United States
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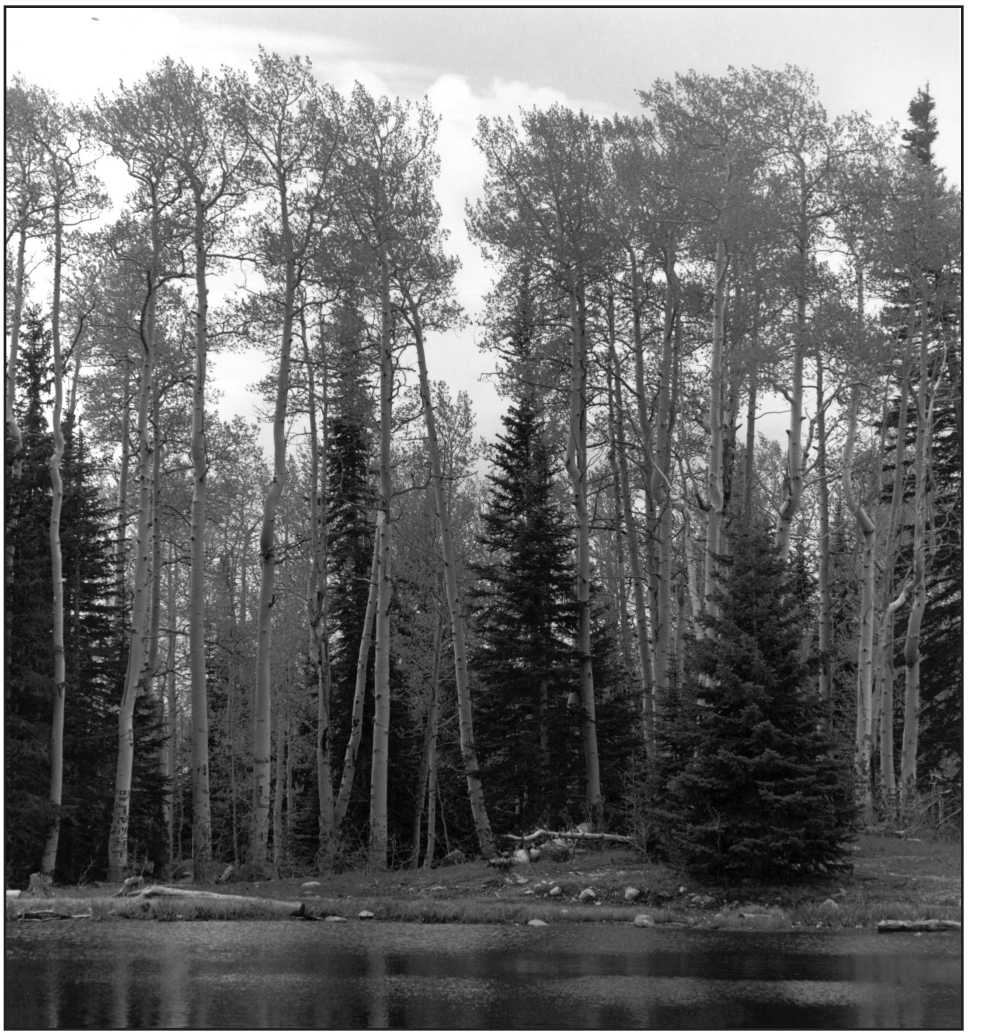
**Southwestern
Region**

Plant Associations of Arizona and New Mexico, edition 3

Volume 1: Forests



Plant Associations of Arizona and New Mexico Volume 1: Forests

Edition 3

USDA Forest Service

Southwestern Region

Habitat Typing Guides

July 1997

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Acknowledgements

This report 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 version has been compiled, written, and edited by Mary Stuever and John Hayden. 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.

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 have been adapted to develop the woodland descriptions.

Information for this update has come from many sources including comments from reviewers, who are 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, 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 these updated 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.

Preface

Over 10 years ago I had the opportunity to attend a 4-day, field-based workshop on habitat typing. The course, one of eight presented in the mid-1980's by Will Moir and Milo Larson, was one of the most significant experiences of my forestry career. I found that by utilizing the habitat typing or plant association concepts, I could finally communicate with my peers about forest ecology observations and rapidly increase my understanding of a wide diversity of forest ecosystems. By providing a language for the transmission of ideas and observations, habitat typing (referring to forest stands by their plant associations) has greatly enhanced our ability to discuss and understand the role of forest management in a wide variety of types.

Although foresters (particularly silviculturists) originally pioneered the use of habitat types in this region, this tool is now employed by many other natural resource professionals, including 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 areas for predicting future responses to management activities.

The nature of this system is 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 presented me with my set of the regional habitat typing guides in 1987, he assured me that this was just the beginning. Yet, I was told, as a working professional in the field, it would be my responsibility, as well as the rest of my colleagues, to collect the information we gleaned from our experiences and enhance these guides.

I have kept this directive in mind, as I have facilitated a dozen habitat typing courses. I have been mentored by hundreds of resource professionals who have been involved in these workshops.

I am grateful to have the daunting, yet exciting opportunity to update the plant association descriptions for the Southwestern Region's forests and woodlands. Our goal has been to enhance the previous edition of the habitat typing guides by expanding information and establishing language for multi-disciplinary use, and yet maintain the information that was already provided.

This publication is edition 3 of our knowledge of plant associations. Edition 2 was the three volume set of Forest and Woodland Habitat Types for three geographic regions within the Southwest compiled by Moir & Larson. Edition 1 was the handouts provided during the first round of habitat typing training in this region (taught by Moir & Larson). I would like to pass along the challenge to all users of this guide to continue to document your observations and experiences for Edition 4. Comments on this guide should be sent to the Regional Forester, USFS Southwestern Region, 333 Broadway Blvd., SE, Albuquerque, New Mexico 87102.

This field guide could not have been assembled in the timeframe needed without the assistance of John Hayden. I am indebted to John for his tireless commitment to this project even though the work exceeded all of our estimates of what would be required.

I would also like to commend Forest Service Regional Silviculturist John Shafer for his commitment and vision to see this project through, and his excellent insight, knowledge, and understanding of the southwestern forest habitat types.

The real credit for the existence of the plant association classification system in the Southwest goes to the hundreds of resource professionals that use this system to communicate their extensive knowledge of our natural resources. Hopefully, you will find this volume a useful resource to your daily operations.

Mary Stuever
Consulting Forester
Placitas, New Mexico
September 30, 1996

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 inactivities. Classification of various types of forests and woodlands allows us to make general statements about observations in one site and apply the knowledge learned to a similar site. The recognition of plant associations provides one system of classification, based on potential natural vegetation, and applied at the plant association level.

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 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.

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 many 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 desired future condition the manager is hoping to attain through prescribed activities. It is helpful to think of the plant association as a "name" rather than a goal for stand conditions.

Another important guideline when matching these descriptions to stands in the woods 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 not all the plants listed will actually occur in any given stand.

Information may not be consistent from association to association. Therefore, 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 PLANT NAMES

Since the publishing of the three Regional Forest and Woodland Habitat Type (Plant Association) guides in 1986 and 1987, approximately 25% of the scientific names of the plants have changed. An effort to update the nomenclature while at the same time provide the older, outdated names was made and is listed in the Synonymy section.

The PLANTS database was used for genus and species names and codes. It is maintained by the USDA Natural Resources Conservation Service and presently considered the appropriate authority recording and abbreviating scientific and common plant names. However the following exceptions were made:

- The scientific name for corkbark fir in the existing version of the PLANTS database is *Abies lasiocarpa*. However, the currently correct name which is accepted by most is *Abies bifolia*.
- 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 normal botanical conventions and omit the possessive voice, so "Gambel's oak" would become "Gambel oak".
- The spelling and punctuation for the common and scientific names from the database was used with one exception. The hyphen for Douglas-fir was included. The spelling of scientific names also varies, where *Pachystima* is spelled throughout the Region, it is referenced in the database as *Paxistima*.
- Although *Pinus fallax* is not in the PLANTS Database, it was decided to continue the use of this name for the single-needled pinyon that occurs in central Arizona. The common name is Arizona pinyon.

SOME ESSENTIAL TERMS AND CONCEPTS

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 - can not 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).

OTHER RELATED DOCUMENTS

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

Terrestrial Ecosystem Survey Mapping Units/Plant Association Crosswalk (in preparation).

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 common name of the plant association appears first, followed by an abbreviated code. 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 scientific name for the plant association is also given. 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 <u>not</u> a habitat type or plant association. For example, PIPO/ARPU c.t. refers to the ponderosa pine/Manzanita community type.

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.

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.

STAND STRUCTURE AND PRODUCTIVITY

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 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.

TREES & LIFE HISTORY TRAITS

When this document is prepared for publication, this information should ultimately be presented in a chart. 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. 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. Trees not listed or mentioned do not occur in the association.

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 highlighted and indicated with an asterisk (*). Species are ordered according to overall importance throughout the range of the plant association, but the occur-

rence 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 ECOSYSTEM CLIMATE CLASS

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, wet.

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 site, and low sun refers to the bulk of the precipitation coming in the winter months. The second part of the climate class is either mild or cold. 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

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.

One value commonly included in this section is Budworm Susceptibility. This is an index value for site climate used in determining a Budworm Susceptibility Rating. The rating is assigned to stands and used to prioritize stand treatments. In addition to site climate index value, the rating also considers species composition, stand density, height class structure, vigor, maturity, regional climate, and surrounding host type. This rating system is currently being revised and these values may be obsolete in the new system.

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.

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.

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).

FOR YOUR INFORMATION

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

The scientific name for:	**has changed from:**	**to:**
subalpine fir	*Abies bifolia v. lasiocarpa*	*A. bifolia v.*
corkbark fir	*Abies lasiocarpa v. arizonica*	*A. bifolia*
thinleaf alder	*Alnus tenuifolia*	*A. incana* ssp. *tenuifolia*
velvet ash	*F. v.* ssp. *pennsylvanica*	*Fraxinus velutina*
black sagebrush	*A. arbuscula* var. *nova*	*Artemisia nova*
Oregongrape	*Berberis repens*	*Mahonia repens*
redosier dogwood	*Cornus stolonifera*	*C. sericea*
Arizona peavine	*Lathyrus arizonica*	*L. lanszwertii* var. *arizonica*
Dore spear grass	*Stipa columbiana*	*Stipa nelsonii* spp. *dorei*
Ross avens	*Geum rossii*	*Acomastylis rossii*

The common name for:	**was last published as:**	**is standardized to:**
Carex foenea	fony sedge	dryspike sedge
Erigeron eximius	forest fleabane	sprucefir fleabane
Senecio cardamine	Cardamine groundsel	bittercress ragwort
Polemonium pulcherrirum	Jacob's ladder	Skunkleaf polemonium
Vaccinium myrtillus	Myrtle huckleberry	whortleberry

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 18.
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 corkbark fir *(Abies bifolia)*, 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. erythrocarpa),* 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 255.
3. Forests of other environments....4

4. Corkbark fir *(Abies bifolia)* and/or Engelmann spruce *(Picea engelmannii)* and/or bristlecone pine *(Pinus aristata)* is dominant or reproducing successfully, clearly not accidental....**Key A: Engelmann Spruce, Corkbark Fir & Bristlecone Pine Series**, page 10**.**
4. Corkbark fir *(Abies bifolia)* 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 13.
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 13**.**
7. White fir is absent or accidental....**Key D: Douglas Fir & Limber Pine Series**, page 15.

8. Ponderosa pine dominant without presence of additional Madrean pines.... **Key E: Ponderosa Pine Series**, page 16.
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 17.

9. Arizona cypress *(Cupressus arizonica)* present, not accidental...13
9. Arizona cypress *(Cupressus arizonica)* absent or accidental 10

10. Woodlands of slopes >40% and rocky or bouldery soils with much rock outcrop or bare rock soils...**Scarp Woodland,** page 159.
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 18.
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 19.
12. Pinyon pine *(Pinus edulis, P. discolor,* or *P. fallax)* is absent or accidental, juniper *(Juniperus monosperma, J. deppeana, J. osteosperma,* or. *erythrocarpa)* is dominant and reproducing successfully.....**Key J: Juniper Woodlands**, page 23.

13. Silverleaf oak *(Quercus hypoleucoides)* common .....**CUAR/QUHY**, Vol. 2, page 25.
13. Silverleaf oak *(Quercus hypoleucoides)* absent or accidental .....**CUAR/QUTU2**, Vol. 2, page 27.

KEY A: ENGELMANN SPRUCE, CORKBARK 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 81.
2. Currants *(Ribes)* scarce, grasses usually well represented...3

3. Thurber fescue *(Festuca thurberi)* common....**PIAR/FETH**, page 79.
3. Thurber fescue *(Festuca thurberi)* absent or scarce....**PIAR/FEAR2**, page 77.

4. Herbs and shrubs are scarce.....5
4. Herbs and shrubs are at least common.....6

5. Corkbark fir *(Abies bifolia)* is codominant, reproducing successfully.... **ABBI/moss**, page 65.
5. Corkbark fir *(Abies bifolia)* is absent, or not reproducing successfully... **PIEN/moss**, page 51.

6. Saturated soils.....**ABBI/MECI3**, page 63.
6. Soils otherwise.....7

7. Beardless wildrye *(Leymus triticoides)* is common (Capitan Mtns, southern NM).....**PIEN/LETR5**, page 33.
7. Beardless wildrye *(Leymus triticoides)* is scarce or absent, or geographic location is other.....8

8. Regeneration of corkbark fir *(Abies bifolia)* is absent, accidental, or minor....9
8. Regeneration of corkbark fir *(Abies bifolia)* 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 corkbark fir *(Abies bifolia)* is minor, if present.....12

10. Whortleberry *(Vaccinium myrtillus)* is present, often well presented; skunkleaf polemonium *(Polemonium pulcherrimum* ssp. *delicatum)* is also present ..... **PIEN/VAMY2-POPUD3, PIEN phase**, page 47.
10. Whortleberry *(Vaccinium myrtillus)* is absent; skunkleaf polemonium *(Polemonium pulcherrimum* ssp. *delicatum)* may be present or absent.....11

11. Ross avens *(Geum rossii)* dominates herbaceous understory; shrubs are scarce [San Francisco Peaks, AZ].....**PIEN/GERO2**, page 31.
11. Gooseberry currant *(Ribes montigenum)* is common, herbs are scarce..... **PIEN/RIMO2**, page 39.

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 45.
13. Whortleberry *(Vaccinium myrtillus)* is poorly represented.....14

14. Kinnikinnick *(Arctostaphylos uva-ursi)* is common.....**PIFL/ARUV**, page 159.
14. Kinnikinnick *(Arctostaphylos uva-ursi)* is scarce or absent.....**PIEN/ACGL**, page 25.

15. Bittercress ragwort *(Senecio cardamine)* is common.....**PIEN/SECA6, ABCO phase**, page 41.
15. Bittercress ragwort *(Senecio cardamine)* is scarce or absent.....16

16. Engelmann spruce *(Picea engelmannii)* is dominant; blue spruce *(Picea pungens)* is minor or absent....**PIEN/EREX4**, page 27.
16. Blue spruce *(Picea pungens)* is dominant, Engelmann spruce *(Picea engelmannii)* is minor....**PIPU/EREX4**, page 95.

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, ABBI phase**, page 47.
18. Skunkleaf polemonium *(Polemonium pulcherrimum* ssp. *delicatum)* is scarce or absent.....19

19. Corkbark fir *(Abies bifolia)* is dominant in regeneration; white fir *(Abies concolor)* is minor or absent.... **ABBI/VAMY2**, page 73.
19. Corkbark fir *(Abies bifolia)* is minor; white fir *(Abies concolor)* regeneration is dominant.....**ABCO/VAMY2**, page 155.

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 103.
21. Twinflower *(Linnaea borealis)* is poorly represented or absent, bittercress ragwort *(Senecio cardamine)* is common..... **PIEN/SECA6**, page 41.

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.....**ABBI/JUCO6**, page 59.
23. Plants are not as above.....24

24. Western thimbleberry *(Rubus parviflorus)* is well represented.....**ABBI/RUPA**, page 67.
24. Western thimbleberry *(Rubus parviflorus)* is absent or poorly represented.....25

25. Cliffbush *(Jamesia americana)* is present; location is in SE Arizona...**ABBI/JAAM**, page 57.
25. Cliffbush *(Jamesia americana)* is absent or location is otherwise....26

26. Dryspike sedge *(Carex foenea)* is abundant or luxuriant.....**ABBI/CAFO3**, page 51.
26. Dryspike sedge *(Carex foenea)* is absent or present, but not abundant....27

27. Bittercress ragwort *(Senecio cardamine)* is common.....**PIEN/SECA6, ABBI phase**, page 41.
27. Bittercress ragwort *(Senecio cardamine)* is absent or scarce....28

28. Burnet ragwort *(Senecio sanguisorboides)* is common (Sacramento Mtns., southern NM).....**ABBI/SESA6**, page 71.
28. Burnet ragwort *(Senecio sanguisorboides)* is absent or scarce....29

29. Arizona peavine *(Lathyrus lanszwertii* var. *arizonica)* is well represented; sprucefir fleabane *(Erigeron eximius)* is scarce or absent...**ABBI/LALAA3**, page 61.
29. Arizona peavine *(Lathyrus lanszwertii* var. *arizonica)* is poorly represented; sprucefir fleabane *(Erigeron eximius)* is common...**ABBI/EREX4**, page 53.

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 91.
1. Forests without riparian obligate shrubs...2

2. Bittercress ragwort *(Senecio cardamine)* is present, usually in patches (currently known from east central Arizona and adjoining areas in New Mexico)... **PIPU/SECA6**, page 105.
2. Bittercress ragwort *(Senecio 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 99.
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 83.
5. Kinnikinnick *(Arctostaphylos uva-ursi)* poorly represented 6

6. Grasses and sedges (graminoids) abundant....**PIPU/CAFO3**, page 87.
6. Forbs abundant; graminoids common or well represented in small patches.... **PIPU/EREX4, PIPO phase**, page 95.

7. Twinflower *(Linnaea borealis)* well represented...**PIPU/LIBO3**, page 103.
7. Twinflower *(Linnaea borealis)* absent or poorly represented...**PIPU/EREX4**, page 95.

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 135.
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 133.
3. Maples absent or present; beardless wildrye is poorly represented or absent....4

4. Herb layer is dominated by burnet ragwort *(Senecio sanguisorboides)*..... **ABCO/SESA6**, page 149.
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 127.
5. Walnut absent or scarce.....6

6. Soils are derived from volcanic ash; New Mexico locust is dominant as an understory shrub .....**ABCO/RONE**, page 147.
6. Soils are <u>not</u> derived from volcanic ash; 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 virescens)* is common or well represented..... **ABCO/MUVI2**, page 139.
9. Screwleaf muhly is scarce or absent....10

10. Dryspike sedge *(Carex foenea)* is often abundant or luxuriant....**ABCO/CAFO3**, page 117.
10. Dryspike sedge not abundant or absent; Arizona fescue *(Festuca arizonica)* or mountain muhly *(Muhlenbergia montana)* is present....**ABCO/FEAR2**, page 123.

11. Arizona peavine *(Lathyrus lanszwertii* var. *arizonica)* is well represented..... **ABCO/LALAA3**, page 131.
11. Arizona peavine is poorly represented .....12.

12. Sprucefir fleabane *(Erigeron eximius)* is well represented.....**ABCO/EREX4**, page 119.
12. Sprucefir fleabane is poorly represented.....13

13. Maples *(Acer* spp.) or Scouler willow *(Salix scouleriana)* are common....14
13. Maples or Scouler willow are scarce or absent....15

14. Bigtooth maple *(Acer grandidentatum)* is common.....**ABCO/ACGR**, page 111.
14. Bigtooth maple is scarce or absent.....**ABCO/ACGL**, page 107.

15. Gambel oak *(Quercus gambelii)* is well represented....**ABCO/QUGA**, page 143.
15. Gambel oak is poorly represented or absent.....16

16. Whortleberry *(Vaccinium myrtillus)* is well represented to luxuriant..... **ABCO/VAMY2**, page 155.
16. Whortleberry is poorly represented or absent....17

17. Kinnikinnick *(Arctostaphylos uva-ursi)* is well represented.....**ABCO/ARUV**, page 115.
17. Kinnikinnick is poorly represented or absent.....18

18. Whortleleaf snowberry *(Symphoricarpos oreophilus)* is a dominant shrub..... **ABCO/SYOR2**, page 151.
18. Whortleleaf snowberry may be present, but not a dominant shrub...19

19. Arizona peavine *(Lathyrus lanszwertii* var. *arizonica)* is well represented..... **ABCO/LALAA3**, page 131.
19. Sprucefir fleabane *(Erigeron eximius)* is well represented.....**ABCO/EREX4**, page 119.

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 159.
2. Kinnikinnick is poorly represented or absent.....3

3. Arizona fescue *(Festuca arizonica)* is common.....**PSME/FEAR2, PIFL2 phase**, page 167.
3. Arizona fescue is absent, or scarce (but not due to grazing pressure) ..... **PSME/MUMO, PIFL2 phase**, page 175.

4. Bigtooth maple common (location generally in southern Arizona or adjoining areas) .....**PSME/ACGR**, page 161.
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 191.
6. Wavyleaf oak is poorly represented or absent 7

7. Gambel oak *(Quercus gambelii)* is well represented ....**PSME/QUGA**, page 183.
7. Gambel oak is poorly represented or absent 8

8. Silverleaf oak *(Quercus hypoleucoides)* is common .... **PSME/QUHY**, page 187.
8. Silverleaf oak is scarce or absent ..... **PSME/QUAR**, page 181.

9. Kinnikinnick *(Arctostaphylos uva-ursi)* is abundant; other shrubs are poorly represented.....**PSME/ARUV**, page 163.
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 171.
11. Rock spirea absent or scarce.....**PSME/MARE11**, page 173.

12. Screwleaf muhly *(Muhlenbergia virescens)* is common.....**PSME/MUVI2**, page 177.
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 167.
13. Grasses not as described above 14

14. Herb cover luxuriant; fringed brome *(Bromus ciliatus)* is usually abundant... **PSME/BRCI**, page 165.
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. Aspen *(Populus tremuloides)* is a major seral tree .... **ABCO/ACGL**, page 107.
16. Aspen is absent or scarce even in young stands ..... **PSME/PHMO4**, page 179.

17. Cliffrose *(Purshia stansburyiana)* is well represented.....**PIPO/PUST**, page 219.
17. Cliffrose is scarce or absent ..... **PSME/MUMO**, page 175.

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 239.
2. Sandy or cindery soils 3

3. Sandy soils; hoary rosemint *(Poliomintha incana)* present...**PIPO/ORHY**, p. 217.
3. Soils of volcanic cinder cones .....**PIPO/BOGR2, ANHA phase**, page 199.

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 207.
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 227.
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* X*pauciloba)*]...13

8. Species of manzanita *(Arctostaphylos* spp.) usually abundant.... **PIPO/ARPU5**, page 195.
8. Species of manzanita not abundant or absent....9

9. Silverleaf oak *(Quercus hypoleucoides)* is well represented.....**PIPO/QUHY**, page 233.
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 225.
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 237.
11. Netleaf oak is scarce or absent.....12

12. Mountain muhly *(Muhlenbergia montana)* is well represented.... **PIPO/MUMO**, page 209.
12. Mountain muhly is poorly represented or absent.....**PIPO/QUAR**, page 221.

13. Gray oak *(Quercus grisea)* is common.... **PIPO/QUGR3**, page 231.
13. Gray oak is scarce, wavyleaf oak is common....**PIPO/QUPA4**, page 235.

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 virescens)* 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/MUVI2**, page 213.

17. Screwleaf muhly *(Muhlenbergia virescens)* is at least common.... **PIPO/MUVI2-FEAR2**, page 215.
17. Screwleaf muhly is scarce or absent.... **PIPO/FEAR2**, page 203.

18. Mountain muhly *(Muhlenbergia montana)* is well represented.... **PIPO/MUMO**, page 209.
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 199.

19. Manzanita *(Arctostaphylos* spp.) is well represented, usually abundant (location is south of Mogollon Rim).....**PIPO/ARPU5**, page 195.
19. Manzanita is poorly represented or absent....20

20. Kinnikinnick *(Arctostaphylos uva-ursi)* is well represented...**PIPO/ARUV**, page 197.
20. Kinnikinnick is poorly represented or absent.....21

21. Cliffrose *(Purshia stansburyiana)*, bitterbrush *(Purshia tridentata)*, or their hybrids are well represented.....**PIPO/PUST**, page 219.
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 193.
22. Big sagebrush *(Artemisia tridentata)* is well represented.....**PIPO/BOGR2, ARTR2 phase**, page 199.

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 249.
2. Silverleaf oak and/or netleaf oak are poorly represented and subdominant, or absent ....**PIEN2/MULO**, page 247.

3. Pinyon ricegrass *(Piptochaetium fimbriatum)* mostly well represented or abundant .....**PILE/PIFI**, page 241.
3. Pinyon ricegrass usually poorly represented....4

4. Silverleaf oak *(Quercus hypoleucoides)* is the leading oak.....**PILE/QUHY**, page 245.
4. Silverleaf oak is minor among other oaks....**PILE/QUAR**, page 243.

KEY G: RIPARIAN FORESTS

(All page numbers refer to Volume 1: Forests. Except where noted see page 301.)

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. Corkbark fir *(Abies bifolia)* and /or Engelmann spruce *Picea engelmannii)* dominates the overstory along streams.....**ABBI (riparian) series**
3. Corkbark 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 91.
4. White fir *(Abies concolor)*, Douglas-fir *(Pseudotsuga menzensii)*, and/or aspen *(Populus tremuloides)* codominates the overstory along streams..... ABCO (riparian) series (see **ABCO/JUMA** in ABCO key), page 127.

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 49.
2. Savannas usually of moderate or steep colluvial slopes.....**QUOB/DAWH2**, page 51.

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 35.
4. Essentially shrubby understory (chaparral woodland).....**QUGR3/CEMO2**, page 37.

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 45.
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 41.
8. Savannas on mostly moderate or steep colluvial slopes.....**QUEM/DAWH2**, page 43.

9. Shrubs abundant or luxuriant....10
9. Shrubs common or well represented....12

10. Manzanita *(Arctostaphylos pungens)* common to abundant....**QUEM/ARPU5**, page 39.
10. Manzanita scarce or absent....11

11. Shrub live oak *(Quercus turbinella)* well represented....**PIFA/QUTU2**, page 99.
11. Shrub live oak poorly represented....**PIED (or PIFA)/CEMO2**, page 65.

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 47.
13. Longtongue muhly scarce; mature oaks are shrubby....**PIDI3/QUHY**, page 109.

14. Grasses poorly represented....**QUAR/RHTR**, page 33.
14. Grasses well represented to abundant....15

15. Savannas mostly of moderate or steep colluvial slopes..**QUAR/MUEM**, page 29.
15. Savannas on mostly alluvial soils....16

16. Utah juniper *(Juniperus osteosperma)* well represented.....**PIFA/BOGR2**, page 95.
16. Utah juniper poorly represented or absent....**QUAR/PIFI**, page 31.

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 87.
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] ....**PIFA/YUBA**, page 101.

4. Pinyon pine is twoneedle pinyon *(Pinus edulis)*.....**PIED/sparse**, page 89.
4. Pinyon pine is either Arizona pinyon *(Pinus fallax)* 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....**PIFA/sparse**, page 89.
5. Border pinyon is the dominant pinyon....**PIDI3/sparse**, page 89.

6. Gambel oak *(Quercus gambelii)* is well represented....**PIED/QUGA**, page 83.
6. Gambel oak *(Quercus gambelii)* is poorly represented....7

7. Rubber rabbitbrush *(Chrysothamnus 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/CHNA2-FAPA**, page 67.
8. The pinyon is Arizona pinyon *(Pinus fallax)* [single needle].....**PIFA/CHNA2-FAPA**, page 94.
8. The pinyon is Mexican pinyon *(Pinus discolor)* [3-needle pinyon].....**PIDI/CHNA2-FAPA**, page 67.

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 105.
12. Alluvial soils of valleys or gentle lower slopes....**PIDI3/PIFI**, page 107.

13. Utah juniper is the leading juniper.....**PIFA/BOGR2, JUOS phase**, page 95.
13. Alligator juniper is the leading juniper....**PIFA/BOGR2, JUDE2 phase**, page 95.

14. Crucifixion thorn *(Canotia holacantha)* present.....**PIFA/CAHO3**, page 197.
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 65.
16. Border pinyon *(Pinus discolor)* well represented.....**PIDI3/RHVIC**, page 113.

17. Oaks well represented to abundant in understory....18
17. Oaks (as understory) poorly represented or absent...**PIDI3/CHDUA**, page 103.

18. Toumey oak *(Quercus toumeyi)* or its hybrids are present.....**PIDI3/QUTO2**, page 111.
18. Toumey oak or its hybrids are absent....19

19. Silverleaf oak *(Quercus hypoleucoides)* is common.....**PIDI3/QUHY**, page 109.
19. Silverleaf oak is scarce or absent.....20.

20. Manzanita *(Arctostaphylos pungens)* is scarce or absent.....**PIFA/QUTU2**, page 99.
20. Manzanita is at least common....21

21. Arizona pinyon *(Pinus fallax)* is well represented....**PIFA/ARPU5**, page 93.
21. Twoneedle pinyon *(Pinus edulis)* or border pinyon *(Pinus discolor)* or mixtures of these pinyons are well represented....**PIED (PIDI3)/ARPU5**, page 55.

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 **PIFA/ARPU5**, page 55.
23. Blackbrush is well represented....**PIED/CORA**, page 69.

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 65.
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 105.
27. Border pinyon is absent or scarce.....28

28. Perennial herbs are scarce....**QUAR/RHTR**, page 33.
28. Perennial herbs (especially grasses) are at least common..**QUAR/PIFI**, page 31.

29. Wavyleaf oak *(Quercus Xpauciloba)* is at least common.....30
29. Wavyleaf oak is absent or scarce.....**PIED/QUGA**, page 83.

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 65.
31. True mountain mahogany is scarce; wavyleaf oak is well represented or abundant....**PIED/QUPA4**, page 85.

32. Pine muhly *(Muhlenbergia dubia)* is common.....**PIED/MUDU**, page 73.
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 75.
33. Twoneedle pinyon and oneseed juniper are codominants.....**PIED/STNED**, page 91.

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 83.
36. Gambel oak present or absent; true mountain mahogany well represented.... **PIED/CEMO2**, page 65.

37. Sandy soils; sand sagebrush *(Artemisia filifolia)* or sand bluestem *(Andropogon hallii)* present to abundant.....**PIED/ANHA**, page 53.
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
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39. Bitterbrush common....**PIED/PUTR2**, page 81.
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40. Cliffrose *(Purshia stansburyiana)* common....**PIED/PUST, ARTR2 phase**, page 79.
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42. Soils otherwise; above grasses scarce or absent....43

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48. Utah juniper scarce or absent .....**PIED/BOGR2, JUMO phase**, page 61.

KEY J: JUNIPER WOODLANDS

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

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2. Geographic location above the Mogollon Rim in Arizona or in southeastern, central or northern New Mexico.....12

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5. Cliffrose is well represented....**JUOS/BOGR2, PUST phase**, page 127.

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17. Oneseed juniper is dominant.....**JUMO/ARTR2**, page 139.
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27. Creosotebush *(Larrea tridentata)* is common.....**JUPI/LATR2**, page 157.
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Engelmann spruce/ Rocky Mountain maple Picea engelmannii/Acer glabrum

PIEN/ACGL

CODE(S)

typic phase 0 04 30 0

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 codominated 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. 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 ABBI/Moss except for absence of corkbark fir. ABBI/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).

TREES & LIFE HISTORY TRAITS

***Engelmann spruce**	
(Picea engelmannii)	C
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)*
cliffbush *(Jamesia americana)*
sidebells wintergreen *(Orthilia secunda)*
Arizona honeysuckle *(Lonicera arizonica)*

HERBS

Well represented (>5% coverage)**:**
Canadian brome *(Bromus canadensis)*
fringed brome *(Bromus ciliatus)*
ravine fescue *(Festuca sororia)*
Canadian white violet *(Viola canadensis)*
starry false Solomon seal *(Maianthemum stellatum)*

Porter licoriceroot *(Ligusticum porteri)*
western brackenfern *(Pteridium aquilinum)*
Rocky Mountain trisetum (*Trisetum montanum*)
sprucefir fleabane *(Erigeron eximius)*
nodding ragwort *(Senecio biglovii)*
Parry goldenrod *(Solidago parryi)*
Virginia strawberry (*Fragaria viginiana* var *virginiana)*
ragweed sagebrush *(Artemisia franserioides)*
woodland strawberry *(Fragaria americana* ssp *americana)*
burnet ragwort *(Senecio sanguisorboides)*
Fendler meadowrue *(Thalictrum fendleri)*
Arizona peavine *(Lathyrus lanszwertii* var *arizonicus*)

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.

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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. Shelterwood and individual tree selection generally favor more shade tolerant associates such as corkbark fir. Seed tree method is not usually successful for tree regeneration due to the susceptibility of Engelmann spruce and corkbark 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 *el al*. 1996).

Budworm susceptibility = 1.5

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 PIEN/EREX4

(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

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 corkbark fir may be accidental species.

STRUCTURE

The overstory is a moderate to dense cover of mixed coniferous trees. Engelmann spruce and Douglas-fir codominate. White fir and southwestern white pine are sometimes abundant as reproduction but never in larger size classes. Corkbark 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

ABBI/EREX4 if corkbark 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 .

TREES & LIFE HISTORY TRAITS

***Engelmann spruce**	C
Douglas-fir *(Pseudotsuga menziesii)*	C
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 foenea)*
Rocky Mountain trisetum (*Trisetum montanum*)
Richardson geranium *(Geranium richardsonii)*
Arizona peavine *(Lathyrus lanszwertii* var *arizonica*)
sprucefir fleabane *(Erigeron eximius)*
nodding ragwort *(Senecio biglovii)*
starry false Solomon seal *(Maianthemum stellatum)*
Fendler meadowrue *(Thalictrum fendleri)*
mountain thermopsis *(Thermopsis rhombifolia* var *montana)*
Parry goldenrod *(Solidago parryi)*
bluntseed sweetroot *(Osmorhiza depauperata)*
Porter licoriceroot *(Ligusticum porteri)*
American vetch *(Vicia americana)*
Virginia strawberry (*Fragaria viginiana* var *virginiana)*
alpine false springparsley *(Pseudocymopteris 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

dryspike sedge *(Carex foenea)* = fony sedge
Arizona peavine *(Lathyrus lanszwertii* var *arizonica = Lathyrus arizonica*)
starry false Solomon seal *(Maianthemum stellatum = Smilacina stellata)*
mountain thermopsis *(Thermopsis rhombifolia* var *montana = Thermopsis montana)*
Parry goldenrod *(Solidago parryi = Haplopappus parryi = Oreochrysum parryi)*
bluntseed sweetroot *(Osmorhiza depauperata)* = sweetcicily *(O. obtusa)*
Virginia strawberry (*Fragaria virginiana* var *virginiana)* = wild strawberry *(F. ovalis)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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. 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.

Budworm Susceptibility = 1.5.

REFERENCE(S)

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

Engelmann spruce/Ross avens PIEN/GERO2

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

Picea engelmannii/Geum rossii

CODE(S)

typic phase 0 04 33 0

KEY CRITERIA

Characterized by nearly pure stands of ***Engelmann spruce**. Where present, the herbaceous cover is dominated by ***Ross avens.** Corkbark 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.

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** *(Acomastylis 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 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 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.

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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.

Budworm susceptibility = 1.

REFERENCE(S)

USFS 1987a
Rominger and Paulik 1983

Engelmann spruce/beardless wildrye PIEN/LETR5
Picea engelmannii/Leymus triticoides

(Formerly: Picea engelmannii/Elymus triticoides)

CODE(S)

typic phase 0 04 32 0

KEY CRITERIA

***Engelmann spruce** present with Douglas-fir as the most important codominant. Corkbark 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. Corkbark 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 desity 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.

TREES & LIFE HISTORY TRAITS

***Engelmann spruce** *(Picea engelmannii)*	C
Douglas-fir *(Pseudotsuga menziesii)*	S
corkbark fir *(Abies bifolia)*	c
aspen *(Populus tremuloides)* [early to mid-seral]	s
southwestern white pine *(Pinus strobiformis)*	s

SHRUBS

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

cliffbush *(Jamesia americana*)
rockspirea *(Holodiscus dumosus)*
Rocky Mountain maple *(Acer glabrum)*
Wolf currant *(Ribes wolfii)*
orange gooseberry *(Ribes pinetorum)*

HERBS

Scarce (<1% cover) to common (>1% cover)**:**

***beardless wildrye** *(Leymus triticoides)*
fringed brome *(Bromus ciliatus)*
Rocky Mountain trisetum *(Trisetum montanum*)
sprucefir fleabane *(Erigeron eximius)*
woodland strawberry *(Fragaria vesca* ssp *americana)*
sidebells wintergreen *(Orthilia secunda)*

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

beardless wildrye *(Leymus triticoides= Elymus triticoides)*
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
woodland strawberry *(Fragaria vesca* ssp *americana = F. americana)*
sidebells wintergreen *(Orthilia secunda = Ramischia secunda = Pyrola secunda*)

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Severe overstory removal (such as clearcuts and seedtree cuts) results in micro environments too dry and exposed for establishment of Engelmann spruce. 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.

Budworm susceptibility— 0.8

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

KEY CRITERIA

*__Engelmann spruce__ dominates overstory. Douglas-fir may or may not have a codominant role. Corkbark 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, corkbark fir may or may not be a codominate and is usually absent in the interior Douglas-fir phase. Aspen is a seral tree being sporadically scattered throughout the overstory. Spruce and occasionally corkbark 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 ABBI/VAMY on more sheltered, wetter sites; by PSME/FEAR 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/GERO and ABBI/LALA; in the Pinaleno Mountains are ecotones with ABBI/VAMY, PIEN/CAFO and dry meadows; on Mount Taylor PIEN/Moss occurs above ABBI/VAMY and is often adjacent to dry meadows.

ALSO SEE

ABBI/Moss has corkbark fir. If whortleberry is common, see PIEN/VAMY or PIEN/VAMY-POPU.

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
corkbark fir *(Abies bifolia)*	c
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
corkbark fir *(Abies bifolia)*	c

Douglas-fir *(Pseudotsuga menziesii)* s
southwestern white pine *(Pinus strobiformis)* s
aspen *(Populus tremuloides)* s
white fir *(Abies concolor)* s

SHRUBS

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

HERBS

Scarce (<1% cover), but may include**:**
fireweed *(Epilobium angustifolium* ssp *angustifolium)*
alpine false mountain parsley *(Pseudocymopteris montana)*
Virginia strawberry *(Frageria virginiana ssp virginiana)*
sprucefir fleabane *(Erigeron eximius)*
American vetch *(Vicia americana)*
Arizona peavine *(Lathyrus lanszwertii* var *arizonica*)
thistle *(Cercium* spp.)
starry false Solomon seal *(Maianthemum stellatum)*
golden columbine *(Aquilegia chrysantha)*
owlsclaws *(Dugaldia hoopsii)*
showy frasera *(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

Arizona peavine *(Lathyrus lanszwertii* var *arizonicus = Lathyrus arizonica*)
owlsclaws *(Dugaldia hoopsii)* = orange sneezeweed *(Helenium hoopsii).*
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
Virginia strawberry *(Fragaria virginiana ssp virginiana = F. ovalis)*
showy frasera *(Frasera speciosa)* = green gentian *(Swertia radiata)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 corkbark 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 corkbark 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 corkbark 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

Timber harvest 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.

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/ gooseberry currant — PIEN/RIMO2

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

Picea engelmannii/Ribes montigenum

CODE(S)

typic phase 0 04 34 0

KEY CRITERIA

Characterized by nearly pure stands of Engelmann spruce. Where present, the shrub cover is dominated by gooseberry currant. Corkbark 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. Windfirmness 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).

TREES & LIFE HISTORY TRAITS

Engelmann spruce (*Picea engelmannii)* C
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

skunkweed polemonium *(Polemonium pulcherrimum* ssp *delicatum)* = Jacob's ladder *(Polemonium delicatum)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class: 7 (subalpine forest)
Elevational Subzone: +1 (cool, wet)
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.

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 1985

Engelmann spruce/ bittercress ragwort — PIEN/SECA6

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

Picea engelmannii/Senecio cardamine

CODE(S)

corkbark (ABBI) phase	0 04 35 0
white fir (ABCO) phase	0 04 35 1

KEY CRITERIA

Tree regeneration is mostly ***Engelmann spruce** and/or Corkbark fir or white fir. The combined number of stems less than 10 inches (25.4 cm) d.b.h. of Engelmann spruce and corkbark 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.** Corkbark 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 corkbark fir. Regeneration is mostly Engelmann spruce and corkbark fir or white fir. Stockability is 1. Herbaceous undergrowth is characterized by patches of bittercress ragwort or boxleaf myrtle. 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/SECA6 is a very productive site for timber (John Shafer, pers. comm.).

LOCATION

This type occurs on gentle to moderate slopes; corkbark 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: ABBI/EREX; also some stands may intergrade with PIPU/SECA6.

TREES & LIFE HISTORY TRAITS

corkbark phase:	
corkbark fir *(Abies bifolia)*	C
Engelmann spruce *(Picea engelmannii)*	C
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
aspen *(Populus tremuloides)*	
Early to Mid-seral	S
Douglas-fir *(Pseudotsuga menziesii)*	
Late Seral	S
white fir *(Abies concolor)*	S

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)*
boxleaf mrytle *(Paxistima myrsinites)*

HERBS

Abundant (>25% coverage)**:**
***bittercress ragwort** *(Senecio cardamine)*
fringed brome *(Bromus ciliatus)*
Richardson geranium *(Geranium richardsonii)*
sprucefir fleabane (*Erigeron eximius)*
Canadian white violet *(Viola canadensis)*
Virginia strawberry *(Fragaria virginiana* ssp *virginiana)*
Wooton ragwort *(Senecio wootonii)*
owlsclaws *(Dugaldia hoopsii)*
western brackenfern *(Pteridium aquilinum)*
dryspike sedge *(Carex foenea)*
Arizona peavine *(Lathyrus lanszwertii* var *arizonicus)*
mountain thermopsis *(Thermopsis rhombifolia* var *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 = cardamine groundsel
Virginia strawberry *(Fragaria virginiana ssp virginiana = F. ovalis)*
woodland strawberry *(Fragaria vesca* ssp *americana = F. americana)*
mountain thermopsis *(Thermopsis rhombifolia* var *montana= Thermopsis montana)*
Arizona peavine *(Lathyrus lanszwertii* var *arizonicus= Lathyrus arizonica*)
owlsclaws *(Dugaldia hoopsii) =* orange sneezeweed *(Helenium hoopsii).*
sprucefir fleabane *(Erigeron eximius) =* forest fleabane *(E. superbus)*
sidebells wintergreen *(Orthilia secunda = Ramischia secunda)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

PHASES

__Corkbark fir (ABBI) phase: corkbark fir has light to moderate regeneration. Utah honeysuckle occurs most often in this phase.

White fir (ABCO) phase: corkbark fir is absent or sparse, while white fir has light to moderate regeneration. Boxleaf myrtle, 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 reponsible 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 corkbark fir, as a result of the cessation of fire over past 50 years. (Fitzhugh *et al* 1987).

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. 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.

Budworm susceptibility is 0.8.

REFERENCES

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

Engelmann spruce/Whortleberry PIEN/VAMY2

(Formerly: Engelmann spruce/Myrtle huckleberry)

Picea engelmannii/Vaccinium myrtillus

CODE(S)

typic phase 0 04 36 0

KEY CRITERIA

***Engelmann spruce** is dominant and strongly competitive. Corkbark 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 codominate, 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, ABBI/VAMY, RUPA and LIBO phases, and PIPU/LIBO.

TREES & LIFE HISTORY TRAITS

***Engelmann spruce** *(Picea engelmannii)*	C
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)*
cliffbush *(Jamesia americana)*
Utah honeysuckle *(Lonicera utahensis)*
orange gooseberry *(Ribes pinetorum)*
boxleaf myrtle *(Paxistima myrsinites)*
Rocky Mountain maple *(Acer glabrum)*
Scouler 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

sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
boxleaf myrtle *(Paxistima myrsinites* = *Pachistima myrsinites)*
Parry goldenrod *(Solidago parryi* = *Haplopappus parryi* = *Oreochrysum parryi)*
sidebells wintergreen *(Orthilia secunda* = *Ramischia secunda* = *Pyrola secunda)*
Virginia strawberry *(Fragaria virginiana* ssp *virginiana* = *F. ovalis)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

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, e.g. 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
corkbark fir (ABBI) phase	0 04 15 2

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 corkbark both are present. Corkbark fir has moderate to heavy regeneration but usually fewer mature individuals in the overstory. Whortleberry is the dominant shrub. The 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 ABBI/Moss. Its lower limit in most locations borders the ABBI/VAMY.

ALSO SEE

Krummholz refers to a forest-tundra border vegetation characterized by stunted, shrubby stature of Engelmann spruce and corkbark fir. See also *Picea engelmannii/Trifolium dasyphyllum* in central Colorado (Hess and Alexander 1986).

TREES & LIFE HISTORY TRAITS

Engelmann spruce phase:

Engelmann spruce *(Picea engelmannii)*	C
corkbark fir *(Abies bifolia)*	c
bristlecone pine *(Pinus aristata)*	s

Corkbark fir phase:

Engelmann spruce *(Picea engelmannii)*	C
corkbark fir *(Abies bifolia)*	C
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)*

HERBS

Well represented (>5%cover)**:**
***skunkweed polemonium** *(Polemonium pulcherrimum* spp *delicatum)*
showy alpine groundsel *(Senecio amplectens)*
sidebells wintergreen *(Orthilia secunda)*
single delight *(Moneses uniflora)*
creeping sibbaldia *(Sibbaldia procumbens)*
Whipple 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 *(Polygonium viviparum)*
tufted hairgrass *(Deschampsia caespitosa)*
creeping Sibbalia *(Sibbaldia procumbens)*
alpine clover *(Trifolium dasyphyllum)*

SYNONYMY

sidebells wintergreen *(Orthilia secunda = Ramischia secunda)*
skunkweed polemonium *(Polemonium pulcherrimum* ssp *delicatum)* = Jacob's ladder *(Polemonium delicatum)*
Ross avens *(Geum rossii = Acomastylis rossii)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class:	7 (subalpine forest)
Elevational Subzone:	+1 (cool, wet)
Climate Class:	LSC (low sun cold)

PHASES

There are two phases recognized: Engelmann spruce (PIEN) phase, in which Engelmann spruce is climax; and corkbark fir(ABBI) phase, with corkbark fir climax or co-climax. PIEN phase is usually higher than 11,200 feet. ABBI 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 also 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 corkbark 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.

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

Corkbark fir/dryspike sedge ABBI/CAFO3

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

Abies bifolia/Carex foenea

(Formerly: Abies lasiocarpa/Carex foenea)

SYNONYMS

Picea engelmannii/Carex foenea (PIEN/CAFO) (Moir and Ludwig 1979).
Common name updated as per USDA Plants database.

CODE(S)

typic phase 0 03 37 0

KEY CRITERIA

Engelmann spruce and ***corkbark 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 corkbark fir. The presence of corkbark fir, especially reproduction, influenced this plant association being assigned to the corkbark (ABBI) 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: ABBI/Moss on drier exposures; ABBI/VAMY.

ALSO SEE

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

TREES & LIFE HISTORY TRAITS

***Engelmann spruce** *(Picea engelmannii)*	C
corkbark fir *(Abies bifolia)*	c
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)
cliffbush *(Jamesia americana)*

HERBS

Abundant (>25% cover) to luxuriant (>50%cover)**:**
Kentucky bluegrass *(Poa pratensis)*
Sedge *(Carex foenea)*
mountain muhly *(Muhlenbergia montana)*
fringed brome *(Bromus ciliatus)*
Richardson geranium *(Geranium richardsonii)*
owlsclaws *(Dugaldia hoopsii)*
Wooton 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

owlsclaws *(Dugaldia hoopsii)* = orange sneezeweed *(Helenium hoopsii)*
dryspike sedge = fony sedge

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 corkbark 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 corkbark fir. Seed tree harvesting method featuring corkbark 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 corkbark fir reproduction. Where present, Engelmann spruce reproduction is less dense. Mid-seral closed pole stands of this type can resemble ABBI/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 ABBI/CAFO3 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

Corkbark fir/sprucefir fleabane ABBI/EREX4

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

Abies bifolia/Erigeron eximius

(Formerly: Abies lasiocarpa/Erigeron eximius)

SYNONYMS

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

CODE(S)

typic phase 0 03 08 0

KEY CRITERIA

Engelmann spruce and ***corkbark 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). Arizona peavine 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 corkbark 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

ABBI/ LALAA3, PIEN1/EREX4, and ABBI/ ACGL (Alexander *et al* 1987, Youngblood and Mauk 1985), the latter on sites with shrubs well represented.

TREES & LIFE HISTORY TRAITS

Engelmann spruce *(Picea engelmannii)*	C
***corkbark fir** *(Abies bifolia)*	C
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 willow *(Salix scouleriana)*
Rocky Mountain maple *(Acer glabrum)*
twinberry honeysuckle *(Lonicera involucrata)*
Utah honeysuckle *(Lonicera utahensis)*
russet buffaloberry *(Sheperdia canadensis)*
cliffbush *(Jamesia americana)*
rockspirea *(Holodiscus dumosus)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*

HERBS

Luxuriant (>50% coverage):
***sprucefir fleabane** *(Erigeron eximius)*
ragweed sagebrush *(Artemisia franserioides)*
Richardson geranium *(Geranium richardsonii)*
bluntseed sweetroot *(Osmorhiza depauperata)*
Canadian white violet *(Viola canadensis)*
sidebells wintergreen *(Orthilia secunda)*
starry false Solomon seal *(Maianthemum stellatum)*
Rocky Mountain trisetum (*Trisetum montanum*)
fringed brome *(Bromus ciliatus)*
Kentucky bluegrass *(Poa pratensis)*
dryspike sedge *(Carex foenea)*

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 Solomon seal *(Maianthemum stellatum = Smilacina stellata)*
bluntseed sweetroot *(Osmorhiza depauperata)* = sweetcicily *(Osmorhiza obtusa)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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.

Budworm Susceptibility is 1.5.

REFERENCE(S)

DeVelice *et al*. 1986
Mathiasen *et al*. 1986
USDA 1986
USDA 1987a
USDA 1987b

Corkbark fir/cliffbush ABBI/JAAM

(Formerly: Corkbark fir/waxflower ABLA/JAAM)

Abies bifolia/Jamesia americana

(Formerly: Abies lasiocarpa/Jamesia americana)

CODES

typic phase 0 03 32 0

KEY CRITERIA

***Corkbark fir** dominates overstory. Shrubs include ***cliffbush** and others. Understory has scattered patches of forbs.

STRUCTURE

Overstory is dominated by corkbark 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; cliffbush is the principal shrub. Site index data are unavailable. Mortality is high in corkbark 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).

TREES & LIFE HISTORY TRAITS

***Corkbark fir** *(Abies bifolia)*	C
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)*
***cliffbush** *(Jamesia americana*)
grayleaf red raspberry *(Rubus strigosus)*
whortleleaf 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*).

BRIEF PLANT ID NOTES

cliffbush = waxflower

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 ABBI/JUCO6

(Formerly: Subalpine fir/Common juniper ABLA/JUCO)

Abies bifolia/Juniperus communis

(Formerly: Abies lasiocarpa/Juniperus communis)

SYNONYMS

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

CODE(S)

typic phase 0 03 09 0

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 ABBI 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 ABBI/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/CAFO3 on lower slopes and adjoining parks.

ALSO SEE

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

TREES & LIFE HISTORY TRAITS

subalpine fir *(Abies bifolia)**	C
Engelmann spruce *(Picea engelmannii)*	C
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)*
Oregon grape *(Mahonia repens)*

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 foenea)*
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)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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. Shelterwood and selection harvesting methods are more likely to withstand blowdown and regenerate conifers. Heavier shelterwood cuts favor fir over spruce because of increased 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.

Budworm susceptibility rating is 1.5. 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

Corkbark fir/Arizona peavine ABBI/LALAA3

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

Abies bifolia/Lathyrus lanszwertii var arizonicus

(Formerly: Abies lasiocarpa/Lathyrus arizonica)

CODE(S)

typic phase 0 03 31 0

KEY CRITERIA

Stand contains ***corkbark fir** and sometimes Engelmann spruce, but may be dominated by white fir or southwestern white pine. Shrub and forb layers in understory with ***Arizona peavine** and other forbs dominating.

STRUCTURE

In the overstory, corkbark fir is the dominant species. Aspen is major seral tree and may form a mixture with corkbark 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. Corkbark fir usually dominates the regeneration. The stockability rating is 1. Understory has a luxuriant herbaceous cover which is dominated by Arizona peavine 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 ABBI/EREX4.

TREES & LIFE HISTORY TRAITS

corkbark fir *(Abies bifolia)* C
Engelmann spruce *(Picea engelmannii)* C
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)*
whortleleaf 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:
***Arizona peavine** *(Lathyrus lanszwertii* var. *arizonicus)*

San Juan Mountains:
Geyer sedge *(Carex geyeri)*
Mogollon Mountains:
aspen peavine *(Lathyrus laetivirens)*
American vetch *(Vicia americana)*
Parry goldenrod *(Solidago parryii)*
western brackenfern *(Pteridium aquilinum)*
starry false Solomon seal *(Maianthemum stellatum)*
Richardson geranium *(Geranium richardsonii)*
dryspike sedge *(Carex foenea)*
fringed brome *(Bromus ciliatus)*
San Francisco Peaks:
Virginia strawberry *(Fragaria virginiana* ssp *virginiana)*
fireweed *(Epilobium angustifolium)*
alpine false springparsley *(Pseudocymopterus montanus)*
owlsclaws *(Dugaldia hoopsii)*
showy frasera *(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, Arizona peavine 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 Solomon seal *(Maianthemum stellatum = Smilacina stellata)*
Arizona peavine *(Lathyrus lanszwertii* var *arizonicus = L. arizonicus)*
showy frasera *(Frasera speciosa)* = green gentian *(Swertia radiata)*
owlsclaws *(Dugaldia hoopsii)* = orange sneezeweed *(Helenium hoopsii)*.

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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. 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

ABBI/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

Corkbark fir/mountain bluebells ABBI/MECI3

(Formerly: Subalpine fir/bluebells ABLA/MECI)

Abies bifolia/Mertensia ciliata

(Formerly : Abies lasiocarpa/Mertensia ciliata)

SYNONYMS

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

CODE(S)

typic phase 0 03 06 0

KEY CRITERIA

Engelmann spruce and corkbark 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 mountain bluebells, Fendler 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 corkbark fir codominate the overstory. Stands near timberline may have little corkbark 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 and budworm susceptibility is 0.6.

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 dominated by the PIEN/VAMY/POPU plant association, the seep itself may be occupied by ABBI/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).

TREES & LIFE HISTORY TRAITS

Engelmann spruce *(Picea engelmannii)* C
***corkbark fir** *(Abies lasiocarpa)* C
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.)
***mountain bluebells** *(Mertensia ciliata)*
Fendler cowbane *(Oxypolis fendleri)*
heartleaf bittercress *(Cardimine cordifolia)*
white marshmarigold *(Caltha leptosepala)*
brook saxifrage *(Saxifraga odontoloma)*
arrowleaf groundsel *(Senecio triangularis)*
beautiful sedge *(Carex bella)*
Coulter daisy *(Erigeron coulteri)*
Porter licoriceroot *(Ligusticum porteri)*
fivestamen miterwort *(Mitella pentandra)*
Richardson geranium *(Geranium richardsonii)*
twisted stalk *(Streptopus amplexifolius)*
skunkweed polemonium *(Polemonium pulcherrimum* ssp. *delicatum)*

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

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

FIRE ECOLOGY

This plant association represents the wettest of nonriparian conditions of the southern Rocky Mountains, resulting in long intervals between fires. Often sheltered from factors causing windthrow, forests of this type may exhibit 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.

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 seep 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

Corkbark fir/Moss ABBI/Moss

(Formerly: corkbark (subalpine) fir/Moss ABLA/Moss)

Abies bifolia/Moss

(Formerly: Abies lasiocarpa/Moss)

SYNONYMS

Abies lasiocarpa-Picea engelmannii/Moss (Johnston 1987)

CODE(S)

corkbark fir (ABBI) phase	0 03 11 0
Engelmann spruce (PIEN) phase	0 03 11 1
Douglas-fir (PSME) phase	0 03 11 2

KEY CRITERIA

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

STRUCTURE

Corkbark 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

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

ALSO SEE

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

TREES LIFE HISTORY TRAITS

<u>corkbark fir phase:</u>	
***corkbark fir** *(Abies bifolia)*	C
Engelmann spruce *(Picea engelmannii)*	c
aspen *(Populus tremuloides)* [early]	s
<u>Engelmann spruce phase:</u>	
Engelmann spruce *(Picea engelmannii)*	C
***corkbark fir** *(Abies bifolia)*	c
aspen *(Populus tremuloides)* [early]	s
bristlecone pine *(Pinus aristata)* [late]	s
Douglas-fir *(Pseudotsuga menziesii)* [mid to late (lower elev.)]	s
<u>Douglas-fir phase:</u>	
Engelmann spruce *(Picea engelmannii)*	C
white fir *(Abies concolor)*	S
Douglas-fir *(Pseudotsuga menziesii)*	S
***corkbark fir** *(Abies bifolia)*	c
southwestern white pine *(Pinus strobiformis)*	s
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 ECOSYSTEM CLIMATE CLASS

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

PHASES

Three phases are recognized:

__**Corkbark 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

Timber harvest methods: Heavy overstory removal may favor aspen if present, otherwise regeneration of trees may be unsuccessful without extraordinary planting measures. 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 corkbark fir by leaving larger amounts of shade. Englemann 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.

Budworm Susceptibility: 0.

REFERENCE(S)

DeVelice *et al.*1986
USFS 1987a
USFS 1987b

Corkbark fir/Thimbleberry
Abies bifolia/Rubus parviflorus

(Formerly: Abies lasiocarpa/Rubus parviflorus)

ABBI/RUPA

(Formerly: ABLA/RUPA)

SYNONYMS

ABLA-PIEN1/RUPA (Johnston 1987)

CODE(S)

whortleberry Phase	0 03 24 0
Rocky Mountain maple Phase	0 03 23 1

KEY CRITERIA

*__Corkbark 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

ABBI/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. Corkbark 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 Mogollon Mountains of southern New Mexico.

ADJACENT PLANT ASSOCIATIONS

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

ABBI/RUPA,VAMY2 phase ecotones with ABBI/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

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

TREES AND LIFE HISTORY TRAITS

<u>whortleberry phase</u>	
***corkbark fir** *(Abies bifolia)*	C
Engelmann spruce *(Picea engelmannii)*	C
aspen *(Populus tremuloides)* [early to late]	S
Douglas-fir *(Pseudotsuga menziesii)* [mid to late]	S
white fir *(Abies concolor)*	s
<u>Rocky Mountain maple phase:</u>	
***corkbark fir** *(Abies bifolia)*	C
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 willow *(Salix scouleriana)*
New Mexico locust *(Robinia neomexicana)*
orange gooseberry *(Ribes pinetorum)*
Utah honeysuckle *(Lonicera utahensis)*
boxleaf myrtle *(Paxistima myrsinites)*

HERBS

Well represented (>5%) sometimes
abundant (>25%) cover:
Fringed brome *(Bromus ciliatus)*
Richardson 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
(Disporum trachycarpum)
fireweed *(Epilobium angustifolium)*
bluntseed sweetroot *(Osmorhiza*
depauperata)
bittercress ragwort *(Senecio cardamine)*
feathery false Solomon seal
(Maiathemum racemosum)
Canadian white violet *(Viola canadensis)*
red baneberry *(Actaea rubra)*
mountain death camas *(Zygadenus elegans)*

BRIEF PLANT ID NOTES

Thimbleberry is generally a low shrub with large, palmately-lobed, simple leaves.

SYNONYMY

whortleberry = myrtle huckleberry
corkbark fir *(Abies bifolia = Abies lasiocarpa*
var *arizonica)*
feathery false Solomon seal *(Maianthemum*
racemosum = Smilacina racemosa)
sidebells wintergreen *(Orthilia secunda =*
Ramischia secunda)
boxleaf myrtle *(Paxistima myrsinites =*
Pachistima myrsinites)
bluntseed sweetroot *(Osmorhiza depauperata)*
= sweetcicily *(Osmorhiza obtusa)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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. 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 corkbark 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

Corkbark fir/Burnet ragwort ABBI/SESA6

(Formerly: Corkbark fir/Burnet groundsel ABLA/SESA)

Abies bifolia/Senecio sanguisorboides

(Formerly: Abies lasiocarpa/Senecio sanguisorboides)

CODE(S)

burnet ragwort (SESA6) phase	0 03 30 0
Douglas-fir (PSME) phase	0 03 30 1

KEY CRITERIA

***Corkbark fir** is most often dominant in the overstory while Engelmann spruce is either less or is codominate. 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

Corkbark 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 corkbark 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.

TREES & LIFE HISTORY TRAITS

burnet ragwort phase:

***corkbark fir** (*Abies bifolia)*	C
Engelmann Spruce (*Picea engelmannii*)	C

Douglas-fir phase:

corkbark fir (*Abies bifolia)*	C
Engelmann spruce(*Picea engelmannii)*	C
aspen *(Populus tremuloides)* early-mid seral	S
Douglas-fir *(Pseudotsuga menziesii)* late seral	S

SHRUBS

Well represented (>5%):

twinberry honeysuckle *(Lonicera involucrata)*
wolf currant *(Ribes wolfii)*
gooseberry currant *(Ribes montigenum)*
Rocky Mountain maple *(Acer glabrum)*
sidebells wintergreen *(Orthilia secunda)*

HERBS

Abundant (>25% coverage):

***burnet ragwort** *(Senecio sanguisorboides)*
fringed brome *(Bromus ciliatus)*
Richardson geranium *(Geranium richardsonii)*
sprucefir fleabane (*Erigeron eximius*)
Canadian white violet *(Viola canadensis)*
bluntseed sweetroot *(Osmorhiza depauperata)*
red baneberry *(Actaea rubra)*

ravine fescue *(Festuca sororia)*
Rocky Mountain trisetum *(Trisetum montanum)*
alpine false mountain parsley *(Pseudocymopteris montana)*
Porter licoriceroot *(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)*
corkbark fir *(Abies bifolia* = *Abies lasiocarpa* var *arizonica)*
sidebells wintergreen *(Orthilia secunda* = *Ramischia secunda)*
boxleaf myrtle *(Paxistima myrsinites*= *Pachistima myrsinites)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

PHASES

ABBI/SESA6, typic phase lacks Douglas-fir and *Ribes* spp. dominate shrub layer. In the ABBI/SESA6, 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

Timber harvest methods: Clearcutting favors aspen in the Douglas-fir phase.
Shelterwood and selection methods favor corkbark fir. Seed tree cutting methods often result in blowdown. Tree planting is likely to be successful for Engelmann spruce and corkbark 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

Corkbark fir/Whortleberry ABBI/VAMY2

(Formerly: Corkbark fir/myrtle huckleberry ABLA/VAMY)

Abies bifolia/Vaccinium myrtillus

(Formerly: *Abies lasiocarpa/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 (LIBO) phase	0 03 20 1
thimbleberry (RUPA) phase	0 03 20 2
cliffbush (JAAM) phase	0 03 20 3

KEY CRITERIA

Engelmann spruce and ***corkbark fir** codominate the overstory. ***Whortleberry** dominates understory and is diagnostic for this type. Douglas-fir, southwestern white pine, and limber pine may occur as accidental species.

STRUCTURE

Corkbark fir and Engelmann spruce codominate the overstory with aspen and occasionally, Douglas-fir appearing as seral trees. The overstory is well stocked (stockability = 1) and usually relatively continuous with most age and size classes represented. At lower elevations, white fir is a minor seral tree. In the undergrowth, whortleberry dominates. Its cover varies from as low as 2% to over 30%. Herbaceous cover is less than shrubs and varies in response to relative moisture of each site.

Timber productivity is low to moderate. The average site index for Engelmann spruce is 57 (N=98).

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: ABBI/Moss on drier exposures; ABBI/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 ABBI/CAFO3 when whortleberry <5% cover; scree forest on talus slopes where whortleberry is patchy; also closely related to ABBI/EREX (Moir and Ludwig 1979).

TREES & LIFE HISTORY TRAITS

<u>whortleberry (VAMY or typic) phase:</u>	
Engelmann spruce *(Picea engelmannii)*	C
***corkbark fir** *(Abies bifolia*	C
aspen *(Populus tremuloides)* [early to mid]	S

twinflower (LIBO) phase:
Engelmann spruce *(Picea engelmannii)* C
***corkbark fir** *(Abies bifolia)* C
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
***corkbark fir** *(Abies bifolia)* C
aspen *(Populus tremuloides)* [early to mid] S
Douglas-fir *(Pseudotsuga menziesii)* [late] S
southwestern white pine *(Pinus strobiformis)* s
white fir *(Abies concolor)* s
cliffbush (JAAM) phase:
Engelmann spruce *(Picea engelmannii)* C
***corkbark fir** *(Abies bifolia)* C
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 currant *(Ribies wolfii)*
gooseberry currant *(Ribes montigenum)*
mountain ash *(Sorbus dumosa)*
thimbleberry (RUPA) phase additionally includes
****thimbleberry*** *(Rubus parviflorus)*
Scouler willow *(Salix scouleriana)*
rockspirea *(Holodiscus dumosus)*
Rocky Mountain maple *(Acer glabrum)*
cliffbush (JAAM) phase includes:
***cliffbush** (*Jamesia americana*) [>5% cover]
twinflower (LIBO) phase includes:
***twinflower** *(Linnaea borealis)*

HERBS

Common (>1%) to well represented (>5%) coverage:
Rocky Mountain trisetum (*Trisetum montanum*)
fringed brome *(Bromus ciliatus)*
sprucefir fleabane *(Erigeron eximius)*
boxleaf myrtle *(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 geranium *(Geranium richardsonii)*
peavine spp. *(Lathyrus* spp.)
Parry goldenrod *(Solidago parryi)*
fireweed *(Epilobium angustifolium* ssp *angustifolium)*
showy frasera *(Frasera speciosa)*
sidebells wintergreen *(Orthilia secunda)*
greenflowered wintergreen *(Pyrola chlorantha)*
Fendler meadowrue *(Thalictrum fendleri)*
mountain 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)

boxleaf myrtle *(Paxistima myrsinites = Pachistima* myrsinites)
Parry goldenrod *(Solidago parryi = Haplopappus parryi)*
sidebells wintergreen (Orthilia secunda = *Ramischia secunda = Pyrola secunda*)
Virginia strawberry *(Frageria virginiana* ssp. *virginiana = F. ovalis)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

PHASES

Whortleberry (ABBI/VAMY2) **or typic phase:** Corkbark 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 (ABBI/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 (ABBI/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.

Cliffbush (ABBI/VAMY, JAAM) **phase:** Similar to ABLA/VAMY, RUPA , the cliffbush phase exhibits the mixed species overstory. In the understory, 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 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). 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, corkbark 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 corkbark fir stands, probably indicates that significant disturbance has occurred within the past 400 years.

REFORESTATION

Timber harvest methods: heavy overstory removal may favor aspen if present, otherwise regeneration may be unsuccessful without extraordinary planting measures. 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 corkbark 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: ABBI/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 southernmost occurrence in the U.S. in the Pinaleno Mountains.

Budworm susceptibility: 0.6 (typic phase); 0.8 (RUPA & LIBO phases).

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/Arizona fescue
Pinus aristata/Festuca arizonica

PIAR/FEAR2

SYNONYMS
PIAR/FEAR2/MUMO/RICE, Shephard 1975

CODE(S)
typic phase 2 38 30 0

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. Aspen *(Populus tremuloides)* occurs as an accidental species in this plant association.

STRUCTURE
Overstory is dominated by bristlecone pine or sometimes codominated 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, and budworm susceptibility is 0.

The resource value rating for cattle in early seral stage is moderate, and in the late seral stage is low.

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).

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)*
whortleleaf 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 ECOSYSTEM CLIMATE CLASS

Life Zone Class: 6 (mixed conifer)
Elevational Subzone: 0 (typical or modal) or +1 (cool, wet)
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 fescue
Pinus aristata/Festuca thurberi

PIAR/FETH

CODE(S)

typic phase 2 38 31 0

KEY CRITERIA

***Bristlecone pine** is dominant or is co-dominant with Engelmann spruce in the overstory; grasses dominate the understory with ***Thurber fescue** as the indicator species. Corkbark fir *(Abies bifolia)* may occur as an accidental.

STRUCTURE

Stands of bristlecone pine are usually pure, even aged and open, may be codominated 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 in late seral stages is low.

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.

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)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
common juniper *(Juniperus communis)*

HERBS

Abundant (>25% cover).
***Thurber 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 goldenrod *(Solidago parryi)*
Fendler meadowrue *(Thalictrum fendleri)*
alpine clover *(Trifolium dasyphyllum)*
bluebell bellflower *(Campanula rotundifolia)*
skunkweed polemonium *(Polemonium pulcherrimum spp delicatum)*
yellowdot saxifrage *(Saxifraga bronchialis)*

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 and Arizona fescue have leaf blades mostly less than 3mm wide, rolled and somewhat stiff.

Thurber 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 ECOSYSTEM CLIMATE CLASS

Life Zone Class:	7 (spruce-fir forest)
Elevational Subzone:	-1 (warm dry)
	0 (typical or modal)
	+1 (cool, wet)
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 in draft).

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 budworm susceptibility is 0.

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 geminability of the seed. It does not exhibit dormancy, undergoes rapid germination, is subject to scarification mortality, and lacks cold hardiness (Preston, R. J. 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 corkbark 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 — PIAR/RIMO2

(Formerly Bristlecone pine/ Mountain currant PIAR/RIMO)

Pinus aristata/Ribes montigenum

CODE

typic phase 2 38 04 0

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).

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 penstemon *(Penstemon whippleanus)*
alpine fescue *(Festuca brachyphylla)*
Fendler 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 ECOSYSTEM CLIMATE CLASS

Life Zone Class: 7 (Spruce-fir forest)
Elevational Subzone: 0 (typical or modal)
+1 (cool, wet)
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/Kinnikinnick PIPU/ARUV
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

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.) Corkbark fir may occur as an accidental species.

STRUCTURE

Blue spruce, Douglas-fir, and possibly white fir codominate 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/COSE; warmer sites merge with ABCO-PSME/QUGA, PIPU/FEAR2 or ABCO/ARUV; cooler sites ecotone with ABBI/EREX4 and ABCO/CAFO3.

ALSO SEE

Picea pungens/Juniperus communis in Utah (Youngblood and Mauk 1985) appears similar, PIPU/FEAR2 occupies drier, warmer sites. PIPU/CAFO3 differs primarily by scarcity of *Arctostaphylos uva-ursi*.

TREES & LIFE HISTORY TRAITS

***blue spruce** *(Picea pungens)*	C
white fir *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
aspen *(Populus tremuloides)*	S
ponderosa pine *(Pinus ponderosa)*	s

SHRUBS

Abundant (>25%):
***kinnikinnick** *(Arctostaphylos uva-ursi)*
common juniper *(Juniperus communis)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
boxleaf myrtle *(Paxistima myrsinites)*
Utah serviceberry *(Amelanchier utahensis* ssp *utahensis)*
Oregongrape *(Mahonia repens)*
Wood rose *(Rosa woodsii)*
thimbleberry *(Rubus parviflorus)*

HERBS

Common (>1%) to well represented (>5%) cover:
Virginia strawberry *(Fragaria virginiana ssp virginiana)*
woodland strawberry *(Fragaria vesca* ssp *americana)*
Richardson geranium *(Geranium richardsonii)*
starry false Solomon seal *(Maianthemum stellatum)*
western yarrow *(Achillea millefolium* var *occidentalis)*
manyflowered gromwell *(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.)

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.

SYNONYMY

Virginia strawberry *(Fragaria virginiana* ssp *virginiana = F. ovalis)*
woodland strawberry *(Fragaria vesca* ssp *americana = F. americana)*
starry false Solomon seal *(Maianthemum stellatum)* = star Solomon seal *(Smilicina stellata)*
western yarrow *(Achillea millefolium* var *occidentalis = A. lanulosa)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Timber harvest methods: heavy overstory removal may be successful. Clearcutting and heavy shelterwood methods favor ponderosa pine, Douglas-fir and aspen. 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. Kinnikinnik 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/root-crown. 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.

Budworm susceptibility = 1.5.

REFERENCE(S)

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

Blue spruce/Dryspike sedge PIPU/CAFO3

(Formerly: Blue spruce/Fony sedge)

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

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 co-dominants, 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 ABBI/EREX4, ABCO/ACGL, ABCO/FEAR, PIPO/FEAR and PIPU/COSE.

ALSO SEE

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

TREES & LIFE HISTORY TRAITS

blue spruce *(Picea pungens)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
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)*
boxleaf myrtle *(Paxistima myrsinites)*
Arizona honeysuckle *(Lonicera arizonica)*
Gambel oak *(Quercus gambelii*)
rockspirea *(Holodiscus dumosus)*
Oregongrape *(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 foenea)*
Ross sedge *(Carex rossii)*
Arizona fescue *(Festuca arizonica)*
prairie junegrass *(Koeleria macrantha)*
screwleaf muhly *(Muhlenbergia virescens)*
mutton grass *(Poa fendleriana)*
Thurber fescue *(Festuca thurberi)*
Virginia strawberry *(Fragaria virginiana ssp. virginiana)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
Richardson geranium *(Geranium richardsonii)*
pussytoes spp. *(Antennaria* spp.*)*
western yarrow *(Achillea millefolium* var. *occidentalis)*
Parry goldenrod *(Solidago parryi)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus*)
sprucefir fleabane *(Erigeron eximius)*
bluebell bellflower *(Campanula rotundifolia)*
alpine false mountain parsley *(Pseudocymopteris montana)*
Wooton ragwort *(Senecio wootonii)*
American vetch *(Vicia americana)*
New Mexico groundsel *(Senecio neomexicana)*
Canadian white violet *(Viola canadensis)*
smooth townsend daisy *(Townsendia formosa)*
Fendler meadowrue *(Thalictrum fendleri)*
bedstraw spp. (*Galium* spp.)

CRYPTOGAMS

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

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)*
woodland strawberry *(Fragaria vesca* ssp. *americana= F. americana)*
western yarrow *(Achillea millefolium* var. *occidentalis= A. lanulosa)*
Parry goldenrod *(Solidago parryi = Haplopappus parryi = Oreochrysum parryi)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = Lathyrus arizonica)*
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Timber harvest methods: Heavy overstory removal may be successful. Clearcutting favors aspen and favors ponderosa pine and Douglas-fir if planted promptly. Heavy shelter and selection cutting favor white fir and blue spruce. Light shelter 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.

Budworm susceptibility: 1.5

REFERENCE(S)

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

Blue spruce/Redosier dogwood PIPU/COSES
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

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 a 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, ABBI/VAMY and PSMEG/MUVI2.

ALSO SEE

PIPU/POPR Fitzhugh *et al.* 1987; and Moir and Ludwig 1979.

TREES & LIFE HISTORY TRAITS

blue spruce *(Picea pungens)* C
Douglas-fir *(Pseudotsuga menziesii)* S
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 willow *(Salix scouleriana)*
Bebb willow *(Salix bebbiana)*
twinberry honeysuckle *(Lonicera involucrata)*
Rocky Mountain maple *(Acer glabrum)*
russet buffaloberry *(Sheperdia canadensis)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
boxleaf myrtle *(Paxistima myrsinites)*
gooseberry currant *(Ribes montigenum)*
thimbleberry *(Rubus parviflorus)*

HERBS

Abundant (>25% cover)**:**
Kentucky bluegrass *(Poa pratensis)*
bluejoint *(Calamagrostis canadensis)*
dryspike sedge *(Carex foenea)*
Ross sedge *(Carex rossii)*
false melic *(Schizachne purpurascens)*
Richardson geranium *(Geranium richardsonii)*
bluntseed sweetroot *(Osmorhiza depauperata)*
common dandelion *(Taraxacum officinale)*
starry false Solomon seal *(Maianthemum stellatum)*
Fendler meadowrue *(Thalictrum fendleri)*
common cowparsnip *(Heracleum maximum)*
yellow avens *(Geum allepicum)*
franciscan bluebells (*Mertensia franciscana)*
mountain thermopsis *(Thermopsis rhombifolia* var. *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

Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = Lathyrus arizonica)*
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
bluntseed sweetroot *(Osmorhiza depauperata)* = sweetcicily *(O. obtusa)*
starry false Solomon seal *(Maianthemum stellatum)* = star Solomon 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)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: -1 (warm, dry)
0 (typic)
+1 (cool, wet)
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 were 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

Timber harvest 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.

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.

Budworm susceptibility: 0.8

REFERENCE(S)

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

Blue spruce/Sprucefir fleabane PIPU/EREX4

(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

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, corkbark 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/MUVI2, PSMEG/QUGA; adjoining PIPU/EREX4 on north slopes: ABBI/EREX4, ABCO/Sparse; on south slopes: ABCO/MUVI2, PIPO/MUVI2, PIPO/QUGR3, PIPO/FEAR2; interspersed: PIPU/CAFO3; on moister sites: PIPU/COSES.

ALSO SEE

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

TREES & LIFE HISTORY TRAITS

typic phase	
Engelmann spruce *(Picea engelmannii)*	c
blue spruce *(Picea pungens)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
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
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)*
boxleaf myrtle *(Paxistima myrsinites)*
Arizona honeysuckle *(Lonicera arizonica)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis)*
Wood rose *(Rosa woodii* var. *ultramontana)*
thimbleberry *(Rubus parviflorus)*

HERBS

Abundant (>25% cover)**:**
sprucefir fleabane *(Erigeron eximius)*
beautiful fleabane *(Erigeron formosissimus)*
Fendler meadowrue *(Thalictrum fendleri)*
Virginia strawberry *(Fragaria virginiana ssp. virginiana)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
Richardson geranium *(Geranium richardsonii)*
ragweed sagebrush *(Artemisia franseroides)*
Canadian white violet *(Viola canadensis)*
alpine false mountain parsley *(Pseudocymopteris montana)*
Parry goldenrod *(Solidago parryi)*
sharpleaf valerian *(Valeriana acutiloba* var. *acutiloba)*
starry false Solomon seal *(Maianthemum stellatum)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus*)
owlsclaws *(Dugaldia hoopsii)*
bluebell bellflower *(Campanula rotundifolia)*
fringed brome *(Bromus ciliatus)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koeleria macrantha)*
dryspike sedge *(Carex foenea)*
screwleaf muhly *(Muhlenbergia virescens)*
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)*
Wood 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 goldenrod *(Solidago parryi = Haplopappus parryi = Oreochrysum parryi)*
sharpleaf valerian *(Valeriana acutiloba var. acutiloba = V. capitata* ssp *acutiloba)*
starry false Solomon seal *(Maianthemum stellatum)* = star Solomon seal *(Smilicina* stellata)
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus= L. arizonicus*)
owlsclaws *(Dugaldia hoopsii)*= orange sneezeweed *(Helenium hoopsii)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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, wet)
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 more moist. Engelmann spruce and rarely, corkbark fir, may be present in the overstory composed of mixed species. Blue spruce regeneration is greater than the combined regeneration of corkbark 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

Timber harvest 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 methods are usually successful; more cover favoring shade tolerant species like spruce, less cover favoring Douglas-fir. 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.

Budworm susceptibility: 1.5

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 PIPU/FEAR2
Picea pungens/Festuca arizonica

CODE(S)

typic phase 0 06 09 0

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/MUVI2 and PIPO/FEAR2 ; ABCO/FEAR2; on more moist sites: PIPU/EREX4, PIPU/CAFO3, and PIPU/COSES.

TREES & LIFE HISTORY TRAITS

blue spruce *(Picea pungens)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
ponderosa pine *(Pinus ponderosa)*	S
white fir *(Abies concolor)*	c
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)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*

HERBS

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

screwleaf muhly *(Muhlenbergia virescens)*
Virginia strawberry *(Fragaria virginiana ssp. virginiana)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
western yarrow *(Achillea millefolium)*
pussytoes spp. *(Antennaria* spp.*)*
Parry goldenrod *(Solidago parryi)*
peavines *(Lathyrus* spp.)
beardlip penstemon *(Penstemon barbatus)*
"mountain parsley" *(Pseudocymopteris montana)*
Wooton ragwort *(Senecio wootonii)*
New Mexico groundsel *(Senecio 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 goldenrod *(Solidago parryi = Haplopappus parryi = Oreochrysum parryi*
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Timber harvest 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 cutting favors ponderosa pine and blue spruce regeneration. Seed tree harvest method is sometimes successful for regenerating ponderosa pine. Selection removal favors the more shade tolerant species, i.e. blue spruce. Light shelter favors Douglas-fir and blue spruce.

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).

Budworm susceptibility: 1.

REFERENCES

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

Blue spruce/Twinflower PIPU/LIBO3
Picea pungens/Linnaea borealis

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

CODE(S)
typic phase 0 06 04

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 corkbark 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 boxleaf myrtle. 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,ABBI/EREX4, ABBI/VAMY-LIBO3, and ABBI/RUPA.

ALSO SEE
PIPU/EREX4

TREES & LIFE HISTORY TRAITS
blue spruce *(Picea pungens)*	C
Douglas-fir *(Pseudotsuga menziesii)*	S
aspen *(Populus tremuloides)* [early to mid]	S
corkbark fir *(Abies bifolia)*	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)*
boxleaf myrtle *(Paxistima myrsinites)*
thimbleberry *(Rubus parviflorus)*
whortleberry (*Vaccinium* spp.)
whortleleaf snowberry *(Symphoricarpos oreophilus)*
sidebells wintergreen *(Orthilia secunda)*

HERBS
Abundant (>25% cover) to luxuriant (>50% cover)**:**
sprucefir fleabane *(Erigeron eximius)*
Fendler meadowrue *(Thalictrum fendleri)*
Virginia strawberry *(Fragaria virginiana ssp. virginiana)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
Richardson geranium *(Geranium richardsonii)*
ragweed sagebrush *(Artemisia franseroides)*
Canadian white violet *(Viola canadensis)*
peavine (*Lathyrus* spp.)
fringed brome *(Bromus ciliatus)*

dryspike sedge *(Carex foenea)*
Rocky Mountain trisetum (*Trisetum montanum*)
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)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Timber harvest 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 methods are usually successful; more cover favoring shade tolerant species like spruce, less cover favoring Douglas-fir. Selection cutting favors spruce and white fir.

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.

Budworm susceptibility: 1.5.

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 PIPU/SECA6

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

Picea pungens/Senecio cardamine

CODE(S)

typic phase 0 06 13 0

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 corkbark 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/SECA6. The low growing shrub, boxleaf myrtle and thimbleberry are usually present. Along with PIEN/SECA6, 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/SECA6 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, ABBI/EREX4; also some stands may intergrade with PIEN/SECA6.

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
corkbark fir *(Abies bifolia)*	c
Engelmann spruce *(Picea engelmannii)*	c
ponderosa pine *(Pinus ponderosa)*	s
aspen *(Populus tremuloides)* [early to mid-seral]	s

SHRUBS

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

HERBS

Abundant (>25% cover) to luxuriant (>50% cover)**:**
***bittercress ragwort** *(Senecio cardamine)*
fringed brome *(Bromus ciliatus)*
dryspike sedge *(Carex foenea)*
muttongrass *(Poa fendleriana)*
Ross sedge *(Carex rossii)*
prairie junegrass *(Koeleria macrantha)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
mountain thermopsis *(Thermopsis rhombifolia* var. *montana)*
Richardson geranium *(Geranium richardsonii)*
sprucefir fleabane (*Erigeron eximius)*
Canadian white violet *(Viola canadensis)*

Virginia strawberry *(Fragaria virginiana* ssp. *virginiana)*
Wooton ragwort *(Senecio wootonii)*
western brackenfern *(Pteridium aquilinum)*
sidebells wintergreen *(Orthilia secunda)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus*)
giant lousewort *(Pedicularis procera)*

BRIEF PLANT ID NOTES

Note: Eleven other shrub species have been identified for PIPU/SECA6 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 = cardamine groundsel
woodland strawberry *(Fragaria vesca* ssp. *americana = F. americana)*
Virginia strawberry *(Fragaria virginiana ssp. virginiana = F. ovalis)*
mountain thermopsis *(Thermopsis rhombifolia* var. *montana = Thermopsis pinetorum)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus= Lathyrus arizonica*)
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
sidebells wintergreen *(Orthilia secunda = Ramischia secunda)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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. Selection harvest methods favor Engelmann spruce over other species. Potential of windthrow may be high, therefore, seed tree cutting may be unsuccessful because of blowdown.

Tree planting is usually highly successful. Recommended species are Douglas-fir and blue spruce. Site preparation can enhance planting success. Moderate to low intensity mechanical methods and low intensity burning are usually beneficial. Sivicultural 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. Budworm susceptibility is 1.6.

REFERENCE(S)

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

White fir/Rocky Mountain Maple
Abies concolor/Acer glabrum

ABCO/ACGL

SYNONYMS
ABCO-PSME/ACGL (Johnston 1987)

CODE(S)

typic phase	0 01 01 0
Oregongrape (MARE11) phase	0 01 01 1
rockspirea (HODU) phase	0 01 01 2
riparian phase	0 01 01 3

KEY CRITERIA
Complex overstory where ***white fir** and Douglas-fir codominate; blue spruce and limber pine may or may not be important, corkbark 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. Oregongrape, 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/CAFO3, ABCO/MARE11, or ABCO/QUGA; ABLA/JAAM on colder sites ABCO/ACGR on moister sites.

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

TREES & LIFE HISTORY TRAITS

white fir *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
aspen *(Populus tremuloides)* [early to mid]	S
limber pine *(Pinus flexilis)* [in northern NM]	s
southwestern white pine *(Pinus strobiformis)*	s
ponderosa pine *(Pinus ponderosa)*	s

SHRUBS

Well represented (>5% cover) to abundant (>25% cover):
Rocky Mountain maple *(Acer glabrum)*
Scouler willow *(Salix scouleriana)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis*)
rockspirea *(Holodiscus dumosus)*
mountain ninebark *(Physocarpus monogynus)*
boxleaf myrtle *(Paxistima myrsinites)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
Arizona honeysuckle *(Lonicera arizonica)*
Oregongrape *(Mahonia repens)*
New Mexico locust *(Robinia neomexicana)*
cliffbush *(Jamesia americana*)
black elderberry *(Sambucus racemosa* ssp. *pubens* var. *melanocarpa)*
common hoptree *(Ptelea trifoliata)*

HERBS

Well represented (>5% cover):
Canadian brome *(Bromus canadensis)*
fringed brome *(Bromus ciliatus)*
ragweed sagebrush *(Artemisia franseriodes)*
Canadian white violet *(Viola canadensis)*
Parry goldenrod *(Solidago parryi)*
Fendler meadowrue *(Thalictrum fendleri)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
bluntseed sweetroot *(Osmorhiza depauperata)*
Richardson geranium *(Geranium richardsonii)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus)*
feathery false Solomon seal *(Maianthemum racemosum)*
roughfruit fairybells *(Disporum trachycarpum)*
dryspike sedge *(Carex foenea)*
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 goldenrod *(Solidago parryi = Haplopappus parryi = Oreochrysum parryi)*
woodland strawberry *(Fragaria vesca* ssp. *americana = F. americana)*
bluntseed sweetroot = sweetcicily *(Osmorhiza depauperata = O. obtusa)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
feathery false Solomon seal *(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*
Canadian brome *(Bromus canadensis = Bromopsis ciliata).*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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).

Oregongrape 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, Oregongrape 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, wet 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; Canadian brome is common grass; forbs vary and can be of sufficient abundance to cover large percentage of the site; Oregongrape 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, 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 stage 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

Timber harvest 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 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.

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.

Budworm Susceptibility = 1.7.

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 ABCO/ACGR
Abies concolor/Acer grandidentatum

CODE(S)

bigtooth maple (typic) phase	0 01 08 0
rockspirea phase	0 01 08 1

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.

TREES & LIFE HISTORY TRAITS

***white fir** *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
***bigtooth maple** *(Acer grandidentatum)*	C
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)*

boxleaf myrtle *(Paxistima myrsinites)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
New Mexico locust *(Robinia neomexicana)*

HERBS

Well represented (>5% cover) to abundant (>25 % cover)**:**
dryspike sedge *(Carex foenea)*
fringed brome *(Bromus ciliatus)*
Canadian brome *(Bromus canadensis)*
golden columbine *(Aquilegia chrysantha)*
Fendler meadowrue *(Thalictrum fendleri)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
feathery false Solomon seal *(Maianthemum racemosum)*
Canadian white violet *(Viola canadensis)*
Richardson geranium *(Geranium richardsonii)*
starry false Solomon seal *(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 Solomon seal *(Maianthemum racemosum = Smilacina racemosa)*
starry false Solomon seal *(Maianthium stellatum = Smilacina stellata)*
Canadian brome *(Bromus canadensis = Bromopsis ciliatus)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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. Canadian 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

Timber harvest methods: Heavy overstory removal favors hardwoods. Selection cutting 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.

Budworm Susceptibility = 1.7.

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/Kinnikinnik ABCO/ARUV
Abies concolor/Arctostaphylos uva-ursi

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

CODE(S)
typic phase 0 01 09 0

KEY CRITERIA
***White fir** and Douglas-fir codominate the overstory, and ponderosa pine is a major seral associate. ***Kinnikinnik** dominates the undergrowth, occasionally along with boxleaf myrtle. 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 kinnikinnik which, along with boxleaf myrtle, 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.

TREES & LIFE HISTORY TRAITS
white fir *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
ponderosa pine *(Pinus ponderosa)*	S
aspen *(Populus tremuloides)*	s
limber pine *(Pinus flexilis)* [in N. NM]	s

SHRUBS
Abundant (>25 % cover)**:**
***kinnikinnik** *(Arctostaphylos uva-ursi)*
boxleaf myrtle *(Paxistima myrsinites)*
common juniper *(Juniperus communis)*
russet buffaloberry *(Shepherdia canadensis)*
wild rose *(Rosa* spp.)
Gambel oak *(Quercus gambelii)*
(<5% cover)
Oregongrape *(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 goldenrod *(Solidago parryi)*
threenerve goldenrod *(Solidago velutina)*

BRIEF PLANT ID NOTES

Kinnikinnik 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 goldenrod *(Solidago parryi = Haplopappus parryi = Oreochrysum parryi)*
threenerve goldenrod *(Solidago velutina = S. sparsiflora)*
Virginia strawberry *(Fragaria virginiana ssp virginiana = F. ovalis = F. canadensis)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical)
Climate Class: LSC (low sun cold)

FIRE ECOLOGY

Kinnikinnik is a seral, shade-intolerant species found in open forests. It grows best in high light situations, thinning as shade increases. The development of kinnikinnik's early seral cover depends on site variables such as elevation and the amount of shading. Kinnikinnik 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

Timber harvest methods: heavy overstory removal (clear cuts and seed tree cuts) may favor ponderosa pine and Douglas-fir regeneration. Shelterwood 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. Selection cutting favors white fir.

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 kinnikinnik. 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 kinnikinnik and quick reestablishment of graminoids.

COMMENTS

Livestock use: Kinnikinnik 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, kinnikinnik 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.

Budworm susceptibility = 1.5. Budworm susceptibility can be reduced by thinning white fir.

REFERENCES

Crane 1991
DeVelice *et al.* 1986
USFS 1987a

White fir/dryspike sedge
Abies concolor/Carex foenea

ABCO/CAFO3

SYNONYMS
White fir/fony sedge (USFS 1987b).

CODE(S)
typic phase 0 01 15 0

KEY CRITERIA
***White fir** and Douglas-fir codominate 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 codominate the overstory with minor corkbark 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/CAFO3 on more moist sites: ABCO/ACGL; and on rockier, cooler sites: ABBI/JAAM.

ALSO SEE
ABCO/MUVI2, Muldavin *et al*. 1996.

TREES & LIFE HISTORY TRAITS
white fir *(Abies concolor)* C
Douglas-fir *(Pseudotsuga menziesii)* C
southwestern white pine *(Pinus strobiformis)* S or s
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 foenea)*
fringed brome *(Bromus ciliatus)*
Kentucky bluegrass *(Poa pratensis)*
mountain muhly *(Muhlenbergia montana)*
Ross sedge *(Carex rossii)*
Richardson geranium *(Geranium richardsonii)*
Fendler meadowrue *(Thalictrum fendleri)*
Wooton ragwort *(Senecio wootonii)*
western brackenfern *(Pteridium aquilinum)*
bluebell bellflower *(Campanula rotundifolia)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus)*
mountain parsley *(Pseudocymopteris 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)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: +1 (cool, wet)
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

Timber harvest methods: heavy overstory removal (clearcuts and seed tree cuts) may regenerate Douglas-fir. 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. 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

Budworm Susceptibility = 1.5.

REFERENCES

USFS 1987b
Moir and Ludwig 1979
Muldavin *et al*. 1996
Youngblood and Mauk 1986

White fir/sprucefir fleabane ABCO/EREX4

(Formerly: white fir/forest fleabane)

Abies concolor/Erigeron eximius

SYNONYMS

ABCO-PSME/EREX (Johnston 1987).

CODE(S)

typic phase 0 01 03 0

KEY CRITERIA

Complex overstory where ***white fir** and Douglas-fir codominate; blue spruce and limber pine may be important; corkbark 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. Corkbark 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, CAFO3 phase usually does not have luxuriant herbs and often occurs on soils with high content of volcanic ash. ABCO/LALAA3 is similar but has a rich legume component (e.g. *Lathyrus* spp.) and ponderosa pine is of greater importance as a seral tree.

TREES & LIFE HISTORY TRAITS

white fir *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
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 willow *(Salix scouleriana)*
rockspirea *(Holodiscus dumosus)*
Gambel oak *(Quercus gambelii)* [<5% cover]
orange gooseberry *(Ribes pinetorum)*
Arizona honeysuckle *(Lonicera arizonica)*
boxleaf myrtle *(Paxistima myrsinites)*
New Mexico locust *(Robinia neomexicana)*
whortleleaf 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)*
owlsclaws *(Dugaldia hoopsii)*
Parry goldenrod *(Solidago parryi)*
bittercress ragwort *(Senecio cardamine)*
Sacramento ragwort *(Senecio sacramentanus)* [Sacramento Mountains]
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus)*
Richardson 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 foenea)*
Rocky Mountain trisetum (*Trisetum montanum*)
red baneberry *(Actaea rubra)*
bluntseed sweetroot *(Osmorhiza depauperata)*
Fendler meadowrue *(Thalictrum fendleri)*
feathery false Solomon seal *(Maianthemum racemosum)*
starry false Solomon seal *(Maianthemum stellatum)*
mountain thermopsis *(Thermopsis rhombifolia* var *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 goldenrod *(Solidago parryi = Haplopappus parryi = Oreochrysum parryi)*
Arizona peavine *(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 Solomon seal *(Maianthemum racemosum =Smilacina racemosa)*
starry false Solomon seal *(Maianthemum stellatum = Smilacina stellata)*
mountain thermopsis *(Thermopsis rhombifolia* var *montana = T. montana = T. pinetorum)*
owlsclaws = orange sneezeweed *(Dugaldia hoopsii = Helenium hoopsii)*
bluntseed sweetroot = sweetcicily *(Osmorhiza depauperata = O. obtusa)*
feathery false Solomon seal *(Maianthemum racemosum =Smilacina racemosa)*

Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis = A. alnifolia)*
black elderberry *(Sambucus racemosa* ssp. *pubens* var. *melanocarpa = Sambucus melanocarpa)*
Canadian brome *(Bromus canadensis = Bromopsis ciliata)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Timber harvest methods: heavy overstory removal favors Douglas-fir regeneration; clear cuts favors 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 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 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.

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. Budworm Susceptibility = 1.7.

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 ABCO/FEAR2
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

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, corkbark 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/CAFO3 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, MUVI2 phase.

ALSO SEE
ABCO/ QUGA, Arizona fescue phase; PSME/FEAR2. Along cold air drainages, see also PIPU/FEAR2. ABCO/LALAA3 and ABCO/RONE also have abundant or luxuriant herbaceous understories in colder or wetter environments.

TREES & LIFE HISTORY TRAITS
<u>Arizona fescue and muttongrass phases:</u>	
white fir *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
ponderosa pine *(Pinus ponderosa)*	S
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
<u>Gambel oak phase:</u>	
white fir *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
ponderosa pine *(Pinus ponderosa)*	S
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)*
boxleaf myrtle *(Paxistima myrsinites)*
New Mexico locust *(Robinia neomexicana)*

HERBS

Abundant (>25% cover)**:**
Arizona fescue *(Festuca arizonica)*
mountain muhly *(Muhlenbergia montana)*
Parry danthonia *(Danthonia parryi)*
Pringle spear grass *(Piptochaetium pringlei)*
muttongrass *(Poa fendleriana)*
screwleaf muhly *(Muhlenbergia virescens)*
dryspike sedge *(Carex foenea)*
Ross sedge *(Carex rossii)*
bottlebrush squirreltail *(Elymus elymoides)*
fringed brome *(Bromus ciliatus)*
prairie junegrass *(Koeleria macrantha)*
pussytoes (*Antennaria* spp.)
beautiful fleabane *(Erigeron formosissimus)*
Arizona peavine *(Lathyrus lanszwertii* var *arizonicus)*
manyflowered gromwell *(Lithospermum multiflorum)*
strawberry *(Fragaria* spp.*)*
American vetch *(Vicia americana)*
woolly cinquefoil *(Potentilla hippiana)*
western yarrow *(Achillea millefolium* var *occidentalis)*
Fendler meadowrue *(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

Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
bottlebrush squirreltail *(Elymus elymoides =Sitanion hystrix)*
western yarrow *(Achillea millefolium* var. *occidentalis = A. lanulosa)*
Pringle spear grass *(Piptochaetium pringlei = Stipa pringlei)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 Oregongrape 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 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

Timber harvest 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 favors more shade tolerate white fir and Douglas-fir; while less shelter favors ponderosa pine. Selection cutting is more favorable to white fir regeneration.

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.

REVEGETATION CONSIDERATIONS

Natural revegetation following disturbance is expected to be rapid primarily due to strong response of graminoids and forbs and sprouting/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.

Budworm Susceptibility = 1.5.

REFERENCES

DeVelice *et al*. 1986
Fitzhugh *et al*. 1987
Johnston 1987
Mathiasen *et al*. 1986
Moir and Ludwig 1979
Stuever 1995
USFS 1986
USFS 1987a

White fir/Arizona walnut
Abies concolor/Juglans major

ABCO/JUMA

CODE(S)

typic phase 0 01 14 0

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 Oregongrape. The herbaceous cover is luxuriant (>50% cover) and diverse in species composition with meadowrue 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/ACGR.

ALSO SEE

Riparian forests; PIPO/JUMA.

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
aspen *(Populus tremuloides)*	s

SHRUBS

Well represented (>5% cover)**:**
Gambel oak *(Quercus gambelii)*
canyon grape *(Vitus arizonica)*
Arizona honeysuckle *(Lonicera arizonica)*
Oregongrape *(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 meadowrue *(Thalictrum fendleri)*
bluntseed sweetroot *(Osmorhiza depauperata)*
Richardson geranium *(Geranium richardsonii)*
Mexican bedstraw *(Galium mexicanum* ssp. *asperrimum)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus)*
mintleaf beebalm *(Monarda fistulosa* ssp. *fistulosa* var *menthaefolia)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana)*
tuber starwort *(Pseudostellaria jamesiana)*
feathery false Solomon seal *(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)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonica = Lathyrus arizonica)*
feathery false Solomon seal *(Maianthemum racemosum = Smilacina racemosa)*
Mexican bedstraw *(Galium mexicanum* ssp. *asperrimum = Galium asperrimum)*
mintleaf beebalm *(Monarda fistulosa* ssp. *fistulosa* var. *menthaefolia = Monarda menthaefolia)*
Virginia strawberry *(Fragaria virginiana ssp. virginiana = F. ovalis = F. canadensis)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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.

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.

Budworm Susceptibility = 1.7.

REFERENCE(S)

Alexander *et al*. 1984a
Fitzhugh *et al*. 1987
Muldavin *et al*. 1996
Stuever 1995

White fir/Arizona peavine
Abies concolor/
Lathyrus lanszwertii var. arizonicus

ABCO/LALAA3

(Formerly: Abies concolor/Lathyrus arizonicus ABCO/LAAR)

SYNONYMS

Abies concolor-Pseudotsuga menziesii/ Lathyrus arizonicus (Moir and Ludwig 1979).

CODE(S)

typic phase 0 01 07 0

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 Oregongrape. Whereas, the forb cover is variable; ranging from as little as 5% to more that 50%. ***Arizona peavine** 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 corkbark 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 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/LALAA3. 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).

TREES & LIFE HISTORY TRAITS

white fir *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
aspen *(Populus tremuloides)*	S
southwestern white pine *(Pinus strobiformis)*	s
ponderosa pine *(Pinus ponderosa)*	s

SHRUBS

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

Oregongrape *(Mahonia repens)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
boxleaf myrtle *(Paxistima myrsinites)*
Arizona honeysuckle *(Lonicera arizonica)*
common juniper *(Juniperus communis)*

HERBS

Well represented (>5% cover) to luxuriant (>50% cover)**:**

Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus)*

starry false Solomon seal *(Maianthemum stellatum)*
roughfruit fairybells *(Disporum trachycarpum)*
Fendler meadowrue *(Thalictrum fendleri)*
muttongrass *(Poa fendleriana)*
dryspike sedge *(Carex foenea)*
Geyer sedge *(Carex geyeri)*
Porter licoriceroot *(Ligusticum porteri)*
mountain thermopsis *(Thermopsis rhombifolia* var. *montana)*

BRIEF PLANT ID NOTES

Since they often grow together, Arizona peavine 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

Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
starry false Solomon seal *(Maianthemum stellatum = Smilacina stellata)*
mountain thermopsis *(Thermopsis rhombifolia* var *montana = T. montana = T. pinetorum)*
Porter licoriceroot = oshá

TERRESTRIAL ECOSYSTEM CLIMATE CLASS:

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. Oregongrape is adapted to fire and survives by suckering from dormant buds on the rhizomes.

REFORESTATION

Timber regeneration methods: heavy overstory removal may encourage regeneration: clearcut favoring aspen and ponderosa pine; and seed tree cuts favoring Douglas-fir and ponderosa pine. Heavy shelterwood cuts favor white fir and Douglas-fir, while lighter shelterwood cuts favor ponderosa pine. Individual tree selection favors the more shade tolerant white fir.

Planting and site preparation: Recommended species for artificial planting are Douglas-fir, 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: Oregongrape may be poisonous to livestock. It is not used to any extent by domestic livestock. Other forbs and grasses provide some livestock forage. ABCO/LALAA3 plant association has a forage value rating for cattle in early seral of "moderate", and "low" in late seral.

Wildlife: Mule deer include Oregongrape in their diets during spring through fall seasons (Severson & Medina 1983). Elk use Oregongrape yearlong; the least use occurring during the summer (Thomas & Toweill 19__). Its fruit is eaten by numerous bird and mammal species including black bear. Early seral stages of stand development are productive for wildlife forage.

Budworm susceptibility = 1.5.

REFERENCES

USFS 1987a
Moir and Ludwig 1979
Thomas and Toweill 1982
Severson and Medina 1983
Uchytil 1989

White fir/Beardless wildrye ABCO/LETR5
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

KEY CRITERIA

***White fir** and Douglas-fir are dominant. Engelmann spruce and corkbark 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 Canadian 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 codominate 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.

TREES & LIFE HISTORY TRAITS

***white fir** *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
southwestern white pine *(Pinus strobiformis)*	S
aspen *(Populus tremuloides)*	s
Gambel oak *(Quercus gambelii)*	S

SHRUBS

Well represented (>5 % cover)**:**
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)*
Canadian brome *(Bromus canadensis)*
dryspike sedge *(Carex foenea)*
Ross sedge *(Carex rossii)*
prairie junegrass *(Koeleria macrantha)*
fringed brome *(Bromus ciliatus)*

pineywoods geranium *(Geranium caespitosum)*
goldenrod *(Solidago* spp*)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus)*

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)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
Canadian brome *(Bromus canadensis = B. richardsonii = Bromus ciliatus)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Timber harvest methods: heavy overstory removals (clearcuts and seed tree cuts) are difficult to regenerate. Selection method favors white fir. Shelterwood is usually successful for establishing conifer regeneration.

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

Budworm Susceptibility = 1.5

REFERENCES

Alexander *et al*. 1984
Moir and Ludwig 1979
Stuever 1995
USFS 1986

White fir/Oregongrape
Abies concolor/Mahonia repens

ABCO/MARE11

SYNONYMS

Abies concolor-Pseudotsuga menziesii/ (sparse understory) (Moir and Ludwig 1979). ABCO-PSME sparse (Johnston 1987), ABCO/ sparse (DeVelice *et al*. 1986).

CODE(S)

Oregon grape (typic)	
(MARE) phase	0 01 02 0
New Mexico locust	
(RONE) phase	0 01 02 1
common juniper	
(JUCO) phase	0 01 02 2

KEY CRITERIA

***White fir** and Douglas-fir codominate the overstory; ponderosa pine and southwestern white pine are minor seral associates. Engelmann spruce and corkbark 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. Oregongrape 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/CAFO3; 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.

TREES & LIFE HISTORY TRAITS

white fir *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
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)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
Oregongrape *(Mahonia repens)*
rockspirea *(Holodiscus dumosus)*
honeysuckle *(Lonicera* ssp.)
boxleaf myrtle *(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 goldenrod *(Solidago parryi)*
Fendler meadowrue *(Thalictrum fendleri)*
western brackenfern *(Pteridium aquilinum)*
Ross sedge *(Carex rossii)*
wild strawberry *(Fragaria* ssp.*)*
fringed brome *(Bromus ciliatus)*
muttongrass *(Poa fendleriana)*
false Solomon seal *(Maianthemum* ssp.*)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus)*
Wooton ragwort *(Senecio wootonii)*

BRIEF PLANT ID NOTES

Oregongrape is a low sub-shrub with pinnately compound, spine-tipped, dark green and often reddish leaves.

SYNONYMY

Parry goldenrod *(Solidago parryi = Haplopappus parryi = Oreochrysum parryi)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana = F. ovalis)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus =L. arizonicus)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class: 6 (mixed conifer forest)
Elevational Subzone: 0 (typical)
Climate Class: LSC (low sun cold)

PHASES

Oregongrape (MARE11) (typic) phase: The understory consists of low evergreen shrubs i.e., Oregongrape (trace to 7% cover), common juniper (trace to 15% cover), or boxleaf myrtle (up to 2% cover) [Moir and Ludwig 1979]; lacks abundant common juniper (>25% cover) and being slightly more moist, 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, whortleleaf snowberry, Scouler 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

Oregongrape is adapted to fire and survives by suckering from dormant buds on the rhizomes.

REFORESTATION

Timber harvest methods: Heavy overstory removal (clearcuts and seed tree cuts) may be successful and favors ponderosa pine and Douglas-fir. 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: Oregongrape may be poisonous to livestock. It is not used to any extent by domestic livestock.

Wildlife: Oregongrape may make up 6 to15% of the diet of mule deer during spring through fall seasons (Severson 1983). Elk use Oregongrape 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.

Budworm susceptibility = 1.7.

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 ABCO/MUVI2
Abies concolor/Muhlenbergia virescens

CODE(S)
typic phase 0 01 06 0

KEY CRITERIA
***White fir** and Douglas-fir codominate 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. Corkbark 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 midslopes, 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/MUVI2 and at higher elevations are various phases of ABCO/QUGA, and lower elevations support PSME/MUVI2 type.

ALSO SEE
PSME/MUVI2 if white fir is accidental; ABCO/FEAR2 (USFS 1986a) if screwleaf muhly is absent; ABCO/QUGA, MUVI2 phase if Gambel oak (as trees or shrubs) >5% cover.

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
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 virescens)*

fringed brome *(Bromus ciliatus)*
muttongrass *(Poa fendleriana)*
Ross sedge *(Carex rossii)*
bottlebrush squirreltail *(Elymus elymoides)*
silvery lupine *(Lupinus argenteus)*
grassleaf peavine *(Lathyrus graminifolius)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus)*
sweetclover vetch *(Vicia pulchella)*
western brackenfern *(Pteridium aquilinum)*
mountain thermopsis *(Thermopsis rhombifolia* var. *montana)*
Wooton ragwort *(Senecio wootonii)*
New Mexico groundsel *(Senecio neomexicanus)*
Parry goldenrod *(Solidago 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)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
mountain thermopsis *(Thermopsis rhombifolia* var *montana = T. montana = T. pinetorum)*
Parry goldenrod *(Solidago parryi = Haplopappus parryi = Oreochrysum parryi)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 consummed 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

Timber harvest methods: heavy overstory removal methods like clearcutting favor Douglas-fir and ponderosa pine regeneration, and locally in some areas, aspen. Seed tree cuts can be useful to encourage pines, especially in mistletoe infected areas. Lesser degrees of overstory removal such as heavy shelterwood favors the more shade tolerant white fir; while more aggressive shelterwood cuts favor ponderosa pine and Douglas-fir. Individual tree removal usually encourages white fir regeneration.

Site preparation techniques: High to moderate intensity burning may create conditions favorable for suckering of aspen. 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/MUVI2 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.

Budworm susceptibility = 1.5.

REFERENCES

Fitzhugh *et al*. 1987
Stuever 1995
USFS 1986
USFS 1987b

White fir/Gambel oak ABCO/QUGA
Abies concolor/Quercus gambelii

SYNONYMS
ABCO-PSME/ QUGA (Johnston 1987).

CODE(S)

Gambel oak (QUGA) phase	0 01 05 0
Screwleaf muhly (MUVI2) 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

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 codominating 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 MUVI2 or MUDU phases. On the drier side of the moisture gradient, the typic phase may be adjoined by PSME/QUGA, or MUDU, MUVI2 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.

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
aspen *(Populus tremuloides)* s

SHRUBS

Usually abundant (>25% cover)**:**
***Gambel oak** *(Quercus gambelii)*
New Mexico locust *(Robinia neomexicana)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
wildrose (*Rosa* spp.)
boxleaf myrtle *(Paxistima myrsinites)*
Oregongrape *(Mahonia repens)*
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 virescens)*
[screwleaf muhly phase]
mountain muhly *(Muhlenbergia montana)*
pine muhly *(Muhlenbergia dubius)*
[pine muhly phase]
Arizona fescue *(Festuca arizonica)*
[Arizona fescue phase]
Richardson geranium *(Geranium richardsonii)*
western brackenfern *(Pteridium aquilinum)*
Fendler meadowrue *(Thalictrum fendleri)*
western yarrow *(Achillea millefolium* var. *occidentalis)*
American vetch *(Vicia americana)*
Arizona peavine *(Lathyrus lanszwertii* var *arizonicus)*
pine goldenpea *(Thermopsis rhombifolia* var *divericarpa)*
Canadian brome *(Bromus canadensis)*
Canadian white violet (Viola canadensis)
rockspirea (HODU) phase additionally includes:
western virgin's bower *(Clematis ligusticifolia)* [>1% cover]
Arizona fescue (FEAR) phase additionally includes:
Vreeland erigeron *(Erigeron vreelandii)* [>1% cover]
Louisiana sagewort *(Artemisia ludoviciana)* [>1% cover]
screwleaf muhly (MUVI) 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)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
pine goldenpea *(Thermopsis rhombifolia* var. *divericarpa = Thermopsis divericarpa)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 mutton grass are common (>1% cover). Forb diversity is generally lacking. Shrub density is usually lower than in QUGA Phase. Pringle needlegrass 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 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.

REFORESTATION

Timber harvest methods: heavy overstory removal methods like clearcutting favor Douglas-fir and ponderosa pine regeneration, and locally in some areas, 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, personal communication). Also, successful regeneration of both conifers is increased through planting in open situations. Lesser degrees of overstory removal such as heavy shelterwood favors more shade tolerate white fir and Douglas-fir; while less shelter favors ponderosa pine. Selection cutting is more favorable to white fir regeneration and may help to suppress oak/locust.

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).

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

Budworm susceptibility = 1.5.

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/New Mexico locust ABCO/RONE
Abies concolor/Robinia neomexicana

CODE(S)

New Mexico locust
(RONE) phase 0 01 11 0
dryspike sedge (CAFO3) phase 0 01 11 1

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 (CAFO3 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/LALAA3, and ABCO/FEAR2.

TREES & LIFE HISTORY TRAITS

New Mexico Locust phase:	
white fir *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	S
ponderosa pine *(Pinus ponderosa)*	S
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
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 foenea)*
woodland strawberry *(Fragaria vesca* ssp. *americana)*
starry false Solomon seal *(Maianthemum stellatum)*
feathery false Solomon seal *(Maianthemum racemosum)*

Richardson 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 Solomon seal *(Maianthemum stellatum = Smilacina stellata)*
feathery false Solomon seal *(Maianthemum racemosum = Smilacina racemosa)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 (CAFO3) 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

Timber harvest 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. Selection cutting is more favorable to white fir.

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. Budworm susceptibility = 1.7.

REFERENCES

Fitzhugh *et al*. 1987
Moir and Ludwig 1979
Pavek 1993
Uchytil 1989
USFS 1986
USFS 1987a

White fir/burnet ragwort ABCO/SESA6
Abies concolor/Senecio sanguisorboides

CODE(S)
typic phase 0 01 16 0

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 corkbark fir and Engelmann spruce are dominant, see ABBI/SESA6 (ABLAA/SESA6).

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 goldenrod *(Solidago parryi)*
***burnet ragwort** *(Senecio 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 goldenrod *(Solidago parryi* = *Haplopappus parryi* = *Oreochrysum parryi)*
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS
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

Timber harvest methods: heavy overstory removal (clearcuts and seed tree cuts) favors Douglas-fir 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 selection cutting, may be more favorable to white fir regeneration.

COMMENTS

This is a newly described plant association, 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 increase micro habitat diversity for birds.

Budworm susceptibility = 1.7.

REFERENCES

Huckaby & Brown 1996
Moir personal communication

White fir/whortleleaf snowberry
Abies concolor/
Symphoricarpos oreophilus

ABCO/SYOR2

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

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. ***Whortleleaf 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.

Whortleleaf 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 corkbark fir (ABBI) 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.

TREES & LIFE HISTORY TRAITS

ponderosa pine phase:	
white fir *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
ponderosa pine *(Pinus ponderosa)*	S
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
aspen *(Populus tremuloides)*	s
bristlecone pine *(Pinus aristata)*	s

SHRUBS

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

whortleleaf snowberry *(Symphoricarpos oreophilus)*
rockspirea *(Holodiscus dumosus)*
cliffbush *(Jamesia americana*)
common juniper *(Juniperus communis)*
Oregongrape *(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 foenea)*
Ross sedge *(Carex rossii)*
Parry goldenrod *(Solidago parryi)*
western yarrow *(Achillea millefolium* var. *occidentalis)*
nodding onion *(Allium cernuum)*
Arizona peavine *(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, whortleleaf snowberry has simple paired leaves with irregular shaped leaf margins.

SYNONYMY

western yarrow *(Achillea millefolium* var. *occidentalis = A. lanulosa)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
Parry goldenrod *(Solidago parryi = Haplopappus parryi = Oreochrysum parryi)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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, wet)
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 whortleleaf 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.

Whortleleaf 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

Whortleleaf 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.

COMMENTS

The forage value rating for cattle in early seral stages is low to medium; diminishing to low or none in late seral stage. Whortleleaf snowberry is an important high elevation forage species for elk and deer. A variety of birds and small mammals eat the fruits.

Budworm susceptibility = 1.5 especially where white fir component is high.

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 ABCO/VAMY2

(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

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 codominating 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 ABBI/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)

TREES & LIFE HISTORY TRAITS

white fir *(Abies concolor)*	C
Douglas-fir *(Pseudotsuga menziesii)*	C
aspen *(Populus tremuloides)*	S
limber pine *(Pinus flexilis)* (in n. NM)	s
Engelmann spruce *(Picea engelmannii)*	c
corkbark fir *(Abies bifolia)*	c
ponderosa pine *(Pinus ponderosa)*	s

SHRUBS

Luxuriant (>50 % cover)**:**
*whortleberry (*Vaccinium myrtillus*)
boxleaf myrtle *(Paxistima myrsinites)*
Rocky Mountain maple *(Acer glabrum)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis*)
Oregongrape *(Mahonia repens)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
kinnikinnik *(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)*
Arizona peavine *(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)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
Virginia strawberry *(Fragaria virginiana ssp. virginiana = F. ovalis)*
Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis) = A. alnifolia)*
corkbark fir *(Abies bifolia = A. lasiocarpa var. arizonica)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Timber harvest methods: heavy overstory removal may favor Douglas-fir regeneration. Clear cuts are likely to favor aspen and to a lesser degree, Douglas-fir; prompt planting is usually required to assure conifer regeneration. Seed tree cut may or may not be successful depending on species of the selected seed trees. Shelterwood 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 such as 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 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.

Budworm susceptibility = 1.7.

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/kinnikinnik PIFL/ARUV
Pinus flexilis/Arctostaphylos uva-ursi

SYNONYMS
Pinus flexilis/Juniperus comminus (Johnston 1987, Hess and Alexander 1986).

CODE(S)
typic phase 2 40 30 0

KEY CRITERIA
This cool, dry plant association has a shrub dominated understory of ***kinnikinnik**, 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 corkbark fir/whortleleaf huckleberry (ABBI/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.

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%):
***kinnikinnic** *(Arctostaphylos uva-ursi)*
common juniper *(Juniperus communis)*

HERBS
Poorly represented (<5%):
Ross sedge *(Carex rossii)*
prairie junegrass *(Koelaria macrantha)*
goldenrod *(Solidago* spp.)
Parry goldenrod *(Solidago 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 boxleaf myrtle *(Paxistima mysinites)* by its rounder, lighter color leaves.

SYNONYMY
Parry goldenrod *(Solidago parryi = Oreochrysum parryi)*.

TERRESTRIAL ECOSYSTEM CLIMATE CLASS
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 kinnikinnic 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. Kinnikinnic has been reported to increase following moderate disturbances (Crane 1991). Stem cuttings taken in the fall are generally the preferred method of reestablishing kinnikinnik artificially (Crane 1991).

COMMENTS

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 kinnikinnic particularly in the winter, as snow accumulation is usually less than adjacent plant associations. Kinnikinnic 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/bigtooth maple PSME/ACGR
Pseudotsuga menziesii/Acer grandidentatum

CODE(S)
typic phase 0 12 39

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/ACGR 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".

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)*
Oregongrape *(Mahonia repens)*
beechleaf frangula *(Frangula betulifolia)*
New Mexico raspberry *(Rubus neomexicanus)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
Gambel oak *(Quercus gambelii)*

HERBS
Common (>1%):
muttongrass *(Poa fendleriana)*
fringed brome *(Bromus ciliatus)*
tasselflower brickellbush *(Brickellia grandiflora)*
fragile fern *(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
Oregongrape *(Mahonia repens = Berberis repens)*
beechleaf frangula *(Frangula betulifolia = Rhamnus betulaefolia)*
Mexican bedstraw *(Galium mexicanum* ssp. *asperrimum = Galium asperrimum)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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/kinnikinnik
Pseudotsuga menziesii/
Arctostaphylos uva-ursi

PSME/ARUV

SYNONYMS
Pseudotsuga menziesii/Arctospahylos adenotricha-Juniperus communis (Johnston 1987).

CODE(S)
typic phase 0 12 31

KEY CRITERIA
***Kinnikinnic** *(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/kinnikinnic, muttongrass phase (PIPO/ARUV, POFE ph) plant associations [Fitzhugh *et al*. 1987].

ALSO SEE
PSME/ARUV (Pfister et. al., 1977).

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%):
***kinnikinnic** *(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 gromwell *(Lithospermum multiflorum)*
rock clematis *(Clematis columbiana)*
coast goldenrod *(Solidago spathulata)*

BRIEF PLANT ID NOTES
Kinnikinnick can be distinguished from boxleaf myrtle *(Paxistima mysinites)* by its rounder, lighter colored leaves.

SYNONYMY
rock clematis *(Clematis columbiana var. columbiana = C. pseudoalpina).*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS
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 aboveground portion of kinnikinnic 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. Kinnikinnic 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 PSME/BRCI
Pseudotsuga menziesii/Bromus ciliatus

CODE(S)
typic phase 0 12 32 0

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 integrading to PSME/BRCI.

TREES & LIFE HISTORY TRAITS
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)*
cliffbush *(Jamesia americana)*
orange gooseberry *(Ribes pinetorum)*

HERBS
Luxuriant (>50%):
fringed brome *(Bromus ciliatus)*
muttongrass *(Poa fendleriana)*
Rocky Mountain trisetum *(Trisetum montanum)*
common yarrow *(Achillea millefolium)*
sprucefir fleabane*(Erigeron eximius)*
Parry goldenrod *(Solidago parryi)*
Fendler meadowrue *(Thalictrum fendleri)*
American vetch*(Vicia americana)*
starry false Solomon's seal *(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 Solomon's seal *(Maianthemum stellatum = Smilacina stellata)*
Parry goldenrod *(Solidago parryi = Oreochrysum parryi)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 cutting systems are generally successful for tree regeneration. Selection cutting favors Douglas-fir. Southwestern white pine (or limber pine depending on geography) and Douglas-fir have been successfully planted in this 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. Budworm susceptibility rating = 1.7.

REFERENCE(S)

Alexander *et. al*. 1987
Esser 1994
Fitzhugh *et al*. 1987
Stuever 1995
USFS 1986
USFS 1987a
USFS 1987b

Douglas-fir/Arizona fescue PSME/FEAR2
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

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.

TREES & LIFE HISTORY TRAITS
bristlecone pine and limber pine phases	
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

aspen phase

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)*
whortleleaf 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)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonica)*
Wooton 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

Arizona peavine *(Lathyrus lanszwertii* var. *arizonica = Lathyrus arizonica)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Reoccuring 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 thinnings, natural regeneration may form dense thickets. On wetter sites, aspen may be a major early successional species. 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 PSME/HODU

(Formerly: Douglas-fir/Oceanspray)

Pseudotsuga menziesii/Holodiscus dumousus

CODE(S)

typic phase 0 12 41

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/Oregongrape [PSME/MARE11] (PSME/BERE in Youngblood & Mauk 1985), Douglas-fir/whortleleaf snowberry [PSME/SYOR2] (Youngblood & Mauk 1985, Johnson 1984), and Douglas-fir/sparse (Alexander et al. 1984b).

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)*
Oregongrape *(Mahonia repens)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
Gambel oak *(Quercus gambelii)* [<5% cover]

HERBS

Scarce (<1%), although occassionally one species may reach 1-2% cover:
Wooton ragwort *(Senecio wootonii)*
woodland strawberry *(Fragaria vesca)*
goldenrod *(Solidago* spp.)
fringed brome *(Bromus ciliatus)*
Richardson geranium *(Geranium richardsonii)*
starry false Solomon's seal *(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 Solomon's seal *(Maianthemum stellatum = Smilacina stellata).*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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.

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. Budworm susceptability = 1.5.

REFERENCES

McMurray 1987
USFS 1986

Douglas-fir/Oregongrape
Pseudotsuga menziesii/
Mahonia repens

PSME/MARE11

(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

KEY CRITERIA

This type is distinguished by a sparse understory. Oregongrape 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/CAFO3, ABCO/ACGL, or ABCO/ACGR. On drier sites PSME/MARE11 may adjoin ABCO/QUGA, PSME/QUGA, PSME/MUVI2, 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/whortleleaf 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].

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%):
Oregongrape *(Mahonia repens)*
common juniper *(Juniperus communis)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*
boxleaf myrtle *(Paxistima myrsinites)*

Fendler 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 meadowrue *(Thalictrum fendleri)*
sedges *(Carex* spp.)
smallleaf pussytoes *(Antennaria parvifolia)*
Virginia strawberry *(Fragaria virginiana)*
rock clematis *(Clematis columbiana)*

CRYPTOGAMS

Soil mosses may be present.

BRIEF PLANT ID NOTES

Oregongrape is a low sub-shrub with pinnately compound, spine-tipped, dark green and often reddish leaves.

SYNONYMY

Oregongrape *(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)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Oregongrape 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 top soil layer or by seed. Recovery of Oregongrape 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 harvests are successful for natural regeneration of conifer species. Selection cutting systems 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. Budworm susceptibility rating = 1.

REFERENCES

Alexander *et al*. 1984b
Muldavin *et al*. 1996
USFS 1986
USFS 1987a
Walkup 1991

Douglas-fir/mountain muhly
Pseudotsuga menziesii/
Muhlenbergia montana

PSME/MUMO

CODE(S)

twoneedle pinyon (PIED) phase 0 12 34 0
limber pine (PIFL) phase 0 12 34 1

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/MUVI2 and PSME/MUVI2 (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.

TREES & LIFE HISTORY TRAITS

<u>limber pine phase</u>	
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
<u>twoneedle pinyon phase</u>	
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 gromwell *(Lithosperma multiflorum)*
pineywoods geranium *(Geranium caespitosum)*
Vreeland 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)*
Vreeland erigeron *(Erigeron vreelandii = Erigeron platyphyllus*)

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 environment for deer. 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 virescens

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

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, MUVI2 phase has >5% cover of Gambel oak. PSME/MUMO lacks screwleaf muhly and Arizona fescue. ABCO/MUVI2 has white fir regeneration or the potential for white fir regeneration.

TREES & LIFE HISTORY TRAITS

Douglas-fir *(Pseudotsuga menziesii)*	C
ponderosa pine *(Pinus ponderosa)*	S
southwestern white pine *(Pinus strobiformis)*	S

SHRUBS

Scarce (<1%):
Fendler ceanothus *(Ceanothus fendleri)*
Gambel oak *(Quercus gambellii)*
boxleaf myrtle *(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 virescens)*
prairie junegrass *(Koelaria macrantha)*
fringed brome *(Bromus ciliatus)*
owlsclaws *(Dugaldia hoopesii)*
sweetclover vetch *(Vicia pulchella)*
manyflowered gromwell *(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 goldenrod *(Solidago parryi)*
yellow hawkweed *(Hieracium fendleri)*
Wooton ragwort *(Senecio wootonii)*
mountain thermopsis *(Thermopsis rhombifolia* var. *montana)*
goldenrod *(Solidago* spp.)
Vreeland erigeron *(Erigeron vreelandii)*

BRIEF PLANT ID NOTES

Screwleaf muhly is a robust bunchgrass with spirally curled dead leaf sheaths.

SYNONYMY

owlsclaws *(Dugaldia hoopesii = Helenium hoopesii)*
Vreeland erigeron *(Erigeron vreelandii = Erigeron platyphyllus*)
Parry goldenrod *(Solidago parryi = Oreochrysum parryi)*
mountain thermopsis *(Thermopsis rhombifolia* var. *montana = T. pinetorum)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Natural regeneration can be quite successful if conifer seedlings can become established before luxuriant grass understory. Mechanical site prep and prescribed burning can improve seedling survival 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. Budworm susceptibility = 1.5.

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

PSME/PHMO4

CODE(S)

typic phase 0 12 13

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 opportunites. 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/cliffbush [PSME/JAAM] (Hess & Alexander 1986) and Douglas-fir/whortleleaf snowberry [PSME/SYOR] (Johnston 1987, Youngblood & Mauk 1985) are perhaps indistinguishable (USFS 1987a). Douglas-fir/Oregongrape [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.

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)*
boxleaf myrtle *(Paxistima myrsinites)*
Oregongrape *(Mahonia repens)*
wild rose *(Rosa* spp.)
rockspirea *(Holodiscus dumosus)*
cliffbush *(Jamesia americana)*
common chokecherry *(Prunus virginiana)*
whortleleaf snowberry *(Symphoricarpos oreophilus)*

HERBS

Well represented (>5%):

goldenrod *(Solidago* spp.)
Richardson geranium *(Geranium richardsonii)*
fringed brome *(Bromus ciliatus)*
starry false Solomon's seal *(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

Oregongrape *(Mahonia repens = Berberis repens)*
boxleaf myrtle *(Paxistima myrsinites)* = mountain lover *(Pachystima myrsinites)*
starry false Solomon's seal *(Maianthemum stellatum = Smilacina stellata)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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-Calamagrostis 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

PSME/QUAR

CODE(S)

typic phase 0 12 43 0

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 abutts 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).

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 ceanothus*(Ceanothus fendleri)*
canyon live oak *(Quercus chrysolepis)* [cooler, wetter sites]
pointleaf manzanita *(Arctostaphylos pungens)*
Pringle manzanita *(Arctostaphylos pringlei)*
Parry 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)*
falsepennyroyal *(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 ECOSYSTEM CLIMATE CLASS

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 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 timber harvest. Selection cutting systems favor Douglas-fir regeneration, which is more shade tolerant. 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

PSME/QUGA

CODE(S)

Gambel oak (QUGA) phase	0 12 14 0
Arizona fescue (FEAR2) phase	0 12 14 1
screwleaf muhly (MUVI2) phase	0 12 14 2
rockspirea (HODU) phase	0 12 14 3

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.

TREES & LIFE HISTORY TRAITS

<u>Gambel oak, Arizona fescue, and screwleaf muhly phases</u>	
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
<u>rockspirea phase</u>	
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)*

whortleleaf snowberry *(Symphoricarpos oreophillus)*

boxleaf myrtle *(Paxistima myrsinites)*
Oregongrape *(Mahonia repens)*
wild rose *(Rosa* spp.)
rockspirea *(Holodiscus dumosus)*
Fendler 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 virescens)*
[>5% cover in MUVI2 phase]
Fendler meadowrue *(Thalictrum fendleri)*
American vetch *(Vicia americana)*
Arizona peavine *(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

boxleaf myrtle = mountainlover *(Paxistima = Pachystima = Pachistima);*
Oregongrape *(Mahonia repens = Berberis repens);*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonica = Lathyrus arizonica)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 (MUVI2) 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 Douglas-fir regeneration. 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. Budworm susceptability = 1.5.

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

PSME/QUHY

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

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.

TREES & LIFE HISTORY STATUS

<u>ponderosa pine phase</u>	
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
<u>Chihuahua pine phase</u>	
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
<u>netleaf oak phase</u>	
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 ceanothus*(Ceanothus fendleri)*
true mountain mahogany *(Cercocarpus montanus)*
New Mexico locust *(Robinia neomexicana)*
banana yucca *(Yucca baccata)*
Schott yucca *(Yucca schottii)*
Wright 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 virescens)*
prairie junegrass *(Koeleria macrantha)*
brickellbush *(Brickellia* spp.)
New Mexico groundsel *(Senecio neomexicanus)*
falsepennyroyal *(Hedeoma hyssopifolia)*
Fendler meadowrue *(Thalictrum fendleri)*
New Mexico fleabane *(Erigeron neomexicanus)*
Louisiana sagewort *(Artemisia ludoviciana)*
New Mexico fleabane *(Erigeron neomexicanus* var. *Erigeron delphinifolius)*

CRYPTOGAMS

Lichens may be common as epiphytes (a non-parasitic 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)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 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

PSME/QUPA4

(Formerly: Pseudotsuga menziesii/Quercus undulata)

SYNONYMS

Pseudotsuga menziesii/Quercus undulata.

CODE(S)

typic phase 0 12 42 0

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).

TREES & LIFE HISTORY TRAITS

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 spear grass *(Stipa nelsonii* spp. *dorei)*
Pringle needlegrass *(Piptochaetium pringlei)*
pine muhly *(Muhlenbergia dubia)*
muttongrass *(Poa fendleriana)*
sideoats grama *(Bouteloua curtipendula)*
little bluestem *(Schizachyrium scoparium)*
Louisiana sagewort *(Artemisia ludoviciana)*
pineywoods geranium *(Geranium caespitosum)*
goldenrod *(Solidago* spp.)
drawf 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 spear grass *(Stipa nelsonii* spp. *dorei = Stipa columbiana)*
Pringle needlegrass *(Piptochaetium pringlei = Stipa pringlei)*
little bluestem *(Schizachyrium scoparium = Andropogon scoparius)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 prepation for reforestation. Selection and heavy shelterwood cutting systems provide shade which favors Douglas-fir. Lighter shelterwood cuts (removing more overstory) tends 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. Budworm susceptibility rating =1.5.

REFERENCE(S)

Huckaby & Brown 1996
USFS 1986

ponderosa pine/black sagebrush PIPO/ARNO4

(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

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).

TREES & LIFE HISTORY TRAITS

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)*
whortleleaf snowberry*(Symphoricarpos oreophilus)*
true mountain mahogany *(Cercocarpus montanus)*
small soapweed *(Yucca glauca)*
green rabbitbrush *(Chrysothamnus viscidiflorus)*
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 *(Oryzopsis 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)

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 occassionally (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 pinque hymenoxys *(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

PIPO/ARPU5

CODE(S)

typic phase 0 11 42 0

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).

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 silktassel *(Garrya wrightii)*

skunkbush sumac *(Rhus trilobata)*

Parry agave *(Agave parryi)*

sacahuista *(Nolina microcarpa)*

Fendler 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 deervetch *(Lotus wrightii)*

falsepennyroyal *(Hedeoma hyssopifolia)*

Louisiana sagewort *(Artemisia ludoviciana)*

Carruth 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)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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. An Arizona pinyon (PIFA) phase would occur in low sun mild (LSM) climates, and a border pinyon (PIDI) phase would occur in high sun mild (HSM) climates.

FIRE ECOLOGY

Manzanita and fendler 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 catastrophic 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. Several large crown fires have burned in this plant association including 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/kinnikinnik
Pinus ponderosa/
Arctostaphylos uva-ursi

PIPO/ARUV

CODE(S)
typic phase 0 11 40 0

KEY CRITERIA
***Kinnikinnic** *(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).

TREES & LIFE HISTORY STATUS
ponderosa pine *(Pinus ponderosa)* C

SHRUBS
Kinnikinnick is abundant (>25%), other shrubs are poorly represented (<5%):
***kinnikinnic** *(Arctostaphylos uva-ursi)*
Gambel oak *(Quercus gambelii)*
true mountain mahoghany *(Cercocarpus montanus)*
Fendler 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 boxleaf myrtle *(Paxistima mysinites)* by its rounder, lighter colored leaves.

TERRESTRIAL ECOSYSTEM CLIMATE CLASS
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 PIPO/BOGR2
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

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.

TREES & LIFE HISTORY TRAITS

<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
<u>Gambel oak phase:</u>	
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
(Chrysothamnus nauseosus)
waxcurrant *(Ribes cereum)*
big sagebrush *(Artemisia tridentata)*
[ARTR phase]
antelope bitterbrush*(Purshia tridentata)*
[ARTR phase]
pinque hymenoxys*(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* sp.)
mountain muhly *(Muhlenbergia montana)*
bottlebrush squirrel tail *(Elymus elymoides)*
pine dropseed *(Blepharoneuron tricholepis)*
prairie junegrass *(Koelaria macrantha)*
fendler 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 pheloides)*
sedges *(Carex* spp.)
redroot buckwheat *(Eriogonum racemosum)*
Wright deervetch *(Lotus wrightii)*
pussytoes *(Antennaria* spp.)
Louisiana sagewort *(Artemisia ludoviciana)*
trailing fleabane *(Erigeron flagellaris)*
spreading fleabane *(Erigeron divergens)*
New Mexico groundsel
(Senecio neomexicanus)
pineywoods geranium
(Geranium caespitosum)
threenerve goldenrod *(Solidago velutina)*
roseheath *(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 threeawn *(Aristida purpurea* var. *fendleriana = Aristida fendleriana)*
threenerve goldenrod *(Solidago velutina = Solidago sparsiflora)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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.

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). Individual tree selection may be successful. Shelterwood cuts 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, Apacheplume 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 recommendation for seedings are 1#/acre, and expect 2-3 years for conditions to favor germination (Harris 1988b).

COMMENTS

Blue grama and shrubs increase on overgrazed livestock ranges. Apacheplume 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 PIPO/FEAR2
Pinus ponderosa/Festuca arizonica

CODE(S)

Arizona fescue (FEAR2) phase	0 11 09 0
Parry danthonia (DAPA2) phase	0 11 09 1
blue grama (BOGR2) phase	0 11 09 2
gambel oak (QUGA) phase	0 11 09 3

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.

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.

TREES & LIFE HISTORY TRAITS

Parry danthonia 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 danthonia *(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 virescens)* [MUVI/FEAR2 h.t.]
manyflowered gromwell *(Lithospermum multiflorum)*
pussytoes *(Antennaria* spp.)
woolly cinquefoil *(Potentilla hippiana)*
rockyscree falsegoldenaster *(Heterotheca fulcrata)*
Louisiana sagewort *(Artemisia ludoviciana)*
Carruth sagewort *(Artemisia carruthii)*
western brackenfern *(Pteridium aquilinum)*
beautiful fleabane *(Erigeron formosissimus)*
grassleaf peavine *(Lathyrus graminifolius),*
hairy 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 goldenaster *(Heterotheca villosa* var. *villosa = Chrysopsis villosa)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class: 5 (ponderosa)
Elevational Subzone: 0 (typic) or +1 (moist) for Parry's danthonia 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 danthonia. The Parry danthonia phase is on cool sites with deep soils and Parry danthonia is present to well represented. The blue grama phase has blue grama or wolfstail *(Lycurus pheloides)*. 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 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. 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 harvesting (and uneven-age management) is also reasonable, 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.

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

PIPO/JUMA

CODE(S)

typic phase 0 11 47 0

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].

TREES & LIFE HISTORY TRAITS

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)*
birchleaf buckthorn *(Rhamnus betulaefolia)*
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 meadowrue *(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

western wheatgrass *(Pascopyrum smithii = Agropyron smithii)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class:	5 (ponderosa)
Elevational Subzone:	-1 (warm, dry) to +1 (cool, wet)
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

PIPO/MUMO

SYNONYMS

Pinus ponderosa/*Poa longiligula* community type (Hanks *et. al.* 1983).

CODE(S)

typic phase 0 11 33 0

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.

TREES & LIFE HISTORY TRAITS

<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

in Southern Arizona & SW New Mexico (south of rim):

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)*
pinque hymenoxys *(Hymenoxys richardsonii)*
Oregongrape *(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 deervetch *(Lotus wrightii)*
manyflowered gromwell *(Lithospermum multiflorum)*
New Mexico groundsel *(Senecio neomexicanus)*
lobeleaf groundsel *(Senecio multilobatus)*
pineywoods geranium *(Geranium caespitosum)*
common yarrow *(Achillea millefolium)*
pussytoes *(Antennaria* spp.)
trailing fleabane *(Erigeron flagellaris)*
Vreeland 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

Oregongrape *(Mahonia repens = Berberis repens)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
Vreeland erigeron *(Erigeron vreelandii = Erigeron platyphyllus*)

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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. 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 gener-

ally have greater numbers of trees, including thickets of regeneration. Burning also tends to stimulate germination of Fendler ceanothus. 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. 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.

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 virescens

PIPO/MUVI2

CODE(S)

screwleaf muhly (MUVI2) phase 0 11 34 0
Gambel oak (QUGA) phase 0 11 34 1

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/MUVI2-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.

TREES & LIFE HISTORY TRAITS

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 ceanothus *(Ceanothus fendleri)*
true mountain mahoghany *(Cercocarpus montanus)*
Gambel oak *(Quercus gambelii)* [other *Quercus* spp. in Southern AZ]
snowberry *(Symphoricarpos oreophila)*

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 deervetch *(Lotus wrightii)*
pineywoods geranium
(Geranium caespitosum)
sweetclover vetch *(Vicia pulchella)*
manyflowered gromwell
(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)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class:	5 (ponderosa)
Elevational Subzone:	+1 (cool, wet)
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.

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

ponderosa pine/ screwleaf muhly-Arizona fescue
Pinus ponderosa/ Muhlenbergia virescens-Festuca arizonica

PIPO/MUVI2-FEAR2

CODE(S)

typic phase	0 11 39 0
blue grama (BOGR2) phase	0 11 39 1
Gambel oak (QUGA) phase	0 11 39 2

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.

TREES & LIFE HISTORY TRAITS

<u>typic phase:</u>	
ponderosa pine *(Pinus ponderosa)*	C
<u>blue grama phase:</u>	
ponderosa pine *(Pinus ponderosa)*	C
twoneedle pinyon *(Pinus edulis)*	c
alligator juniper *(Juniperus deppeana)*	s
<u>Gambel oak phase:</u>	
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 ceanothus *(Ceanothus fendleri)*
pingue hymenoxys *(Hymenoxys richardsonii)* [QUGA & BOGR2 phases]

HERBS

Abundant (>25%), especially grasses:
***screwleaf muhly** *(Muhlenbergia virescens)*
***Arizona fescue** *(Festuca arizonica)*
bottlebrush squirrel tail *(Elymus elymoides)*
pine dropseed *(Blepharoneuron tricholepis)*
muttongrass *(Poa fendleriana)*
prairie junegrass *(Koelaria macrantha)*
sedges *(Carex* spp.)
Louisiana sagewort *(Artemisia ludoviciana)*
New Mexico groundsel *(Senecio neomexicanus)*
common yarrow *(Achillea millefolium)*
smallleaf pussytoes *(Antennaria parvifolia)*
pineywoods geranium *(Geranium caespitosum)*
alpine false parsley *(Pseudocymopterus montanus)*
manyflowered gromwell *(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)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class: 5 (ponderosa)
Elevational Subzone: +1 (cool, wet)
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/MUVI2-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/Indian ricegrass
Pinus ponderosa/
Oryzopsis hymenoides

PIPO/ORHY

CODE(S)
typic phase 0 11 35 0

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.

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 *(Oryzopsis hymenoides)*
little bluestem *(Schizachyrium scoparium)*
bottlebrush squirrel tail *(Elymus elymoides)*
hairy 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 goldenaster*(Heterotheca villosa* var. *villosa = Chrysopsis villosa)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS
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 as much of 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.

REFERENCE(S)

DeVelice *et. al.* 1986
Hickerson 1986
USFS 1987a

ponderosa pine/Stansbury cliffrose PIPO/PUST

(Formerly: ponderosa pine/cliffrose)

Pinus ponderosa/Purshia stansburiana

(Formerly: Pinus ponderosa/Cowania mexicana)

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

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).

TREES & LIFE HISTORY TRAITS

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)*
Oregongrape *(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 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)*
Oregongrape *(Mahonia repens = Berberis repens)*
little bluestem *(Schizachyrum scoparium = Andropogon scoparius)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
hairy goldenaster *(Heterotheca villosa* var. *villosa = Chrysopsis villosa)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 PIPO/QUAR
Pinus ponderosa/Quercus arizonica

CODE(S)

typic phase	0 11 41 0
blue grama phase	0 11 41 1

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).

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 ceanothus*(Ceanothus fendleri)*
pointleaf manzanita *(Arctostaphylos pungens)*
Pringle manzanita *(Arctostaphylos pringlei)*
Schott yucca *(Yucca schottii)*
skunkbush sumac *(Rhus trilobata)*
mimosa *(Mimosa aculeaticarpa* var. *biuncifera)*
sacahuista *(Nolina microcarpa)*
Wright 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 deervetch *(Lotus wrightii)*
falsepennyroyal *(Hedeoma hyssopifolia)*
Louisiana sagewort *(Artemisia ludoviciana)*
Carruth 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

Arizona pinyon *(Pinus fallax = P. californiarum)*
mimosa *(Mimosa aculeaticarpa* var. *biuncifera = M. biuncifera)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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.

REVEGETATION CONSIDERATIONS

Revegetation is rapid following disturbance due to oak and alligator juniper sprouting.

COMMENTS

Gradient analysis on south-facing aspects near Mazatzal Peak have the following climatic features:

Elev.	MAAT	Summer
5,600	53.2	69.6
6,000	51.5	67.7

Winter	MAST	MAP
38.2	53.1	24.0
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

This plant association provides important cover, browse, and mast for deer and turkey. Firewood production can be a desirable objective in this type.

REFERENCE(S):

Dieterich & Hibbert 1990
Muldavin *et. al.* 1996
Stuever 1995
USFS 1987b

ponderosa pine/Emory oak PIPO/QUEM
Pinus ponderosa/Quercus emoryi

CODE(S)

typic phase 0 11 44 0

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) distinguish 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).

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 ceanothus*(Ceanothus fendleri)*
pointleaf manzanita
(Arctostaphylos pungens)
Pringle manzanita *(Arctostaphylos pringlei)*
Schott yucca *(Yucca schottii)*

skunkbush sumac *(Rhus trilobata)*
mimosa *(Mimosa aculeaticarpa* var. *biuncifera)*
sacahuista *(Nolina microcarpa)*
Wright 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 deervetch *(Lotus wrightii),*
falsepennyroyal *(Hedeoma hyssopifolia)*
Louisiana sagewort *(Artemisia ludoviciana)*
Carruth 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

Arizona pinyon *(Pinus fallax = P. californiarum)*
mimosa *(Mimosa aculeaticarpa* var. *biuncifera = M. biuncifera)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 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 Qemoryi 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

PIPO/QUGA

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

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 mid-story 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.

TREES & LIFE HISTORY TRAITS

<u>Gambel oak and Arizona fescue phases</u>	
ponderosa pine *(Pinus ponderosa)*	C
Gambel oak *(Quercus gambelii)*	S
Rocky Mountain juniper *(Juniperus scopulorum)*	c
twoneedle pinyon *(Pinus edulis)*	a
<u>twoneedle pinyon phase</u>	
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%]
whortleleaf snowberry *(Symphoricarpos oreophilus)*
wild rose *(Rosa* spp.)
New Mexico locust *(Robinia neomexicana)*
true mountain mahogany *(Cercocarpus montanus),*
Oregongrape *(Mahonia repens)*
Fendler 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)*
Louisiana sagewort *(Artemisia ludoviciana)*
Carruth's sagewort *(Artemisia carruthii)*
western brackenfern *(Pteridium aquilinum)* [FEAR2 phase]
Wright deervetch *(Lotus wrightii)*
hairy goldenaster *(Heterotheca villosa* var. *villosa)*
smallleaf pussytoes *(Antennaria parvifolia)*
Fendler meadowrue *(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 goldenaster *(Heterotheca villosa* var.*villosa = Chrysopsis villosa)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class: 5 (ponderosa)
Elevational Subzone: +1 (cool, wet) 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. Selection methods are generally successful for pine regeneration, especially in mistletoe free stands.

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 PIPO/QUGR3
Pinus ponderosa/Quercus grisea

CODE(S)
mountain muhly (MUMO) phase 0 11 36 0
longtongue muhly (MULO) phase 0 11 36 1

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 ECOSYSTEM CLIMATE CLASS
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm, dry)
Climate class: HSM (high sun mild)

TREES & LIFE HISTORY TRAITS
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 ceanothus *(Ceanothus fendleri)*
waxcurrant *(Ribes cereum)*
banana yucca *(Yucca baccata)*
pinque hymenoxys*(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 virescens)*
muttongrass *(Poa fendleriana)*
bottlebrush squirrel tail *(Elymus elymoides)*
Louisiana sagewort *(Artemisia ludoviciana)*
trailing fleabane *(Erigeron flagellaris)*
Wright 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.

SYNONOMY

bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*

PHASES

The longtongue muhly phase is found on the Gila and Apache-Sitgreaves National Forests. 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 selection cuttings systems also favor conifers in the stand when adequate shade suppresses oak regeneration. 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 1986

ponderosa pine/Silverleaf oak PIPO/QUHY
Pinus ponderosa/Quercus hypoleucoides

CODE(S)
typic phase 0 11 22 0

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.

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 yucca *(Yucca schottii)*
Fendler ceanothus*(Ceanothus fendleri)*
Arizona madrone *(Arbutus arizonica)*

HERBS
Common (>1%) or well represented (>5%) canopy coverage:
longtongue muhly *(Muhlenbergia longiligula)*
screwleaf muhly *(Muhlenbergia virescens)*
single threeawn *(Aristida orcuttiana)*
muttongrass *(Poa fendleriana)*
White Mountain sedge *(Carex geophila)*
prairie junegrass *(Koeleria macrantha)*
falsepennyroyal *(Hedeoma hyssopifolia)*
Fendler meadowrue *(Thalictrum fendleri)*
alpine false springparsley *(Pseudocymopterus montanus)*

Mexican bedstraw *(Galium mexican* ssp. *asperrimum)*
Fendler 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)*

Terrestrial Ecosystem Climate Class
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. Selection and shelterwood systems are generally more appropriate in this type, with the latter often providing the best results for pine 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:	7,000/N	6,750/N	7,000/S	6,500/S
MAP (inches/year):	26.7	25.8	26.7	25.0
MAST (F):	48	49	50	52

REFERENCE(S)

Muldavin *et. al.* 1991
Niering & Lowe 1984
Stuever 1995
USFS 1987b

ponderosa pine/wavyleaf oak PIPO/QUPA4
Pinus ponderosa/ Quercus X pauciloba

(Formerly: Pinus ponderosa/Quercus undulata)

SYNONYMS

Pinus ponderosa/Quercus undulata

CODE(S)

typic phase 0 11 37 0

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)].

TREES & LIFE HISTORY TRAITS

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)*
Louisiana sagewort *(Artemisia ludoviciana)*
manyflowered gromwell *(Lithospermum multiflorum)*
pineywoods geranium *(Geranium caespitosum)*
hairy 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 goldenaster *(Heterotheca villosa* var. *villosa = Chrysopsis villosa)*
Quercus x pauciloba = *Q. undulata*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 PIPO/QURU4
Pinus ponderosa/Quercus rugosa

CODE(S)
typic phase 0 11 43 0

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/MUVI2 h.t.s.

ALSO SEE
Douglas-fir is the dominant tree at late succession in PSME/QUHY, QURU4 phase.

TREES & LIFE HISTORY TRAITS

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 agave *(Agave parryi)*
sacahuista *(Nolina microcarpa)*

HERBS
Poorly represented (<5%) to scarce (<1%):
muttongrass *(Poa fendleriana)*
screwleaf muhly *(Muhlenbergia virescens)*
longtongue muhly *(Muhlenbergia longiligula)*
single threeawn *(Aristida orcuttiana)*
prairie junegrass *(Koeleria macrantha)*
White Mountain sedge *(Carex geophila)*
falsepennyroyal *(Hedeoma hyssopifolia)*
pineywoods geranium *(Geranium caespitosum)*
Fendler meadowrue *(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)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

PIPO/rockland

CODE(S)

typic phase 0 11 50 0

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.

TREES & LIFE HISTORY TRAITS

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 ECOSYSTEM CLIMATE CLASS

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 habitat 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

Chihuahuan pine/pinyon ricegrass PILE/PIFI
Pinus leiophylla/ Piptochaetium fimbriatum

CODE(S)
typic phase 0 33 01 0

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".

TREES & LIFE HISTORY TRAITS
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 yucca *(Yucca schottii)*
Wright 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 ticktrefoil *(Desmodium rosei)*
Fendler meadowrue *(Thalictrum fendleri)*
Lemmon brickellbush *(Brickellia lemmonii)*
bracted bedstraw *(Galium microphyllum)*
wild beans *(Phaseolus* spp.)
drawf 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).*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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 PILE/QUAR
Pinus leiophylla/Quercus arizonica

CODE(S)
typic phase 0 33 02 0

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 ECOSYSTEM CLIMATE CLASS
Life Zone Class: 5 (ponderosa)
Elevational Subzone: -1 (warm,dry)
Climate class: HSM (high sun mild)

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 yucca *(Yucca schottii)*
Parry 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 lipfern *(Cheilanthes fendleri)*
falsepennyroyal *(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 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).*

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

PILE/QUHY

CODE(S)

CSDS 0 33 03 0

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).

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 yucca *(Yucca schottii)*
Parry 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 lipfern *(Cheilanthes fendleri)*
falsepennyroyal *(Hedeoma hyssopifolia)*,
drawf 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)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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/longtongue muhly
Pinus engelmannii/ Muhlenbergia longiligula

PIEN2/MULO
(Formerly: PINEN/MULO)

SYNONYMS
Pinus ponderosa/Poa longiligula community type (Hanks *et. al.* 1983).

CODE(S)
typic phase 0 32 01 0

KEY CRITERIA
***Apache pine** is present and not accidental, and silverleaf oak and netleaf oak are poorly represented and subdominant or absent. Longtongue 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.

TREES & LIFE HISTORY TRAITS
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 squawbush *(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 thermopsis *(Thermopsis rhombifolia* var. *montana)*
falsepennyroyal *(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 squawbush*(Rhus trilobata* var.*pilosissima = Rhus aromatica)*
mountain thermopsis *(Thermopsis rhombifolia* var. *montana = Thermopsis pinetorum)*

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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

Apache pine/silverleaf oak
Pinus engelmannii/
Quercus hypoleucoides

PIEN2/QUHY
(Formerly: PINEN/QUHY)

SYNONYMS
PIEN2/QUHY = PINEN/QUHY

CODE(S)
CSDS 0 32 03 0

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.

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 yucca *(Yucca schottii)*
skunkbush sumac *(Rhus trilobata)*
Fendler ceanothus *(Ceanothus fendleri)*
Parry agave *(Agave parryi)*
Wright 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)*
falsepennyroyal *(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 ECOSYSTEM CLIMATE CLASS

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
corkbark fir*(Abies bifolia)* 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

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:

- 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 Environ-

mental Protection Agency. The Nature Conservancy's Colorado Program.

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

Life Zone Class: all: 3 - 7
Elevational Subzone: cold, cool, warm; very moist to wet
Climate Class: all

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 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)*
sandbar willow *(Salix exigua)*
Pacific willow *(Salix lucidia* spp. *lasiandra)*
thinleaf alder *(Alnus incana* ssp. *tenuifolia)*
redosier dogwood *(Cornus sericea ssp sericea)*
seepwillow *(Baccharis salicifolia)*
sandbar willow *(Salix irrorata)*
Other common species can include:
canyon grape *(Vitis arizonica)*
Virginia creeper *(Parthenocissus quinquefolia* var *quinquefolia)*
poison ivy *(Toxicodendron radicans)*
twinberry honeysuckle *(Lonicera involucrata)*
Scouler willow *(Salix scouleriana)*
Rocky Mountain maple *(Acer glabrum)*
boxleaf myrtle *(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 lacinata)*
redtop *(Agrostis gigantea)*
western wheatgrass *(Pascopyrum smithii)*
blue wildrye *(Elymus glaucus)*
cowparsnip *(Heracleum maximum)*
Fendler cowbane *(Oxypolis fendleri)*
California false helibore *(Veratrum californicum)*
yellow avens *(Geum allepicum)*
Scouler St. Johnswort *(Hypericum formosum)*

SYNONYMY

redosier dogwood *(Cornus sericea ssp. sericea = C. stolonifera = swida)*
seepwillow (*Baccharis salicifolia = B. glutinosa*)
Virginia creeper *(Parthenocissus quinquefolia var quinquefolia = P. inserta)*
western wheatgrass *(Pascopyrum smithii = Agropyron smithii)*
cowparsnip *(Heracleum maximum = H. sphondylium)*
Rio Grande cottonwood *(Populus deltoides* spp *wislizeni = P. fremontii)*

MANAGEMENT IMPLICATIONS

Riparian forests require special standards and guidelines as stated in Forest Plans and project level prescriptions.

COMMENTS

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:

1. bigtooth maple—white fir *Acer grandidentatum—Abies concolor*
2. blue spruce *Picea pungens*
3. narrowleaf cottonwood *Populus angustifolia*
4. boxelder *Acer negundo*
5. boxelder—Mixed deciduous *Acer negundo—Mixed deciduous*
6. Arizona alder *Alnus oblongifolia*
7. Arizona walnut *Junglans major*
8. velvet ash *Fraxinus pennsylvanica (*now *F. velutina)*
9. Arizona walnut—Arizona sycamore *Juglans major — Platanus wrightii*
10. Arizona sycamore *Platanus wrightii*
11. Arizona sycamore—velvet ash *Platanus wrightii — Fraxinus pennsylvanica*
12. Rio Grande cottonwood *Populus fremontii* (now = *P. deltoides* spp. *wislizeni*)
13. Rio Grande cottonwood—velvet ash *Populus fremontii — Fraxinus pennsylvanica*
14. Rio Grande cottonwood—Gooding willow *Populus fremontii — Salix gooddingii*
15. red willow *Salix bonplandiana*
16. wingleaf soapberry—Arizona walnut *Sapindus saponaria — Juglans major*
17. velvet mesquite *Prosopis velutina*
18. Gooding willow *Salix gooddingii*
19. fivestamen tamarisk *Tamarix pentandra* (now *T. chinensis*)
20. California palm *Washingtonia filifera*

The Terrestrial Ecosystem Survey program (USFS, Region 3) 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 ABBI/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)

corkbark fir/scree (ABBI/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

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/boxleaf myrtle (PSME/PAMY, Komarkova 1986); Douglas-fir/cliffbush (PSME/JAAM, Johnston 1987); and in the Capitan Mountains, ABCO/LETR and PIEN/LETR

TREES

Usually open, sparsely stocked stands, composition depends primarily upon climate.

SHRUBS

Scarce (<1%) to well represented (>5%):
currant *(Ribes* spp.*)*
cliffbush *(Jamesia americana)*
rockspirea *(Holodiscus dumosus)*
Scouler willow *(Salix scouleriana)*
Rocky Mountain maple *(Acer glabrum)*

HERBS

Scarce (<1%), variable.

CRYPTOGAMS

Well represented to abundant. Lichens on rocks are especially conspicuous.

SYNONYMY

cliffbush (JAAM) = waxflower.

TERRESTRIAL ECOSYSTEM CLIMATE CLASS

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. Budworm susceptibility = 1.5.

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 5/21/95 version of USDA, NRCS 1995, The PLANTS database. Listed for each taxon treated are the accepted common name and its accepted scientific name. The former common name(s) and/or the former scientific names follow depending on the nature of the change involved. Occasionally, more than one change is shown.

This list is separated into three main categories—trees, shrubs, and herbs—each category is organized alphabetically by scientific name.

TREES

corkbark fir *(Abies bifolia = A. lasiocarpa* var. *arizonica)*
subalpine fir *(Abies bifolia = A. lasiocarpa* var. *arizonica)*
thinleaf alder *(Alnus incana* ssp. *tenuifolia = A. tenuifolia)*
redberry juniper *(Juniperus erythrocarpa = J. coahuilensis)*
yellow paloverde *(Parkinsonia microphylla = Cercidium microphyllus)*
Arizona pine *(Pinus arizonica = P. ponderosa* var. *arizonica)*
Arizona pinyon *(Pinus fallax = Pinus californiarum)*
Rio Grande cottonwood *(Populus deltoides* ssp. *wislizeni = P. fremontii)*

SHRUBS

Utah serviceberry *(Amelanchier utahensis* ssp. *utahensis = A. alnifolia)*
black sagebrush *(Artemisia nova)* = low sagebrush *(A. arbuscula* var. *nova)*
dwarf stickpea *(Calliandra humilis* var. *reticulata = C. reticulata)*
hairy mountain mahogany *(Cercocarpus montanus* var. *paucidentatus = C. breviflorus)*
Mexican orange *(Choisya dumosa* var.*arizonica)* = star-leaf *(C. arizonica)*
redosier dogwood *(Cornus sericea* ssp. *sericea = C. stolonifera)*
beechleaf frangula *(Frangula betulifolia = Rhamnus betulaefolia)*
velvet ash *(Fraxinus velutina = F. v.* ssp. *pennsylvanica)*
spiny greasebush *(Glossopetalon spinescens = G. nevadense)*
broom snakeweed *(Guiterrizia sarothrae = Xanthocephalum sarothrae)*
cliffbush = waxflower = *(Jamesia americana)*
littleleaf ratany *(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 *(Mahonia trifoliata = Berberis trifoliata)*
Oregongrape *(Mahonia repens = Berberis repens)*
mimosa *(Mimosa aculeaticarpa* var. *biuncifera = M. biuncifera)*
Rio Grande saddlebush *(Mortonia sempervirens* ssp. *scabrella = M. scabrella)*

boxleaf myrtle *(Paxistima myrsinites)* = mountain lover *(Pachystima myrsinites)*
broom dalea *(Psorothamnus scoparius = Dalea scoparia)*
Stansbury cliffrose *(Purshia stansburiana = Cowania stansburiana = C. mexicana)*
wavyleaf oak *(Quercus* X *pauciloba = Q. undulata)*
pubescent squawbush *(Rhus trilobata* var. *pilosissima = R. aromatica)*
evergreen sumac = leatherleaf sumac *(Rhus virens* var. *choriophylla = R. coriophylla)*
Wood rose *(Rosa woodsii* var. *ultramonana = R. w.* var. *woodsii)* = Fendler rose *(R. fendleriana)*
Wood rose (*Rosa woodsii* var. *ultramontana = R. arizonica)*
black elderberry *(Sambucus racemosa* ssp. *pubens* var. *melanocarpa = S. melanocarpa)*

HERBS

western yarrow *(Achillea millefolium* var. *occidentalis = A. lanulosa)*
Fendler threeawn *(Aristida purpurea* var. *fendleriana = A. fendleriana)*
Fendler threeawn *(Aristida purpurea* var. *longiseta)* = red threeawn *(A. longiseta)*
nodding brome *(Bromus anomalus = B. porteri)*
Canadian brome *(Bromus canadensis = B. richarsonii)*
rose heath *(Chaetopappa ericoides = Leucelene ericoides)*
rock clematis *(Clematis columbiana var. columbiana = C. pseudoalpina)*
redosier dogwood *(Cornus sericea* ssp. *sericea = C. stolonifera)*
owlsclaws *(Dugaldia hoopsii)* = orange sneezeweed *(Helenium hoopsii)*
Arizona wheatgrass *(Elymus arizonicus = Andropogon arizonicum)*
bottlebrush squirreltail *(Elymus elymoides = Sitanion hystrix)*
sprucefir fleabane *(Erigeron eximius)* = forest fleabane *(E. superbus)*
trailing fleabane *(Erigeron flagellaris = E. nudiflorus)*
New Mexico fleabane *(Erigeron neomexicanus = E. delphinifolius)*
Vreeland erigeron *(Erigeron vreelandii = E. platyphyllus*)
hairy woollygrass *(Erioneuron pilosum = Tridens pilosus)*
woodland strawberry *(Fragaria vesca* var. *americana = F. americana)*
Virginia strawberry *(Fragaria virginiana* ssp. *virginiana = F. ovalis = F. canadensis)*
showy frasera *(Frasera speciosa)* = green gentian *(Swertia radiata)*
Mexican bedstraw *(Galium mexicanum* ssp. *asperrimum = G. asperrimum)*
hairy goldenaster *(Heterotheca villosa* var. *villosa = Chrysopsis villosa)*
Idaho hymenopappus *(Hymenopappus filifolius* var. *lugens = H. lugens)*
prairie junegrass *(Koelaria macrantha = K. pyrimidata = K. cryptandrus)*
Arizona peavine *(Lathyrus lanszwertii* var. *arizonicus = L. arizonicus)*
beardless wildrye *(Leymus triticoides* = Elymus triticoides) slender goldenweed *(Macraeranthera gracilis = Haplopappus gracilis)*
lacy tansyaster *(Macraeranthera pinnatifida = Haplopappus spinulosus)*
feathery false Solomon seal *(Maianthemum racemosum = Smilacina racemosa)*

starry false Solomon seal *(Maianthemum stellatum = Smilacina stellata)*
mintleaf beebalm *(Monarda fistulosa* ssp. *fistulosa* var. *menthifolia = M. menthifolia)*
slimflower muhly *(Muhlenbergia tenuifolia = M. monticola)*
sidebells wintergreen *(Orthilia secunda = Ramischia secunda)*
bluntseed sweetroot = sweetcicily *(Osmorhiza depauperata = O. obtusa)*
western wheatgrass *(Pascopyrum smithii = Agropyron smithii)*
Pringle spear grass *(Piptochaetium pringlei = Stipa pringlei)*
canyon bog orchid *(Platanthera sparsiflora* var. *sparsiflora = Habenaria sparsiflora)*
skunkweed polemonium *(Polemonium pulcherrimum* ssp. *delicatum)* = Jacob's ladder *P. delicatum)*
slimflower scurfpea *(Psoralidium tenuiflorum = Psoralea tenuiflora)*
black elderberry *(Sambucus racemosa* ssp. *pubens* var. *melanocarpa = S. melanocarpa)*
Texas bluestem *(Schizachyrium cirratum = Andropogon cirratus)*
little bluestem *(Schizachyrum scoparium = Andropogon scoparius)*
bittercress ragwort = cardamine groundsel *(Senecio cardamine)*
Parry goldenrod *(Solidago parryi = Haplopappus parryi = Oreochrysum parryi)*
threenerve goldenrod *(Solidago velutina = S. sparsifolia)*
Dore spear grass *(Stipa nelsonii* spp. *dorei)* = western needlegrass *(S. columbiana)*
mountain thermopsis *(Thermopsis rhombifolia* var. *montana = T. montana = T. pinetorum)*
pine goldenpea *(Thermopsis rhombifolia* var. *divericarpa = T. divericarpa)*
rough tridens *(Tridens muticus* var. *elongatus = T. elongatus)*
sharpleaf valerian *(Valeriana acutiloba* var. *acutiloba = V. capitata* var. acutiloba *= V. capitata)*

Plant Reference List

This reference list compiles the plant names which appear in the plant association descriptions. It is not necessary to be familiar with all of these plants in order to 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 three main categories—trees, shrubs, and herbs—and is then organized alphabetically.

TREES

*corkbark fir *(Abies bifolia)*	
*white fir *(Abies concolor)*	
*Arizona alder *(Alnus oblongifolia)*	
*thinleaf alder *(Alnus incana* ssp. *tenuifolia)*	
Arizona madrone *(Arbutus arizonica)*	
velvet ash *(Fraxinus velutina)*	
*Arizona walnut *(Juglans major)*	
*alligator juniper *(Juniperus deppeana)*	
*redberry juniper *(Juniperus erythrocarpa)*	
*Utah juniper *(Juniperus osteosperma)*	
*oneseed juniper *(Juniperus monosperma)*	
*Pinchot juniper *(Juniperus pinchotii)*	
*Rocky Mountain juniper *(Juniperus scopulorum)*	c
yellow paloverde *(Parkinsonia microphylla)*	
*Engelmann spruce *(Picea engelmannii)*	
*blue spruce *(Picea pungens)*	
Arizona pine *(Pinus arizonica)*	C
*bristlecone pine *(Pinus aristata)*	C
*border pinyon *(Pinus discolor)*	c
*twoneedle pinyon *(Pinus edulis)*	c
*Apache pine *(Pinus engelmannii)*	C
*Arizona pinyon *(Pinus fallax)*	
*limber pine *(Pinus flexilis)*	C
*Chihuahuan pine *(Pinus leiophylla)*	c
*ponderosa pine *(Pinus ponderosa)*	C
*southwestern white pine *(Pinus strobiformis)*	C
*Arizona sycamore *(Platanus wrightii)*	a
narrowleaf cottonwood *(Populus angustifolia)*	s
Rio Grande cottonwood *(Populus deltoides* ssp. *wislizensi)*	s
*quaking aspen *(Populus tremuloides)*	s
black cherry *(Prunus serotina)*	a
*Douglas-fir *(Pseudotsuga menzensii)*	c
*netleaf oak *(Quercus rugosa)*	S
*silverleaf oak *(Quercus hypoleucoides)*	S

*Emory oak *(Quercus emoryi)* s
*Gambel oak *(Quercus gambelii)* s
*gray oak *(Quercus grisea)* s
*Arizona white oak *(Quercus arizonica)* s

SHRUBS

catclaw acacia *(Acacia greggii)*
*Rocky Mountain maple *(Acer glabrum)*
*bigtooth maple *(Acer grandidentatum)*
*lecheguilla *(Agave lechuguilla)*
Palmer century plant *(Agave palmeri)*
Parry agave *(Agave parryi)*
Utah agave *(Agave utahensis)*
Utah service berry *(Amelanchier utahensis)*
service berry *(Amelanchier* spp.)
manzanita *(Arctostaphylos* spp.)
*pointleaf manzanita *(Arctostaphylos pungens)*
Pringle manzanita *(Arctostaphylos pringlei)*
*kinnikinnick *(Arctostaphylos uva-ursi)*
*Bigelow sagebrush *(Artemisia bigelovii)*
sand sagebrush *(Artemisia filifolia)*
*black sagebrush *(Artemisia nova)*
*big sagebrush *(Artemisia tridentata)*
fourwing saltbush *(Atriplex canescens)*
California brickellbush *(Brickellia californica)*
fairyduster *(Calliandra eriophylla)*
*crucifixion thorn *(Canotia holacantha)*
Bigelow bristlehead *(Carphochaete bigelovii)*
*Fendler ceanothus *(Ceanothus fendleri)*
*desert ceanothus *(Ceanothus greggii)*
hairy mountain mahogany *(Cercocarpus montanus* var. *paucidentatus)*
*true mountain mahogany *(Cercocarpus montanus)*
mountain mahogany *(Cercocarpus* spp.)
fernbush *(Chamaebatiaria millefolium)*
desert willow *(Chilopsis linearis)*
*Mexican orange *(Choisya dumosa* var. *arizonica)*
longflower rabbitbrush *(Chrysothamnus depressus)*
*rubber rabbitbrush *(Chrysothamnus nauseosus)*
green rabbitbrush *(Chrysothamnus viscidiflorus)*
rabbitbrush *(Chrysothamnus* spp.)
*blackbrush *(Coleogyne ramosissima)*
squawbush *(Condalia spathulata)*
featherplume *(Dalea formosa)*
green sotol *(Dasylirion leiophyllum)*
common sotol *(Dasylirion wheeleri)*
Mormon tea *(Ephedra viridis)*
bastardsage *(Eriogonum wrightii)*

*Apacheplume *(Fallugia paradoxa)*
cliff fendlerbush *(Fendlera rupicola)*
Utah fendlerbush *(Fendlera utahensis)*
beechleaf frangula *(Frangula betulifolia)*
eggleaf silktassel *(Garrya ovata)*
ashy silktassel *(Garrya flavescens)*
*Wright silktassel *(Garrya wrightii)*
spiny greasebush *(Glossopetalon spinescens)*
broom snakeweed *(Guiterrizia sarothae)*
gumhead *(Gymnosperma glutinosum)*
*rockspirea *(Holodiscus dumosus)*
pinque hymenoxys *(Hymenoxys richardsonii)*
*cliffbush *(Jamesia americana)*
*common juniper *(Juniperus comminus)*
littleleaf ratany *(Krameria erecta)*
*winterfat *(Krascheninnikovia lanata)*
*creosotebush *(Larrea tridentata)*
*twinflower *(Linnaea borealis)*
Arizona honeysuckle *(Lonicera arizonica)*
pale wolfberry *(Lycium pallidum)*
Fremont mahonia *(Mahonia fremontii)*
red barberry *(Mahonia haematocarpa)*
*Oregongrape *(Mahonia repens)*
algerita *(Mahonia trifoliata)*
rough mendora *(Mendora scabra)*
mimosa *(Mimosa aculeaticarpa* var. *biuncifera)*
Rio Grande saddlebush *(Mortonia sempervirens)*
*sacahuista *(Nolina microcarpa)*
tree cholla *(Opuntia imbricata)*
tulip pricklypear *(Opuntia phaeacantha)*
plains pricklypear *(Opuntia polyacantha)*
walkingstick cactus *(Opuntia spinosior)*
cholla & pricklypear *(Opuntia* spp.)
Whipple cholla *(Opuntia whipplei)*
boxleaf myrtle *(Paxistima myrsinites)*
*mountain ninebark *(Physocarpus monogynus)*
honey mesquite *(Prosopsis glandulosa)*
velvet mesquite *(Prosopsis velutina)*
common chokecherry *(Prunus virginiana)*
broom dalea *(Psorothamnus scoparius)*
common hoptree *(Ptelea trifoliata)*
*Stansbury cliffrose *(Purshia stansburyiana)*
*antelope bitterbrush *(Purshia tridentata)*
shrubby forms oaks *(Quercus* spp.)
canyon live oak *(Quercus chrysolepis)*
*Gambel oak *(Quercus gambelii)*
*gray oak *(Quercus grisea)*

*silverleaf oak *(Quercus hypoleucoides)*
*netleaf oak *(Quercus rugosa)*
*wavyleaf oak *(Quercus* X*pauciloba)*
*Toumey oak *(Quercus toumeyi)*
*shrub live oak *(Quercus turbinella)*
redberry buckthorn *(Rhamnus crocaea)*
*evergreen sumac *(Rhus virens* var. *choriophylla)*
sugar sumac *(Rhus ovata)*
*skunkbush sumac *(Rhus trilobata)*
pubescent squawbush *(Rhus trilobata* var. *pilosissima)*
wax currant *(Ribes cereum)*
*gooseberry currant *(Ribes montigenum)*
orange gooseberry *(Ribes pinetorum)*
currant *(Ribes* spp.*)*
*New Mexico locust *(Robinia neomexicana)*
wild rose *(Rosa* spp.)
New Mexico raspberry *(Rubus neomexicanus)*
*western thimbleberry *(Rubus parviflorus)*
*Scouler willow *(Salix scouleriana)*
*whortleleaf snowberry *(Symphoricarpos oreophilus)*
turpentinebroom *(Thamnosma montana)*
*whortleberry *(Vaccinium myrtillus)*
skeletonleaf goldeneye *(Viguiera stenoloba)*
*canyon grape *(Vitis arizonica)*
narrowleaf yucca *(Yucca angustissima)*
*banana yucca *(Yucca baccata)*
soaptree yucca *(Yucca elata)*
Schott yucca *(Yucca schottii)*
yucca *(Yucca* spp.)

HERBS

common yarrow *(Achillea millefolium)*
Kunth onion *(Allium kunthii)*
big bluestem *(Andropogon gerardii)*
*sand bluestem *(Andropogon hallii)*
pussytoes *(Antennaria* spp.)
smallleaf pussytoes *(Antennaria parvifolia)*
rosy pussytoes *(Antennaria rosea)*
threeawn *(Aristida* spp.)
Arizona threeawn *(Aristida arizonica)*
Fendler threeawn *(Aristida purpurea* var. *longiseta)*
single threeawn *(Aristida orcuttiana)*
Fendler threeawn *(Aristida purpurea* var. *fendleriana)*
fringed sagewort *(Artemisia frigida)*
Louisiana sagewort *(Artemisia ludoviciana)*
sagewort *(Artemisia* spp.)

yellow milkvetch *(Astragalus flavus)*
pine dropseed *(Blepharoneuron tricholepis)*
Herter cane bluestem *(Bothriochloa barbinodis)*
*sideoats grama *(Bouteloua curtipendula)*
*black grama *(Bouteloua eriopoda)*
*blue grama *(Bouteloua gracilis)*
*hairy grama *(Bouteloua hirsuta)*
purple grama *(Bouteloua radicosa)*
slender grama *(Bouteloua repens)*
tasselflower brickellbush *(Brickellia grandiflora)*
Lemmon brickellbush *(Brickellia lemmonii)*
brickellbush *(Brickellia* spp.)
nodding brome *(Bromus anomalus)*
*fringed brome *(Bromus ciliatus)*
woolly brome *(Bromus lanatipes)*
foxtail brome *(Bromus rubens)*
brome *(Bromus* spp.)
drawf stickpea *(Calliandra humilis)*
drawf stickpea *(Calliandra humilis* var. *reticulata)*
White Mountain sedge *(Carex geophila)*
*dryspike sedge *(Carex foenea)*
Ross sedge *(Carex rossii)*
sedges *(Carex* spp.)
rose heath *(Chaetopappa ericoides)*
Fendler lipfern *(Cheilanthes fendleri)*
rock clematis *(Clematis columbiana)*
brittle bladderfern *(Cystopteris fragilis)*
Rose ticktrefoil *(Desmodium rosei)*
ticktrefoil (*Desmodium* spp.)
Arizona wheatgrass *(Elymus arizonicus)*
bottlebrush squirreltail *(Elymus elymoides)*
plains lovegrass *(Eragrostis intermedia)*
spreading fleabane *(Erigeron divergens)*
*sprucefir fleabane *(Erigeron eximius)*
beautiful fleabane *(Erigeron formosissimus)*
trailing fleabane *(Erigeron flagellaris)*
New Mexico fleabane *(Erigeron neomexicanus)*
Vreeland erigeron *(Erigeron vreelandii)*
winged buckwheat *(Eriogonom alatum)*
James buckwheat *(Eriogonum jamesii)*
redroot buckwheat *(Eriogonum racemosum)*
hairy woollygrass *(Erioneuron pilosum)*
redstem stork's bill *(Erodium cicutarium)*
spreading wallflower *(Erysium repandum)*
*Arizona fescue *(Festuca arizonica)*
*Thurber fescue *(Festuca thurberi)*
woodland strawberry *(Fragaria vesca)*

Virginia strawberry *(Fragaria virginiana)*
bedstraw *(Galium* ssp.)
Mexican bedstraw *(Galium mexicanum* ssp. *asperrimum)*
bracted bedstraw *(Galium microphyllum)*
pineywoods geranium *(Geranium caespitosum)*
Richardson geranium *(Geranium richardsonii)*
falsepennyroyal *(Hedeoma hyssopifolia)*
common sunflower *(Helianthus annuus)*
hairy goldenaster *(Heterotheca villosa* var. *villosa)*
yellow hawkweed *(Hieracium fendleri)*
*curlymesquite *(Hilaria belangeri)*
*galleta *(Hilaria jamesii)*
*tobosagrass *(Hilaria mutica)*
Idaho hymenopappus *(Hymenopappus filifolius* var. *lugens)*
prairie junegrass *(Koelaria macrantha)*
*Arizona peavine *(Lathyrus lanszwertii* var. *arizonica)*
green sprangletop *(Leptochloa dubia)*
mucronate sprangletop *(Leptochloa mucronata)*
*beardless wildrye *(Leymus triticoides)*
Wright deervetch *(Lotus wrightii)*
manyflowered gromwell *(Lithospermum multiflorum)*
common wolfstail *(Lycurus pheloides)*
slender goldenweed *(Machaeranthera gracilis)*
starry false Solomon's seal *(Maianthemum stellatum)*
plains blackfoot *(Melampodium leucanthum)*
Macdougal bluebells *(Mertensia macdougalii)*
Colorado four o'clock *(Mirabalis multiflora)*
*pine muhly *(Muhlenbergia dubia)*
*bullgrass *(Muhlenbergia emersleyi)*
*longtongue muhly *(Muhlenbergia longiligula)*
*mountain muhly *(Muhlenbergia montana)*
*New Mexico muhly *(Muhlenbergia pauciflora)*
bush muhly *(Muhlenbergia porteri)*
*sandhill muhly *(Muhlenbergia pungens)*
curlyleaf muhly *(Muhlenbergia setifolia)*
slimflower muhly *(Muhlenbergia tenuifolia)*
ring muhly *(Muhlenbergia torreyi)*
*screwleaf muhly *(Muhlenbergia virescens)*
*Indian ricegrass *(Oryzopsis hymenoides)*
littleseed ricegrass *(Oryzopsis micrantha)*
bulb panicgrass *(Panicum bulbosum)*
witchgrass *(Panicum capillare)*
obtuse panicgrass *(Panicum obtusum)*
western wheatgrass *(Pascopyrum smithii)*
dwarf lousewort *(Pedicularis centranthera)*
toadflax penstemon *(Penstemon linarioides)*
wild beans *(Phaseolus* spp.)

phlox *(Phlox* spp.)
*pinyon ricegrass *(Piptochaetium fimbriatum)*
Pringle needlegrass *(Piptochaetium pringlei)*
*muttongrass *(Poa fendleriana)*
*Kentucky bluegrass *(Poa pratensis)*
*Skunkbush polemonium *(Polemonium pulcherrimum* ssp. *delicatum)*
woolly cinquefoil *(Potentilla hippiana)*
white milkwort *(Polygala alba)*
greenstem paperflower *(Psilotrophe sparsiflora)*
slimflower scurfpea *(Psoralidium tenuiflorum)*
western brackenfern *(Pteridium aquilinum)*
Texas bluestem *(Schizachyrium cirratum)*
*little bluestem *(Schizachyrium scoparium)*
*bittercress ragwort *(Senecio cardamine)*
New Mexico groundsel *(Senecio neomexicanus)*
*burnet ragwort *(Senecio sanguisorboides)*
Wooton ragwort *(Senecio wootonii)*
plains bristlegrass *(Setaria macrostachya)*
Parry goldenrod *(Solidago parryi)*
coast goldenrod *(Solidago spathulata)*
threenerve goldenrod *(Solidago velutina)*
goldenrod *(Solidago* spp.)
globemallow *(Sphaeralcea* spp.)
*alkali sacaton *(Sporobolus airoides)*
spike dropseed *(Sporobolus contractus)*
sand dropseed *(Sporobolus cryptandrus)*
needlegrass *(Stipa* spp.)
*needleandthread *(Stipa comata)*
*Dore needlegrass *(Stipa nelsonii* spp. *dorei)*
New Mexico needlegrass *(Stipa neomexicana)*
desert needlegrass *(Stipa speciosa)*
Schribner needlegrass *(Stipa schribneri)*
Fendler meadowrue *(Thalictrum fendleri)*
alpine pennycress *(Thlaspi montanum* var. *montanum)*
mountain thermopsis *(Thermopsis rhombifolia* var. *montana)*
slim tridens *(Tridens muticus)*
rough tridens *(Tridens muticus* var. *elongatus)*
Rocky Mountain trisetum *(Trisetum montanum)*
sharpleaf valerian *(Valeriana acutiloba)*
American vetch *(Vicia americana)*
sweetclover vetch *(Vicia pulchella)*
Rocky Mountain zinnia *(Zinnia grandiflora)*

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