)

gooseberry currant (*Ribes montigenum*)
Arizona mountain ash (*Sorbus dumosa*)
thimbleberry (RUPA) phase additionally includes
*thimbleberry (*Rubus parviflorus*)
Scouler's willow (*Salix scouleriana*)
rockspirea (*Holodiscus dumosus*)
Rocky Mountain maple (*Acer glabrum*)
fivepetal cliffbush (JAAM) phase includes:
*fivepetal cliffbush (*Jamesia americana*) [>5% cover]
twinflower (LIBO3) phase includes:
*twinflower (*Linnaea borealis*)

Herbs
Common (>1%) to well represented (>5%) coverage:
spike trisetum (*Trisetum spicatum*)
fringed brome (*Bromus ciliatus*)
sprucefir fleabane (*Erigeron eximius*)
Oregon boxleaf (*Paxistima myrsinites*)
sickletop lousewort (*Pedicularis racemosa*)
Mogollon Mountain lousewort (*Pedicularis angustifolia*)
heartleaf arnica (*Arnica cordifolia*)
ragweed sagebrush (*Artemisia franseriodes*)
Virginia strawberry (*Fragaria virginiana* ssp. *Virginiana*)
Richardson's geranium (*Geranium richardsonii*)
peavine spp. (*Lathyrus spp.)*
Parry's goldenrod (*Oreochrysum parryi*)
fireweed (*Epilobium angustifolium* ssp *angustifolium*)
elkweed (*Frasera speciosa*)
sidebells wintergreen (*Orthilia secunda*)
greenflowered wintergreen (*Pyrola chlorantha*)
Fendler's meadow-rue (*Thalictrum fendleri*)
tall fringed bluebells (*Mertensia ciliata*) [in wet microsites]

Cryptogams
Abundant (>25%) to luxuriant (>50%) cover, especially mosses.

Brief plant ID notes
Whortleberry and grouse whortleberry may be found occurring in the same plant communities. Since whortleberry seems to be the more

common of the two species in northern New Mexico and southern Colorado, it was chosen to name the plant association. Grouse whortleberry does not occur in south central New Mexico or in Arizona.

Synonymy
whortleberry = myrtle huckleberry
sprucefir fleabane (*Erigeron eximius*) = forest fleabane (*E. superbus*)
Oregon boxleaf (*Paxistima myrsinites = Pachistima myrsinites*)
Parry's goldenrod (*Oreochrysum parryi = Haplopappus parryi*)
sidebells wintergreen (*Orthilia secunda = Ramischia secunda = Pyrola secunda*)
Virginia strawberry (*Frageria virginiana* ssp. *virginiana = F. ovalis*)
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
fireweed *(Chamerion angustifolium spp. angustifolium = Epilobium angustifolium* ssp *angustifolium)*
spike trisetum *(Trisetum spicatum = T. montanum* = Rocky Mountain trisetum*)*
Mogollon Mountain lousewort *(Pedicularis angustifolia = P. angustissima)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: 0 (typic) [whortleberry and fivepetal cliffbush phases]
-1 (warm, dry) [thimbleberry and twinflower phases]
Climate Class: LSC (low sun cold)

Phases
Whortleberry (ABLA/VAMY2) **or typic phase:** Subalpine fir and Engelmann spruce are codominant in overstory. Douglas-fir and aspen are seral trees. Undergrowth may exceed 30% cover and Vaccinium spp. dominate. Occurs on all aspects; moderate to steep, middle to upper slopes; widespread in Arizona, New Mexico, southern Utah and Colorado.

Twinflower (ABLA/VAMY2, LIBO3) **phase:** Listed as ABLA/VAMY2-LIBO3 Habitat Type by DeVelice et al. 1986—Usually found at lower elevations at ecotone with mixed conifer forest types; thus, supports seral trees species such as white fir, aspen, and

Douglas-fir. In the understory, whortleberry and twinflower are the dominant indicators. Occurs predominately on north and northeast-facing mid and lower slopes; is most common in the San Juan Mountains of Colorado and the Sangre de Cristo Range of New Mexico and Colorado.

Thimbleberry (ABLA/VAMY2, RUPA) **phase:** Listed as ABLA/VAMY2-RUPA Habitat Type by DeVelice *et al.* 1986—Douglas-fir and aspen are the most important seral trees. Understory diverse with total cover often exceeding 100% where thimbleberry occurs along with other shrubs and forbs. Occurs on moist, steep, northerly, lower slopes of Colorado's San Juan Mountains and in central New Mexico.

Fivepetal cliffbush (ABLA/VAMY, JAAM) **phase:** Similar to ABLA/VAMY, RUPA, the fivepetal cliffbush phase exhibits the mixed species overstory. In the understory, fivepetal cliffbush dominates with >5% cover in the shrub layer, and wintergreens the most common forb. Known distribution: north-facing slopes above 9,500 feet in elevations, near the summits of the Pinaleno Mountains, Arizona.

Fire ecology
Thimbleberry phase-late successional stage vegetation following fire included: Rocky Mountain maple, Scouler's willow, aspen, rockspirea, and New Mexico locust (>25% cover); fir and spruce reproduction, large survivors of the fire (Douglas-fir) (Fitzhugh *et al.* 1987).

Fire and or blowdowns may result in aspen as a principal tree (early seral stage); herb cover is scarce and comprised mostly of graminoids. Evidence of fire and/or windthrow can be found in most stands. Crown fires tend to result in even-aged stands. Windthrown and lighter intensity fires with accompanying gap phase reproduction produce uneven-aged and in time mixed stands (Niering and Lowe 1984). Stromberg and Patten (1991) characterize the Pinaleno Mountains as having an abundance of old-growth stands (developed and undisturbed over centuries, having large old trees, a multilayered canopy and many downed logs/standing dead trees) (Prior to recent wildfire occurrences during the 1990s-2000s). The spruce-fir stands have few disturbed sites, but data suggests a slow recovery from disturbance. Following disturbance, such as fire, within 30 years or so, spruce becomes the

dominating colonizing species. Eighty to 150 years later, subalpine fir may invade along with additional recruitment of spruce. In about 150 to 200 years, the stand reaches maturity and old-growth at 250 to 350 years.

The absence of any old-growth subalpine fir stands, probably indicates that significant disturbance has occurred within the past 400 years.

Reforestation
Silvicultural cutting methods: heavy overstory removal may favor aspen if present, otherwise regeneration may be unsuccessful without extraordinary planting measures. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance. Wetter, herb-rich sites may be converted to sedge fields following clearcutting thus creating severe regeneration problems (DeVelice et al. 1986). Lesser degrees of overstory removal may be successful and can be expected to favor Engelmann spruce especially at higher elevations. Windthrow susceptibility may increase once a stand is opened through cutting. Selection cutting favors subalpine fir. Selection methods can be used to modify species composition especially in early to mid-seral stands. Some slopes are too steep for conventional timber harvest methods.

Artificial planting of conifers with appropriate site preparation can result in a high degree of success. Site preparation techniques must create microsite conditions required by species to be planted, e.g., burning usually favors natural aspen regeneration and may give satisfactory condition for planting of Douglas-fir or even white fir at lower elevations, but conditions for planting spruce or fir on south or west slopes would be too dry and too exposed. North and east slopes are easier to reforest and do not require extraordinary planting measures.

Revegetation considerations
Natural revegetation is slow to moderate after disturbance due to the short growing season.

Comments
Livestock**:** Livestock seldom use this plant association due to little available forage.

Wildlife: ABLA/VAMY provides cover/shelter for wildlife (primarily elk and deer) that feed in adjacent plant associations.

Presence of whortleberry is indicative of characteristically deep snowpack. This plant association is thought to be the most important of all subalpine types in R-3 for winter snow accumulation and regulated summer discharge of water. (Fitzhugh *et al.* 1987).

This plant association reaches its southern-most occurrence in the U.S. in the Pinaleno Mountains.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings. The RUPA & LIBO3 may be more susceptible to budworm than the typic phase.

Reference(s)

Alexander et al. 1987
DeVelice et al. 1986
Fitzhugh et al. 1987
Stromberg and Patten 1991
USFS 1986
USFS 1987a
USFS 1987b
Uchytil 1991

Bristlecone Pine Series

PIAR/FEAR2

Bristlecone pine/Arizona fescue
Pinus Aristata/Festuca Arizonica

Synonyms
PIAR/FEAR2/MUMO/RICE, Shephard 1975

Code(s)
typic phase 2 38 30 0

Ecological Response Unit
Mixed Conifer – Frequent Fire (BP) (= "dry mixed conifer")

National Vegetation Classification Group
Rocky Mountain Subalpine-Montane Limber Pine - Bristlecone Pine Woodland (G221)

Key criteria
***Bristlecone pine** is dominant or is codominant with Douglas-fir in the overstory; and grasses dominate the understory with ***Arizona fescue** as the indicator species. Quaking aspen *(Populus tremuloides)* occurs as an accidental species in this plant association.

Structure
Overstory is dominated by bristlecone pine or sometimes co-dominated by Douglas-fir and is often open grown (park like) or occurs in clusters interspersed with grass meadows. Moderate to low density bristlecone pine and Douglas-fir regeneration is found in the understory. Productivity of this plant association is low. No site index data are available. Stockability is 0.8. The resource value rating for cattle in early seral stage is moderate, and in the late seral stage is low.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated

heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Location
Occurs on steep, westerly or southerly, upper slopes with rocky soils. Elevations range from 8,600' to 10,000' (2620 to 3050 m) primarily in the Sangre de Cristo Mountains of New Mexico.

Adjacent plant associations
PIAR/FETH at higher elevations; PSME/FEAR2 at lower elevations.

Also see
PSME/FEAR2, *Pinus flexilis* phase occurs on similar sites in the San Fransico Peaks, Arizona; TES mapping units 300 and 302 for Carson National Forest (Edwards 1987).

Important and key plants from research plots
Trees & life history traits
***bristlecone pine** *(Pinus aristata)* [drier, more exposed sites] C
limber pine (*Pinus flexilis*) c
blue spruce (*Picea pungens*) c
Douglas-fir *(Pseudotsuga menziesii)* c

Shrubs
Common (>1% cover):
wax currant *(Ribes cereum)*
mountain snowberry
(Symphoricarpos oreophilus)
common juniper *(Juniperus communis)*

Herbs
Abundant (> 25% cover):
***Arizona fescue** *(Festuca arizonica)*
mountain muhly *(Muhlenbergia montana)*
prairie junegrass *(Koeleria macanthra)*
fleabanes (*Erigeron* spp.)
forest sage *(Artemisia franserioides)*
bluebell bellflower *(Campanula rotundifolia)*.

Brief plant ID notes

Bristlecone pine is a small evergreen needle tree up to 40 feet tall, with irregular, broad crown, or a low bushy shrub at timberline. The needles are numerous, densely crowded, and short (0.5 - 1.5 inches [1.3 - 3.8 cm] long) and in 5-needle bundles.

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: 0 (typical or modal) or +1 (cool, moist)
Climate Class: LSC (low sun cold)

Fire ecology
This is often an interesting and attractive plant association because of open grassy stands and contrast in tree form between bristlecone pine and Douglas-fir or blue spruce. Historically, fires of sufficient frequency and intensity-maintained meadows. Cessation of grass fires contributes to tree encroachment into former meadows.

Due to graminoid dominant undergrowth, fires seldom reach sufficient intensities to produce devastating crown fires.

Reforestation
Reforestation Methods: Heavy overstory removal usually favors expansion of meadows where established grasses are likely to out compete conifers in these dry exposed sites. Lesser and staged overstory removal may encourage some conifer regeneration. Selection cutting tends to favor Douglas-fir or blue spruce regeneration. Seedling survival from planting projects has been low. Species recommended for planting are bristlecone pine or blue spruce where appropriate. Low intensity mechanical site preparation methods such as hand scalping may enhance planting success.

Revegetation considerations
Natural revegetation following fire or other disturbance is likely to be moderate to slow due to dry site conditions; however, grasses have been reported to re-establish quickly (Jack Carpenter, pers. comm.). Response to heavy livestock/wildlife grazing may produce bluegrass sod.

Comments
Good deer and elk summer range.

References

DeVelice *et al.* 1986
Little 1950
USFS 1987a

bristlecone pine/Thurber's fescue
Pinus aristata/Festuca thurberi

Code(s)
typic phase 2 38 31 0

Ecological Response Unit
Bristlecone Pine (BP)

National Vegetation Classification Group
Rocky Mountain Subalpine-Montane Limber Pine - Bristlecone Pine Woodland (G221)

Key criteria
***Bristlecone pine** is dominant or is codominant with Engelmann spruce in the overstory; grasses dominate the understory with ***Thurber's fescue** as the indicator species. Subalpine fir *(Abies lasiocarpa* var. *arizonica)* may occur as an accidental.

Structure
Stands of bristlecone pine are usually pure, even aged and open, may be co-dominated by Engelmann spruce. No site index data are available. Productivity for bristlecone pine is low. Resource value rating for cattle in early seral stages is moderate and low in late seral stages.

Location
Occurs on steep mid and upper slopes; cold, dry sites mostly near timberline or within spruce-fir zone on skeletal soils. Elevations exceed 10,500' (3200 m) primarily in the San Juan Mountains in Colorado and the Sangre de Cristo Mountain Range of Colorado and northern New Mexico.

Adjacent plant associations
Adjoins Arizona fescue grasslands in drier situations and PIEN/VAMY2/POPU2 plant association on moister sites (north aspects/less windy exposures).

Also see
TES mapping unit 303 for Carson National Forest (Edwards 1987); if *Festuca thurberi* is scarce, see PIAR/FEAR2.

Important and key plants from research plots
Trees & life history traits
***bristlecone pine** (*Pinus aristata*) [drier more exposed sites] C
Engelmann spruce *(Picea engelmannii*) C

Shrubs
Scarce (<1% cover):
gooseberry currant *(Ribes montigenum)*
wax currant *(Ribes cereum)*
mountain snowberry *(Symphoricarpos oreophilus)*
common juniper *(Juniperus communis)*

Herbs
Abundant (>25% cover).
***Thurber's fescue** *(Festuca thurberi)*
Arizona fescue *(Festuca arizonica)*
Kentucky bluegrass *(Poa pratensis)*
muttongrass *(Poa fendleriana)*
heartleaf arnica *(Arnica cordifolia)*
western yarrow *(Achillea millefolium* var *occidentalis)*
fireweed *(Epilobium angustifolium* ssp *angustifolium)*
Parry's goldenrod *(Oreochrysum parryi)*
Fendler's meadow-rue *(Thalictrum fendleri)*
alpine clover *(Trifolium dasyphyllum)*
bluebell bellflower *(Campanula rotundifolia)*
skunkweed polemonium *(Polemonium pulcherrimum* spp *delicatum)*
yellowdot saxifrage *(Saxifraga bronchialis)*

Synonymy
western yarrow (Achillea millefolium var. occidentalis = A. lanulosa)
fireweed (Chamerion angustifolium spp. angustifolium = Epilobium angustifolium ssp angustifolium)
Parry's goldenrod (Oreochrysum parryi = Haplopappus parryi = Solidago parryi)
skunkweed polemonium *(Polemonium pulcherrimum* var. *delicatum)* = Jacob's ladder *(Polemonium delicatum)*

Brief plant ID notes
Fescues are relatively easy to identify: inflorescence is a panicle; spikelets are several-flowered and disarticulate (separate) above the

glumes; and the lemmas are awned or at least have a pointed tip (acuminate). Both Thurber's and Arizona fescue have leaf blades mostly less than 3mm wide, rolled and somewhat stiff. Thurber's fescue: ligules 2.5 to 9 mm long; lemmas are awnless or only awn-tipped. Arizona fescue ligules <2 mm long; lemmas awned usually <2 mm long. (Allred 1994)

Terrestrial Ecological Unit attributes
Life zone class: 7 (spruce-fir forest)
Elevational subzone: -1 (warm dry), 0 (typical or modal), +1 (cool, moist)
Climate class: LSC (low sun cold)

Fire ecology
Studies of fire history in the Pecos Wilderness obtained from bristlecone pine stands indicate that fire played a dramatic role in development of coniferous stands. Prehistoric and historic fire regimes created and maintained the characteristic mosaic of these high elevation coniferous forests, aspen groves and mountain meadows. As elsewhere in the Southwest, prior to 1873, low intensity spreading fires occurred at regular intervals. Apparently, this pattern of fires ceased after 1873, due most likely to increasing numbers of free-roaming, grazing domestic livestock. Grazing animals removed the dense herbaceous fuels which previously allowed surface fires to spread. (Moir *et al.* 1995).

Reforestation
Most timber harvest methods are not especially practical or successful for assuring reforestation of bristlecone pine. Clearcutting generally favors meadows; seed tree cutting may not produce conifer regeneration; and selection favors Engelmann spruce regeneration. Shelterwood may be successful for either Engelmann spruce or bristlecone pine.

Tree planting for bristlecone pine is likely to have low success probability due to extreme dry and cold site conditions. Site preparation methods do not seem to enhance bristlecone seedling planting. Stockability is 0.8 and This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers.

Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Revegetation considerations
Natural revegetation after disturbances is moderate to slow. Recovery following logging, road building and other disturbance is extremely slow, often taking hundreds of years (Hess and Alexander 1986).

Establishment of bristlecone pine from seed is chancy at best. Given the proper conditions and timing, natural in-seeding can be successful. However, the limited occurrence of Rocky Mountain bristlecone pine, is probably due to low germinability of the seed. It does not exhibit dormancy, undergoes rapid germination, is subject to scarification mortality, and lacks cold hardiness (R.J. Preston Jr. 1948, in Ahleslager 1986).

Comments
Bristlecone pine is shade intolerant and generally favors drier, more exposed situations. Engelmann spruce is slightly less drought tolerant than bristlecone pine, but more so than subalpine fir. In contrast, Engelmann spruce is more highly shade tolerant than Bristlecone pine, yet in the drier, open exposures does not express its usual competitive edge over bristlecone pine. Thus, codominance of these two species or occasional sole dominance of bristlecone pine is expressed in PIAR/FETH plant association.

Bristlecone pine is considered by some to be a senescent species; i.e., its range does not expand nor recede (Peet, R.K. 1978).

Often this is an interesting and attractive plant association because of open grassy stands, distinctive form of bristlecone pine, and contrasts in tree form between bristlecone pine and spire-like crowns of Engelmann spruce. Cessation of grass fires contributes to tree encroachment into the meadows.

References
Ahleslager, K.E. *Pinus aristata* 1986
Allred, Kelly 1993
DeVelice *et al.* 1986

Hess & Alexander 1986
Moir *et al.* 1995
USFS 1987a

Bristlecone pine/Gooseberry currant

(Formerly Bristlecone pine/ Mountain currant PIAR/RIMO)

Pinus aristata/Ribes montigenum

Code
typic phase 2 38 04 0

Ecological Response Unit
Bristlecone Pine (BP)

National Vegetation Classification Group
Rocky Mountain Subalpine-Montane Limber Pine - Bristlecone Pine Woodland (G221)

Key criteria
***Bristlecone pine** is dominant or is codominant with Engelmann spruce and/or limber pine in the overstory; and sparse shrubs dominate the understory with ***gooseberry currant** as the indicator species.

Structure
This plant association generally has no potential for commercial timber and forage production.

Location
Occurs on scree and cobbly soils on ridgetops, slopes and dry, exposed sites; elevations from 10,500' to 11,500' (3,200 to 3,450 m) in northern Arizona, Utah, Colorado, and northern New Mexico.

Also see
Scree forest (DeVelice *et al.* 1986); (Rominger and Paulik 1983); *Pinus aristata/Trifolium dasyphyllum* H.T. (Hess and Alexander 1986).

Important and key plants from research plots
Trees & life history traits
***bristlecone pine** *(Pinus aristata)* [drier more exposed sites] C
Engelmann spruce *(Picea engelmannii)* c
limber pine *(Pinus flexilis)* c

Shrubs
Well represented (>5% cover):

***gooseberry current** *(Ribes montigenum)*
common juniper *(Juniperus communis)*

Herbs
Scarce (<1% cover):
***yellowdot saxifrage** *(Saxifraga bronchialis)*
Whipple's penstemon *(Penstemon whippleanus)*
alpine fescue *(Festuca brachyphylla)*
Fendler's pennycress *(Thlaspi montanum* var *fendleri)*
tall blacktip ragwort *(Senecio atratus)*
alpine clover *(Trifolium dasyphyllum)*

Brief plant ID notes
Bristlecone pine is a small evergreen needle tree up to 40 feet tall, with irregular, broad crown or a low bushy shrub at timberline. The needles are numerous, densely crowded, short (.5 - 1.5 inches [1.3 -3.8 cm] long) and in 5-needle bundles.

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (Spruce-fir forest)
Elevational Subzone: 0 (typical or modal), +1 (cool, moist)
Climate Class: LSC (Low Sun Cold)

Comments
The principal values of this plant association are for watershed protection and wildlife habitat management. Because of their great age and sensitive response to change in climatic conditions, bristlecone pine is of interest to researchers. Using cross-dating from a number of sources, researchers have developed a 7,100-year tree ring chronology for bristlecone pine in the White Mountains of east-central California. This was done by adding data from long-dead specimens to a 4,600-year record developed from living trees. In some areas, the esthetic appeal of the bristlecone trees and sites in which they live are attracting growing numbers of visitors. Preservation of the old wood and the trees is a concern.

References
DeVelice *et al*. 1986
Ferguson 1968
USFS 1987a

Blue Spruce Series

PIPU/ARUV

Blue spruce/kinnikinnick
Picea pungens/arctostaphylos uva-ursi

Synonyms
Picea pungens-Pseudotsuga menziesii h.t. (Moir and Ludwig 1979); *Picea pungens-Pseudotsuga menziesii/ Arctostaphylos uva-ursi* (Johnston 1987).

Code(s)
typic phase 0 06 08 0

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
The overstory may contain varying mixtures of other species, but ***blue spruce** is at least common and is successfully reproducing. ***Kinnikinnick**, the characteristic understory dominant, is well represented (>5% cover.) Subalpine fir may occur as an accidental species.

Structure
Blue spruce, Douglas-fir, and possibly white fir co-dominate in the mixed overstory. All ages and sizes may be present with densities widely variable. Shrubs, both tall and low, are conspicuously abundant in the understory where kinnikinnick is the characteristic dominant. Productivity is low to moderate. It prefers highly leached, acidic soils. One site index value for Douglas-fir is 61. Blue spruce has age/height values of 64/50, 84/59, and 96/74.

The resource value rating for cattle in early seral stage is low; late seral is none. An otherwise rich diversity of forage species is offset by lack of abundance. Wildlife find a wide range of options in this diverse habitat.

Location
This type occurs on warm, dry, moderately steep south and east slopes, ridges, and benches within cold air drainages. Elevations range from about 7,900 to 9,100 feet (2,408 to 2,774 m). Distribution is known from the Sangre de Cristo Mountains and San Juan Mountains of northern New Mexico extending northward into Colorado.

Adjacent plant associations
Ecotones with PIPU/COSES; warmer sites merge with ABCO-PSME/QUGA, PIPU/FEAR2 or ABCO/ARUV; cooler sites ecotone with ABLA/EREX4 and ABCO/CASI12.

Also see
Picea pungens/Juniperus communis in Utah (Youngblood and Mauk 1985) appears similar, PIPU/FEAR2 occupies drier, warmer sites. PIPU/CASI12 (formerly PIPU/CAFO) differs primarily by scarcity of *Arctostaphylos uva-ursi*.

Important and key plants from research plots
Trees & life history traits
***blue spruce** (*Picea pungens*) C
white fir (*Abies concolor*) C
Douglas-fir (*Pseudotsuga menziesii*) C
quaking aspen (*Populus tremuloides*) S
ponderosa pine (*Pinus ponderosa*) s

Shrubs
Abundant (>25%):
***kinnikinnick** (*Arctostaphylos uva-ursi*)
common juniper (*Juniperus communis*)
mountain snowberry (*Symphoricarpos oreophilus*)
Oregon boxleaf (*Paxistima myrsinites*)
Utah serviceberry (*Amelanchier utahensis* ssp *utahensis*)
creeping barberry (*Mahonia repens*)
Woods' rose (*Rosa woodsia* var. *ultramontana*)
thimbleberry (*Rubus parviflorus*)

Herbs
Common (>1%) to well represented (>5%) cover:
Virginia strawberry (*Fragaria virginiana* ssp *virginiana*)
woodland strawberry (*Fragaria vesca*)
Richardson's geranium (*Geranium richardsonii*)
starry false lily of the valley (*Maianthemum stellatum*)
western yarrow (*Achillea millefolium var occidentalis*)
manyflowered stoneseed (*Lithospermum multiflorum*)
Arizona fescue (*Festuca arizonica*)
roughleaf ricegrass (*Oryzopsis asperifolia*)
Kentucky bluegrass (*Poa pratensis*)
mountain muhly (*Muhlenbergia montana*)
prairie junegrass (*Koeleria macrantha*)
bedstraw spp. (*Galium* spp.)

Synonymy
Virginia strawberry (*Fragaria virginiana)* = wild strawberry *(F. ovalis)*
woodland strawberry *(Fragaria vesca* ssp *americana = F. americana)*
starry false lily of the valley *(Maianthemum stellatum)* = starry false Solomon's seal *(Smilicina stellata)*
western yarrow *(Achillea millefolium* var *occidentalis = A. lanulosa)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis = A. alnifolia)*
creeping barberry (*Mahonia repens = Berberis repens*) aka Oregongrape
Oregon boxleaf *(Paxistima myrsinites)* = mountain lover *(Pachystima myrsinites)*
Woods' rose *(Rosa woodsii* var. *ultramontana = R. arizonica)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*

Brief plant ID notes
Kinnikinnick is a low growing, mat-forming shrub with leaves that are simple, leathery, shiny green on upper surface with a smooth margin.

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typic)
Climate Class: LSC (low sun cold)

Phases

This type was previously described by Moir and Ludwig (1979) as the *Arctostaphylos uva-ursi* phase of their *Picea pungens/Pseudotsuga menziesii* habitat type.

Reforestation
Silvicultural cutting methods: heavy overstory removal may be successful. Clearcutting and heavy shelterwood methods favor ponderosa pine, Douglas-fir and aspen. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance. Light cutting (selection methods) favors white fir and blue spruce. Seed tree harvest method is sometimes successful.

Tree planting can be highly successful; recommended species are ponderosa pine, Douglas-fir, and blue spruce. Planting success can be enhanced by low intensity burning and low to moderate intensity mechanical site preparation methods.

Fire ecology
Past fire occurrences along with selection cutting are the most common disturbances. Kinnikinnick is a seral, shade-intolerant species found in open forests. It grows best in high light situations, thinning as shade increases. Overtopping cover of other shrubs and site variables such as elevation are primary factors affecting development of its early seral cover. It is deep rooted on mineral soil, less so on organic material. It is a sprouting species, possessing latent buds on the horizontal stem and dormant buds on the stembase/rootcrown. Sprouting or suckering following fire may be possible with survival of any of the aforementioned parts. It is best suited to short fire cycles with low fuel buildup and low fire intensity.

Revegetation considerations
Natural revegetation after disturbance may be moderately rapid. This type is relatively dry for a blue spruce plant association but is a good site for Douglas-fir.

Comments
This is a scenically attractive plant association with its variety of tree and shrub species.

Livestock use: Kinnikinnick itself is unpalatable to domestic livestock. PIPU/ARUV plant association has a forage value rating for cattle in the early seral stages of “low” and “none” in late seral due to the relative lack of suitable forage.

Wildlife: As a browse species, kinnikinnick is of moderate importance to bighorn sheep and mule deer, and possibly elk, especially in winter. The fruit lasts through the winter and is available when other fruits are gone. Many songbirds, gamebirds, small mammals, bear, turkey, grouse, deer and elk eat the fruit. It is an important food for bear in early spring. The presence of common juniper can provide good nesting habitat for turkey.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)

Crane 1991
DeVelice *et al.* 1986
Moir and Ludwig 1979
USFS 1987a

Blue spruce/redosier dogwood
Picea pungens/Cornus sericea ssp. sericea

(Formerly: Picea pungens/Cornus stolonifera)

Synonyms
Picea pungens/Amelanchier alnifolia-Swida sericea (Johnston 1987)
Picea pungens/Poa pratensis (Moir and Ludwig 1979)

Codes
typic phase 0 06 01 0

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
Found in wet canyons and well-watered sites: the overstory may contain a mixture of species but ***blue spruce** and Douglas-fir are usually codominant and successfully reproducing. The shrub layer is the dominant undergrowth component and redosier dogwood is the dominant shrub species. Ground vegetation layer is subordinate to shrubs. Caution: The shrub component may be significantly diminished and the forb/grass layer seemingly dominating in stream bottoms that have been heavily disturbed by livestock grazing, wildlife (esp. beaver), and recreationists. Redosier dogwood may not be present on sites subject to heavy livestock and/or wild game grazing. The following species may be present as accidental trees:

- white fir (*Abies concolor*)
- southwestern white pine (*Pinus strobiformis*)
- ponderosa pine (*Pinus ponderosa*)
- Engelmann spruce (*Picea engelmannii*)
- Rocky Mountain juniper (*Juniperus scopulorum*)
- narrowleaf cottonwood (*Populus angustifolia*)

Structure
Blue spruce, forming dense stands is the climax overstory dominant and is present in all sizes and ages, and is reproducing successfully. Douglas-fir is a major seral tree and may even be codominant. Aspen is abundant and is an early seral tree persisting through later stages of stand development. Other conifers may be present. On less disturbed sites, the tall shrubs layer may provide an average cover of 45%, or can be three times as dense as the forb component or two times as dense as grass component. Disturbance (grazing, browsing, and recreation activities) may significantly reduce variety and extent of this layer. In those instances, the forb/grass component will appear to be enhanced proportionately. The mean basal area for overstory trees in the Zuni Mountains was 178 square feet per acre (40.8 m^2/ha). The site quality for blue spruce is high to moderate. No site index data are available. Stockability is 1.

Location
This type is restricted to well-watered canyons, streamsides or slightly elevated benches; elevations range from 7,500 to 9,100' (2,286 to 2,774 m); distribution: Arizona, New Mexico and Colorado.

Adjacent plant associations
Often borders grassy parks. Ecotones with PIPO/ FEAR2, ABCO/QUGA, ABCO/FEAR2, PIPU/FEAR2, ABLA/VAMY and PSMEG/MUST.

Also see
PIPU/POPR Fitzhugh *et al*. 1987; and Moir and Ludwig 1979.
PIPU/ALTE-ROWO CT Muldavin *et al*. 2000.

Important and key plants from research plots
Trees & life history traits
blue spruce (*Picea pungens*) C
Douglas-fir (*Pseudotsuga menziesii*) S
quaking aspen *(Populus tremuloides)* S

Shrubs
Well represented (>5% cover) to luxuriant (>50% cover)**:**
redosier dogwood *(Cornus sericea ssp sericea)*
Utah serviceberry *(Amelanchier utahensis* ssp *utahensis)*

thinleaf alder *(Alnus incana* ssp *tenuifolia)*
common chokecherry *(Prunus virginiana)*
Scouler's willow *(Salix scouleriana)*
Bebb willow *(Salix bebbiana)*
twinberry honeysuckle *(Lonicera involucrata)*
Rocky Mountain maple *(Acer glabrum)*
russet buffaloberry (Shepherdia canadensis)
mountain snowberry (Symphoricarpos oreophilus)
Oregon boxleaf (Paxistima myrsinites)
gooseberry currant *(Ribes montigenum)*
thimbleberry *(Rubus parviflorus)*

Herbs
Abundant (>25% cover)**:**
Kentucky bluegrass *(Poa pratensis)*
bluejoint *(Calamagrostis canadensis)*
dryspike sedge *(Carex siccata)*
Ross' sedge *(Carex rossii)*
false melic *(Schizachne purpurascens)*
Richardson's geranium *(Geranium richardsonii)*
bluntseed sweetroot *(Osmorhiza depauperata)*
common dandelion *(Taraxacum officinale)*
starry false lily of the valley *(Maianthemum stellatum)*
Fendler's meadow-rue *(Thalictrum fendleri)*
common cowparsnip *(Heracleum maximum)*
yellow avens *(Geum aleppicum)*
Franciscan bluebells (*Mertensia franciscana)*
mountain goldenbanner *(Thermopsis montana)*
western yarrow *(Achillea millefolium* var. *occidentalis)*
American vetch *(Vicia americana)*
northern bog violet *(Viola nephrophylla)*
sprucefir fleabane *(Erigeron eximius)*
scouringrush *(Equisetum* spp.)
Virginia strawberry *(Fragaria virginiana* ssp. *glauca)*
western yarrow *(Achillea millefolium* var. *occidentalis)*
woodland strawberry *(Fragaria vesca* ssp*. bracteata)*

Brief plant ID notes
The slender stems of the redosier dogwood are generally bright red, although younger bark is somewhat purplish.

Synonymy
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus = Lathyrus arizonica)*
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
bluntseed sweetroot *(Osmorhiza depauperata)* = sweetcicily *(O. obtusa)*
starry false lily of the valley *(Maianthemum stellatum)* = starry false Solomon's seal *(Smilicina stellata)*
common cowparsnip *(Heracleum maximum = H. lanatum)*
Virginia strawberry *(Fragaria virginiana* ssp. *glauca = F. glauca)*
woodland strawberry *(Fragaria vesca* ssp. *bracteata = F. bracteata)*
redosier dogwood *(Cornus sericea* ssp. *sericea = Swida sericea)*
thinleaf alder *(Alnus incana* ssp. *tenuifolia = A. tenuifolia)*
Rocky Mountain juniper *(Juniperus scopulorm = J. s.* var. *columnaris)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis = A. alnifolia)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
dryspike sedge *(Carex siccata)* = fony sedge
western yarrow *(Achillea millefolium* var. *occidentalis = A. lanulosa)*
mountain goldenbanner *(Thermopsis montana = Thermopsis rhombifolia* var. *montana = T. pinetorum),* aka mountain thermopsis
russet buffaloberry *(Shepherdia canadensis = Elaeagnus canadensis)*
false melic *(Schizachne purpurascens = Trisetum purpurascens)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: -1 (warm, dry), 0 (typic), +1 (cool, moist)
Climate Class: LSC (low sun cold)

Fire ecology
Presence of ponderosa pine and aspen stands scattered throughout the type is indicative of past fire occurrence. Fires are probably less frequent in these stream bottoms and moist benches than on adjoining sideslopes or warmer, drier environments. In riparian areas where blue spruce occurs, intervals between fires are about 350 to 400 years (Crane 1982). Based on fire scar data from the White Mountains of Arizona, successive fires may prevent blue spruce from dominance because it is

fire intolerant. Historical fire frequency in mixed-conifer forests was about 22 years (Dieterich 1983).

Reforestation
Silvicultural cutting methods: Heavy overstory removal such as clearcutting may result in conversion to bluegrass meadow. Similar results may be expected for seed tree cut with the additional potential of blowdown. Partial or staged removal of the overstory is usually successful but may suffer blowdown of residual on poorly drained sites. Selection removal methods favor blue spruce and has been considered one of the best methods for timber harvesting on riparian pastures.

Tree planting can be moderately successful. Recommended species are Douglas-fir and blue spruce. Blue spruce is subject to frost heave on tight (high clay) soils. Planting success can be enhanced by moderate intensity mechanical site preparation methods to reduce grass competition. Burning favors re-establishment of forbs and aspen but is often detrimental to less fire-resistant species such as blue spruce.

Revegetation considerations
Natural revegetation after disturbance is very rapid. Regeneration, artificial or natural, may need to be protected from grazing/browsing animals.

Comments
This plant community contains sites that are prime recreational, visual, wildlife, and livestock habitat. Periodic flooding may bring about tree and meadow mosaics. Redosier dogwood becomes more abundant on sites that are more level due to periodic high-water tables. This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as fir and spruce arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Livestock: The high cover of graminoids and other forbs and readily available water makes these sites highly desirable for livestock grazing.

The forage value rating for cattle in early seral stage is high and for late seral is still moderate.

Wildlife: These streamside sites are also among the most important wildlife habitats and corridors as they provide water and rich food resources and serve as critical linkages between numerous other plant associations.

Reference(s)

Alexander *et al*. 1987
Crane 1989
Dieterich 1983
Fitzhugh *et al.* 1987
Johnston 1987
Kittel and Lederer 1993
Moir and Ludwig 1979
Muldavin *et al.* 2000
Pavek 1993
USFS 1987a
USFS 1986

Blue spruce/dryspike sedge

(Formerly: *Blue spruce/Fony sedge*)

Picea pungens/Carex siccata

(Formerly: Picea pungens/Carex foenea)

Synonyms
Picea pungens/Fraxinus ovalis (now *Fragaria virginiana* ssp. *virginiana)*

(Alexander *et al.* 1984)

Code(s)
typic phase 0 06 06 0

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
The overstory may contain varying mixtures of other species, but ***blue spruce** is at least common and is successfully reproducing. Ground vegetation layer is strongly herbaceous with graminoids appearing to provide the greatest coverage (forbs may actually have greater coverage).

Structure
Blue spruce and Douglas-fir are climax codominants, both reproducing successfully. Ponderosa pine, aspen and southwestern white pine are conspicuous seral trees. White fir is usually absent or has a minor role. On colder sites where Engelmann spruce is present, its regeneration is less abundant than that of blue spruce and Douglas-fir combined. All sizes and ages may be present, and stands are well stocked (stockability = 1). A minor shrub layer is present with kinds and numbers of species inconsistent. The ground vegetation is a strongly herbaceous cover with graminoids having the appearance of greater abundance than forbs which may have more actual coverage.

Timber productivity for this plant association is moderate to high for ponderosa pine and Douglas-fir. Average site indices are 73 for the former and 89 for the latter. Site quality for blue spruce is good to moderate.

Location
This type occurs on lower slopes and drainages, streamsides, and forest borders of grassy parks; elevations range from 8,600 to 9,100 feet (2,621 to 2,774 m). Known from White and Blue Mountains and Kaibab Plateau of Arizona; Mogollon, Jemez, and Zuni Mountains and Mount Taylor of New Mexico; and San Juan Mountains of Colorado, with probable wider distribution.

Adjacent plant associations
Often borders grassy parks. Ecotones with ABLA/EREX4, ABCO/ACGL, ABCO/FEAR, PIPO/FEAR and PIPU/COSE.

Also see
PIPU/FRVIV (Alexander *et al*. 1984a) [formerly PIPU/FROV]

Important and key plants from research plots
Trees & life history traits
blue spruce *(Picea pungens)* C
Douglas-fir *(Pseudotsuga menziesii)* C
quaking aspen *(Populus tremuloides)* S
ponderosa pine *(Pinus ponderosa)* S
white fir *(Abies concolor)* c
southwestern white pine *(Pinus strobiformis)* s

Shrubs
Scarce (<1% cover) to well represented (>5% cover):
common juniper (*Juniperus communis*)
Oregon boxleaf (*Paxistima myrsinites*)
Arizona honeysuckle (*Lonicera arizonica*)
Gambel oak (*Quercus gambelii*)
rockspirea (*Holodiscus dumosus*)
creeping barberry (*Mahonia repens*)
Rocky Mountain maple (*Acer glabrum*)
currants (*Ribes spp*.)
thimbleberry (*Rubus parviflorus*)

redosier dogwood (*Cornus sericea* ssp. *sericea*)
grayleaf red raspberry (*Rubus idaeus* ssp. *strigosus*)

Herbs
Abundant (>25% cover) sometimes luxuriant (>50% cover):
dryspike sedge (*Carex siccata*)
Ross' sedge (*Carex rossii*)
Arizona fescue (*Festuca arizonica*)
prairie junegrass (*Koeleria macrantha*)
screwleaf muhly (*Muhlenbergia straminea*)
muttongrass (*Poa fendleriana*)
Thurber's fescue (*Festuca thurberi*)
Virginia strawberry (*Fragaria virginiana* ssp. *virginiana*)
woodland strawberry (*Fragaria vesca*)
Richardson's geranium (*Geranium richardsonii*)
pussytoes spp. (*Antennaria* spp.)
western yarrow (*Achillea millefolium* var. *occidentalis*)
Parry's goldenrod (*Oreochrysum parryi*)
Nevada pea (*Lathyrus lanszwertii* var. *arizonicus*)
sprucefir fleabane (*Erigeron eximius*)
bluebell bellflower (*Campanula rotundifolia*)
alpine false springparsley (*Pseudocymopterus montanus*)
Wooton's ragwort (Senecio wootonii)
American vetch (*Vicia americana*)
New Mexico groundsel (*Packera neomexicana*)
Canadian white violet (*Viola canadensis*)
smooth Townsend daisy (*Townsendia formosa*)
Fendler's meadow-rue (*Thalictrum fendleri*)
bedstraw spp. (*Galium* spp.)

Cryptogams
Abundant (>25% cover) to luxuriant (>50% cover), especially mosses.

Synonymy
Virginia strawberry (*Fragaria virginiana* ssp. *virginiana = F. ovalis*)
woodland strawberry (*Fragaria vesca = F. americana*)
western yarrow (*Achillea millefolium* var. *occidentalis= A. lanulosa*)
Parry's goldenrod (*Oreochrysum parryi = Haplopappus parryi = Oreochrysum parryi*)

Nevada pea (*Lathyrus lanszwertii* var. *arizonicus = Lathyrus arizonica*)
sprucefir fleabane (*Erigeron eximius*) = forest fleabane (*E. superbus*)
redosier dogwood (*Cornus sericea* ssp. *sericea = C. stolonifera = swida*)
creeping barberry (*Mahonia repens = Berberis repens*) aka Oregongrape Oregon boxleaf (*Paxistima myrsinites*) = mountain lover or boxleaf myrtle (*Pachystima myrsinites*)
dryspike sedge (*Carex siccata*) = fony sedge
prairie junegrass (*Koelaria macrantha = K. pyrimidata = K. cryptandrus*)
screwleaf muhly (*Muhlenbergia straminea = M. virescens*)
New Mexico groundsel (*Packera neomexicana = Senecio neomexicana*)
Wooton's ragwort = Wooton's groundsel
grayleaf red raspberry (*Rubus idaeus* ssp. *strigosus = R. strigosus*)
smooth Townsend daisy *(Townsendia formosa = T. pinetorum)*

Brief plant ID notes
Sedges are difficult to tell apart, but easy to recognize from other graminoids by the combination of leaves and culms originating from the base (no sheaths), solid triangle-shaped culms, and one flower with a single scale below it per spike or spikelet. Dryspike sedge has flat, bright green leaves and four to twelve spikes in the linear, oblong flower head.

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typic)
Climate Class: LSC (Low Sun Cold)

Phases
Fitzhugh *et al*. (1987) separated the PIPU/CAFO3 HT of Moir and Ludwig (1979) into PIPU/CAFO3 and PIPU/FEAR habitat types (plant associations). The current description is approximately equivalent to PIPU/CAFO3, *Pseudotsuga menziesii* phase of Moir and Ludwig.

Fire ecology
Presence of ponderosa pine and aspen stands scattered throughout the type is indicative of past fire occurrence. Fire created openings may demonstrate herb dominance for only a few years. Rapid re-establishment of aspen from root suckering soon regains tree

dominance. In some locations, blue spruce may regenerate under dense cover of aspen following fire.

Reforestation
Silvicultural cutting methods: Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance. Heavy overstory removal may be successful. Clearcutting favors aspen and favors ponderosa pine and Douglas-fir if planted promptly. Light shelter and selection cutting favor white fir and blue spruce. Heavy shelter wood and selection cutting favors ponderosa pine and Douglas-fir. Seed tree harvest method is sometimes successful; blowdown may be a problem.

Tree planting can be highly successful; recommended species are ponderosa pine, Douglas-fir, blue spruce and white fir. Planting success can be enhanced by moderate and low intensity burning and mechanical site preparation methods. Heavy burning strongly favors re-establishment of forbs soon followed by aspen resprouting.

Revegetation considerations
Natural revegetation after disturbance may be moderately rapid.

Comments
The high cover of graminoids and the diversity of other forbs provide foraging opportunities for livestock and wildlife. Forage value rating for cattle in the early seral stage is high; late seral is low.

This plant association has high visual quality with pleasing arrangements of tall, large-diameter pine mixed with aspen and blue spruce. It also has potential for creating vertical diversity using contrasting stands adjacent to one another.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)

Alexander *et al*. 1987a
DeVelice *et al*. 1986
Fitzhugh *et al.* 1987
Moir and Ludwig 1979
USFS 1987a
USFS 1987b

Blue spruce/sprucefir fleabane

(Formerly: Blue spruce/forest fleabane)

Picea pungens/Erigeron eximius

Synonyms
Picea pungens-Pseudotsuga menziesii h.t., *Valeriana acutiloba* phase (Moir and Ludwig 1979); *Picea pungens-Pseudotsuga menziesii/Erigeron eximius* (Johnston 1987).

Code(s)
typic phase 0 06 07 0
ponderosa pine phase 0 06 07 1

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
***Blue spruce** and Douglas-fir codominate the overstory. Undergrowth has variable composition, but always characterized by forb dominance. Forbs abundant (>25% cover) graminoids common (>1% cover) to well represented (>5% cover) in small patches [ponderosa pine phase]; twinflower absent or poorly represented (<5% cover) in typic phase.

Structure
Blue spruce and Douglas-fir are codominant in the overstory which varies from closed to open canopy. Variations include numerous larger diameter old growth individuals including blue and Engelmann spruce, Douglas-fir and white fir. Typically, the mixed overstory is well stocked; often all sizes and ages will be represented. Engelmann spruce and rarely, subalpine fir occupy frost pockets. Aspen is the major seral species. Blue spruce is successfully regenerating throughout. The shrub layer is scattered, of light density, and highly inconsistent in percent cover and presence of species. The herb rich undergrowth is characterized by forb dominance.

Stockability = 1. Site quality is good for blue and Engelmann spruces (no site index data available) and is moderate to high for Douglas-fir. Mathiasen *et al.* (1986) reported an average site index for Douglas-fir of 82.6 +/-10.7 (N = 27 stands). Another reported average site index is 63 +/- 10 (USFS 1987).

Location
This type occurs on lower elevation sites (7,820' to 8,450' or 2,383 to 2,575 m) all aspects on lower slopes and higher elevation sites 8,040' to 9,050'; 2,450 to 2,758 m) on sideslopes and benches on northerly aspects (Burro Mountain all aspects at 9,800', 3,000 meters); known distribution: widespread in mountains and drainages of northern Arizona, central and northern New Mexico, and southern Colorado.

Adjacent plant associations
Drier upslope: ABCO/QUGA, PSMEG/MUST, PSMEG/QUGA; adjoining PIPU/EREX4 on north slopes: ABLA/EREX4, ABCO/Sparse; on south slopes: ABCO/MUST, PIPO/MUST, PIPO/QUGR3, PIPO/FEAR2; interspersed: PIPU/CASI12; on moister sites: PIPU/COSES.

Also see
PIPU/FROV (Alexander *et al.* 1984).

Important and key plants from research plots
Trees & life history traits
typic phase
Engelmann spruce *(Picea engelmannii)* c
blue spruce *(Picea pungens)* C
Douglas-fir *(Pseudotsuga menziesii)* C
quaking aspen *(Populus tremuloides)* [early to mid] S
white fir *(Abies concolor)* s
southwestern white pine *(Pinus strobiformis)* s
ponderosa pine (PIPO) phase
blue spruce *(Picea pungens)* C
Douglas-fir *(Pseudotsuga menziesii)* C
quaking aspen *(Populus tremuloides)* [early to mid] S
white fir *(Abies concolor)* c
limber pine *(Pinus flexilis)* (in n. NM) s
southwestern white pine *(Pinus strobiformis)* s

ponderosa pine *(Pinus ponderosa)* s

Shrubs
Well represented (>5% cover):
Rocky Mountain maple *(Acer glabrum)*
Gambel oak *(Quercus gambelii)*
common juniper *(Juniperus communis)*
Oregon boxleaf *(Paxistima myrsinites)*
Arizona honeysuckle *(Lonicera arizonica)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis)*
Woods' rose *(Rosa woodii* var. *ultramontana)*
thimbleberry *(Rubus parviflorus)*

Herbs
Abundant (>25% cover)**:**
sprucefir fleabane *(Erigeron eximius)*
beautiful fleabane *(Erigeron formosissimus)*
Fendler's meadow-rue *(Thalictrum fendleri)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
Richardson's geranium *(Geranium richardsonii)*
ragweed sagebrush *(Artemisia franseroides)*
Canadian white violet *(Viola canadensis)*
alpine false springparsley *(Pseudocymopterus montanus)*
Parry's goldenrod *(Oreochrysum parryi)*
sharpleaf valerian *(Valeriana acutiloba* var. *acutiloba)*
starry false lily of the valley *(Maianthemum stellatum)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus*)
owl's-claws *(Dugaldia hoopsii)*
bluebell bellflower *(Campanula rotundifolia)*
fringed brome *(Bromus ciliatus)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koeleria macrantha)*
dryspike sedge *(Carex siccata)*
screwleaf muhly *(Muhlenbergia straminea)*
mountain muhly *(Muhlenbergia montana)*
Arizona fescue *(Festuca arizonica)*
Kentucky bluegrass *(Poa pratensis)*

Brief plant ID notes
The majority of the field season, sprucefir fleabane has a single spatula-shaped basal leaf, often growing in robust patches. Unfortunately this characteristic is common to many plants, especially composites. With a flower, this fleabane is still difficult to distinguish from some other fleabanes. When identifying this association, one often relies on the diversity and luxuriance of the herb understory.

Synonymy
Utah serviceberry *(Amelanchier utahensis* ssp*. utahensis = A. alnifolia)*
Woods' rose (*Rosa woodii* var. *ultramontana = R. arizonica*)
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
Virginia strawberry *(Fragaria virginiana* ssp*. virginiana = F. ovalis)*
woodland strawberry *(Fragaria vesca* ssp*. americana = F. americana)*
Parry's goldenrod *(Oreochrysum parryi = Haplopappus parryi = Oreochrysum parryi)*
sharpleaf valerian *(Valeriana acutiloba* var. *acutiloba = V. capitata* ssp *acutiloba)*
starry false lily of the valley *(Maianthemum stellatum)* = starry false Solomon's seal *(Smilicina stellata*)
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus= L. arizonicus*)
owl's-claws *(Dugaldia hoopsii)* = orange sneezeweed *(Helenium hoopsii)*97
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
dryspike sedge *(Carex siccata)* = fony sedge
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*

Terrestrial Ecological Unit attributes
typic phase
Life Zone Class: 7 (subalpine forest) **Elevational Subzone:** 0 (typical) - 1 (warm, dry) **Climate Class:** LSC (low sun cold)
ponderosa pine phase
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical) +1 (cool, moist)
Climate Class: LSC (low sun cold)

Phases
Typic Phase: These sites are generally higher (typically 8,000 feet [2,438 m] and above) in elevation, tend to be cooler and moister. Engelmann spruce and rarely, subalpine fir, may be present in the overstory composed of mixed species. Blue spruce regeneration is greater than the combined regeneration of subalpine fir and Engelmann spruce. Sprucefir fleabane is usually present in the forb component of the undergrowth.

Ponderosa Pine Phase: These sites are generally lower (below 8,400 feet [2,560 m]), warmer, and drier. The undergrowth component may lack sprucefir fleabane and be typified instead by strawberries and western yarrow. In the overstory, Engelmann spruce will decrease or disappear, and ponderosa pine will increase, usually as large individuals.

Fire ecology
Moir and Ludwig (1979) found fire scarring on bases of large trees indicating past ground fires. They suggest herbaceous cover carried dry season fires through stands. Some fires may have originated from open grassy parks bordering these stands. Stands of 200 to 300- year old ponderosa pine and Douglas-fir may become established in former openings.

Reforestation
Silvicultural cutting methods: Heavy overstory removal is sometimes successful: clearcutting and seed tree methods favor aspen (where present), however exposure may leave subsequent coniferous regeneration subject to frost damage. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance. Shelterwood and selection methods are usually successful; more cover favoring shade tolerant species like spruce, less cover favoring Douglas-fir. Light selection cutting favors spruce and white fir.

Artificial planting: blue spruce and white fir are recommended species; success probability is high and can be enhanced by moderate intensity mechanical site preparation methods to reduce grass competition. In the ponderosa pine (PIPO) phase, plant Douglas-fir and ponderosa pine. High to moderate intensity burning favors re-establishment of forbs and

aspen but is often detrimental to less fire-resistant species such as blue spruce. It may be necessary to treat stands to reduce stocking and reduce the proportion of white fir.

Revegetation considerations
Natural revegetation is usually rapid.

Comments
High visual quality along meadow borders and roads; good potential for thermal and hiding cover for wildlife; good possibilities for aspen management.

Livestock: This plant association is forb rich with varying amounts of grasses. During early seral stages, the forage value rating for cattle is moderate and is low during late seral because the increasing overstory canopy diminishes the undergrowth.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)
Alexander *et al*. 1984a
Alexander *et al*. 1986
DeVelice *et al*.1986
Fitzhugh *et al*. 1987
Johnstone 1987
Moir and Ludwig 1979
Pavek 1993
USFS 1986
USFS 1987a
USFS 1987b

Blue spruce/Arizona fescue
Picea pungens/Festuca arizonica

Code(s)
typic phase 0 06 09 0

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= “dry mixed conifer”)

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
The overstory may contain varying mixtures of other species, but ***blue spruce** and Douglas-fir are codominant in the overstory. Ponderosa pine is a common seral tree, often persisting in late succession. Shrubs, although present, are usually scarce. The undergrowth is dominated by various bunch grasses with sedges often present; dominant graminoids such as Arizona fescue and screwleaf muhly are well represented (>5% cover).

Structure
Blue spruce and Douglas-fir are climax codominants, both reproducing successfully. Ponderosa pine is a early- or mid- seral tree and may codominant in older stands. Where white fir is present, its regeneration will be less than that of blue spruce. Aspen, if present, is found only locally in small short-lived clones. All sizes and ages of conifers may be present, and stands are well stocked (stockability = 1). Shrubs are minor. The ground vegetation is strongly herbaceous cover with bunch grasses dominating.

Timber productivity for this plant association is moderate for blue spruce, ponderosa pine and Douglas-fir. Limited average site index data for Douglas-fir is 48, N=4. Average site index for ponderosa pine may range from 50 to 60.

Location
This type occurs on all slopes and aspects in elevations ranging from 7,560' to 9,120' (2,304 to 2,770 m). Above 9,000' (2,743 m), it is found

on southerly aspects and in all positions on the slope. Below 8,300 feet (2,530 m), it occurs on northerly aspects of lower slopes. It is known from the White Mountains of Arizona, Mogollon and Jemez Mountains of New Mexico and the San Juan Mountains of New Mexico and Colorado.

Adjacent plant associations
Drier sites support PSMEG/MUST and PIPO/FEAR2; ABCO/FEAR2; on more moist sites: PIPU/EREX4, PIPU/CASI12, and PIPU/COSES.

Important and key plants from research plots
Trees & life history traits
blue spruce (Picea pungens) C
Douglas-fir (Pseudotsuga menziesii) C
ponderosa pine (Pinus ponderosa) S
white fir (Abies concolor) c
quaking aspen (Populus tremuloides) s
southwestern white pine
(Pinus strobiformis) s

Shrubs
Scarce (<1% cover)**:**
whitestem gooseberry *(Ribes inerme)*
wax currant *(Ribes cereum)*
common juniper *(Juniperus communis)*
thimbleberry *(Rubus parviflorus)*
mountain snowberry *(Symphoricarpos oreophilus)*

Herbs
Abundant (>25% cover) sometimes luxuriant (>50% cover)**:**
Arizona fescue *(Festuca arizonica)*
mountain muhly *(Muhlenbergia montana)*
dryspike sedge *(Carex siccata)*
Ross' sedge *(Carex rossii)*
Parry's oatgrass *(Danthonia parryi)*
fringed brome *(Bromus ciliatus)*
prairie junegrass *(Koeleria macrantha)*
bottlebrush squirreltail *(Elymus elymoides)*
beautiful fleabane *(Erigeron formosissimus)*
wooly cinquefoil *(Potentilla hippiana)*

muttongrass *(Poa fendleriana)*
screwleaf muhly *(Muhlenbergia straminea)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
western yarrow *(Achillea millefolium)*
pussytoes spp. *(Antennaria* spp.*)*
Parry's goldenrod *(Oreochrysum parryi)*
peavines *(Lathyrus* spp.)
beardlip penstemon *(Penstemon barbatus)*
alpine false springparsley *(Pseudocymopterus montanus)*
Wooton's ragwort *(Senecio wootonii)*
New Mexico groundsel *(Packera neomexicana)*

Cryptogams
Mosses cover rock and bare soil. Little bare ground occurs due to moss plus litter cover.

Brief plant ID notes
Arizona fescue is a cool season, perennial bunchgrass with tightly rolled, narrow leaf blades and a multi-flowered panicle with somewhat flattened spikelets.

Synonymy
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana = F. ovalis)*
western yarrow *(Achillea millefolium* var. *occidentalis = A. lanulosa)*
Parry's goldenrod *(Oreochrysum parryi = Haplopappus parryi)*
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
dryspike sedge *(Carex siccata)* = fony sedge
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*
woodland strawberry *(Fragaria vesca = Fragaria americana)*
New Mexico groundsel (Packera neomexicana = Senecio neomexicana)
Wooton's ragwort = Wooton's groundsel

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)

Elevational Subzone: 0 (typic)
Climate Class: LSC (low sun cold)

Fire ecology
Presence of ponderosa pine and aspen stands scattered throughout the type is indicative of past fire occurrence. However, aspen may be absent from many stands and, where present, is found in small short-lived clones.

The dominance of many meadow species such as Arizona fescue and open, park-like forest structure suggest a high fire frequency in the past. Unpublished data at the Rocky Mountain Station indicates that most coniferous forests with grassy understories in the Southwest had as high fire frequencies as reported for PIPO/FEAR2. Cessation of understory burns during this century have resulted in: 1.) Increasing proportions of blue spruce and white fir in regeneration; 2.) Higher tree densities; 3.) Cessation of ponderosa pine regeneration; and 4.) Conversion of sun-loving herbs and graminoids to shade tolerant species such as dryspike sedge and sprucefir fleabane (Allen *et al.* 1995).

Reforestation
Silvicultural cutting methods: heavy overstory removal encourages conifer regeneration. Clearcutting favors aspen and ponderosa pine. Tree seedlings should be planted promptly following disturbance to avoid grass competition. Heavy shelterwood and selection cutting favors ponderosa pine and blue spruce regeneration. Seed tree harvest method is sometimes successful for regenerating ponderosa pine. Light selection cutting favors the more shade tolerant species, i.e. blue spruce. Light shelter favors Douglas-fir and blue spruce. Where aspen is minor seral, regeneration of aspen may be patchy or clumpy following disturbance, where healthy root stock exists. Aspen is unlikely to form a dominant cover type.

Although tree planting can be highly successful, grass competition, frost heaving, and lack of shade may make artificial reforestation extremely difficult. Recommended species for planting are ponderosa pine, Douglas-fir, and blue spruce. Planting success can be enhanced by high to low intensity burning and mechanical site preparation methods.

Revegetation considerations
Natural revegetation after disturbance is usually rapid.

Comments
PIPU/FEAR2 is the warmest and driest of the blue spruce forests.

Livestock and wildlife: The PIPU/FEAR2 plant association is productive, providing grasses for cattle and elk and forbs for sheep and deer. Forage value rating for cattle in early seral stage is high; late seral is low. As timber stands mature, Arizona fescue and mountain muhly decrease under the closing canopy. Interspersed openings remain productive.

Wildlife: Aspen is important for wildlife cover and forage. PIPU/FEAR2 is usually a relatively poor site for aspen; therefore, in some areas, it may be necessary to perpetuate the aspen by harvesting or burning.

PIPU/FEAR2 plant associations exhibit high visual quality when adjoining meadows or roads (diversity of trees).

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
Allen *et al*. 1995
DeVelice *et al*. 1986
Fitzhugh *et al.* 1987
Johnston 1987
Pavek 1993
USFS 1986
USFS 1987a

Blue spruce/Twinflower
Picea pungens/Linnaea borealis

Synonyms
Picea pungens-Pseudotsuga menziesii/Linnaea borealis (Johnston 1987).

Code(s)
typic phase 0 06 04

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Lower (SFM)

National Vegetation Classification Group
Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland (G218)

Key criteria
***Blue spruce** and Douglas-fir codominate the overstory. Ponderosa pine is absent or accidental, even in early succession. Undergrowth has a rich assemblage of shrubs and herbs. ***Twinflower** is well represented (>5% cover) to abundant (> 25% cover) in the shrub layer.

Structure
Blue spruce and Douglas-fir are codominant in the overstory. Limber pine and white fir commonly occur. The successional status of white fir is not clearly understood. Frost pockets may support minor amounts of subalpine fir and Engelmann spruce. Typically, the mixed overstory is well stocked; often all sizes and ages are represented. Aspen is the major seral species. Blue spruce is successfully regenerating throughout. The shrub layer is characterized by mostly low growing species such as twinflower, whortleberry and Oregon boxleaf. Adding to this diversity is a rich variety of forbs and graminoids.

Stockability = 1. Site quality is good for blue spruce (no site index data available) and is moderate for Douglas-fir (site index = 63 + 10).

Location
This type occurs on steep, lower to upper slopes and ridges having north, east or south aspects that are protected from wind and sun;

elevations range from 8,200 to 9,500' (2,500 to 2,896 m); known from the Jemez, Sangre de Cristo and San Juan Mountains in northern New Mexico and southern Colorado, and locally in the White Mountains of New Mexico.

Adjacent plant associations
Adjoins other diverse plant associations such as,ABLA/EREX4, ABLA/VAMY-LIBO3, and ABLA/RUPA.

Also see
PIPU/EREX4

Important and key plants from research plots
Trees & life history traits
blue spruce *(Picea pungens)* C
Douglas-fir *(Pseudotsuga menziesii)* S
quaking aspen *(Populus tremuloides)* [early to mid] S
subalpine fir *(Abies lasiocarpa* var. *arizonica)* c
Engelmann spruce *(Picea engelmannii)* c
white fir *(Abies concolor)* s
limber pine *(Pinus flexilis)* s

Shrubs
Well represented (>5% cover)**:**
***twinflower** *(Linnaea borealis)*
common juniper *(Juniperus communis)*
Oregon boxleaf *(Paxistima myrsinites)*
thimbleberry *(Rubus parviflorus)*
whortleberry (*Vaccinium* spp.)
mountain snowberry *(Symphoricarpos oreophilus)*
sidebells wintergreen *(Orthilia secunda)*

Herbs
Abundant (>25% cover) to luxuriant (>50% cover)**:**
sprucefir fleabane *(Erigeron eximius)*
Fendler's meadow-rue *(Thalictrum fendleri)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
Richardson's geranium *(Geranium richardsonii)*
ragweed sagebrush *(Artemisia franseroides)*

Canadian white violet *(Viola canadensis)*
peavine *(Lathyrus* spp.)
fringed brome *(Bromus ciliatus)*
dryspike sedge *(Carex siccata)*
spike trisetum (*Trisetum spicatum*)
roughleaf ricegrass *(Oryzopsis asperifolia)*

Cryptogams
Abundant (>50% coverage), especially mosses and the nitrogen-fixing lichen, *Parmelia aphthosa*.

Brief plant ID notes
Twinflower is a low growing, creeping, evergreen semi-shrub. Leaves are simple and opposite, and roundish with a very slightly toothed margin. The pink funnel-shaped flowers occur as pairs at the ends of 1-3 inch (3 to 10 cm) stalks. Twinflower inhabits damp sites; flowering from June to August.

Synonymy
sidebells wintergreen (*Orthilia secunda = Ramischia secunda*)
sprucefir fleabane (*Erigeron eximius*) =
forest fleabane (*E. superbus*)
Virginia strawberry (*Fragaria virginiana* ssp *virginiana = F. ovalis*)
woodland strawberry (*Fragaria vesca* ssp *americana = F. americana*)
Oregon boxleaf (*Paxistima myrsinites = Pachistima myrsinites*)
fringed brome (*Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome (aka *B. richardsonii*)
dryspike sedge (*Carex siccata*) = fony sedge
spike trisetum *(Trisetum spicatum = T. montanum* = Rocky Mountain trisetum*)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest) Elevational Subzone: -1 (warm, dry)
Climate Class: LSC (low sun cold)

Fire ecology
Twinflower's fire survival strategy is avoidance (Noste and Bushy 1987). During fire, small patches of twinflower in draws, moist duff, or other protected places usually escape burning. Cooper 1927; Crane and

Fischer 1986. It may re-establish following fire from stolons produced from unburned plants (Archibold 1980).

Reforestation
Silvicultural cutting methods: Heavy overstory removal is sometimes successful: clearcutting and seed tree methods favor aspen however exposure may leave subsequent coniferous regeneration subject to frost damage. Shelterwood and heavy selection cutting methods are usually successful; more cover favoring shade tolerant species like spruce, less cover favoring Douglas-fir. Light selection cutting favors spruce and white fir. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance.

Artificial planting: blue spruce and Douglas-fir are recommended species; success probability is high and can be enhanced by moderate intensity mechanical site preparation methods to reduce forb/grass competition. High to moderate intensity burning favors re-establishment of forbs and aspen, but is often detrimental to less fire-resistant species such as blue spruce. It may be necessary to treat stands to reduce stocking and reduce the proportion of white fir.

Revegetation considerations
Natural revegetation is usually rapid.

Comments
PIPU/LIBO3 is the most mesic of the blue spruce plant associations.

Livestock: This plant association is forb rich with varying amounts of grasses. During early seral stages, the forage value rating for cattle is moderate, and low during late seral.

Wildlife: This plant association has potential for providing thermal and hiding cover for wildlife; also provides forage for larger browsing/grazing wildlife such as deer and elk.

The visual quality is high along meadow borders and roads.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated

heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References

Archibold 1980
Cooper 1927
Crane and Fischer 1986
DeVelice *et al*.1986
Howard 1993
Johnston 1987
Moir and Ludwig 1979
Noste and Bushey 1987
USFS 1987a

Blue spruce/bittercress ragwort

(Formerly: Blue spruce/cardamine groundsel PIPU/SECA)

Picea pungens/Packera cardamine

(Formerly: Pieca pungens/Senecio cardamine PIPU/SECA)

Code(s)
typic phase 0 06 13 0

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
White fir and Douglas-fir may be overstory dominants. ***Blue spruce** is important, especially as regeneration. The luxuriant ground cover of forbs including conspicuous patches of ***bittercress ragwort** and the low cover (<5%) of shrubs help identify this plant association.

Structure
The overstory is composed of a varied mixture of conifers where subalpine fir and Douglas-fir are codominants. Blue spruce is successfully reproducing. White fir, aspen and southwestern white pine may be present. Most mature trees are Douglas-fir and aspen. The luxuriant herbaceous ground cover of forbs such as bittercress ragwort and a low cover (<5%) of shrubs characterize PIPU/PACA34. The low growing shrub, Oregon boxleaf and thimbleberry are usually present. Along with PIEN/PACA34, these sites may have the highest stand tree diversity of all southwestern plant associations.

This type is a productive environment capable of growing attractive stands of large diameter trees. Stockability is 1. Average site index for Engelmann spruce is 110. Douglas-fir and blue spruce have good growth potential. These are important plant associations containing old growth stands and have good commercial timber potential.

Location
This type occurs on lower, middle, and upper, steep slopes with northerly aspects; elevations range from 8,640 to 8,800' (2,633 to 2,620 m); known from the vicinity of East Fork of Thomas Creek and Hannagan drainages of the White Mountains, Arizona.

Adjacent plant associations
PIPU/PACA34 seems to be very near the soil temperature boundary between spruce-fir and mixed conifer forests. At lower elevations, ABCO/QUGA and PIPU/FRIV; at higher elevations, ABLA/EREX4; also some stands may intergrade with PIEN/PACA34.

Important and key plants from research plots
Trees & life history traits
blue spruce *(Picea pungens)* C
Douglas-fir *(Pseudotsuga menziesii)* S
white fir *(Abies concolor)* S
southwestern white pine *(Pinus strobiformis)* S
subalpine fir *(Abies lasiocarpa* var. *arizonica)* c
Engelmann spruce *(Picea engelmannii)* c
ponderosa pine *(Pinus ponderosa)* s
quaking aspen *(Populus tremuloides)* [early to mid-seral] s

Shrubs
Well represented (>5% cover):
Oregon boxleaf *(Paxistima myrsinites)*
thimbleberry *(Rubus parviflorus)*

Herbs
Abundant (>25% cover) to luxuriant (>50% cover)**:**
***bittercress ragwort** *(Packera cardamine)*
fringed brome *(Bromus ciliatus)*
dryspike sedge *(Carex siccata)*
muttongrass *(Poa fendleriana)*
Ross' sedge *(Carex rossii)*
prairie junegrass *(Koeleria macrantha)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
mountain goldenbanner *(Thermopsis montana)*
Richardson's geranium *(Geranium richardsonii)*

sprucefir fleabane (*Erigeron eximius)*
Canadian white violet *(Viola canadensis)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana)*
Wooton's ragwort *(Senecio wootonii)*
western brackenfern *(Pteridium aquilinum)*
sidebells wintergreen *(Orthilia secunda)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus*)
giant lousewort *(Pedicularis procera)*

Brief plant ID notes
Note: Eleven other shrub species have been identified for PIPU/PACA34 but were not listed due to infrequent, inconsistent coverage. Bittercress ragwort is a yellow flowered composite, with a clump of mostly basal, egg-shaped to circular leaves that have wavy margins. One good vegetative feature is that the lowest leaf is usually a small leaf with a purple underside.

Synonymy
bittercress ragwort (*Packera cardamine = Senecio cardamine = cardamine groundsel)*
woodland strawberry *(Fragaria vesca* ssp. *americana = F. americana)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana = F ovalis)*
mountain goldenbanner *(Thermopsis montana = Thermopsis pinetorum)*
aka mountain thermopsis
Nevada pea *(Lathyrus lanszwertii*
var. *arizonicus= Lathyrus arizonica*)
sprucefir fleabane *(Erigeron eximius)* =
forest fleabane *(E. superbus)*
sidebells wintergreen *(Orthilia secunda = Ramischia secunda)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
dryspike sedge *(Carex siccata)* = fony sedge
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
Wooton's ragwort = Wooton's groundsel

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest) 7 (subalpine fir)

Elevational Subzone: 0 (typic) -1 (warm, dry)
Climate Class: LSC (low sun cold)

Fire ecology
The mixture of such seral species as ponderosa pine, aspen, southwestern white pine and western brackenfern suggests a long-term history (centuries) of low intensity fires interspersed by larger, higher intensity surface fires. The major seral species after fire is aspen but many conifers of the late seral or climax vegetation may also become quickly established after fire.

Reforestation
Heavy overstory removal favors aspen and Douglas-fir. Lesser or staged removal of overstory (shelterwood cutting) is usually successful with light shelter favoring Douglas-fir and ponderosa pine, heavier shelter favoring more shade tolerant species. Light selection harvest methods favor Engelmann spruce over other species; heavier selection cutting is similar to shelterwood in species favored by cutting. Potential of windthrow may be high, therefore, seed tree cutting may be unsuccessful because of blowdown. Where aspen is minor seral, regeneration of aspen may be patchy or clumpy following disturbance, where healthy root stock exists. Aspen is unlikely to form a dominant cover type.

Tree planting is usually highly successful. Recommended species are Douglas-fir, southwestern white pine, and blue spruce. Site preparation can enhance planting success. Moderate to low intensity mechanical methods and low intensity burning are usually beneficial. Silvicultural treatments in regeneration can improve stocking levels and species composition.

Revegetation considerations
Natural revegetation is rapid.

Comments
Livestock: Abundance of the herbaceous layers (forbs) indicates a greater utility for foraging/browsing by sheep and/or deer than for cattle. The resource value rating for cattle in early seral is high and in late seral is low due to decrease of herbaceous cover under increasing overstory canopy.

This plant association has very high values for esthetics because of excellent species diversity and ease of access at relatively low elevations. This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)

Dieterich 1983
Fitzhugh *et al*. 1987
Moir and Ludwig 1979

White Fir Series

ABCO/ACGL

White fir/Rocky Mountain Maple
Abies concolor/Acer glabrum

Synonyms
ABCO-PSME/ACGL (Johnston 1987)

Code(S)
typic phase 0 01 01 0
creeping barberry (MARE11) phase 0 01 01 1
rockspirea (HODU) phase 0 01 01 2
riparian phase 0 01 01 3

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
Complex overstory where ***white fir** and Douglas-fir co-dominate; blue spruce and limber pine may or may not be important, subalpine fir and Engelmann spruce occur in frost pockets, ponderosa pine is accidental, and aspen is a major seral dominant. The shrub component usually exhibits two layers. The tall shrub layer, which includes ***Rocky Mountain maple**, is diagnostic of this plant association. The low shrub layer is variable, and a high coverage of a particular species may indicate a phase, e.g., creeping barberry, rockspirea. Low shrubs and herbaceous species comprise the ground cover.

Structure
White fir is the dominant overstory species in all phases. It may be present in all age classes. If white fir is lacking in the overstory, it is usually well represented as reproduction under normal fire exclusion situations. Douglas-fir is codominant; limber pine or southwestern white pine may be important and ponderosa pine is absent or accidental in

most stands. Aspen is the major successional species. The overstory is usually complex and variable. In the case of the riparian phase, white fir is the only conifer in the overstory. The stand structure is three storied: trees, shrubs and forbs. The composition and cover of each tier vary in phases.

Timber productivity is low to moderate. Site index is variable; one average site index reported for Douglas-fir is 61+/- (N=24) (USFS 1987). Additionally, Mathiasen *et al.* (1986) reported a mean site index for Douglas fir of 89.5 +/-11.4 (N = 69 stands). Stockability = 1. Forage production is generally high in early seral conditions, diminishing in late seral conditions as shading inhibits aspen, shrubs, and herbs.

Location
This type may occur on any aspect or slope within elevations ranging from 8,200' to 9,850' (2,500 to 3,000 m) and is widely distributed throughout mountains of the Southwest. Although widespread, ABCO/ACGL is uncommon south of the Mogollon Rim. ABCO/ACGL represents transition between higher, colder spruce-fir forests and the ABCO/QUGA plant association.

Adjacent plant associations
ABCO/CASI12, ABCO/MARE11, or ABCO/QUGA; ABLA/JAAM on colder sites ABCO/ACGR3 on moister sites.

Also see
ABCO/ EREX4; PSME/PAMY HT Hess and Wasser 1982, Hoffman and Alexander 1980.

Important and key plants from research plots
Trees & life history traits
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
quaking aspen *(Populus tremuloides)* S [early to mid] s in rockspirea phase
limber pine *(Pinus flexilis)* s [in northern NM]
southwestern white pine s *(Pinus strobiformis)*
ponderosa pine *(Pinus ponderosa)* s

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

Rocky Mountain maple *(Acer glabrum)*
Scouler's willow *(Salix scouleriana)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis*)
rockspirea *(Holodiscus dumosus)*
mountain ninebark *(Physocarpus monogynus)*
Oregon boxleaf *(Paxistima myrsinites)*
mountain snowberry *(Symphoricarpos oreophilus)*
Arizona honeysuckle *(Lonicera arizonica)*
creeping barberry *(Mahonia repens)*
New Mexico locust *(Robinia neomexicana)*
fivepetal cliffbush *(Jamesia americana*)
black elderberry *(Sambucus racemosa* ssp. *pubens* var. *melanocarpa)*
common hoptree *(Ptelea trifoliata)*

Herbs
Well represented (>5% cover):
fringed brome *(Bromus ciliatus)*
ragweed sagebrush *(Artemisia franseriodes)*
Canadian white violet *(Viola canadensis)*
Parry's goldenrod *(Oreochrysum parryi)*
Fendler's meadow-rue *(Thalictrum fendleri)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
bluntseed sweetroot *(Osmorhiza depauperata)*
Richardson's geranium *(Geranium richardsonii)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus)*
feathery false lily of the valley *(Maianthemum racemosum)*
roughfruit fairybells *(Prosartes trachycarpum)*
dryspike sedge *(Carex siccata)*
sprucefir fleabane *(Erigeron eximius)*
alpine woodsorrel *(Oxalis alpina)*

Cryptogams
Known to be present but not described in research publications.

Brief plant ID notes
Rocky Mountain maple is a shrub or small tree with reddish brown twigs and leaves that are opposite, 3-5" long with long, red leafstalks. The leaf blades are 3- or 5- lobed, lobes sharply short-pointed, edges

doubly saw-toothed, or some or all deeply divided into 3 lance-shaped leaflets; shiny dark green above and paler beneath.

Synonymy
Parry's goldenrod *(Oreochrysum parryi = Haplopappus parryi = Solidago parryi)*
woodland strawberry *(Fragaria vesca* ssp. *americana = F. americana)*
bluntseed sweetroot = sweetcicily *(Osmorhiza depauperata = O. obtusa)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
feathery false lily of the valley *(Maianthemum racemosum = Smilacina racemosa)*
sprucefir fleabane = forest fleabane *(Erigeron eximius = E. superbus)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis = A. alnifolia)*
black elderberry *(Sambucus racemosa* ssp. *pubens* var. *melanocarpa = Sambucus melanocarpa*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
fivepetal cliffbush = waxflower = *(Jamesia americana)*
creeping barberry *(Mahonia repens = Berberis repens)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
dryspike sedge *(Carex siccata)* = fony sedge

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: +1 (cool wet)
Climate Class: LSC (low sun cold)

Phases
Typic Phase: Widespread throughout Arizona and New Mexico; specifically noted in Mogollon, Tularosa, San Mateo, Zuni, Sandia and Manzano Mountains; and San Juan Mountains of northern New Mexico and southern Colorado: tree species mix shown above in overstory; dominated by Rocky Mountain maple in shrub layer; Gambel oak is usually absent (sometimes minor); graminoids >25%; forbs are typically diverse in species and variable in coverage (Alexander *et al.* 1987).

creeping barberry Phase: Known from the San Mateo, Zuni, Sandia and Manzano Mountains and other mountains of northern New Mexico with an outlier in the White Mountains of Arizona: tree species mix shown above in overstory; less Rocky Mountain maple than typic phase and more Gambel oak but not exceeding 5% cover, creeping barberry is always present 1-10% cover, fringed brome is present; **forbs dominate the site** with western white clematis abundant (>25% cover) (Alexander *et al.* 1987).

Rockspirea Phase: Known from mountains of southern New Mexico (Gila and Lincoln National Forests, especially the Sacramento, Mogollon, Chiricahua, and Pinaleno Mountains) where it occurs on cool, moist sites on west to north-facing canyon sides and slopes, and upper elevation ridges and knolls. Rocky Mountain maple and rockspirea are always present; Gambel oak may be present but having low coverage values; fringed brome is common grass; forbs vary and can be of sufficient abundance to cover large percentage of the site; creeping barberry is usually lacking in this phase (Alexander *et al.* 1984a).

Riparian Phase: Known from the San Mateo, Zuni, Sandia and Manzano Mountains, white fir is the only coniferous tree in the overstory. There is usually a high shrub cover, and the site is restricted to streamside canyon bottoms. Rocky Mountain maple with >50% cover, fivepetal cliffbush >25%, snowberry >25%, Gambel oak variable, but not exceeding 5% (Alexander *et al.* 1987). The Riparian Phase may be similar to Johnston's thinleaf alder *(Alnus incana* spp. *tenuifolia)* phase.

Fire ecology

Because of the cool, moist conditions characteristic of this habitat type, fires are mostly low intensity, erratic, and infrequent, resulting in a diversity of stand structures within the type. Mosaics in forest structure are probably caused by erratic nature of past fires (Muldavin *et al.* 1996).

Hanks (1966), who studied successional relationships of the rockspirea phase concluded that fire was a principal factor in initiating succession. In wet sites where fires were usually infrequent, erratic in nature and generally of light intensity, mosaics in stand structure were probably

created by localized intense fires (Jones 1974). Preliminary findings in the Sacramento Mountains (Huckaby & Brown 1996) suggest fires in the 17th to 19th centuries in this habitat type occurred primarily in the middle of the growing season.

Succession stages suggested are:

- overstory removal by fire, followed by herbaceous recovery;
- then domination by New Mexico locust and/or Gambel oak and;
- within a few years, increasing presence of Rocky Mountain maple, rockspirea and common hoptree (Moir and Ludwig 1979);
- coniferous stage with white fir, Douglas-fir and southwestern white pine seedlings in under shrubs and in openings becoming established during the later stages.

Successional stages for the other phases are likely to be similar except that aspen is the major successional species. New Mexico locust and Gambel oak may carry out similar successional roles.

Rocky Mountain maple is a long-lived, shade-tolerant, seral species, often persisting in the understory of late seral or climax coniferous stands. Sprouting ability of Rocky Mountain maple following overstory removal by fire or logging may initiate its response as part of the immediate post-disturbance community. (Plummer *et al*. 1968; Steele and Geier-Hayes 1989a).

Reforestation
Silvicultural cutting methods: Heavy overstory removal (clearcuts and seedtree cuts) favors Douglas-fir. Successful regeneration of Douglas-fir in open situations is expected to be high; competition from rapidly growing shrubs can be expected following removal of overstory canopy. Lesser degrees of overstory removal such as light selection cutting, may be more favorable to white fir regeneration.

Site preparation techniques: High to moderate intensity burning may create conditions favorable for suckering of aspen. High intensity burning that heats the soil may significantly reduce sprouting ability of Rocky Mountain maple. Low to high intensity mechanical methods such as scalping and pitting should reduce short-term competition from grasses and low shrubs.

Tree Planting: Douglas-fir and/or southwestern white pine. Successful planting will require suppression of re-sprouting woody shrubs and Rocky Mountain maple.

Revegetation considerations
Natural revegetation following disturbance is expected to be rapid due to recovery of graminoids and forbs and sprouting/suckering of aspen and/or Rocky Mountain maple.

Comments
Livestock use: Forage value rating for cattle in early seral is high; diminishing significantly in late seral due to shading by overstory, also steep slopes may impede livestock access.

Wildlife: This type is prime habitat (forage and cover) for large game. Highly variable stand structure with multi-storied shrub layers and species increase microhabitat diversity for birds (Fitzhugh *et al.* 1987). Rocky Mountain maple is highly valued as big game browse. Winter range conditions can be improved by prescribed burning of decadent or high browse-line plants. Both fall and spring burning causes this maple to sprout vigorously. Fall burning eliminates food supply during first winter because plants do not sprout until the following spring.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)
Alexander *et al.* 1984
Alexander *et al.* 1987
DeVelice *et al.* 1986
Fitzhugh *et al.* 1987
Hanks 1966
Hanks and Dick-Peddie 1974
Huckaby & Brown 1996

Johnston 1987
Jones 1974
Little 1950
Mathiasen *et al.* 1986
Moir and Ludwig 1979
Muldavin *et al.* 1996
Niering & Lowe 1984
Plummer *et al* 1968
Steele & Geier-Hayes 1989a
Stuever 1995
Uchytil 1989
USFS 1986
USFS 1987a
USFS 1987b
Youngblood & Mauk 1986

White fir/Bigtooth Maple
Abies concolor/Acer grandidentatum

Code(s)
bigtooth maple (typic) phase 0 01 08 0

rockspirea phase 0 01 08 1

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
***White fir** is the climax stand dominant. The shrub component may exhibit two layers. The tall shrub layer is diagnostic of this plant association. Here, ***bigtooth maple** is always present (common [>1% cover]) and dominates the understory. The low shrub layer is variable. Low shrubs and herbaceous species comprise the ground cover.

Structure
White fir is the primary climax species and is the stand dominant. Douglas-fir may or may not occur as an overstory codominant especially as a late successional species. In younger stands, Douglas-fir is often more numerous along with even more dense white fir reproduction. Aspen, where present, is an important seral tree. Southwestern white pine is a minor seral species. In some areas, other commercial timber conifers may be absent. Sometimes attaining larger tree sizes, bigtooth maple, boxelder, and Gambel oak dominate the understory. Some stands reaching 60% bigtooth cover have a relatively low cover of conifers.

Data for timber productivity are not available but the moist, protected site conditions are normally very productive. Historically many stands in this plant association have been logged, removing much Douglas-fir and ponderosa pine. This action probably accelerated the growth and development of bigtooth maple. Conifer establishment in such areas

does not seem to have been retarded by strong dominance of the bigtooth maple.

Stockability = 1.

Location
This is a restricted type usually occurring on gentle to steep lower slopes rising from cool, moist, draws, ravines, or canyon settings; mostly southwestern or northern aspects; within elevations ranging from 6,500 to 8,500' (1,981 to 2,590 m) and is widespread throughout the mountains of the Southwest.

Adjacent plant associations
PSME/QUGA, PIPO/QUGA at lower elevations; ABCO/ACGL-HODU phase on gentle slopes; ABCO/QUGA upslope and riparian communities downstream.

Also see
Niering and Lowe, 1984; white fir ravine forests.

Important and key plants from research plots
Trees & life history traits
*white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
*bigtooth maple *(Acer grandidentatum)* C
quaking aspen *(Populus tremuloides)* s
limber pine *(Pinus flexilis)* (in N. NM) s
southwestern white pine *(Pinus strobiformis)* s
Gambel oak *(Quercus gambelii)* s
ponderosa pine *(Pinus ponderosa)* s
boxelder *(Acer negundo)*
Shrubs
Abundant (>25% cover):
*bigtooth maple *(Acer grandidentatum)*
*rockspirea *(Holodiscus dumosus)* [>5% cover in rockspirea phase]
Gambel oak *(Quercus gambelii)*
Rocky Mountain maple *(Acer glabrum)*
New Mexico raspberry *(Rubus neomexicanus)*
mountain ninebark *(Physocarpus monogynus)*
Oregon boxleaf *(Paxistima myrsinites)*

mountain snowberry *(Symphoricarpos oreophilus)*
New Mexico locust *(Robinia neomexicana)*

Herbs
Well represented (>5% cover) to abundant (>25 % cover)**:**
dryspike sedge *(Carex siccata)*
fringed brome *(Bromus ciliatus)*
Fringed brome *(Bromus ciliatus)*
golden columbine *(Aquilegia chrysantha)*
Fendler's meadow-rue *(Thalictrum fendleri)*
woodland strawberry *(Fragaria vesca* ssp*. americana)*
feathery false lily of the valley *(Maianthemum racemosum)*
Canadian white violet *(Viola canadensis)*
Richardson's geranium *(Geranium richardsonii)*
starry false lily of the valley *(Maianthemum stellatum)*
northern bedstraw *(Galium boreale)*

Brief plant ID notes
Bigtooth maple is a small to medium tree with bright red twigs and leaves that are opposite, 2-5 inches long and broad, 3-lobed, the lobes broad, blunt-pointed with a few large blunt teeth or small lobes; thick and firm, shiny dark green above, paler beneath.

Synonymy
woodland strawberry *(Fragaria vesca* ssp*. americana = F. americana)*
feathery false lily of the valley *(Maianthemum racemosum = Smilacina racemosa)*
starry false lily of the valley *(Maianthemum stellatum = Smilacina stellata),* aka starry false Solomon seal
fringed brome *(Bromus ciliatus = Bromopsis canadensis)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
dryspike sedge (*Carex siccata = C. foenea*) = fony sedge

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical) typic phase
+1 (cool wet) rockspirea phase
Climate Class: LSC (low sun cold)

Phases
There are two phases (described in Alexander, *et al*. 1987)**:**

Typic phase: This is the drier of the two; here, rockspirea is absent and graminoids are common.

Rockspirea (HODU) phase: This phase is found on wetter components of the plant association. Rockspirea is diagnostic. Fringed brome is the dominant graminoid found in this phase.

Fire ecology
Because of the cool, moist conditions characteristic of this habitat type, fires are mostly low intensity, erratic, and infrequent, resulting in a diversity of stand structures within the type. Mosaics in forest structure are probably caused by erratic nature of past fires. (Muldavin, *et al.* 1996).

Reforestation
Silvicultural cutting methods: Heavy overstory removal favors hardwoods. Lighter cutting methods favors the more shade-tolerant white fir.

Planting: Survival rates are high for planted conifers and hardwoods. Seedlings may need protection from grazing livestock and browsing big game. Site preparation may be desired depending on species to be planted.

Revegetation considerations
Natural revegetation is probably very high due to diversity of herb community and sprouting/suckering abilities of hardwoods.

Comments
Fitzhugh *et al*. (1987) suggest: “The importance of this riparian type for wildlife and fish habitat and as a fire barrier probably is much greater than its importance as a timber and grazing resource, particularly considering the small areas involved.”

Livestock use: Bigtooth maple provides some browse but is usually consumed in small amounts. Where the extent of bigtooth maple is limited, it may be heavily grazed and browsed.

Wildlife: This type provides optimal habitat for black bears, and very high hiding and food requirements for wildlife. Seeds, buds, and flowers

of maples provide food for numerous species of birds and small mammals. Squirrels and chipmunks eat the seeds, frequently storing them in caches sans hull and wing.

Many species of wildlife including the Arizona gray squirrel, river otter, zone-tailed hawk, common black-hawk, American dipper, summer tanager, bullock oriole, yellow warbler, Arizona alligator lizard, Sonoran mud turtle and canyon tree frog are largely or totally dependent on this and similar broadleaf riparian woodlands.

In general, maple thickets provide good hiding cover for big game animals. Mule deer favor such areas for bedding and hiding.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References

Alexander *et al.* 1987
Fitzhugh *et al.* 1987
Little 1950
Moir and Ludwig 1979
Muldavin *et al.* 1996
Niering and Lowe 1984
Uchytil 1989
USFS 1987b

White fir/kinnikinnick
Abies concolor/Arctostaphylos uva-ursi

Synonyms
Abies concolor-Pseudotsuga menziesii/Arctostaphylos uva-ursi (Johnston 1987).

Code(s)
typic phase 0 01 09 0

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
***White fir** and Douglas-fir co-dominate the overstory, and ponderosa pine is a major seral associate. ***Kinnikinnick** dominates the undergrowth, occasionally along with Oregon boxleaf. ABCO/ARUV represents a dry, cool environment.

Structure
The overstory contains white fir, Douglas-fir, and occasional ponderosa pine of varying sizes and densities. Crown cover varies from continuous (closed) to broken (open). The undergrowth is characterized by the low shrub kinnikinnick which, along with Oregon boxleaf, can attain over 25% cover in open areas. Young and advanced regeneration of white fir, Douglas-fir, ponderosa pine and southwestern white pine may be present.

Timber productivity for this association is low to moderate. Average site index for Douglas-fir is 57 +/- 10 and for ponderosa pine is 54 +/- 11. Stockability = 1. Early seral stages may produce 500-1500 lbs/ac/yr of forage (mostly graminoids), but this significantly decreases with crown closure in the canopy.

Location
This type occurs most commonly on ridgetops and occasionally on all aspects of moderate to steep lower slopes within elevations ranging

from 7,900’ to 9,500’ (2410 to 2900 m) and is widely distributed throughout northern New Mexico and southern Colorado.

Adjacent plant associations
PIPO/ ARUV in dry, warm situations and ABCO/VAMY in dry, cold sites.

Also see
Pfister *et al.* (1977): PSME/ARUV h.t.

Important and key plants from research plots
Trees & life history traits
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* S
quaking aspen *(Populus tremuloides)* s
limber pine *(Pinus flexilis)* [in N. NM] s

Shrubs
Abundant (>25 % cover)**:**
***kinnikinnick** *(Arctostaphylos uva-ursi)*
Oregon boxleaf *(Paxistima myrsinites)*
common juniper *(Juniperus communis)*
russet buffaloberry *(Shepherdia canadensis)*
wild rose *(Rosa spp.*)
Gambel oak *(Quercus gambelii)* (<5% cover)
creeping barberry *(Mahonia repens)*

Herbs
Scarce (<1% cover) to common (>1 % cover)**:**
Arizona fescue *(Festuca arizonica)*
mountain muhly *(Muhlenbergia montana)*
prairie junegrass *(Koeleria macrantha)*
Ross’ sedge *(Carex rossii)*
muttongrass *(Poa fendleriana)*
bottlebrush squirreltail *(Elymus elymoides)*
roughleaf ricegrass *(Oryzopsis asperifolia)*
Virginia strawberry *(Fragaria virginiana* ssp*. virginiana)*
Parry’s goldenrod *(Oreochrysum parryi)*
threenerve goldenrod *(Solidago velutina)*

Brief plant ID notes
Kinnikinnick is a low growing shrub with entire (smooth margins) leaves that are simple, leathery, and shiny green on the upper surface.

Synonymy
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
Parry's goldenrod *(Oreochrysum parryi = Haplopappus parryi = Oreochrysum parryi)*
threenerve goldenrod *(Solidago velutina = S. sparsiflora)*
Virginia strawberry *(Fragaria virginiana* ssp *virginiana = F. ovalis = F. canadensis)*
creeping barberry *(Mahonia repens = Berberis repens)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
russet buffaloberry *(Shepherdia canadensis = Elaeagnus canadensis)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical)
Climate Class: LSC (low sun cold)

Fire ecology
Kinnikinnick is a seral, shade-intolerant species found in open forests. It grows best in high light situations, thinning as shade increases. The development of kinnikinnick's early seral cover depends on site variables such as elevation and the amount of shading. Kinnikinnick is deep rooted on mineral soil, less so on organic material. It sprouts from latent buds on the horizontal stem and dormant buds on the stembase/rootcrown. Sprouting or suckering following fire may be possible with survival of any of the aforementioned parts. It is best suited to short fire cycles with low fuel buildup and low fire intensity.

Reforestation
Silvicultural cutting methods: heavy overstory removal (clear cuts and seed tree cuts) may favor ponderosa pine and Douglas-fir regeneration. Shelterwood and selection methods favor ponderosa pine and Douglas-fir with heavier cuts, and white fir with lighter cuts. Seed tree cuts are often successful for regenerating ponderosa pine and Douglas-fir. Light cutting methods favor white fir. Aspen (a major seral species) has the

potential to form a seral cover type if sufficient healthy rootstock exists before disturbance.

Planting: Recommended species for artificial planting are Douglas-fir and ponderosa pine. USFS (1987a) reports high success probability for planting. Planting may be difficult where gravelly soils exist. Site preparation techniques may augment planting efforts. Moderate to low intensity mechanical (scalping and water harvesting techniques) and moderate to low intensity burning may be considered. High intensity burning is likely to diminish the recovery of kinnikinnick. Prescribed burning will kill most white fir seedlings and saplings.

Revegetation considerations
Natural revegetation following disturbance is usually rapid due to sprouting or suckering of kinnikinnick and quick reestablishment of graminoids.

Comments
Livestock use: Kinnikinnick itself is unpalatable to domestic livestock. ABCO/ARUV plant association has a forage value rating for cattle in early seral of "moderate" due to the relative abundance of graminoids and "none" in late seral due to the low cover of suitable forage.

Wildlife: As a browse species, kinnikinnick is of moderate importance to bighorn sheep and mule deer, and possibly elk, especially in winter. The fruit lasts through the winter and is available when other fruits are gone. Many songbirds, gamebirds, small mammals, bear, turkey, grouse, deer and elk eat the fruit which is an important food for bear in early spring. The presence of common juniper can provide good nesting habitat for turkey.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings. Budworm susceptibility can be reduced by thinning white fir.

References

Crane 1991
DeVelice *et al.* 1986
USFS 1987a

White fir/dryspike sedge

(Formerly: White fir/fony sedge ABCO/CAFO3)

Abies concolor/Carex siccata

(Formerly: Abies concolor/Carex foenea ABCO/CAFO3)

Synonyms
White fir/fony sedge (USFS 1987b).

Code(s)
typic phase 0 01 15 0

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
***White fir** and Douglas-fir co-dominate the overstory, and ponderosa pine and southwestern white pine are minor seral associates. Engelmann spruce is absent or accidental. The shrub layer usually has < 5% cover. Forbs are luxuriant (>50% cover) with ***dryspike sedge** having upward of 80% coverage.

Structure
White fir and Douglas-fir co-dominate the overstory with minor subalpine fir or Engelmann spruce reproduction. Mature aspen may be present. Southwestern white pine and ponderosa pine are minor seral associates. Shrubs are poorly represented (<5% cover) but Rocky Mountain maple can be common (>1% cover). Dryspike sedge is the dominant forb.

Site quality for Douglas-fir and white fir is good. Establishment of regeneration following overstory clearing may be extremely difficult due to competition from dense graminoid cover. Site index data are not available.

Grazing potential for livestock and wildlife is high.

Location
This type occurs on upper slopes near mountain summits within elevations ranging from 9,000' to 10,200' (2740 to 3110 m). It is known from the Santa Catalina and Pinaleno Mountains of Arizona.

Adjacent plant associations
Adjoining ABCO/CASI12 on more moist sites: ABCO/ACGL; and on rockier, cooler sites: ABLA/JAAM.

Also see
ABCO/MUST, Muldavin *et al.* 1996.

Important and key plants from research plots
Trees & life history traits
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
southwestern white pine
(Pinus strobiformis) S or s
quaking aspen *(Populus tremuloides)* s
ponderosa pine *(Pinus ponderosa)* s

Shrubs
Poorly represented (<5%) cover**:**
Rocky Mountain maple *(Acer glabrum)*
orange gooseberry *(Ribes pinetorum)*
rockspirea *(Holodiscus dumosus)*

Herbs
Luxuriant (>50% cover):
dryspike sedge *(Carex siccata)*
fringed brome *(Bromus ciliatus)*
Kentucky bluegrass *(Poa pratensis)*
mountain muhly *(Muhlenbergia montana)*
Ross' sedge *(Carex rossii)*
Richardson's geranium *(Geranium richardsonii)*
Fendler's meadow-rue *(Thalictrum fendleri)*
Wooton's ragwort *(Senecio wootonii)*
western brackenfern *(Pteridium aquilinum)*
bluebell bellflower *(Campanula rotundifolia)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus)*

alpine false springparsley *(Pseudocymopterus montanus)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana)*

Brief Plant ID Notes
Sedges are difficult to tell apart, but easy to recognize from other graminoids by the combination of leaves and culms originating from the base (no sheaths), solid triangle-shaped culms, and one flower with a single scale below it per spike or spikelet. Dryspike sedge has flat, bright green leaves and four to twelve spikes in the linear, oblong flower head.

Synonymy
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana = F. ovalis)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
dryspike sedge *(Carex siccata)* = fony sedge
Wooton's ragwort = Wooton's groundsel

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: +1 (cool, moist)
Climate Class: HSC (high sun cold)

Fire ecology
Presence of mature aspen in a major seral role indicates that stand replacement fires have been a part of their ecology.

Reforestation
Silvicultural cutting methods: heavy overstory removal (clearcuts and seed tree cuts) may regenerate Douglas-fir. Light selection cuts and shelterwood cuts favor white fir. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance

Recommended species for artificial planting are Douglas-fir, southwestern white pine, and ponderosa pine; success probability is moderate. Site preparation techniques, such as mechanical scalping of graminoid turf, greatly enhance seedling survival.

Revegetation considerations
Natural revegetation following disturbance is usually rapid due to high herbaceous cover.

Comments
This forest type is susceptible to endemic and epidemic budworm populations when high density stands conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
USFS 1987b
Moir and Ludwig 1979
Muldavin *et al.* 1996
Youngblood and Mauk 1986

White fir/sprucefir fleabane

(Formerly: white fir/forest fleabane)

Abies concolor/Erigeron eximius

(Formerly: Abies concolor/Erigeron superbous ABCO/ERSU)

Synonyms
ABCO-PSME/EREX (Johnston 1987).

Code(s)
typic phase 0 01 03 0

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
Complex overstory where ***white fir** and Douglas-fir codominate; blue spruce and limber pine may be important; subalpine fir and Engelmann spruce may occur in frost pockets; ponderosa pine is accidental; and seral communities are dominated by aspen. The shrub component is less important than in the related.

ABCO/ACGL type. The herb layer is typically luxuriant; species diversity and cover high with sprucefir fleabane up to 30% cover.

Structure
Under fire exclusion conditions, at late succession, white fir and Douglas-fir are codominant in the overstory forming a closed canopy over a luxuriant understory. Young regeneration of white fir can be dense. Southwestern white pine is a prominent late seral associate. Not able to survive competition from more shade tolerant species, ponderosa pine is only occasionally present. Subalpine fir and Engelmann spruce are found in minor amounts often in frost pockets. The shrub layer is well represented by diverse species and may have coverage from 0 to 60%. Greater cover is expressed by grasses and forbs. Grasses are

dominated by fringed brome and cover 6 to 95%. Forbs can cover 6 to 124%. Aspen and New Mexico locust dominate seral stands.

Timber productivity for white fir and Douglas-fir is moderate to good. Average site indices for Douglas-fir are reported as 72+/- 9 (N=28) (USFS 1987) and 81.2 +/-10.8 (N = 52) (Mathiasen *et al.* 1986).

Stockability = 1.

The forage value rating for cattle in early seral conditions is high; diminishing slightly in late seral stages to moderate forage production.

Location
This type occurs on all aspects and on all slopes within elevations ranging from 8,700' to 9,700' (2,650 to 2,960 m) and is found locally in forests of Arizona and southern Utah; widespread in New Mexico and southern Colorado.

Adjacent plant associations
Adjoining on drier sites: ABCO/QUGA; on moister sites: ABCO/ACGL; along stream channels: ABLA/JUMA.

Also see
ABCO/ACGL is very similar but has less herb cover and may indicate more cobbly or stony soils. ABCO/RONE, CASI12 phase usually does not have luxuriant herbs and often occurs on soils with high content of volcanic ash. ABCO/LALAL3 is similar but has a rich legume component (e.g. *Lathyrus* spp.) and ponderosa pine is of greater importance as a seral tree.

Important and key plants from research plots
Trees & life history traits
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
quaking aspen *(Populus tremuloides)* [early to mid] S
limber pine *(Pinus flexilis)* [in N. NM] s
southwestern white pine *(Pinus strobiformis)* s

Shrubs
Scarce (<1% cover) to abundant (>25% cover)
Rocky Mountain maple *(Acer glabrum)*
Scouler's willow *(Salix scouleriana)*
rockspirea *(Holodiscus dumosus)*

Gambel oak *(Quercus gambelii)* [<5% cover]
orange gooseberry *(Ribes pinetorum)*
Arizona honeysuckle *(Lonicera arizonica)*
Oregon boxleaf *(Paxistima myrsinites)*
New Mexico locust *(Robinia neomexicana)*
mountain snowberry *(Symphoricarpos oreophilus)*

Herbs
Luxuriant (>50% cover):
fringed brome *(Bromus ciliatus)*
sprucefir fleabane *(Erigeron eximius)*
Arizona valerian *(Valeriana arizonica)* [high cover in VAAR3 Phase]
western yarrow *(Achillea millefolium* var. *occidentalis)*
owl's-claws *(Dugaldia hoopsii)*
Parry's goldenrod *(Oreochrysum parryi)*
bittercress ragwort *(Packera cardamine)*
Sacramento ragwort *(Senecio sacramentanus)* [Sacramento Mountains]
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus)*
Richardson's geranium *(Geranium richardsonii)*
sharpleaf valerian *(Valeriana acutiloba* var. *acutiloba)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana)*
western yarrow *(Achillea millefolium* var. *occidentalis*)
ragweed sagebrush *(Artemisia franseroides)*
Canadian white violet *(Viola canadensis)*
ravine fescue *(Festuca sororia)*
dryspike sedge *(Carex siccata)*
spike trisetum (*Trisetum spicatum*)
red baneberry *(Actaea rubra)*
bluntseed sweetroot *(Osmorhiza depauperata)*
Fendler's meadow-rue *(Thalictrum fendleri)*
feathery false lily of the valley *(Maianthemum racemosum)*
starry false lily of the valley *(Maianthemum stellatum)*
mountain goldenbanner *(Thermopsis montana)*

Brief plant ID notes
The majority of the field season, sprucefir fleabane has a single spatula-shaped basal leaf, often growing in robust patches. Unfortunately this characteristic is common to many plants, especially composites. With a flower, this fleabane is still difficult to distinguish from some other

fleabanes. When identifying this association, one often relies on the diversity and luxuriance of the herb understory.

Synonymy
sprucefir fleabane = forest fleabane *(Erigeron eximius = E. superbus)*
Parry's goldenrod *(Oreochrysum parryi = Haplopappus parryi = Oreochrysum parryi)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
sharpleaf valerian *(Valeriana acutiloba* var. *acutiloba = V. capitata* var. *acutiloba))*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana = F. ovalis = F. canadensis)*
bluntseed sweetroot = sweetcicily *(Osmorhiza depauperata = O. obtusa)*
feathery false lily of the valley *(Maianthemum racemosum =Smilacina racemosa)*
starry false lily of the valley *(Maianthemum stellatum = Smilacina stellata)*
mountain goldenbanner *(Thermopsis montana = T. montana = T. pinetorum)* aka mountain thermospsis
owl's-claws = orange sneezeweed *(Dugaldia hoopsii = Helenium hoopsii)*
feathery false lily of the valley *(Maianthemum racemosum =Smilacina racemosa)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis = A. alnifolia)*
black elderberry *(Sambucus racemosa* ssp. *pubens* var. *melanocarpa = Sambucus melanocarpa)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
dryspike sedge *(Carex siccata)* = fony sedge
bittercress ragwort (*Packera cardamine = Senecio cardamine = cardamine groundsel)*
spike trisetum *(Trisetum spicatum = T. montanum* = Rocky Mountain trisetum*)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: +1 (cool wet)
Climate Class: LSC (low sun cold)

Phases
Muldavin *et al.* (1996) describes *a Valeriana arizonica* (VAAR) Phase occurring along the base of the Mogollon Rim, north central highlands of Arizona; on northerly aspects of lower ravine slopes at about 7,000 feet (2133 m). Similar to the typic phase, the VAAR Phase is distinguished in the understory where sprucefir fleabane is scarce (<1% cover) or is absent and Arizona valerian has high cover.

Fire ecology
Fire is presumed to have been a major factor in historic development of stands in this plant association. Fires that are light to moderate intensity, erratic and infrequent tend to result in a diversity of stand structures within the type. Mosaics in forest structure are probably caused by erratic nature of past fires (Muldavin *et al.* 1996). Preliminary findings by Huckaby and Brown (1996) suggest fires are generally less frequent at higher elevations. On an ABCO/EREX4 site (Cosmic Ray), mean fire intervals were 31 +/- 28 years, with a range of 1 to 72 years between fires for the 17th through 19th centuries. For comparison, on a PSME/QUPA4 site (James Ridge) in the same study, the mean fire interval was 7 +/-5 years, with a range of 2 - 17 years between fires.

Care may be required during logging and prescribed burning to prevent excessive increases in shrub density (Fitzhugh *et al*. 1987).

Reforestation
Silvicultural cutting methods: heavy overstory removal favors Douglas-fir regeneration. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance; clear cuts favor aspen and to a lesser degree, Douglas-fir; planting is usually required to assure conifer regeneration. Seed tree cuts are sometimes successful if Douglas-fir is the selected seed tree species. Shelterwood and selection methods are generally successful, heavy cover favoring white fir, light cover favoring Douglas-fir. Successful regeneration of Douglas-fir in open situations is expected to be high; competition from rapidly growing shrubs can be expected

following removal of overstory canopy. Lesser degrees of overstory removal such as light selection cutting, may be more favorable to white fir regeneration.

Site preparation techniques: High to moderate intensity burning may create conditions favorable for suckering of aspen. Low to moderate mechanical methods such as scalping and pitting should reduce short-term competition from grasses and low shrubs. High intensity mechanical methods may cause severe disturbance and drying to these deep, well-watered soils.

Planting: Douglas-fir and Southwestern white pine

Revegetation considerations
Natural revegetation following disturbance is expected to be rapid due to recovery of graminoids and forbs and sprouting/suckering of aspen, Rocky Mountain maple or oak.

ABCO/EREX4 type is easily regenerated and is highly productive. Timber production is good where gentle slopes exist.

Comments
This type provides good habitat (forage and cover) for large game, although heavy winter snow accumulations may limit access. Luxuriant understories have high visual appeal in mature stands along roads or bordering meadows. This forest type is susceptible to endemic and epidemic budworm populations when high density stands conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
DeVelice *et al.* 1986
Fitzhugh *et al.* 1987
Huckaby & Brown 1996
Johnston 1987
Mathiasen *et al.* 1986
Moir and Ludwig 1979

Muldavin *et al.* 1996
Stuever 1995
Uchytil 1989
USFS 1986
USFS 1987a
USFS 1987b

White fir/Arizona fescue
Abies concolor/Festuca arizonica

Synonyms
ABCO-PSME/ FEAR1 (Johnston 1987),

ABCO/PSME, POFE HT Moir and Ludwig 1979 (POFE phase).

Code(s)
Arizona fescue phase (FEAR) 0 01 04 0
muttongrass phase (POFE) 0 01 04 1
Gambel oak phase (QUGA) 0 01 04 2

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
Ponderosa pine dominates in early to mid-seral stages; white fir and Douglas-fir are codominants with pine in late seral stands. Blue spruce, subalpine fir and Engelmann spruce are absent or accidental. In understory, coverage of shrubs and forbs are subordinate to codominant with graminoids. Arizona fescue is dominant in Arizona fescue phase and absent or minor in the muttongrass phase. The Gambel oak phase has <5% cover for Gambel oak.

Structure
White fir and Douglas-fir may be present in all age classes, if lacking in larger sizes, they will be well represented as reproduction. In mature stands ponderosa pine may be a codominant in the overstory and produce some regeneration which are under severe competition by more shade tolerant species. Limber pine or southwestern white pine, aspen, and Gambel oak are minor seral species.

Timber productivity is moderate for Douglas-fir; better for ponderosa pine. Some average site indices are: for Douglas-fir, 63 and for ponderosa pine, 77. Mathiasen *et al.* (1986) reported an average site index for Douglas-fir of 87.5 +/-8.2 (N = 25 stands). Stockability = 1.

The forage value rating for cattle in early seral is high; diminishing significantly in late seral due to shading by overstory.

Location
This type occurs on all aspects and on all slopes within elevations ranging from 8,200' to 9,850' (2,500 to 3,000 m) and is widely distributed throughout mountains of Arizona, New Mexico, and southern Colorado.

Adjacent plant associations
ABCO/FEAR2 intergrades into PIEN/CASI12 and ABCO/PSME MARE11 phase. On warmer, dries sites it merges into PIPO/FEAR2 and related types. It is similar to ABCO/LETR5, and ABCO/QUGA, MUST phase.

Also see
ABCO/ QUGA, Arizona fescue phase; PSME/FEAR2. Along cold air drainages see also PIPU/FEAR2. ABCO/LALAL3 and ABCO/RONE also have abundant or luxuriant herbaceous understories in colder or wetter environments.

Important and key plants from research plots
Trees & life history traits
Arizona fescue and muttongrass phases:
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* S
quaking aspen *(Populus tremuloides)* [early to mid] s
limber pine *(Pinus flexilis)* (in N. NM) s
southwestern white pine *(Pinus strobiformis)* s
blue spruce *(Picea pungens)*
[adjoining cold air drainages] c
Gambel oak phase:
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* S
quaking aspen *(Populus tremuloides)* [early to mid] s
limber pine *(Pinus flexilis)* (in N. NM) s
southwestern white pine *(Pinus strobiformis)* s
Gambel oak *(Quercus gambelii)* s

blue spruce *(Picea pungens)* [adjoining cold air drainages] c

Shrubs
Scarce (<1% cover)**:**
Gambel oak *(Quercus gambelii)*
rockspirea *(Holodiscus dumosus)*
orange gooseberry *(Ribes pinetorum)*
Oregon boxleaf *(Paxistima myrsinites)*
New Mexico locust *(Robinia neomexicana)*

Herbs
Abundant (>25% cover)**:**
Arizona fescue *(Festuca arizonica)*
mountain muhly *(Muhlenbergia montana)*
Parry's oatgrass *(Danthonia parryi)*
Pringle's speargrass *(Piptochaetium pringlei)*
muttongrass *(Poa fendleriana)*
screwleaf muhly *(Muhlenbergia straminea)*
dryspike sedge *(Carex siccata)*
Ross' sedge *(Carex rossii)*
bottlebrush squirreltail *(Elymus elymoides)*
fringed brome *(Bromus ciliatus)*
prairie junegrass *(Koeleria macrantha)*
pussytoes (*Antennaria* spp.)
beautiful fleabane *(Erigeron formosissimus)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus)*
manyflowered stoneseed *(Lithospermum multiflorum)*
strawberry *(Fragaria* spp.*)*
American vetch *(Vicia americana)*
woolly cinquefoil *(Potentilla hippiana)*
western yarrow *(Achillea millefolium* var. *occidentalis)*
Fendler's meadow-rue *(Thalictrum fendleri)*

Brief plant ID notes
Arizona fescue is a cool season, perennial bunchgrass with tightly rolled, narrow leaf blades and a multi-flowered panicle with somewhat flattened spikelets.

Synonymy
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)* aka Arizona peavine
bottlebrush squirreltail *(Elymus elymoides =Sitanion hystrix)*
western yarrow *(Achillea millefolium* var. *occidentalis = A. lanulosa)*
Pringle's speargrass *(Piptochaetium pringlei = Stipa pringlei)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
dryspike sedge *(Carex siccata)* = fony sedge
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical)
Climate Class: LSC (low sun cold)

Phases
Arizona fescue phase: (typic phase) Known from San Francisco Peaks, Mogollon Plateau, White Mountains and San Juan Mountains. Elevations range from 7,000' to 9,400' (2139 to 2870 m). Tree species mix shown above in overstory; moderate to heavy stocking of white fir regeneration and light to moderate stocking of Douglas-fir regeneration. Ponderosa pine may have scattered regeneration in mature stands. Shrubs are minor except on some stony soils where creeping barberry may dominate beneath conifers. Understory dominated by bunch grasses including Arizona fescue, screwleaf muhly and mountain muhly. Forbs are rich in variety and generally have high cover (Moir and Ludwig 1979.)

Muttongrass phase: Known from the White Mountains of Arizona, 8,600 to 8,900 feet (2,620 to 2,710 m). Overstory as shown above; white fir and Douglas-fir having moderate young and advanced regeneration. Undergrowth characterized by high coverage of grasses and forbs. The grasses are dominated by muttongrass (15 to 20% cover) and Arizona fescue is absent or rare; other grasses and a very diverse

range of forbs make up the remaining undercover. — ABCO/PSME, POFE HT Moir and Ludwig 1979.

Gambel oak phase: Similar to other phases except Gambel is a minor seral but constitutes <5% cover. When cover for Gambel oak exceeds 5% refer to descriptions to similar types, e.g., ABCO/QUGA, FEAR2 phase.

Fire ecology
Fire history is important in the succession of stands in this type (see also discussion for PIPU/FEAR2). Under a pre-1890 fire regime, the erratic nature of wildfire and the competitive factor of Arizona fescue creates patchy mosaics of regeneration. Fire is a thinning agent which often kills young/smaller trees at low intensities or may consume entire stands with high intensity crown fires. In the latter situation, the resulting openings are often conducive to reestablishment of herbs because of the favorable light conditions and temporarily elevated nutrient supply. Low intensity surface fires can be a useful management tool.

Reforestation
Silvicultural cutting methods: Heavy overstory removal methods (like clearcutting) favor Douglas-fir and ponderosa pine, and locally in some areas, aspen. Seed tree cutting can be successful if ponderosa pine and Douglas-fir seed trees are left. Planting in open situations improves regeneration success. Lesser degrees of overstory removal such as heavy shelterwood or selection favors more shade tolerant white fir and Douglas-fir; while less shelter favors ponderosa pine. Light selection cutting is more favorable to white fir regeneration. Aspen (a minor seral species) may become established in clumps or patches where sufficient healthy rootstocks exist prior to disturbance.

Site preparation techniques: High to moderate intensity burning may create conditions favorable for suckering of aspen. Low to high intensity mechanical methods such as scalping and pitting should reduce short-term competition from grasses and low shrubs.

Planting: Ponderosa pine

Revegetation considerations
Natural revegetation following disturbance is expected to be rapid primarily due to strong response of graminoids and forbs and sprout-

ing/suckering of aspen. Following removal of an overstory canopy, competition from rapidly growing shrubs and herbaceous species and more shade tolerant conifers can present problems for restocking of ponderosa pine.

Comments
On certain grazing allotments, muttongrass or Kentucky bluegrass may be abundant. Forests in late succession may have few bunchgrasses (e.g. Arizona fescue, etc.), but these remain well expressed in local openings. This plant association is well adapted to timber management. Management for early seral species can result in large, high quality ponderosa pine.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
DeVelice et al. 1986
Fitzhugh et al. 1987
Johnston 1987
Mathiasen et al. 1986
Moir and Ludwig 1979
Stuever 1995
USFS 1986
USFS 1987

White fir/Arizona walnut
Abies concolor/Juglans major

Code(s)
typic phase 0 01 14 0

Ecological Response Unit
Arizona Walnut (300)

National Vegetation Classification Group
Western Interior Riparian Forest & Woodland (G797)

Key criteria
Overstory is dominated by ***white fir** and a varying mixture of large deciduous trees of which ***Arizona Walnut** is diagnostic. It is restricted to drainages. Southwestern white pine, twoneedle pinyon pine, alligator juniper, blue spruce, and narrowleaf cottonwood are absent or accidental.

Structure
White fir is the dominant conifer in the overstory. Douglas-fir is a minor climax or, in some locations, a major seral associate. Ponderosa pine may be a minor or major seral tree. Blue spruce may be a minor seral on some sites. The conifers vary in density from lightly scattered to moderately dense. The sub-canopy layer is a diverse mixture of deciduous species such a narrowleaf cottonwood, boxelder, Gambel oak, and Arizona walnut which, although considered a minor species by some researchers, is diagnostic. The shrub layer is minor and, in some sites, the most common species is creeping barberry. The herbaceous cover is luxuriant (>50% cover) and diverse in species composition with meadow-rue present throughout.

Overall, the understory component of these sites is very productive. Coniferous stocking is low; however regeneration may be abundant. Timber productivity is low to moderate. Site index data are not available.

Location
This is a plant association of streamsides, canyon benches, and lower slopes, usually proximate to perennial streams; within elevations ranging from about 6,400' to 8,000'+ (1,950 to 2,440+ m). It is known from higher elevation drainages in mountains of central Arizona and New Mexico (Lincoln National Forest, Mogollon Mountains, Mogollon Rim, Sierra Ancha, and San Mateo Mountains). Soils are of alluvial origin (Aquents-Muldavin *et al.* 1996) and vary from being very rocky and silty to sandy with low organic content to cobbly, bouldery canyon debris.

Adjacent plant associations
ABCO/JUMA, being restricted to water courses, is likely to merge into other riparian series up channel and down channel. It traverses several different vegetative zones with change in elevation and, therefore, adjoins many different plant associations. It can border pinyon- juniper woodlands at lower elevations and may eventually be replaced in higher elevation sites by other cooler ABCO plant associations such as ABCO/ACGL or ABCO/ACGR3.

Also see
Riparian forests; PIPO/JUMA.

Important and key plants from research plots
Trees & life history traits
*white fir *(Abies concolor)* C
*Arizona walnut *(Juglans major)* C
Douglas-fir *(Pseudotsuga menziesii)* S to c
ponderosa pine *(Pinus ponderosa)* S or s
Gambel oak *(Quercus gambelii)* s to C
boxelder *(Acer negundo)* c
quaking aspen *(Populus tremuloides)* s
Shrubs
Well represented (>5% cover):
Gambel oak *(Quercus gambelii)*
canyon grape *(Vitus arizonica)*
Arizona honeysuckle *(Lonicera arizonica)*
creeping barberry *(Mahonia repens)*
velvet ash *(Fraxinus velutina)*

common hoptree *(Ptelea trifoliata)*
western poison ivy *(Toxicodendron rydbergii)*

Herbs
Luxuriant (>50% cover)**:**
Kentucky bluegrass *(Poa pratensis)*
fringed brome *(Bromus ciliatus)*
Canadian white violet *(Viola canadensis)*
Fendler's meadow-rue *(Thalictrum fendleri)*
bluntseed sweetroot *(Osmorhiza depauperata)*
Richardson's geranium *(Geranium richardsonii)*
Mexican bedstraw *(Galium mexicanum* ssp. *asperrimum)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus)*
mintleaf bergamot *(Monarda fistulosa* ssp. *fistulosa* var *menthaefolia)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana)*
tuber starwort *(Pseudostellaria jamesiana)*
feathery false lily of the valley *(Maianthemum racemosum)*

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

Synonymy
bluntseed sweetroot = sweetcicily *(Osmorhiza depauperata = O. obtusa)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)* aka Arizona peavine
feathery false lily of the valley *(Maianthemum racemosum = Smilacina racemosa)*
Mexican bedstraw *(Galium mexicanum* ssp. *asperrimum = Galium asperrimum)*
mintleaf bergamot *(Monarda fistulosa* ssp. *fistulosa* var. *menthaefolia = Monarda menthaefolia)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana = F. ovalis = F. canadensis)*
creeping barberry *(Mahonia repens = Berberis repens)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: +1 (cool wet)
Climate Class: LSC (low sun cold)

Fire ecology
Arizona walnut has few adaptations to fire. The montane riparian settings supporting Arizona walnut probably burn infrequently and then erratically. As a disturbance factor, flooding has more consistent effects.

Revegetation considerations
Natural revegetation following disturbance is expected to be rapid due to recovery of graminoids and forbs and sprouting/suckering of aspen, Rocky Mountain maple or oak. Aspen (a minor seral species) may become established in clumps or patches where sufficient healthy rootstocks exist prior to disturbance.

Comments
Livestock use: Forage value rating for cattle in early seral is high; diminishing only slightly with canopy closure in late seral stages. Proximity to water and bluegrass bottoms and the high shade attract grazing animals.

Wildlife: The multi-storied stand structure and highly variable species mixtures increases micro habitat diversity for a wide variety of animals, large and small. ABCO/JUMA may be critical habitat component for mammals with daily ranges that extend beyond the boundaries of this plant association. Other species are completely dependent on or within its bounds. Fitzhugh *et al*. (1987) describes some of the highly complex biotic/resource relationships associated with these restricted types: "Grasses are important to turkey and quail communities because they supply food and cover, and provide a substrate for insects, which are necessary for survival of young birds." Spring grazing may be detrimental to some wildlife populations because of its effect on cover and insect populations when the young are vulnerable. Grasses also provide cover for rodents which are an important unit in the predatory food chain. Deciduous trees in riparian areas are important to game and nongame animals because they moderate the microclimate and provide suitable conditions for a more luxuriant plant community than that found on adjacent sites.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)

Alexander *et al.* 1984a
Fitzhugh *et al.* 1987
Muldavin *et al.* 1996
Stuever 1995

White fir/Nevada pea
Abies concolor/Lathyrus lanszwertii var. leucanthus

(Formerly: Abies concolor/Lathyrus arizonicus ABCO/LAAR; Abies concolor/Lathyrus lanszwertii var. *arizonicus ABCO/LALAA)*

Synonyms
Abies concolor-Pseudotsuga menziesii/ Lathyrus arizonicus (Moir and Ludwig 1979).

Code(s)
typic phase 0 01 07 0

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
***White fir** and Douglas-fir may be present in all size classes. One or both may dominate the overstory. Aspen is the major seral associate. Southwestern white pine and ponderosa pine are minor seral trees. The undergrowth is composed of relatively sparse shrub cover up to 4% cover with creeping barberry. Whereas the forb cover is variable, ranging from as little as 5% to more than 50%. ***Nevada pea** dominates the herb layer with cover up to 20%.

Structure
White fir and Douglas-fir dominate the forest regeneration, with light to moderate stocking of young and advanced regeneration, often beneath an overstory of aspen, the major seral tree. Ponderosa pine and southwestern white pine are minor seral associates. Blue spruce and subalpine fir may be present as accidentals. A low shrub layer is common (> 1% cover) to well represented (> 5% cover). The herbaceous undergrowth varies in cover from >5% to >50% depending on amount of crown cover.

Stockability = 1.

Timber productivity for this association is high. Site index data are not available.

Location
This type occurs on north-facing slopes and elevated plains within elevations ranging from 8,500' to 9,400' (2590 to 2870 m). It is known from Bill Williams Mountain, San Francisco Peaks, Arizona and is local in New Mexico.

Adjacent plant associations
Adjoining ABCO/MARE11 on cooler, wetter sites.

Also see
As environments become drier, this type grades into ABCO/MARE11. The well expressed herb cover, however, distinguishes ABCO/LALAL3. ABCO/FEAR2 is also similar but occurs on warmer sites. ABCO/EREX4 indicates colder environments. See TES mapping unit 350 for Carson National Forest (Edward 1987).

Important and key plants from research plots
Trees & life history traits
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
quaking aspen *(Populus tremuloides)* S
southwestern white pine *(Pinus strobiformis)* s
ponderosa pine *(Pinus ponderosa)* s

Shrubs
Common (>1%) to well represented (>5%) cover**:**
creeping barberry *(Mahonia repens)*
mountain snowberry *(Symphoricarpos oreophilus)*
Oregon boxleaf *(Paxistima myrsinites)*
Arizona honeysuckle *(Lonicera arizonica)*
common juniper *(Juniperus communis)*

Herbs
Well represented (>5% cover) to luxuriant (>50% cover):
Nevada pea *(Lathyrus lanszwertii* var. *leucanthus)*
starry false lily of the valley *(Maianthemum stellatum)*
roughfruit fairybells *(Prosartes trachycarpum)*

Fendler's meadow-rue *(Thalictrum fendleri)*
muttongrass *(Poa fendleriana)*
dryspike sedge *(Carex siccata)*
Geyer's sedge *(Carex geyeri)*
Porter's licorice-root *(Ligusticum porteri)*
mountain goldenbanner *(Thermopsis rhombifolia* var. *montana)*

Brief plant ID notes
Since they often grow together, Nevada pea is often confused with another legume, American vetch. This particular peavine lacks tendrils and the larger leaflet is more heavily veined. There are few leaflets on the peavine, which has white and pink flowers while the vetch has reddish to lavender flowers.

Synonymy
Nevada pea *(Lathyrus lanszwertii* var. *leucanthus = L. lanszwertii* var. *arizonicus = L. arizonicus)* aka Arizona peavine.
starry false lily of the valley *(Maianthemum stellatum = Smilacina stellata)*
mountain goldenbanner *(Thermopsis montana = T. montana = T. pinetorum)*
Porter's licorice-root *(Ligusticum porteri) = oshá*
creeping barberry *(Mahonia repens = Berberis repens)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
dryspike sedge *(Carex siccata)* = fony sedge

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical)
Climate Class: LSC (low sun cold)

Fire ecology
The presence of mature aspen indicates former stand replacement from past fire. Creeping barberry is adapted to fire and survives by suckering from dormant buds on the rhizomes.

Reforestation
Tree regeneration methods: Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy rootstock exists before disturbance heavy overstory removal may encourage regenera-

tion: clearcut favoring aspen and ponderosa pine; and seed tree cuts favoring Douglas-fir and ponderosa pine. Light shelterwood and selection cuts favor white fir and Douglas-fir, while heavier shelterwood and selection cuts favor ponderosa pine. Light individual tree selection favors the more shade tolerant white fir.

Planting and site preparation: Recommended species for artificial planting are Douglas-fir, southwestern white pine, and ponderosa pine on selected sites. Success probability is high. Site preparation techniques may augment planting efforts. Moderate intensity mechanical (scalping and water harvesting techniques) and burning may be considered. Burning at high to moderate intensities will encourage the regeneration of aspen.

Revegetation considerations
Natural revegetation following disturbance is usually rapid due to strong herbaceous response.

Comments
Livestock use: Creeping barberry may be poisonous to livestock. It is not used to any extent by domestic livestock. Other forbs and grasses provide some livestock forage. ABCO/LALAL3 plant association has a forage value rating for cattle in early seral of “moderate”, and “low” in late seral.

Wildlife: Mule deer include creeping barberry in their diets during spring through fall seasons (Severson & Medina 1983). Elk use creeping barberry yearlong; the least use occurring during the summer (Thomas & Toweill 1982). Its fruit is eaten by numerous bird and mammal species including black bear. Early seral stages of stand development are productive for wildlife forage.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References

USFS 1987a
Moir and Ludwig 1979
Thomas and Toweill 1982
Severson and Medina 1983
Uchytil 1989

White fir/beardless wildrye
Abies concolor/Leymus triticoides

(Formerly: Abies concolor/Elymus triticoides ABCO/ELTR)

Synonyms
Abies concolor-Pseudotsuga menziesii/Elymus triticoides (Moir & Ludwig 1979)

Code(s)
typic phase 0 01 12 0

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
***White fir** and Douglas-fir are dominant. Engelmann spruce and subalpine fir regeneration are absent; other timber species are rare. Southwestern white pine is not important or may be absent. A light density tall shrub layer is present. The herbaceous layer is dominated by grasses such as ***beardless wildrye** and fringed brome. Forb representation is minimal. Soils are rubble pavements or extremely cobbly; grass cover being interrupted by patches of surface cobble.

Structure
White fir and Douglas-fir co-dominate the overstory with young and advanced regeneration present in most stands. Southwestern white pine is a major seral associate. Aspen is represented by occasional advanced regeneration. Ponderosa pine is an accidental species probably in the drier, warmer exposures. The tall shrub layer is very light density. Note that Rocky Mountain maple is absent.

ABCO/LETR5 plant association is capable of low to moderate productivity. Average site index for Douglas-fir is 67. Stockability rating is 1.

The forage value rating for cattle in early seral is moderate and late seral is low to none depending on degree of overstory closure. Deer forage availability is fair during early successional stages.

Location
This is a unique plant association known only from the Capitan Mountains in New Mexico. It occurs on gentle to steep upper slopes at elevations ranging from 9,000' to 9,900' (2745 to 3017 m).

Adjacent plant associations
PIEN/LETR5 on colder sites.

Also see
Scree forest (e.g., ABCO/HODU of DeVelice et al. 1986) have a scarce or poorly represented herbaceous layer.

Important and key plants from research plots
Trees & life history traits
***white fir** (Abies concolor) C
Douglas-fir (*Pseudotsuga menziesii*) C
southwestern white pine
(*Pinus strobiformis*) S
quaking aspen (*Populus tremuloides*) s
Gambel oak (*Quercus gambelii*) S

Shrubs
Well represented (>5 % cover)**:**
fivepetal cliffbush (*Jamesia americana*)
rockspirea (*Holodiscus dumosus*).
Gambel oak (*Quercus gambelii*)
orange gooseberry (*Ribes pinetorum*)

Herbs
Well represented (>5% cover) to
abundant (>25 % cover)**:**
***beardless wildrye** (*Leymus triticoides*)
mountain muhly (*Muhlenbergia montana*)
fringed brome (*Bromus canadensis*)
dryspike sedge (*Carex siccata*)
Ross' sedge (*Carex rossii*)
prairie junegrass (*Koeleria macrantha*)

fringed brome (*Bromus ciliatus*)
pineywoods geranium (*Geranium caespitosum*)
goldenrod (*Solidago* spp)
Nevada pea (*Lathyrus lanszwertii* var. *leucanthus*)

Brief plant ID notes
Beardless wildrye is a native, perennial bunchgrass with slender rhizomes and clasping auricles (extensions of the leaf blade which wrap around the culm at the ligule).

Synonymy
beardless wildrye (*Leymus triticoides = Elymus triticoides*)
Nevada pea (*Lathyrus lanszwertii* var. *arizonicus = L. arizonicus*)
fivepetal cliffbush = waxflower = (*Jamesia americana*)
fringed brome (*Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome (aka *B. richardsonii*)
dryspike sedge (*Carex siccata*) = fony sedge
prairie junegrass (*Koelaria macrantha = K. pyrimidata = K. cryptandrus*)

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: +1 (cool wet)
Climate Class: LSC (low sun cold)

Fire ecology
Presence of aspen in a minor seral role indicates that low intensity fires have been a part of the ecology of those stands.

Reforestation
Silvicultural cutting methods: heavy overstory removals (clearcuts and seed tree cuts) are difficult to regenerate. Light selection methods favor white fir, heavier cutting favors Douglas-fir and southwestern white pine. Shelterwood is usually successful for establishing conifer regeneration. Aspen (a minor seral species) may become established in clumps or patches where sufficient healthy rootstocks exist prior to disturbance.

Planting: Recommended species for artificial planting are Douglas-fir, southwestern white pine, and white fir. Probability of success is

moderate. Site preparation techniques, such as moderate intensity mechanical scalping of graminoid turf, improves seedling survival.

Revegetation considerations
Natural revegetation following disturbance can be slow on stony soils.

Comments
This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
Alexander *et al*. 1984
Moir and Ludwig 1979
Stuever 1995
USFS 1986

White fir/creeping barberry

(Formerly: White fir/Oregon grape ABCO/BERE)

Abies concolor/Mahonia repens

(Formerly: *Abies concolor/Berberis repens* ABCO/BERE)

Synonyms

Abies concolor-Pseudotsuga menziesii/ (sparse understory) (Moir and Ludwig 1979). ABCO-PSME sparse (Johnston 1987), ABCO/sparse (DeVelice *et al.* 1986).

Code(s)
creeping barberry (typic)
(MARE) phase 0 01 02 0
New Mexico locust
(RONE) phase 0 01 02 1
common juniper
(JUCO) phase 0 01 02 2

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
***White fir** and Douglas-fir co-dominate the overstory; ponderosa pine and southwestern white pine are minor seral associates. Engelmann spruce and subalpine fir are absent or accidental. Shrub layer variable and not consistent. Undergrowth usually sparse (<1%) cover, especially in mature stands. No shrub or herb is diagnostic or indicative of this type. Creeping barberry does not need to be present.

Structure
The overstory can be quite variable. Old growth stands tend to be unevenaged with a varied mix of overstory species. White fir and Douglas-fir may be present in all size classes with moderate to heavy stocking of young and advanced regeneration. White fir may be absent as large individuals but present in younger age classes. Southwestern

white pine and aspen are major seral associates. Ponderosa pine is a minor seral tree but may persist especially on drier sites. Crown dominance can be expressed by all four conifers in closed canopy. The undergrowth has very sparse shrub and forb cover; often less than 1% but occasionally ranging as high as 15% (Moir and Ludwig 1979). A discontinuous, inconsistent tall shrub layer may be sporadically present. The characteristic feature of this plant association is the sparse layer of low shrubs and forbs.

Timber productivity for this association is low to moderate. Site index is variable. Mathiasen *et al.* (1986) reported an average site index for Douglas-fir of 74.5 +/-9.6 (N = 87 stands). Another reported average site index for Douglas-fir is 67 +/- 12 (N= 67) (USFS 1987) For ponderosa pine, the average site index reported by Mathiasen *et al* (1987) is 79.3 +/-12.7 (N=20 stands), and by USFS (1987) is 71 +/- 10 (Number of samples = 67). Stockability = 1.

Location
This type occurs on all aspects of gentle to steep slopes, canyon slopes and ridges within elevations ranging from 7,900 to 9,500' (2410 to 2900 m) and is widely distributed throughout Arizona, New Mexico and southern Colorado.

Adjacent plant associations
Adjoining ABCO/MARE11 on cooler, wetter sites: ABCO/ACGL, PIEN/ACGL, and ABCO/CASI12; and on warmer, drier sites: ABCO/QUGA and PIPO/QUGA.

Also see
ABCO-PSME/SYOR (Johnston 1987); *Abies concolor/Symphoricarpos oreophilus* h.t. (Youngblood and Mauk 1985). If *Quercus gambelii* attains >5% cover and shade tolerant herbs are well represented, the see ABCO/QUGA. On limestone parent materials compare ABCO/MARE11 with ABCO/HODU if rockspirea is well represented.

Important and key plants from research plots
Trees & life history traits
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
quaking aspen *(Populus tremuloides)* S

southwestern white pine *(Pinus strobiformis)* S
ponderosa pine *(Pinus ponderosa)* s

Shrubs
Common (>1%) to well represented (>5%) cover**:**
Gambel oak *(Quercus gambelii)*
New Mexico locust *(Robinia neomexicana)*
mountain snowberry *(Symphoricarpos oreophilus)*
creeping barberry *(Mahonia repens)*
rockspirea *(Holodiscus dumosus)*
honeysuckle *(Lonicera* ssp.)
Oregon boxleaf *(Paxistima myrsinites)*
thimbleberry *(Rubus parviflorus)*
elderberry *(Sambucus* ssp.)
common juniper *(Juniperus communis)*
mountain ninebark *(Physocarpus monogynus)*

Herbs
Scarce (<1% cover), occasional species may reach 2-3 % cover:
Parry's goldenrod *(Oreochrysum parryi)*
Fendler's meadow-rue *(Thalictrum fendleri)*
western brackenfern *(Pteridium aquilinum)*
Ross' sedge *(Carex rossii)*
wild strawberry *(Fragaria* ssp.*)*
fringed brome *(Bromus ciliatus)*
muttongrass *(Poa fendleriana)*
mayflower *(Maianthemum* ssp.*)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus)*
Wooton's ragwort *(Senecio wootonii)*

Brief plant ID notes
Creeping barberry is a low sub-shrub with pinnately compound, spine-tipped, dark green and often reddish leaves.

Synonymy
Parry's goldenrod *(Oreochrysum parryi = Haplopappus parryi = Oreochrysum parryi)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana = F. ovalis)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus =L. arizonicus)*
creeping barberry *(Mahonia repens*=Oregon grape*)*

Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
Wooton's ragwort = Wooton's groundsel

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical)
Climate Class: LSC (low sun cold)

Phases
creeping barberry (MARE11) (typic) phase: The understory consists of low evergreen shrubs i.e., creeping barberry (trace to 7% cover), common juniper (trace to 15% cover), or Oregon boxleaf (up to 2% cover) [Moir and Ludwig 1979]; lacks abundant common juniper (>25% cover) and being slightly moister, has more forbs than RONE and JUCO Phases [Youngblood and Mauk 1985].

New Mexico locust (RONE) phase: This phase has a low shrubby understory absent from most stands and having instead sporadic occurrence of such deciduous shrubs as New Mexico locust, mountain snowberry, Scouler's willow and Gambel oak. Moir and Ludwig 1979

Common juniper (JUCO) phase: This is a dry extreme of ABCO/MARE11 distinguished by presence of high coverage of common juniper occurring in large patches; forbs and graminoids not important. [Youngblood and Mauk 1985]:

Fire ecology
Creeping barberry is adapted to fire and survives by suckering from dormant buds on the rhizomes.

Reforestation
Silvicultural cutting methods: Heavy overstory removal (clearcuts and seed tree cuts) may be successful and favors ponderosa pine and Douglas-fir. Light Selection cuts and shelterwood cuts favor white fir.

Recommended species for artificial planting are Douglas-fir, southwestern white pine, and ponderosa pine; success probability is moderate to high.

Site preparation techniques may augment planting efforts. Moderate intensity mechanical (scalping and water harvesting techniques) and high intensity mechanical and burning methods are likely to be detrimental.

Revegetation considerations
Natural revegetation following disturbance is usually slow due to dryness or nutrient restrictions; poor site quality for aspen which is usually short-lived.

Comments
Livestock use: Creeping barberry may be poisonous to livestock. It is not used to any extent by domestic livestock.

Wildlife: Creeping barberry may make up 6 to15% of the diet of mule deer during spring through fall seasons (Severson 1983). Elk use creeping barberry yearlong; the least use occurring during the summer (Thomas & Toweill 1982). Its fruit is eaten by numerous bird and mammal species including black bear. Early seral stages of stand development are productive for wildlife forage.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
DeVelice *et al.* 1986
Fitzhugh *et al.* 1987
Johnston 1987
Mathiasen *et al* 1987
Mathiasen *et al* 1986
Moir and Ludwig 1979
Muldavin *et al.* 1996
Thomas and Toweill 1982
Severson and Medina 1983

Uchytil 1989
USFS 1986
USFS 1987a
USFS 1987b
Youngblood and Mauk 1986

White fir/screwleaf muhly
Abies concolor/Muhlenbergia straminea

(Formerly: Abies concolor/Muhlenbergia viriscens ABCO/MUVI2)

Code(s)
typic phase 0 01 06 0

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
***White fir** and Douglas-fir co-dominate but white fir may be poorly represented in the overstory. Ponderosa pine is a major seral tree usually having scattered old individuals in the overstory with sparse reproduction beneath. Southwestern white pine is often represented by young and advanced regeneration in the understory. Blue spruce may be accidental and is present in smaller size classes. Subalpine fir, Engelmann spruce, junipers and riparian tree species are absent. In the understory, coverage of shrubs is less than 5%. Gambel oak is a major shrub. ***Screwleaf muhly** dominates the grasses with more than 1% cover. In shaded microsites, screwleaf muhly may be reduced and other graminoids more strongly expressed. Forbs are also prominent in the herb layer.

Structure
White fir and Douglas-fir are the dominant forest species. White fir may be poorly represented (<5% cover) in the overstory. Both may be present in all age classes, if lacking in larger sizes, they will be well represented as regeneration. Ponderosa pine may be present as sparse regeneration and scattered old individuals as well. Southwestern white pine may be present in smaller age classes. In the understory, shrubs, except for Gambel oak, are minor or poorly represented (<5% cover). Both grasses and forbs are prominent in the herbaceous layer. Relative proportions of species varies with ground conditions.

Timber productivity is moderate for Douglas-fir, ponderosa pine, and southwestern white pine. Site index data are not available. Stockability = 1. Grass production is high in early seral stages. Shading due to canopy closure substantially decreases forage production.

Location
This type occurs on ridges down to mid-slopes, all aspects, especially south; elevations range from 8,000' to 9,200' (2500 to 2800 m) and is known from the White Mountains of Arizona, and the Black Range and Mogollon Mountains of New Mexico.

Adjacent plant associations
ABCO/MUVI adjoins herb rich blue spruce- Douglas-fir stands on moister sites. Dryer upslopes support PIPO/MUST and at higher elevations are various phases of ABCO/QUGA, and lower elevations support PSME/MUST type.

Also see
PSME/MUST if white fir is accidental; ABCO/FEAR2 (USFS 1986a) if screwleaf muhly is absent; ABCO/QUGA, MUST phase if Gambel oak (as trees or shrubs) >5% cover.

Important and key plants from research plots
Trees & life history traits
white fir (Abies concolor) C
Douglas-fir (*Pseudotsuga menziesii*) C
ponderosa pine (*Pinus ponderosa*) S
southwestern white pine (*Pinus strobiformis*) S
quaking aspen (*Populus tremuloides*) [early to mid] s
Gambel oak *(Quercus gambelii)* s

Shrubs
Scarce (<1% cover)**:**
Gambel oak *(Quercus gambelii)*
orange gooseberry *(Ribes pinetorum)*
wildrose (*Rosa spp.*)

Herbs
Abundant (>25% cover) to luxuriant (>50% cover)**:**
***screwleaf muhly** *(Muhlenbergia straminea)*
fringed brome *(Bromus ciliatus)*

muttongrass *(Poa fendleriana)*
Ross' sedge *(Carex rossii)*
bottlebrush squirreltail *(Elymus elymoides)*
silvery lupine *(Lupinus argenteus)*
grassleaf peavine *(Lathyrus graminifolius)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus)*
sweetclover vetch *(Vicia pulchella)*
western brackenfern *(Pteridium aquilinum)*
mountain goldenbanner *(Thermopsis montana)*
Wooton's ragwort *(Senecio wootonii)*
New Mexico groundsel *(Senecio neomexicanus)*
Parry's goldenrod *(Oreochrysum parryi)*
Kentucky bluegrass *(Poa pratensis)* [on disturbed sites]

Brief Plant ID Notes
Screwleaf muhly is a robust bunchgrass with spirally curled dead leaf sheaths; individual "clumps" commonly grow to 12 to 18 inches in diameter.

Synonymy
bottlebrush squirreltail (*Elymus elymoides = Sitanion hystrix*)
Nevada pea (*Lathyrus lanszwertii var. arizonicus = L. arizonicus*)
mountain goldenbanner (*Thermopsis montana = T. montana = T. pinetorum*)
Parry's goldenrod (*Oreochrysum parryi = Haplopappus parryi = Oreochrysum parryi*)
fringed brome (*Bromus ciliata var. ciliata = B. canadensis* = Canadian brome (aka *B. richardsonii*)
screwleaf muhly (*Muhlenbergia straminea = M. virescens*)
Wooton's ragwort = Wooton's groundsel

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical)
Climate Class: HSC (high sun cold)

Fire ecology
Fire history is important in the succession of stands in this type (see discussion in PIPO/Fear2.) With fire exclusion, white fir and Douglas-fir are more dominant and regeneration is dense. The erratic burning

characteristics of fire creates patchy mosaics of regeneration. Prior to this century, fire was a common thinning agent whether it merely killed younger, smaller trees at low intensities or consumed entire stands from high intensity crown fires. Low intensity surface fires can be a useful management tool to perpetuate ponderosa pine as the primary species.

Reforestation

Silvicultural cutting methods: heavy overstory removal methods like clearcutting favor Douglas-fir and ponderosa pine regeneration, and locally in some patches, aspen. Seed tree cuts can be useful to encourage pines, especially in mistletoe infected areas. Lesser degrees of overstory removal such as light shelterwood favors the more shade tolerant white fir, while more aggressive shelterwood and selection cuts favor ponderosa pine and Douglas-fir. Light individual tree removal usually encourages white fir regeneration. Tree regeneration in this type tends to be robust under all canopy densities; more open densities favoring shade intolerant ponderosa pine, Douglas-fir and Southwestern white pine. Higher overstory densities favor white fire. This type tends toward development of random tree (not aggregated) patterns due to robust regeneration, regulated by surface fire and other disturbances. Artificial regeneration is seldom necessary in this type, except when disturbances remove seed trees.

Site preparation techniques: High to moderate intensity burning may create conditions favorable for suckering of aspen, however aspen distribution in this type tends to be irregular, seldom forming a stand-level cover type. Low intensity surface fires can be a useful management tool. Low to high intensity mechanical methods such as scalping and pitting should reduce short-term competition from grasses and low shrubs.

Revegetation considerations

Natural revegetation following disturbance is expected to be rapid primarily due to strong response of graminoids and forbs. Following removal of an overstory canopy, competition from rapidly growing shrubs and herbaceous species can present problems for restocking of ponderosa pine.

Comments
Western brackenfern, silvery lupine, and Kentucky bluegrass increase in coverage when sites are disturbed by fire or repeated long-term heavy grazing. In dense pole stands the herbaceous layer is often sparse, but occasional screwleaf muhly clumps may persist.

ABCO/MUST sites are subject to high evaporation, especially during the dry season from May through June; mean annual precipitation (MAP) = 26 - 27"/year.

Timber: This type is well adapted for timber management. Ponderosa pine usually regenerates naturally quite well in open stands. If managed for early seral species, such sites are capable of producing large, high quality ponderosa pine trees.

Livestock use: The forage value rating for cattle in early seral is high; diminishing to low in late seral due to shading by the overstory.

Wildlife: Mosaics of stands at different successional stages have wildlife benefits.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
Fitzhugh *et al.* 1987
Stuever 1995
USFS 1986
USFS 1987b

White fir/Gambel oak
Abies concolor/Quercus gambelii

Synonyms
ABCO-PSME/ QUGA (Johnston 1987).
Code(s)
Gambel oak (QUGA) phase 0 01 05 0
Screwleaf muhly (MUST) phase 0 01 05 1
Arizona fescue (FEAR2) phase 0 01 05 2
Pine muhly (MUDU) phase 0 01 05 3
Rockspirea (HODU) phase 0 01 05 4

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group

Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
***White fir** and Douglas-fir are the principal climax forest species. Ponderosa pine and southwestern white pine are common seral associates. ***Gambel oak** is a major seral tree in shrub layer usually with cover values exceeding 5%. Twoneedle pinyon and alligator juniper may occur as accidental trees especially on the drier sites. Five phases have been described in the Southwest.

Structure
White fir and Douglas-fir are the dominant overstory species in all phases. Both may be present in all age classes, if lacking in larger sizes, they will be well represented as reproduction. As a stand matures, the more shade tolerant white fir may eventually replace Douglas-fir. On drier sites, Douglas-fir may assume a prominent climax role. Southwestern white pine may demonstrate greater frequency on more moist sites especially during early to mid-seral stages of stand development. Stands tend to be well stocked. Gambel oak is a major seral small tree or tall shrub and tends to dominate the undercover. The HODU phase has a rich understory with Gambel oak and graminoids often co-dominating

and 50 or more taxa represented. Refer to the phase descriptions for other details.

Timber productivity varies from low to high for Douglas-fir and ponderosa pine. Some measured site indices for Douglas-fir and ponderosa pine respectively are: 61+/- 12 and 59 +/- 10 (N=20). Some sites on the Alpine District of the Apache-Sitgreaves National Forests may have site indices of 80 + for Douglas-fir. Mathiasen *et al.* (1986) reported an average site index for Douglas-fir of 76.9 +/-10.7 (N = 92 stands). For ponderosa pine, the average site index reported by Mathiasen *et al* (1987) is 83.5 +/-11.1 (N=72 stands). Stockability = 1.

The forage value rating for cattle in early seral is low to medium; diminishing to low or none in late seral.

Location
This common plant association occurs on all aspects and a variety of topographical settings within elevations ranging from 6,500 to 9,000+ feet (1980 to 2740 m) and is widely distributed throughout mountains of Arizona, New Mexico, and southern Colorado.

Adjacent plant associations
The typic phase, according to Moir and Ludwig (1979), may be characterized as moderate temperature and moisture regimes, relative to the environmental gradient within mixed conifer forests. As moisture conditions increase, the typic phase may adjoin the HODU phase which may border the even more moist ABCO/ACGL, HODU phase (less Gambel oak, more Rocky Mountain maple). The typic phase may be bordered also by MUST or MUDU phases. On the drier side of the moisture gradient, the typic phase may be adjoined by PSME/QUGA, or MUDU, MUST or FEAR2 phases, or other associations of ponderosa pine series or pinyon-juniper woodlands.

Also see
ABCO/RONE only if soils are derived from volcanic ash or cinders.

Important and key plants from research plots
Trees & life history traits
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* S

southwestern white pine *(Pinus strobiformis)* [in geographic area] S
Gambel oak *(Quercus gambelii)* S
limber pine *(Pinus flexilis)* [in N. NM] s
quaking aspen *(Populus tremuloides)* s

Shrubs
Usually abundant (>25% cover)**:**
***Gambel oak** *(Quercus gambelii)*
New Mexico locust *(Robinia neomexicana)*
mountain snowberry *(Symphoricarpos oreophilus)*
wildrose (*Rosa spp.*)
Oregon boxleaf *(Paxistima myrsinites)*
creeping barberry *(Mahonia repens)*
fivepetal cliffbush *(Jamesia americana*)
rockspirea *(Holodiscus dumosus)* [rockspirea phase]

Herbs
Well represented (>5% cover) to abundant (>25% cover)**:**
muttongrass *(Poa fendleriana)*
fringed brome *(Bromus ciliatus)*
Ross' sedge *(Carex rossii)*
prairie junegrass *(Koeleria macrantha)*
screwleaf muhly *(Muhlenbergia straminea)* [screwleaf muhly phase]
mountain muhly *(Muhlenbergia montana)*
pine muhly *(Muhlenbergia dubius)* [pine muhly phase]
Arizona fescue *(Festuca arizonica)* [Arizona fescue phase]
Richardson's geranium *(Geranium richardsonii)*
western brackenfern *(Pteridium aquilinum)*
Fendler's meadow-rue *(Thalictrum fendleri)*
western yarrow *(Achillea millefolium* var. *occidentalis)*
American vetch *(Vicia americana)*
Nevada pea *(Lathyrus lanszwertii* var *arizonicus)*
prarie thermopsis *(Thermopsis rhombifolia* var *divericarpa)*
fringed brome *(Bromus canadensis)*
Canadian white violet *(Viola canadensis)*
<u>rockspirea (HODU) phase additionally includes:</u>
western virgin's bower *(Clematis ligusticifolia)* [>1% cover]
<u>Arizona fescue (FEAR) phase additionally includes:</u>
Vreeland's erigeron *(Erigeron vreelandii)* [>1% cover]

white sagebrush *(Artemisia ludoviciana)* [>1% cover]
screwleaf muhly (MUST) phase additionally includes:
squirreltail bottlebrush *(Elymus elymoides)* [>1% cover]
pine muhly (MUDU) phase additionally includes:
pine muhly *(Muhlenbergia dubius)*

Synonymy
western yarrow *(Achillea millefolium* var. *occidentalis = A. lanulosa)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
prarie thermopsis *(Thermopsis rhombifolia* var. *divericarpa = Thermopsis divericarpa)*
fivepetal cliffbush = waxflower = *(Jamesia americana)*
creeping barberry *(Mahonia repens = Berberis repens)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*
Vreeland erigeron *(Erigeron vreelandii = E. platyphyllus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical)
Climate Class: LSC (low sun cold)

Phases
Relationships defining the phases of ABCO/QUGA are not well understood at present. The wide variation of soil parent materials, stoniness and depth may be some of the factors responsible for phase variation.

Gambel Oak (typic or QUGA) phase: Common throughout the Southwest; most aspects of upper canyons and ridge tops at elevations ranging from 6,000' to 9,560' (1830 to 2915 m). This phase has Gambel oak (>5% cover) as a subcanopy and shrub component; however, it is characterized by not having adequate diagnostic species. Often shrub species will form dense, sometimes impenetrable thickets following major disturbances. The undercover is herb rich often with more than 50 species of grasses and forbs, however, no single species is constant nor

diagnostic. The presence of muttongrass increases as the stand nears climax stage.

Rockspirea (HODU) phase: Known from the Lincoln National Forest; elevations ranging from 7,000' to above 9,000' (2133 to 2740 m); canyon slopes on north and west aspects below 8,000' (2440 m) and east canyon slopes above 8,000'. This phase is characterized by the presence of rockspirea which may have canopy cover of up to 25%. Gambel oak maintains high coverage.

Arizona fescue (FEAR2) phase: Arizona fescue is the diagnostic species with coverage up to 20%. Mountain muhly and muttongrass are common (>1% cover). Forb diversity is generally lacking. Shrub density is usually lower than in QUGA Phase. Pringle's speargrass and bottlebrush squirreltail are common (>1% cover). It occupies east aspects at lower elevations trending toward warmer south slopes as elevation increases; elevations: 7,000' to 8,500' (2130 to 2590 m).

Pine muhly (MUDU) phase: This is the most xeric of all the ABCO plant associations. It is characterized by the presence of pine muhly. It is restricted to cool canyon settings at low elevations; north to northeast slopes or canyons at 6,500 to 7,000' (1980 to2130 m). Forb diversity is generally lacking. Shrub density is usually lower than in QUGA Phase, especially after disturbance.

Fire ecology
Huckaby and Brown (1995, 1996) have studied fire scars in tree rings on several sites in this habitat type (ABCO/QUGA) in the Sacramento Mountains. Preliminary analysis for one site (Delworth) shows a mean fire interval of 16 +/-8 years, with a range of 6 to 31 years between fires for the 17th -19th century. Fires tended to occur in early to mid-growing season. On one site (Fir Campground Area IV), fires were more frequent in the 19th century than the 17th or 18th century. Fires in the 20th century have been very limited.

Fire history is important in determining stand structure and composition. Oaks rapidly recover, and where crown fires have removed conifer canopies, oaks have the potential to dominate the site for over a hundred years. See also Hanks and Dick-Peddie 1974. Antidotal observations suggest that oak response in this type can be

more robust on coarse textured granitic soils, and less so on fine textured clay soils.

Reforestation
Silvicultural cutting methods: heavy overstory removal methods like clearcutting favor Douglas-fir, Southwestern white pine, and ponderosa pine regeneration, and locally in some patches, aspen. Seed tree cutting can be successful if ponderosa pine and Douglas-fir seed trees are left. Clearcutting or seed tree cutting may result in long-term oak/locust domination as mentioned under fire ecology, especially in the QUGA Phase (John Shafer, James Youtz, personal communication). Also, successful regeneration of both conifers is increased through planting in open situations. Lesser degrees of overstory removal such as light shelterwood and selection cutting favors more shade tolerate white fir and Douglas-fir, while less shelter favors ponderosa pine. light selection cutting is more favorable to white fir regeneration and may help to suppress oak/locust.

Tree Planting: conifers can be successful if competing oak and woody shrubs can be suppressed during establishment.

Site preparation techniques: High to moderate intensity burning may encourage oak and locust. High to moderate intensity mechanical methods such as scalping and pitting should reduce short-term competition from grasses and low shrubs. However, discing may encourage sprouting/suckering of oak and locust. Herbicides may successfully reduce competition from oak and/or locust (John Shafer, personal communication).146

Revegetation considerations
Natural revegetation following disturbance is expected to be rapid primarily due to sprouting/suckering of oak and/or locust. Following removal of an overstory canopy, competition from rapidly growing shrubs and herbaceous species and more shade tolerant conifers can present problems for restocking of ponderosa pine.

Comments
This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce

species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References

Alexander *et al*. 1984a
DeVelice *et al.* 1986
Fitzhugh *et al.* 1987
Hanks and Dick-Peddie 1974
Johnston 1987
Mathiasen *et al* 1987
Mathiasen *et al* 1986
Moir and Ludwig 1979
Muldavin *et al.* 1996
Severson and Medina 1983
John Shafer, R3 Silviculturalist 1996
Thomas and Toweill 1982
Uchytil 1989
USFS 1986
USFS 1987a
USFS 1987b
Youngblood and Mauk 1986

White fir/burnet ragwort

(Formerly: Abies concolor/Muhlenbergia viriscens ABCO/MUVI2)

Abies concolor/Packera sanguisorboides

(Formerly: Abies concolor/Senecio sanguisorboides ABCO/SESA6)

Code(s)
typic phase 0 01 16 0

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
This is a cold, often snowy mixed conifer forest. The overstory is dominated by Douglas-fir. White fir dominates the tree regeneration. Aspen and ponderosa pine are absent or accidental. Understory shrub layer has a cover of <10%. The herb layer is well represented (> 5% cover) and is dominated by ***burnet ragwort**.

Structure
Douglas-fir is the overstory dominant. White fir dominates the tree regeneration. Timber productivity is low to moderate. Site index data are not available. Stockability = 1.

Location
This type occurs on gentle slopes that are cold and well watered. The elevation is 9,200' -9,300' (2800 - 2835 m). It is known only in the Sacramento Ranger District of the Lincoln National Forest in the vicinity of Sunspot, and may occur in the vicinity of Sierra Blanca.

Adjacent plant associations
Similar to and may border: ABCO/ACGL and ABCO/EREX.

Also see

If subalpine fir and Engelmann spruce are dominant, see ABLA/PASA12 (ABLAA/PASA12).

Important and key plants from research plots
Trees & life history traits

white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
southwestern white pine *(Pinus strobiformis)* s

Shrubs
Well represented (>5 % cover)
rockspirea *(Holodiscus dumosus*
Rocky Mountain maple *(Acer glabrum)*
elderberry *(Sambucus* spp.*)*

Herbs
Well represented (>5% cover)
sprucefir fleabane *(Erigeron eximius)*
Parry's goldenrod *(Oreochrysum parryi)*
***burnet ragwort** *(Packera sanguisorboides)*
fringed brome *(Bromus ciliatus)*
tuber starwort *(Pseudostellaria jamesiana)*
fragrant bedstraw *(Galium triflorum)*

Brief plant ID notes
Burnet ragwort is a multi-headed, yellow-flowered composite, with pinnately lobed leaves.

Synonymy
Parry's goldenrod *(Oreochrysum parryi = Haplopappus parryi = Solidago parryi)*
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
burnet ragwort *(Packera sanguisorboides = Senecio sanguisorboides)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: +1 (cool wet)
Climate Class: LSC (low sun cold)

Fire ecology
A fire history dendrochronology study is currently being conducted by Huckaby & Brown (1996), and specific plant association information is

not yet available for this type. However, this same study has noted that historic fire frequency intervals are longer in cooler sites such as these (ABCO/EREX4: MFI = 31 years, whereas PSME/QUPA4: MFI = 7 years). Fire climate category and fuel are probably similar to ABCO/ACGL and ABCO/EREX4.

Reforestation
Silvicultural cutting methods: heavy overstory removal (clearcuts and seed tree cuts) favors Douglas-fir and southwestern white pine regeneration. Successful regeneration of Douglas-fir in open situations is expected to be high; competition from rapidly growing shrubs can be expected following removal of overstory canopy. Lesser degrees of overstory removal such as light selection cutting, may be more favorable to white fir regeneration.

Comments
This is a scarcely known plant association, described based on a single plot.

This type is prime habitat (forage and cover) for large game. Highly variable stand structure with multi-storied shrub layers and species increases micro habitat diversity for birds.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
Huckaby & Brown 1996
Moir personal communication

White fir/New Mexico locust
Abies concolor/Robinia neomexicana

Code(s)
New Mexico locust (RONE) phase 0 01 11 0
dryspike sedge (CASI12) phase 0 01 11 1

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
***White fir** and Douglas-fir are the characteristic overstory trees. Also, Douglas-fir regeneration is light density, while white fir regeneration is abundant. The undergrowth is dominated by shrubs with 45-75% cover; ***New Mexico locust** being the characteristic shrub species. This plant association is similar to ABCO/QUGA except soils must be volcanic ash or cinder-derived.

Structure
White fir and Douglas-fir are the dominant overstory species in both phases. Both may be present in all age classes. If lacking in larger sizes, they will be well represented as regeneration. White fir regeneration is usually more abundant than that for Douglas-fir. Site quality for Douglas-fir and ponderosa pine is considered to be poor in Arizona (RONE phase) and may be moderate to high in New Mexico (CASI12 phase).

Stockability rating = 1. One measured site index for ponderosa pine is 63.

The forage value rating for cattle in early seral stage is high, diminishing to low in late seral. Early seral stages provide cover and forage for a variety of wildlife.

Location
This plant association occurs on gentle slopes of cinder cones and other volcanic ash or cinder soils; within elevations ranging from 8,500' to

8,800 feet (2590 to 2680 m) and is known from the cinder cones near Lakeside and Springerville, Arizona and Jemez Mountains and vicinity, New Mexico.

Adjacent plant associations
ABCO/RONE may occur on small knolls near other mixed conifer types such as ABCO/QUGA.

Also see
ABCO/EREX, ABCO/QUGA, ABCO/LALAL3, and ABCO/FEAR2.

Important and key plants from research plots
Trees & life history traits

New Mexico Locust phase:
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* S
ponderosa pine *(Pinus ponderosa)* S
quaking aspen *(Populus tremuloides)* S
southwestern white pine *(pinus strobiformis)* s
dryspike sedge phase
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* S
quaking aspen *(Populus tremuloides)* S

Shrubs
Well represented (>5% cover) to abundant (>25% cover)**:**
***New Mexico locust** *(Robinia neomexicana)*
Arizona honeysuckle *(Lonicera arizonica)*
Gambel oak *(Quercus gambelii)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis*)
grayleaf red raspberry *(Rubus idaeus* ssp. *strigosus)*
thimbleberry *(Rubus parviflorus)*
Rocky Mountain maple *(Acer glabrum)*

Herbs
Well represented (>5% cover)**:**
dryspike sedge *(Carex siccata)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
starry false lily of the valley *(Maianthemum stellatum)*

feathery false lily of the valley *(Maianthemum racemosum)*
Richardson's geranium *(Geranium richardsonii)*
Canadian white violet *(Viola canadensis)*
fringed brome *(Bromus ciliatus)*
roughleaf ricegrass *(Oryzopsis asperifolia)*

Brief plant ID notes
New Mexico locust is a small tree or shrub with spiny, stout branches and pinnately compound leaves with oval leaflets. It bears showy panicles of pinkish/purplish pea-like blossoms.

Synonymy
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis = A. alnifolia)*
woodland strawberry *(Fragaria vesca* ssp. *americana = F. americana)*
starry false lily of the valley *(Maianthemum stellatum = Smilacina stellata)*
feathery false lily of the valley *(Maianthemum racemosum = Smilacina racemosa)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
dryspike sedge *(Carex siccata)* = fony sedge *(Carex foenea)*
grayleaf red raspberry *(Rubus idaeus* ssp. *strigosus = R. strigosus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical)
Climate Class: LSC (low sun cold)

Phases
New Mexico locust (RONE) phase: Known from the cinder cones and volcanic cinder soils in the vicinity of Springerville, Arizona. This phase has high cover of New Mexico locust (30% to 60% cover).

Dryspike sedge (CASI12) Phase: Known from the Jemez Caldera of northern New Mexico. This phase is characterized by the presence of dryspike sedge which may have cover of up to 25%.

Fire ecology
Fire history was important in the succession of ABCO/RONE, which may be a fire derived or logging-stimulated seral community. Fire may

kill the above ground portion of New Mexico locust, but roots and rhizomes survive most fires and sucker rapidly (Pavek 1993).

Reforestation
Silvicultural cutting methods: Heavy overstory removal methods like clearcutting favor locust and graminoids. To reestablish conifers, clearcuts should be planted promptly following cutting. Seed tree cutting favors shrubs and forbs and is seldom successful for conifer regeneration. Lesser degrees of overstory removal may develop conifer understories if enough shelter is left to suppress locust, sedges and other herbs. Light selection cutting is more favorable to white fir.

Tree planting: conifer regeneration can be successful if done soon after locust removal. Conifers can establish under locust canopy; however, growth will be suppressed until dominance is established over locust.

Site preparation techniques: High intensity burning may produce conditions suitable for sprouting/suckering of aspen. Except for low intensity fires, most burning will tend to remove white fir. Mechanical methods of low to high intensity such as scalping of graminoids and forbs or grubbing and chopping of shrubs should reduce short-term competition from sedges and low shrubs but may have little effect on locust. Herbicides may be the only effective control on locust.

Revegetation considerations
Natural revegetation following disturbance is expected to be rapid primarily due to sprouting/suckering of locust. Following removal of an overstory canopy, competition from rapidly growing shrubs and herbaceous species and more shade tolerant conifers can present problems for restocking of ponderosa pine and Douglas-fir.

Comments
Disturbances such as logging and fire may increase coverage of shrubs, sedges, and other forbs, often at the expense of tree regeneration. This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in

growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References

Fitzhugh *et al.* 1987
Moir and Ludwig 1979
Pavek 1993
Uchytil 1989
USFS 1986
USFS 1987a

White fir/mountain snowberry
Abies concolor/Symphoricarpos oreophilus

Formerly white fir/whortleleaf snowberry

Synonyms
Abies concolor-Pseudotsuga menziesii/ Symphoricarpos oreophilus (Johnston 1984)

Code(s)
ponderosa pine (PIPO) phase 0 01 14 0

limber pine (PIFL) phase 0 01 14 1

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
***White fir** and Douglas-fir are the principal climax forest species. White fir may be present primarily as regeneration. Ponderosa pine and southwestern white pine are common seral associates. ***Mountain snowberry** occurs in the sparse understory and may attain a coverage exceeding 5%. Aspen is a minor seral tree in this association. There are two phases.

Structure
The overstory tends to be varied and complex. In the PIFL phase, white fir and Douglas-fir are codominant overstory species along with limber pine and bristlecone pine. In the PIPO phase, white fir may have little presence in the overstory, however, is represented in the regeneration.

The stockability rating is unknown. Timber productivity is low (poor to very poor). Site index data are not available.

Mountain snowberry is considered a climax species in the shrub layers. It may be a major component throughout all successional stages. Where present, following disturbance, it often is established in early seral stages and is likely to coexist with later arriving species.

Location
This common plant association occurs mostly on steep, northerly, canyon side slopes and ridges within elevations ranging from 8,500' to 9,500'+ (2590 to 2895 m) and is widely distributed throughout mountains of Arizona, New Mexico, southern Utah, and southern Colorado.

Adjacent plant associations
On moister sites, ABCO/SYOR2 adjoins ABCO/ACGL. Cooler adjoining sites are likely to be of the subalpine fir (ABLA) series.

Also see
Youngblood and Mauk 1985 describe a plant association in Utah resembling our PIPO phase; TES mapping unit 922 on the Carson National Forest (Edwards 1987). ABCO/ACGL intergrades into ABCO/SYOR2 but typically occupies wetter or colder sites. ABCO/MARE11 occupies drier or more nutrient impoverished sites.

Important and key plants from research plots
Trees & life history traits
ponderosa pine phase: white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* S
quaking aspen *(Populus tremuloides)* s
limber pine phase: white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
limber pine *(Pinus flexilis)* (in n. NM) S
quaking aspen *(Populus tremuloides)* s
bristlecone pine *(Pinus aristata)* s

Shrubs
Well represented (>5% cover)**:**
mountain snowberry *(Symphoricarpos oreophilus)*
rockspirea *(Holodiscus dumosus)*
fivepetal cliffbush *(Jamesia americana*)
common juniper *(Juniperus communis)*
creeping barberry *(Mahonia repens)*
Gambel oak *(Quercus gambelii)*
Rocky Mountain maple *(Acer glabrum)*
mountain ninebark *(Physocarpus monogynus)*

Herbs
Common (>1% cover) to well represented (>5% cover)**:**
fringed brome *(Bromus ciliatus)*
prairie junegrass *(Koeleria macrantha)*
muttongrass *(Poa fendleriana)*
dryspike sedge *(Carex siccata)*
Ross' sedge *(Carex rossii)*
Parry's goldenrod *(Oreochrysum parryi)*
western yarrow *(Achillea millefolium* var. *occidentalis)*
nodding onion *(Allium cernuum)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus)*
groundsel *(Senecio* spp.)

Cryptogams
Lichens and mosses may form on micro sites free of tree litter.

Brief plant ID notes
A member of the honeysuckle family, mountain snowberry has simple paired leaves with irregular shaped leaf margins.

Synonymy
western yarrow *(Achillea millefolium* var. *occidentalis = A. lanulosa)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
Parry's goldenrod *(Oreochrysum parryi = Haplopappus parryi = Oreochrysum parryi)*
fivepetal cliffbush = waxflower = *(Jamesia americana)*
creeping barberry *(Mahonia repens = Berberis repens)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
dryspike sedge *(Carex siccata)* = fony sedge
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*

Terrestrial Ecological Unit attributes
ponderosa pine phase:
Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical)
Climate Class: LSC (low sun cold)
limber pine phase
Life Zone Class: 6

Elevational Subzone: +1 (cool, moist)
Climate Class: LSC

Phases
There are two phases:

Ponderosa pine (PIPO) phase: An association of cool and dry situations, this phase has Douglas-fir and ponderosa pine dominating the overstory of mature stands. White fir may be represented by scattered large trees. This phase occurs throughout northern New Mexico, southern Colorado and Utah; on moderate to steep, mid slopes with northerly aspects; elevations range from 6,800' to 9,300' (2070 to 2835 m). A light shrub layer dominates the otherwise sparse undercover.

Limber pine (PIFL) phase: This phase demonstrates overstory codominance of white fir, Douglas-fir, and limber pine. Bristlecone pine is a minor seral associate. Undergrowth is sparse and only mountain snowberry has coverage exceeding 5%, This phase generally occurs at elevations ranging from 8,200' to 9,850' (2300 to 3000 m); on all aspects of steep canyon side slopes and ridges.

Fire ecology
Fire history indicates frequent, probably low to moderate intensity fires were common in spite of thin, dissected ground cover and litter.

Mountain snowberry may be top consumed by most fires but often survives by sprouting from remaining root crowns.

Reforestation
Site preparation techniques: Reforestation may be difficult if shrub and grass components are well established

Revegetation considerations
Mountain snowberry is valued for re-establishing cover on disturbed sites. Transplanted wildings do especially well. Propagation can be accomplished through stem cuttings and cultivation of seedlings. Snowberry is recommended for use in riparian plantings and in forested communities. Aspen (a minor seral species) may become established in clumps or patches where sufficient healthy rootstocks exist prior to disturbance.

Comments
The forage value rating for cattle in early seral stages is low to medium; diminishing to low or none in late seral stage. Mountain snowberry is an important high elevation forage species for elk and deer. A variety of birds and small mammals eat the fruits.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist (especially where white fir component is high), especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
DeVelice *et al.* 1986
McMurray 1987
Collins and Urness 1983
Stanton 1974
Monson and Christenson 1975
Plummer *et al* 1968
Stevens *et al* 1981
Koniak 1985
Stickney 1986
Moir and Ludwig 1979
USFS 1987a
Youngblood and Mauk 1986

White fir/whortleberry

(Formerly: white fir/myrtle huckleberry)

Abies concolor/Vaccinium myrtillus

Synonyms
Abies concolor-Pseudotsuga menziesii/Vaccinium myrtillus (Johnston 1987)

Code(s)
typic phase 0 01 10 0

Ecological Response Unit
Spruce-Fir Forest (SFF), subclass Spruce-Fir Lower (SFM)

National Vegetation Classification Group
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

Key criteria
Complex overstory where ***white fir** may be present with five to six other tree species. The shrub component is luxuriant (>50% cover) having several shrub species co-dominating with the usually conspicuous ***whortleberry** layer. Blue spruce is absent, accidental, or very minor in the stand.

Structure
The highly mixed overstory of mixed conifer species presents numerous management options. For example, to manage for Douglas-fir would be difficult because of the competition by other species more suited to this environment. Site productivity is low and cutting will continue to favor white fir under most circumstances. This plant association is uncommon and local when found.

Timber productivity for white fir and Douglas-fir is low to moderate. Some measurement data for Douglas-fir show site indices ranging from 50 to 70 (Jack Carpenter, personal communication).

Stockability = 1.

Location
This type occurs on cold, steep, northerly slopes within elevations ranging from 8,500' to 9,400' (2600 to 2870 m) and is known from the Jemez, San Juan, and Sangre de Cristo Mountains in New Mexico and southern Colorado.

Adjacent plant associations
Adjoins ABLA/VAMY2 at higher elevations and herb rich mixed conifer stands at lower elevations.

Also see
Pseudotsuga menziesii/Paxistima myrsinites h.t. (Hoffman and Alexander 1980)

Important and key plants from research plots
Trees & life history traits

white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
quaking aspen *(Populus tremuloides)* S
limber pine *(Pinus flexilis)* (in n. NM) s
Engelmann spruce *(Picea engelmannii)* c
subalpine fir *(Abies lasiocarpa* var. *arizonica)* c
ponderosa pine *(Pinus ponderosa)* s

Shrubs
Luxuriant (>50 % cover)**:**
*whortleberry (*Vaccinium myrtillus*)
Oregon boxleaf *(Paxistima myrsinites)*
Rocky Mountain maple *(Acer glabrum)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis*)
creeping barberry *(Mahonia repens)*
mountain snowberry *(Symphoricarpos oreophilus)*
kinnikinnick *(Arctostaphylos uva-ursi)*
thimbleberry *(Rubus parviflorus)*

Herbs
Well represented (>5% cover)
sprucefir fleabane *(Erigeron eximius)*
ragweed sagebrush *(Artemisia franseriodes)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana)*

Nevada pea *(Lathyrus lanszwertii var. arizonicus)*
Canadian white violet *(Viola canadensis)*
fringed brome *(Bromus ciliatus)*
roughleaf ricegrass *(Oryzopsis asperifolia)*

Brief plant ID notes
Whortleberry is a low, sprawling shrub from the heather family (Ericaceae). The light greenish leaves are thin and somewhat translucent.

Synonymy
sprucefir fleabane *(Erigeron eximius = forest fleabane E. superbus)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana = F. ovalis)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis) = A. alnifolia)*
subalpine fir *(Abies lasiocarpa* var. *arizonica)*
creeping barberry *(Mahonia repens = Berberis repens)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (subalpine forest)
Elevational Subzone: -1 (warm, dry)
Climate Class: LSC (low sun cold)

Fire ecology
Fire is presumed to have been a major factor in development of stands in this plant association. Fires that are of light to moderate intensity, erratic and infrequent, tend to result in a diversity of stand structures.

Vaccinium is rhizomatous, having extensive, branched rhizomes that are responsible for vegetative regeneration following fire. It is well adapted to a regime of frequent fire and also thrives under longer fire intervals.

Reforestation
Silvicultural cutting methods: heavy overstory removal may favor Douglas-fir regeneration. Clear cuts are likely to favor aspen and to a lesser degree, Douglas-fir and southwestern white pine; prompt planting is usually required to assure conifer regeneration. Aspen (a major seral species) has the potential to form a seral cover type if sufficient healthy

rootstock exists before disturbance Seed tree cut may or may not be successful depending on species of the selected seed trees. Shelterwood and selection methods may encourage conifer regeneration, heavy cover favoring shade tolerant species. Successful regeneration of Douglas-fir in open situations is expected to be difficult; competition from rapidly growing shrubs can be expected following removal of overstory canopy. Lesser degrees of overstory removal may be more favorable to white fir regeneration.

Site preparation techniques: High to moderate intensity burning may create conditions favorable for suckering of aspen. Low to moderate mechanical methods such as scalping and pitting should reduce short-term competition from grasses and low shrubs. High intensity mechanical methods may cause severe soil disturbance. Steepness of slopes may be prohibitive to most mechanical methods.

Revegetation considerations
Natural revegetation following disturbance is expected to be rapid due to the recovery of graminoids and forbs, and the suckering/sprouting of aspen.

Vaccinium can aid in preventing soil erosion once established. It may be stimulated with most timber treatments, except after clearcutting which usually will lead to diminished coverage. VAMY2 has been known to provide a nurse cover for establishment of Douglas-fir seedlings.

Comments
This is the coldest of the white fir plant associations; it is also the warmest extreme of the cryic soil temperature regime. Soils are Cryochrepts, Cryoborolls, and Cryorthents.

Livestock: The forage value rating for cattle is rated as having low potential.

Wildlife: This plant association provides habitat (forage and cover) for large game. VAMY is consumed by a variety of small and large mammals and birds. Its palatability rating for cattle and horses is poor, and for most wildlife is fair. *Vaccinium* berries are an important part of the diet of bears.

This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when

composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References

DeVelice *et al.* 1986
Johnston 1987
Moir & Ludwig 1979
Muldavin *et al.* 1996
Tirmenstein, D. 1990
Clagg 1975
Crouch 1986
Martin 1979
Richardson 1980
Ritchie 1956
Vander Kloet and Hall 1981
USFS 1987a

Limber Pine Series

PIFL2/ARUV

Limber pine/kinnikinnick
Pinus flexilis/Arctostaphylos uva-ursi

Synonyms
Pinus flexilis/Juniperus comminus (Johnston 1987, Hess and Alexander 1986).

Code(s)
typic phase 2 40 30 0

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
This cool, dry plant association has a shrub dominated understory of ***kinnikinnick**, a low-growing shrub and common juniper. Herbs are generally scarce. Ponderosa pine is absent or accidental.

Structure
Timber productivity is generally low. Selection and shelterwood cutting methods are usually successful for forest re-establishment. Seed tree and clearcut cutting methods usually are not successful for regenerating trees.

Location
This plant association is minor in occurrence and is known from northern New Mexico to Colorado and Wyoming. On upper slopes and ridgetops, 9,500 - 10,000' (2895 -3050 m), high insolation and evapotranspiration.

Adjacent plant associations
Often adjoins subalpine fir/whortleleaf huckleberry (ABLA/VAMY2) which is on less exposed sites with cooler environments within the same

elevational zone (DeVelice *et al.* 1986). May also transition to white fir/sparse (ABCO/sparse).

Also see
Climatic data at station C-1 in Marr (1961) and subsequent records from Inst. Arctic and Alpine Res., Univ. Colorado, Boulder.

Important & key plants from research plots
Trees & life history status

limber pine *(Pinus flexilis)* C
Douglas-fir *(Pseudotsuga menzensii)* C
quaking aspen *(Populus tremuloides)* S
Engelmann spruce *(Picea engelmannii)* c
Shrubs
Well represented (>5%) or abundant (>25%):
***kinnikinnick** *(Arctostaphylos uva-ursi)*
common juniper *(Juniperus communis)*

Herbs
Poorly represented (<5%):
Ross' sedge *(Carex rossii)*
prairie junegrass *(Koelaria macrantha)*
goldenrod *(Solidago* spp.)
Parry's goldenrod *(Oreochrysum parryi)*

Brief Plant ID Notes
In this habitat type, limber pine resembles its northern populations and is distinct from southwestern white pine *(Pinus strobiformis).* Kinnikinnick can be distinguished from Oregon boxleaf *(Paxistima myrsinites)* by its rounder, lighter color leaves.

Synonymy
Parry's goldenrod *(Oreochrysum parryi = Solidago parryi)*

prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 7 (spruce/fir)
Elevational Subzone: -1 (dry, warm)
Climate class: LSC (low sun cold)

Phases
There is only one phase identified for this habitat type.

Fire ecology
Although the above ground kinnikinnick plant is easily killed by fire, if the root crown (often at the surface) of the plant survives, sprouting from roots often occurs. Regeneration by seed is less common, but seeds may be fire resistant (Crane 1991).

Reforestation
Douglas-fir and limber pine have been planted in this plant association with moderate survival success.

Revegetation Considerations
After disturbance, revegetation is very slow. Kinnikinnick has been reported to increase following moderate disturbances (Crane 1991). Stem cuttings taken in the fall are generally the preferred method of reestablishing kinnikinnick artificially (Crane 1991).

Comments
This association is similar to the Douglas-fir/kinnikinnick (Fitzhugh *et al.* 1987) in terms of structure and composition but clearly differs by geography in that the Douglas-fir/kinnikinnick occurs further south in the San Mateo and Sacramento ranges of central and southern New Mexico. This association occurs on drier and lower positions than the limber pine/kinnikinnick, and with southwestern white pine (*Pinus strobiformis*) instead of limber pine. This plant association is one of the few sites where limber pine dominates and is, therefore, important for providing diversity of wildlife habitats. Big game animals such as mule deer and elk may browse the kinnikinnick particularly in the winter, as snow accumulation is usually less than adjacent plant associations. Kinnikinnick berries spoil slowly and are often available through the winter for songbirds, grouse, turkey, and in early spring for bears.

References
Crane 1991
DeVelice et al. 1986
USFS 1987a

Douglas-Fir Series

PSME/ACGR3

Douglas-fir/bigtooth maple
Pseudotsuga menziesii/acer grandidentatum

Code(s)
typic phase 0 12 39

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
***Bigtooth maple** is common. White fir is absent or accidental.

Structure
Site productivity for Douglas-fir is low (Muldavin *et al.* 1996).

Location
Presently known from the Galiuro Mountains (Coronado National Forest), Arizona, where it occurs on north slopes and streamside terraces, 5,300' - 7,200' (1615 - 2195 m).

Adjacent plant associations
On drier, lower slopes adjoining pine-oak woodlands. Where PSME/ACGR3 p.a. occurs on streamside terraces, adjacent riparian plant communities may include Arizona alder, velvet ash, boxelder, or bigtooth maple.

Also see
White fir/bigtooth maple *(Abies concolor/Acer grandidentatum)* is similar but does not have evergreen oaks. If velvet ash *(Fraxinus velutina)* is common along intermittent streams, see "Riparian Forests".

Important & key plants from research plots
Trees & life history status

Douglas-fir *(Pseudotsuga menzensii)* C

bigtooth maple *(Acer grandidentatum)* C
border pinyon *(Pinus discolor)* S
ponderosa pine *(Pinus ponderosa)* s
Arizona white oak *(Quercus arizonica)* s
Arizona madrone *(Arbutus arizonica)* s

Shrubs
Abundant (>25%) or luxuriant
(>50%) canopy coverage:
bigtooth maple *(Acer grandidentatum)*
netleaf oak *(Quercus rugosa)*
canyon live oak *(Quercus chrysolepis)*
silverleaf oak *(Quercus hypoleucoides)*
Arizona honeysuckle *(Lonicera arizonica)* creeping barberry *(Mahonia repens)*
beechleaf frangula *(Frangula betulifolia)*
New Mexico raspberry *(Rubus neomexicanus)*
mountain snowberry *(Symphoricarpos oreophilus)*
Gambel oak *(Quercus gambelii)*

Herbs
Common (>1%):
muttongrass *(Poa fendleriana)*
fringed brome *(Bromus ciliatus)*
tasselflower brickellbush *(Brickellia grandiflora)*
brittle bladderfern *(Cystopteris fragilis)*
Mexican bedstraw *(Galium mexicanum* ssp. *asperrimum)*

Brief Plant ID notes
Bigtooth maple has 3 to 5 lobed “maple” leaves with entire leaf margins.

Synonymy
creeping barberry *(Mahonia repens = Berberis repens)*
beechleaf frangula *(Frangula betulifolia = Rhamnus betulaefolia)*
Mexican bedstraw *(Galium mexicanum* ssp. *asperrimum = Galium asperrimum)*
border pinyon *(Pinus discolor = Pinus cembroides = Mexican pinyon)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: 0 (typic)
Climate class: HSC (high sun cold)

Phases
No phases have been described for this plant association, however, there may be another phase in central New Mexico (Manzano Mtns, Fourth of July Canyon).

Fire ecology
Due to the cool, moist environment of this plant association, fires are probably less frequent than drier types. Where maple cover is luxuriant, understory herb growth may not be sufficient to carry a surface fire (Uchytil 1990). When the bigtooth maple crown is killed by fire, some resprouting can occur, but sprouting vigor is thought to be low (Uchytil 1990). In Utah, bigtooth maple has been observed to be expanding its range into stands of Gambel Oak. One hypothesis to explain this recent migration is that fire suppression has favored maple, since Gambel oak sprouting has not been as vigorous with the lower fire frequencies of the last century.

Reforestation
Douglas-fir reproduction success following harvesting is unlikely (Muldavin *et al.* 1996).

Revegetation considerations
Bigtooth maple reproduces most often vegetatively by layering. Seeds are important in establishing bigtooth maple in new areas and are dispersed by the wind in the fall and early winter (Uchytil 1990).

Comments
Hiding cover is excellent for wildlife species due to the shrub canopies, but shrubbiness may impede livestock use (Muldavin *et al.* 1996).

Reference(s)
Muldavin *et al.* 1996
Stuever 1995
Uchytil 1990
USFS 1987b

Douglas-fir/kinnikinnick
Pseudotsuga menziesii/Arctostaphylos uva-ursi

Synonyms
Pseudotsuga menziesii/Arctospahylos adenotricha-Juniperus communis (Johnston 1987).

Code(s)
typic phase 0 12 31

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
***Kinnikinnick** *(Arctostaphylos uva-ursi),* a low-growing shrub, ranges from 25%-70% canopy coverage, and generally is the sole dominant understory species. Aspen may be a long-term seral component in the stand.

Structure
Timber productivity is low. Researchers noted tree heights of about 30' with rounded or dead tops (Fitzhugh *et al.* 1987).

Location
Known from the San Mateo Mountains, Cibola National Forest. Found on ridgetops between 9,800' and 9,900' (2990 -3020 m).

Adjacent plant associations
Warm, dry lower slopes adjacent to this type may support white fir/Arizona fescue (ABCO/FEAR2) or ponderosa pine/kinnikinnick, muttongrass phase (PIPO/ARUV, POFE ph) plant associations [Fitzhugh *et al.* 1987].

Also see
PSME/ARUV (Pfister et. al., 1977).

Important & key plants from research plots
Trees & life history status

Douglas-fir *(Pseudotsuga menzensii)* C
southwestern white pine
(Pinus strobiformis) C
quaking aspen *(Populus tremuloides)* S
ponderosa pine *(Pinus ponderosa)* S

Shrubs
Kinnikinnick is abundant (>25%), other shrubs are poorly represented (<5%):
***kinnikinnick** *(Arctostaphylos uva-ursi)*
common juniper *(Juniperus comminus)*
Arizona honeysuckle *(Lonicera arizonica)*

Herbs
Well represented (>5%):
mountain muhly *(Muhlenbergia montana)*
fringed brome *(Bromus ciliatus)*
sedges *(Carex spp.*)
manyflowered stoneseed *(Lithospermum multiflorum)*
rock clematis *(Clematis columbiana)*
coast goldenrod *(Solidago spathulata)*

Brief plant ID notes
Kinnikinnick can be distinguished from Oregon boxleaf *(Paxistima myrsinites)* by its rounder, lighter colored leaves.

Synonymy
rock clematis *(Clematis columbiana* var. *columbiana = C. pseudoalpina).*

fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: -1 (dry, warm)
Climate class: LSC (low sun cold)

Fire ecology

Extensive, severe fires in this plant association have resulted in seral stands dominated by aspen (Fitzhugh *et al.* 1987). The above-ground portion of kinnikinnick is easily killed by fire, but sprouting from roots often occurs. Kinnikinnick regeneration by seed is less common, but seeds may be fire resistant (Crane 1991).

Reforestation
No information on reforestation is available for this association.

Revegetation considerations
Aspen sprouting can be prolific following some disturbances. Kinnikinnick has reportedly increased following moderate disturbances (Crane 1991). Stem cuttings taken in the fall are generally the preferred method of reestablishing kinnikinnick artificially (Crane 1991).

References
Crane 1991
Fitzhugh *et al.* 1987
Johnston 1987

Douglas-fir/fringed brome
Pseudotsuga menziesii/Bromus ciliatus

Code(s)
typic phase 0 12 32 0

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
The most shade tolerant tree present is Douglas-fir. Fringed brome is abundant, often luxuriant. Arizona fescue is usually scarce or not present. Forbs are well represented and often abundant. Rocky mountain maple may be well represented in the shrub layer. Engelmann spruce and/or white fir are absent or accidental.

Structure
Where this type is found on ridgetops and exposed conditions, slow timber growth rates and severe regeneration problems can be expected. Fully stocked stands may take hundreds of years to become established under natural conditions (Fitzhugh *et al.* 1987). On other sites, productivity may be moderate. Stockability = 1. In absence of regular fire regime, some stands may benefit from thinning to reduce stocking.

Location
Southeast Arizona, southwest to central New Mexico, and local in northern New Mexico. Cold, wet, windy sites, but dry in May and June, 9,300' - 10,100' (2830 - 3090 m).

Adjacent plant associations
PSME/BRCI often occurs upslope from drainages containing ABCO/ACGL, and ABCO/QUGA h.t. may be upslope (Alexander *et al.* 1987). Other plant associations adjacent to PSME/BRCI include PSME/QUGA (warmer), ABCO/EREX4 (lower in drainages), as well as spruce-fir forests (slightly colder), grassy ponderosa pine types (rapid topographic change), and grassy parks (Fitzhugh *et al.* 1987).

Also see
ABCO/EREX4 if white fir *(Abies concolor)* has common regeneration in mature stands. PSME/FEAR2, POTR phase represents an environment intergrading to PSME/BRCI.

Important & key plants from research plots
Trees & life history status

Douglas-fir *(Pseudotsuga menziesii)* C
southwestern white pine *(Pinus strobiformis)* [where occurs geographically] S
ponderosa pine *(Pinus ponderosa)* s
quaking aspen *(Populus tremuloides)* s
limber pine *(Pinus flexilis)* [in no. NM] s

Shrubs
Scarce (<1%) to abundant (>25%):
rockspirea *(Holodiscus dumosus)*
Rocky Mountain maple *(Acer glabrum)*
mountain ninebark *(Physocarpus monogynus)*
fivepetal cliffbush *(Jamesia americana)*
orange gooseberry *(Ribes pinetorum)*

Herbs
Luxuriant (>50%):
fringed brome *(Bromus ciliatus)*
muttongrass *(Poa fendleriana)*
spike trisetum *(Trisetum spicatum)*
common yarrow *(Achillea millefolium)*
sprucefir fleabane*(Erigeron eximius)*
Parry's goldenrod *(Oreochrysum parryi)*
Fendler's meadow-rue *(Thalictrum fendleri)*
American vetch*(Vicia americana)*
starry false lily of the valley *(Maianthemum stellatum)*
Ross' sedge *(Carex rossii)*
mountain muhly *(Muhlenbergia montana)*

Brief Plant ID notes
The lemma margins of the fringed brome floret are hairy.

Synonymy
starry false lily of the valley *(Maianthemum stellatum = Smilacina stellata)*
Parry's goldenrod *(Oreochrysum parryi = Oreochrysum parryi)*
fivepetal cliffbush = waxflower = *(Jamesia americana)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
sprucefir fleabane (*Erigeron eximius*) = forest fleabane (E. superbus)

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: +1 (moist, cool)
Climate class: LSC (low sun cold)

Fire ecology
Fire frequency is not documented for this type; however, grass fires are thought to have occurred (Fitzhugh *et al.* 1987). Fringed brome is generally top-killed by fire. With moderate or high intensity fire, recovery is very slow. Seeds probably can survive grass fires (Esser 1994).

Reforestation
Reforestation can be difficult. Large openings are prone to wind scouring. Grasses and forbs can prevent seedling germination and survival. Prescribed burning or mechanical site preparation at light or moderate intensities can reduce herbaceous understory to provide for increased tree seedling survival. Clearcuts that have been planted promptly have been successful. Seed tree cutting methods can experience windthrow, especially when soils are wet. Shelterwood and selection cutting systems are generally successful for tree regeneration. Light selection cutting favors Douglas-fir. Southwestern white pine (or limber pine depending on geography) and Douglas-fir have been successfully planted in this type. Where aspen is minor seral, regeneration of aspen may be patchy or clumpy following disturbance, where healthy root stock exists. Aspen is unlikely to form a dominant cover type.

Revegetation considerations
Herbaceous regrowth can be rapid.

Comments
Fringed brome is highly palatable to deer, elk, and all classes of livestock (Esser 1994). Band-tailed pigeons have nested in this plant association (Fitzhugh *et al.* 1987). Early seral stages have good forage for turkeys and small mammals. This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)
Alexander *et al.* 1987
Esser 1994
Fitzhugh *et al.* 1987
Stuever 1995
USFS 1986
USFS 1987a
USFS 1987b

Douglas-fir/Arizona fescue
Pseudotsuga menziesii/Festuca arizonica

Synonyms
Pinus strobiformis/Festuca arizonica (Moir & Ludwig 1979)

Code(s)
typic or Douglas-fir
(PSME) phase 0 12 33 0
bristlecone pine (PIAR) phase 0 12 33 1
limber pine (PIFL2) phase 0 12 33 2
aspen (POTR) phase 0 12 33 3

Ecological Response Unit
Mixed Conifer w/ Aspen (MCW) (= "wet mixed conifer")

National Vegetation Classification Group
Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)

Key criteria
Must have (or historically had) ***Arizona fescue**, which is usually the dominant grass, although other grasses, such as mountain muhly, muttongrass and fringed brome, may also be codominant. Surface rock can exceed 15% in some stands. Tree mix is diverse, but white fir is absent, or accidental. (ABCO/FEAR2 is frequently misidentified as PSME/FEAR2: be sure no white fir regeneration is present in the stand.)

Structure
Mathiasen *et al.* (1987) reported an average site index for ponderosa pine of 87.0 +/-12.5 (N = 10 stands). Grass forage should be high, especially where tree canopies are sparse. Timber productivity is probably moderate to high compared with other associations in the Douglas-fir series.

Location
Local throughout New Mexico, central Arizona, and southern Colorado. Dry upper, south-facing slopes and ridges, 9,200' - 10,200'. (2800 - 3110 m). Soils include Borolls, Boralfs, and Orthents.

Adjacent plant associations
May adjoin ABCO/FEAR2, which differs mainly by the presence of white fir, suggesting a cooler, wetter site than PSME/FEAR2. As rocks increase, often intergrades to PSME/QUGA. PSME/FEAR2 may also adjoin meadows. At lower elevations, this type intergrades to PIPO/FEAR2.

Also see
PSME/FEAR2 is usually limited in extent to a narrow elevational range between PIPO/FEAR2 and ABCO/FEAR2. Where fires are common, white fir regeneration may be sparse in an ABCO/FEAR2 plant association. Therefore, if any white fir regeneration is in the stand, carefully consider ABCO/FEAR2.

PSME/BRCI occurs on wetter, colder sites. PSME/MUMO and PIAR/FEAR2 are environmentally indistinguishable. In locations such as the Zuni Mountains where white fir is absent by accident of geography and migration, PSME/FEAR2, POTR phase is indistinguishable from ABCO/FEAR2 (Alexander *et al.* 1987). For a description of PSME/FEAR2 in Arizona, see Alexander *et al.* 1984b or Fitzhugh *et al.* 1987; in northern New Mexico and southern Colorado, see DeVelice *et al.* 1986. This type may be similar to PSME/grass types described by Shepherd (1975). PSME/FEAR2 is also similar to PSME/FEID decribed by Pfister *et al.* (1977) and Steele *et al.* (1981) in the northern Rockies.

Important & key plants from research plots
Trees & life history status

<u>bristlecone pine and limber pine phases</u>
Douglas-fir *(Pseudotsuga menziesii)* C
limber pine *(Pinus flexilis)* c
bristlecone pine *(Pinus aristata)* c
ponderosa pine *(Pinus ponderosa)* s
quaking aspen *(Populus tremuloides)* s
<u>aspen phase</u>
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* S
quaking aspen *(Populus tremuloides)* S
limber pine *(Pinus flexilis)* s

bristlecone pine *(Pinus aristata)* s
central AZ & central NM
Douglas-fir *(Pseudotsuga menziesii)* C
southwestern white pine *(Pinus strobiformis)* C
ponderosa pine *(Pinus ponderosa)* S
quaking aspen *(Populus tremuloides)* s

Shrubs
Scarce (<1%), to well represented (>5%):
rockspirea *(Holodiscus dumosus)*
Gambel oak *(Quercus gambelii)*
Fendler's ceanothus *(Ceanothus fendleri)*
wax currant *(Ribes cereum)*
mountain snowberry *(Symphoricarpos oreophilus)*
kinnikinnick *(Arctostaphylos uva-ursi)* [Northern NM, Southern CO]

Herbs
Well represented (>5%); sometimes abundant (>25%):
***Arizona fescue** *(Festuca arizonica)*
fringed brome *(Bromus ciliatus)*
mountain muhly *(Muhlenbergia montana)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koelaria macrantha)*
common yarrow *(Achillea millefolium)*
Nevada pea *(Lathyrus lanszwertii* var. *leucanthus)*
Wooton's ragwort *(Senecio wootonii)*
beautiful fleabane *(Erigeron formosissimus)*
Kentucky bluegrass *(Poa pratensis)* [Aspen phase]

Brief plant ID notes
Arizona fescue is a bunchgrass with fine leaves. The seedhead consists of a panicle with flattened spikelets of several flowers.

Synonymy
Nevada pea *(Lathyrus lanszwertii* var *leucanthus = L. lanszwertii* var *arizonica* = Arizona peavine)
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*

Wooton's ragwort = Wooton's groundsel

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: -1 (dry, warm)
Climate class: LSC (low sun cold)

Phases
The limber pine and bristlecone pine phases most likely occur in northern New Mexico and northern Arizona. The aspen phase occurs on wetter sites, where aspen is present. The typic phase is probably most often encountered in other geographical areas.

Fire ecology
Re-occurring surface fires in the grass tend to reduce conifer saplings and maintains grass cover in this type (Fitzhugh, *et al.* 1987). Overstory dominance by either ponderosa pine or Douglas-fir is probably determined by periodicity of fires in the stand. As mature trees, both species are fire-resistant, but ponderosa pine saplings develop more fire-resistant characteristics at an earlier age. More frequent fires may favor ponderosa pine, less frequent fires may favor the more shade tolerant Douglas-fir (Alexander *et al.* 1984b).

Reforestation
In the absence of a frequent fire regime or timber stand improvement thinning projects, natural regeneration may form dense thickets. Under a characteristic frequent fire regime, regeneration establishment tends to be aggregated in groups and patches, due to the patchy nature of fire and the competitive characteristics of Arizona fescue. When Arizona fescue sod is well established on heavy clay soils, heavy removal cuts such as clearcutting and seed tree tend to be difficult to regenerate due to sod competition, Shelterwood and selection cutting can favor ponderosa pine and Douglas-fir, especially when combined with site preparation to reduce sod competition. On wetter sites, aspen may be a major early successional species, establishing in patches. Planting success for ponderosa pine and Douglas-fir has been moderate to high. Seedling survival can improve with prescribed burning or mechanical site preparation to remove grass competition for the short run, either prior to planting or before a seed crop is released.

Revegetation considerations
Natural revegetation is moderately rapid.

Comments
Deer, elk, and bighorn sheep are known to find winter cover and forage in this type (DeVelice *et. al.* 1986).

Reference(s)
Alexander *et al.* 1984b
Alexander *et al.* 1987
DeVelice *et al.* 1986
Fitzhugh *et al.* 1987
Mathiasen *et al.* 1987
Moir & Ludwig 1979
Sheperd 1975
Stuever 1995
USFS 1986
USFS 1987a

Douglas-fir/rockspirea

(Formerly: Douglas-fir/Oceanspray)

Pseudotsuga menziesii/Holodiscus dumousus

Code(s)
typic phase 0 12 41

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
Douglas-fir and southwestern white pine are dominant trees. ***Rockspirea** is common, but Gambel oak is poorly represented, and the understory is scarce to poorly represented. White fir is absent or accidental.

Structure
Timber productivity is low to moderate. Forage value rating for cattle is none. Browse production may be fair. Stockability = 1.

Location
Found in the Sacramento Mountains (Lincoln NF, NM) on often steep, mid to upper south or southwest-facing slopes and ridgetops, 8,500' - 9,200' (2,590 - 2,800 m). Usually occurs on cobbly soils and limestone parent materials. Mean annual precipitation (MAP) = 25-26"/year.

Also see
The Douglas-fir/rockspirea [PSME/HODU] of DeVelice *et al.* (1986) and Fitzhugh *et al.* (1987) occurs on scree or rubble soils and is not comparable to this PSME/HODU plant association in the Sacramento Mountains. The former plant association is currently called Douglas-fir/scree (PSME/scree). PSME/HODU is similar to Douglas-fir/creeping barberry [PSME/MARE11] (PSME/BERE in Youngblood & Mauk 1985), Douglas-fir/mountain snowberry [PSME/SYOR2] (Youngblood & Mauk 1985, Johnson 1984), and Douglas-fir/sparse (Alexander et al. 1984b).

Important & key plants from research plots
Trees & life history status

Douglas-fir *(Pseudotsuga menziesii)* C
southwestern white pine *(Pinus strobiformis)* C
ponderosa pine *(Pinus ponderosa)* c
quaking aspen *(Populus tremuloides)* s

Shrubs
Common (>1%):
rockspirea *(Holodiscus dumosus)* [cover to 7-8%]
wax currant *(Ribes cereum)*
creeping barberry *(Mahonia repens)*
mountain snowberry *(Symphoricarpos oreophilus)*
Gambel oak *(Quercus gambelii)* [<5% cover]

Herbs
Scarce (<1%), although occassionally one
species may reach 1-2% cover:
Wooton's ragwort *(Senecio wootonii)*
woodland strawberry *(Fragaria vesca)*
goldenrod *(Solidago* spp.)
fringed brome *(Bromus ciliatus)*
Richardson's geranium *(Geranium richardsonii)*
starry false lily of the valley *(Maianthemum stellatum)*

Brief plant ID notes
Rockspirea, also known as mountain spray or ocean spray, is a small to medium sized shrub with dense branches. The strongly toothed leaves often occur in clumps (up to 7 leaves/fascicle). *H. dumosus* has been lumped with *H. discolor* in the past, although these are currently considered separate species.

Synonymy
woodland strawberry *(Fragaria vesca* var. *americana = F. americana)*
starry false lily of the valley *(Maianthemum stellatum = Smilacina stellata).*
creeping barberry (*Mahonia repens = Berberis repens*) aka Oregongrape

fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
starry false lily of the valley (*Maianthemum stellatum = Smilacina stellata*), aka starry false Solomon seal
Wooton's ragwort = Wooton's groundsel
whortleleaf snowberry = mountain snowberry *(Symphoricarpos oreophilus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: -1 (dry, warm)
Climate class: LSC (low sun cold)

Fire ecology
Historically, natural fires may not have been as widespread or frequent as in other plant associations in this series, due to the sparse nature of the understory. Fires do occur on these sites, however, and rockspirea has been reported to be a conspicuous component of the stand within a few years following a fire (McMurray 1987). The biological response of rockspirea to fire is not documented, however, a similar species *Holodiscus discolor* is known to be a prolific sprouter (McMurray 1987).

Reforestation
Natural regeneration can be difficult to achieve. Planting success decreases from moderate to low with increasing rock content in soil. Recommended species for planting are Douglas-fir and southwestern white pine. Clearcuts are difficult to regenerate in conifer trees. Seed tree cuts may be useful in heavy mistletoe stands but are also difficult to establish conifer seedlings. Shelterwood harvesting methods are generally successful. Selection methods favor Douglas-fir regeneration when stands are mistletoe-free. Where aspen is minor seral, regeneration of aspen may be patchy or clumpy following disturbance, where healthy root stock exists. Aspen is unlikely to form a dominant cover type.

Revegetation considerations
Revegetation may be slow to moderate depending upon the severity of the disturbance and the soil texture.

Comments
May provide fair winter range for deer. This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
McMurray 1987
USFS 1986

Douglas-fir/creeping barberry

(Formerly: Douglas-fir/Oregon grape ABCO/BERE)

Pseudotsuga menziesii/Mahonia repens

(Formerly: Pseudotsuga menziesii/Berberis repens PSME/BERE)

Synonyms
Pseudotsuga menziesii/ sparse undergrowth (Alexander *et al.* 1984b)
Pseudotsuga menziesii/Berberis repens (Youngblood & Mauk 1985, Johnston 1987)

Code(s)
typic phase 0 12 03

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
This type is distinguished by a sparse understory. Creeping barberry does not need to be in the understory. Oaks are poorly represented and rockspirea is also scarce. White fir is absent or accidental. Aspen may occur on moist microsites.

Structure
Timber productivity for Douglas-fir is low (Larson & Moir 1986) to moderate (Muldavin 1996). When dense canopies are disturbed reducing shading, shrubs and herbs will exhibit a moderate response rate (Muldavin 1996). Stockability =1.

Location
From central Arizona north to Idaho; local in Northern NM and Southern Colorado. Often occurs on special topographic sites that are relatively dry and possibly nutrient poor on a variety of slopes and aspects, 7,000' - 8,500' (2130 -2590 m).

Adjacent plant associations
Changes from PIPO/grassy plant associations to PSME/MARE11 are usually abrupt, although transitions to ABCO plant associations may be gradual (Alexander 1984b). Neighboring plant associations on more mesic sites may include ABCO/CASI12, ABCO/ACGL, or ABCO/ACGR3. On drier sites PSME/MARE11 may adjoin ABCO/QUGA, PSME/QUGA, PSME/MUST, or PSME/QUHY, QURU4 phase (Muldavin 1996).

Also see
Earlier successional stages of other Douglas-fir plant associations can resemble this type where dense Douglas-fir pole stands inhibit understory development (Muldavin 1996). Sites where white fir has more than accidental regeneration are ecotonal to ABCO/MARE11. Douglas fir/rockspirea [PSME/HODU] (Fitzhugh *et al.* 1987) occurs on limestone parent materials in NM and is similar. Douglas fir/mountain snowberry [PSME/SYOR2] (Youngblood & Mauk 1985) may be very similar. If shrubs are well represented, see Douglas fir/ninebark [PSME/PHMO]. If herb cover is well represented, see Douglas fir/Arizona fescue [PSME/FEAR2]. If Gambel oak is well represented, see Douglas fir/Gambel oak [PSME/QUGA].

Important & key plants from research plots
Trees & life history status

Douglas fir *(Pseudotsuga menzensii)* C
southwestern white pine *(Pinus strobiformis)* S
ponderosa pine *(Pinus ponderosa)* s
twoneedle pinyon *(Pinus edulis)* s

Shrubs
Poorly represented (<5%):
creeping barberry *(Mahonia repens)*
common juniper *(Juniperus communis)*
mountain snowberry *(Symphoricarpos oreophilus)*
Oregon boxleaf *(Paxistima myrsinites)*
Fendler's ceanothus *(Ceanothus fendleri)*
Gambel oak *(Quercus gambelii)*
rockspirea *(Holodiscus dumosus)*

Herbs
Scarce (<1%):
mountain muhly *(Muhlenbergia montana)*
muttongrass *(Poa fendleriana)*
Arizona fescue *(Festuca arizonica)*
fringed brome *(Bromus ciliatus)*
sharpleaf valerian *(Valeriana acutiloba)*
Fendler's meadow-rue *(Thalictrum fendleri)*
sedges *(Carex* spp.)
small-leaf pussytoes *(Antennaria parvifolia)*
Virginia strawberry *(Fragaria virginiana)*
rock clematis *(Clematis columbiana)*

Cryptogams
Soil mosses may be present.

Brief plant ID notes
Creeping barberry is a low sub-shrub with pinnately compound, spine-tipped, dark green and often reddish leaves.

Synonymy
creeping barberry *(Mahonia repens = Berberis repens)*
rock clematis *(Clematis columbiana* var. *columbiana = C. pseudoalpina)*
Virginia strawberry *(Fragaria virginiana = F. ovalis)*
sharpleaf valerian *(Valeriana acutiloba* var. *acutiloba = V. capitata* var. *acutiloba)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
fringed brome *(Bromus ciliata var. ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: -1 (dry, warm)
Climate class: LSC (low sun cold)

Phases
A North Kaibab phase for this plant association has been described by Alexander (1984b). Rock clematis and sharpleaf valerian are more likely to occur in this phase, than in other geographic areas.

Fire ecology
Creeping barberry generally survives all but severe fires. This understory plant, often found in shady locations, can also tolerate full sunlight. The plant regenerates following fire from rhizomes in the topsoil layer or by seed. Recovery of creeping barberry may take several years (Walkup 1991).

Reforestation
Natural regeneration of seed tree cuts and clearcuts is not dependable. Planting success is moderate for ponderosa pine, southwestern white pine (in proper geographical setting), and Douglas-fir. Low and moderate levels of mechanical site preparation and moderate levels of prescribed burning may improve seedling survival. High levels of disturbance are not beneficial to the site and seedling survival. Clearcut cutting may be a viable timber harvesting option, particularly if a stand is heavily infected with dwarf mistletoe. Shelterwood and selection harvests are successful for natural regeneration of conifer species. Light cuttings tend to favor Douglas-fir regeneration.

Revegetation considerations
After disturbance, recovery rates are moderate, slower than expected rates on more mesic sites.

Comments
This association has a fair grazing potential in openings or clearings. Aspen management is generally not an option for this type. This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
Alexander *et al.* 1984b
Muldavin *et al.* 1996
USFS 1986
USFS 1987a
Walkup 1991

Douglas-fir/mountain muhly
Pseudotsuga menziesii/Muhlenbergia montana

Code(s)
twoneedle pinyon (PIED) phase 0 12 34 0

limber pine (PIFL) phase 0 12 34 1

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
Although mountain muhly is often present to well represented, it does not have to be present in this plant association. ***Douglas-fir** is codominant with ponderosa pine. The understory has more shrubs and forbs than a typic PIPO/MUMO plant association. Gambel oak, if present, is <5% canopy cover. White fir is absent or accidental.

Structure
Timber productivity is generally moderate to poor for ponderosa pine and poor for Douglas-fir. Steep slopes often preclude timber management. Site index for ponderosa pine = 58 +/-13 (N=8). Stockability = 1.

Location
Southwest and central New Mexico up to northern New Mexico; local in southern Arizona. Often found on steep, south or west facing slopes, 8,700' - 9,700' (2650 - 2960 m), or on northerly lower slopes, 7,500' - 8,000' (2285 - 2440 m). Soils generally are dry, with low water holding capacity and often are very cobbly or gravelly or shallow. Some soils identified with this plant association are Typic or Lithic Dystochrepts (higher elevations) and Typic or Lithic Ustochrepts (lower elevations).

Adjacent plant associations
On warmer sites, usually adjacent to PIPO/MUMO or PIPO/FEAR2. At higher elevations, often adjoins ABCO/QUGA (Alexander *et al.* 1987). Also found adjoining ABCO/ACGL, ABCO/Sparse and PIPO/BOGR2

on ridgetops (Fitzhugh *et al.* 1987). Sites at lower elevations include ABCO/MUST and PSME/MUST (Fitzhugh *et al.* 1987). In the Santa Catalina Mountains in southern Arizona, this type was adjoined by ABCO/JAAM and PSME/QUGA (Muldavin *et al.* 1996).

Also see
TES mapping unit 202, Cimarron Mountains, New Mexico (Edwards 1987); PSME/MUMO in Fitzhugh *et al.* (1987); *Pseudotsuga menziesii/Carex rossii* in Hess & Alexander (1986) in CO.

Important & key plants from research plots
Trees & life history status

limber pine phase
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* C
limber pine *(Pinus flexilis)* c
Rocky Mountain juniper *(Juniperus scopulorum)* s
twoneedle pinyon *(Pinus edulis)* s
Gambel oak *(Quercus gambelii)* s
twoneedle pinyon phase
Douglas-fir *(Pseudotsuga menziesii)* c
ponderosa pine *(Pinus ponderosa)* C
southwestern white pine *(Pinus strobiformis)* c
Rocky Mountain juniper *(Juniperus scopulorum)* c
twoneedle pinyon *(Pinus edulis)* c
alligator juniper *(Juniperus deppeana)* [Central & Southwest NM] c
Gambel oak *(Quercus gambelii)* s

Shrubs
Usually poorly represented (<5%):
Gambel oak *(Quercus gambellii),*
other *Quercus* spp. in Southern AZ
Fendler's ceanothus *(Ceanothus fendleri)*
rockspirea *(Holodiscus dumosus)*
wax currant *(Ribes cereum)*
true mountain mahoghany *(Cercocarpus montanus)*

Herbs
Well represented (>5%):

pine dropseed *(Blepharoneuron tricholepis)*
brome *(Bromus* spp.)
sedges *(Carex* spp.)
prairie junegrass *(Koelaria macrantha)*
muttongrass *(Poa fendleriana)*
mountain muhly *(Muhlenbergia montana)*
bottlebrush squirrel tail *(Elymus elymoides)*
manyflowered stoneseed *(Lithosperma multiflorum)*
pineywoods geranium *(Geranium caespitosum)*
Vreeland's erigeron *(Erigeron vreelandii)*

Brief plant ID notes
Mountain muhly is small bunchgrass with flat or slightly rolled leaves. The seedhead is often recognizable by the wiry awns of the lemmas.

Synonymy
bottlebrush squirrel tail *(Elymus elymoides = Sitanion hystrix)*
Rocky Mountain juniper *(Juniperus scopulorm = J. s. var. columnaris)*
Vreeland's erigeron *(Erigeron vreelandii = Erigeron platyphyllus*)
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: -1 (dry, warm)
Climate class: LSC (low sun cold)

Phases
The research literature for the Southwest does not delineate the phases, but the limber pine phase is most likely encountered in northern New Mexico. The PSME/MUMO described by Muldavin *et al.* (1996) occurs at higher elevations on more lithic soils.

Fire ecology
Under a reoccurring fire regime, ponderosa pine should dominate this site. With light and moderate fire severity, mountain muhly averages about 3 years to recover to pre-fire levels but may increase after that (Walsh 1995). In extremely dry conditions, severe fires can kill mountain muhly plants.

Reforestation
Conifer seedlings may have difficultly competing with grasses following disturbances (Walsh 1995).

Revegetation considerations
With canopy removal, grasses increase on drier sites and shrubs increase on more mesic sites (Alexander *et al.* 1987).

Comments
Good deer habitat. Fitzhugh *et al.* (1987) noted that successional changes occur in stands that are consistently grazed in the same season. Improper grazing can result in an understory dominated by forbs which are unpalatable. Mountain muhly is a good forage plant for cattle, especially when it is actively growing (Walsh 1995).

Reference(s)
Alexander *et al.* 1987
Fitzhugh *et al.* 1987
Muldavin *et al.* 1996
Stuever 1995
USFS 1987a
Walsh 1995

Douglas-fir/screwleaf muhly
Pseudotsuga menziesii/Muhlenbergia straminea

(Formerly: Pseudotsuga menziesii/Muhlenbergia viriscens PSME/MUVI2)

Synonyms
Douglas-fir-southwestern white pine/screwleaf muhly *(Pseudotsuga menziesii-Pinus strobiformis/Muhlenbergia virescens)* [Moir and Ludwig 1979].

Code(s)
typic phase 0 12 35 0

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
***Screwleaf muhly** is well represented in the grass dominated understory. Dominant overstory trees are ponderosa pine, southwestern white pine and Douglas-fir. White fir is absent or accidental.

Structure
Timber productivity is moderate to high for Douglas-fir and ponderosa pine. One known value for Douglas-fir site index is 70+. Stockability =1. Clearcuts and seed tree cuts favor grass regeneration over conifer re-establishment, although clearcuts may reduce mistletoe in severly infected stands. Shelterwood cutting methods favor ponderosa pine. Selection cuts usually favor Douglas-fir regeneration which is more shade tolerant. In the absence of frequent fires, abundant conifer regeneration can result in a depauperate herb layer (Muldavin *et al.* 1996).

Location
In southwest and central New Mexico and southeast and central Arizona. Generally occurs on upper slopes and ridges, 7,800'-9400' (2,375 - 2,870 m). Mean annual precipitation (MAP) = 25"/yr.

Adjacent plant associations
Associations in the blue spruce series or ABCO/EREX4 may be adjacent on lower and moister slopes. Drier slopes may support PIPO/MUVI-FEAR2. As soils get deeper and more gravelly, association may move to PSME/QUGA. (Fitzhugh *et al.* 1987).

Also see
PSME/QUGA, MUST phase has >5% cover of Gambel oak.
PSME/MUMO lacks screwleaf muhly and Arizona fescue.
ABCO/MUST has white fir regeneration or the potential for white fir regeneration.

Important & key plants from research plots
Trees & life history status
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* S
southwestern white pine *(Pinus strobiformis)* S

Shrubs
Scarce (<1%):
Fendler's ceanothus *(Ceanothus fendleri)*
Gambel oak *(Quercus gambellii)*
Oregon boxleaf *(Paxistima myrsinites)*
New Mexico locust *(Robinia neomexicana)*
netleaf oak *(Quercus rugosa)* [in s. AZ]

Herbs
Abundant (>25%) to luxuriant (>50%), especially grasses:
***screwleaf muhly** *(Muhlenbergia straminea)*
prairie junegrass *(Koelaria macrantha)*
fringed brome *(Bromus ciliatus)*
owl's-claws *(Dugaldia hoopesii)*
sweetclover vetch *(Vicia pulchella)*
manyflowered stoneseed *(Lithospermum multiflorum)*
western brackenfern*(Pteridium aquilinum)*
muttongrass *(Poa fendleriana)*
White Mountain sedge *(Carex geophila)*
Ross' sedge *(Carex rossii)*
New Mexico groundsel *(Senecio neomexicanus)*
grassleaf peavine *(Lathyrus graminifolius)*

common yarrow *(Achillea millefolium)*
Parry's goldenrod *(Oreochrysum parryi)*
yellow hawkweed *(Hieracium fendleri)*
Wooton's ragwort *(Senecio wootonii)*
mountain goldenbanner *(Thermopsis montana)*
goldenrod *(Solidago* spp.)
Vreeland's erigeron *(Erigeron vreelandii)*

Brief plant ID notes
Screwleaf muhly is a robust bunchgrass with spirally curled dead leaf sheaths.

Synonymy
owl's-claws *(Dugaldia hoopesii = Helenium hoopesii)*
Vreeland's erigeron *(Erigeron vreelandii = Erigeron platyphyllus*)
Parry's goldenrod *(Oreochrysum parryi = Oreochrysum parryi)*
mountain goldenbanner *(Thermopsis montana = T. pinetorum)*
Oregon boxleaf *(Paxistima myrsinites = Pachistima myrsinites)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*
Wooton's ragwort = Wooton's groundsel

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: -1 (dry, warm)
Climate class: LSC (low sun cold)

Fire ecology
Ponderosa pine dominates the overstory when frequent fires inhibit Douglas-fir regeneration.

Reforestation
All cutting methods can be successful in this type. Natural regeneration following disturbance is typically robust and rapid. Regeneration typically establishes in waves, resulting a random tree distribution pattern. Mechanical site prep and prescribed burning can improve seedling growth rates when conducted prior to planting or cones

opening. Artificial regeneration is highly successful with site preparation. Species planted with success are Douglas-fir, ponderosa pine, and southwestern white pine.

Revegetation considerations
Grasses usually recover rapidly following disturbance.

Comments
Livestock grazing potential can be high if water availability and access is not an issue (Muldavin 1996). Good potential for wildlife (deer and elk) forage in early seral stages, and good hiding cover in later stages. This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)
Alexander *et al.* 1984b
Fitzhugh *et al.* 1987
Moir & Ludwig 1979
Muldavin *et al.* 1996
Stuever 1995
USFS 1986
USFS 1987b

Douglas-fir/mountain ninebark
Pseudotsuga menziesii/Physocarpus monogynus

Code(s)
typic phase 0 12 13

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
The dominant tree species is ***Douglas-fir**. Ponderosa pine is either absent or an early to mid-succession species. White fir, aspen, blue spruce, and twoneedle pinyon are absent or accidental. The understory is essentially shrubby, although herbs may be well represented.

Structure
Hess & Alexander (1986) describe this as one of the most productive plant associations in the Douglas-fir series for the section of Colorado they studied, although they encountered relatively low site indices. Generally steep slopes will limit management opportunities. Moir & Ludwig (1979) reported trees with poor growth forms in this association.

Location
Found from central New Mexico (San Mateo Mtns.) to Colorado. Occurs in limited topographic sites in the landscape, usually very steep slopes with gravelly or cobbly, excessively drained soils, 7,000' - 9,500' (2130 - 2890 m).

Also see
Douglas-fir/fivepetal cliffbush [PSME/JAAM] (Hess & Alexander 1986) and Douglas-fir/mountain snowberry [PSME/SYOR] (Johnston 1987, Youngblood & Mauk 1985) are perhaps indistinguishable (USFS 1987a). Douglas-fir/creeping barberry [PSME/MARE] has weaker expressions of herbs and shrubs, but intergrades to Douglas-fir/ninebark

[PSME/PHMO4] (USFS 1987a). If soils are fragmental (>90% gravels and cobbles), see Scree Forests.

Important & key plants from research plots
Trees & life history status
Douglas-fir *(Pseudotsuga menziesii)* C
limber pine *(Pinus flexilis)* s
ponderosa pine *(Pinus ponderosa)* s
bristlecone pine *(Pinus aristata)* s

Shrubs
Well represented (>5%) to abundant (>25%):
Rocky Mountain maple *(Acer glabrum)*
mountain ninebark *(Physocarpus monogynus)*
Gambel oak *(Quercus gambelii)*
Oregon boxleaf *(Paxistima myrsinites)*
creeping barberry *(Mahonia repens)*
wild rose *(Rosa* spp.)
rockspirea *(Holodiscus dumosus)*
fivepetal cliffbush *(Jamesia americana)*
common chokecherry *(Prunus virginiana)*
mountain snowberry *(Symphoricarpos oreophilus)*

Herbs
Well represented (>5%):
goldenrod *(Solidago* spp.)
Richardson's geranium *(Geranium richardsonii)*
fringed brome *(Bromus ciliatus)*
starry false lily of the valley *(Maianthemum stellatum)*
mountain muhly *(Muhlenbergia montana)*
muttongrass *(Poa fendleriana)*

Brief plant ID notes
Rarely reaching more than 4 feet in height, mountain ninebark has shreddy bark, and simple leaves with 3 to 5 doubly toothed lobes.

Synonymy
creeping barberry *(Mahonia repens = Berberis repens)*
Oregon boxleaf *(Paxistima myrsinites)* = mountain lover *(Pachystima myrsinites)*

starry false lily of the valley *(Maianthemum stellatum = Smilacina stellata)*
fivepetal cliffbush = waxflower = *(Jamesia americana)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: -1 (dry, warm)
Climate class: LSC (low sun cold)

Fire ecology
No information is available on natural fire regime in the southwest, although in western Montana, a similar habitat type, *Pseudotsuga menziesii/Physocarpus malvaceus-Calama-grostis rubescens,* probably had fire-maintained stands of ponderosa pine overstory under natural conditions (Fischer & Bradley 1987). *Physocarpus malvaceus* is fire resistant and resprouts from root crowns or horizontal rhizomes.

Reforestation
Regeneration of conifers on this type may be difficult due to shallow soils, steep slopes, and competition from shrubs.

Revegetation considerations
Probably slow response to disturbance.

Comments
Forage for livestock is poor, but deer may heavily browse shrubs at times (Hess & Alexander 1986).

References
Fischer & Bradley 1987
Hess & Alexander 1986
Johnston 1987
Moir & Ludwig 1979
USFS 1987a

Douglas-fir/Arizona white oak
Pseudotsuga menziesii/Quercus Arizonica

Code(s)
typic phase 0 12 43 0

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Madrean Upper Montane Conifer - Oak Forest & Woodland (G202)

Key criteria
***Arizona white oak** *(Quercus arizonica)* is well represented (>5% canopy coverage). ***Douglas-fir** is present, generally more than 10 trees per acre. White fir is absent or accidental. Alligator juniper is a sub-canopy climax species.

Structure
As this type is at the warm limit of the ecological range of Douglas-fir, timber production for this species is low (Muldavin *et al.* 1996). One reported site index for this association for Douglas-fir is 55+ (USFS 1987b). Ponderosa pine productivity is generally moderate to poor but can be good in more mesic sites with adequate moisture supports larger trees (Muldavin *et al.* 1996). Cattle forage rating value ranges from low in early seral stages to none in mature, closed canopy stands (USFS 1987b). Wildlife forage and cover is moderate (Muldavin *et al.* 1996).

Location
Central Arizona south of the Mogollon Rim, Sierra Ancha and Mazatzal Mountains. On gentle to steep mountain slopes, 6,800' -7,200' (2070 - 2195 m), extending down intermittent drainages to about 6,200' (1890 m). Mean annual precipitation (MAP) = 26"/year, mean annual air temperature (MAAT) = 46 degrees F (on a south-facing slope at 7,200 ft. on Mazatzal Peak, MAP = 29.6"/yr; MAAT = 46 degrees F from TES climate gradients).

Adjacent plant associations
PSME/QUAR often abuts montane chaparral or PIPO/QUAR plant associations on drier sites. On more mesic sites, PSME/QUAR adjoins PSME/QUGA or PIPO/QUGA plant associations. A common landscape pattern is to find PSME/QUAR in drainages, and PIPO/QUAR on ridges (Muldavin *et al.* 1996).

Also see
Muldavin *et al.* (1996). PIPO/QUAR if Douglas-fir is accidental or occasional (<10 trees/acre in mature stands).

Important & key plants from research plots
Trees & life history status
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* C
alligator juniper *(Juniperus deppeana)* C
Arizona white oak *(Quercus arizonica)* S
southwestern white pine *(Pinus strobiformis)* c
twoneedle pinyon *(Pinus edulis)* c
Emory oak *(Quercus emoryi)* s

Shrubs
Well represented (>5%):
shrubby forms oaks *(Quercus* spp.*)*
Fendler's ceanothus *(Ceanothus fendleri)*
canyon live oak *(Quercus chrysolepis)* [cooler, wetter sites]
pointleaf manzanita *(Arctostaphylos pungens)*
Pringle manzanita *(Arctostaphylos pringlei)*
Parry's agave *(Agave parryi)*

Herbs
Well represented (>5%):
longtongue muhly *(Muhlenbergia longiligula)*
mountain muhly *(Muhlenbergia montana)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koeleria macrantha)*
dwarf lousewort *(Pedicularis centranthera)*
aromatic false pennyroyal *(Hedeoma hyssopifolia)*

Brief plant ID notes
Arizona white oak has light gray bark and dark green leaves. The underside of the leaf is matted with brownish yellow hairs.

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: -1 (dry, warm)
Climate class: HSM (high sun mild)

Fire ecology
Oak sprouting is prolific and rapid after a fire. Manzanita and Fendler's ceanothus can be important shrubs after a fire. Arizona white oak can survive low intensity fires and usually resprouts from the roots if the top is killed. Presettlement mean fire frequency intervals for one area were reported between 7 and 10 years (Baisan & Swetnam 1990).

Reforestation
Natural regeneration of ponderosa pine and Douglas-fir may be inhibited by oak and alligator juniper sprouting on disturbed sites. Oak and alligator juniper are favored by prescribed fire, mechanical site preparation, clearcuts, and seed tree cuts. Ponderosa pine and Douglas-fir regeneration can be successful following a shelterwood cutting method. Selection cutting systems can favor conifer species regeneration by suppressing understory shrubs and oak growth. Planting of ponderosa pine and Douglas-fir has been moderately successful for this plant association.

Revegetation considerations
Revegetation is usually rapid after a disturbance due to sprouting of oaks and alligator juniper.

Comments
Precommercial thinning and pine seedling release are some management practices applied in this plant association (USFS 1987b). Arizona white oak is important for neotropical migratory birds, white-tail deer, and a large diversity of mammals, reptiles, and amphipians (Pavek 1994).

Reference(s)
Baisan & Swetnam 1990
Muldavin *et. al.* 1996
Pavek 1994c
Stuever 1995
USFS 1987b

Douglas-fir/Gambel oak
Pseudotsuga menziesii/Quercus gambelii

Code(s)
Gambel oak (QUGA) phase 0 12 14 0 Arizona fescue (FEAR2) phase 0 12 14 1 screwleaf muhly (MUST) phase 0 12 14 2 rockspirea (HODU) phase 0 12 14 3

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)

Key criteria
***Douglas-fir** is regenerating, and ponderosa pine or southwestern white pine (rockspirea phase) is a dominant seral tree. ***Gambel oak** must be at least well represented (>5% canopy cover) and is present as a tree and/or a shrub**.** White fir is absent (Alexander *et al.* 1984a) or may be present as a minor tree in the rockspirea (HODU) phase, but white fir regeneration is greatly outnumbered by Douglas-fir regeneration (Alexander *et al.* 1984b).

Structure
Generally, timber site quality is poor (Alexander *et. al.* 1987b), however Fitzhugh *et. al.* (1987) believes site quality values for ponderosa pine may be higher under more natural fire regimes. From a sample size of 12 plots, site indices for ponderosa pine were 61 +/-8 and for Douglas-fir were 52+/-8. Stockability =1. Occasionally Gambel oak may dominate the canopy for extended time periods.

Location
Widespread and common throughout New Mexico, Arizona, Utah and southern Colorado. 6,900'-8,000' (2100 - 2440 m), on a wide variety of slopes, aspects, landforms, and soils. Often on restricted topography within the white fir zone (e.g., south slopes) or with the ponderosa pine zone (e.g., north slopes).

Adjacent plant associations
May adjoin many other plant associations, but typically PIPO/QUGA on drier sites and ABCO/QUGA on wetter sites. Often PSME/QUGA is a narrow ecotone between PIPO and ABCO types. On the Cibola National Forest in New Mexico, PSME/QUGA occurs in cool canyons adjacent to warmer forest types such as PIPO/FEAR.

Also see
If Gambel oak is poorly represented, see PSME/HODU (Sacramento Mountains) or PSME/FEAR. If herbaceous cover is poorly represented, see PSME/BERE.

Important & key plants from research plots
Trees & life history status
Gambel oak, Arizona fescue, and screwleaf muhly phases
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* S
Gambel oak *(Quercus gambelii)* S
southwestern white pine *(Pinus strobiformis)* s
twoneedle pinyon *(Pinus edulis)* s
rockspirea phase
Douglas-fir *(Pseudotsuga menziesii)* C
southwestern white pine *(Pinus strobiformis)* S
Gambel oak *(Quercus gambelii)* S
ponderosa pine *(Pinus ponderosa)* s
twoneedle pinyon *(Pinus edulis)* s

Shrubs
Well represented (>5%) to abundant (>25%):
***Gambel oak** *(Quercus gambellii)* [>5% cover]
New Mexico locust *(Robinia neomexicana)*
mountain snowberry *(Symphoricarpos oreophillus)*
Oregon boxleaf *(Paxistima myrsinites)*
creeping barberry *(Mahonia repens)*
wild rose *(Rosa* spp.)
rockspirea *(Holodiscus dumosus)*
Fendler's ceanothus *(Ceanothus fendleri)*

Herbs
Well represented (>5%):
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koelaria macrantha)*
Ross' sedge *(Carex rossii)*
Arizona fescue *(Festuca arizonica)*
[>5% cover in FEAR2 phase]
screwleaf muhly *(Muhlenbergia straminea)* [>5% cover in MUST phase]
Fendler's meadow-rue *(Thalictrum fendleri)*
American vetch *(Vicia americana)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonica)*

Brief plant ID notes
Gambel oak is a deciduous oak with deeply lobed, prickle "free" leaves. At lower elevations, it may cross with other oaks, making definitive identifications difficult.

Synonymy
Oregon boxleaf = boxleaf myrtle = mountainlover *(Paxistima = Pachystima = Pachistima)*
creeping barberry *(Mahonia repens = Berberis repens)*
Nevada pea *(Lathyrus lanszwertii* var. *arizonica = Lathyrus arizonica)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: -1 (dry, warm)
Climate class: LSC (low sun cold), HSC (high sun cold)

Phases
The screwleaf muhly (MUST) phase has a graminoid component dominated by screwleaf muhly and more developed than the graminoid component of the QUGA phase (Alexander *et al.* 1984b).

The Arizona fescue (FEAR2) phase also has a developed graminoid component with Arizona fescue as one of the dominant grasses.

The Gambel oak (QUGA) phase has a less developed graminoid component.

The rockspirea (HODU) phase is known from the Sacramento Mountains in southern New Mexico (Alexander *et al.* 1984a). It is a more mesic phase and generally occurs on northwest to northeast aspects of canyon sideslopes and ridges. To clarify any confusion from the literature, some researchers refer to rockspirea as *Holodiscus discolor var. dumosus.*

Fire ecology
Ponderosa pine is the dominant tree species under a regular fire regime. Douglas-fir and southwestern white pine become more established with fire exclusion (Alexander *et al.* 1984a, Muldavin *et al.* 1996). Following a fire, Gambel oak forms dense thickets by extensive root sprouting (Tirmenstein 1988). Gambel oak is rarely killed by fire due to buried rhizomes. Repeated, relatively high severity successive fires may reduce Gambel oak in the stand (Tirmenstein 1988b).

Reforestation
Clearcuts often convert to oak woodlands due to conifer seedlings encountering stiff competion with oaks. For the same reason, seed tree cuts are seldom successful for regenerating conifer trees. Shelterwood harvests can regenerate conifers if enough shade remains to help suppress the oaks. Selection cutting favors conifer regeneration, by suppressing oak growth. Survival is moderate for planting ponderosa pine, Douglas-fir, and southwestern white pine (HODU phase). Burning a site prior to planting stimulates oak and decreases conifer seedling survival. Mechanical site preparation can improve conifer seedling survival. Seedling and sapling release from oaks may be a viable management activity. Herbicides can be used to effectively reduce oak and locust competition.

Revegetation considerations
Natural revegetation is rapid due to oak and locust regeneration. Following a fire, oak sprouting was reported within 10 days to 3 weeks (Tirmenstein 1988).

Other management comments
Dwarf mistletoe can be severe on drier sites within this plant association (Fitzhugh *et al.* 1987). Shallow soils may be damaged by management activities (Alexander *et al.* 1987). Stands in this plant association tend to have structural vertical diversity and support a variety of bird species (Fitzhugh *et al.* 1987). Potentials for range, timber, and forage production exist in this type due to the grassy understories, shrubby midstories, and conifer canopies (DeVelice *et al.* 1986). Potential for wildlife management is good due to available food and cover. This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)
Alexander *et al.* 1987
Alexander *et al.* 1984a
Alexander *et al.* 1984b
DeVelice *et al.* 1986
Fitzhugh *et al.* 1987
Tirmenstein 1988b
USFS 1987a
USFS 1987b
USFS 1986

Douglas-fir/Silverleaf oak
Pseudotsuga menziesii/Quercus hypoleucoides

Synonyms
Douglas-fir/netleaf oak *(Pseudotsuga menziesii/Quercus rugosa)* described in Muldavin *et al.* 1996 for the netleaf oak phase.

Code(s)
ponderosa pine (PIPO) phase 0 12 36 0 Chihuahua pine (PILE) phase 0 12 36 1 netleaf oak (QURU4) phase 0 12 36 2

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Madrean Upper Montane Conifer - Oak Forest & Woodland (G202)

Key criteria
Oaks are well represented and dominated by **silverleaf oak** *(Quercus hypoleucoides)*. ***Douglas-fir** is a dominant tree at late succession, often codominant with ponderosa pine.

Structure
Timber site quality is generally poor. Fitzhugh *et al.* (1987) found conifers rarely reaching beyond 45 to 55 feet in height. Trees over 200 years old typically had dead tops. Potential for large oak development is good. Forage production is limited, but acorns or oak shrub browse may be abundant. Dense pole stands can develop under fire suppression regime. Stockability = 1.

Location
In the USA, this association is limited more or less to the Basin & Range Region of southeastern Arizona and southwestern New Mexico. In New Mexico: Mogollon Mountains, Black Range, Brushy Mountains, and Animas Mountains. In Arizona: Chiricahua, Pinaleno, Huachuca Mountains, vicinity of Rose Peak, Nantanes Plateau (San Carlos Reservation). Hot, dry south to west facing mid to upper slopes and ridgetops, 7,500' - 8,640' (2285 - 2620 m), or north to northeast

facing lower and mid slopes, 6,500' - 7,500' (1980 - 2285 m). Mean annual precipitation (MAP) = 28-29"/year.

Adjacent plant associations
PSME/QUGA occurs in more mesic, cooler settings. Adjoining types in drier conditions may include PSME/QUAR, PIPO/QUHY, and PIPO/QURU4 plant associations.

Also see
Muldavin *et al.* (1996). PIPO/QUHY if Douglas-fir is accidental or occasional (< 10 trees/acre in mature stands). PSME/QUAR if silverleaf oak is scarce.

Important & key plants from research plots
Trees & life history status
ponderosa pine phase
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* C
silverleaf oak *(Quercus hypoleucoides)* S
southwestern white pine *(Pinus strobiformis)* c
border pinyon *(Pinus discolor)* c
twoneedle pinyon *(Pinus edulis)* c
alligator juniper *(Juniperus deppeana)* c
Arizona white oak *(Quercus arizonica)* s
Chihuahua pine phase
Douglas-fir *(Pseudotsuga menziesii)* C
ponderosa pine *(Pinus ponderosa)* C
silverleaf oak *(Quercus hypoleucoides)* S
Chihuahua pine *(Pinus leiophylla)* c
border pinyon *(Pinus discolor)* c
twoneedle pinyon *(Pinus edulis)* c
alligator juniper *(Juniperus deppeana)* c
Arizona white oak *(Quercus arizonica)* s
southwestern white pine *(Pinus strobiformis)* a
Emory oak *(Quercus emoryi)* a
netleaf oak phase
Douglas-fir *(Pseudotsuga menziesii)* C
southwestern white pine *(Pinus strobiformis)* C
ponderosa pine *(Pinus ponderosa)* c

alligator juniper *(Juniperus deppeana)* c
Arizona white oak *(Quercus arizonica)* s
silverleaf oak *(Quercus hypoleucoides)* s
border pinyon *(Pinus discolor)* a

Shrubs
Well represented (>5%) canopy coverage:
*silverleaf oak *(Quercus hypoleucoides)*
netleaf oak *(Quercus rugosa)*
gray oak *(Quercus grisea)*
canyon live oak *(Quercus chrysolepis)*
black cherry *(Prunus serotina)*
Fendler's ceanothus *(Ceanothus fendleri)*
true mountain mahogany *(Cercocarpus montanus)*
New Mexico locust *(Robinia neomexicana)*
banana yucca *(Yucca baccata)*
Schott's yucca *(Yucca x schottii)*
Wright's silktassel *(Garrya wrightii)*

Herbs
Common (>1%) or well represented (>5%) canopy coverage:
longtongue muhly *(Muhlenbergia longiligula)*
muttongrass *(Poa fendleriana)*
White Mountain sedge *(Carex geophila)*
screwleaf muhly *(Muhlenbergia straminea)*
prairie junegrass *(Koeleria macrantha)*
brickellbush *(Brickellia* spp.)
New Mexico groundsel *(Senecio neomexicanus)*
aromatic false pennyroyal *(Hedeoma hyssopifolia)*
Fendler's meadow-rue *(Thalictrum fendleri)*
New Mexico fleabane *(Erigeron neomexicanus)*
white sagebrush *(Artemisia ludoviciana)*
New Mexico fleabane *(Erigeron neomexicanus* var. *Erigeron delphinifolius)*

Cryptogams
Lichens may be common as epiphytes (a nonparasitic plant that grows on another plant but gets nourishment from the air).

Brief plant ID notes

The lance shaped leaves of silverleaf oak are dark green on top and woolly white underneath. The rolled margins of the leaves are entire and rarely have lobes, as silverleaf oak is less likely to hybridize than other southwestern oaks.

Synonymy
New Mexico fleabane *(Erigeron neo-mexicanus* var. *delphinifolius)*
border pinyon *(Pinus discolor = Pinus cembroides = Mexican pinyon)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: -1 (dry, warm)
Climate class: HSM (high sun mild)

Phases
The PSME/QUHY, QURU4 phase is described by Muldavin *et al.* (1996) as the PSME/QURU4 habitat type and occurs on cooler sites than other PSME/QUHY phases. In this phase, usually netleaf oak is well represented and silverleaf oak tends to be shrubby (windy exposures on shallow soils).

The PSME/QUHY, PIPO phase occurs on more alluvial sites than the PILE phase, and pine is more abundant.

Fire ecology
Oak sprouting is prolific and rapid after a fire. Silverleaf oak woodland may be established after severe fires (Wagner 1978).

Reforestation
Tree planting has moderate success for ponderosa pine and Douglas-fir. Site preparation usually promotes oak and grasses over conifer seedlings. Release of conifer seedlings by killing adjacent oaks can improve seedling survival. Low timber volumes, erosion-prone soils, and steep, poor sites typically preclude logging. However, where logging is feasible, clearcutting and seed tree cuts generally are difficult to regenerate conifer seedlings but do stimulate oak reproduction. Shelterwood and selection harvesting methods are usually successful for regenerating ponderosa pine and Douglas-fir, and selection cut

maintains adequate shading to encourage Douglas-fir regeneration but discourage ponderosa pine regeneration.

Revegetation considerations
Revegation is usually rapid due to oak response.

Comments
Generally, this plant association provides good deer habitat and may support large numbers of cavity nesting birds (Fitzhugh *et al.* 1987). Firewood production from alligator juniper and oaks may be an important management objective for some stands within this association.

Reference(s)
Fitzhugh *et al.* 1987
Moir & Ludwig 1979
Muldavin *et al.* 1996
Stuever 1995
USFS 1987b
USFS 1986
Wagner 1978

Douglas-fir/wavyleaf oak
Pseudotsuga menziesii/Quercus X pauciloba

(Formerly: Pseudotsuga menziesii/Quercus undulata)

Synonyms
Pseudotsuga menziesii/Quercus undulata.

Code(s)
typic phase 0 12 42 0

Ecological Response Unit
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group
Madrean Upper Montane Conifer - Oak Forest & Woodland (G202)

Key criteria
Must have at least 5% cover of oaks, and ***wavyleaf oak** is at least common and dominant over other oaks. Ponderosa pine is the dominant tree species, although ***Douglas-fir** and southwestern white pine are also present. White fir is absent or accidental.

Structure
Timber productivity is generally low. Browse from oak is more available in early successional stages. Stockability =1.

Location
Known from southcentral New Mexico, Mescalero Apache Reservation, Lincoln National Forest (Cloudcroft, Mayhill, & Smokey Bear Ranger Districts)-Sacramento Mountains, Carrizo Peak. Found on hot, dry exposures, very shallow, rocky soils 6,800'-7,800' (2,070 - 2,380 m).

Also see
PIPO/QUPA (PIPO/QUUN) is very similar, but Douglas-fir is absent or accidental (USFS 1986a).

Important & key plants from research plots
Trees & life history status
ponderosa pine *(Pinus ponderosa)* C
twoneedle pinyon *(Pinus edulis)* S

Douglas-fir *(Pseudotsuga menziesii)* c
southwestern white pine *(Pinus strobiformis)* c
alligator juniper *(Juniperus deppeana)* s

Shrubs
Well represented (>5%):
wavyleaf oak *(Quercus* X *pauciloba)
true mountain mahogany *(Cercocarpus montanus)*
skunkbush sumac *(Rhus trilobata)*

Herbs
Well represented (>5%):
Dore's speargrass *(Stipa nelsonii spp. dorei)*
Pringle's speargrass *(Piptochaetium pringlei)*
pine muhly *(Muhlenbergia dubia)*
muttongrass *(Poa fendleriana)*
sideoats grama *(Bouteloua curtipendula)*
little bluestem *(Schizachyrium scoparium)*
white sagebrush *(Artemisia ludoviciana)*
pineywoods geranium *(Geranium caespitosum)*
goldenrod *(Solidago* spp.)
dwarf stickpea *(Calliandra humilis* var. *reticulata)*

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

Synonomy
Dore's speargrass *(Stipa nelsonii* spp. *dorei = Stipa columbiana)*
Pringle's speargrass *(Piptochaetium pringlei = Stipa pringlei)*
little bluestem *(Schizachyrium scoparium = Andropogon scoparius)*
dwarf stickpea *(Calliandra humilis* var. *reticulata = C. reticulata)*
wavyleaf oak *(Quercus X pauciloba = Q. undulata)*

Terrestrial Ecological Unit attributes
Life Zone Class: 6 (mixed conifer)
Elevational Subzone: -1 (dry, warm)
Climate class: HSC (high sun cold)

Fire ecology
Fires influence stand dynamics. Huckaby & Brown (1996) on one site in the Sacramento Mountains determined that the fire frequency interval in this plant association prior to 1876 was 9 +/- 5 years with a range of 4 to 19 years between fire events. Fires generally occurred before the monsoon period. No fires had occurred since 1876.

Frequent fires probably favored pine over Douglas-fir. Oak sprouting is also stimulated by burning, and oak woodlands may have been a dominant feature within this plant association.

Reforestation
Clearcuts and seed tree cuts favor oak regeneration and inhibit natural regeneration. Planting success is low to moderate, with mechanical site preparation at moderate and high intensities providing some improvement in conifer seedling survival. Burning encourages oak sprouting and is not recommended for site preparation for reforestation. Selection and light shelterwood cutting systems provide shade which favors Douglas-fir. Heavier shelterwood and selection cuts (removing more overstory) tend to favor ponderosa pine.

Revegetation considerations
Natural revegetation is rapid due to oak sprouting.

Comments
This association may provide good food and cover, and winter range for deer. Firewood harvesting may also have some potential for some stands in this association. The site climax index for this plant association used in determining a This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

Reference(s)
Huckaby & Brown 1996
USFS 1986

Ponderosa Pine Series

PIPO/ACHY

Ponderosa pine/Indian ricegrass
Pinus ponderosa/Achnetherum hymenoides

(Formerly: Pinus ponderosa/Oryzopsis hymenoides)

Code(s)
typic phase 0 11 35 0

Ecological Response Unit
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Bunchgrass (PPG)

National Vegetation Classification Group
Southern Rocky Mountain Ponderosa Pine Open Woodland (G229)

Key criteria
Must have ***hoary rosemarymint (Poliomintha incana)***, which is a shrub. An open forest that occurs on sandy soils.

Structure
Stocking levels for ponderosa pine are low (Stockability = 0.6) and site productivity is low. Forage rating values are low.

Location
Very local in northern New Mexico (on stabilized sand dunes near Española) and southern Colorado (on the eastern edge of the Great Sand Dunes). Occurs on deep, sandy soils. 5,900’ to 6,300’ (1800 - 1920 M).

Adjacent plant associations
May form an ecotone with active sand dunes. Less sandy edges support PIPO/QUGA or pinyon-juniper woodlands.

Important and key plants from research plots
Trees & life history traits
ponderosa pine *(Pinus ponderosa)* C
oneseed juniper *(Juniperus monosperma)* C

Shrubs
Common (>1%).

***hoary rosemarymint** (Poliomintha incana)*
true mountain mahoghany *(Cercocarpus montanus)*

Herbs
Common (>1%).
Indian ricegrass *(Achnatherum hymenoides)*
little bluestem *(Schizachyrium scoparium)*
bottlebrush squirrel tail *(Elymus elymoides)*
hairy false goldenaster *(Heterotheca villosa var. villosa)*
spike dropseed *(Sporobolus contractus)*
sand bluestem *(Andropogon hallii)*
sandhill muhly *(Muhlenbergia pungens)*

Brief plant ID notes
Indian ricegrass is a hardy, cool-season, densely tufted bunchgrass with an elegant open panicle of slender branches tipped by florets with hairy seeds.

Synonymy
little bluestem *(Schizachyrium scoparium = Andropogon scoparius)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
hairy false goldenaster *(Heterotheca villosa var. villosa = Chrysopsis villosa)*
Indian ricegrass *(Achnatherum hymenoides = Oryzopsis hymenoides)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry)
Climate class: LSC (low sun cold)

Phases
There are no phases delineated for this plant association.

Fire ecology
Fire may not be a key natural force for this type as for other pine/grass types due to lack of continuous fuels. Indian ricegrass re-establishes from seed from adjacent areas following a fire. Postfire recovery for Indian ricegrass is reported as 2 to 4 years (Hickerson 1986).

Reforestation
This association is usually not a commercial forest due to low productivity. Shelterwood or selection cutting methods may sometimes

regenerate ponderosa pine. Clearcut and seed tree methods are not usually successful. Expect low survival rates when planting ponderosa pine. Site preparation for planting generally causes detrimental disturbances such as destabilizing sandy soils.

Revegetation considerations
Heavy disturbance can cause a return to sand dune conditions. Revegetation after disturbance is slow to very slow.

Comments
This plant association is rare in occurrence and may have a high content of both plant and animal diversity or endemism due to the special habitat (stabilized sand dunes) not found elsewhere.

References
DeVelice *et al.* 1986
Hickerson 1986

Ponderosa pine/black sagebrush

(Formerly: ponderosa pine/low sagebrush)

Pinus ponderosa/Artemisia nova

(Formerly: Pinus ponderosa/Artemisia arbuscula)

Synonyms
Pinus ponderosa/Artemisia arbuscula (USFS, 1987)

Code(s)
typic phase 0 11 38 0

Ecological Response Unit
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Bunchgrass (PPG)

National Vegetation Classification Group
Southern Rocky Mountain Ponderosa Pine Open Woodland (G229)

Key criteria
Must have ***black sagebrush**, which is a short sagebrush shrub found from nw New Mexico and Northern Arizona (Kaibab Plateau & Grand Canyon) north to Oregon and Idaho. The open stand structure of ponderosa pine combines with a denser structure in woodland species, and greater than 5% cover of shrubs.

Structure
Without major disturbances, ponderosa pine maintains a climax position in the stand, but rarely does this plant association support a commercial timber stocking (Stockability = 0.6). Although there is no research data, site indices are probably low on these dry sites. Pinyon and Rocky Mountain juniper regeneration can be dense (DeVelice, 1986) and may compete with ponderosa pine (USFS, 1987). Forage values are generally low to none. Firewood production may be high.

Location
Local in northern New Mexico, northern Arizona, and southern Colorado. Widespread in southern Utah. This plant association has a minor distribution in New Mexico and Arizona. Around 8,200’ (2,500 m). Occurs primarily on flat, basaltic mesa tops and elevated plains. In

Southern Utah, often occurs on flat benches. Rooting depths are often shallow due to restrictive subsurface horizons. Youngblood & Mauk (1985) state that in Southern Utah, "sites may potentially have seasonal high-water tables and even ponding".

Adjacent plant associations
For drier sites, pinyon-juniper woodlands; for wetter sites, PIPO/QUGA, PIED phase, or PIPO/BOGR2, ARTR phase.

Also see
PIPO/BOGR2, ARTR phase may be hard to distinguish; compare also with PIPO/QUGA, PIED phase described by Hanks *et. al.* (1983).

Important & key plants from research plots
Trees & life history status
ponderosa pine *(Pinus ponderosa)* C
twoneedle pinyon *(Pinus edulis)* C
Rocky Mountain juniper *(Juniperus scopulorum)* C
Gambel oak *(Quercus gambelii)* s

Shrubs
Abundant (>25%):
***black sagebrush** *(Artemisia nova)*
big sagebrush *(Artemisia tridentata)*
Gambel oak *(Quercus gambelii)*
wax currant *(Ribes cereum)*
mountain snowberry *(Symphoricarpos oreophilus)*
true mountain mahogany *(Cercocarpus montanus)*
small soapweed *(Yucca glauca)*
green rabbitbrush (*Ericameria teretifolia)*
fourwing saltbush *(Atriplex canescens)*
Mormon tea *(Ephedra viridis)*

Herbs
Well represented (>5%):
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koeleria macrantha)*
sedges *(Carex spp.*)
blue grama *(Bouteloua gracilis)*
bottlebrush squirreltail *(Elymus elymoides)*

trailing fleabane *(Erigeron flagellaris)*
mountain muhly *(Muhlenbergia montana)*
Indian ricegrass *(Achnatherum hymenoides)*

Brief plant ID notes
Black sagebrush *(Artemisia nova)* is also called dwarf sage and scab sagebrush. One of 15 species of *Artemisia* in our region, its leaves are similar to *A. tridentata,* but it is a smaller shrub with fewer flowers and smooth, rather than hairy phyllaries. Black sagebrush is generally associated with well-drained, rocky to gravelly soils. There are generally carbonates present to the surface (USFS 1989).

Synonymy
black sagebrush *(Artemisia nova)* = low sagebrush *(A. arbuscula var. nova)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
Rocky Mountain juniper *(Juniperus scopulorm = J. s. var. columnaris)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
Indian ricegrass *(Achnatherum hymenoides = Oryzopsis hymenoides)*
trailing fleabane *(Erigeron flagellaris = E. nudiflorus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry)
Climate class: LSC (low sun cold)

Phases
There is only one phase identified for this habitat type.

Fire ecology
Fire may not be as important in this plant association as it is in other ponderosa pine associations due to less continuous ground cover, which may prevent widespread surface fires (Youngblood & Mauk, 1985). Black sagebrush is highly susceptible to fire. It recolonizes by seed from unburned areas, which can take 75 years to replace a mature stand (McMurray 1986a).

Reforestation
Natural regeneration occurs only occasionally (Youngblood & Mauk 1985). Because regeneration of ponderosa pine is light (DeVelice,

1986), clearcut and seed tree cutting methods may not maintain a climax population of pine. Shelterwood and selection cutting methods may be more successful. Ponderosa pine may be planted, but survival rates may be low. Mechanical site preparation or burning at moderate or high intensities may reduce regeneration success.

Revegetation considerations
After disturbance, natural revegetation is moderate to slow. Black sagebrush can be direct seeded onto mineral soils with very good results. If reseeding black sagebrush, the Pine Valley Ridge cultivar is best for mule deer. Welch *et al.* (1994) suggests using 1/4 to 1/2#/acre in areas with 7-16"/year MAP, and a 75-day growing season.

Comments
This association is known to provide good winter range for elk (USFS, 1987a). There is a strong "Great Basin" floral influence as this association contains several species common to the Great Basin region (DeVelice, 1986). Disturbed sites may have conspicuous amounts of pingue rubberweed *(Hymenoxys richardsonii)* or bottlebrush squirreltail (Youngblood & Mauk, 1985).

Black sagebrush is an extremely high-quality big game browse. Successful grazing regimes have included moderate mid-winter browsing, or alternate year grazing for other seasons. Black sagebrush can tolerate up to 70% use on current year's growth. Moderate sheep grazing can deter pronghorn use (McMurray 1986).

References
DeVelice *et al.* 1986
McMurray 1986
USFS 1987a
Welch *et al.* 1986
Youngblood & Mauk 1985

Ponderosa pine/pointleaf manzanita c. t.
Pinus ponderosa/Arctostaphylos pungens

Code(s)
typic phase 0 11 42 0

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Shrub (PPS)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
***Pointleaf manzanita** *(Arctostaphylos pungens),* a large shrub, is abundant (> 25% canopy coverage). This community type is interpreted (Muldavin et.al., 1986) as a fire-derived expression of various ponderosa pine/evergreen oak habitat types. Douglas-fir and silverleaf oak are absent or accidental.

Structure
The pine overstory in this type is often quite open, with a dense shrub understory. Stocking generally does not reach commercial timber levels (Stockability = 0.7).

Location
Central Arizona, south of the Mogollon Rim, particularly on the Tonto National Forest and San Carlos Reservation, and north of the rim in the Pinedale/Showlow area and vicinity. On steep upper slopes, ridgetops, or elevated plains. 5,600’ to 6,800’ (1700 -2070 m).

Adjacent plant associations
On the dry, warm side, adjoins chaparral and pinyon-juniper woodlands. On cooler sites, this association usually grades to PIPO/QUAR, PIPO/QUEM, PIPO/QUHY, or PIPO/QUGA.

Also see
Mapping Units 5065 and 5440 of the Terrestrial Ecosystem Survey for Globe Ranger District (USFS 1984). TES mapping unit 572 on the Coconino NF (Miller *et al.* 1995).

Important & key plants from research plots
Trees & life history status
ponderosa pine *(Pinus ponderosa)* C
alligator juniper *(Juniperus deppeana)* C
Arizona white oak *(Quercus arizonica)* S
Emory oak *(Quercus emoryi)* S
Arizona pinyon *(Pinus fallax)* c
border pinyon *(Pinus discolor)* c

Shrubs
Abundant (>25%):
***pointleaf manzanita** *(Arctostaphylos pungens)*
***Pringle manzanita** *(Arctostaphylos pringlei)*
Wright's silktassel *(Garrya wrightii)*
skunkbush sumac *(Rhus trilobata)*
Parry's agave *(Agave parryi)*
sacahuista *(Nolina microcarpa)*
Fendler's ceanothus *(Ceanothus fendleri)*
shrubby evergreen oaks *(Quercus arizonica & Q. emoryi)*
redberry buckthorn *(Rhamnus crocaea)*

Herbs
Scarce (<1%) or poorly represented (<5%), scattered grasses & forbs:
longtongue muhly *(Muhlenbergia longiligula)*
White Mountain sedge *(Carex geophila)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koeleria macrantha)*
bottlebrush squirreltail *(Elymus elymoides)*
Texas bluestem *(Schizachyrium cirratum)*
pinyon ricegrass *(Piptochaetium fimbriatum)*
dwarf stickpea*(Calliandra humilis)*
pineywoods geranium
(Geranium caespitosum)
Wright's deervetch *(Lotus wrightii)*
aromatic false pennyroyal *(Hedeoma hyssopifolia)*
white sagebrush *(Artemisia ludoviciana)*
Carruth's sagewort *(Artemisia carruthii)*

Brief plant ID notes

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

Synonymy
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
Arizona pinyon *(Pinus fallax = Pinus californiarum)*
border pinyon *(Pinus discolor = Pinus cembroides = Mexican pinyon)*
dwarf stickpea *(Calliandra humilis* var. *reticulata = C. reticulata)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
Texas bluestem *(Schizachyrium cirratum = Andropogon cirratus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry)
Climate class: HSM (high sun mild)
LSM (low sun mild)

Phases
No phases are identified here, however, Muldavin *et al.* (1996) identifies two phases, for this plant association, the Arizona white oak phase and the Gambel oak phase. Norm Ambos (personal communication) suggests that two phases could be distinguished by which pinyon was present. A singleleaf pinyon (PIMO) phase would occur in low sun mild (LSM) climates, and a border pinyon (PIDI3) phase would occur in high sun mild (HSM) climates.

Fire Ecology
Manzanita and Fendler's ceanothus seeds germinate after fire and can persist into mid or late succession. The oaks are vigorous sprouters after fire. As chaparral species age to the point of decadence and fuel loadings increase, stands are extremely susceptible to stand-replacing fires. If fires continue to recur, PIPO/ARPU plant community may remain. With fire exclusion, ponderosa pine and oak canopies can close suppressing manzanita, and becoming a ponderosa pine/evergreen oak plant association. Many large crown fires have burned in this plant association. Some examples include the Dude, Carrizzo, and Mingus fires.

Reforestation
Natural regeneration of trees is slow due to strong competition with rapidly revegetating shrubs. Ponderosa pine seedlings have been planted in this type, but survival rates are low. Mechanical site preparation or prescribed burning tends to favor manzanita and oak when present. These methods of site preparation are not usually successful for encouraging pine regeneration.

Revegetation Considerations
Natural revegetation is rapid due to oak sprouting and quick shrub establishment.

Comments
Generally, grazing is poor due to scarce grasses. Deer and elk use may be limited by water availability. In some stands, dwarf mistletoe infestations can be severe.

References
Fitzhugh *et al.* 1987
Muldavin *et al.* 1996
USFS 1987b
USFS 1984

Ponderosa pine/kinnikinnick
Pinus ponderosa/Arctostaphylos uva-ursi

Code(s)
typic phase 0 11 40 0

Ecological Response Unit
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Bunchgrass (PPG)

National Vegetation Classification Group
Southern Rocky Mountain Ponderosa Pine Open Woodland (G229)

Key criteria
***Kinnikinnick** *(Arctostaphylos uva-ursi),* a low-growing shrub, ranges from 25%-70% canopy coverage and generally is the sole dominant understory species. Douglas-fir, twoneedle pinyon, and white fir are absent or accidental.

Structure
Timber productivity is moderate to low for this type (PIPO Site Index (Minor) = 57 to 67). Stocking is usually adequate for commercial timber production (Stockability = 1). Thick regeneration can sometimes occur. Forage production is low (early seral) to none (late seral).

Location
Northern New Mexico (Jemez, Sangre de Cristos, and San Juan mountains) and southern Colorado. 7,700’ - 9,200’ (2350 - 2800 m). Shallow soils of ridgetops, stony or excessively well drained soils on other slopes.

Adjacent plant associations
Upper slopes: ABCO/ARUV, ABCO/QUGA, PIPO/QUGA. Lower slopes: PIPO/FEAR2, PIPU/FEAR2 (mesic).

Also see
PSME/ARUV (Fitzhugh, et. al., 1987).

Important & key plants from research plots
Trees & life history status
ponderosa pine *(Pinus ponderosa)* C

Shrubs
Kinnikinnick is abundant (>25%), other shrubs are poorly represented (<5%):
***kinnikinnick** *(Arctostaphylos uva-ursi)*
Gambel oak *(Quercus gambelii)*
true mountain mahoghany *(Cercocarpus montanus)*
Fendler's ceanothus *(Ceanothus fendleri)*
wax currant *(Ribes cereum)*

Herbs
Well represented (>5%):
mountain muhly *(Muhlenbergia montana)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koeleria macrantha)*
Arizona fescue *(Festuca arizonica)*
sedges *(Carex spp.)*
beautiful fleabane *(Erigeron formosissimus)*
woolly cinquefoil *(Potentilla hippiana)*
rosy pussytoes *(Antennaria rosea)*

Brief plant ID notes
Kinnikinnick can be distinguished from Oregon boxleaf *(Paxistima myrsinites)* by its rounder, lighter colored leaves.

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: 0 (typical)
Climate class: LSC (low sun cold)

Phases
There is only one phase identified for this habitat type.

Fire ecology
Natural fires are frequent in this plant association.

Reforestation
Natural regeneration can be difficult. Clearcuts are usually not successful in re-establishing pine, although some seed tree cuts have

had adequate pine regeneration. Pine regeneration is usually present under shelterwood and selection cutting methods. Ponderosa pine plantings have had moderate survival rates in this plant association. Moderate levels of prescribed burning or mechanical site preparation have aided seedling survival.

Revegetation considerations
After a disturbance, natural revegetation recovers at a moderate rate.

Comments
Can provide good forage for deer and turkey. Dwarf mistletoe infestations can be severe.

References
DeVelice *et al.* 1986
USFS 1987a

Ponderosa pine/blue grama
Pinus ponderosa/Bouteloua gracilis

Code(s)
blue grama (BOGR2) phase 0 11 03 0
little bluestem (SCSC) phase 0 11 03 1
sand bluestem (ANHA) phase 0 11 03 2
big sagebrush (ARTR2) phase 0 11 03 3
gray oak (QUGR3) phase 0 11 03 4
gambel oak (QUGA) phase 0 11 03 5
blue grama (typic), little bluestem, sand bluestem, and big sagebrush phases

Ecological Response Unit
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Bunchgrass (PPG)

National Vegetation Classification Group
Southern Rocky Mountain Ponderosa Pine Open Woodland (G229)
gambel oak phase

Ecological Response Unit
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Gamble Oak (PPO)

National Vegetation Classification Group
Southern Rocky Mountain Ponderosa Pine Forest & Woodland (G228)
gray oak phase

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Perennial Grass (PPP)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
***Blue grama** is well represented, or if poorly represented, alligator juniper or pinyon are common. Arizona fescue is scarce or absent.

***Ponderosa pine** overstory is often open; shrubs are poorly represented although big sagebrush may be well represented on some sites.

Structure
This type is generally a dry ponderosa pine type with low stocking levels and poor site indices. Average site indices (Minor's) for ponderosa pine have been reported by USFS (1987) as 60 +/-18, (N=6) and by Mathiasen *et al.* (1987) as 74.3 +/-13.4 (N= 39). In areas with a history of fire exclusion, pole stands occasionally get dense. Grass productivity is generally high but can be quite reduced with erosion and/or heavy grazing pressure. Early successional stages generally provide excellent forage on well managed sites. Late successional stages may have large trees with heavy duff layers and forage production is moderate. Dense pole stands may have little or no forage production.

Location
Widespread in New Mexico, Arizona, Colorado and Utah. Lower elevations (6,250' - 8,550' or 1,900 - 2,610 m) of the ponderosa pine series.

Adjacent plant associations
On rocky slopes, PIPO/BOGR2 intergrades to PIPO/QUGA or PIPO/QUPA. On lower slopes, PIPO/BOGR2 forms an ecotone with pinyon-juniper woodlands. At higher elevations, this type may be adjacent to a more mesic ponderosa pine site. PIPO/BOGR2 may also form mosaics with PIPO/MUMO.

Also see
Pinus ponderosa/Muhlenbergia montana in S. Utah (Youngblood & Mauk, 1985); *Pinus ponderosa/Bouteloua gracilis, Pinus edulis* phase (Hanks, et. al., 1983); TES mapping unit 162 for the Carson NF (Edwards, 1987); TES mapping units 578 & 567 on the Coconino NF; *Pinus ponderosa/Purshia tridentata* in southern Colorado (Johnston, 1987). The *Pinus ponderosa/Bouteloua gracilis, Andropogon hallii* phase (Hanks et. al., 1983) may be similar to the *Pinus ponderosa/* Cinder soils habitat type described by Alexander *et.al.* 1987.

Important & key plants from research plots
Trees & life history status
<u>blue grama, little bluestem, sand bluestem, and big sagebrush phases:</u>

ponderosa pine *(Pinus ponderosa)* C
twoneedle pinyon *(Pinus edulis)* C
alligator juniper *(Juniperus deppeana)* S
Rocky Mountain juniper
(Juniperus scopulorum) c
Utah juniper *(Juniperus osteosperma)* c
oneseed juniper *(Juniperus monosperma)* c
Gambel oak *(Quercus gambelii)* s
Gambel oak phase:
ponderosa pine *(Pinus ponderosa)* C
twoneedle pinyon *(Pinus edulis)* C
Utah juniper *(Juniperus osteosperma)* c
Gambel oak *(Quercus gambelii)* s
Rocky Mountain juniper *(Juniperus scopulorum)* a
gray oak phase:
ponderosa pine *(Pinus ponderosa)* C
alligator juniper *(Juniperus deppeana)* S
twoneedle pinyon *(Pinus edulis)* c
gray oak *(Quercus grisea)* s

Shrubs
Poorly represented (<5%):
Gambel oak *(Quercus gambelii)* [QUGA phase (<5%)]
gray oak *(Quercus grisea)* [QUGR phase (<5%)]
shrubby oaks *(Quercus spp*.) [<5%]
broom snakeweed *(Gutierrezia sarothrae)*
skunkbush sumac *(Rhus trilobata)*
rubber rabbitbrush *(Ericameria nauseosa)*
waxcurrant *(Ribes cereum)*
big sagebrush *(Artemisia tridentata)* [ARTR phase]
antelope bitterbrush *(Purshia tridentata)* [ARTR phase]
pingue rubberweed *(Hymenoxys richardsonii)*
Apacheplume *(Fallugia paradoxa)* [ANHA phase]

Herbs
Well represented (>5%) to abundant (>25%), especially grasses:
blue grama *(Bouteloua gracilis)*
muttongrass *(Poa fendleriana)*
needlegrass *(Stipa spp.)*

mountain muhly *(Muhlenbergia montana)*
bottlebrush squirrel tail *(Elymus elymoides)*
pine dropseed *(Blepharoneuron tricholepis)*
prairie junegrass *(Koelaria macrantha)*
Fendler's threeawn *(Aristida purpurea var. fendleriana)*
Arizona threeawn *(Aristida arizonica)*
little bluestem *(Schizachyrium scoparium)* [>5% SCSC phase]
sand bluestem *(Andropogon hallii)* [ANHA phase]
common wolfstail *(Lycurus phleoides)*
sedges *(Carex spp.*)
redroot buckwheat *(Eriogonum racemosum)*
Wright's deervetch *(Lotus wrightii)*
pussytoes *(Antennaria spp.)*
white sagebrush *(Artemisia ludoviciana)*
trailing fleabane *(Erigeron flagellaris)*
spreading fleabane *(Erigeron divergens)*
New Mexico groundsel *(Senecio neomexicanus)*
pineywoods geranium *(Geranium caespitosum)*
threenerve goldenrod *(Solidago velutina)*
rose heath *(Chaetopappa ericoides)*

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)*
little bluestem *(Schizachyrium scoparium = Andropogon scoparius)*
rose heath *(Chaetopappa ericoides = Leucelene ericoides)*
Fendler's threeawn *(Aristida purpurea* var. *fendleriana = Aristida fendleriana)*
threenerve goldenrod *(Solidago velutina = Solidago sparsiflora)*
Rocky Mountain juniper *(Juniperus scopulorm = J. s. var. columnaris)*
rubber rabbitbrush *(Ericameria nauseosa = Chrysothamnus nauseosus)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
trailing fleabane *(Erigeron flagellaris = E. nudiflorus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry)
Climate class: LSC (low sun cold)
HSC (high sun cold)
HSM (high sun mild) [QUGR3 phase]

Phases
The blue grama phase or typic phase has been described by Hanks *et al.* (1983) for northern Arizona, Muldavin *et al.* (1996) for southern Arizona, and by Alexander *et al.* (1987), DeVelice *et al.* (1986), and Fitzhugh *et al.* (1987) for New Mexico. In northern New Mexico, DeVelice *et al.* (1986) identified the little bluestem phase which generally had >5% cover of little bluestem.

The big sagebrush phase has been described by Hanks *et al.* (1983) for northern Arizona, Muldavin *et al.* (1996) for southern Arizona. Muldavin felt this phase, which he found in the Aubrey Cliffs area, may represent a persistent grazing disclimax.

Hanks *et al.* (1983) and Fitzhugh *et al.* (1987) found a twoneedle pinyon phase in northern Arizona and central Arizona and New Mexico which may resemble the gray oak phase listed above.

The sand bluestem phase (described by Hanks et al. 1983) is found in open forests on cinder soils.

Fire Ecology
Historically fires were prominent in the ecological functioning of this type. Heavy grass cover provided for frequent, reoccurring surface fires. Where grass cover has been reduced due to erosion or heavy grazing pressure, fires may burn in a sporadic and patchy manner or not at all. Likewise, fires may tend to crown where stand stocking conditions are dense and regenerating pine thickets provide fuel ladders. Open stands frequently have low fuel loadings and crown fire potential is very low. Where surface fires have been suppressed, this type often accrues high understory stocking levels of woodland conifer and live oak species, increasing probabilities for uncharacteristic crown fires.

Reforestation
Natural regeneration is not consistent in this type and is dependent on cyclical cone crops, ideal weather for seedling germination and establishment, and access of mineral soil for the seed. Seed tree and clearcut regeneration methods usually are not successful for natural tree re-establishment. Tree planting is generally not a reliable regeneration method (see below). Light shelterwood cuts may be successful. Selection cutting methods are often the best method, provided sufficient time is allowed between stand entries.

Tree planting is often difficult, and usually limited to ponderosa pine or woodland species. Survival rates for spring planting projects appear to be linked to the El Niño/Southern Oscillation cycle. Based on a regionwide survey in 1991 (Stuever, unpublished data), survival rates for El Niño years have ranged up to 95%, and in La Niña years (dry years), have averaged less than 10% regionwide. Other years have varied success rates. Many successful tree plantings in this type have incorporated water harvesting practices such as furrows, careful microsite selections, etc. Fall plantings may generally be more successful. Grass competition can be a problem for seedling survival. Mechanical site preparation can reduce grass competition. Moderate intensity burning can also provide beneficial site preparation. Significant areas have been successfully planted in this plant association, but failures are more common than in more mesic plant associations.

Revegetation Considerations
Natural revegetation is often slow due to the dryness of the site, and sites may have high soil erosion potential. Since ponderosa pine/blue grama plant associations often have more bare ground compared with more mesic ponderosa pine associations, sheet erosion is often a problem. Sheet erosion can be reduced by increasing branch litter on the site which provide microsites for grass establishment.

For some PIPO/BOGR2 sites, Apache-plume may be an excellent plant to seed for erosion control and increased deer browse. These sites may include the ANHA phase, or in unstable washes with cobbles. Generally, ponderosa pine regeneration establishment is sporadic and episodic on these sites (Harris 1988b).

Comments
Blue grama and shrubs increase on overgrazed livestock ranges. Apache plume can dominate on deep, cinder soils. Firewood potential is often high for this plant association. Dwarf mistletoe infestations can be severe. Large ponderosa pine may be important turkey roosts. Gambel oak, when present, offers mast and cover for wildlife.

Where big sagebrush is present (particularly in the ARTR2 phase), the variety of big sagebrush can make a big difference for management. The high protein content of Wyoming big sagebrush *(Artemisia tridentata var. wyomingensis)* makes this variety good winter browse for deer and elk. Another high protein variety, mountain big sagebrush *(A. t. var. vaseyana),* is considered good summer browse. The basin big sagebrush *(A. t. var. tridentata)* is not considered good browse, sometimes designated as "starvation food". All varieties are susceptible to fire and only the mountain big sagebrush is known to reseed quickly. (Bradley 1986a).

Reference(s)
Alexander *et al.* 1987
Bradley 1986a
DeVelice *et al.* 1986
Fitzhugh *et al.* 1987
Hanks *et al.* 1983
Harris 1988b
Mathiasen *et al.* 1987
USFS 1987a
USFS 1987b
USFS 1986

Ponderosa pine/Arizona fescue
Pinus ponderosa/Festuca arizonica

Code(s)
Arizona fescue (FEAR2) phase 0 11 09 0
Parry's oatgrass (DAPA2) phase 0 11 09 1
blue grama (BOGR2) phase 0 11 09 2
gambel oak (QUGA) phase 0 11 09 3

Ecological Response Unit
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Bunchgrass (PPG)

National Vegetation Classification Group
Southern Rocky Mountain Ponderosa Pine Open Woodland (G229)

Key criteria
Must have ***Arizona fescue**, or if grazing history includes persistent use which can explain the absence of Arizona fescue, then Kentucky bluegrass is present. Douglas-fir, white fir, pinyon, and juniper are generally absent or accidental. The DAPA2 phase may contain Douglas-fir, usually in microsites, and the BOGR2 phase may contain some pinyon and junipers.

Structure
There is a range of timber productivity in this widespread type. For the typic phase, Hanks et. al. 1983 reported a mean basal area of 91.3 sq. ft./ac (20.9 sq. m/ha). Similar averages were for the Gambel oak phase: 79 sq. ft./ac (18.1 sq. m/ha), and for the blue grama phase: 50 sq. ft./ac (11.5 sq. m/ha). Some of the highest timber volumes (35,000 MBF) of ponderosa pine have been reported in this type. Mathiasen *et al.* (1987) found an average site index for ponderosa pine (Minor) of 83.6 +/-11.2. (N= 112 stands). Forage value ratings are high in early seral stages decreasing to moderate or low in late successional stages. Forage value ratings are quite low where dense pole stands have developed. Under historic conditions, this type exhibited strong aggregation in tree spatial patterns, with tree groups interspaced by grass/forb patches.

Location
Widespread in New Mexico, central Arizona, and southern Colorado, infrequent south of the Mogollon Rim. Elevated and valley plains, piedmont hillslopes and mountain slopes, 6,800' - 8,800' (2,070 - 2,680 m) to 9,400' (2,865 m) on south-facing slopes. Mean annual precipitation = 20-25"/year.

Important & key plants from research plots
Trees & life history status
Parry's oatgrass phase:
ponderosa pine *(Pinus ponderosa)* C
Rocky Mountain juniper *(Juniperus scopulorum)* s
quaking aspen *(Populus tremuloides)* s
Douglas-fir *(Pseudotsuga menziesii)* c
Arizona fescue phase:
ponderosa pine *(Pinus ponderosa)* C
Gambel oak phase:
ponderosa pine *(Pinus ponderosa)* C
twoneedle pinyon *(Pinus edulis)* s
Gambel oak *(Quercus gambelii)* s
blue grama phase:
ponderosa pine *(Pinus ponderosa)* C
twoneedle pinyon *(Pinus edulis)* s
Rocky Mountain juniper *(Juniperus scopulorum)* s
oneseed juniper *(Juniperus monosperma)* s

Shrubs
Scarce (<1%), [poorly represented (<5%) in QUGA phase, sometimes common in BOGR2 phase]:
Gambel oak *(Quercus gambelii)* [QUGA phase]
wax currant *(Ribes cereum)*
true mountain mahoghany *(Cercocarpus montanus)*
Fendler's ceanothus *(Ceanothus fendleri)*
broom snakeweed *(Gutierrezia sarothrae)* [BOGR2 phase]

Herbs
Well represented (>5%) to abundant (>25%):
***Arizona fescue** *(Festuca arizonica)*
mountain muhly *(Muhlenbergia montana)*

blue grama *(Bouteloua gracilis)* [<2% in BOGR2 phase]
Pringle speargrass *(Piptochaetium pringlei)*
Parry's oatgrass *(Danthonia parryi)* [DAPA phase]
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koelaria macrantha)*
pine dropseed *(Blepharoneuron tricholepis)*
Ross' sedge *(Carex rossii)*
bottlebrush squirrel tail *(Elymus elymoides)*
Kentucky bluegrass *(Poa pratensis)*
screwleaf muhly *(Muhlenbergia straminea)* [MUST/FEAR2 h.t.]
manyflowered stoneseed *(Lithospermum multiflorum)*
pussytoes *(Antennaria spp.*)
woolly cinquefoil *(Potentilla hippiana)*
rockyscree false goldenaster *(Heterotheca fulcrata)*
white sagebrush *(Artemisia ludoviciana)*
Carruth's sagewort *(Artemisia carruthii)*
western brackenfern *(Pteridium aquilinum)*
beautiful fleabane *(Erigeron formosissimus)*
grassleaf peavine *(Lathyrus graminifolius),*
hairy false goldenaster *(Heterotheca villosa var. villosa)*

Brief plant ID notes
Arizona fescue is a cool season, native, perennial bunchgrass with tightly rolled leaves and a multi-flowered panicle with flattened spikelets.

Synonymy
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
hairy false goldenaster *(Heterotheca villosa var. villosa = Chrysopsis villosa)*
Rocky Mountain juniper *(Juniperus scopulorm = J. s. var. columnaris)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: 0 (typic) or
+1 (moist) for Parry's oatgrasss phase
Climate class: LSC (low sun cold),
LSM (low sun mild)

Phases
The typic or Arizona fescue phase lacks blue grama, Gambel oak, or Parry's oatgrass. The Parry's oatgrass phase is on cool sites with deep soils and Parry's oatgrass is present to well represented. The blue grama phase has blue grama or wolfstail *(Lycurus phleoides).* The Gambel oak phase has <5% cover of gambel oak.

Adjacent plant associations
In the mid-elevational range of ponderosa pine plant associations and may be adjacent to many other PIPO p.a.'s. As soils become rockier, PIPO/FEAR2 may adjoin PIPO/QUGA. On wetter sites, PIPO/FEAR2 may adjoin ABCO/FEAR2.

Also see
Pinus ponderosa/Muhlenbergia montana on the north Kaibab Plateau is very similar but lacks Arizona fescue; *Pinus ponderosa/Poa longiligula* community type (Hanks, et. al., 1983); Currie (1975), Pearson (1950); The gambel oak phase of PIPO/FEAR2 (QUGA=<5%) is difficult to distinguish from the Arizona fescue phase of PIPO/QUGA (QUGA=>5%).

Fire ecology
Historically, surface fires in this plant association were frequent (4-8 years) and often covered large (ave. 3,000 acres) areas (Swetnam & Dieterich 1985). These fires would encourage a heavy grass component that would favor frequent surface fires (DeVelice *et. al.* 1986). In the absence of fire, denser stands of trees develop, and grasses are not as prolific. On the more mesic sites in this plant association, western brackenfern and Kentucky bluegrass can dominate where fires or livestock grazing have had past or repeated occurrences. Where present, burning can stimulate Fendler's ceanothus which has high value for wildlife browsing.

Reforestation
Natural regeneration can form dense thickets in the absence of a frequent fire regime or timber stand improvement thinnings. Occasionally, competition from grasses can be severe and prevent trees from becoming established until the site is further disturbed, especially where this plant association occurs on heavy clay soils. Arizona fescue competition often limits regeneration establishment to "safe" sites where grass competition is lower, resulting in an aggregated tree distribution pattern, interspaced with grass/forb patches. Shelterwood cutting practices provide the most reliable even-age management regeneration. Seed trees are often successful at regenerating pine, and clear cuts may be reasonable in stands heavily infected with mistletoe. Selection cutting methods are successful, and are currently the preferred management for this type, especially where mistletoe is not a concern. Artificial regeneration (planting seedlings) is usually successful if thorough site preparation is done.

Revegetation considerations
Natural revegetation is moderately rapid. Aspen (which can be a minor seral species) may become established in clumps or patches where sufficient healthy rootstocks exist prior to disturbance.

Comments
This is a cool, mesic plant association for the ponderosa pine series in the Southwest. In central Arizona, PIPO/FEAR2 represents the middle range within the vegetation gradient in the ponderosa pine series.

Reference(s)
Alexander *et al.* 1987
DeVelice *et al.* 1986
Fitzhugh *et al.* 1987
Hanks *et al.* 1983
Mathiasen *et al.* 1987
Muldavin *et al.* 1991
Stuever 1995
USFS 1986
USFS 1987a
USFS 1987b

Ponderosa pine/Arizona walnut
Pinus ponderosa/Juglans major

Code(s)
typic phase 0 11 47 0

Ecological Response Unit
Ponderosa Pine/Willow (350)

National Vegetation Classification Group
Western Interior Riparian Forest & Woodland (G797)

Key criteria
***Arizona walnut** or ***canyon grape** are common, but riparian trees like Arizona alder *(Alnus oblongifolia),* boxelder *(Acer negudo),* sycamore *(Platanus wrightii),* or species of cottonwood *(Populus* spp.) are limited to microsites. Twoneedle pinyon *(Pinus edulis),* border pinyon *(Pinus discolor),* and Arizona pinyon *(Pinus fallax)* are absent or accidental.

Structure
If soils are not saturated, productivity for ponderosa pine may be high for this type (Muldavin *et. al.* 1991). Grasses and forbs are generally quite productive. Fluctuating water tables may affect the plant community.

Location
Occasionally found on alluvial terraces of intermittent washes or stream sides south of the Mogollon Rim and in southwestern New Mexico. 5,500 - 6,400' (1,680 - 1,950 m).

Adjacent plant associations
Often adjacent to "riparian forests" near streams, especially in draws and intermittent washes leading to year-round water. On the upper slopes, frequently a gradual transition to the PIPO/oak plant associations or other PIPO plant associations.

Also see
Classified as "riparian forests" if riparian trees mentioned in "Key criteria" are common and not limited to microsites. The *Pinus ponderosa/Acer grandidentata* habitat type of the Galiuro Mtns. and

Mexico described in Muldavin et. al. 1991 also has Arizona walnut in the sub-canopy. Szaro (1989) describes a *Juglans major* community type that contains ponderosa pine (his table 12, p. 104) in 43% of his sample sites. In the Guadalupe Mountains in southcentral New Mexico and western Texas, a *Pinus ponderosa/Juglans microcarpa* (ponderosa pine/Texas black walnut) plant association is very similar to PIPO/JUMA except for some key species. This p.a. is also found on canyon bottoms adjacent to riparian areas [TES mapping unit 2 for Dark Canyon EMA, Lincoln NF (Escobedo 1995) and TES of Southern Guadalupe Escarpment (Soil and Water West Inc. 1995].

Important & key plants from research plots
Trees & life history status
ponderosa pine *(Pinus ponderosa)* C
alligator juniper *(Juniperus deppeana)* C
Arizona walnut *(Juglans major)* S
Gambel oak *(Quercus gambelii)* S
Rocky Mountain juniper *(Juniperus scopulorum)* c
Arizona oak *(Quercus arizonica)* s

Shrubs
Well represented (>5%):
shrubby forms of oaks *(Quercus spp.)* and junipers *(Juniperus spp.)*
skunkbush sumac *(Rhus trilobata)*
beechleaf *(Frangula betulifolia)*
canyon grape *(Vitis arizonica)*

Herbs
Abundant (>25%):
various species of brome *(Bromus spp.*)
western wheatgrass *(Pascopyrum smithii)*
bottlebrush squirreltail *(Elymus elymoides)*
Kentucky bluegrass *(Poa pratensis)*
Canada wildrye *(Elymus canadensis)*
bulb panicgrass *(Panicum bulbosum)*
species of fleabane *(Erigeron spp.)*
Mexican bedstraw *(Galium mexicanum ssp. asperrimum)*
Fendler's meadow-rue *(Thalictrum fendleri)*
and numerous other forbs

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

Synonymy
Rocky Mountain juniper *(Juniperus scopulorm = J. s. var. columnaris)*
western wheatgrass *(Pascopyrum smithii = Agropyron smithii)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
Mexican bedstraw *(Galium mexicanum ssp. asperrimum = G. asperrimum)*
beechleaf frangula *(Frangula betulifolia = Rhamnus betulaefolia)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry) to
+1 (cool, moist)
Climate class: HSC (high sun cold)
HSM (high sun mild)
LSM (low sun mild)

Fire ecology
This plant association occurs in predominately more mesic sites which may burn less frequently than upland sites (Pavek 1993). Arizona walnut has few adaptations to fire, although buried seeds may survive fires and provide post-fire regeneration.

Reforestation
Clearcut and seed tree harvesting systems may encourage sheet erosion and decrease water quality due to the close proximity of this association to the stream course. Selection cuts usually protect water quality objectives and provide for adequate regeneration, and shelterwood cuts often provide the best forest regeneration. Natural regeneration is usually adequate, and there is little information on tree planting for this association. When oak is a major component of the stand, burning or heavy cutting may stimulate oak resprouting. Grass and forb competition may be intense. Natural regeneration may be dependent on flooding events which create mineral seedbeds on newly created alluvial terraces.

Revegetation Considerations
Natural revegetation response is generally moderate.

Comments
This type is ideal livestock and wildlife habitat because forage, cover and water are ample. High potential for walnut production.

Reference(s)
Escobedo 1995
Muldavin *et al.* 1996
Soil and Water West Inc. 1995
Szaro 1989
USFS 1987b

Ponderosa pine/mountain muhly
Pinus ponderosa/Muhlenbergia montana

Synonyms
Pinus ponderosa/Poa longiligula community type (Hanks *et. al.* 1983).

Code(s)
typic phase 0 11 33 0

Ecological Response Unit
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Bunchgrass (PPG)

National Vegetation Classification Group
Southern Rocky Mountain Ponderosa Pine Open Woodland (G229)

Key criteria
Although mountain muhly is often present to well represented, it does not have to be present to be called this plant association. Gambel oak, if present, is <5% canopy cover. Douglas-fir *(Pseudotsuga menziesii)* and quaking aspen *(Populus tremuloides)* are absent or accidental and then usually in microsites, or if present, may represent an ecotone between PIPO/MUMO and an adjacent plant association.

Structure
Timber productivity is low. Site index for PIPO (Minor) 58 +/- 13 (n=8). Stockability = 1. Forage productivity is high especially in early seral stages. Thickets of pine regeneration, which are prone to snow damage, are common and may be suitable for thinning projects.

Location
Southwest and central New Mexico up through southern Colorado, southern Arizona to southern Utah. 7,100’ (2160 m) to 9,400’ (2870 m) on south-facing slopes. Elevated and valley plains, piedmont hillslopes, mountain slopes, mesas and benches. Soils are varied (see appropriate TES mapping units if applicable). Mean annual precipitation (MAP) = 20-25”/year.

Adjacent plant associations
PIPO/MUMO often forms a mosaic with PIPO/QUGA. On more mesic sites, PIPO/MUMO forms an ecotone with PIPO/FEAR2. Likewise, on more xeric sites, PIPO/MUMO forms an ecotone with PIPO/BOGR2.

Also see
Pinus ponderosa/Arizona fescue is distinguished by a common occurrence of Arizona fescue. PIPO/MUMO described by Hess and Alexander (1986) and Youngblood and Mauk (1985) may be geographic phases. Certain stands classified as PIPO/BOGR2 by Hanks et. al. (1983) are assigned to PIPO/MUMO if blue grama is less than 5% cover. PIPO/QUGA and PIPO/QUGR3 have an oak canopy cover of >5%.

PIPO/FEAR2, PIPO/BOGR2, and stages of PIPO/MUMO derived from livestock grazing may appear similar. Seral stages of ponderosa pine/Arizona fescue, especially on livestock allotments (pine-bunchgrass range), can resemble PIPO/MUMO. Heavily grazed lands of PIPO/MUMO can also resemble PIPO/BOGR2.

Important & key plants from research plots
Trees & life history status
<u>In Northern Arizona (Kaibab Plateau & Defiance Plateau) to Southern Utah:</u>
ponderosa pine *(Pinus ponderosa)* C
Rocky Mountain juniper *(Juniperus scopulorum)* s
Gambel oak *(Quercus gambelii)* s
<u>in Northern New Mexico and Southern Colorado:</u>
ponderosa pine *(Pinus ponderosa)* C
twoneedle pinyon *(Pinus edulis)* c
oneseed juniper *(Juniperus monosperma)* c
Gambel oak *(Quercus gambelii)* s
<u>in Southern Arizona & sw New Mexico (south of rim):</u>
ponderosa pine *(Pinus ponderosa)* C
Rocky Mountain juniper *(Juniperus scopulorum)* S
twoneedle pinyon *(Pinus edulis)* c
alligator juniper *(Juniperus deppeana)* c
Gambel oak *(Quercus gambelii)* s

Shrubs
Common (>1%) or well represented (>5%):
Fendler's ceanothus *(Ceanothus fendleri)*
gambel oak *(Quercus gambellii)* [other *Quercus spp.* in Southern AZ]
true mountain mahoghany *(Cercocarpus montanus)*
pingue rubberweed *(Hymenoxys richardsonii)*
creeping barberry *(Mahonia repens)*
rubber rabbitbrush *(Chrysothamnus nauseosus)*

Herbs
Well represented (>5%) to abundant (>25%), especially grasses:
mountain muhly *(Muhlenbergia montana)*
pine dropseed *(Blepharoneuron tricholepis)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koleria macrantha)*
bottlebrush squirrel tail *(Elymus elymoides)*
sedges *(Carex spp.*)
blue grama *(Bouteloua gracilis)* usually scarce
bluestems *(Andropogon spp.)*
threeawns *(Aristida spp*.)
Wright's deervetch *(Lotus wrightii)*
manyflowered stoneseed *(Lithospermum multiflorum)*
New Mexico groundsel *(Senecio neomexicanus)*
lobeleaf groundsel *(Packera multilobatus)*
pineywoods geranium *(Geranium caespitosum)*
common yarrow *(Achillea millefolium)*
pussytoes *(Antennaria spp.)*
trailing fleabane *(Erigeron flagellaris)*
Vreeland's erigeron *(Erigeron vreelandii)*
grassleaf peavine *(Lathyrus graminifolius)*
milkvetches *(Astragalus spp.)*

Brief plant ID notes
Mountain muhly is a meager-sized bunchgrass compared with some other muhly's, such as screwleaf muhly, bullgrass, or longtongue muhly. Mountain muhly has long wiry awns protruding from the yellowish lemmas.

Synonymy
creeping barberry *(Mahonia repens = Berberis repens)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
Vreeland's erigeron *(Erigeron vreelandii = Erigeron platyphyllus*)
Rocky Mountain juniper *(Juniperus scopulorm = J. s. var. columnaris)*
rubber rabbitbrush *(Ericameria nauseosa = Chrysothamnus nauseosus)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*
trailing fleabane *(Erigeron flagellaris = E. nudiflorus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa),
Elevational Subzone: -1 (warm dry), 0 (typic)
Climate class: HSC (high sun cold), LSC (low sun cold), HSM (high sun mild)

Phases
Although no phases have been formally identified for this plant association, there seems to be a recognizable difference between dry, hillslope conditions and bottomland conditions. Also, in some places, aspen may play a significant role, from minor to major seral expression, which may represent a separate phase. Fitzhugh *et. al.* 1987 suggest this type should be broken out into phases, primarily associated with geographic distributions.

Fire Ecology
This association generally experienced frequent fires (every 3 to 10 years) in pre-settlement times. Stands were probably more open, and surface fires were carried in the graminoid dominated understories. Savage and Swetnam (1990) found that livestock grazing in the Chuska Mountains in the 19th century disrupted natural fire occurrence patterns essentially excluding fire by removing fine fuels. Today, forests in this association generally have greater numbers of trees, including thickets of regeneration. Burning also tends to stimulate germination of Fendler's ceanothus, and in some places, aspen. Prescribed fire can be useful to reduce conifer thickets, maintain visual quality, and stimulate herbage production.

Reforestation
Natural regeneration is generally abundant, often resulting in thickets of pine saplings. Where grass competition is strong, regeneration may be reduced. Under historic conditions with frequent surface fire occurrence, this type typically exhibits clumpy and groupy tree distribution pattern with tree groups interspaced by patches of grasses and forbs. Shelterwood, selection, and seed tree harvesting systems have been successful in regenerating pine. Clearcuts may be warranted, especially in mistletoe infected stands. Planting usually results in high survival of ponderosa pine, unless there is some grass or oak competition (such as gray oak in central Arizona). Site preparation (mechanical or burning) often improves survival rates of pine seedlings.

Revegetation Considerations
Natural revegetation is usually rapid following fire but may be slower to respond to severe overgrazing or mechanical disturbance. Aspen has been observed to form a dominant seral forest following disturbances on the Kaibab Plateau in northern AZ, in this plant association. In other locations where aspen occurs in this plant association, it has been in minor patches within the ponderosa pine forest.

Comments
Stands can have high visual quality where large pines occur in clumped mosaics with grassy understories. Since this type often occurs on gentle topography, overuse is frequently a concern. Where grazing is heavy, muttongrass tends to increase in cover. Merrill *et al.* (1987) found that dwarf mistletoe was heavier in this plant association, than in more mesic associations in Colorado.

Reference(s)

Alexander *et. al.* 1987
DeVelice *et al.* 1986
Fitzhugh *et al.* 1987
Merrill *et al.* 1987
Muldavin *et al.* 1996
Savage & Swetnam 1990
Stuever 1995
USFS 1986
USFS 1987a
USFS 1987b
Youngblood & Mauk 1985

Ponderosa pine/screwleaf muhly
Pinus ponderosa/Muhlenbergia straminea

(Formerly: Pinus ponderosa/Muhlenbergia viriscens PIPO/MUVI2)

Code(s)
screwleaf muhly (MUST) phase 0 11 34 0
Gambel oak (QUGA) phase 0 11 34 1

Ecological Response Unit
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Bunchgrass (PPG)

National Vegetation Classification Group
Southern Rocky Mountain Ponderosa Pine Open Woodland (G229)

Key criteria
A mesic ponderosa pine site must have ***screwleaf muhly**. This is the wettest type in the ponderosa pine series in northern Arizona. Douglas-fir, white fir, and pinyon are absent or accidental.

Structure
Hanks *et. al.* (1983) reported a mean basal area for ponderosa pine of 87 square feet/acre (19.5 square meters/ha) for the screwleaf muhly phase and 91 square feet/acre (20.9 square meters/ha) for the Gambel oak phase. Ponderosa pine regeneration in this study averaged 220 and 126 stems/acre for the phases respectively. Timber production can be high in this association. Mathiasen *et al.* (1987) reported a mean site index for ponderosa pine of 81.1 +/-8.6 (N= 12). Forage value ratings are high in early seral stages, decreasing to moderate in late successional stages.

Location
Southwest and central New Mexico, southern Arizona to central Arizona (up to San Francisco Peaks area). 6,700’ - 8,800’ (2,040 - 2,680 m) to 9,400’ (2,879 m) on south-facing slopes. Mean annual precipitation = 23-25”/year. Found on many slopes and aspects.

Adjacent plant associations
One of the wettest in the PIPO series, this type is transitional to mixed conifer forests. On the drier sites, it may adjoin PIPO/MUST-FEAR2, PIPO/FEAR2, and PIPO/QUGA.

Also see
PIPO/MUVI2-FEAR2 (Hanks, et. al. 1983); PIPO/QUGA (with an oak canopy cover of >5%) sometimes has a high cover of screwleaf muhly. If southwestern white pine, white fir and/or Douglas fir is >5-10 stems/acre, or a component of the climax canopy, see the ABCO or PSME series.

Important & key plants from research plots
Trees & life history status
screwleaf muhly phase:
ponderosa pine *(Pinus ponderosa)* C
southwestern white pine *(Pinus strobiformis)* c [or absent]
Gambel oak phase:
ponderosa pine *(Pinus ponderosa)* C
Gambel oak *(Quercus gambelii)* s

Shrubs
Scarce (<1%):
Fendler's ceanothus *(Ceanothus fendleri)*
true mountain mahoghany *(Cercocarpus montanus)*
Gambel oak *(Quercus gambelii)* [other *Quercus spp*. in Southern AZ]
mountain snowberry *(Symphoricarpos oreophilus)*

Herbs
Abundant (>25%), especially grasses:
***screwleaf muhly** *(Muhlenbergia virescens), >5%*
bottlebrush squirrel tail *(Elymus elymoides)*
pine dropseed *(Blepharoneuron tricholepis)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koelaria macrantha)*
White Mountain sedge *(Carex geophila)*
Ross' sedge *(Carex rossii)*
trailing fleabane *(Erigeron flagellaris)*
New Mexico groundsel *(Senecio neomexicanus)*
Wright's deervetch *(Lotus wrightii)*

pineywoods geranium *(Geranium caespitosum)*
sweetclover vetch *(Vicia pulchella)*
manyflowered stoneseed *(Lithospermum multiflorum)*
grassleaf peavine *(Lathyrus graminifolius)*

Brief plant ID notes
Screwleaf muhly is a robust bunchgrass with spirally curled dead leaf sheaths; individual "clumps" commonly grow to 12 to 18 inches in diameter.

Synonymy
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*
trailing fleabane *(Erigeron flagellaris = E. nudiflorus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: +1 (cool, moist)
Climate class: LSC (low sun cold)

Phases
In the Gambel oak phase, Gambel oak occurs as a tree in most locations. Screwleaf muhly coverage may be poorly represented in the Gambel oak phase, and well represented in the screwleaf muhly phase.

Fire Ecology
Fires occur in this type with moderate frequency and are generally surface fires. Crowning is more likely if fuel ladders from dense pine regeneration or oak thickets exist. Swetnam & Dieterich (1985) found presettlement fire frequencies in the Gila Wilderness ranged from 1 to 22 years with mean fire intervals from 4 to 8 years.

Reforestation
Natural regeneration can be dense. Shelterwood and selection cutting practices usually provide reliable regeneration. Seed trees are also often successful at regenerating pine, and clear cuts may be reasonable in heavy mistletoe infected stands. Ponderosa pine seedling survival rates are generally moderate to high. The robust regeneration characteristic of this type characteristically results in random (not aggregated) tree

spatial patterns. Unless adequate seed trees are absent, this type seldom requires artificial regeneration following disturbances.

Revegetation considerations
Natural revegetation is usually rapid following disturbance.

Comments
Stands can be visually attractive ("parklike") with open yellow pines and grassy understories. Good summer range for elk and deer, but with low hiding cover. Bottlebrush squirreltail, Canada bluegrass *(Poa compressa),* and Rocky Mountain iris *(Iris missouriensis)* can increase under grazing.

Reference(s)
Alexander *et al.* 1987
Fitzhugh *et al.* 1987
Hanks *et al.* 1983
Mathiasen *et al.* 1987
Muldavin *et al.* 1996
Stuever 1995
Swetnam & Dieterich 1985
USFS 1986
USFS 1987b

PIPO/MUST-FEAR2

Ponderosa pine/screwleaf muhly-Arizona fescue

Pinus ponderosa/Muhlenbergia straminea-Festuca arizonica

(Formerly: Pinus ponderosa/Muhlenbergia viriscens-Festuca arizona PIPO/MUVI2-FEAR)

Code(s)
typic phase 0 11 39 0
blue grama (BOGR2) phase 0 11 39 1 Gambel oak (QUGA) phase 0 11 39 2

Ecological Response Unit
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Bunchgrass (PPG)

National Vegetation Classification Group
Southern Rocky Mountain Ponderosa Pine Open Woodland (G229)

Key criteria
A mesic ***ponderosa pine** site must have ***screwleaf muhly** and ***Arizona fescue**. Douglas-fir *(Pseudotsuga menziesii),* southwestern white pine *(Pinus strobiformis)*, and Utah juniper *(Juniperus osteosperma)* are absent or accidental.

Structure
This type is one of the most productive for timber and forage of the associations in the ponderosa pine series. Hanks *et. al.* 1983 reported an average basal area of 94.4 sq. ft./acre (21.7 sq. m./ha) for the typic phase, and 85 sq. ft./acre (19.7 sq. m./ha) for the Gambel oak phase.

Location
Central Arizona (generally north of the Mogollon Rim up to the San Francisco Peaks area), and southwestern New Mexico (Gila NF). 6,900’ - 9,200’ (2100 - 2800 m). Found on many slopes and aspects.

Important & key plants from research plots
Trees & life history status
typic phase:
ponderosa pine *(Pinus ponderosa)* C
blue grama phase:
ponderosa pine *(Pinus ponderosa)* C
twoneedle pinyon *(Pinus edulis)* c
alligator juniper *(Juniperus deppeana)* s
Gambel oak phase:
ponderosa pine *(Pinus ponderosa)* C
Gambel oak *(Quercus gambelii)* s
Shrubs
Poorly represented (<5%):
Gambel oak *(Quercus gambelii)* [other *Quercus* spp. in Southern AZ]
Fendler's ceanothus *(Ceanothus fendleri)*
pingue rubberweed *(Hymenoxys richardsonii)* [QUGA & BOGR2 phases]

Herbs
Abundant (>25%), especially grasses:
***screwleaf muhly** *(Muhlenbergia straminea)*
***Arizona fescue** *(Festuca arizonica)*
bottlebrush squirrel tail *(Elymus elymoides)*
pine dropseed *(Blepharoneuron tricholepis)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koelaria macrantha)*
sedges *(Carex spp.)*
white sagebrush *(Artemisia ludoviciana)*
New Mexico groundsel *(Senecio neomexicanus)*
common yarrow *(Achillea millefolium)*
small-leaf pussytoes *(Antennaria parvifolia)*
pineywoods geranium *(Geranium caespitosum)*
alpine false springparsley *(Pseudocymopterus montanus)*
manyflowered stoneseed *(Lithospermum multiflorum)*
grassleaf peavine *(Lathyrus graminifolius)*
New Mexico fleabane *(Erigeron neomexicanus)*
trailing fleabane *(Erigeron flagellaris)*
thistle *(Cirsium spp.)*

Synonymy
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
New Mexico fleabane *(Erigeron neomexicanus =Erigeron delphinifolius)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*
trailing fleabane *(Erigeron flagellaris = E. nudiflorus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: +1 (cool, moist)
Climate class: HSC (high sun cold)

Phases
The Gambel oak (QUGA) phase generally has much lower canopy coverage of screwleaf muhly and Arizona fescue. The blue grama (BOGR2) phase may be a secondary successional stage resulting from heavy grazing. This phase is probably much drier than the other phases of this plant association.

Fire ecology
Fires occur in this type with moderate frequency and are generally surface fires. Swetnam & Dieterich (1985) found presettlement fire frequencies in the Gila Wilderness ranged from 1 to 22 years with mean fire intervals from 4 to 8 years.

Reforestation
Natural regeneration can be dense. Shelterwood and selection cutting practices usually provide reliable regeneration. Seed tree cuts are also often successful at regenerating pine, and clear cuts may be reasonable in stands with heavy mistletoe. Planted ponderosa pine seedling survival rates are generally moderate to high.

Revegetation considerations
Natural revegetation is moderately rapid.

Comments
Arizona fescue has a low shade tolerance and will not be as strongly expressed when the overstory is a closed canopy, or Gambel oak is

poorly represented. The management implications for PIPO/MUST-FEAR2 are very similar to those for PIPO/FEAR2.

Reference(s)

Alexander *et al.* 1987
Fitzhugh *et al.* 1987
Hanks *et al.* 1983
Muldavin *et al.* 1996
Stuever 1995
Swetnam & Dieterich 1985
USFS 1986
USFS 1987b

Ponderosa pine/Stansbury cliffrose

(Formerly: ponderosa pine/cliffrose)

Pinus ponderosa/Purshia stansburiana

(Formerly: Pinus ponderosa/Cowania Mexicana PIPO/COME5*)*

Synonyms
Pinus ponderosa/Cowania mexicana
(USFS, 1987)
Pinus ponderosa/Cowania mexicana
community type (Hanks *et. al.*,1983)

Code(s)
typic phase 0 11 32 0

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Shrub (PPS)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
Must have ***Stansbury cliffrose** in the understory. White fir is absent or accidental, but occasional Douglas-fir may be present in the late successional overstory.

Structure
Site productivity for this association is generally low for timber and forage. Stockability = 1.

Location
Central and northern Arizona, local in central and northern New Mexico (Zuni Mountains, Jicarilla Apache Reservation); also in Utah, Colorado, Wyoming, and Idaho. Rough, rocky topography at warmer limits of ponderosa pine forests. Elevations: 6,700’ - 7,400’ (2,040 - 2,260 m). Usually on soils with sandstone-limestone parent materials. Mean annual precipitation (MAP) = 19-20”/yr.

Also see
Pinus ponderosa/Purshia tridentata (Johnston 1984, Youngblood and Mauk 1985).

Important & key plants from research plots
Trees & life history status
ponderosa pine *(Pinus ponderosa)* C
twoneedle pinyon *(Pinus edulis)* C
Utah juniper *(Juniperus osteosperma)* C
Douglas fir *(Pseudotsuga menziesii)* c
Rocky Mountain juniper *(Juniperus scopulorum)* c
Gambel oak *(Quercus gambelii)* s

Shrubs
Well represented (>5%):
***Stansbury cliffrose** *(Purshia stansburiana)*
antelope bitterbrush *(Purshia tridentata)*
Gambel oak *(Quercus gambelii)*
skunkbush sumac *(Rhus trilobata)*
banana yucca *(Yucca baccata)*
creeping barberry *(Mahonia repens)*

Herbs
Well represented (>5%):
mountain muhly *(Muhlenbergia montana)*
Arizona three-awn *(Aristida arizonica)*
muttongrass *(Poa fendleriana)*
pine dropseed *(Blepharoneuron tricholepis)*
little bluestem *(Schizachyrium scoparium)*
blue grama *(Bouteloua gracilis)*
bottlebrush squirreltail *(Elymus elymoides)*
redroot buckwheat *(Eriogonum racemosum)*
Douglas dustymaiden *(Chaenactis douglasii)*
Wright's deervetch *(Lotus wrightii)*
goldenrod *(Solidago* spp.)
pinewoods spiderwort *(Tradescantia pinetorum)*
hairy false goldenaster *(Heterotheca villosa var. villosa)*

Brief plant ID notes
Cliffrose *(Purshia stansburiana),* which recently has been known as *Cowania mexicana* and *Cowania stansburyiana* var. *mexicana,* can be confused with Apacheplume, but has sticky leaves and fewer achenes per seedhead. For hybridization among *Purshia*, see McArthur et. al. 1983.

Synonymy
Stansbury cliffrose = Mexican cliffrose *(Purshia stansburyiana = Cowania stansburyiana = C. mexicana)*
creeping barberry *(Mahonia repens = Berberis repens)*
little bluestem *(Schizachyrum scoparium = Andropogon scoparius)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
hairy false goldenaster *(Heterotheca villosa var. villosa = Chrysopsis villosa)*
Rocky Mountain juniper *(Juniperus scopulorm = J. s. var. columnaris)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: varied, often occurs in unusual topographic settings
Climate class: LSC (low sun cold)
HSC (high sun cold)

Phases
There is only one phase identified for this habitat type.

Fire ecology
Cliffrose resprouts poorly and most sprouts die within the first few years of a fire. Where a mosaic burn leaves mature cliffrose patches unburned, recolonization via seed can be rapid.

Reforestation
Natural regeneration is usually slow. Clearcuts and seed tree cuts do not generally come back to pine without planting. Planting success is low. Site preparation at low intensities may reduce shrub competition and improve pine seedling survival. Severe site disturbance is generally harmful to pine seedling success.

Revegetation considerations
Natural revegetation is slow. The lack of litter on site can reduce revegetation potential and promote erosion. Cliffrose can be revegetated by drilling seed, planting seedlings, or caching seeds in areas that can't be drilled such as areas with limestone rock outcroppings. Cliffrose growth is slow, but for long-term projects, cliffrose has a high potential of improving wildlife habitat and soil stabilization (Howard 1995 and Suminski, personal observation).

Comments
This association can provide important browse for wintering big game and has good potential for firewood production.

Decadent cliffrose stands that have grown out of reach of mule deer can be rejuvenated through manipulation. One method is the "soft push" which involves breaking decadent stems until theses lie on the ground. If the limb is still attached to the main stem, sprouting will occur along the limb. Layering is another more technical technique which is successful for creating more lower layer shrubs. (See Phillips 1987 for details on this technique.)

Reference(s)
Hanks *et al.* 1983
Howard 1995
McArthur *et al.* 1983
Phillips 1987
USFS 1987a
Youngblood & Mauk 1985

Ponderosa pine/Arizona white oak
Pinus ponderosa/Quercus arizonica

Code(s)
typic phase 0 11 41 0 blue grama phase 0 11 41 1

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Shrub (PPS)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
***Arizona white oak** *(Quercus arizonica)* is well represented (>5% canopy coverage). This is one of the warmest, driest ***ponderosa pine** environments. Gambel oak, silverleaf oak, and Emory oak are poorly represented or absent. Douglas-fir, white fir, southwestern white pine and rocky mountain juniper are absent or accidental.

Structure
This type generally has low productivity for timber. Site Index (Minor) = 60; Stockability = 0.8. Shrub browse is abundant, but forage rating values for cattle are less than 500 lbs./acre/year (low to none).

Location
South of the Mogollon Rim, in southwestern New Mexico and southern Arizona. More likely found in the Central Highlands, along the base of the Mogollon Rim and the Nantanes Plateau. Uncommon in the basin ranges and plateau regions of southern Arizona. On a wide range of soils and parent materials (see TES reports). 5,380’ to 7,750’ (1640 - 2360 m).

Adjacent plant associations
Upslope, this association may adjoin PSME/QUAR, PIPO/QUGA, or in the southern end of PIPO/QUAR’s distribution, PIPO/QUHY or PIPO/QURU4. Downslope, PIPO/QUAR adjoins PIPO/QUEM, PIPO/BOGR2, PIPO/ARPU, or even woodlands or grasslands.

Also see
See discussion under PIPO/QUEM for separating PIPO/QUAR from PIPO/QUEM. PIPO/QUGR3 described by Fitzhugh et. al. (1987) is perhaps indistinguishable. Vegetation subseries for the northern portions of the Tonto include PIPO-JUDE2-QUAR, PIPO-JUDE2-QUAR-ARPU5-ARPR, PIPO-JUDE2-QUAR-RONE-ARPR, PIPO-JUDE2-QUAR-ARPU5-ARPR, PIPO-PIMO-JUDE2-QUAR-QUTU2-ARPU5-ARPR, and PIPO-JUDE2-QUAR-ARPU5-COME(PUST) (on calcareous parent materials) and for the Clifton Ranger District (Apache NF) PIPOS-QUHY and PIPOS-PIED-QUHY (USFS 1986, 1987b). Mapping units (MUs) with these subseries are likely to contain the PIPO/QUAR habitat type. On the Globe RD, see MUs 5024, 5345, 5864, and 5865 where the PIPO-PIMO-JUDE2-QUAR-ARPU5 has been described (USFS 1987b).

Important & key plants from research plots
Trees & life history status
typic phase
ponderosa pine *(Pinus ponderosa)* C
alligator juniper *(Juniperus deppeana)* C
Arizona white oak *(Quercus arizonica)* S
Arizona pinyon *(Pinus fallax)* c
border pinyon *(Pinus discolor)* c
twoneedle pinyon *(Pinus edulis)* c
Emory oak *(Quercus emoryi)* s
blue grama phase
ponderosa pine *(Pinus ponderosa)* C
alligator juniper *(Juniperus deppeana)* C
Arizona pinyon *(Pinus fallax)* C
border pinyon *(Pinus discolor)* C
twoneedle pinyon *(Pinus edulis)* C
Arizona white oak *(Quercus arizonica)* S
Emory oak *(Quercus emoryi)* s

Shrubs
Common (>1%) to well represented (>5%) canopy coverage, depending on fire history:
Fendler's ceanothus *(Ceanothus fendleri)*
pointleaf manzanita *(Arctostaphylos pungens)*

Pringle manzanita *(Arctostaphylos pringlei)*
Schott's yucca *(Yucca x schottii)*
skunkbush sumac *(Rhus trilobata)*
catclaw mimosa *(Mimosa aculeaticarpa var. biuncifera)*
sacahuista *(Nolina microcarpa)*
Wright's silktassel *(Garrya wrightii)*
broom snakeweed *(Guiterrizia sarothae)*
shrubby forms oaks *(Quercus spp.)*
true mountain mahogany *(Cercocarpus montanus)*

Herbs
Common (>1%) or well represented (>5%) canopy coverage:
longtongue muhly *(Muhlenbergia longiligula)*
White Mountain sedge *(Carex geophila)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koeleria macrantha)*
bottlebrush squirreltail *(Elymus elymoides)*
Texas bluestem *(Schizachyrium cirratum)*
pinyon ricegrass *(Piptochaetium fimbriatum)*
dwarf stickpea *(Calliandra humilis)*
pineywoods geranium *(Geranium caespitosum)*
Wright's deervetch *(Lotus wrightii)*
aromatic false pennyroyal *(Hedeoma hyssopifolia)*
white sagebrush *(Artemisia ludoviciana)*
Carruth's sagewort *(Artemisia carruthii)*

Brief plant ID notes
Arizona white oak has light gray bark and dark green leaves. The underside of the leaf is matted with brownish yellow hairs. Arizona white oak and gray oak hybridize freely and may be difficult to separate along the Arizona-New Mexico border.

Synonymy
singleleaf pinyon (*Pinus monophylla = P. fallax = P. californiarum*)
aka Arizona pinyon
catclaw mimosa *(Mimosa aculeaticarpa var. biuncifera = M. biuncifera)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
border pinyon *(Pinus discolor = Pinus cembroides = Mexican pinyon)*

dwarf stickpea *(Calliandra humilis* var. *reticulata = C. reticulata)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
Texas bluestem *(Schizachyrium cirratum = Andropogon cirratus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry)
Climate class: HSM (high sun mild)
LSM (low sun mild)

Phases
The blue grama phase is drier than the typic phase, with a stronger expression of pinyon.

Fire ecology
Although fires may have been absent or infrequent in the past century, one study (Dieterich & Hibbert 1990) found a presettlement pattern of fires occurring on a 2-year average in a stand surrounded by chaparral on the Prescott National Forest. After a fire, oak sprouting is prolific and rapid. If manzanita is present in the stand, areas experiencing severe fires can establish a chaparral shrub community that may eventually return to a PIPO/ARPU community type.

Reforestation
After a disturbance, natural regeneration of ponderosa pine is generally slow due to competition with oak and juniper sprouting. Planting ponderosa pine has low success rates due to competition. Clearcutting and seed tree cutting methods favor oak and juniper. Selection and shelterwood cuts generally favor ponderosa pine if enough canopy is retained to suppress oak sprouting. Shelterwood cutting systems are the most commonly applied even-age harvesting plan for this type, and individual tree selection is the most successful uneven-aged management strategy for this type.

Revegetation considerations
Revegetation is rapid following disturbance due to oak and alligator juniper sprouting.

Comments
This plant association provides important cover, browse, and mast for deer and turkey. Firewood production can be a desirable objective in this type.

Gradient analysis on south-facing aspects near Mazatzal Peak have the following climatic features:

Elevation	MAAT	Summer	Winter	MAST	MAP
5,600	53.2	69.6	38.2	53.1	24.0
6,000	51.5	67.7	36.7	51.2	25.4

MAAT = Mean Annual Air Temperature, degrees Fahrenheit
MAST = Mean Annual Soil Temperature, degrees Fahrenheit
MAP = Mean Annual Precipitation, inches

Reference(s):
Dieterich & Hibbert 1990
Muldavin *et al.* 1996
Stuever 1995
USFS 1987b

Ponderosa pine/Emory oak
Pinus ponderosa/Quercus emoryi

Code(s)
typic phase 0 11 44 0

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Shrub (PPS)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
***Emory oak** is well represented (>5% canopy coverage). Located primarily in drainages and lower slopes. Gambel oak and silverleaf oak are absent or poorly represented. Rocky Mountain juniper *(J. scopulorum)* is absent or accidental.

Structure
Site productivity is low, except where this type occurs on alluvial benches where soils are deeper and have higher available soil moisture. Forage is primarily limited to oak browse. Firewood potential is good. Example ponderosa pine site index (Minor) = 60. Stockability = 0.8.

Location
This plant association occurs south of the Mogollon Rim, in southwestern New Mexico, and southern Arizona. It is more likely found in the Central Highlands, along the base of the Mogollon Rim and the Nantanes Plateau, and it is uncommon in the basin ranges and plateau regions of southern Arizona. Found most commonly on mid to lower slopes and ravine bottoms, PIPO/QUEM is most differentiated along drainages with granitic soils (Udic Ustochrepts). Elevation: 5300’ -6900’ (1615-2100 m). Mean annual precipitation (MAP) = 20-22”/yr (50-56 cm/yr).

Adjacent plant associations
PIPO/QUEM is generally found in lower landscape positions than PIPO/QUAR. On drier sites with high fire frequencies, PIPO/QUEM

may adjoin PIPO/ARPU. On the lower end, PIPO/QUEM grades to Emory oak woodlands or manzanita or mahogany chaparral.

Also see
PIPO/QUAR is very similar. PIPO/QUEM is well expressed in drainages and in these settings is distinct from PIPO/QUAR. In upland settings, this distinction is not clear. Muldavin *et. al.* (1996) distinguishes PIPO/QUEM by Emory oak being well represented (in mature stands), whereas in PIPO/QUAR this oak is poorly represented. With this criteria, PIPO/QUEM appears to be a weakly differentiated association somewhat hotter and drier than PIPO/QUAR. To avoid confusion between these two different descriptions for PIPO/QUEM, generally upland stands should be called PIPO/QUAR, and lower slope and drainage stands with Emory oak identified as PIPO/QUEM. This call should be made in the field, as special conditions could warrant naming an upland site PIPO/QUEM.

Mapping unit 5351 near Payson, AZ contains examples of PIPO/QUEM described within the PIPO-PIMO-JUDE2-QUAR-QUTU2-ARPU5 subseries (USFA Forest Service 1984).

Important & key plants from research plots
Trees & life history status
ponderosa pine *(Pinus ponderosa)* C
alligator juniper *(Juniperus deppeana)* C
Emory oak *(Quercus emoryi)* S
Arizona pinyon *(Pinus fallax)* c
border pinyon *(Pinus discolor)* c
Arizona white oak *(Quercus arizonica)* s
Utah juniper *(Juniperus osteosperma)* s

Shrubs
Common (>1%) to well represented (>5%) canopy coverage, depending on fire history (Same list as PIPO/QUAR):
Fendler's ceanothus *(Ceanothus fendleri)*
pointleaf manzanita *(Arctostaphylos pungens)*
Pringle manzanita *(Arctostaphylos pringlei)*
Schott's yucca *(Yucca x schottii)*
skunkbush sumac *(Rhus trilobata)*
catclaw mimosa *(Mimosa aculeaticarpa var. biuncifera)*

sacahuista *(Nolina microcarpa)*
Wright's silktassel *(Garrya wrightii)*
broom snakeweed *(Guiterrizia sarothae)*
shrubby forms oaks *(Quercus spp*.)
true mountain mahogany *(Cercocarpus montanus)*

Herbs
Scarce (1%) or common (>1%). (Same species as PIPO/QUAR.)
longtongue muhly *(Muhlenbergia longiligula)*
White Mountain sedge *(Carex geophila)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koeleria macrantha)*
bottlebrush squirreltail *(Elymus elymoides)*
Texas bluestem *(Schizachyrium cirratum)*
pinyon ricegrass *(Piptochaetium fimbriatum)*
dwarf stickpea *(Calliandra humilis)*
pineywoods geranium *(Geranium caespitosum)*
Wright's deervetch *(Lotus wrightii),*
aromatic false pennyroyal *(Hedeoma hyssopifolia)*
white sagebrush *(Artemisia ludoviciana)*
Carruth's sagewort *(Artemisia carruthii)*

Brief plant ID notes
Emory oak has dark brown to black bark and leaves are a shiny bright green. Matted hairs are often concentrated at the base of the leaf undersides.

Synonymy
singleleaf pinyon (*Pinus monophylla = P. fallax = P. californiarum*)
aka Arizona pinyon
catclaw mimosa *(Mimosa aculeaticarpa var. biuncifera = M. biuncifera)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
border pinyon *(Pinus discolor = Pinus cembroides = Mexican pinyon)*
dwarf stickpea *(Calliandra humilis var. reticulata = C. reticulata)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
Texas bluestem *(Schizachyrium cirratum = Andropogon cirratus)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry)
Climate class: LSM (low sun mild)

Phases
There is only one phase identified for this habitat type. There is a noticeable difference in tree stature, however, between sites on shallow, skeletal soils and sites on dry, alluvial benches of riparian zones.

Fire ecology
Fire ecology is probably quite similar to PIPO/QUAR. Oak sprouting may be prolific and rapid after a fire. If manzanita is present in the stand, areas experiencing severe fires can establish a chaparral shrub community that may eventually become a PIPO/ARPU community type.

Reforestation
After a disturbance, natural regeneration of ponderosa pine is generally slow and survival rates of planted pine are generally low due to competition with oak sprouting. Clearcutting and seed tree cutting methods favor oak. Selection and shelterwood cuts generally favor ponderosa pine if enough canopy is retained to suppress oak sprouting. Shelterwood cutting systems are the most commonly applied even-age harvesting plan, and individual tree selection is the most successful uneven-aged management strategy for this type. Occasionally, thickets of pine will develop in this association, which generally respond to thinning for increased timber yield.

Revegetation considerations
Natural revegetation is usually rapid due to oak sprouting.

Comments
Often important for turkey roost areas in a generally woodland environment. Firewood production is important since *Q. emoryi* is a preferred fuel. Severe infestations of dwarf mistletoe have been observed in this plant association.

Reference(s)
Muldavin *et al.* 1996
Stuever 1995
USFS 1987b

Ponderosa pine/Gambel oak
Pinus ponderosa/Quercus gambelii

Synonyms
Pinus ponderosa/Poa fendleriana c.t. (Hanks, *et.al.* 1983)

Code(s)
Gambel oak (QUGA) phase 0 11 21 0
Arizona fescue (FEAR2) phase 0 11 21 1
longtongue muhly (MULO) phase 0 11 21 2
twoneedle pinyon (PIED) phase 0 11 21 3
mountain muhly (MUMO) phase 0 11 21 4
blue grama (BOGR2) phase 0 11 21 5
New Mexico locust (RONE) phase 0 11 21 6

Ecological Response Unit
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Gamble Oak (PPO)

National Vegetation Classification Group
Southern Rocky Mountain Ponderosa Pine Open Woodland (G229)

Key criteria
Must have at least 5% cover of ***Gambel oak.** Overstory regeneration is ponderosa pine. Douglas-fir *(Pseudotsuga menzensii)* is absent or accidental.

Structure
Generally, timber productivity is low to high in this widely diverse plant association. In one study (reported in USFS 1987) on 56 research plots, the ponderosa pine site index was 58 +/- 10. Mathiesan *et al.* (1987) in a separate study found a mean site index of 82.3 +/-15.1 from 135 stands. Stockability = 1. Stand structure can be dense locally. Forage rating values are low to moderate in early seral stages, decreasing with canopy closure.

Location
Widespread and common throughout New Mexico, Arizona, Colorado and Utah. Elevations range from 6,000’ - 9,200’ (1,830 - 2,800 m) on a

wide variety of slopes, landforms, and soils. Mean annual precipitation (MAP) = 20-22"/year.

Adjacent plant associations
PIPO/QUGA often forms mosaics with the PIPO/bunchgrass habitat types, with PIPO/QUGA occurring on the rockier microsites and the grassy types dominating sites with deeper soils. PIPO/QUGA may adjoin ABCO/QUGA or PSME/QUGA on wetter sites. On the dry end, PIPO/QUGA may adjoin pinyon/juniper woodlands.

Also see
In Arizona, Gambel oak can become a midstory tree with abundant or luxuriant herbs beneath. This has been described as Gambel oak phases of PIPO/FEAR2 and PIPO/BOGR2 by Hanks *et. al.* (1983). Various grasses phases of PIPO/QUGA typically consist of mosaics of oaks and grasses in patchy distribution.

This is a very broadly defined association, doubtless needing refinement. See TES reports and mapping units within PIPO/QUGA and PIPO-PIED-JUDE2-JUMO-QUGA subseries. In southern Utah, Youngblood and Mauk reported some aspen in these sites.

In the southern Guadalupe Mountains of the Lincoln National Forest, a similar plant association is PIPO/QUMO. See "Also see" section of PIPO/QUPA4 for more details.

Important & key plants from research plots
Trees & life history status
Gambel oak and Arizona fescue phases
ponderosa pine *(Pinus ponderosa)* C
Gambel oak *(Quercus gambelii)* S
Rocky Mountain juniper *(Juniperus scopulorum)* c
twoneedle pinyon *(Pinus edulis)* a
twoneedle pinyon phase
ponderosa pine *(Pinus ponderosa)* C
twoneedle pinyon *(Pinus edulis)* C
Gambel oak *(Quercus gambelii)* S
Rocky Mountain juniper *(Juniperus scopulorum)* c
Utah juniper *(Juniperus osteosperma)* c
oneseed juniper *(Juniperus monosperma)* c

longtongue muhly and blue grama phases
ponderosa pine *(Pinus ponderosa)* C
alligator juniper *(Juniperus deppeana)* C
Gambel oak *(Quercus gambelii)* S
twoneedle pinyon *(Pinus edulis)* c
Utah juniper *(Juniperus osteosperma)* s

Shrubs
Well represented (>5%) to abundant (>25%):
Gambel oak *(Quercus gambelii) [>5%]
mountain snowberry *(Symphoricarpos oreophilus)*
wild rose *(Rosa spp*.)
New Mexico locust *(Robinia neomexicana)*
true mountain mahogany *(Cercocarpus montanus),*
creeping barberry *(Mahonia repens)*
Fendler's ceanothus *(Ceanothus fendleri)*
small soapweed *(Yucca glauca)*
skunkbush sumac *(Rhus trilobata)*
Stansbury cliffrose *(Purshia stansburiana)* [<5%]

Herbs
Well represented (>5%):
muttongrass *(Poa fendleriana)*
White Mountain sedge *(Carex geophila)*
Ross' sedge *(Carex rossii)*
mountain muhly *(Muhlenbergia montana)*
longtongue muhly *(Muhlenbergia longiligula)*
Arizona fescue *(Festuca arizonica)* [>1% in FEAR2 phase]
prairie junegrass *(Koelaria macrantha)*
bottlebrush squirrel tail *(Elymus elymoides)*
fringed brome *(Bromus ciliatus)*
little bluestem *(Schizachyrium scoparium)*
blue grama *(Bouteloua gracilis)* [BOGR2 phase]
Kentucky bluegrass *(Poa pratensis)* [FEAR2 phase]
American vetch *(Vicia americana)*
common yarrow *(Achillea millefolium)*
white sagebrush *(Artemisia ludoviciana)*
Carruth's sagewort *(Artemisia carruthii)*
western brackenfern *(Pteridium aquilinum)* [FEAR2 phase]

Wright's deervetch *(Lotus wrightii)*
hairy false goldenaster *(Heterotheca villosa var. villosa)*
small-leaf pussytoes *(Antennaria parvifolia)*
Fendler's meadow-rue *(Thalictrum fendleri)*

Brief plant ID notes
Gambel oak is a deciduous oak with deeply lobed, prickle "free" leaves. At lower elevations, it may cross with other oaks, making definitive identifications difficult.

Synonymy
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
little bluestem *(Schizachyrium scoparium = Andropogon scoparius)*
hairy false goldenaster *(Heterotheca villosa var. villosa = Chrysopsis villosa)*
Rocky Mountain juniper *(Juniperus scopulorm = J. s. var. columnaris)*
creeping barberry *(Mahonia repens = Berberis repens)*
Stansbury cliffrose = Mexican cliffrose *(Purshia stansburyiana = Cowania stansburyiana = C. mexicana)*
fringed brome *(Bromus ciliata* var. *ciliata = B. canadensis* = Canadian brome *(aka B. richardsonii)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
white sagebrush = Louisiana sagewort

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone:
+1 (cool, moist) for QUGA & FEAR2 phases
0 (typic) for QUGA, FEAR2 & MUMO phases
-1 (warm, dry) for PIED, MULO, & BOGR2 phases
Climate class: LSC (low sun cold)
HSC (high sun cold)

Phases
Arizona fescue is present, and usually common in the FEAR2 phase. Longtongue muhly is present in the MULO phase and occurs primarily on Gila National Forest. In the QUGA phase, Gambel oak is usually greater than 10%, Arizona fescue and pinyon are scarce (<1%), and longtongue muhly is absent. Twoneedle pinyon is at least common

(>1%) in the PIED phase. Alexander *et. al.* 1987 also describes a SCSC (little bluestem) phase on rocky sites in the Cibola National Forest. The New Mexico locust often replaces or grows with oak in the shrub understory in the RONE phase.

Fire Ecology
The Gambel oak component can be highly affected by fire. This type today, in areas where fires have been excluded for 100+ years, are probably very different from stands that encountered a frequent fire regime. After an initial fire, shrubby Gambel oak can resprout prolificly establishing thick brush fields. Large Gambel oak trees are less likely to resprout. Repeated annual burns can inhibit Gambel oak regeneration. Oak response will vary depending on fuel conditions, fire intensity, and seasonality of the fire (Tirmenstein 1988).

Reforestation
In the Gambel oak phase (also often in other phases), clearcuts typically convert to oak woodlands. Seed tree cuts also favor oak over pine. Shelterwood cuttings systems are most successful for even-age pine management when ample pine canopy remains to suppress oaks. The individual tree selection method is generally successful for pine regeneration, especially in mistletoe free stands. Group selection cutting often results in sparse ponderosa pine regeneration due to oak competition. Regeneration patterns and species composition responses to disturbance can be highly variable for this type, due to the influence of differing soil parent materials.

In other phases, group selection may be an option.

Expect low survival for planted seedling. Plant projects may call for tighter spacing and locating seedlings in the interspaces between oak clumps.

Revegetation Considerations
Natural revegetation is rapid due to oak and, often, locust regeneration.

Comments
Surface water may be limiting for livestock and big game use in this type. Large Gambel oak, grown under open conditions, may be especially important for several wildlife species, including turkey. Oak

sprouts provide good forage for some wildlife species including mule deer.

Reference(s)

Alexander *et al.* 1988
Alexander *et al.* 1984
DeVelice *et al.* 1986
Fitzhugh *et al.* 1987
Hanks *et al.* 1983
Mathiasen *et al.* 1987
Tirmenstein 1988b
USFS 1987a
USFS 1987b
USFS 1986

Ponderosa pine/Gray oak
Pinus ponderosa/Quercus grisea

Code(s)
mountain muhly (MUMO) phase 0 11 36 0 longtongue muhly (MULO) phase 0 11 36 1

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Shrub (PPS)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
Oaks must be well represented (>5%). Must have at least 1% cover of ***gray oak**, but gray oak must be the dominant oak. Gambel oak, if present, is clearly minor in abundance to gray oak. Southwestern white pine and Douglas-fir are absent or accidental. These grasses are absent or accidental: Arizona fescue, pine muhly, bullgrass, and pinyon ricegrass.

Structure
This is a generally poor habitat type for ponderosa pine fiber production (<50 cu. ft./acre/year). Stocking is generally below commercial forest land (stockability = 0.6), and the average site index is 47 (ponderosa pine, Minor). Early seral stages may provide moderate forage for cattle, with forage value lessening at later seral stages.

Location
In central New Mexico and and east-central Arizona: on Apache-Sitgreaves National Forests (Clifton and Alpine ranger districts) - Big Lue, Blue Mtns, AZ; on the Gila National Forest (Luna, Reserve, Mimbres, and Quemado ranger districts) - Blue Mtns., NM, Saliz Mts, San Francisco Mtns, Mogollon Mtns, Black Range, NM, Tularosa Mtns, NM; on the Cibola National Forest (Magdalena and Mountainair ranger districts) - San Mateo, Gallinas Mtns. NM, also in Organ Mtns, NM. Frequently on slopes and ridgetops, often on shallow soils and rocky outcrops. Also found on deep soils of alluvial terraces and valley plains.

Elevation: 6,100-8,800’ (1,860-2,680 m), at upper elevations on south or west slopes); Mean annual precip. = 19-21”/yr.

Adjacent plant associations
Generally, this plant association is adjacent to wetter ponderosa pine and Douglas-fir associations. Riparian canyon bottoms adjacent to this type often support the PIPU/EREX4 h.t., with a narrow band of PIPO/QUGA h.t. between it and PIPO/QUGR3 h.t. (Fitzhugh *et. al.* 1987).

Also see
PIPO/QUPA4, PIPO/BOGR2 (where gray oak is <5% cover)

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry)
Climate class: HSM (high sun mild)

Important & key plants from research plots
Trees & life history status
mountain muhly phase:
ponderosa pine *(Pinus ponderosa)* C
gray oak *(Quercus grisea)* S
twoneedle pinyon *(Pinus edulis)* c
alligator juniper *(Juniperus deppeana)* s
longtongue muhly phase:
ponderosa pine *(Pinus ponderosa)* C
alligator juniper *(Juniperus deppeana)* S
gray oak *(Quercus grisea)* S
twoneedle pinyon *(Pinus edulis)* c

Shrubs
Well represented (>5%):
gray oak *(Quercus grisea)*
true mountain mahogany *(Cercocarpus montanus)*
Fendler’s ceanothus *(Ceanothus fendleri)*
waxcurrant *(Ribes cereum)*
banana yucca *(Yucca baccata)*
pingue rubberweed *(Hymenoxys richardsonii)*
broom snakeweed *(Gutierrezia sarothrae)*

Herbs
Well represented (>5%) to abundant (>25%):
pine dropseed *(Blepharoneuron tricholepis)*
blue grama *(Bouteloua gracilis)*
sideoats grama *(Bouteloua curtipendula)*
nodding brome *(Bromus anomalous)*
White Mountain sedge *(Carex geophila)*
prairie junegrass *(Koelaria macrantha)*
longtongue muhly *(Muhlenbergia longiligula)*
mountain muhly *(Muhlenbergia montana)*
screwleaf muhly *(Muhlenbergia straminea)*
muttongrass *(Poa fendleriana)*
bottlebrush squirrel tail *(Elymus elymoides)*
white sagebrush *(Artemisia ludoviciana)*
trailing fleabane *(Erigeron flagellaris)*
Wright's deervetch *(Lotus wrightii)*
winged buckwheat *(Eriogonum alatum)*
New Mexico groundsel *(Senecio neomexicanus)*

Brief plant ID notes
Gray oak is difficult to distinguish from Arizona white oak. In future treatment, these oaks may be combined into one species. Generally, they have different habitats, with Arizona white being a "below the Mogollon Rim" species. Arizona white oak declines rapidly from the Arizona/New Mexico border eastward, and gray oak increases. Gray oak has stalked acorns and generally darker bark.

Synonymy
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
nodding brome *(Bromus anomalus = B. porteri)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*
trailing fleabane *(Erigeron flagellaris = E. nudiflorus)*

Phases
The longtongue muhly phase is found on the Gila and Apache-Sitgreaves National Forests, and adjacent Fort Apache Indian Reservation. The mountain muhly phase is slightly north in the San

Mateo and Mogollon Mtns. If both muhlys are present, the dominant muhly determines the phase.

Fire Ecology
Oak resprouting can be prolific following fire. Fire ecology may be similar to PIPO/QUAR.

Reforestation
Clearcut and seed tree cutting methods result in a strong oak response which suppresses ponderosa pine regeneration. Shelterwood cutting systems usually favor ponderosa pine, and individual tree selection cutting system also favors conifers in the stand when adequate shade suppresses oak regeneration. Group selection cutting favors a strong oak response. Ponderosa pine can be planted on these sites; however, survival rates have been low. High and moderate levels of mechanical site preparation can set back the oaks for higher survival rates for planted ponderosa pine seedlings.

Revegetation considerations
Natural revegetation after disturbance is fairly rapid due to oak and alligator juniper sprouting.

Comments
Thinning is generally not needed, although in heavily grazed areas, alligator juniper can acquire high densities and thinning juniper regeneration will enhance pine regeneration. This plant association can be a major source for firewood, although firewood productivity can vary on different soils (see TES reports for specific information on productivity). These stands may provide important wildlife winter range. Mixture of old yellow pine and oaks can provide good visual quality along roads.

Reference(s)
Dick-Peddie and Moir 1970
Fitzhugh *et. al.* 1987
USFS 198

Ponderosa pine/Silverleaf oak
Pinus ponderosa/Quercus hypoleucoides

Code(s)
typic phase 0 11 22 0

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Shrub (PPS)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
***Silverleaf oak** *(Quercus hypoleucoides)* is well represented (>5%).

***Ponderosa pine** is the dominant overstory species, and Douglas-fir *(Pseudotsuga menziesii)* and white fir *(Abies concolor)* are absent or accidental.

Structure
Pine overstory may vary from scattered to open to occasionally dense (stockability = 0.8). Timber productivity for this type is generally low. One measured value of site index for pine for this type was 65. Forage for cattle is moderate with early seral sites, decreasing as pine and oak cover dominate the site.

Location
A major plant association in southeastern Arizona, including the following geographic areas: Chiricahua, Pinaleno, Santa Rita, Santa Catalina, Huachuca and the Galiuro Mountains, with outliers to San Carlos and Ft. Apache Reservation, and in New Mexico, to the Brushy Mountains on the Glenwood Ranger District (Gila NF). Elevations generally 5,700’ - 8,000’ (1,740 -2,440 m) but can be outside this range on special topographic sites.

Adjacent plant associations
As temperatures decrease, Gambel oak and netleaf oak gain dominance over silverleaf oak and the association will shift to PIPO/QUGA or PIPO/QURU4. With increases in temperature, the shift will be to PIPO/QUAR or PIPO/QUEM, or in southern Arizona, possibly plant associations in the Chihuahua or Apache pine series.

Also see
PSME/QUHY if Douglas-fir exceeds about 10 trees/acre in mature stands. Vegetation subseries PIPO-PIED-JUDE2-QUGR3-QUHY on the Glenwood RD [TES mapping units 5906, 5911, 5912, where mean annual precip. is reported at 21 in/year (53 cm/year)] USFS 1985. Described by Niering and Lowe (1984) as ponderosa pine oak forest between 2,100-2,450 M on southern slopes of the Santa Catalina Mountains.

Important & key plants from research plots
Trees & life history status
ponderosa pine *(Pinus ponderosa)* C
silverleaf oak *(Quercus hypoleucoides)* S
alligator juniper *(Juniperus deppeana)* S
southwestern white pine *(P. strobiformis)* c
Gambel oak *(Quercus gambelii)* s
border pinyon *(Pinus discolor)* s

Shrubs
Well represented (>5%) canopy coverage:
shrubby forms of oaks (mostly silverleaf, netleaf, and Arizona white oak)
skunkbush sumac *(Rhus trilobata)*
sacahuista *(Nolina microcarpa)*
Schott's yucca *(Yucca x schottii)*
Fendler's ceanothus*(Ceanothus fendleri)*
Arizona madrone *(Arbutus arizonica)*

Herbs
Common (>1%) or well represented (>5%) canopy coverage:
longtongue muhly *(Muhlenbergia longiligula)*
screwleaf muhly *(Muhlenbergia straminea)*
single threeawn *(Aristida orcuttiana)*

muttongrass *(Poa fendleriana)*
White Mountain sedge *(Carex geophila)*
prairie junegrass *(Koeleria macrantha)*
aromatic false pennyroyal *(Hedeoma hyssopifolia)*
Fendler's meadow-rue *(Thalictrum fendleri)*
alpine false springparsley *(Pseudocymopterus montanus)*
Mexican bedstraw *(Galium mexican ssp. asperrimum)*
Fendler's bedstraw *(Galium fendleri)*

Brief plant ID notes
The lance shaped leaves of silverleaf oak are dark green on top and woolly white underneath. The rolled margins of the leaves are entire and rarely have lobes, as silverleaf oak is less likely to hybridize than other southwestern oaks.

Synonymy
Mexican bedstraw *(Galium mexicanum ssp. asperrimum = Galium asperrimum)*
border pinyon *(Pinus discolor = Pinus cembroides = Mexican pinyon)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: 0 (typic)
Climate class: HSM (high sun mild)

Fire ecology
Oak sprouting is prolific and rapid after a fire. If manzanita is present in the stand, severe fires may eventually return to a PIPO/ARPU community type.

Reforestation
Seed tree and clearcut harvesting methods favor oak, and pine regeneration is difficult. Individual tree selection and shelterwood systems are generally more appropriate in this type. Group selection cutting favors oak regeneration. Ponderosa pine has been planted in this type with moderate success. Site preparation (burning or mechanical) favors grass and oak over pine. Occasionally, dense stands of

precommercial saplings and poles can dominate this type, or pine saplings may benefit from oak release.

Revegetation considerations
Natural revegetation is generally rapid following disturbances due to oak resprouting.

Comments
Large diameter oaks, which are important for cavity nesting birds, cannot be reliably produced with overhead shade from pine trees. Although cover is abundant, generally this type is scarce on water and forage for wildlife. This habitat type has been important for deer and turkey and can also be important for firewood production.

Climatic gradients from the Santa Catalina Mountains, near Tucson, AZ suggest the following mean annual precipitation (MAP) and mean annual soil temperature (MAST) based on linear regression between weather stations:

Elevation/Aspect	MAP (inches/year)	MAST (F)
7,000/N	26.7	48
6,750/N	25.8	49
7,000/S	26.7	50
6,500/S	25.0	52

Reference(s)
Muldavin *et. al.* 1991
Niering & Lowe 1984
Stuever 1995
USFS 1987b

Ponderosa pine/wavyleaf oak
Pinus ponderosa/Quercus X pauciloba
(Formerly: Pinus ponderosa/Quercus undulata)

Code(s)
typic phase 0 11 37 0

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Shrub (PPS)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
This ponderosa pine dominated plant association must have at least 5% cover of oak, with at least 1% cover of ***wavyleaf oak.** Gray oak is scarce or absent, and Gambel oak, if present, is less dominant than wavyleaf oak.

Structure
Due to hot, dry environmental conditions, timber productivity is low. Example site index for ponderosa pine (Minor) = 47, although site productivity on the Mescalero Apache Reservation in south central New Mexico may be higher than this limited site index information indicates. Stockability = 0.8.

Location
Widespread in southern (Sacramento Mountains, Lincoln NF and Mescalero Apache Reservation) and central to northeastern New Mexico. Found locally in other reaches of northern New Mexico. 6,500' - 8,200' (2,000-2,500 m) on hot, dry sites. Surface rock cover can be high [averaging 27% in one study (DeVelice, 1986)]. Mean annual precipitation = 20-21"/year, with hot and dry weather in May and June.

Adjacent plant associations
On hotter, drier sites, adjoins pinyon-juniper woodlands. On cooler sites, intergrades with the warm, dry end of PIPO/QUGA.

Also see
PIPO/QUGA in warmer sites may have a minor cover of wavyleaf oak. PIPO/QUGR3. Alexander et. al. (1984) describe three phases of PIPO/QUUN(PIPO/QUPA4) based priomarily upon grass dominance in late succession stands. In the southern Guadalupe Mountains of New Mexico and Texas, a *Pinus ponderosa/Quercus mohriana* (ponderosa pine/Mohr oak) occurs on northern aspects between 6,000' and 7,000' (1,850 - 2,150 m). The overstory includes ponderosa pine (C), alligator juniper (C), Rocky Mountain juniper (c), twoneedle pinyon (c), Douglas-fir (s), and Texas madrone (a). Shrubs include Mohr oak, sacahuista, skunkbush sumac, and mountain mahogany [TES mapping unit 256, Lincoln NF Dark Canyon EMA (Escobedo 1995)].

Important & key plants from research plots
Trees & life history status
ponderosa pine *(Pinus ponderosa)* C
twoneedle pinyon *(Pinus edulis)* S
alligator juniper *(Juniperus deppeana)* S
Rocky mountain juniper *(Juniperus scopulorum)* c
oneseed juniper *(Juniperus monosperma)* s

Shrubs
Well represented (>5%):
wavyleaf oak *(Quercus* X *pauciloba) [>5%]
skunkbush sumac *(Rhus trilobata)*
true mountain mahogany *(Cercocarpus montanus)*
species of *Yucca*, and cacti *(Opuntia & Echinocereus)*

Herbs
Well represented (>5%):
pine muhly *(Muhlenbergia dubia)* [s. NM]
mountain muhly *(Muhlenbergia montana)*
sideoats grama *(Bouteloua curtipendula)*
blue grama *(Bouteloua gracilis)*
big bluestem *(Andropogon gerardii)*
pinyon ricegrass *(Piptochaetium fimbriatum)*
Arizona threeawn *(Aristida arizonica)*
common wolfstail *(Lycurus phleoides)*
little bluestem *(Schizachyrium scoparium)*

white sagebrush *(Artemisia ludoviciana)*
manyflowered stoneseed *(Lithospermum multiflorum)*
pineywoods geranium *(Geranium caespitosum)*
hairy false goldenaster *(Heterotheca villosa var.villosa)*

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

Synonymy
little bluestem *(Schizachyrium scoparium = Andropogon scoparius)*
hairy false goldenaster *(Heterotheca villosa var. villosa = Chrysopsis villosa)*
Quercus x pauciloba = Q. undulata
Rocky Mountain juniper *(Juniperus scopulorm = J. s. var. columnaris)*
wavyleaf oak *(Quercus X pauciloba = Q. undulata)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry)
Climate class: HSC (high sun cold)

Phases
No phases have been described for this type.

Fire ecology
Fire history similar to PSME/QUPA4 plant association. Fire frequency was probably 2-5 years prior to 1900, and then as surface fires carried by dry oaks and herbaceous fuels, seldom crowning. With dense oak and pine thickets and well-developed oak understories common in this type now, ample fuel ladders exist for frequent crowning and hot, intense fires.

Reforestation
Natural regeneration is slow due to competition with oaks. Clearcut and seed tree harvesting systems favor oak. Selection and shelterwood cuts can favor pine regeneration when remaining overstory canopy is sufficient to suppress oak regeneration. Planted pine seedlings generally have low survival rates. Prescribed burning stimulates oak. Mechanical site preparation at moderate and high rates may reduce oak competition sufficiently to improve pine seedling survival.

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 (DeVelice *et. al.* 1986).

Reference(s)
DeVelice *et al.* 1986
Huckaby and Brown 1996
USFS 1987a
USFS 1986

Ponderosa pine/netleaf oak
Pinus ponderosa/Quercus rugosa

Code(s)
typic phase 0 11 43 0

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Shrub (PPS)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
***Netleaf oak** is well represented, or if poorly represented, oaks are well represented and netleaf oak is the dominant species of oak. This association deviates from the typical series rule as Douglas-fir and southwestern white pine can be minor in the stand at climax.
***Ponderosa pine** is still the dominant overstory species. White fir is absent or accidental.

Structure
The average site index for ponderosa pine (Minor) is 55. Stand stockability = 0.7. Forage value rating for cattle is low (250-500 lbs./acre/year in early seral stages, to none (<250 lbs/acre/year) in late seral stages. Forage for wildlife is limited to oak browsing.

Location
Mostly found in southeastern Arizona and southwestern New Mexico (Animas Mtns, with outliers in the Mogollon Mtns near Glenwood). This is the highest elevational type of the ponderosa pine plant associations with an evergreen oak understory. Generally, on steep, upper slopes or ridgetops with shallow rocky soils with rocky outcrops. Elevation: 5,200’ - 8,800’ (1,590 - 2,700 m).

Adjacent plant associations
As elevation decreases or temperature increases, shifts to PIPO/QUHY. In contrast, with cooler conditions PIPO/QURU4 usually adjoins PSME/QUHY, QURU4 phase, PIPO/QUGA, or PIPO/MUST h.t.s.

Also see
Douglas-fir is the dominant tree at late succession in PSME/QUHY, QURU4 phase.

Important & key plants from research plots
Trees & life history status
ponderosa pine *(Pinus ponderosa)* C
Arizona pine *(Pinus arizonica)* C
netleaf oak *(Quercus rugosa)* S
silverleaf oak *(Quercus hypoleucoides)* S
southwestern white pine *(Pinus strobiformis)* c
border pinyon *(Pinus discolor)* c
Douglas fir *(Pseudotsuga menzensii)* c
alligator juniper *(Juniperus deppeana)* c
Gambel oak *(Quercus gambelii)* s
Arizona white oak *(Quercus arizonica)* s

Shrubs
Abundant (>25%) mostly shrubby oaks:
netleaf oak *(Quercus rugosa)
silverleaf oak *(Quercus hypoleucoides)*
Gambel oak *(Quercus gambelii)*
skunkbush sumac *(Rhus trilobata)*
Parry's agave *(Agave parryi)*
sacahuista *(Nolina microcarpa)*

Herbs
Poorly represented (<5%) to scarce (<1%):
muttongrass *(Poa fendleriana)*
screwleaf muhly *(Muhlenbergia straminea)*
longtongue muhly *(Muhlenbergia longiligula)*
single threeawn *(Aristida orcuttiana)*
prairie junegrass *(Koeleria macrantha)*
White Mountain sedge *(Carex geophila)*
aromatic false pennyroyal *(Hedeoma hyssopifolia)*
pineywoods geranium
(Geranium caespitosum)
Fendler's meadow-rue *(Thalictrum fendleri)*

Brief plant ID notes
The leaves of netleaf oak have a three dimensional appearance with the margins rolled under. The upper leaf veins are sunken on the dark green leaf surfaces. The mild leaf lobes end in small spiny teeth.

Synonymy
Arizona pine *(Pinus arizonica = P. ponderosa* var. *arizonica)*
border pinyon *(Pinus discolor = Pinus cembroides = Mexican pinyon)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa) or 6 (mixed conifer)
Elevational Subzone: +1 (cool, mesic) -1 (warm, dry)
Climate class: HSM (high sun mild)

Fire ecology
Oak sprouting is prolific and rapid after a fire. If manzanita is present in the stand, severe fires may eventually return to a PIPO/ARPU5 community type.

Reforestation
Seed tree and clearcut cutting methods favor oak regeneration. Shelterwood cutting methods are generally best for regenerating ponderosa pine. Selection cuts usually favor ponderosa pine. Ponderosa pine can be planted, but survival rates may be low. Both mechanical and prescribed fire site preparation favors oak, other shrubs, and alligator juniper (if present) over ponderosa pine.

Revegetation considerations
Natural revegetation is rapid, due to sprouting of oaks.

Comments
Provide browse and cover for deer. Limited potential for firewood. Steep slopes may limit management activities.

Reference(s)
Muldavin *et al.* 1991
USFS 1987b

Ponderosa pine/rockland
Pinus ponderosa/rockland

Code(s)
typic phase 0 11 50 0

Ecological Response Unit
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Bunchgrass (PPG)

National Vegetation Classification Group
Southern Rocky Mountain Ponderosa Pine Open Woodland (G229)

Key criteria
Exposed rock outcroppings or very shallow (<4" deep) soil comprises 50 - 90% of the surface. Understory species are scarce and trees include ***ponderosa pine**, pinyon and/or junipers.

Structure
Productivity is very low for trees and forage. Stocking is generally low (stockability = 0.4) and trees are often stunted. Dwarfed pine growing in rock fissures may be hundreds of years old.

Location
Scattered throughout the southwest where large rock outcroppings occur in the ponderosa pine region. 7,500' - 8,500' (2,285 - 2,590 m).

Also see
Malpais rockland described by Lindsey (1951) and several types described by Grissino-Mayer and Swetnam (1995) can be assigned to PIPO/Rockland. See Scree Forests if talus or debris slopes with cobbles and stones > 90% of soil volume.

Important & key plants from research plots
Trees & life history status
ponderosa pine *(Pinus ponderosa)* C
alligator juniper *(Juniperus deppeana)* C
twoneedle pinyon *(Pinus edulis)* c
oneseed juniper *(Juniperus monosperma)* c

Shrubs
Scarce (<1%):
Gambel oak *(Quercus gambelii)*
true mountain mahogany *(Cercocarpus montanus)*
species of yucca *(Yucca spp.)*
Apacheplume *(Fallugia paradoxa)*
broom snakeweed *(Gutierrezia sarothrae)*

Herbs
Scarce (<1%) to common (>1%):
mountain muhly *(Muhlenbergia montana)*
sideoats grama *(Bouteloua curtipendula)*
hairy grama *(Bouteloua hirsuta)*
pine dropseed *(Blepharoneuron tricholepis)*
goldenrods *(Solidago spp*.)
little bluestem *(Schizachyrium scoparium)*

Brief plant ID notes
Ponderosa pine was formerly known as *Pinus scopulorum,* which means rock pine.

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

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry) to +1 (cool,wet)
Climate class: all

Phases
This is the only phase identified for this plant association. However, since this type occurs region-wide, there is likely wide variance among stands keying out to this type.

Fire ecology
No single fire regime characterizes fire history over the diversity of all habitats indicated by PIPO/rockland (Grissino-Mayer & Swetnam 1995). Rock outcropping often protect trees from wide-spreading fires. However, some fires have been reported to spread through litter and lichens and moss growing on rocks, such as experienced in El Malpais near Grants, New Mexico.

Reforestation
Timber harvesting and tree planting are generally not appropiate in this plant association.

Revegetation considerations
Natural revegetation is very slow.

Comments
Landscapes with this plant association are often very attractive with rock outcrops and scattered large trees.

References
Alexander *et. al.* 1984
Fitzhugh *et. al.* 1987
Grissino-Mayer & Swetnam 1995
USFS 1986
USFS 1987a
USFS 1987b

Chihuahua Pine Series

PILE/PIFI

Chihuahuan pine/pinyon ricegrass
Pinus leiophylla/Piptochaetium fimbriatum

Code(s)
typic phase 0 33 01 0

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Perennial Grass (PPP)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
***Pinyon ricegrass** *(Piptochaetium fimbriatum)* is mostly well represented or abundant. ***Chihuahuan pine** is present, although Apache pine is not present.

Structure
Chihuahuan pine reaches its greatest stature in this plant association, most likely a function of more available moisture and soil nutrients. Muldavin and DeVelice (1987) suggest that productivity for Chihuahuan pine is closely correlated to plant association.

Location
Known from southwestern New Mexico, southern Arizona: Peloncillo Mtns, NM; Chiricahua Mtns, Canelo Hills, AZ. Upper alluvial terraces of streamsides and adjoining intermittent streams and washes. 5,000’ - 6,000’ (1,520 - 1,830 m). Mean annual precipitation (MAP) = 24”/yr. Mean annual soil temperature (MAST) = 51 degrees Fahrenheit. Soils are commonly Typic Ustifluvents or Aquic Ustifluvents derived from alluvial sediments.

Adjacent plant associations
On drier sites, PILE/PIFI is adjoined by PILE/QUEM, PIEN2/MULO, or PILE/QUAR plant associations, or pinyon-juniper woodlands. PILE/QUHY or PIPO/QUHY is often found upslope.

Also see
If Arizona sycamore is common (>1%), see "riparian forests".

Important & key plants from research plots
Trees & life history status
Chihuahuan pine *(Pinus leiophylla)* C
border pinyon *(Pinus discolor)* C
alligator juniper *(Juniperus deppeana)* C
Arizona white oak *(Quercus arizonica)* S
oneseed juniper *(Juniperus monosperma)* c
silverleaf oak *(Quercus hypoleucoides)* s
Emory oak *(Quercus emoryi)* s
Riparian broadleaf trees are sometimes present, including:
Arizona sycamore *(Platanus wrightii)* a
black cherry *(Prunus serotina)* a
velvet ash *(Fraxinus velutina)* a
Arizona walnut *(Juglans major)* a

Shrubs
Well represented (>5%):
shrubby oaks *(Quercus spp.)*
sacahuista *(Nolina microcarpa)*
skunkbush sumac *(Rhus trilobata)*
pointleaf manzanita *(Arctostaphylos pungens)*
black cherry *(Prunus serotina)* beechleaf frangula *(Frangula betulifolia)*
canyon grape *(Vitis arizonica)*
Apacheplume *(Fallugia paradoxa)*
Schott's yucca *(Yucca x schottii)*
Wright's silktassel *(Garrya wrightii)*

Herbs
Abundant (>25%):
pinyon ricegrass *(Piptochaetium fimbriatum)*
White Mountain sedge *(Carex geophila)*
nodding brome *(Bromus anomalus)*

single threeawn *(Aristida orcuttiana)*
sideoats grama *(Bouteloua curtipendula)*
blue grama *(Bouteloua gracilis)*
longtongue muhly *(Muhlenbergia longiligula)*
muttongrass *(Poa fendleriana)*
New Mexico groundsel *(Senecio neomexicanus)*
Rose's ticktrefoil *(Desmodium rosei)*
Fendler's meadow-rue *(Thalictrum fendleri)*
Lemmon's brickellbush *(Brickellia lemmonii)*
bracted bedstraw *(Galium microphyllum)*
wild beans *(Phaseolus* spp.)
dwarf stickpea *(Calliandra humilis var. reticulata)*

Brief Plant ID Notes
Chihuahua pine has short needles in bundles of three. Small cones remain on the limbs after opening.

The seeds of pinyon ricegrass are large for grass seeds and have long awns. The narrow leaves start at the base of the bunch, and the culms are woolly below the nodes.

Synonymy
dwarf stickpea *(Calliandra humilis var. reticulata = C. reticulata)*
nodding brome *(Bromus anomalus = Bromus porteri)*
beechleaf frangula *(Frangula betulifolia = Rhamnus betulaefolia)*.
border pinyon *(Pinus discolor = Pinus cembroides = Mexican pinyon)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry)
Climate class: HSM (high sun mild)

Fire ecology
Chihuahuan pine has some serotinous cones and sprouting potential and is considered to be more dominant on sites where fires have occurred (Pavek 1994).

Reforestation
Flooding may be required for Chihuahuan pine and other tree species to regenerate in this habitat type.

Comments
This plant association provides important habitat in the Chiricahua Mountains for many primarily Mexican bird species during their summer breeding seasons. This primarily riparian environment is subject to occasional flooding.

Reference(s)
Muldavin *et. al.* 1991
Pavek 1994
USFS 1987b

Chihuahuan pine/Arizona white oak
Pinus leiophylla/Quercus arizonica

Code(s)
typic phase 0 33 02 0

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Shrub (PPS)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
***Chihuahuan pine** *(Pinus leiophyllla)* is climax. Apache pine is absent. ***Arizona white oak** *(Quercus arizonica)* is the leading oak, especially more dominant than silverleaf oak.

Structure
Timber productivity for ponderosa pine and Chihuahuan pine is low. Grazing potential is also low, with common grasses having low palatability.

Location
South of the Mogollon Rim, in southwestern New Mexico and southern Arizona. In New Mexico, known in the Peloncillo Mountains; In Arizona, known from the Chiricahua, Galiuro, and Pinaleno Mountains, with some isolated locations on the Tonto NF and Fort Apache Reservation. 5,200’ (1,580 m) on north slopes to 7,000’ (2,130 m) on south slopes. Found on mountain slopes, intermittent washes, and dry streamside terraces. Mean annual precipitation (MAP) = 24 in/yr. Mean annual soil temperature (MAST) = 51 degrees Fahrenheit. Soils are often shallow (<50 cm to bedrock), cobbly, and with low water holding capacity.

Adjacent plant associations
The PILE/QUAR plant association lies at elevations between PILE/QUHY and PILE/QUEM plant associations. It may also adjoin PILE/ARPU5 plant association, especially where fire frequencies are

higher. On drier sites, PILE/QUAR may grade directly to pinyon-juniper-oak woodlands.

Also see
Pine-Oak woodlands (Marshall, 1957; Whittaker & Niering 1965,1968);

Muldavin et. al. 1991; USFS 1987b and this publication have included PILE/QUEM (from Muldavin *et. al.* 1991) in this plant association description. A PILE/ARPU community type has been described by Muldavin *et. al.* 1991.

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm,dry)
Climate class: HSM (high sun mild)

Important & key plants from research plots
Trees & life history status
Chihuahuan pine *(Pinus leiophylla)* C
border pinyon *(Pinus discolor)* C
alligator juniper *(Juniperus deppeana)* C
Arizona white oak *(Quercus arizonica)* S
Emory oak *(Quercus emoryi)* S
ponderosa pine *(Pinus ponderosa)* c
Arizona pine *(Pinus arizonica)* c
silverleaf oak *(Quercus hypoleucoides)* s
Douglas fir *(Pseudotsuga menziesii)* a

Shrubs
Well represented (>5%):
shrubby oaks *(Quercus spp*.)
sacahuista *(Nolina microcarpa)*
skunkbush sumac *(Rhus trilobata)*
pointleaf manzanita *(Arctostaphylos pungens)*
Bigelow bristlehead *(Carphochaete bigelovii)*
Schott's yucca *(Yucca x schottii)*
Parry's agave *(Agave parryi)*

Herbs
Well represented (>5%) canopy coverage:
longtongue muhly *(Muhlenbergia longiligula)*
White Mountain sedge *(Carex geophila)*
muttongrass *(Poa fendleriana)*
single threeawn *(Aristida orcuttiana)*
Fendler's lipfern *(Cheilanthes fendleri)*
aromatic false pennyroyal *(Hedeoma hyssopifolia)*
dwarf stickpea*(Calliandra humilis var. reticulata)*
New Mexico groundsel *(Senecio neomexicanus)*
wild beans *(Phaseolus spp*.)
pinyon ricegrass *(Piptochaetium fimbriatum):* if abundant, see PILE/PIFI
threenerve goldenrod *(Solidago velutina)*
Carruth's sagewort *(Artemisia carruthii)*
Texas bluestem *(Schizachyrium cirratum)*
bulb panicgrass *(Panicum bulbosum)*
bullgrass *(Muhlenbergia emersleyi)*

Brief Plant ID Notes
Arizona white oak has light gray bark and dark green leaves. The underside of the leaf is matted with brownish yellow hairs.

Synonymy
dwarf stickpea *(Calliandra humilis var. reticulata = C. reticulata)*
threenerve goldenrod *(Solidago velutina = Solidago sparsifolia)*.
Arizona pine *(Pinus arizonica = P. ponderosa var. arizonica)*
border pinyon *(Pinus discolor = Pinus cembroides = Mexican pinyon)*
Texas bluestem *(Schizachyrium cirratum = Andropogon cirratus)*

Phases
No phases have been identified for this plant association. Muldavin *et. al.* (1991) described a PILE/QUEM habitat type, which is included in this description.

Fire ecology
In a fire history study in the Rincon Mountains of Saguaro National Monument, Baisan & Swetnam (1990) found approximately 7-year fire return intervals on three sites during the 18th and 19th centuries in the open pine forest type.

Reforestation
After a disturbance, natural regeneration of pine is generally slow due to competition with oak and juniper sprouting.

Revegetation considerations
Revegetation is rapid following disturbance due to oak and alligator juniper sprouting.

Comments
In the Peloncillo Mountains (NM) this plant association is important habitat for Gould's turkey. Its extent (together with PILE/QUHY) within a portion of the turkey's range was mapped by Willging (1987). This plant association is more common in northern Mexico, than in the United States.

Reference(s)
Baisan & Swetnam 1990
Muldavin *et. al.* 1991
Stuever 1995
USFS 1987b
Willging 1987

Chihuahuan pine/Silverleaf oak
Pinus leiophylla/Quercus hypoleucoides

Code(s)
CSDS 0 33 03 0

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Shrub (PPS)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
***Silverleaf oak** *(Quercus hypoleucoides)* is leading oak. Apache pine is absent, but ***Chihuahuan pine** is present. Pinyon ricegrass is poorly represented or absent.

Structure
Site productivity is low. Grass and sedge biomass is generally low with few palatable species available for livestock.

Location
Mostly found in southeastern Arizona, including the following geographic areas: Chiricahua, Pinaleno, Santa Rita, and Santa Catalina Mountains, with outliers at Ft. Apache Reservation, and in New Mexico, the Peloncillo Mountains. On mountain slopes, intermittent washes, and dry streamside terraces, 5,700’ (1,735 m) on north slopes to 7,100’ (2,165 m) on south slopes. Mean annual precipitation (MAP) = 25 in/yr. Mean annual soil temperature (MAST) = 50 degrees Fahrenheit (TES gradient analysis, north slopes Santa Catalina Mtns).

Adjacent plant associations
Often under moist conditions, PILE/QUHY adjoins PIPO/QUHY or occasionally PIEN2/QUHY or rarely PSME/QUHY. Drier sites may adjoin PILE/QUAR, PILE/ARPU5, or PIEN2/MULO or pinyon-juniper woodlands or chaparral.

Also see
PILE/QUAR occurs on slightly drier, warmer environments. Pine-oak woodlands have been described more generally by Marshall (1957), Whittaker and Niering (1965,1968), and Niering and Lowe (1984).

Important & key plants from research plots
Trees & life history status
Chihuahuan pine *(Pinus leiophylla)* C
alligator juniper *(Juniperus deppeana)* C
silverleaf oak *(Quercus hypoleucoides)* S
Arizona white oak *(Quercus arizonica)* S
ponderosa pine *(Pinus ponderosa)* c
Arizona pine *(Pinus arizonica)* c
border pinyon *(Pinus discolor)* c
Emory oak *(Quercus emoryi)* s
Arizona madrone *(Arbutus arizonica)* s
Douglas fir *(Pseudotsuga menzensii)* a

Shrubs
Well represented (>5%) canopy coverage:
shrubby oaks *(Quercus spp*.)
sacahuista *(Nolina microcarpa)*
skunkbush sumac *(Rhus trilobata)*
pointleaf manzanita *(Arctostaphylos pungens)*
Pringle manzanita *(Arctostaphylos pringlei)*
Bigelow bristlehead *(Carphochaete bigelovii)*
Schott's yucca *(Yucca x schottii)*
Parry's agave *(Agave parryi)*

Herbs
Well represented (>5%) canopy coverage:
longtongue muhly *(Muhlenbergia longiligula)*
muttongrass *(Poa fendleriana)*
White Mountain sedge *(Carex geophila)*
single threeawn *(Aristida orcuttiana)*
Fendler's lipfern *(Cheilanthes fendleri)*
aromatic false pennyroyal *(Hedeoma hyssopifolia)*,
dwarf stickpea *(Calliandra humilis var. reticulata)*
New Mexico groundsel *(Senecio neomexicanus)*

wild beans *(Phaseolus spp*.)
pinyon ricegrass *(Piptochaetium fimbriatum)* [in washes and streamside terraces]

Brief Plant ID Notes
Chihuahuan pine has short needles in bundles of three. Small cones remain on the limbs after opening. Silverleaf oak has distinctive leaves, dark green on the top, and whitish underneath, with rolled, entire leaf margins.

Synonymy
dwarf stickpea *(Calliandra humilis var. reticulata = C. reticulata)*
Arizona pine *(Pinus arizonica = P. ponderosa var. arizonica)*
border pinyon *(Pinus discolor = Pinus cembroides = Mexican pinyon)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: 0 (typic)
Climate class: HSM (high sun mild)

Fire ecology
Fire is important for maintaining open stands and shrub dominance in the understory (Muldavin *et. al.* 1991, Niering & Lowe 1984).

Reforestation
Although Chihuahuan pine can resprout from the root crown, this regeneration method appears to have a neglible effect on reproduction and maintenance of the species (Muldavin *et. al.* 1991).

Revegetation considerations
Natural revegetation after disturbance is fairly rapid due to oak sprouting.

Reference(s)
Muldavin *et. al.* 1991
Niering and Lowe 1984
USFS 1987b

Apache Pine Series

PIEN2/MULO

(Formerly: PINEN/MULO)

Apache pine/longtongue muhly
Pinus engelmannii/Muhlenbergia longiligula

Synonyms
Pinus ponderosa/Poa longiligula community type (Hanks *et. al.* 1983).

Code(s)
typic phase 0 32 01 0

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Perennial Grass (PPP)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
***Apache pine** is present and not accidental, and silverleaf oak and netleaf oak are poorly represented and subdominant or absent. Long-tongue muhly is usually present, although this grass may not be present in all locations within this plant association.

Structure
Timber productivity is low.

Location
Currently known from the Canelo Hills, Santa Rita and Chiricahua Mountains of Southern Arizona, where this plant association is generally found on northeasterly slopes or dry benches. Elevations range from 5,560’ - 6,900’ (1,690 - 2,100 m).

Adjacent plant associations
On drier sites, adjoins PILE/QUAR or pinyon-juniper-oak woodlands. On wetter sites, adjoins PILE/PIFI or PILE/QUHY plant associations.

Important & key plants from research plots
Trees & life history status
Apache pine *(Pinus engelmannii)* C
border pinyon *(Pinus discolor)* c
twoneedle pinyon *(Pinus edulis)* c
alligator juniper *(Juniperus deppeana)* c
Chihuahuan pine *(Pinus leiophylla)* s
Emory oak *(Quercus emoryi)*: QUEM phase s

Shrubs
Scarce (<1%) to well represented (>5%):
shrubby forms oaks (mostly silverleaf, Emory, Gambel, and Arizona white oak)
pubescent skunkbush sumac *(Rhus trilobata* var. *pilosissima)*
canyon grape *(Vitis arizonica)*

Herbs
Well represented (>5%) to abundant (>25%), especially grasses:
longtongue muhly *(Muhlenbergia longiligula)*
bullgrass *(Muhlenbergia emersleyi)*
bulb panicgrass *(Panicum bulbosum)*
pinyon ricegrass *(Piptochaetium fimbriatum)*
White Mountain sedge *(Carex geophila)*
prairie junegrass *(Koeleria macrantha)*
mountain goldenbanner*(Thermopsis rhombifolia var. montana)*
aromatic false pennyroyal *(Hedeoma hyssopifolia)*
bedstraw *(Galium ssp*.)
single threeawn *(Aristida orcuttiana)*
muttongrass *(Poa fendleriana)*

Brief Plant ID Notes
Apache pine has stout twigs, long needles (8-15”), and often has a few cone scales remaining on twig after the cone falls off.

Synonymy
prairie junegrass *(Koeleria macrantha = K. pyramidata = K. gracilis)*
pubescent skunkbush sumac *(Rhus trilobata var.pilosissima = Rhus aromatica)*
mountain goldenbanner *(Thermopsis montana = Thermopsis pinetorum)*
border pinyon *(Pinus discolor = Pinus cembroides = Mexican pinyon)*

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: 0 (typic)
Climate class: HSM (high sun mild)

Phases
Muldavin (1996) suggests three tentative phases: 1.) an upper elevation or typic phase where longtongue muhly and bulb panicgrass are well represented in the understory; 2.) an intermediate elevation Arizona white oak dominated phase; and 3.) a low elevation Emory oak phase, where longtongue muhly and bullgrass dominate the understory. There are currently no phase "vegetation codes" assigned to this plant association.

Fire Ecology
See PIEN2/QUHY for general fire effects on Apache pine. The open pine type, in Baisan & Swetnam (1990), may also be applicable to this association. They found a pre-fire exclusion fire return interval of approxiamately 7 years in the Rincon Moutains near Tucson.

Reforestation
Apache pine reproduces by seed. Natural regeneration is dependent on seed crops and exposure of mineral soil for successful germination. Seedlings are shade tolerant, but saplings are more shade intolerant.

Revegetation Considerations
Where oak is present on the site, oak sprouting can be prolific following disturbances.

Reference(s)
Baisan and Swetnam 1990
Muldavin *et. al.* 1996
Pavek 1994a
Stuever 1995

(Formerly: PINEN/QUHY)

Apache pine/silverleaf oak
Pinus engelmannii/Quercus hypoleucoides

Synonyms
PIEN2/QUHY = PINEN/QUHY

Code(s)
CSDS 0 32 03 0

Ecological Response Unit
Ponderosa Pine – Evergreen Oak (PPE), subclass Ponderosa Pine – Evergreen Oak, Shrub (PPS)

National Vegetation Classification Group
Madrean Lower Montane Pine - Oak Forest & Woodland (G203)

Key criteria
***Apache pine** and ***silverleaf oak** are present. There is also a rich diversity of tree species including Chihuahan pine, Arizona pine, ponderosa pine, southwestern white pine, and occassionally Douglas-fir.

Structure
No information on stand structure or productivity was available for this type.

Location
Found in southeastern Arizona, known from the Chiricahua and Santa Rita Mountains, also in Pinaleno Mountains. This type has also been found at least 300 km south of Arizona in the north central Sierra Madre in Mexico. Elevations 6,200’ - 7,200’ (1,890 -2,190 m). Lower slopes and elevated streamside terraces. Mean annual precipitation (MAP) = 26”/yr. Mean annual soil temperature (MAST) = 50 degrees Fahrenheit.

Adjacent plant associations
On drier sites, intergrades to PILE/QUHY or oak woodlands. On cooler sites, this type may adjoin PIPO/QUHY.

Also see
This pine-oak woodland is discussed by Marshall (1957), Moir and Lukens (1979, plots F2 & F3 in Chiricahua Mtns.), and Muldavin *et. al.* 1991.

Important & key plants from research plots
Trees & life history status
Apache pine *(Pinus engelmannii)* C
silverleaf oak *(Quercus hypoleucoides)* S
border pinyon *(Pinus discolor)* c
alligator juniper *(Juniperus deppeana)* c
ponderosa pine *(Pinus ponderosa)* c
Arizona pine *(Pinus arizonica)* c
southwestern white pine *(Pinus strobiformis)* c
Douglas-fir *(Pseudotsuga menzensii)* c
Chihuahuan pine *(Pinus leiophylla)* s
Arizona white oak *(Quercus arizonica)* s
Arizona walnut *(Juglans major)* s
Emory oak *(Quercus emoryi)* a
white fir *(Abies concolor)* a

Shrubs
Scarce (<1%) to well represented (>5%):
shrubby forms of oaks (mostly silverleaf, netleaf, and Arizona white oak)
Schott's yucca *(Yucca x schottii)*
skunkbush sumac *(Rhus trilobata)*
Fendler's ceanothus *(Ceanothus fendleri)*
Parry's agave *(Agave parryi)*
Wright's silktassel *(Garrya wrightii)*

Herbs
Common (>1%) to well represented (>5%):
longtongue muhly *(Muhlenbergia longiligula)*
bulb panicgrass *(Panicum bulbosum)*
single threeawn *(Aristida orcuttiana)*
muttongrass *(Poa fendleriana)*
aromatic false pennyroyal *(Hedeoma hyssopifolia)*

Brief Plant ID Notes
Apache pine branches less often than ponderosa pine, although where the ranges overlap, hybrids occur between Apache pine, ponderosa pine, and Arizona pine. Arizona pine has five needles, which are about twice the length of southwestern white pine.

Terrestrial Ecological Unit attributes
Life Zone Class: 5 (ponderosa)
Elevational Subzone: +1 (cool, mesic)
Climate class: HSM (high sun mild)

Fire Ecology
Mature Apache pine are generally fire resistant. Seedlings and saplings may be killed by fire. Oaks resprout following most fires. Swetnam *et. al.* (1989, 1992) report historic fire intervals between 1 and 38 years in Rhyolite Canyon in the Chiricahua Mountains.

Reforestation
Apache pine regenerates by seed and seedlings are shade tolerant.

Revegetation Considerations
Natural revegetation is generally rapid following disturbances due to oak resprouting.

Reference(s)
Muldavin and DeVelice 1987
Muldavin 1991
Pavek 1994a
Stuever 1995
Swetnam *et. al.* 1992
Swetnam *et. al.* 1989
USFS 1987b

Riparian Forests

Codes
thinleaf alder *(Alnus incana ssp. tenuifolia)* series 1 23
narrowleaf cottonwood *(Populus angustifolia)* series 1 03
Rio Grande cottonwood *(Populus deltoides spp. wislizeni)* series 1 04
subalpine fir*(Abies lasiocarpa var. arizonica)* series (riparian) 0 03
blue spruce *(Picea pungens)* series (riparian) 0 11
Arizona sycamore *(Platanus wrightii)* series 1 30
Bebb willow *(Salix bebbiana)* series 3 35
thinleaf alder

Ecological Response Unit
Willow – Thinleaf Alder (290)
Upper Montane Conifer/Willow (280)
National Vegetation Classification Group
Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506)
narrowleaf cottonwood

Ecological Response Unit
Narrowleaf Cottonwood / Shrub (230)
Narrowleaf Cottonwood – Spruce (240)

National Vegetation Classification Group
Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506)
Rio Grande cottonwood

Ecological Response Unit
Rio Grande Cottonwood / Shrub (260)

National Vegetation Classification Group
Western Interior Riparian Forest & Woodland (G797)
subalpine fir

Ecological Response Unit
Upper Montane Conifer/Willow (280)

National Vegetation Classification Group
Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506)
blue spruce

Ecological Response Unit
Upper Montane Conifer/Willow (280)

National Vegetation Classification Group
Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506)
Arizona sycamore

Ecological Response Unit
Sycamore – Fremont's Cottonwood (270)

National Vegetation Classification Group
Western Interior Riparian Forest & Woodland (G797)
Bebb willow

Ecological Response Unit
Willow – Thinleaf Alder (290)

National Vegetation Classification Group
Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506)

Key Criteria
This is a general category for differentiating riparian forest communities from the upland plant associations described in this field book. Please see the "Also see" section for some references which describe plant community types and associations in riparian areas, and the "Comments" section for listings of community types and vegetation subseries.

Location
Widespread throughout the Southwest. Sites: Perennial and intermittent streamsides, all elevations; aquic, cumulic, and fluventic soils where roots reach water table and its capillary fringe.

Adjacent plant associations
Highly varied.

Also see
This broad category encompasses several series, which are described in the U.S.F.S. Riparian Area Handbook. Subseries descriptions are provided in various TES reports.

Plant association descriptions include *Picea Pungens/Cornus stolonifera* (Fitzhugh *et al*, 1987), *Abies concolor/Galium triflorum (*DeVelice *et al* 1986)*, Pinus ponderosa/Poa pratensis* (DeVelice *et al* 1986). *Abies concolor/Juglans major* (Alexander *et al*, 1984). PIPU/COSES and ABCO/JUMA are described in this publication.

The plant association concept focuses on describing long-term stable plant communities which, in frequently flooded sites (such as riparian zones), loses meaning. Therefore, most classifications of riparian forest focus on describing current, rather than expected, plant communities. Some other sources describing some of these communities are:

Muldavin, E., Durkin, P., Bradley, M., Stuever, M., and Mehlhop, P. (2000). Handbook of Wetland Vegetation Communities of New Mexico. Volume 1: Classification and Community Descriptions. New Mexico Natural Heritage Program, Biology Department, University of New Mexico, Albuquerque.

USDA Forest Service, Region 3, Riparian Area Handbook.

USDA Forest Service, Region 3, various Terrestrial Ecosystem Survey reports.

Szaro, Robert. Riparian forest and scrubland community types of Arizona and New Mexico. Desert Plants. 1989; 9(3-4): 69-138.

Durkin, Paula *et al.,* A Riparian/Wetland Vegetation Community Classification of New Mexico: Pecos River Basin. Report submitted to NM Environment Department. New Mexico Natural Heritage Program.

Durkin, Paula *et al.,* Riparian/Wetland Vegetation Communities of the Rio Grande: classification and site evaluation. Report submitted to NM Environment Department. New Mexico Natural Heritage Program.

Baker, W. L., Classification of the riparian vegetation of the montane and subalpine zones in western Colorado. Great Basin Naturalist, Vol. 49, No. 2, p. 214-228.

Kittel, Gwen, *et. al.* A classification of the riparian vegetation of the White and Colorado River Basins, CO. Report submitted to the Colorado Dept. of Natural Resources and Environmental Protection Agency. Colorado Natural Heritage Program.

Kittel, G. M. & N. D. Lederer. A preliminary classification of the riparian vegetation of the Yampa and San Miguel/Dolores River Basins. Report submitted to the Colorado Dept. of Natural Resources and Environmental Protection Agency. The Nature Conservancy's Colorado Program.

Terrestrial Ecological Unit attributes
Life Zone Class: all: 3 - 7
Elevational Subzone: cold, cool, warm; very moist to wet
Climate Class: all

Important & key plants

Trees
Well represented (>5% cover) to luxuriant (>50% cover) overstories. Any of the following are diagnostic when present:
Rio Grande cottonwood *(Populus deltoides spp. wislizeni)*
narrowleaf cottonwood *(Populus angustifolia)*
Arizona walnut *(Juglans major)*
boxelder *(Acer negundo)*
Arizona alder *(Alnus oblongifolia)*
Gooding's willow *(Salix gooddingii)*
velvet ash *(Fraxinus velutina)*
Russian olive *(Elaeagnus angustifolia)*
Arizona sycamore *(Platanus wrightii)*

Shrubs
Often abundant (>25% cover); any of the following are diagnostic**:**
Bebb willow *(Salix bebbiana)*
narrowleaf willow *(Salix exigua)*
Pacific willow *(Salix lucidia spp. lasiandra)*
thinleaf alder *(Alnus incana ssp. tenuifolia)*

redosier dogwood *(Cornus sericea ssp sericea)*
mule-fat *(Baccharis salicifolia)*
sandbar willow *(Salix irrorata)*
Other common species can include:
canyon grape *(Vitis arizonica)*
Virginia creeper *(Parthenocissus quinquefolia)*
poison ivy *(Toxicodendron radicans)*
twinberry honeysuckle *(Lonicera involucrata)*
Scouler's willow *(Salix scouleriana)*
Rocky Mountain maple *(Acer glabrum)*
Oregon boxleaf *(Paxistima myrsinites)*
Arizona cypress *(Cupressus arizonica)*

Herbs
Abundant (>25% cover) to luxuriant (>50% cover). There is a highly diverse flora**.** Common species include**:**
Kentucky bluegrass *(Poa pratensis)*
brome grasses *(Bromus spp.)*
cutleaf coneflower *(Rudbeckia laciniata)*
redtop *(Agrostis gigantea)*
western wheatgrass *(Pascopyrum smithii)*
blue wildrye *(Elymus glaucus)*
cowparsnip *(Heracleum maximum)*
Fendler's cowbane *(Oxypolis fendleri)*
California false helibore *(Veratrum californicum)*
yellow avens *(Geum aleppicum)*
Scouler's St. Johnswort *(Hypericum scouleri)*

Synonymy
redosier dogwood *(Cornus sericea* ssp. *sericea = C. stolonifera = C. swida)*
mule-fat (*Baccharis salicifolia = B. glutinosa*)
Virginia creeper *(Parthenocissus quinquefolia = P. inserta)*
western wheatgrass *(Pascopyrum smithii = Agropyron smithii)*
cowparsnip *(Heracleum maximum = H. sphondylium)*
Rio Grande cottonwood *(Populus deltoides* spp *wislizeni = P. fremontii)*
Oregon boxleaf *(Paxistima myrsinites)* = mountain lover *(Pachystima myrsinites)*

Management implications
Riparian forests require special standards and guidelines as stated in Forest Plans and project level prescriptions.

Comments
Over time, ERUs, the NVC, and legacy classifications are likely to be organized into a common classification framework. Most of the associations within this handbook have already been integrated with the NVC. Riparian classification work, including Muldavin *et al*. (2000) and Szaro (1989), have likewise largely been brought into the NVC. At the same time, ERUs of the Southwest are gradually being normalized with LANDFIRE Biophysical Settings (Barrett et al. 2010) to create a common listing of ecosystem types for the region (site potential + disturbance regime), each with the ability to couch sets of one or more associations, much as Ecological Site Descriptions and state-and-transition models are able to convey relationships among multiple associations and structure types within a dynamic system (Creque et al. 1999, SRM 1995). Meanwhile, the riparian forest and woodland community types that have been identified are listed here, and users are instructed to refer to the actual references for community descriptions.

Muldavin *et al.* (2000) developed a classification system for wetland (and riparian) vegetation communities of New Mexico. There are three major categories: forested wetlands, scrub-shrub wetlands, and persistent emergent (herbaceous) wetlands.

In the forested wetlands, communities include:

Arizona alder alliance including Arizona alder/bluestem willow c.t., Arizona alder-Gooding willow c.t., Arizona alder/seepwillow c.t., and Arizona alder/rice cutgrass c.t.

Arizona sycamore alliance including Arizona sycamore-Arizona alder/seepwillow c.t., Arizona sycamore/California brickelbush c.t., and Arizona sycamore/sparse c.t.

Arizona walnut alliance including Arizona walnut/sideoats grama c.t., Arizona walnut/New Mexico olive c.t., Arizona walnut-boxelder/skunkbush sumac c.t., Arizona walnut-netleaf hackberry/California brickellbush c.t.

Blue spruce alliance including blue spruce/thinleaf alder-wood rose c.t and blue spruce/Kentucky bluegrass c.t.

Boxelder alliance including boxelder/thinleaf alder c.t., boxelder-velvet ash c.t., and boxelder/coyote willow c.t..

Fremont cottonwood alliance including Fremont cottonwood-Arizona sycamore c.t., Fremont cottonwood/velvet ash c.t., Fremont cottonwood-Goodding willow/seepwillow c.t., Fremont cottonwood-Gooding willow/coyote willow c.t., Fremont cottonwood/seepwillow c.t., Fremont cottonwood/scour c.t., Fremont cottonwood/sparse c.t.

Goodding willow alliance including Gooding willow/Emory baccharis c.t. and Goodding willow/deergrass c.t.

Narrowleaf cottonwood alliance including narrowleaf cottonwood/thinleaf alder-redosier dogwood c.t., narrowleaf cottonwood/Arizona alder c.t., narrowleaf cottonwood-Rocky Mountain juniper/sand dropseed c.t., narrowleaf cottonwood/New Mexico olive c.t., narrowleaf cottonwood/common chokecherry c.t., narrowleaf cottonwood/bluestem willow c.t., narrowleaf cottonwood/coyote willow c.t., narrowleaf cottonwood-boxelder/Kentucky bluegrass c.t., and narrowleaf cottonwood/Kentucky bluegrass c.t.

Netleaf Hackberry alliance including netleaf hackberry/California brickellbush c.t. and netleaf hackberry/wingleaf soapberry c.t.

Plains cottonwood alliance including plains cottonwood/yerba mansa c.t., plains cottonwood/silver buffaloberry c.t., plains cottonwood-Russian olive/New Mexico olive c.t., plains cottonwood/New Mexico olive c.t., plains cottonwood/hoary rosemarymint c.t., plains cottonwood-peachleaf willow c.t., plains cottonwood-Goodding willow c.t., plains cottonwood/coyote willow c.t., plains cottonwood/Nebraska sedge c.t., plains cottonwood/smooth horsetail c.t., plains cottonwood/big sagebrush c.t., plains cottonwood/rubber rabbitbrush c.t., plains cottonwood, New Mexico bluestem c.t., plains cottonwood/alkali sacaton c.t., plains cottonwood/sideoats grama c.t., plains cottonwood-Russian olive c.t., plains cottonwood-Russian olive/saltcedar c.t., plains cottonwood/saltcedar c.t., plains cottonwood/scour c.t., and plains cottonwood/sparse c.t.

Russian olive alliance including Russian olive/coyote willow c.t., Russian olive/alkali sacaton c.t., Russian olive/redtop c.t., and Russian olive/sparse c.t.

In the scrub-shrub wetlands, communities include:

Bluestem willow alliance including bluestem willow/beaked sedge c.t., bluestem willow/common spikerush c.t., bluestem willow-redosier dogwood c.t., bluestem willow-Pacific willow c.t., bluestem willow-coyote willow c.t., and bluestem willow/scour c.t.

Coyote willow alliance including coyote willow-seepwillow c.t., coyote willow/yerba mansa c.t., coyote willow/vine mesquite c.t., coyote willow/false quackgrass c.t., coyote willow/deergrass c.t., coyote willow/threesquare bulrush c.t., coyote willow/water sedge c.t., coyote willow/common spikerush c.t., coyote willow/Baltic rush c.t., coyote willow/smooth horsetail c.t., coyote willow/redtop c.t., and coyote willow/gravel bar c.t.

Diamondleaf willow alliance has one community type: diamonleaf willow/water sedge c.t.

Emory baccharis alliance including Emory baccharis-coyote willow c.t., Emory baccharis/Baltic rush c.t., Emory baccharis/inland saltgrass c.t., and Emory baccharis/alkali sacaton c.t.

River birch alliance alliance has one community type: river birch-redosier dogwood c.t.

Saltcedar alliance including saltcedar/buffalograss c.t., saltcedar/false quackgrass c.t., saltcedar-coyote willow c.t., saltcedar/inland saltgrass c.t., saltcedar/alkali sacaton c.t., saltcedar/pickleweed c.t., saltcedar/redtop c.t., and saltcedar/sparse c.t.

Seepwillow alliance including seepwillow/threesquare bulrush c.t. and seepwillow/gravel bar c.t.

Thinleaf alder alliance including thinleaf alder-redosier dogwood c.t., thinleaf alder-bluestem willow c.t., thinleaf alder-Pacific willow c.t., and thinleaf alder/Canada reedgrass c.t.

See Muldavin *et al.* (2000) for listing of herbaceous community types.

Robert Szaro describes forest and scrubland community types for Arizona and New Mexico. The key feature of riparian environments is their successional dynamics. The dynamic nature of these systems equates to change rather than a steady state. The concept of a community type represents the existing structure and composition of communities without regard to successional status. Szaro recognizes the following riparian forest community types:

bigtooth maple—white fir *Acer grandidentatum—Abies concolor*
blue spruce *Picea pungens*
narrowleaf cottonwood *Populus angustifolia*
boxelder *Acer negundo*
boxelder—Mixed deciduous *Acer negundo—Mixed deciduous*
Arizona alder *Alnus oblongifolia*
Arizona walnut *Junglans major*
velvet ash *Fraxinus pennsylvanica (*now *F. velutina)*
Arizona walnut—Arizona sycamore *Juglans major — Platanus wrightii*
Arizona sycamore *Platanus wrightii*
Arizona sycamore—velvet ash *Platanus wrightii — Fraxinus pennsylvanica*
Rio Grande cottonwood *Populus fremontii* (now = *P. deltoides* spp. *wislizeni*)
Rio Grande cottonwood—velvet ash *Populus fremontii — Fraxinus pennsylvanica*
Rio Grande cottonwood—Gooding's willow *Populus fremontii — Salix gooddingii*
red willow *Salix bonplandiana*
wingleaf soapberry—Arizona walnut *Sapindus saponaria — Juglans major*
velvet mesquite *Prosopis velutina*
Gooding's willow *Salix gooddingii*
fivestamen tamarisk *Tamarix pentandra* (now *T. chinensis*)
California palm *Washingtonia filifera*

The Terrestrial Ecological Unit Inventory (formerly R3 Terrestrial Ecosystem Survey) maps vegetation at the subseries level. Below is a compilation of the vegetation subseries which could be classified as "riparian forests". These are compiled by the following national forests

in Arizona and New Mexico. When available, the TES climate class is included.

National Forests

SFNF = Santa Fe National Forest CANF = Carson National Forest
PNF = Prescott National Forest LNF = Lincoln National Forest
CINF = Cibola National Forest CONF = Coconino National Forest
KNF = Kaibab National Forest

TES Vegetation Subseries

Acne2/Sair CINF
Alob2/Plwr PNF
Alob2/Poan3/Sala6 PNF
Alte2 SFNF
Alte2/Sabe2 SFNF, CANF LSC, 7, -1
Alte2/Samo2 SFNF
Alte2/Sasu CANF LSC, 7, 0
Frve2/Sabo PNF
Plwr2/Alob CONF
Plwr2/Frve2/Sabo PNF
Plwr2/Pofr2/Alob/Sala5 CONF
Plwr2/Sago PNF
Pipos/Alob2/Plwr PNF
Pipos/Jude2/Plwr PNF
Poan3 CONF
Poan3/Acne2 CINF
Poan3/Acne2/Sair CINF
Poan3/Alte2/Abco/Psmeg/Pipu CANF LSC, 6, +1
Poan3/Alte2/Sabe CANF LSC, 6, +1
Poan3/Juma/Alob CONF
Poan3/Juma/Alob/Sala6 CONF
Poan3/Juma/Psmeg CONF
Poan3/Jusc2/Pipos/Artr2
SFNF
Poan3/Plwr2/Alob CONF
Poan3/Sabe2 SFNF, CANF LSC, 5. 0
Poan3/Saex SFNF

Podew SFNF, KNF LSC, 2
Podew/Dain/Popr CANF LSC, 6, +1
Podew/Frve2/Sabo PNF
Podew/Jusc2/Artr2 SFNF
Podew/Plwr2 PNF
Podew/Plwr2/Cuarg CONF
Podew/Plwr2/Saex CONF
Podew/Popr SFNF
Podew/Popr/Deca5/Feov CANF LSC, 7, 0
Podew/Sabo PNF
Podew/Saex SFNF, CANF LSC, 4, 0
Podew/Saex/Chna2 SFNF
Podew/Sago PNF
Podew/SALIX PNF
Popr/Poan3/Pipu CANF LSC, 6, +1
Popr/Poan3/Sabe2 CANF LSC, 5, 0
Sabe/Alte2/Deca5/Judr CANF LSC, 7, -1
Sabe2/Cave6 SFNF
Sabe2/Popr SFNF
Sagl/Cale/Caaq SFNF
Samo2/Caaq SFNF
Samo2/Pien SFNF
Sapl/Cale/Caaq/Juba CANF LSC, 7, 0
Sasu/CAREX/Juba/Cale
CANF LSC, 7, 0

References

Baker 1989
Durkin *et al.* 1995
Durkin *et al.* 1994
Kittel *et al.* 1994
Kittel & Lederer 1993
Szaro 1989
USFS 1986
USFS 1987a
USFS 1987b
USFS TES data, Region 3

Scree Forests

Synonyms
For ABLA/scree:

*Abies lasiocarpa/*scree (USFS 1986)
Abies lasiocarpa/Saxifraga bronchialis (DeVelice *et al.* 1986) [26005]
Abies lasiocarpa/Holodiscus dumosus (Fitzhugh *et al.* 1987) [26004]

For ABCO/scree:

Abies concolor/Holodiscus dumosus (DeVelice *et al.* 1986) [26001]
Abies concolor/Jamesia americana
(Fitzhugh *et al.* 1987) [26002]
Abies concolor-Pseudotuga menziesii/ Holodiscus dumosus (Johnson *et al.* 1987)

For PSME/scree:

Pseudotuga menziesii/Holodiscus dumosus (DeVelice *et al.* 1986, Fitzhugh *et al.* 1987) [26007]

For PIPO/scree:

Pinus ponderosa/Ribes inerme
(DeVelice *et al.* 1986) [26006]

Code(s)
subalpine fir/scree (ABLA/scree) 0 03 35 0
white fir/scree (ABCO/scree) 0 11 13 0
Douglas-fir/scree (PSME/scree) 0 12 38 0
ponderosa pine/scree (PIPO/scree) 0 11 46 0
subalpine fir/scree

Ecological Response Unit (primary)
Spruce-Fir Forest (SFF), subclass Spruce-Fir Upper (SFP)

National Vegetation Classification Group (primary)
Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland (G218)
Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)

white fir/scree

Ecological Response Unit (primary)
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group (primary)
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
Douglas-fir/scree

Ecological Response Unit (primary)
Mixed Conifer – Frequent Fire (MCD) (= "dry mixed conifer")

National Vegetation Classification Group (primary)
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
ponderosa pine/scree

Ecological Response Unit (primary)
Ponderosa Pine Forest (PPF), subclass Ponderosa Pine/Bunchgrass (PPG)

National Vegetation Classification Group (primary)
Southern Rocky Mountain Ponderosa Pine Open Woodland (G229)

Key criteria
Rock fragments make up over 90% of the soil surface. The most shade tolerant tree growing in the stand determines the plant association name.

Structure
Not a commercially viable forest type. Stockability = 0.5. Forage value rating = none.

Location
Found throughout the Southwest on rocky outcroppings, usually on moderate to steep slopes below cliffs; soils are mostly cobbles and boulders, which along with stones and gravels make up >90% of soil volume.

Adjacent plant associations
Any plant association could adjoin a scree forest and is dependent on the elevational gradient where the scree occurs.

Also see
Douglas-fir/Oregon boxleaf (PSME/PAMY, Komarkova 1986); Douglas-fir/fivepetal cliffbush (PSME/JAAM, Johnston 1987); and in the Capitan Mountains, ABCO/LETR and PIEN/LETR

Important & key plants from research plots
Trees

Usually open, sparsely stocked stands, composition depends primarily upon climate.

Shrubs
Scarce (<1%) to well represented (>5%):
currant *(Ribes* spp.*)*
fivepetal cliffbush *(Jamesia americana)*
rockspirea *(Holodiscus dumosus)*
Scouler's willow *(Salix scouleriana)*
Rocky Mountain maple *(Acer glabrum)*

Herbs
Scarce (<1%), variable.

Cryptogams
Well represented to abundant. Lichens on rocks are especially conspicuous.

Synonymy
fivepetal cliffbush (JAAM) = waxflower.

Terrestrial Ecological Unit attributes
All climatic and elevation zones.
Soils are entisols, include talus, scree, rock glaciers, etc.

Phases
No phases are described for these associations.

Fire ecology
Natural fires are generally rare in this type, due to the lack of fuels to carry a fire. Trees often attain very old ages in these naturally fire excluded areas.

Reforestation
Natural regeneration is not reliable. Planting trees is not feasible.

Revegetation considerations
After a disturbance, revegetation can be extremely slow.

Comments
These sites are important for groundwater recharge but are generally non-commercial forests. Depending upon locality and geography, the scree environment may provide special wildlife habitat for species such as certain herpefauna (lizards, snakes, and salamanders) and small mammals (chipmunks, pikas, etc.). Occasionally, large trees develop which are attractive or important to wildlife. Snags and spike-top trees may be important for cavity nesters. This forest type is susceptible to endemic and epidemic budworm populations when high density stand conditions exist, especially when composition is dominated by host species such as true fir and spruce species arranged in multiple canopy layers. Defoliation by western spruce budworm can cause growth loss after 1 or 2 years. Repeated heavy defoliation (4 or 5 years) can cause a significant decrease in growth, tree deformity, top-killing, and ultimately tree mortality, particularly in seedlings and saplings.

References
DeVelice *et al.* 1986
Fitzhugh *et al.* 1987
Pfister *et al.* 1977
USFS 1987a
USFS 1987b
USFS 1986

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 version of USDA, NRCS 2021, 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 four main categories—trees, shrubs, graminoid and forbs (and other herbs)—each category is organized alphabetically by scientific name.

Trees

subalpine fir (*Abies lasiocarpa var. arizonica = A. arizonica = A. bifolia*) aka corkbark fir

corkbark fir (*Abies lasiocarpa var. arizonica = A. arizonica = A. bifolia*)

subalpine fir (*Abies lasiocarpa = A. bifolia)*

thinleaf alder *(Alnus incana* ssp. *tenuifolia = A. tenuifolia)*

velvet ash *(Fraxinus velutina = F. v.* ssp. *pennsylvanica)*

Arizona cypress (*Hesperocyparis arizonica = Cupressus arizonica)*

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

redberry juniper (*Juniperus coahuilensis = J. erythrocarpa* var. *coahulensis)* or Redberry juniper (*Juniper coahuilensis = J. erythrocarpa*)

yellow paloverde *(Parkinsonia microphylla = Cercidium microphyllum)*

Arizona pine *(Pinus arizonica = P. ponderosa var. arizonica)*

border pinyon (*Pinus discolor = Pinus cembroides)* = Mexican pinyon

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

Emory's baccharis = Emory falsewillow

mule-fat *(Baccharis salicifolia = B. glutinosa)* aka seepwillow

dwarf stickpea *(Calliandra humilis* var. *reticulata = C. reticulata)*

alderleaf mountain mahogany (*Cercocarpus montanus*) = true mountain mahogany

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

desert sweet = fernbush

Mexican orange *(Choisya dumosa var.arizonica)* = star-leaf *(C. arizonica)*

green rabbitbrush (*Ericameria teretifolia = Chrysothamnus teretifolius)*

redosier dogwood *(Cornus sericea* ssp. *sericea = C. stolonifera = C. swida)*

tree cholla *(Cylindropuntia imbricata = Opuntia imbricata)*

walkingstick cactus *(Cylindropuntia spinosor = Opuntia spinosor)*

Cholla cacti are now in *Cylindropuntia* instead of *Opuntia*

Whipple cholla *(Cylindropuntia whipplei = Opuntia whipplei)*

turpentine bush (*Ericameria larcifolia = Happlopappus laricifolius)*

rubber rabbitbrush (*Ericameria nauseosa = Chrysothamnus nauseosus*)

rubber rabbitbrush *(Ericameria nauseosa ssp. nauseosa var. glabrata = Chrysothamnus nauseosus* ssp. *gravolens*)

bastardsage = Wright's buckwheat

Utah fendlerbush (*Fendlerella utahensis = Fendlera utahensis*)

stretchberry *(Forestiera pubescens var. pubescens)* = New Mexico olive *(Forestiera neomexicana)*

beechleaf frangula *(Frangula betulifolia = Rhamnus betulaefolia)*

California buckthorn *(Frangula californica) = (Rhamnus californica)*

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

broom snakeweed *(Guiterrizia sarothrae = Xanthocephalum sarothrae)*

cliffbush = waxflower = *(Jamesia americana)*

Krameria erecta = K. parvifolia

winterfat *(Krascheninnikovia lanata = Ceratoides lanata = Eurotia lanata)*
creosotebush *(Larrea tridentata = L. divaricata)*
Fremont mahonia *(Mahonia fremontii = Berberis fremontii)*
red barberry *(Mahonia haematocarpa = Berberis haematocarpa)* = algerita
creeping barberry *(Mahonia repens = Berberis repens)* aka Oregongrape
algerita *(Mahonia trifoliata = Berberis trifoliata)*
catclaw mimosa *(Mimosa aculeaticarpa var. biuncifera = M. biuncifera)*
Rio Grande saddlebush *(Mortonia sempervirens* ssp. *scabrella = M. scabrella)*
Virginia creeper *(Parthenocissus quinquefolia = P. inserta)*
Oregon boxleaf *(Paxistima myrsinites)* = mountain lover or boxleaf myrtle *(Pachystima myrsinites)*
shrubby cinquefoil (*Dasiphora fruticosa* ssp. *floribunda = Pentaphylloides floribunda = Potentilla fruticosa*)
frosted mint (*Poliomintha incana*) = hoary rosemint
velvet mesquite (*Prosopis velutina = Prosopis juliflora*)
broom dalea *(Psorothamnus scoparius = Dalea scoparia)*
Stansbury cliffrose *(Purshia stansburiana = Cowania stansburiana = C. mexicana)*
wavyleaf oak *(Quercus* X *pauciloba = Q. undulata)*
redberry buckthorn = redleaf holly
hollyleaf redberry *(Rhamnus ilicifolia = Rhamnus crocea* var. *ilicifolia)*
pubescent skunkbush *(Rhus trilobata var. pilosissima = R. aromatica)*
evergreen sumac = leatherleaf sumac *(Rhus virens* var. *choriophylla = R. co-riophylla)*
Wood rose (*Rosa woodsii* var. *ultramontana = R. arizonica)*
narrowleaf willow = coyote willow
dewystem willow = bluestem willow
Rocky Mountain elder *(Sambucus racemosa var. melanocarpa =Sambucus racemosa* ssp. *pubens* var. *melanocarpa = S. mela-nocarpa)*
catclaw acacia *(Senegalia greggii = Acacia greggii)*

whortleleaf snowberry = mountain snowberry *(Symphoricarpos oreophilus)*
whitethorn acacia *(Vachellia constricta = Acacia constricta)*
viscid acacia *(Vachellia vernicosa = Acacia neovernicosa)*
skeletonleaf goldeneye = resinbush
yucca *(Yucca madrensis = Yucca schottii)*

Graminoids
needlegrass spp. *(Achnatherum spp. = Stipa spp.)*
Indian ricegrass *(Achnatherum hymenoides = Oryzopsis hymenoides)*
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)*
Fendler threeawn *(Aristida purpurea var. fendleriana = A. fendleriana)*
Fendler threeawn *(Aristida purpurea var. longiseta)* = red threeawn *(A. longiseta)*
Orcutt's threeawn (*Aristida schiedeana var. orcuttiana = Aristida orcuttiana*) = single threeawn
nodding brome *(Bromus anomalus = B. porteri)*
fringed brome (*Bromus ciliatus var. ciliata = B. canadensis* = Canadian brome (aka *B. richardsonii*))
red brome = foxtail
dryspike sedge *(Carex siccata = C. foenea)* = fony sedge
low woollygrass (*Dasyochloa pulchella = Erioneuron pulchellum)* = fluffgrass
tufted hairgrass (*Deschampsia cepitosa = D. caespitosa)*
Arizona wheatgrass *(Elymus arizonicus = Andropogon arizonicum)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
hairy woollygrass *(Erioneuron pilosum = Tridens pilosus)*
Nevada pea *(Lathyrus lanszwertii var. arizonicus = L. arizonicus)* aka Arizona peavine
needle and thread *(Hesperostipa comata = Stipa comata)*
New Mexico feathergrass *(Hesperostipa neomexicana = Stipa neomexicana)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*

mucronate sprangletop *(Leptochloa panicea* ssp. *mucronata = Leptochloa mucronata)*
beardless wildrye (*Leymus triticoides = Elymus triticoides*)
screwleaf muhly *(Muhlenbergia straminea = M. virescens)*
slimflower muhly *(Muhlenbergia tenuifolia = M. monticola)*
vine mesquite = obtuse panicgrass
western wheatgrass *(Pascopyrum smithii = Agropyron smithii)*
littleseed ricegrass *(Piptatheropsis micrantha = Oryzopsis micrantha)*
Pringle's spear grass *(Piptochaetium pringlei = Stipa pringlei)*
James' galleta (*Pleuraphis jamesii = Hilaria jamesii*)
tobosagrass (*Pleuraphis mutica = Hilaria mutica*)
Texas bluestem *(Schizachyrium cirratum = Andropogon cirratus)*
little bluestem *(Schizachyrum scoparium = Andropogon scoparius)*
large-spike bristlegrass = yellow bristlegrass
slim tridens *(Tridens muticus var. elongatus = T. elongatus)*
spike trisetum (*Trisetum spicatum* = *T. montanum* = Rocky Mountain trisetum)

Forbs and other plants

prairie acacia (*Acaciella angustissima = Acacia angustissima*)

western yarrow (*Achillea millefolium var. occidentalis = A. lanulosa*)

white sagebrush = Louisiana sagewort

rose heath (*Chaetopappa ericoides = Leucelene ericoides*)

fireweed (*Chamerion angustifolium spp. angustifolium = Epilobium angustifolium* ssp *angustifolium)*

rock clematis (*Clematis columbiana var. columbiana = C. pseudoalpina*)

brittle bladderfern = brittle fragile fern

sprucefir fleabane (*Erigeron eximius*) = forest fleabane (*E. superbus*)

trailing fleabane (*Erigeron flagellaris = E. nudiflorus*)

New Mexico fleabane (*Erigeron neomexicanus = E. delphinifolius*)

Vreeland erigeron (*Erigeron vreelandii = E. platyphyllus*)

woodland strawberry (*Fragaria vesca = Fragaria americana*)

Virginia strawberry (*Fragaria virginiana*) = wild strawberry (*F. ovalis*)

elkweed (*Frasera speciosa*) = green gentian (*Swertia radiata*)

Mexican bedstraw (*Galium mexicanum ssp. asperrimum = G. asperrimum*)

Ross' avens (Geum rossii var. *turbinatum = Acomastylis rossii)*

hairy false goldenaster (*Heterotheca villosa var. villosa = Chrysopsis villosa*) = hairy goldenaster

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

owl's-claw (*Hymenoxys hoopesii*) = owlsclaws (*Dugaldia hoopesii*) = orange sneezeweed (*Helenium hoopesii*)

Nevada pea *(Lathyrus lanszwertii* var *leucanthus = L. lanszwertii var arizonica = L. arizonica*) aka Arizona peavine

Porter's licorice-root aka *oshá*

manyflowered stoneseed = manyflowered gromwell

slender goldenweed (*Machaeranthera gracilis = Haplopappus gracilis*)

lacy tansyaster (*Machaeranthera pinnatifida = Haplopappus spinulosus*)

feathery false lily of the valley *(Maianthemum racemosum = Smilacina racemosa* aka feathery false Solomon seal*)*
starry false lily of the valley (*Maianthemum stellatum = Smilacina stellata*), aka starry false Solomon seal
mintleaf beebalm (*Monarda fistulosa* ssp. *fistulosa var. menthifolia = M. menthifolia)*
alpine pennycress *(Noccaea fendleri* ssp. *glauca = Thlaspi montanum* var. *montanum*)
Parry's goldenrod (*Oreochrysum parryi = Haplopappus parryi = Solidago parryi*)
bluntseed sweetroot (*Osmorhiza depauperata*) = sweetcicily (*O. obtusa*)
bittercress ragwort *(Packera cardamine = Senecio cardamine = cardamine groundsel)*
New Mexico groundsel (*Packera neomexicana = Senecio neomexicana)*
New Mexico groundsel (*Packera neomexicana* var. *neomexicana = Senecio neomexicanus)*
burnet ragwort (*Packera sanguisorboides = Senecio sanguisorboides)*
canyon bog orchid (*Platanthera sparsiflora var. sparsiflora = Habenaria sparsiflora*)
Jacob's ladder (*Polemonium pulcherrimum var. delicatum*) = skunkweed polemonium (*Polemonium delicatum)*
slimflower scurfpea (*Psoralidium tenuiflorum = Psoralea tenuiflora)*
Wooton's ragwort = Wooton's groundsel
threenerve goldenrod (*Solidago velutina = S. sparsifolia)*
mountain goldenbanner (*Thermopsis montana = Thermopsis rhombifolia var. montana = T. pinetorum),* aka mountain thermopsis
pine goldenpea (*Thermopsis rhombifolia var. divericarpa = T. divericarpa)*
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 accurately be able to identify plant associations in the Southwest. For most geographic areas, you will need to be familar 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 in four main categories—trees, shrubs, graminoids and forbs—and is then organized alphabetically by scientific name. CODES are unique identifiers assigned by the NRCS.

Trees

*	ABCO	white fir	Abies concolor
*	ABLA	subalpine fir	Abies lasiocarpa
*	ABLAA	corkbark fir	Abies lasiocarpa var. arizonica
*	ABLAL	subalpine fir	Abies lasiocarpa var. lasiocarpa
	ACNE2	boxelder	Acer negundo
	AIAL	tree of heaven	Ailanthus altissima
*	ALINT	thinleaf alder	Alnus incana ssp. tenuifolia
	ALOB2	Arizona alder	Alnus oblongifolia
	ARAR2	Arizona madrone	Arbutus arizonica
	BEOC2	water birch	Betula occidentalis
	CABI8	southern catalpa	Catalpa bignonioides
	CELAR	netleaf hackberry	Celtis laevigata var reticulata
	ELAN	Russian olive	Elaeagnus angustifolia
	FRAN2	singleleaf ash	Fraxinus anomala
	FRVE2	velvet ash	Fraxinus velutina
	GLTR	honeylocust	Gleditsia triacanthos
	HEAR22	Arizona cypress	Hesperocyparis arizonica
	HEGL4	smooth Arizona cypress	Hesperocyparis glabra
*	JUMA	Arizona walnut	Juglans major
	JUMI	little walnut	Juglans microcarpa
*	JUCO11	redberry juniper	Juniperus coahuilensis
*	JUDE2	alligator juniper	Juniperus deppeana
*	JUMO	oneseed juniper	Juniperus monosperma
*	JUOS	Utah juniper	Juniperus osteosperma
*	JUPI	Pinchot's juniper	Juniperus pinchotii
*	JUSC2	Rocky Mountain juniper	Juniperus scopulorum
	MASY2	European crab apple	Malus sylvestris
	MOAL	white mulberry	Morus alba
	PAMI5	yellow paloverde	Parkinsonia microphylla
*	PIEN	Engelmann spruce	Picea engelmannii

*	PIPU	blue spruce	Picea pungens
*	PIAR	bristlecone pine	Pinus aristata
*	PIARA	Arizona pine	Pinus arizonica
*	PIDI3	border pinyon	Pinus discolor
*	PIED	twoneedle pinyon	Pinus edulis
*	PIEN2	Apache pine	Pinus engelmannii
*	PIFL2	limber pine	Pinus flexilis
*	PILE	Chihuahua pine	Pinus leiophylla
*	PIMO	singleleaf pinyon	*Pinus monophylla*
*	PIPO	ponderosa pine	*Pinus ponderosa*
*	PIST3	southwestern white pine	*Pinus strobiformis*
*	PLWR2	Arizona sycamore	*Plantanus wrightii*
	POAC5	lanceleaf cottonwood	*Populus* X *acuminata*
*	POAN3	narrowleaf cottonwood	*Populus angustifolia*
	PODEM	plains cottonwood	*Populus deltoides* spp. *monilifera*
*	PODEW	Rio Grande cottonwood	*Populus deltoides* spp. *wislizeni*
*	POFR2	Fremont's cottonwood	*Populus fremontii*
*	POTR5	quaking aspen	*Populus tremuloides*
	PRSE2	black cherry	*Prunus serotina*
*	PSME	Douglas-fir	*Pseudotsuga menziesii*
*	QUAR	Arizona white oak	*Quercus arizonica*
*	QUEM	Emory oak	*Quercus emoryi*
*	QUGA	Gambel oak	*Quercus gambelii*
*	QUGR3	gray oak	*Quercus grisea*
*	QUHY	silverleaf oak	*Quercus hypoleucoides*
*	QUOB	Mexican blue oak	*Quercus oblongifolia*
*	QURU4	netleaf oak	*Quercus rugosa*
	ROPS	black locust	*Robinia pseudoacacia*
	SABA	weeping willow	*Salix babylonica*
	SABE2	Bebb willow	*Salix bebbiana*
	ULPU	Siberian elm	*Ulmus pumila*

Shrubs

	ACAN11	prairie acacia	Acaciella angustissima
*	ACGL	Rocky Mountain maple	Acer glabrum
*	ACGR3	bigtooth maple	Acer grandidentatum
*	AGLE	lechuguilla	Agave lechuguilla
	AGPA3	Palmer's century plant	Agave palmeri
	AGPA4	Parry's agave	Agave parryi
	AGUT	Utah agave	Agave utahensis
	AGHE5	fragrant snakeroot	Ageratina herbacea
	ALWR	Wright beebrush	Aloysia wrightii
	AMELA	serviceberry	Amelanchier spp.
	AMUT	Utah serviceberry	Amelanchier utahensis
	ARPR	Pringle manzanita	Arctostaphylos pringlei
*	ARPU5	pointleaf manzanita	Arctostaphylos pungens
	ARCTO3	manzanita	Arctostaphylos spp.

*	ARUV	kinnikinnick	Arctostaphylos uva-ursi
*	ARBI3	Bigelow sagebrush	Artemisia bigelovii
	ARFI2	sand sagebrush	Artemisia filifolia
**	ARNO4	black sagebrush	Artemisia nova
*	ARTR2	big sagebrush	Artemisia tridentata
	ATCA2	fourwing saltbush	Atriplex canescens
	BAEM	Emory's baccharis	Baccharis emoryi
	BAPT	yerba de pasmo	Baccharis pteronioides
	BASA4	mule-fat	Baccharis salicifolia
	BATH	Arizona baccharis	Baccharis thesiodes
	BRBR2	plumed brickellbush	Brickellia brachyphylla
	BRCA3	California brickellbush	Brickellia californica
	BRRU	stinking brickellbrush	Brickellia rusbyi
	CAER	fairyduster	Calliandra eriophylla
	CAHUR	dwarf stickpea	Caliandra humilis var. reticulata
*	CAHO3	crucifixion thorn	Canotia holacantha
	CABI6	Bigelow bristlehead	Carphochaete bigelovii
*	CEFE	Fendler's ceanothus	Ceanothus fendleri
*	CEGR	desert ceanothus	Ceanothus greggii
**	CEMO2	Alderleaf mountain mahogany	Cercocarpus montanus
	CEMOP	hairy mountain mahogany	Cercocarpus montanus var. paucidentatus
	CERCO	mountain mahogany	Cercocarpus spp.
	CHMI2	desert sweet	Chamaebatiaria millefolium
	CHLI2	desert willow	Chilopsis linearis
*	CHDUA	Mexican orange	Choisya dumosa var. arizonica
	CHDE2	longflower rabbitbrush	Chrysothamnus depressus
	CHRYS9	rabbitbrush	Chrysothamnus spp.
	CHVI8	yellow rabbitbrush	Chrysothamnus viscidiflorus
	ERTE	green rabbitbrush	Ericameria teretifolia
	CLLI2	western white clematis	Clematis ligusticifolia
*	CORA	blackbrush	Coleogyne ramosissima
	COSP3	knifeleaf condalia	Condalia spathulata
	COSES	redosier dogwood	Cornus sericea
	CRER	cerro hawthorn	Crataegus erythropoda
	CYIM2	tree cholla	Cylindropuntia imbricata
	CYSP8	walkingstick cactus	Cylindropuntia spinosior
	CYLIN2	cholla (generic)	Cylindropuntia spp.
	CYWH	Whipple cholla	Cylindropuntia whipplei
	DAFO	featherplume	Dalea formosa
	DALE2	green sotol	Dasylirion leiophyllum
	DAWH2	common sotol	Dasylirion wheeleri
	EPTR	lonlleaf jointfir	Ephedra trifurca
	EPVI	Mormon tea	Ephedra viridis
	ERLA12	turpentine bush	Ericameria laricifolia

*	ERNA10	rubber rabbitbrush	Ericameria nauseosa
	ERNAG	rubber rabbitbrush	Ericameria nauseosa spp. nauseosa var. glabrata
	ERWR	bastardsage	Eriogonum wrightii
*	FAPA	Apacheplume	Fallugia paradoxa
	FERU	cliff fendlerbush	Fendlera rupicola
	FEUT	Utah fendlerbush	Fendlerellfra utahensis
	FOPUP	stretchberry	Forestiera pubescens var pubescens
	FOSP2	ocotillo	Fouquieria splendens
	FERBE2	beechleaf frangula	Frangula betulifolia
	FRCAU	California buckthorn	Frangula californica spp. ursina
	GAFL2	ashy silktassel	Garrya flavescens
	GAOV	eggleaf silktassel	Garrya ovata
*	GAWR3	Wright silktassel	Garrya wrightii
	GLSP	spiny greasebush	Glossopetalon spinescens
	GUMI	threadleaf snakeweed	Gutierrezia microcephala
	GUSA2	broom snakeweed	Gutierrezia sarothrae
	GYGL	gumhead	Gymnosperma glutinosum
*	HODU	rockspirea	Holodiscus dumosus
	HYMO	singlewhorl burrobush	Hymenoclea monogyra
	HYRI	pingue rubberweed	Hymenoxys richardsonii
	ISPL	southern goldenbush	Isocoma pluriflora
	ISTE2	burroweed	Isocoma tenuisecta
*	JAAM	fivepetal cliffbush	Jamesia americana
*	JUCO6	common juniper	Juniperus communis
	KRER	littleleaf ratany	Krameria erecta
*	KRLA2	winterfat	Krascheninnikovia lanata
*	LATR2	creosotebush	Larrea tridentata
*	LIBO3	twinflower	Linnaea borealis
	LOAL	western white honeysuckle	Lonicera albiflora
	LOAR	Arizona honeysuckle	Lonicera arizonica
	LOIN5	twinberry honeysuckle	Lonicera involucrata
	LOUT2	Utah honeysuckle	Lonicera utahensis
	LYBE	Berlandier's wolfberry	Lycium berlandieri
	LYPA	pale wolfberry	Lycium pallidum
	MAFR3	Fremon'st mahonia	Mahonia fremontii
	MAHA4	red barberry	Mahonia haematocarpa
**	MARE11	creeping barberry	Mahonia repens
	MATR3	algerita	Mahonia trifoliata
	MESC	rough menodora	Menodora scabra
	MIACB	catclaw mimosa	Mimosa aculeaticarpa
	MOSE	Rio Grande saddlebush	Mortonia sempervirens
	MOMI	Texas mulberry	Morus microphylla
*	NOMI	sacahuista	Nolina microcarpa
	OPUNT	prickly pear (generic)	Opuntia spp.

	OPEN3	cactus apple	Opuntia engelmannii
	OPPH	tulip pricklypear	Opuntia phaeacantha
	OPPO	plains pricklypear	Oputia polyacantha
	ORSE	sidebells wintergreen	Orthilia secunda
	PAQU2	Virginia creeper	Parthenocissus quinquefolia
	PAMY	Oregon boxleaf	Paxistima myrsinites
	DAFL3	shrubby cinquefoil	Pentaphylloides floribunda
	PERA4	wild crab apple	Peraphyllum ramosissimum
	PHMI4	littleleaf mock orange	Philadelphus microphyllus
*	PHMO4	mountain ninebark	Physocarpus monogynus
	PLSE	arrowweed	Pluchea sericea
*	POIN3	frosted mint	Poliomintha incana
	PRGL2	honey mesquite	Prosopis glandulosa
	PRVE	velvet mesquite	Prosopis velutina
	PRAM	American plum	Prunus americana
	PRVI	common chokecherry	Prunus virginiana
	PSSC6	broom dalea	Psorothamnus scoparius
	PTTR	common hoptree	Ptelea trifoliata
**	PUST	Stansbury cliffrose	Purshia stansburiana
*	PUTR2	antelope bitterbrush	Purshia tridentata
	PYCH	greenflowered wintergreen	Pyrola chlorantha
	QUCH2	canyon live oak	Quercus chrysolepis
*	QUGA	Gambel oak	Quercus gambelii
*	QUGR3	gray oak	Quercus grisea
*	QUHY	silverleaf oak	Quercus hypoleucoides
*	QURU4	netleaf oak	Quercus rugosa
	QUERC	shrubby forms oaks	Quercus spp.
*	QUTO2	Toumey oak	Quercus toumeyi
*	QUTU2	shrub live oak	Quercus turbinella
**	QUPA4	wavyleaf oak	Quercus X pauciloba
	RHCR	redberry buckthorn	Rhamnus crocea
	RHIL	hollyleaf redberry	Rhamnus ilicifolia
	RHOV	sugar sumac	Rhus ovata
*	RHTR	skunkbush sumac	Rhus trilobata
	RHTRP	pubescent skunkbush	Rhus trilobata var. pilosissima
*	RHVIC	evergreen sumac	Rhus virens var. choriophylla
	RICE	wax currant	Ribes cereum
*	RIMO2	gooseberry currant	Ribes montigenum
	RIPI	orange gooseberry	Ribes pinetorum
	RIBES	currant	Ribes spp.
	RIWO	Wolf's currant	Ribes wolfii
*	RONE	New Mexico locust	Robinia neomexicana
	ROSA5	wild rose	Rosa spp.
	ROWOU	wood rose	Rosa woodsii var. ultramontana
	RUNE	New Mexico raspberry	Rubus neomexicanus
*	RUPA	thimbleberry	Rubus parviflorus

	SAAM2	peachleaf willow	Salix amygdaloides
	SAEX	narrowleaf willow	Salix exigua
	SAGO	Goodding's willow	Salix gooddingii
	SAIR	bluestem willow	Salix irrorata
*	SASC	Scouler's willow	Salix scouleriana
	SARAM4	Rocky Mountain elderberry	Sambucus racemosa var. melanocarpa
	SEGR4	catclaw acacia	Senegalia greggii
	SHAR	silver buffaloberry	Shepherdia argentea
	SODU2	Arizona mountain ash	Sorbus dumosa
*	SYOR2	mountain snowberry	Symphoricarpos oreophilus
	THMO	turpentinebroom	Thamnosma montana
	TORA2	eastern poison ivy	Toxicodendron radicans
	TORY	western poison ivy	Toxicodendron rydbergii
	VACE	dwarf bilberry	Vaccinium cespitosum
*	VAMY2	whortleberry	Vaccinium myrtillus
	VASC	grouse whortleberry	Vaccinium scoparium
	VACO9	whitethorn acacia	Vachellia constricta
	VAVE	viscid acacia	Vachellia vernicosa
	VIST	resinbush	Viguiera stenoloba
*	VIAR2	canyon grape	Vitis arizonica
	YUAN2	narrowleaf yucca	Yucca angustissima
*	YUBA	banana yucca	Yucca baccata
	YUEL	soaptree yucca	Yucca elata
	YUMA4	Schott yucca	Yucca madrensis
	YUCCA	yucca	Yucca spp

Graminoids

	ACHNA	needlegrass spp.	Achnatherum
*	ACHY	Indian ricegrass	Achnatherum hymenoides
*	ACNED	Dore's needlegrass	Achnatherum nelsonii ssp. dorei
	ACSC11	Scribner needlegrass	Achnatherum scribneri
	ACSP12	desert needlegrass	Achnatherum speciosum
	ANGE	big bluestem	Andropogon gerardii
*	ANHA	*sand bluestem	Andropogon hallii
	ARAR6	Arizona threeawn	Aristida arizonica
	ARPUF	Fendler's threeawn	Aristida purpurea var. fendleriana
	ARPUL	Fendler's threeawn	Aristida purpurea var. longiseta
	ARSCO	orcutt's threeawn	Aristida schiedeana var. orcuttiana
	ARIST	threeawn	Aristida spp.
	ARTE3	spidergrass	Aristida ternipes
	BLTR	pine dropseed	Blepharoneuron tricholepis
	BOBA3	cane bluestem	Bothriochloa barbinodis
*	BOCU	sideoats grama	Bouteloua curtipendula
*	BOER4	black grama	Bouteloua eriopoda
*	BOGR2	blue grama	Bouteloua gracilis
*	BOHI2	hairy grama	Bouteloua hirsuta

	BORA	purple grama	Bouteloua radicosa
	BORE2	slender grama	Bouteloua repens
	BRAN	nodding brome	Bromus anomalus
*	BRCI2	fringed brome	Bromus ciliatus
	BRLA6	woolly brome	Bromus lanatipes
	BRRU2	red brome	Bromus rubens
	BROMU	brome	Bromus spp.
	CAGE	White Mountain sedge	Carex geophila
	CARO5	Ross' sedge	Carex rossii
*	CASI12	dryspike sedge	Carex siccata
	CAREX	sedges	Carex spp.
	DAPA2	Parry's oatgrass	Danthonia parryi
	DAPU7	low woollygrass	Dasyochloa pulchella
	DECE	tufted hairgrass	Deschampsia cespitosa
	ELAR7	Arizona wheatgrass	Elymus arizonicus
	ELEL5	bottlebrush squirreltail	Elymus elymoides
	ERIN	plains lovegrass	Eragrostis intermedia
	ERPI5	hairy woollygrass	Erioneuron pilosum
*	FEAR2	Arizona fescue	Festuca arizonica
	FEBRB	alpine fescue	Festuca brachyphylla ssp. brachyphylla
	FESO	ravine fescue	Festuca sororia
*	FESC	Thurber's fescue	Festuca thurberi
*	HECO26	intermediate needle and thread	Hesperostipa comata
	HENE5	New Mexico feathergrass	Hesperostipa neomexicana
*	HIBE	curlymesquite	Hilaria belangeri
	KOMA	prairie junegrass	Koelaria macrantha
	LEDU	green sprangletop	Leptochloa dubia
	LEPAM	mucronate sprangletop	Leptochloa panicea ssp. mucronata
*	LETR5	beardless wildrye	Leymus triticoides
	LYPH	common wolfstail	Lycurus phleoides
*	MUDU	pine muhly	Muhlenbergia dubia
*	MUEM	bullgrass	Muhlenbergia emersleyi
*	MULO	longtongue muhly	Muhlenbergia longiligula
*	MUMO	mountain muhly	Muhlenbergia montana
*	MUPA2	New Mexico muhly	Muhlenbergia pauciflora
	MUPO2	bush muhly	Muhlenbergia porteri
*	MUPU2	sandhill muhly	Muhlenbergia pungens
	MURI	mat muhly	Muhlenbergia richardsonis
	MUSE	curlyleaf muhly	Muhlenbergia setifolia
*	MUST	screwleaf muhly	Muhlenbergia straminea
	MUTE4	slender muhly	Muhlenbergia tenuifolia
	MUTO2	ring muhly	Muhlenbergia torreyi
	PABU	bulb panicgrass	Panicum bulbosum

	PACA6	witchgrass	Panicum capillare
	PAOB	vine mesquite	Panicum obtusum
	PASM	western wheatgrass	Pascopyrum smithii
	PIMI	littleseed ricegrass	Piptatheropsis micrantha
*	PIFI	pinyon ricegrass	Piptochaetium fimbriatum
	PIPR2	Pringle's needlegrass	Piptochaetium pringlei
*	PLJA	James' galleta	Pleuraphis jamesii
*	PLMU3	tobosagrass	Pleuraphis mutica
*	POFE	muttongrass	Poa fendleriana
*	POPR	Kentucky bluegrass	Poa pratensis
	SCCI2	Texas bluestem	Schizachyrium cirratum
*	SCSC	*little bluestem	Schizachyrium scoparium
	SEMAS	large-spike bristlegrass	Setaria macrostachya
*	SPAI	alkali sacaton	Sporobolus airoides
	SPCO4	spike dropseed	Sporobolus contractus
	SPCR	sand dropseed	Sporobolus cryptandrus
	TRMUE	slim tridens	Tridens muticus
	TRSP2	spike trisetum	Trisetum spicatum

Forbs

	ACAN11	prairie acacia	Acaciella angustissima
	ACMI2	common yarrow	Achillea millefolium
	ACRU2	red baneberry	Actaea rubra
	ALKU	Kunth onion	Allium kunthii
	ANPA4	small-leaf pussytoes	Antennaria parvifolia
	ANRO2	rosy pussytoes	Antennaria rosea
	ANTEN	pussytoes	Antennaria spp.
	AQCH	golden columbine	Aquilegia chrysantha
	ARFR4	prairie sagewort	Artemisia frigida
	ARLU	white sagebrush	Artemisia ludoviciana
	ARTEM	sagebrush	Artemisia spp.
	ARFR3	ragweed sagebrush	Artemsia franserioides
	ASFL	yellow milkvetch	Astragalus flavus
	BRGR	tasselflower brickellbush	Brickellia grandiflora
	BRLE	Lemmon's brickellbush	Brickellia lemmonii
	BRICK	brickellbush	Brickellia spp.
	CAHU	dwarf stickpea	Calliandra humilis
	CAHUR	dwarf stickpea	Calliandra humilis var. reticulata
	CHER2	rose heath	Chaetopappa ericoides
	CHANA2	fireweed	Chamerion angustifolium spp. angustifolium
	CHFE2	Fendler's lipfern	Cheilanthes fendleri
	CIRSI	thistle	Cirsium
	CLCO2	rock clematis	Clematis columbiana
	CYFR2	brittle bladderfern	Cystopteris fragilis
	DERO2	Rose's ticktrefoil	Desmodium rosei

	DESMO	ticktrefoil	Desmodium spp.
*	EREX4	sprucefir fleabane	Erigeron eximius
	ERFL	trailing fleabane	Erigeron flagellaris
	ERFO3	beautiful fleabane	Erigeron formosissimus
	ERNE3	New Mexico fleabane	Erigeron neomexicanus
	ERVR	Vreeland's erigeron	Erigeron vreelandii
	ERAL4	winged buckwheat	Eriogonom alatum
	ERJA	James' buckwheat	Eriogonum jamesii
	ERRA3	redroot buckwheat	Eriogonum racemosum
	ERCI6	redstem stork’s bill	Erodium cicutarium
	ERRE4	spreading wallflower	Erysimum repandum
	FRVE	woodland strawberry	Fragaria vesca
	FRVI	Virginia strawberry	Fragaria virginiana
	FRSP	elkweed	Frasera speciosa
	GAMEA	Mexican bedstraw	Galium mexicanum ssp. asperrimum
	GAMI	bracted bedstraw	Galium microphyllum
	GALIU	bedstraw	Galium ssp.
	GECA3	pineywoods geranium	Geranium caespitosum
	GERI	Richardson's geranium	Geranium richardsonii
	GEAL	yellow avens	Geum aleppicum
	GEROT	Ross' avens	Geum rossii var. turbinatum
	GORE2	lesser rattlesnake plantain	Goodyera repens
	HEHY	aromatic false pennyroyal	Hedeoma hyssopifolia
	HEAN3	common sunflower	Helianthus annuus
	HEVIV	hairy false goldenaster	Heterotheca villosa var. villosa
	HIFE	yellow hawkweed	Hieracium fendleri
	HYFIL	fineleaf hymenopappus	Hymenopappus filifolius var. lugens
	HYHO	owl's-claws	Hymenoxys hoopseii
*	LALAL3	Nevada pea	Lathyrus lanszwertii var. leucanthus
	LIPO	Porter's licorice-root	Ligusticum porteri
	LIMU3	manyflowered stoneseed	Lithospermum multiflorum
	LOWR	Wright's deervetch	Lotus wrightii
	MAGR10	slender goldenweed	Machaeranthera gracilis
	MAPI	lacy tansyaster	Machaeranthera pinnatifida
	MARA7	feathery false lily of the valley	Maianthemum racemosum
	MAST4	starry false lily of the valley	Maianthemum stellatum
	MELE2	plains blackfoot	Melampodium leucanthum
	MESC	rough menodora	Menodora scabra
*	MECI3	tall fringed bluebells	Mertensia ciliata
	MEFR2	Franciscan bluebells	Mertensia franciscana
	MEMA2	Macdougal's bluebells	Mertensia macdougalii
	MIMU	Colorado four o'clock	Mirabilis multiflora

	MOFIF2	wild bergamot	Monarda fistulosa var. fistulosa
	MOUN2	single delight	Monesis uniflora
	NOFEG	alpine pennycress	Noccaea fendleri ssp.glauca
	ORPA3	Parry's goldenrod	Oreochrysum parryi
	OSDE	bluntseed sweetroot	Osmorhiza depauperata
**	PACA34	bittercress ragwort	Packera cardamine
	PANE7	New Mexico groundsel	Packera neomexicana
	PANEN	New Mexico groundsel	Packera neomexicana var. neomexicana
**	PASA12	burnet ragwort	Packera sanguisorboides
	PECE	dwarf lousewort	Pedicularis centranthera
	PELI2	toadflax penstemon	Penstemon linarioides
	PEWH	Whipple's penstemon	Penstemon whippleanus
	PHASE	wild beans	Phaseolus spp
	PHLOX	phlox	Phlox spp.
	PLSP2	sparse-flowered bog orchid	Platanthera sparsiflora
*	POPUD2	Jacob’s ladder	Polemonium pulcherrimum var. delicatum
	POAL4	white milkwort	Polygala alba
	POVI3	alpine bistort	Polygonum viviparum
	POAL9	whiteflower cinquefoil	Potentilla albiflora
	POHI6	woolly cinquefoil	Potentilla hippiana
	PSMO	alpine false springparsley	Pseudocymopterus montanus
	PSSP	greenstem paperflower	Psilostrophe sparsiflora
	PSTE5	slimflower scurfpea	Psoralidium tenuiflorum
	PTAQ	western brackenfern	Pteridium aquilinum
	SEAM	showy alpine ragwort	Senecio amplectens
	SEBI2	nodding ragwort	Senecio bigelovii
	SEWO	Wooton's ragwort	Senecio wootonii
	SIPR	creeping sibbaldia	Sibbaldia procumbens
	SOSP	coast goldenrod	Solidago spathulata
	SOLID	goldenrod	Solidago spp.
	SOVE6	threenerve goldenrod	Solidago velutina
	SPHAE	globemallow	Sphaeralcea spp.
	THFE	Fendler's meadow-rue	Thalictrum fendleri
	THMO6	mountain goldenbanner	Thermopsis montana
	THRH	prairie thermopsis	Thermopsis rhombifolia
	VAAC	sharpleaf valerian	Valeriana acutiloba
*	VAAR3	Arizona valerian	Valeriana arizonica
	VIAM	American vetch	Vicia americana
	VIPU2	sweetclover vetch	Vicia pulchella
	VICA4	Canadian white violet	Viola canadensis
	ZIGR	Rocky Mountain zinnia	Zinnia grandiflora

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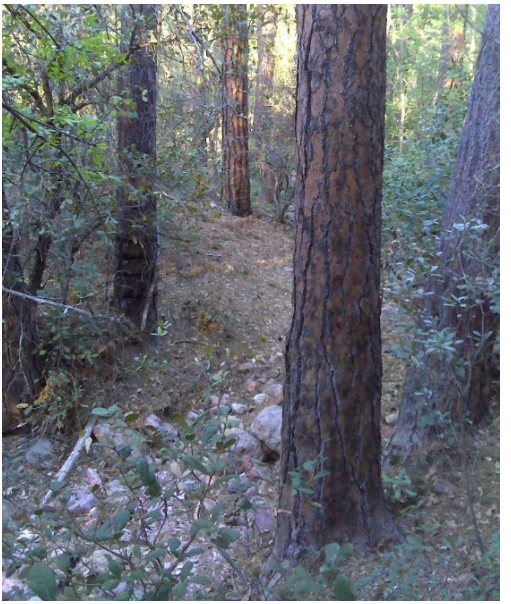
Photos (some associations)

Ponderosa Pine/Arizona Fescue (PIPO/FEAR) habitat type (Ponderosa Pine Forest ERU, Ponderosa Pine/Bunchgrass subclass)

Ponderosa Pine/Arizona White Oak (PIPO/QUAR) habitat type
(Ponderosa Pine – Evergreen Oak ERU, Shrub subclass)



Ponderosa Pine/Gambel Oak (PIPO/QUGA) habitat type (Ponderosa Pine Forest ERU, Ponderosa Pine/Gambel Oak subclass)

Ponderosa Pine/Pointleaf Manzanita (PIPO/ARPU) habitat type
(Ponderosa Pine – Evergreen Oak ERU, Shrub subclass)

Ponderosa Pine/Screwleaf Muhly (PIPO/MUVI) habitat type (Ponderosa Pine Forest ERU, Ponderosa Pine/Bunchgrass subclass)

Ponderosa Pine/Emory Oak (PIPO/QUEM) habitat type (Ponderosa Pine – Evergreen Oak ERU, Shrub subclass)

Ponderosa Pine/Blue Grama (Ponderosa Pine Forest ERU, Ponderosa Pine/Bunchgrass subclass)

White Fir/Arizona Fescue (ABCO/FEAR) habitat type (Mixed Conifer – Frequent Fire ERU)

Corkbark Fir/Arizona Peavine (ABLA/LALA) (Spruce-Fir Forest ERU, Upper subclass)

Corkbark Fir/Dryspike Sedge (ABLA/CAFO3) habitat type (Spruce-Fir Forest ERU, Upper subclass)

Douglas-fir/Gambel Oak (PSME/QUGA) habitat type (Mixed Conifer – Frequent Fire ERU)