

**DESCRIPTIONS OF ARIZONA VEGETATION
REPRESENTED ON THE GAP VEGETATION MAP**

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Introduction

Broadly, the Gap Analysis Program (GAP) is a national effort to catalog the habitats in every state and then compare them to land ownership patterns. These data permit a rough assessment of the adequacy of their protection from destruction. The program places special emphasis on vertebrate distributions as determined from their habitats.

GAP habitats are primarily defined on the basis of vegetation. Vegetation, as used here, is a word with 3 meanings: (1) as a collective term indicating plants in general, distributed on the landscape; (2) as a narrow term indicating assemblages of plants on the basis of how they appear, i.e., their physiognomy; and (3) as a narrow term indicating assemblages of plants on the basis of their taxonomic names. The first meaning requires no further comment because it is in colloquial use.

The second meaning describes how the vegetation looks (physiognomy) is the most traditional and favored by European ecologists. An example is the description of a spruce and fir community as “needle-leaved evergreen forest with conical crowns.” This tells the ecologist that it is a community of coniferous trees growing closely together and with pointed crowns. Such a shape and the tree spacing will protect the trees from heavy snow loads in habitats with abundant snow. The “needle-leaved evergreen forest with rounded crowns” indicates trees that are closely spaced again but have broader crowns that do not shed snow as easily. These trees are less well adapted to withstand heavy snow without breaking down. The utility of this classification is that communities with similar structures tend to be ecologically similar. Many vertebrates are more closely tied to community structure than to kinds of plants present.

The third meaning describes the taxonomic relationships of the plants. Systems based on plant taxonomy are often referred to as floristic classifications. These communities are named for either the most common (dominant) plants or for the plants that are most characteristic but not necessarily the most common. Such less common plants may only occur in 1 kind of community and are called discriminant plants. Other plants that may be used to separate closely related communities are called differential plants. Use of discriminant and differential plants for classification requires detailed analysis in the field and in the office. In consequence, the method is best suited to detailed analysis of small areas. Examples are “*Abies lasiocarpa*—*Mertensia ciliata* Forest” or “*Pinus ponderosa*—*Bouteloua gracilis* Forest” which are examples of the “needle-leaved evergreen forest with conical crowns” and “needle-leaved evergreen forest with rounded crowns” examples above. Neither the *Mertensia* (bluebells) nor the *Bouteloua* (bluegrass) are dominant plants and are greatly outweighed by the trees in the community. European ecologists often favor use of discriminant and differential plants for definition of communities.

Vegetation classification is a complex subject. Its philosophies and even the names of the vegetation units are confusing. The reader who is interested in details is referred to Whittaker, 1962.

The National Vegetation Classification System (NVCS) and the Federal Geographic Data Committee Classification Standard, 1996 (FGDC '96) mentioned in this report are both physiognomic classifications at their upper levels. Personnel using physiognomic classifications need not know the taxonomy of the plants being classified. Simply matching their appearance to technical language of the classification

is sufficient. This is a considerable advantage since most field people find it easier to master physiognomic classification than to learn the botanical names of the plants. The NVCS has been modified and strengthened by the joint efforts of the U.S. Geological Survey (USGS), the National Park Service (NPS), and The Nature Conservancy (TNC). The NVCS (USGS-NPS-TNC) system is superior to FGDC '96 in that it is more detailed and consistent and is classified down to the floristic level.

Dominance classifications are based on the plants that control the community by occupying the most space or controlling the light. They are often the species with the most biomass. Examples of dominance classifications are “Engelmann spruce—alpine fir community” or the “pine” community. These community names are often further refined by use of species names of the dominant plants “*Picea engelmannii*—*Abies lassiocarpa* community” or “*Pinus ponderosa* community.” Species dominance/commonness classifications are traditionally favored by American ecologists who are concerned with broad studies over large areas. Less data and less sophisticated analysis are required to make them work. The field worker need only know the more common perennial species.

Few North American vegetation classifications are pure discriminant/differential or dominance/commonness, they are most often combinations of the 2 with climatic, geographical, and edaphic terms added. Barbour and Major (1977), Barbour and Billings (1988), Brown, Lowe, and Pase (1979), International Union for Conservation of Nature and Natural Resources (1973, 1974), and Bailey & Cushwa (1982), are examples of successful mixed systems.

Pending completion of the USGS National Vegetation Classification System (NVCS: USGS-NPS-TNC) or FGDC '96 systems we have adopted that of Brown, Lowe, and Pase (1979, 1980, 1982). The Brown, Lowe, and Pase (BLP) system is exactly that—a system or format for organizing and storing vegetation data. BLP was never intended to be a classification—it is only a method illustrated by examples. Users failing to appreciate this point will be disappointed when they look for their favorite vegetation type.

Use of the biome concept by BLP is its strength. Biomes are natural communities characterized by a distinctive vegetation physiognomy and evolutionary history within a formation, i.e. forest, grassland, swamp, etc., persisting together through time and space. Thus they tend to be centered in, but not restricted to particular biogeographic provinces. Biogeographic provinces are contiguous (non-disjunctive) geographic regions. Biomes may be and often are discontinuous (disjunctive) and are named for the biogeographic province where they are centered.

All vegetation classifications are, to a degree artificial abstractions, but since the biota of a biome have similar physiognomy and evolved from ancestral stocks growing in the same environment they are a naturally defined vegetation unit (see the glossary). Larger (more generalized) units than the biome and smaller (more specific) units than the biome become progressively more artificial since they have evolved under more widespread or more narrow environmental conditions than the biome in question. Thus, classifications bench marked on the biome have a greater degree of reality (naturalness) than those based on species or climate zones, for example.

BLP, as used here, recognizes 8 levels of organization; an understanding of them is needed to understand what follows. For a more detailed discussion of the classification system structure the reader is referred to Brown, Lowe, and Pase (1979). The 8 levels of organization are (in order from broad to narrowly restricted):

- (1) **Biogeographic Realms.** (1) Nearctic (New World temperate), (2) Palearctic (Old World temperate), (3) Neotropical (New World tropical and is combined with the Antarctic), (4) Oriental, (5) Ethiopian, (6) Australian, and (7) Oceanic. Biogeographic realms are contiguous and are subdivided into contiguous biogeographic regions. BLP recognizes 22 biogeographic regions within the Nearctic Realm.
- (2) **Upland/Wetland.** Wetlands have soils that are saturated with water for significant periods of time (i.e., swamps, marshes, or elsewhere where vegetation grows in or near to streams or ponds, etc.) and are often called “riparian.” Uplands are better drained and not saturated with moisture for significant periods of time.
- (3) **Formation types.** Upland types: Tundra, Forest (including woodland), Scrubland, Grassland, Desertland, Nonvegetated. Wetland types: Wet tundra, Swampforest (riparian forest), Swampscrub (riparian scrub), Marshland, Strandland, Submergent aquatic.
- (4) **Climatic zone.** Arctic-Boreal (Antarctic-Austral), Cold temperate, Warm temperate, Tropical-subtropical.
- (5) **Biome.** A biome is a subcontinental biotic community of similar physiognomy that has persisted (and evolved) in time and space. Strictly speaking, biomes include both plants and animals. However, because most animals are more mobile than plants, they may be found in more than 1 biome. Unlike Biogeographic Realms and Biogeographic regions, biomes are not necessarily contiguous but are often disjunct; they are mostly centered in but not confined to a single biogeographic province. For example, the Madrean biome occurs on the Sierra del Ajo (Mexico), the Huachuca Mts., the Santa Catalina Mts., the Pinalino Mts., etc. but it does not occur in between, i.e. the biome is disjunct. Be careful to distinguish between biome names and biogeographic province epithets which are used in biome names. See the glossary for more information.
- (6) **Series.** A series is 1 of a number of principal plant-animal communities comprising a biome. Series are distinguished by climax (sometimes endemic) dominant plant genera and are equivalent to climax communities of Daubenmire and Daubenmire (1968).
- (7) **Association.** These are distinctive plant association and associates (successional associations) based on the occurrence of a particular dominant or codominant species and they are roughly equivalent to habitat types of Daubenmire and Daubenmire (1968).

- (8) **Subassociation.** These are distinctive plant assemblages within the association but of more limited distribution.

The hierarchical structure of the BLP system makes is readily applicable to vegetation studies from generalized continental scales to those of small plots. This ability to zoom in or zoom out allows generalization and presentation of data at a level consistent with data available. Another important feature of the natural and hierarchical system is that vegetation of similar evolutionary history and geographical distribution is grouped together which are powerful intellectual tools for visualization of vegetational significance.

BLP, as published was tagged with decimal codes to make computer storage more convenient. For example, the Rocky Mountain *Pinus ponderosa* Association was coded “122.321.” Each digit from left to right signifies a more restrictive (narrower) vegetation unit. In this example a “1,” indicating the Nearctic Realm at the beginning is omitted because the entire published BLP list lies within the Nearctic. Also the digit for the subassociation code is also not given. Note that the biome is coded as the first digit to the right of the decimal point, signifying its “benchmark” quality.

In addition to making computer storage more convenient, the code also makes concise reference to a vegetation type easy and less subject to error. The full name of the pine example given above (122.321) is:

[Nearctic]/ [1] Upland / [2] Forests and Woodlands / [2] Cold Temperate / [.3] Rocky Mountain Montane Conifer Forest / [2] Pine Series/ [1] *Pinus ponderosa* Association.

Even when arranged into a syntactically possible sentence this is a difficult name to remember or to check for proof reading errors. The 122.321 code is easier to deal with.

Several difficulties, both conceptual and practical, with BLP digital code as published became quickly apparent when we began expanding it for classification of field data. The original paper did not present data at the biome level in consistent order. For example “.3” could signify the Rocky Mountain biome or the Canadian Low Arctic Tundra, or the Relict Conifer Forest. Limited coding possibilities (“0”–“9”) presented a more serious problem since each level was confined to no more than 10 entities. Converting the code from decimal to hexadecimal (“0” to “15”) would offer some but inadequate relief. Also most users and their desktop PC computers would experience human and data storage problems. Another system of coding involves use of underscores, i.e., 6, 7, 8, 9, 10, 11, 12, etc., allowing considerable expansion of the numerical series. However such codes are laborious to type and sorting by different brands of software produces inconsistent results. We explored use of an alphanumeric code, i.e., a0, a1, a2, a3 . . . c9, d0, d1, etc. which gave 260 codes at each level. The alpha character was always done in lowercase because it sorts well, is easier to type, and because it gave better visual grouping of the dyads. Compare the appearance of A2A5B5 with a2a5b5. The latter more visually represents 3 alpha-numeric elements than the former. We coded our classification by this system.

The changes we contemplated to BLP were significant enough that a working group of Charles H. Lowe, R. Roy Johnson, Peter S. Bennett, and Michael R. Kunzmann was assembled to undertake the task. The new system was renamed Johnson, Bennett, Kunzmann (JBK) to distinguish it from BLP.

The coding limitation was particularly severe beyond the series level (more than 2 places left of the decimal place. For example, 22 associations are to be coded in the Great Basin Pinyon—Juniper Woodland. The ability to distinctively tag the 22

geographic biome names would be convenient. These problems were solved by conversion to the alphanumeric code described.

The original BLP System did not always list biogeographic provinces in the same order nor did any single numeral always represent them. JBK rearranged the list, placing the biogeographic provinces in the same order within any formation and climate zone. They are listed from north to south and east to west in so far as possible. Each was given its own alphanumeric code. The Madrean biogeographic province is always “t0,” Rocky Mountain “k0,” the Sonoran is “u0.”

The JBK list is presented as an appendix in this report. The alpha-numeric code is listed to 8 places, i.e., “1223.t0a1a1a2.” Where the code is only applied to series level it appears as “1223.t0a1----.” Listed to the association level it is “1223.t0a1a1--.” The hyphens are used as place keepers making the classification level more visually apparent.

The BLP was a system and not a classification—with most of its entries at the series level and below marked as “Examples only.” Only the most widespread and significant series were listed. The system needed to be fleshed out. The original BLP was to be published together with formal descriptions, diagnoses, and illustrative photographs. Funding never materialized for this project but the system was eventually published with some descriptive material (Brown 1982).

Field data were collected in connection with other projects including the Gap Analysis Program itself. The JBK committee added much material from the literature. References Useful for Arizona Gap Program (attached to this report) lists many of these sources. Aside from being competent, data sources had to have quantified plant cover or importance information. These data were processed by the methods detailed in Manual for GAP Program: Collecting Vegetation Classification Data attached to this report. These sources are particularly rich for forests and woodlands and depauperate for deserts and other formations of little economic importance. Simultaneously, the data used for JBK expansion data were collected and summarized forming the basis for formal descriptions at the series level. These descriptions appear as Descriptions of Arizona Vegetation from Brown, Lowe, and Pase System at the Series Level with Modified Coding and Emendations attached to this report.

Those portions of JBK relevant to the Gap Program appear as Outline of Vegetation Types from Brown, Lowe, and Pase Vegetation Classification System with Modified Coding and Emendations: GAP Associations attached to this report.

Developing a List of Standard Plant Names

While preparing the JBK classification and collecting data for its expansion, numerous taxonomic and synonymy problems were encountered. Since Arizona lacks a comprehensive up-to-date plant list with synonymy, the resources needed to resolve these difficulties were fragmented. The GAP project needed a stable source for plant names that is scientifically credible, and contains geographic distribution and synecological data. Such a list of 1,300 plants for southeastern Arizona was developed for another project (Bennett, Kunzmann, and Johnson 1995). This list was synonymized using Kartesz (1994) but distribution data came from herbarium searches and from various published floras (Abrams 1940; Bassett, Larson, and Moir 1987; Benson and Darrow 1941, 1984; Bowers and McLaughlin 1987; Correll and Johnston 1970; Johnson 1988; Kearney and Peebles 1960; Lehr 1978, 1980, 1982; Little 1950, 1953; Reeves 1976; Sudworth 1908; Wagner 1973, 1979) and many others.

The Arizona list currently contains these data: (1) technical name; (2) synonymous names; (3) common name; (4) family name; (5) low and high elevation of occurrence; (6) flowering months; (7) life and growth forms; (8) leaf size and texture; habitat; (9) other plant species that are likely to occur with the listed species; (10) distribution by Arizona county, U.S. and biome associated with; (11) plant uses; (12) locations of exsiccatae (Bennett, Johnson, and Kunzmann 1996).

For convenience, the Arizona Gap Analysis Program has elected to use the Brown, Lowe and Pase (1979 [BLP]) classification system to template Arizona vegetation data pending completion of the National Vegetation Classification System (NVCS) (Bennett 1997). The BLP's hierarchical structure groups communities logically and to a degree into natural groups. This logical hierarchical arrangement facilitates interconversion between similarly structured classifications.

GAP Vegetation Descriptions Format

The vegetation descriptions which follow are uniformly formatted for the convenience of the user. The bolded headings given in the explanation which follows are identical to those used in the descriptions.

Vegetation Name from Legend

Full BLP name for community: biogeographic realm; upland/wetland designation; climatic zone; vegetation formation; biome; series.

Distribution: distribution within Arizona and general notes.

Physiognomy: physiognomic description of the communities.

Floristics: dominant or codominant and common species found in the series.

Diagnostic Characteristics: attributes that distinguish this vegetation from similar communities.

Dominance type examples: examples of associations that are included in the series. The association names are followed by their alphanumeric code.

FGDC '96 type: the FGDC '96 physiognomic description of the vegetation followed by its code.

NVCS (USGS-NPS-TNC) type: the NVCS name for the vegetation to the alliance level.

References: references relevant to the vegetation described above. Each description has its own references which are repeated for each type. Full citations are found in the References section.

GAP VEGETATION DESCRIPTIONS

Rocky Mountain Alpine Tundra: Mixed Herb Series

Nearctic Upland, Arctic Boreal Tundra, Alpine Rocky Mountain, Mixed Herb Series (1111.k0a1----

Distribution: Very limited in extent, this series occurs only on the summits of the San Francisco Peaks in irregular patches at elevations between 3,200 and 3,850 m.

Upslope the Alpine Mixed Herb Series occupies suitable microhabitats up to the mountain summits and abuts the Englemann spruce-Alpine fir (1121.k0a0), Bristlecone pine—Limber pine (1121.k0a1----), or Bristlecone pine Elfinwood Series (1131.k0a2----). A harsh climate, short growing season, and steep slopes prevent development of mature soils. Note that the Avens–Sedge Series (1111.k0a2----) has been included here.

Physiognomy: An open stand of low perennial forbs, graminoids, and crustose lichens growing in soil pockets among rocks. Total vegetation cover is less than 1%.

Floristics: *Primula parryi*, *Poa reflexa*, *Carex bella* (sedge), *Geum rossii*, *Silene acaulis*, *Oxyria digyna* (Alpine mountain sorrel), *Heuchera rubescens* var. *versicolor* (Painted alumroot), *Sedum rhodanthum* (stonecrop), *Trisetum spicatum* (Spike trisetum), *Elymus scribneri* (wheatgrass) are the most important herbs. *Senecio franciscanus* is endangered and is not known to occur elsewhere.

Diagnostic Characteristics: Herbaceous vascular plants dominant rather than cryptophytes. This type is found at high elevations.

Dominance type examples:

Primula parryi—*Poa reflexa* Association (1111.k0a1a0)

FGDC '96 type: Sparse vegetation; boulder, gravel, cobble, or talus; high mountain talus/scree slopes; natural; mixed herb. Code: VIIB1c.

NVCS (USGS-NPS-TNC) type: Mountain talus: *Ribes montigenum* Sparsely Vegetated Alliance. Code IX.C.2.b

Carex foenea Sparsely Vegetated Alliance

Ribes montigenum Sparsely Vegetated Alliance

References:

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Pase, C. P. 1982.

Rominger, J. M. and L. A. Paulik. 1983.

Rocky Mountain Subalpine Conifer Forest: Engelmann Spruce—Alpine Fir

Nearctic Upland, Arctic-Boreal Forest and Woodland, Englemann Spruce—Alpine Fir Series (1121.k0a0---)

Distribution: Elevation range is 2,275–3,650 m. This series is the highest elevation and wettest forest in Arizona. Soils are typically thin, coarse-textured, and poorly stratified. Although tree foliage often touches the ground, and fallen dead trees and needle litter form heavy fuel loading, these forests seldom burn because of typically high fuel moisture. However, when fires occur they are intense and stand replacement often occurs. Aspens quickly populate burned areas, sometimes forming nearly pure stands. Such vegetation is favorable to elk and deer. Following re-establishment of the coniferous canopy, a few aspens persist through time.

The Spruce—Fir Series ascends to timberline where it is bounded by the Bristlecone pine—Limber pine (1121.k0a1----), Bristlecone pine Elfinwood (1131.k0a2----), or Lichen—Moss Series (1111.k0a0----) depending on the slope and exposure. Steep south-facing slopes reduce the width of the first 2 of the above named series, thus the Spruce—Fir Series is proximate to the tundra. Down-slope the Spruce—Fir Series abuts the Douglas-fir—Mixed Conifer Series (sometimes with a considerable Pine Series component).

The Englemann spruce—Alpine fir Series is confined to the highest elevation mountains of northern Arizona. The San Francisco Peaks, White Mountains, Pinaleno Mountains, and highest elevations of the North Rim of Grand Canyon have well developed stands.

Physiognomy: Evergreen needleleaf forest of mesophanerophytes with spire-shaped crowns supported by a straight unbranched trunk. Trees are adapted to shed heavy snow loads. Trees are in evenly spaced stands with total cover ranging from 50 to 90 percent. Deciduous broad-leaved meso- or microphanerophyte trees grow in irregular patches throughout but are especially common following fire in temporary openings in the coniferous canopy. In favorable habitats trees exceed 30 m in height but near timber-line their stature greatly decreases. Shrubby scaleleaf conifers or dwarf trees may occur on the forest floor. Ground cover is irregular, absent, or sparse. Where ground cover occurs it is composed of grasses, sedges, and herbs.

Floristics: *Picea engelmannii* (Englemann spruce), *P. pungens* (blue spruce), and *Abies lasiocarpa* (subalpine fir) are the most important species. *Abies lasiocarpa* var. *arizonica* (corkbark fir) is an interesting tree with smooth, soft, corky bark mostly confined to northern Arizona, northern New Mexico, and southern Colorado (a few individuals occur on Mount Lemon [Pima County] and Mt. Graham [Pinal County]). Other important species are *Populus tremuloides* (Quaking aspen), *Juniperus communis* (Dwarf juniper), *Abies concolor* (White fir), *Pseudotsuga menziesii* (Douglas-fir), *Pinus ponderosa* (Ponderosa pine), *Robinia neomexicana* (New Mexico locust), *Fragaria* sp. (Strawberry), *Pteridium aquilinum* (Bracken fern), *Mertensia franciscana* (San Francisco Peaks bluebells), *Carex* spp. (sedge), and *Geranium caespitosum* (Purple geranium).

Diagnostic Characteristics:

High altitude forests with spire-crowned spruces and/or subalpine fir. Cannot be confused with any other community in Arizona.

Dominance type examples:

Picea engelmannii—*Abies lasiocarpa* Association (1121.k0a0a0--)
Picea engelmannii—*Abies lasiocarpa*—*Populus tremuloides* Association
 (1121.k0a0a5--)
Picea engelmannii Association (1121.k0a0a1--)
Picea engelmannii—Mixed Conifer Association (1121.k0a0a6--)
Picea pungens Association (1121.k0a0a4--)
Abies lasiocarpa Association (1121.k0a0a2--)
Abies lasiocarpa arizonica Association (1121.k0a0a3--)
Abies lasiocarpa—Mixed Conifer Association (1121.k0a0a7--)

FGDC '96 type: Conical-crowned temperate or subpolar needle-leaved evergreen forest and conical-crowned temperate or subpolar needle-leaved evergreen woodland. Code: IA8c/IIA4b.

NVCS (USGS-NPS-TNC) type: Needle-leaved evergreen forest with conical crowns/Needle-leaved evergreen woodland with conical crowns. Code: I.A.9.c/II.A.2.a

Picea engelmannii Forest Alliance.
Picea engelmannii—*Geum rossii* Association
Picea engelmannii—*Picea pungens*—*Senecio cardamine* Alliance
Picea pungens—*Poa pratensis* Alliance
Picea pungens—*Carex foenea* Alliance
Picea pungens—*Pseudotsuga menziesii* Association
Abies lasiocarpa—*Lathyrus arizonicus* Association
Abies lasiocarpa—*Erigeron superbus* Association

References:

Brown, D. E., C. H. Lowe and C. P. Pase. 1979.
 Brown, D. E., C. H. Lowe and C. P. Pase. 1980.
 Fitzhugh, E. L., W. H. Moir, and F. Ronco. 1987.
 Johnston, B. C. 1984.
 Moir, W. H. and J. A. Ludwig. 1979.
 Rominger, J. M. and L. A. Paulik. 1983.
 Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.

Rocky Mountain Subalpine Conifer Forest: Bristlecone Pine—Limber Pine

Nearctic Upland, Arctic-Boreal Forest and Woodland, Bristlecone Pine—Limber Pine Series (1121.k0a1--) and **Nearctic Upland, Cold Temperate Scrubland, Rocky Mountain and Subalpine, Bristlecone Pine Elfinwood Series (1131.k0a2----**)

Distribution: Very limited distribution in Arizona but found on south-facing slopes and ridges of the San Francisco Peaks and the Pinalino Mountains at elevations between 3,200 and 3,510 m. Growing conditions are harsh. Soils are poorly developed and coarse textured. The series abuts the Rocky Mountain Alpine Tundra: Mixed Herb Series or Rocky Mountain Subalpine Conifer Forest: Engelmann Spruce—Alpine Fir Series.

Physiognomy: Evergreen needle-leaf woodland or scrub of nano- or microphanerophytes with conical crowns in protected habitats. Tree crowns become wind-pruned “flagged” or even pressed flat to the ground in exposed habitats. Tree branches are flexible and do not break easily with heavy snow loads. The stand is open to very open with scattered shrubs and grasses. Overall vegetative cover is usually less than 20%.

Floristics: *Pinus aristata* (bristlecone pine) and *P. flexilis* (limber pine) dominate the tree layer. The first named species is more common at the upper elevation limit and the latter more common at lower elevations. *Juniperus communis* (common juniper), *J. scopulorum* (Rocky Mountain juniper), and *Ribes* spp. (gooseberry) constitute the shrub layer. The few herbs present are *Thlaspi montanum* var. *fendleri* (meadowrue), *Draba aurea*, *Penstemon whippleanus* (Whipple beardtongue), and *Festuca* spp. (fescue).

Diagnostic characteristics: Preponderance of 5-needled pines on exposed slopes at high elevations. *Pinus strobiformis* (Mexican white pine) is also 5-needled and morphologically superficially resembles limber pine but is a Madrean species, does not form extensive stands, and is not a timber line inhabitant and thus should not confuse vegetation classifiers.

Dominance type examples:

- Pinus aristata*—*Pinus flexilis* Association (1121.k0a1a0--)
- Pinus aristata* Association (1121.k0a1a1--)
- Pinus flexilis* Association (1121.k0a1a2--)
- Pinus aristata* Elfinwood Association (1131.k0a1a0--)

FGDC '96 type: Rounded-crown temperate or subpolar needle-leaved evergreen forest and shrubland. Code: IA8b/IIA4a/IIIA3a

NVCS (USGS-NPS-TNC) type: Needle-leaved evergreen woodland with rounded crowns/Montane scree/High mountain scree. Codes: II.A.2.a/ IX.C.1.b/ IX.C.1.c
Abies concolor Sparsely Vegetated Alliance

Pinus flexilis Sparsely Vegetated Alliance
Abies lasiocarpa Sparsely Vegetated Alliance
Abies concolor Sparsely Vegetated Alliance
Picea engelmannii Sparsely Vegetated Alliance
Pinus aristata Sparsely Vegetated Alliance
Pinus ponderosa Sparsely Vegetated Alliance
Pseudotsuga menziesii Sparsely Vegetated Alliance
Rubus idaeus Sparsely Vegetated Alliance
Pinus aristata Woodland Alliance
Pinus flexilis—*Arctostaphylos uva-ursi* Alliance
Pinus aristata Shrubland Alliance
Populus tremuloides Sparsely Vegetated Alliance
Rubus idaeus Sparsely Vegetated Alliance

References:

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.
Brown, D. E., C. H. Lowe, and C. P. Pase. 1980.
DeVelice, R. L., J. A. Ludwig, W. H. Moir, F. Ronco Jr. 1986.
Pase, C. P., and Brown. 1982a.
Rominger, J. M. and L. A. Paulik. 1983.

Rocky Mountain Montane Conifer Forest: Douglas-fir—Mixed Conifer

Nearctic Upland, Cold Temperate Forest and Woodland, Rocky Mountain Montane Conifer Forest, Douglas-fir—Mixed Conifer Series (1122.k0a0----

Distribution: On mesic sites between 1,830 and 2,680 m but may extend downward on steep north facing slopes or in deep canyons. At higher elevations it is found on more gentle terrain. This series appears to be best developed on limestone and sandstone rather than on igneous parent materials. These communities are shaped to a significant extent by forest fires. The presence of aspen, oaks, and manzanita are indicators of past burning.

The Douglas-fir—Mixed Conifer Series occurs in all major mountain ranges in Arizona but are perhaps best developed in the White Mountains. Douglas-firs of great size (1.2 m dbh) occur in Tsegi Canyon (Navajo County) and stumps of trees felled with stone axes 800 years ago still persist. Another noteworthy occurrence is below the south rim of Grand Canyon where the community has become trapped in mesic pockets since perhaps early Quaternary warming.

Physiognomy: Predominantly evergreen needle-leaved forest of mesophanerophytes with spire-shaped crowns supported by a straight unbranched trunk. Occasional patches of broadleaf deciduous mesophanerophytes are encountered but they are rarely extensive. Understory shrubs are deciduous spinose pinnate leguminous or broad-leaf deciduous microphanerophytes and nanophanerophytes. Needle-leaf microphanerophytes may be present where xeric conditions prevent development of the normal closed tree canopy. Tree cover at least 50% but often 80% in favorable habitats. Development of the shrub layer is inhibited by shading from the normally dense overstory and is usually less than 30%. Perennial forbs are widely scattered and not more than 10% cover and usually much less. Total cover is 60% (greater in favorable habitats) but more open (40%) in xeric places.

Floristics: *Pseudotsuga menziesii* (Douglas-fir), *Abies concolor* (White fir), *Robinia neomexicana* (New Mexico locust), *Acer glabrum* (Rocky Mountain maple), *A. grandidentatum* (Bigtooth maple), and *Amelanchier alnifolia* (Saskatoon serviceberry) are the most important species in mature stands. *Quercus gambelii* (Gambel oak), *Fendlera rupicola* (fendlerbush), *Ptelea trifoliata* (Bracken fern), *Populus tremuloides* (Quaking aspen), *Cercocarpus intricatus* (Littleleaf mountain-mahogany), *Mahonia repens* (Creeping Mahonia), and *Arctostaphylos pungens* (Pointleaf manzanita) are present in seral stands.

Diagnostic characteristics: This series seldom forms monospecific stands. Douglas-fir generally predominates with lesser amounts of white fir, spruces, and aspen present. Ponderosa pine is often present but does not predominate. When fire is excluded, this series may invade ponderosa stands which may confuse the vegetation classifier. Within such invaded communities **mature** pines predominate while the invading species are decidedly less mature.

Dominance type examples:

Pseudotsuga menziesii Association (1122.k0a0a0--)
Pseudotsuga menziesii—*Abies concolor* Association (1122.k0a0a1--)
Pseudotsuga menziesii—*Abies concolor*—*Robinia neomexicana* Subassociation
 (1122.k0a0a1a0)
Pseudotsuga menziesii—*Abies concolor*—Mixed Conifer Association (1122.k0a0a3--)
Pseudotsuga menziesii—*Abies concolor*—*Populus tremuloides* Association
 (1122.k0a0a4--)

FGDC '96 type: Conical-crown temperate or subpolar needle-leaved evergreen forest and rounded-crown temperate or subpolar needle-leaved evergreen woodland.

Code: IA8c/IIA4b

NVCS (USGS-NPS-TNC) type: Needle-leaved evergreen forest with conical crowns/Needle-leaved evergreen woodland with conical crowns. Code: I.A.9.C/II.A.2.b

Abies concolor Woodland Alliance
Picea engelmannii Woodland Alliance
Picea pungens Woodland Alliance
Pseudotsuga menziesii Woodland Alliance

References:

Develice, R. L., J. A. Ludwig, W. H. Moir, and F. Ronco Jr. 1986.
 Fitzhugh, E. L., W. H. Moir, J. A. Ludwig, and F. Ronco Jr. 1987.
 Moir, W. H. and J. A. Ludwig. 1979.
 Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.
 Youngblood, A. P. and R. L. Mauk. 1885.

Rocky Mountain Montane Conifer Forest: Pine

Nearctic Upland, Cold Temperate Forest and Woodland, Rocky Mountain Montane Conifer Forest, Pine Series (1122.k0a1----)

Distribution: Elevational range is between 2,070 and 2,680 m. The series is usually found on gentle to moderate slopes of all aspects. The soils are shallow to deep and well-drained. Stands growing on deep soils tend to have taller and more closely spaced trees. The soils are moderately acidic except beneath patches of oaks and aspens. The cold temperate climate and acidic soils slow decomposition of fallen needles and wood, creating heavy fuel loading. These stands carry fire well.

At higher elevations the Pine Series is bounded by the Douglas-fir—Mixed Conifer Series (1122.k0a0----) or the Engelmann spruce—Alpine fir (1121.k0a0). At lower elevations it is bounded by Pinyon—Juniper (1122.l0a0----) and scrub Series such as Sagebrush (1152.l0a0----). Within the Pine Series, patches of these adjoining series may be expected, as well as stands of such successional plants as aspen and Gambel oak. Within Arizona this series lies mainly on the Kaibab Plateau, Coconino Plateau, Mogollon Rim, and outlying ranges such as the Bradshaws and the Hualapai Mountains at elevations between 2,130 and 2,680 m.

Physiognomy: Forest of evergreen needleleaf mesophanerophytes with oval crowns born on unbranched stems. In youth the trees are conical crowned but gradually broaden with age. Broadleaf deciduous mesophanerophytes occur individually and in scattered patches. Understory shrubs are deciduous spinose pinnate leguminous or broadleaf deciduous microphanerophytes and nanophanerophytes or broadleaf sclerophyll nanophanerophytes in woodland stands. Needleleaf microphanerophytes may be present where xeric conditions prevent development of a closed tree canopy. Tree cover is 40% but often 70% in favorable habitats. Understory cover is variable and sometimes nearly absent. Herbaceous cover is often of perennial graminoids, but annual plants become more predominant following overgrazing.

This series is formed of stands whose composition and spacing are maintained by ground fire. Where ground fire is excluded shade tolerant, thin-barked tree species with conical crowns, such as white fir and Douglas-fir, become significant components. Total cover ranges from 25% in the cinder fields around the San Francisco Peaks to 70% in more typically mesic habitats. More mesic conditions and absence of fire favor closed stands (80% or more total cover).

Floristics: *Pinus ponderosa* (Ponderosa pine) is the dominant tree. Within burn mosaics aspen may be codominant. *Juniperus osteosperma* (Utah juniper), *Abies concolor* (White fir), *Pseudotsuga menziesii* (Douglas-fir), *Quercus gambelii* (Gambel oak), *Robinia neomexicana* (New Mexico locust), *Symphoricarpos* spp. (snowberry), *Arctostaphylos pungens* (Pointleaf manzanita), and *Ribes* (gooseberry) are common woody species. Grasses and sedges are common in open stands.

Diagnostic characters: Ponderosa pine is always present and prominent in the tree layer. *Pinus arizonica* (Arizona pine) and *Pinus engelmannii* (Apache pine) are 2 species

in the Madrean Biome that can be confused with ponderosa pine and may occur in the same stands. *Pinus aristata* (Bristlecone pine), *Pinus flexilis* (limber pine), and *Pinus strobiformis* (Mexican white pine) occur in ponderosa pine stands. When these species predominate the stand should be classified accordingly and not forced into a ponderosa pine association.

Dominance type examples:

Pinus ponderosa Association (1122.k0a1a0--)
Pinus ponderosa—Mixed Conifer Association (1122.k0a1a1--)
Pinus ponderosa—*Quercus gambelii* Association (1122.k0a1a2--)
Pinus ponderosa—*Quercus arizonica* Association (1122.k0a1a3--)
Pinus ponderosa—*Juniperus deppeana* Association (1122.k0a1a4--)
Pinus ponderosa—*Populus tremuloides* Association (1122.k0a1a5--)
Pinus ponderosa—*Picea engelmannii* Association (1122.k0a1a6--)
Pinus ponderosa—*Abies concolor* Association (1122.k0a1a8--)
Pinus ponderosa—*Pinus leiophylla* Association (1122.k0a1b0)
Quercus gambelii Association (1122.k0a2a1--)

FGDC '96 type: Closed rounded-crown temperate or subpolar needle-leaved evergreen forest/Open rounded-crown temperate or subpolar needle-leaved evergreen woodland.
 Code: IA8b/IIA4a

NVCS (USGS-NPS-TNC) type: Needle-leaved evergreen forest with rounded crowns/Needle-leaved evergreen woodland with rounded crowns. Code: I.A.9.b/II.A.2.a.

Pinus ponderosa Forest Alliance
Pinus ponderosa—*Pseudotsuga menziesii* Forest Alliance

References:

Alexander, B. G., F. Ronco Jr., E. L. Fitzhugh, and J. A. Ludwig. 1984.
 Brown, D. E., C. H. Lowe, and C. H. Pase. 1979.
 Brown, D. E., C. H. Lowe, and C. H. Pase. 1980.
 Develice, R. L., J. A. Ludwig, W. H. Moir, and F. Ronco Jr. 1986.
 Fitzhugh, E. L.; W. H. Moir, J. A. Ludwig, and F. Ronco Jr. 1987.
 Larson, M. and W. H. Moir. 1987.
 Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.
 Youngblood, A. P. and R. L. Mauk. 1885.

Great Basin Conifer Woodland: Pinyon—Juniper

Nearctic Upland, Cold Temperate Forest and Woodland, Great Basin Conifer Woodland, Pinyon—Juniper Series (1122.10a0----)

Distribution: Elevation range is between 1,220 and 2,130 m. Wide ecological amplitude of the dominant tree species and high diversity permits this series to develop on a wide variety of sites. Sites range from slick rock, to gravelly shallow soils, to steep slopes. The soils are always well-drained and are usually shallow and not acidic. Fuel loading is generally too light to carry ground fire. Although these communities do burn, high winds are necessary to carry the flames from plant to plant.

“Pinyon pines” and “junipers” inhabit various biomes. When pinyon—juniper vegetation is mentioned, the Great Basin Conifer Biome is intended.

The Pinyon—Juniper Series is bounded at higher elevations by the Pine Series (1122.k0a1----) and at lower elevations by the Mogollon Chaparral, notably the Mountain Mahogany Series (1133.q0a3----), Scrub Oak Series (1133.q0a0----), or the Great Basin Desertscrub Sagebrush Series (1152.10a0----). In localities adjacent to the Mohavian Biome, Blackbrush Series (1152.10a2----) may also be a boundary.

The analysis of pinyon—juniper community distribution in Arizona is complicated by taxonomic uncertainty of the pinyon pines (Malusa 1992). We take the position that there are only 4 species of pinyon in Arizona: Rocky Mountain pinyon (*Pinus edulis edulis*), singleleaf Rocky Mountain pinyon (*P. edulis fallax*), singleleaf pinyon (*P. monophylla*), and the Mexican pinyon (*Pinus discolor*) as published by Kartesz (1994). The last 2 belong in the Mohave Desert Biome and the Madrean Biome respectively and need not be further discussed here.

Within the Great Basin Biome *P. edulis edulis* is almost completely restricted to the Colorado Plateau. *Pinus edulis fallax* is diagonally distributed from Oatman in the southern portion of the Black Mountains southeasterly toward Clifton in a band between the Mogollon Rim and chaparral and desert communities. *Pinus monophylla* is confined to a stand in the Black Mountains and appears more extensively in the Virgin Mountains. The Pinyon—Juniper Series is largely confined to the Kaibab, Coconino, and Kaibito Plateaus (among others), and at suitable elevations along the Mogollon Rim.

Physiognomy: Evergreen needleleaf woodland of mesophanerophyte or microphanerophyte trees. Tree crowns are round to oval in shape. Trunks may be nearly unbranched or formed from a forked trunk. Even moderate snow loading breaks down broad-crowned trees, but oval-shaped crowns are more resistant to damage. Tree heights are between 4.6 and 9.2 m. The understory of these communities is composed of sclerophyllous evergreen, or gray-green evergreen shrubs 0.9–1.8 m in height. Half-shrubs are present and important on more xeric sites. Perennial grasses are not prominent. Total cover ranges between 10 and 50%.

Floristics: *Pinus edulis edulis*, *P. edulis fallax*, *P. monophylla*, *Juniperus osteosperma*, *J. monosperma*, *J. deppeana*, *J. scopulorum*, and *J. erythrocarpa* dominate the

community. The pines are codominant and unlike the junipers, rarely, if ever, form pure stands. Other species characteristic of the Pinyon—Juniper are *Quercus turbinella*, *Q. x pauciloba*, *Ephedra viridis*, *Ceanothus intricatus*, *Gutierrezia sarothrae*, *Cercocarpus greggii*, *Yucca baccata*, *Artemisia tridentata*, *Purshia mexicana*, and *Bouteloua gracilis*.

Dominance type examples:

Pinus edulis—*Juniperus scopulorum* Association (1122.10a0a0--)
Pinus edulis Association (1122.10a0a1--)
Juniperus scopulorum Association (1122.10a0a2--)
Juniperus monosperma Association (1122.10a0a3--)
Pinus monophylla—*Juniperus osteosperma* Association (1122.10a0a4--)
Pinus edulis—*Juniperus osteosperma* Association (1122.10a0a5--)
Pinus monophylla Association (1122.10a0a6--)
Juniperus osteosperma Association (1122.10a0a7--)
Pinus monophylla—*Juniperus californica* Association (1122.10a0a8--)
Juniperus californica Association (1122.10a0a9--)
Pinus edulis—*Juniperus deppeana* Association (1122.10a0b3--)
Pinus edulis—*Juniperus monosperma* Association (1122.10a0b4--)
Juniperus monosperma—*Juniperus osteosperma* Association (1122.10a0b5--)
Pinus edulis—Mixed Oaks—Mixed Junipers Association (1122.10a0b6--)
Pinus edulis fallax—*Juniperus deppeana* Association (1122.10a0b7--)
Pinus edulis fallax—*Quercus turbinella* Association (1122.10a0b8--)
Pinus edulis fallax—*Juniperus californica* Association (1122.10a0b9--)
Pinus edulis fallax—*Juniperus osteosperma* Association (1122.10a0c0--)

FGDC '96 type: Rounded-crowned temperate or subpolar needle-leaved evergreen forest and rounded-crowned temperate or subpolar needle-leaved evergreen woodland. Code: IA8b/IIA4a

NVCS (USGS-NPS-TNC) type: Needle-leaved evergreen woodland with rounded crowns. Code: II.A.2.a

Juniperus deppeana Woodland Alliance
Juniperus erythrocarpa Woodland Alliance
Juniperus monosperma Woodland Alliance
Juniperus occidentalis Woodland Alliance
Juniperus osteosperma Woodland Alliance
Juniperus scopulorum Woodland Alliance
Pinus discolor Woodland Alliance
Pinus edulis Woodland Alliance
Pinus engelmannii Woodland Alliance
Pinus leiophylla Woodland Alliance
Pinus monophylla Woodland Alliance
Pinus ponderosa Woodland Alliance
Pinus ponderosa—*Quercus garryana* Woodland Alliance

References:

Brown, D. E., C. H. Lowe and C. P. Pase. 1979.
 Kartesz, J. T. 1994.

Larson, M. and W. H. Moir. 1987.

Malusa, J. 1992.

Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.

Madrean Montane Conifer Forest: Douglas-fir—Mixed Conifer

Nearctic Upland, Cold Temperate Forest and Woodland, Rocky Mountain Montane Conifer Forest, Douglas-fir—Mixed Conifer Series (1122.t0a0----)

Distribution: On mesic sites between 1,830 and 2,680 m but may extend downward on cool slopes and in mesic canyons. These communities are shaped to a significant extent by forest fires. The presence of aspen, oaks, and manzanita are indicators of past burning. The Madrean Douglas-fir—Mixed Conifer Series occurs at the higher elevations of the Chiricahua, Huachuca, and Pinaleno mountains.

Physiognomy: Predominantly evergreen needle-leaved forest of mesophanerophytes with spire-shaped crowns supported by a straight unbranched trunk. Occasional patches of broadleaf deciduous mesophanerophytes are encountered but they are rarely extensive. Understory shrubs are deciduous spinose pinnate leguminous or broadleaf deciduous microphanerophytes and nanophanerophytes. Tree cover is at least 50% but often 80% in favorable habitats. Development of the shrub layer is inhibited by shading from the normally dense overstory and is usually less than 30%. Perennial forbs are widely scattered and not more than 10% cover and usually much less. Total cover is 60% (greater in favorable habitats).

Floristics: *Pseudotsuga menziesii* (Douglas-fir), *Abies concolor* (White fir), *Robinia neomexicana* (New Mexico locust), *Acer grandidentatum* (Bigtooth maple), and *Pinus strobiformis* (Mexican white pine) are the most important species in mature stands. *Pinus arizonica* (Arizona pine), *Quercus gambelii* (Gambel oak), *Q. hypoleuroides* (silverleaf oak), *Ptelea trifoliata* (bracken fern), *Populus tremuloides* (aspen), *Arctostaphylos pungens* (pointleaf manzanita) are present in seral stands. In the Chiricahua Mountains, Engelmann spruce reaches southern limit.

Diagnostic characteristics: This series seldom forms monospecific stands. Douglas-fir generally predominates with lesser amounts of white fir and aspen present.

Dominance type examples:

Pseudotsuga menziesii (1122.t0a0a0--)

Pseudotsuga menziesii—*Quercus hypoleuroides*—*Pinus arizonica* (1122.t0a0a0a0)

Pseudotsuga menziesii—*Quercus hypoleuroides*—*Pinus leiophylla* (1122.t0a0a0a1)

Pseudotsuga menziesii—*Quercus hypoleuroides*—*Quercus rugosa*—*Quercus arizonica* (1122.t0a0a0a2)

Pseudotsuga menziesii—*Pinus strobiformis*—*Acer glabrum*—*Pinus arizonica*,
et al. (1122.t0a0a1--)

Pseudotsuga menziesii—*Abies concolor*—*Pinus strobiformis*—*Pinus arizonica*—
Quercus gambelii (1122.t0a0a1a0)

Pseudotsuga menziesii—*Pinus strobiformis*—*Pinus arizonica*—*Quercus gambelii*—
Muhlenbergia virescens (1122.t0a0a1a1)

Pseudotsuga menziesii—*Abies concolor*—*Pinus strobiformis*—*Pinus arizonica*—
Mahonia repens (1122.t0a0a1a2)

Pseudotsuga menziesii—*Abies concolor*—*Pinus strobiformis*—*Pinus arizonica*—*Carex foenea* (1122.t0a0a1a3)

Pseudotsuga menziesii—*Acer grandidentatum*—*Pinus discolor* (1122.t0a0a2--)

Pseudotsuga menziesii—*Pinus strobiformis*—Grass (1122.t0a0a3--)

FGDC '96 type: Rounded-crown temperate or subpolar needle-leaved evergreen forest, and rounded-crown temperate or subpolar needle-leaved evergreen. Code: IA8c/IIA4b

NVCS (USGS-NPS-TNC) type: Needle-leaved evergreen woodland with conical crowns. Code: II.A.2.b

Abies concolor Woodland Alliance

Picea engelmannii Woodland Alliance

Picea pungens Woodland Alliance

Pseudotsuga menziesii Woodland Alliance

References:

Bassett, D, M. Larson, and W. Moir. 1987.

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Leithliter, J. R. 1980.

Moir, W. H. and M. Dodd. 1973.

Pase, C. P. and D. E. Brown. 1982b.

Madrean Montane Conifer Forest: Pine

Nearctic Upland, Cold Temperate Forest and Woodland, Madrean Montane Conifer Forest, Pine Series (1122.t0a1---)

Distribution: The Pine Series forest is the highest elevation vegetation type with undoubted Madrean affinities. The community occurs at elevations between 2,130 and 2,590 m on the ranges comprising the Madrean Archipelago, i.e., Chiricahua, Huachuca, Pinaleno, Santa Catalina, and Santa Rita Mountains. The Pine Series, and the Nearctic Upland Cold Temperate Forest and Woodland Rocky Mountain Montane Conifer Forest, and Douglas-fir-Mixed Conifer Series (1121.k0a0---) lie in the same elevation band and receive similar amounts of precipitation. For the purpose of the GAP project, we will consider the Rocky Mountain and the Madrean Douglas-fir—Mixed Conifer Series to be synonymous. The Pine Series communities develop on warmer, less protected west-, south-, and southwest-facing slopes, or flats. This series abuts the Spruce-Fir Series upslope and the Madrean Oak-Pine Series (1123.t0a0---) below. These forests burn periodically, killing less fire tolerant trees from the adjacent communities, particularly the Mixed Conifer Series.

Physiognomy: Evergreen needleleaf forest of oval-crowned trees with single straight trunks adapted for shedding moderate snow loads. The dominant pines are evenly distributed. Broadleaf deciduous trees are usually present. The pines are 15–27-m high in favorable habitats and shorter (12–18 m) elsewhere. Total cover is 60–85%.

Floristics: There are 3 pines within the Ponderosa complex (*Pinus arizonica*, *Pinus ponderosa* var. *scopulorum*, *P. engelmannii*). These pines appear to form hybrids with characteristics of all 3 parent species. Possible hybrids occur around 2,134-m elevation. Commonly encountered understory trees are *Quercus hypoleucoides*, *Q. arizonica*, *Q. rugosa*, *Q. gambelii*, *Pinus discolor*, and *Juniperus deppeana*. Abundance and composition of the shrub layer depends on recent fire history. *Robinea neomexicana*, *Ceanothus fendleri*, *Rubus neomexicanus*, *Lonicera arizonica*, and *Sambucus cerulea* are commonly found. *Antennaria parvifolia*, *Tradescantia pinetorum*, *Senecio bigelovii*, *S. wootonii*, *Geranium richardsonii*, *Elymus trachycaulus*, *Koeleria macrantha*, *Muhlenbergia longiligula*, *M. montana*, and *M. virescens* are frequently encountered herbs.

Diagnostic characters: *Pinus arizonica* (Arizona pine) always present and in addition, hybrids between this pine and *Pinus engelmannii* (Apache pine) may also be present.

Dominance type examples:

Pinus arizonica Association (1122.t0a1a2--)

Pinus arizonica—Mixed Conifer Association (1122.t0a1a3--)

Pinus arizonica—*Juniperus deppeana* Association (1122.t0a1a4--)

Pinus arizonica—spp. Association (1122.t0a1a5--)

Pinus strobiformis Association (1122.t0a1a6--)

Pinus arizonica—*Quercus hypoleucoides* Association (1122.t0a1a6a1)

FGDC '96 type: Rounded-crowned temperate or subpolar needle-leaved evergreen forest. Code: IA8b/IIA4a

NVCS (USGS-NPS-TNC) type: Needle-leaved evergreen forest/Needle-leaved evergreen woodland with rounded crowns. Code: I.A.9.b/II.A.2.a

Pinus leiophylla Woodland Alliance
Pinus monophylla Woodland Alliance
Pinus ponderosa Woodland Alliance
Juniperus deppeana Woodland Alliance
Juniperus erythrocarpa Woodland Alliance
Juniperus monosperma Woodland Alliance
Juniperus occidentalis Woodland Alliance
Juniperus osteosperma Woodland Alliance
Juniperus scopulorum Woodland Alliance
Pinus aristata Woodland Alliance
Pinus discolor Woodland Alliance
Pinus edulis Woodland Alliance
Pinus engelmannii Woodland Alliance
Pinus flexilis Woodland Alliance
Pinus ponderosa—Quercus garryana Woodland Alliance.

References:

Bassett, D, M. Larson, and W. Moir. 1987.
Brown, D. E., C. H. Lowe and C. P. Pase. 1979.
Leithliter, J. R. 1980.
Moir, W. H. and M. Dodd. 1973.
Pase, C. P. and D. E. Brown. 1982a.

Madrean Evergreen Forest: Oak—Pine

Nearctic Upland, Warm Temperate Madrean Evergreen Forest Woodland, Oak—Pine Series (1123.t0a0----)

Distribution: This series lies between about 1,680 and 2,290-m elevation on gently to moderately steep slopes. Soils are deep and well-drained, and derived from volcanic substrates.

The Oak-Pine Series lies in contact with the Encinal Series (1123.t0a1----) below, and the Pine Series (1122.t0a1----) above. Below, it tongues downslope in cool canyons descending to where it lies between the encinal upslope and the Interior Southwestern Riparian Deciduous Forest and Woodland (1223.q0a----). Winter temperatures are mild and snowfall is light.

Physiognomy: Evergreen broadleaf short-tree forest and woodland with evergreen oval-crowned needleleaf conifers. Four vegetation layers are apparent (dominant tree, subdominant tree, shrub, and herb). The dominant trees are pines with crowns 12–24-m tall at maturity. Subdominant trees are oaks, pinyons, and junipers 6–15-m tall when mature. Nowhere do the dominant trees form a closed canopy. The subdominant layer is also usually open. Species diversity is high.

Floristics: The dominant tree is *Pinus leiophylla* with *Pinus engelmannii* being less common. Crowns are 12–24-m tall at maturity. Subdominant trees are *Quercus hypoleuroides*, *Q. arizonica*, *Arbutus arizonica*, *Juniperus deppeana*, and *Pinus discolor*. Typical shrubs are *Nolina microcarpa*, *Rhus aromatica*, *Arctostaphylos pungens*, *Vitis arizonica*, *Yucca schottii*, *Garrya wrightii*, *Frangula betulifolia*, *Prunus serotina* ssp. *rufula*, and *Ceanothus fendleri*. *Muhlenbergia longiligula*, *M. emersleyi*, *Aristida orcuttiana*, and *Piptochaetium fimbriatum* are all common grasses. Some prominent forbs are *Hedeoma hyssopifolia*, *Senecio neomexicanus*, *Brickellia lemmonii*, *Echeandia flavescens*, *Clitoria mariana*, *Tradescantia pinetorum*, *Phaseolus grayanus*, and *P. parvulus*.

Diagnostic characters: *Pinus leiophylla* (Chihuahua pine) commonly, but not always, present. *Pinus engelmannii* (Apache pine) present in more mesic communities. These pines are accompanied by *Quercus hypoleuroides* (silverleaf oak) and *Q. rugosa* (netleaf oak). On the San Carlos Reservation in central Arizona, there is a stand with *P. ponderosa* (Ponderosa pine) mixed with *P. leiophylla* but this is apparently a rarity.

Dominance type examples:

Quercus arizonica—*Quercus rugosa* Association (1123.t0a0a1a2)

Quercus arizonica—*Quercus rugosa*-*Pinus leiophylla* Subassociation
(1123.t0a0a1a0)

Quercus spp.—*Pinus leiophylla* Association (1123.t0a0a1--)

Quercus spp.—*Pinus engelmannii* Association (1123.t0a0a2--)

Quercus spp.—*Pinus* spp. Association (1123.t0a0a3--)

Quercus turbinella—*Pinus edulis fallax* Association (1123.t0a0a5--)

Pinus cembroides—*Pinus edulis*—Mixed Oak—Mixed Juniper Association
(1123.t0a0a6--)

Pinus cembroides—*Juniperus deppeana*—Mixed Oak Association
(1123.t0a0a7--)

FGDC '96 type: Mixed needle-leaved evergreen—cold-deciduous forest, and mixed needle-leaved evergreen—cold-deciduous woodland. Code: IC3a/IIC3a¹

NVCS (USGS-NPS-TNC) type: Broad-leaved evergreen woodland/Needle-leaved evergreen woodland with rounded crowns. Code: II.A.1.a /II.A.2.a

Juniperus deppeana Woodland Alliance
Juniperus erythrocarpa Woodland Alliance
Juniperus monosperma Woodland Alliance
Juniperus osteosperma Woodland Alliance
Juniperus scopulorum Woodland Alliance
Pinus discolor Woodland Alliance
Pinus edulis Woodland Alliance
Pinus engelmannii Woodland Alliance
Pinus flexilis Woodland Alliance
Pinus leiophylla Woodland Alliance
Pinus monophylla Woodland Alliance
Pinus ponderosa Woodland Alliance
Pinus ponderosa—*Quercus garryana* Woodland Alliance
Quercus arizonica Woodland Alliance
Quercus emoryi Woodland Alliance
Quercus grisea Woodland Alliance

References:

Bassett, D, M. Larson, and W. Moir. 1987.
 Brown, D. E. 1982.
 Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.
 Moir, W. H. and M. Dodd. 1973.

¹These 2 FGDC '96 classifications are not very satisfactory since the broad-leaf species are live oaks, and no provision is made for mixed evergreen communities.

Madrean Evergreen Forest: Encinal

Nearctic Upland, Warm Temperate Madrean Evergreen Forest and Woodland, Encinal (Oak) Series (1123.t0a1----

Distribution: “Encinal” is derived from the Spanish *encino* = live-oaks + *al* = place of (Brown 1982a). Encinal vegetation develops in the Madrean Archipelago between 1,370 and 1,830-m elevation. This series is the most characteristic and widespread of the Madrean woodland vegetation types in the Madrean Archipelago.

The Oak-Pine Woodland (1123.t0a0----) abuts this series above and the Scrub-Grassland (Semi-desert) (1143.z0a5----) below. Encinal vegetation often forms an ecotone several kilometers wide with the Scrub-Grassland (Semi-desert) and is especially species-rich in that circumstance. Contact with Desert Grassland is apparently controlled by soil depth and type. The encinal occupies thin coarse-textured soils, while the grassland is found on deeper, finer soils.

Physiognomy: Evergreen broadleaf sclerophyll forest and woodland with open understory of shrubs and herbs. At lower elevations the encinal tree layer is open to very open with a herbaceous understory of grasses and low shrubs. At higher elevations the tree layer becomes nearly closed and a layer of shrubs may appear. The herbaceous layer, though generally present, is better developed where there is less overstory. Encinal trees are usually less (often much less) than 9-m high.

Floristics: Five trees occur in variable proportions in the encinal. They are *Quercus emoryi* and *Q. arizonica* (most important in the lower encinal), and *Q. hypoleucoides* and *Q. rugosa* (more important at higher elevations). *Juniperus deppeana*, *J. erythrocarpa*, and *Pinus discolor* (in order of decreasing importance) are also found in the tree layer. Oak-juniper or juniper-pine woodlands form nearly pure stands in patches, obscuring their evolutionary and distributional relationship within the Madrean Encinal. Where oaks are locally absent because environmental factors are unsuitable, overall habitat remains encinal (although one composed of accessory species).

Shrubs are not always present, but some commonly found shrubs include *Nolina microcarpa*, *Garrya wrightii*, *Rhus aromatica*, *Mimosa aculeaticarpa* var. *biuncifera*, *Dasyllirion wheeleri*, *Agave palmeri*, *Ericameria laricifolia*, *Quercus toumeyii*, *Q. turbinella*, and *Opuntia spinosior*.

Herbaceous plants, especially grasses, are abundant including grama (*Bouteloua gracilis*, *B. curtipendula*, *B. rothrockii*, *Muhlenbergia emersleyi*, *Aristida orcuttiana*, *Eragrostis intermedia*), and many others. Non-graminaceous herbs are *Astragalus nothoxys*, *Bouvardia ternifolia*, *Cheilanthes fendleri*, *Eriogonum wrightii*, *Gaillardia pinnatifida*, *Penstemon linarioides*, and *Verbena neomexicana*.

Diagnostic characteristics: One or more species of broad-leaved sclerophyll oaks present and important, i.e., *Quercus emoryi*, *Q. arizonica*, *Q. rugosa*, *Q. oblongifolia*, *Q. grisea*, and *Q. chrysolepis*. The scrub oaks *Quercus turbinella* and *Q. toumeyii* though they may be present are not abundant. These oaks share dominance with *Juniperus*

deppeana, *J. erythrocarpa*, and *Pinus discolor*. Even when both pinyon pines and junipers are present this community is not considered to be a “pinyon juniper woodland” which is a term more properly applied to the Great Basin woodlands composed of *Pinus edulis* var. *edulis*, *Juniperus osteosperma*, and *J. monosperma*.

Dominance type examples:

Mixed *Quercus* spp. (1123.t0a1a0--)
Quercus grisea Association (1123.t0a1a1--)
Quercus emoryi Association (1123.t0a1a2--)
Quercus arizonica Association (1123.t0a1a4--)
Quercus hypoleucoides Association (1123.t0a1a5--)
Quercus spp.—*Pinus discolor*—*Juniperus* spp. Association (1123.t0a1a6--)
Quercus oblongifolia Association (1123.t0a1b0--)
Quercus turbinella—Mixed Scrub Association (1123.t0a1a9--)
Pinus discolor Association (1123.t0a1a7--)
Juniperus deppeana Association (1123.t0a1a8--)
Juniperus osteosperma—*Juniperus erythrocarpa* Association (1123.t0a1b1--)
Juniperus erythrocarpa Association (1123.t0a1b2--)
Juniperus erythrocarpa—*Quercus turbinella* Association (1123.t0a1b3--)
Juniperus deppeana—*Pinus edulis fallax*—Mixed Oaks Association (1123.t0a1b4--)
Mixed Oak—*Pinus edulis fallax* Association (1123.t0a1b5--)

FGDC ‘96 type: Temperate submontane broad-leaved seasonal evergreen closed seasonal evergreen closed tree canopy (mainly broad-leaved evergreen with some foliage reduction in the dry season)/Temperate submontane broad-leaved evergreen open woodland. Code: IA3b/IIA2a

NVCS (USGS-NPS-TNC) type: Broad-leaved evergreen woodland/Needle-leaved evergreen woodland with rounded crowns. Code: I.A.2.b²/II.A.1.a³

Juniperus deppeana Woodland Alliance
Juniperus erythrocarpa Woodland Alliance
Quercus arizonica Woodland Alliance
Quercus emoryi Woodland Alliance
Quercus grisea Woodland Alliance

References:

Bassett, D, M. Larson, and W. Moir. 1987.
Brown, D. E. 1982a.
Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.
Moir, W. H. and M. Dodd. 1973.

² Dense phases of the encinal would seem to fall here but is not presented as an example in the classification.

³ The encinal usually includes junipers and pinyon (usually *Pinus discolor*). These conifers occasionally form small nearly pure patches but should not be classified as a different series because of their limited extent and seral nature.

Relict Conifer Forest: Cypress

Nearctic Upland, Warm Temperate Relict Forest and Woodland, Cypress Series (1123.y0a1----)

Distribution: These forests and woodlands are restricted to small groves at mid-elevation where winter temperatures are mild and summer temperatures are moderate. The fossil record indicates that this vegetation was widespread before the Pleistocene but subsequent decreasing minimum temperatures and increasing aridity reduced their distribution to the most favorable temperate habitats where they persist as relicts. This series is distributed between elevations of 460 and 2,130 m in the Chiricahua, Huachuca, Dragoon, Pinaleno, Rincon, Santa Catalina, and Sierra Ancha Mountains and other uplands of the Madrean Archipelago. The Cypress Series is also found in the foothills of the Bradshaws and other mountains of Pinal, Yavapai, and Gila Counties.

Relict Cypress Series generally occurs in patches within the Interior Chaparral, Madrean Encinal, and mesoriparian communities such as the Interior Southwestern Riparian Deciduous Forest and Woodland: Mixed Broadleaf Series (1223.q0a1----).

Physiognomy: Evergreen scaleleaf forests and woodlands with evergreen sclerophyll broadleaf short tree understories. Chaparral species and grasses may be present and appear to be successional.

Floristics: The community is dominated by *Cupressus arizonica* in southeastern Arizona or *C. a. var. glabra* in the north. Common accessory species are *Juniperus deppeana*, *Pseudotsuga menziesii*, *Quercus hypoleucoides*, *Q. rugosa*, *Berberis* spp., *Calliandra eriophylla*, *Rhus trilobata*, and *Juglans major*. *Pinus discolor*, *Arctostaphylos pungens*, *Quercus turbinella*, *Ceanothus greggii*, and *Nolina microcarpa* are successional following disturbance or fire. *Bouteloua curtipendula*, *Poa fendleriana*, *Koeleria macrantha*, *Stipa* spp., *Elymus elymoides*, *Muhlenbergia longiligula*, and *Senecio neomexicanus* are common herbs.

Diagnostic characteristics: *Cupressus arizonica* must be dominant. *Pseudotsuga menziesii* and *Pinus ponderosa* may be present but not dominant. The cypress occurs as an accessory species in many upland communities and even riparian communities—its mere presence does not define the type.

Dominance type examples:

Cupressus arizonica Association (1123.y0a1a0--)

FGDC '96 type: Conical-crowned tropical or subtropical needle-leaved evergreen, temperate evergreen forest with closed tree canopy/IIA3a tropical or subtropical needle-leaved evergreen temperate open tree layer woodland. Code: IA8c/IIA4b

NVCS (USGS-NPS-TNC) type: Needle-leaved evergreen forest with conical crowns.

Code: I.A.9.c⁴

Cupressus arizonica Forest Alliance

References:

Bassett, D, M. Larson, and W. Moir. 1987.

Brown, D. E. 1982b.

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

⁴ Forest-like stand density is usually found where Arizona cypress occurs in nearly pure stands, however, mixed stands are more usual and closed forests are unusual.

Mogollon Chaparral Scrubland: Manzanita

Nearctic Upland, Warm Temperate Scrubland, Mogollon Chaparral, Manzanita Series (1133.q0a1----)

Distribution: Widely distributed between 1,250 and 2,590-m elevation. It occurs on non-calcareous soils from Grand Canyon National Park in northwest Arizona to the Chiricahua Mountains in the southeast. The series abuts the Encinal (1123.t0a1----) or Pinyon-Juniper Series (1123.i0a0----).

The Manzanita Series is successional, often forming extensive, nearly pure, stands within Encinal and Pinyon-Juniper Woodland Associations. Such stands appear to be very slowly replaced with tree-dominated vegetation although manzanita remnants seem to never completely disappear.

Physiognomy: Unevenly distributed evergreen sclerophyll shrubs 0.9–1.8-m tall. Grasses usually present in openings between shrub clumps. Total vegetation cover is 50–80%.

Floristics: *Arctostaphylos patula*, *A. pringlei*, *A. pungens*, *A. uva-ursi* are the most prominent shrubs with *A. pungens* most usually found. *Quercus turbinella*, *Garrya flavescens*, *Glossopetalon spinescens* var. *nevadense*, *Cercocarpus montanus*, *Yucca baccata*, *Rhus trilobata*, and *Agave utahensis* are often present in small numbers. *Aristida purpurea* var. *fendleriana*, *A. orcuttiana*, *Bouteloua aristidoides*, *B. curtipendula*, and *Stipa neomexicana* are grasses commonly occurring in scrub openings.

Diagnostic characteristics: Manzanita, usually *Arctostaphylos pungens*, is dominant and tends to occur in nearly pure stands but may be mixed with other chaparral species such as *Quercus turbinella* and *Cercocarpus montanus*.

Dominance type examples:

- Arctostaphylos pringlei* Association (1133.q0a1a0--)
- Arctostaphylos pungens* Association (1133.q0a1a1--)

FGDC '96 type: Sclerophyllous temperate broad-leaved evergreen shrubland.
Code: IIIA2c

NVCS (USGS-NPS-TNC) type: Broad-leaved evergreen sclerophyllous shrubland/Temperate deciduous shrubland. Code: IV.A.1.d/IV.B.2.a

- Ambrosia deltoidea* Shrubland Alliance
- Arctostaphylos patula* Shrubland Alliance
- Arctostaphylos pungens* Shrubland Alliance
- Arctostaphylos viscida* Shrubland Alliance
- Cercocarpus ledifolius* Shrubland Alliance
- Quercus oblongifolia* Shrubland Alliance
- Quercus toumeyii* Shrubland Alliance

Quercus turbinella Shrubland Alliance
Simmondsia chinensis Shrubland Alliance
Ambrosia deltoidea Shrubland Alliance

References:

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.
Larson, M. and W. H. Moir. 1987.
Moir, W. and M. Dodd. 1973.
Pase, C.P. and Brown, D. E. 1982c.
Roseberry, R. D. and N. E. Dole. 1939.

Mogollon Chaparral Scrubland: Mixed Evergreen Sclerophyll

Nearctic Upland, Warm Temperate Scrubland, Mogollon Chaparral, Mixed Evergreen Sclerophyll Series (1133.q0a5----

Distribution: Widely distributed, occurring on non-calcareous soils from Grand Canyon National Park in northwest Arizona to the Chiricahua Mountains in the southeast. Elevation range is between 1,250 and 2,590 m. The series abuts the Encinal (1123.t0a1----) or Pinyon-Juniper Series (1123.10a0----). Particularly fine stands are found in the Bradshaw Mountains and associated ranges.

This series contains plants which rarely occur in pure stands. The *Ceanothus-Cercocarpus* elements appear to be favored in limestone-derived soils while the evergreen oak woodland is confined to rhyolite-derived soils.

Although this vegetation may be a fire disclimax, none of the inhabitants are particularly flammable. *Quercus toumeyi* responds to burning by crown sprouting and *Arctostaphylos*, *Ceanothus*, and *Cercocarpus* produce seed which seldom germinate without being fire scarified.

Physiognomy: Evergreen broadleaf sclerophyll scrub. These particular plants have limited amounts of oils and waxes (< 4.5%) and are thus less flammable than their more famous analogues in the California Chaparral. Where moisture permits and deep soils are present, dense scrub typically covers 70–85% of the ground.

Floristics: At least 3 broadleaf sclerophyll shrubs are codominant. Some common examples are: *Ceanothus greggii*, *C. fendleri*, *Arctostaphylos pungens*, *A. pringlei*, *Rhamnus crocea*, *Cercocarpus montanus*, *Ribes quercetorum*, *Quercus toumeyi*, *Q. turbinella*, *Celtis laevigata* var. *reticulata*, and *Purshia mexicana*. In addition, *Eriogonum wrightii*, *Mimosa aculeaticarpa* var. *biuncifera*, *Calliandra eriophylla*, *Fallugia paradoxa*, *Agave parryi*, and *Dasylirion wheeleri* are less important and present in various combinations. *Pinus discolor*, *Juniperus erythrocarpa*, and *Quercus emoryi* are found scattered on sites with better moisture but never dominate the landscape.

Beneath the dense canopy of mature vegetation, little herbaceous cover can be found. Where openings occur *Aristida purpurea* var. *fendleriana*, *A. orcuttiana*, *Bouteloua aristidoides*, *B. curtipendula*, and *Stipa neomexicana* are found. Ferns, particularly *Pellaea intermedia*, grow on sunny slopes in soil pockets. *Bromus rubens* and *B. tectorum* may form a patchy herb layer along with *Castilleja integra*, *Penstemon linarioides*, *Astragalus nuttallianus*, *A. nothoxys*, *A. wootonii*, and *Kallstroemia grandiflora* grow where light and space permit.

Diagnostic characteristics: This series is a catchall that gathers together the Arizona chaparral, other than those dominated by manzanita. Although the chaparral in Arizona forms a number of distinct communities, they are small, patchy, and fine-grained. Most are smaller in the minimum mapping unit of 40 ha and thus must be lumped.

Dominance type examples:

Quercus turbinella Association (1133.q0a0a0--)
Quercus turbinella-Arctostaphylos pungens Subassociations (1133.q0a0a0a0)
Quercus turbinella-Cercocarpus breviflorus Association (1133.q0q0a1--)
Quercus turbinella-Cercocarpus montanus glaber Association (1133.q0a0a2--)
Quercus turbinella-Mixed Sclerophyll Association (1133.q0a0a3--)
Quercus pungens Association (1133.q0a0a8--)
Quercus pungens-Mixed Sclerophyll Association (1133.q0a0a9--)
Quercus toumeyii Association (1133.q0a0b1--)
Quercus turbinella-Quercus toumeyii Association (1133.q0q0b2--)
Cercocarpus breviflorus Association (1133.q0a3a0--)
Cercocarpus montanus Association (1133.q0a3a1--)
Mixed Evergreen Sclerophyll Association (1133.q0a5a0--)
Ribes quercetorum-Ptelea trifoliata Mixed Scrub Association (1133.q0a5a1--)

FGDC '96 type: Sclerophyllous temperate broad-leaved evergreen shrubland.

Code: IIIA2c.

NVCS (USGS-NPS-TNC) type: Broad-leaved evergreen sclerophyllous shrubland.

Code: IV.A.1.d

Ambrosia deltoidea Shrubland Alliance
Cercocarpus ledifolius Shrubland Alliance
Quercus oblongifolia Shrubland Alliance
Quercus toumeyii Shrubland Alliance
Quercus turbinella Shrubland Alliance
Simmondsia chinensis Shrubland Alliance
Ambrosia deltoidea Shrubland Alliance
Arctostaphylos patula Shrubland Alliance
Arctostaphylos pungens Shrubland Alliance
Arctostaphylos viscida Shrubland Alliance

References:

Brown, D. E., C. H. Lowe, C. P. Pase. 1979.
Pase, C. P. and D. E. Brown. 1982c.
Roseberry, R. D. and N. E. Dole. 1939.
Warren, P. L., J. E. Bowers, B. D. Treadwell, and K. L. Reichhardt. 1980.
Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982

Plains Grassland: Mixed "Short Grass"

Nearctic Upland, Cold Temperate Grassland, Plains, (Mixed "Short Grass") Series (1142.j0a3----

Distribution: Found in northeastern Arizona at elevations above 1,520 m. This series is distinguished from the lower elevation and much warmer Scrub-Grassland series (1143.z0-----) by having invasions of short stature half-shrubs of equal stature to the grasses. The cool arid climate and poor soils have created an open vegetation that is not typical of grasslands. This vegetation is often adjacent to and mixes with the Cold Temperate Grassland, Plains, Shrub Grass Disclimax Series (1142.j0a4). The Mixed "Short Grass" series is distinguished from the disclimax type by having fewer disturbance "increasers" (plants that become more numerous with grazing or browsing) such as *Gutierrezia sarothrae*, *Bromus tectorum*, and *B. rubens*.

Physiognomy: Very open stand of short bunch-grasses with scattered half-shrubs and tall grasses. Many of the half-shrubs are gray-green evergreen xeromorphs. Occasional clumps of tall coarse bunch-grasses are found in places with better moisture. The vegetation is uniformly tall (< 0.6 m) except for scattered taller shrub clumps. Total cover is 5–15%.

Floristics: *Bouteloua gracilis*, *B. curtipendula*, *B. hirsuta*, *Buchloe dactyloides*, and *Eragrostis intermedia* are common short grasses, and *Sporobolus airoides*, *Hilaria jamesii* and *Stipa comata* are taller grasses growing on more moist soils. Common half-shrubs are *Artemisia tridentata*, *A. filifolia*, *Purshia tridentata*, *Chrysothamnus nauseosus*, *C. viscidiflorus*, yuccas, and cacti.

Dominance type examples:

Bouteloua gracilis—Mixed "Short Grass" Association (1142.j0a3a0--)

FGDC '96 type: Short sod temperate or subpolar grassland (including sod or mixed sod-bunch graminoids. Code: VA5e

NVCS (USGS-NPS-TNC) type: Dense short grassland (> 60% cover) (including sod or mixed sod-bunch graminoids, e.g., short grass prairie)/Open short grassland (< 60% cover, including sod or mixed sod-bunch graminoids)/ Short bunch grassland. Code: VIII.C.2.a/VIII.C.2.b/VIII.C.2.c

Bouteloua gracilis—*Buchloe dactyloides* Herbaceous Alliance

Elymus trachycaulus—*Festuca rubra*—*Koeleria macrantha* Herbaceous Alliance

Bouteloua eriopoda Herbaceous Alliance

Bouteloua gracilis Herbaceous Alliance

Bouteloua hirsuta Herbaceous Alliance

Carex douglasii Herbaceous Alliance

Hilaria jamesii Herbaceous Alliance

Muhlenbergia filiculmis Herbaceous Alliance

Poa secunda Herbaceous Alliance

Danthonia intermedia Herbaceous Alliance
Puccinellia nuttalliana Herbaceous Alliance
Bouteloua gracilis Herbaceous Alliance

References:

Brown, D. E. 1982d.
Brown, D. E., C. H. Lowe, and P. A. Pase. 1979.
Miller, D. A., D. A. Mouat, and B. D. Treadwell. 1977.
Sawyer, J. O. and T. Keeler-Woolf. 1995.

Plains Grassland: Shrub-Grass Disclimax

Nearctic Upland, Cold Temperate Grassland, Plains, (Shrub-Grass) Disclimax Series (1142.j0a4----)

Distribution: The Shrub-Grass Disclimax Series occurs in northeastern Arizona at elevations above 1,520 m. This series is distinguished from the lower elevation and much warmer Scrub-Grassland series (1143.z0-----) by having invasions of large-shrub monocultures and/or by short stature half-shrubs of stature equal to the grasses.

Physiognomy: Short bunch-grasses and half-shrubs in very open irregularly spaced stands. There are scattered patches of gray-green evergreen shrubs and tall coarse bunch-grasses in places with better moisture. The vegetation is uniformly tall (0.6 m) except for scattered taller shrub clumps. Total cover is 5–15%.

Floristics: *Bouteloua gracilis*, *B. curtipendula*, *B. hirsuta*, *Buchloe dactyloides*, and *Eragrostis intermedia* are common short grasses. *Hilaria jamesii* and *Stipa comata* are taller grasses growing on more moist soils. Common half-shrubs are *Gutierrezia sarothrae*, *Artemisia tridentata*, *A. filifolia*, yuccas, and cacti.

Dominance type example: *Gutierrezia sarothrae* Association (1142.j0a4a0--)

FGDC '96 type: Temperate or subpolar short grassland with a microphyllous dwarf-shrub layer. Code: VA8a.

NVCS (USGS-NPS-TNC) type: Deciduous subdesert with succulents/Facultatively drought-deciduous sparse dwarf-shrubland (herbaceous strata undefined)/Open short grassland (< 60% cover). Code: IV.C.3.a/VII.C.1.a/VIII.C.2.b

Bouteloua gracilis-*Buchloe dactyloides* Herbaceous Alliance

(*Agropyron caninum*)-*Festuca rubra*-(*Koeleria macrantha*) Herbaceous Alliance

Bouteloua eriopoda Herbaceous Alliance

Bouteloua gracilis Herbaceous Alliance

Bouteloua hirsuta Herbaceous Alliance

Carex douglasii Herbaceous Alliance

Hilaria jamesii Herbaceous Alliance

Muhlenbergia filiculmis Herbaceous Alliance

Poa secunda Herbaceous Alliance

Danthonia intermedia Herbaceous Alliance

Puccinellia nuttalliana Herbaceous Alliance

Bouteloua gracilis Herbaceous Alliance

Aloysia wrightii Shrubland Alliance

Atriplex confertifolia Shrubland Alliance

Ceratoides lanata Shrubland Alliance

Chrysothamnus nauseosus Shrubland Alliance

References:

Brown, D. E. 1982c.

Brown, D. E. 1982d.

Brown, D. E., C. H. Lowe, and P. A. Pase. 1979.

Miller, D. A., D. A. Mouat, and B. D. Treadwell. 1977.

Rocky Mountain Montane Grassland: Mixed Meadow

Nearctic Upland, Cold Temperate Grassland, Rocky Mountain Montane, Mixed Meadow (1142.k0a0----)

Distribution: These are the low elevation analogue of Nearctic Upland, Arctic-Boreal Grassland, Rocky Mountain Alpine-Subalpine, Bunch-grass Series (1141.k0a0----). They are widely scattered within the Rocky Mountain Montane Conifer Forest, Pine Series (1122.k0a1----) at elevations between 2,440 and 2,900 m. Although these meadows may become saturated after the spring thaw, they are not saturated during most of the growing season.

Physiognomy: Forbs and perennial grasses form mixed cover of uneven heights (0.3-0.9-m high). Total plant cover is 60–100%. Presence of significant amounts of annual grasses often indicates past and/or present over-grazing. Over-grazing usually results in lowering of soil moisture which permits invasion by shrubs and trees that may be present.

Floristics: The *Lupinus* spp., *Lathyrus* spp., *Helianthus* spp., *Aster* spp., *Penstemon* spp., *Solidago* spp., *Lotus* spp., *Astragalus* spp., *Vicia* spp., *Rudbeckia laciniata*, *Dugaldia hoopesii*, *Achillea millefolium* var. *occidentalis*, *Androsace septentrionalis*, *Bahia dissecta*, *Cerastium nutans*, *C. sordidum*, *Gentianella wislizeni*, *Helenia recurva*, *Linum lewisii*, *Oenothera elata* ssp. *hookeri*, *O. laciniata*, *Oxalis alpina*, *Potentilla hippiana*, *Senecio bigelovii*, *S. wootonii*, *Sisyrinchium longipes*, *Taraxacum laevigatum*, *Trifolium pinetorum*, and *Viola nephrophylla* are native members of the meadow flora. *Rumex orthoneurus*, one of the genuine plant rarities in the Chiricahua Mountains, also occurs in wet marshes of these meadows.

Important meadow grasses are: *Blepharoneuron tricholepis*, *Bromus marginatus*, *Festuca arizonica*, *Poa fendleriana*, *P. pratensis*, *Agrostis scabra*, *Bromus canadensis*, *B. frondosus*, *Koeleria macrantha*, and *Muhlenbergia montana*. Grass-like species are *Carex wootonii*, *Eleocharis montevidensis*, and *Juncus saximontanus*.

The ubiquitous presence of *Iris missouriensis* and *Pteridium aquilinum* indicate disturbance as do the naturalized *Taraxacum officinale*, *Erodium cicutarium*, and *Rumex acetosella*. Forbs are usually more abundant than are grasses, sedges, or spike-rushes.

Diagnostic characteristics: Sedges and rushes are not dominant. Forbs are usually codominant with grasses.

Dominance type example:

Mixed Forb-Grass Association (1142.k0a0a0----)

Pteridium aquilinum Association (1142.k0a2a1--)

FGDC '96 type: Short bunch temperate or subpolar grassland/Short alpine or sub-alpine sod grassland. Code: VA5f/VA5g

NVCS (USGS-NPS-TNC) type: Seasonally or temporarily flooded medium tall grassland/Alpine and subalpine meadows rich in forbs.

Code: VIII.B.2.d/VIII.B.2.e/VIII.C.2.d

Aristida longiseta Herbaceous Alliance
Bouteloua curtipendula Herbaceous Alliance
Carex aquatilis Herbaceous Alliance
Danthonia californica Herbaceous Alliance
Festuca arizonica Herbaceous Alliance
Festuca brachyphylla Herbaceous Alliance
Festuca idahoensis Herbaceous Alliance
Festuca thurberi Herbaceous Alliance
Hilaria mutica Herbaceous Alliance
Muhlenbergia emersleyi Herbaceous Alliance
Muhlenbergia montana Herbaceous Alliance
Oryzopsis hymenoides Herbaceous Alliance
Panicum bulbosum Herbaceous Alliance
Poa palustris Herbaceous Alliance
Pseudoroegneria spicata Herbaceous Alliance
Schizachyrium scoparium Herbaceous Alliance
Sporobolus airoides Herbaceous Alliance
Sporobolus flexuosus Herbaceous Alliance
Stipa comata Herbaceous Alliance
Stipa nelsonii Herbaceous Alliance
Stipa neomexicana Herbaceous Alliance

References:

Brown, D. E. 1982e.
 Brown, D. E., C. H. Lowe, and P. A. Pase. 1979.
 Brown, D. E., C. H. Lowe, and P. A. Pase. 1980.
 Leithliter, J. R. 1980.
 Russell, R. P., Jr. 1982.

Rocky Mountain Montane Grassland: Rush

Nearctic Upland, Cold Temperate Grassland, Rocky Mountain Montane, Rush Series (1142.k0a1----)

Distribution: These are the low elevation analogue of Arctic-Boreal Grassland, Rocky Mountain Alpine-Subalpine, Sedge-Forb-Grass Series (1141.k0a1----). They are widely scattered north of the Mogollon Rim in the Rocky Mountain Montane Conifer Forest, Pine Series (1122.k0a1----) at elevations between 1,830 and 2,680 m. Soil is poorly drained, saturated with moisture, and often kept wet by springs or cienegas.

Physiognomy: Closed stands of short (0.3–0.7m-high) perennial graminoids and forbs. Graminoids are aspect dominants. The meadows are usually scattered and isolated from one another.

Floristics: The species present vary from meadow to meadow. *Stipa lettermanii*, *Muhlenbergia montana*, *Elymus trachycaulus* ssp. *subsecundus*, *Phleum pratense*, *Poa pratensis*, *Dactylis glomerata*, *Carex athrostachya*, *C. lenticularis*, *C. microptera*, *C. rossii*, *Juncus balticus*, *J. drummondii*, and *J. interior* are typical graminoids. Frequently found forbs are *Lupinus hillii*, *Potentilla hippiana*, *Achillea millefolium* var. *occidentalis*, and *Delphinium scaposum*. Degraded meadows are often invaded by iris, specially *Iris missouriensis*. Species diversity is high.

Diagnostic characteristics: Sedges and rushes are dominant or codominant. Forbs, though present, are never codominant.

Dominance type example: Rush Association (1142.k0a0a1--)

FGDC '96 type: Rocky Mountain Montane Grassland (Mixed Meadow) Series.
Code: VA5k.

NVCS (USGS-NPS-TNC) type: Semi-permanently flooded medium tall grassland.
Code: VIII.B.2.e

Carex aquatilis Herbaceous Alliance

Festuca ovina Herbaceous Alliance

References:

Brown, D. E. 1982c and 1982e.

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Great Basin Scrub Grassland: Mixed Bunch-grass

Nearctic Upland, Cold Temperate Grassland, Great Basin Scrub, Mixed Bunch-grass Series (1142.10a1----)

Distribution: The Mixed Bunch-grass Series occurs in northwestern and northcentral Arizona at elevations between 1,520 and 2,290 m. The Great Basin grassland forms a wide ecotone with the Plains grassland represented to the east. Within Arizona, these 2 fasciations are mixed and difficult to separate. Grazing is widespread and pervasively influences grassland composition. Heavily grazed areas are subject to establishment of low palatability shrubs. The grasses are better adapted to fire than are invading shrubs. Heavy grazing reduces residual grass fuels and fire intensity. This permits shrub establishment. At higher elevations the grassland usually contacts Pinyon—Juniper Woodland (1122.10a0----) and less often the Rocky Mountain Montane Conifer Forest (1122.k0a1----). Low elevation contacts are with Scrub—Grassland (1143.z0a5----) or the Mogollon (Interior) Chaparral (1133.q0-----).

Physiognomy: Closed to very open stands of fibrous-rooted perennial bunch-grasses of varying heights. Where growing conditions are moderately good or better, these grasses form a soil protecting sod. Total graminoid cover is 15–80%. Shrubs and forbs are rare unless fire has been excluded or grazing has been intense. The appearance of abundant shrubs, forbs, and/or annual grasses indicates ecosystem degradation.

Floristics: Important grass species are *Bromus tectorum*, *Bouteloua gracilis*, *B. hirsuta*, *B. chondrosioides*, *B. curtipendula*, *B. eriopoda*, *Buchloe dactyloides*, *Hilaria jamesii*, *Eragrostis intermedia*, *Panicum obtusum*, *Sporobolus airoides*, *Koeleria macrantha*, *Oryzopsis hymenoides*, *Pascopyrum smithii*, and *Stipa comata*. *Atriplex tridentata*, *A. canescens*, and *Krascheninnikovia lanata* are important shrubs. *Artemisia tridentata*, saltbush (*Atriplex canescens*) and its gray-green evergreen allies (*Chrysothamnus nauseosus* and *Artemisia tridentata*) are found along with *Gutierrezia sarothrae* and occur on sodless degraded former grasslands.

Dominance type examples:

- Mixed Grass Association (1142.10a1a0--)
- Mixed Grass—*Atriplex tridentata* Association (1142.10a1a1--)
- Mixed Grass—*Chrysothamnus* spp. (1142.10a1a3--)
- Oryzopsis hymenoides* Association (1142.10a2a0--)
- Pascopyrum smithii*—Mixed scrub Association (1142.10a0a1--)
- Pascopyrum smithii*—*Artemisia tridentata* Association (1142.10a0a2--)

FGDC '96 type: Short temperate or subpolar grassland with microphyllous evergreen shrub layer. Code: VA7j.

NVCS (USGS-NPS-TNC) type: Open short grassland (< 60% cover including sod or mixed sod-bunch graminoids). Code: VIII.C.2.b

(Agropyron caninum)—Festuca rubra—(Koeleria macrantha) Herbaceous Alliance

Agropyron dasystachyum Herbaceous Alliance

Bouteloua eriopoda Herbaceous Alliance

Bouteloua gracilis Herbaceous Alliance

Bouteloua hirsuta Herbaceous Alliance

Carex douglasii Herbaceous Alliance

Hilaria jamesii Herbaceous Alliance

Muhlenbergia filiculmis Herbaceous Alliance

Poa secunda Herbaceous Alliance

Reference:

Brown, D. E. 1982d.

Sawyer, J. O. and T. Keeler-Woelf. 1995.

Great Basin Scrub Grassland: Sacaton

Nearctic Upland, Cold Temperate Grassland, Cold Temperate Great Basin Scrub, Sacaton Series (1142.10a3----)

Distribution: Closed to very open stands of tall fibrous-rooted perennial bunchgrasses of varying heights. Total graminoid cover is 15–80%. Found at elevations between 1,220 and 1,670 m. Shrubs and forbs are rare unless fire has been excluded or grazing has been intense. The appearance of shrubs, forbs, and/or annual grasses indicates ecosystem degradation.

Physiognomy: Open stands of tall perennial graminoids with scattered shrubs.

Floristics: *Sporobolus airoides*, *S. wrightii*, *Hilaria jamesii*, *Bouteloua gracilis*, *Artemisia tridentata*, *Atriplex canescens*, *Baccharis*, *Sphaeralcea* spp., and *Senecio* spp.

Dominance type examples:

- Sporobolus airoides* Association (1142.10a3a0--)
- Sporobolus airoides*—*Atriplex canescens* Association (1142.10a3a1--)
- Sporobolus airoides*—*Atriplex confertifolia* Association (1142.10a3a2--)
- Sporobolus airoides*—*Atriplex confertifolia*—*Bouteloua gracilis*—*Hilaria jamesii* Subassociation (1142.10a3a2a0)
- Sporobolus airoides*—*Atriplex jonesii* Association (1142.10a3a4)

FGDC '96 type: Short temperate or subpolar grassland with microphyllous evergreen shrub layer. Code: VA7j.

NVCS (USGS-NPS-TNC) type: Medium tall bunch grassland. Code: VIII.B.2.c

- Sporobolus airoides* Herbaceous Alliance
- Aristida longiseta* Herbaceous Alliance
- Bouteloua curtipendula* Herbaceous Alliance
- Festuca arizonica* Herbaceous Alliance
- Hilaria mutica* Herbaceous Alliance
- Muhlenbergia emersleyi* Herbaceous Alliance
- Stipa comata* Herbaceous Alliance

Reference:

Brown, D. E. 1982d.

Scrub–Grassland: Tobosa Grass—Scrub

Nearctic Upland, Warm Temperate Grassland, Scrub-Grassland (Semidesert), Tobosa Grass—Scrub Series (1143.z0a1----

Distribution: Distribution lies within a diagonal band from west-central to southeastern Arizona at elevations between 1,070 and 1,520 m on a variety of soils. The semidesert grassland adjoins the 3 Arizona desertscrubs (Chihuahuan, Sonoran, and Mohave) but has the greatest affinity with the Chihuahuan. Within Arizona, it contacts the Madrean Evergreen Woodland (1123.t0-----), Great Basin Conifer Woodland (1122.i0-----), or less commonly, the Interior Chaparral (1133.q0-----). Heavy grazing and fire exclusion have permitted proliferation of invasive shrubs and cacti.

Physiognomy: Open to closed stands of bunch-grasses interspersed with annual grasses, shrubs, and half-shrubs. Annual grasses are 0.3–0.6-m tall with shrubs to 3-m tall.

Floristics: *Hilaria mutica*, *H. belangeri*, *Bouteloua eriopoda*, *B. gracilis*, *B. curtipendula*, *Aristida* spp., *Buchloe dactyloides*, and *Eragrostis* spp. are most common grasses. *Prosopis glandulosa* var. *torreyana*, *Acacia greggii*, *Mimosa aculeaticarpa* var. *biuncifera*, *Isocoma tenuisecta*, *Ericameria laricifolia*, *Opuntia chlorotica*, *O. phaeacantha*, *O. acanthocarpa*, *Agave palmeri*, and *Yucca elata*, are common shrubs. *Eragrostis lehmanniana* and *Bromus rubens* commonly invade the community following disturbance.

Dominance type example:

Hilaria belangeri—Mixed Scrub Association (1143.z0a2a0--)

Hilaria mutica—Mixed Scrub (1143.z0a1a2--)

Hilaria mutica—*Prosopis glandulosa* var. *torreyana* Association (1143.z0a1a1--)

Hilaria mutica—Mixed Scrub Association (1143.z0a1a2--)

FGDC '96 type: Tropical or subtropical grassland with a microphyllous dwarf-shrub layer Code: VA4a.

NVCS (USGS-NPS-TNC) type: Microphyllous evergreen sparse shrubland with medium tall graminoids/Medium tall bunch grassland. Code: V.A.3.b/ VIII.B.2.c

Hilaria mutica Shrub Herbaceous Alliance

Hilaria mutica Sparse Shrubland Alliance

Hilaria rigida Sparse Shrubland Alliance

Reference:

Brown, D. E. 1982d.

Sawyer, J. O. and T. Keeler-Woelf. 1995.

Scrub-Grassland: Sacaton—Scrub

Nearctic Upland, Grassland, Warm Temperate Scrub-Grassland (Semidesert), Sacaton—Scrub Series (1143.z0a3----

Distribution: The semidesert grassland adjoins the 3 Arizona desertscrubs (Chihuahuan, Sonoran, and Mohave) but has the greatest affinity with the Chihuahuan. Within Arizona, it contacts the Madrean Evergreen Woodland (1123.t0----), Great Basin Conifer Woodland (1122.10-----), or less commonly, the Interior Chaparral (1133.q0-----). The community is widely distributed. The dominant grasses occur on semi-saline as well as normal soils. The community is best developed on floodplains, bolsons, and intermittent drainages.

Physiognomy: Nearly closed to open stands of perennial grasses dominated by taller coarse perennial bunch-grass, scattered shrubs, and short trees.

Floristics: *Sporobolus wrightii*, *S. airoides*, *Vulpia octoflora*, *Setaria macrostachya*, *Acacia greggii*, *Mimosa aculeaticarpa* var. *biuncifera*, *Prosopis glandulosa* var. *torreyana*, and *P. velutina*.

Dominance type example:

Sporobolus wrightii Association (1143.z0z3a0--)

Sporobolus wrightii—*Prosopis velutina* Association (1143.z0a3a1--)

Sporobolus wrightii—*Prosopis glandulosa* var. *torreyana* Association
(1143.z0a3a2--)

FGDC '96 type: Tropical or subtropical grassland with a microphyllous dwarf-shrub layer. Code: VA4a.

NVCS (USGS-NPS-TNC) type: Microphyllous evergreen sparse shrubland with medium tall graminoids/Open short grassland (<60% cover) (including sod or mixed sod-bunch graminoids). Code: V.A.3.b/VIII.B.2.b.

Artemisia tridentata Sparse Shrubland Alliance

Artemisia tridentata ssp. *wyomingensis* Sparse Shrubland Alliance

Hilaria mutica Sparse Shrubland Alliance

Hilaria rigida Sparse Shrubland Alliance

Reference:

Brown, D. E. 1982d.

Scrub Grassland: Mixed Grass-Scrub

Nearctic Upland, Grassland, Warm Temperate Scrub-Grassland (Semidesert), Mixed Grass-Scrub Series (1143.z0a0----

Distribution: Lies within a diagonal band from west-central to southeastern Arizona at elevations between 1,070 and 1,520 m on a variety of soils. The semidesert grassland adjoins the 3 Arizona desertscrubs (Chihuahuan, Sonoran, and Mohave) but has the greatest affinity with the Chihuahuan. Within Arizona, it contacts the Madrean Evergreen Woodland (1123.t0-----), Great Basin Conifer Woodland (1122.10-----), or less commonly, the Interior Chaparral (1133.q0-----). This is by far the most important grassland type in the state. Contrary to casual appearance, the grasslands are quite diverse.

Intensive cattle grazing during the past 200 years has altered the appearance of the grassland, in some cases profoundly. Heavy grazing reduced the vigor of the bunch-grasses, disturbed the soil encouraging establishment of annual grasses, and favored growth of plants (often shrubs) unpalatable to cattle. Highly successful suppression of range fires in modern times has further protected non-fire resistant scrubs at the expense of fire tolerant grasses. Even light grass fires will check growth and spread of these thin barked scrub species. Heavy grazing and fire exclusion have permitted proliferation of invasive shrubs and cacti.

Physiognomy: Mixed stands of perennial bunch-grasses and annual grasses of uniform stature with scattered shrubs and succulents. Total vegetative cover quite variable from 15–85%. Grass height 0.3–0.6 m with shrubs reaching 3 m.

Floristics: *Aristida ternipes*, *Bouteloua curtipendula*, *B. eriopoda*, *B. gracilis*, *B. hirsuta*, *B. radicata*, *B. rothrockii*, *Elymus elymoides*, *Buchloe dactyloides*, *Eragrostis intermedia*, *Heteropogon contortus*, *Hilaria belangeri*, *Lycurus setosus*, *Muhlenbergia asperifolia*, *M. porteri*, *Panicum obtusum*, *Tridens muticus*, and *Sporobolus airoides* are the most abundant bunch-grasses of the Scrub-Grassland.

Annual grasses that have replaced the bunch-grasses are: *Aristida adscensionis*, *Bouteloua aristidoides*, *B. barbata*, *Brachiaria arizonica*, *Bromus hordeaceus*, *B. rubens*, *Cenchrus carolinianus*, *Eragrostis cilianensis*, *E. pectinacea*, *E. mexicana*, *Eriochloa lemmonii*, *Panicum hirticaule*, and *Vulpia octoflora*

Acacia greggii, *Mimosa aculeaticarpa* var. *biuncifera*, *Isocoma tenuisecta*, *Ericameria laricifolia*, *Dasyilirion wheeleri*, *Nolina microcarpa*, *Opuntia* spp., *Prosopis glandulosa*, *P. velutina*, *Senecio flaccidus* var. *douglasii*, and *Gutierrezia microcephala* are all normal members of the Scrub-Grassland, and may become unnaturally prevalent. In extreme cases, complete conversion from grassland to scrub has taken place. Extensive mesquite stands near Portal, Paradise, and Douglas represent former grasslands now controlled by this shrub. *Amaranthus palmeri*, *Gomphrena caespitosa*, *Salsola kali*, *Acourtia thurberi*, *A. wrightii*, *Baccharis pteronioides*, *Cirsium neomexicanum*, *Chaetopappa ericoides*, and *Mentzelia albicaulis* are a few of the annual broadleaf plants specializing in colonizing disturbed habitats.

In addition, *Agave palmeri*, *Yucca schottii* and *Y. elata*, and *Fouquieria splendens* are commonplace. *Opuntia engelmannii*, *O. chlorotica*, *O. spinosior*, *Escobaria vivipara* var. *vivipara*, *Echinocereus pectinatus* are frequently encountered cacti.

In good years, when late winter rains are adequate, the Scrub-Grassland puts on a spectacular wildflower display. Many of these flowering plants are important wildlife resources. The showiest species are: *Brickellia californica*, *Gaillardia pinnatifida*, *G. pulchella*, *Lasthenia californica*, *Zinnia acerosa*, *Ipomoea costellata*, *Sphaeralcea laxa*, *Mirabilis multiflora*, *Oenothera primiveris*, *Escholtzia californica* ssp. *mexicana*, *Eriastrum diffusum*, *Gilia sinuata*, *Ipomopsis multiflora*, *Penstemon parryi*, and *Verbena neomexicana*.

Dominance type examples:

Bouteloua eriopoda—*Yucca elata* Association (1143.z0a0a0--)
Bouteloua eriopoda—*Prosopis glandulosa* var. *torreyana* Association (1143.z0a0a1--)
Bouteloua eriopoda—*Prosopis velutina* Association (1143.z0a0a5--)
Bouteloua eriopoda—*Gutierrezia sarothrae*—*Ericameria laricifolia*—*Atriplex canescens* Subassociation (1143.z0a0a2a0)
Bouteloua spp.—Mixed Grass-Scrub (1143.z0a0a3--)
Bouteloua gracilis—*Eriogonum wrightii* Association (1143.z0a0a4--)
Gutierrezia sarothrae Association (1143.z0a5b1--)
Gutierrezia sarothrae—*Prosopis velutina* Association (1143.z0a5a4--)
Gutierrezia sarothrae—*Mimulus biuncifera* Association (1143.z0a5b0--)
Gutierrezia sarothrae—*Prosopis velutina* Shrub—Scrub Disclimax Association (1143.z0a5a4--)
Isocoma tenuisecta Shrub—Scrub Disclimax Association (1143.z0a5a0--)
Isocoma tenuisecta—*Acacia greggii* Association (1143.z0a5a9--)
Isocoma tenuisecta—*Yucca elata* Shrub-Scrub Disclimax Association (1143.z0a5a1--)
Isocoma tenuisecta—*Prosopis velutina* Association (1143.z0a5a2--)
Isocoma tenuisecta—Mixed Scrub (1143.z0a5a3--)
Isocoma tenuisecta—*Prosopis velutina*—*Acacia constricta* Association (1143.z0a5a8--)
Opuntia spp. Associations (1143.z0a5a6--)
Prosopis velutina—*Acacia greggii* Association (1143.a5a7--)
Mixed Grass—*Yucca elata* Association (1143.z0a4a0--)
Mixed Grass—*Prosopis glandulosa* var. *torreyana* Association (1143.z0a4a1--)
Mixed Grass—*Acacia greggii* Association (1143.z0a4a2--)
Mixed Grass—*Fouquieria splendens* Association (1143.z0a4a3--)
Mixed Grass—Mixed Scrub (1143.z0a4a4--)
Mixed Grass—*Nolina macrocarpa* Association (1143.z0a4a5--)

FGDC '96 type: Tropical or subtropical grassland with a microphyllous dwarf-shrub layer. Code: VA4a.

NVCS (USGS-NPS-TNC) type: Microphyllous evergreen sparse shrubland with medium tall graminoids/Open short grassland (< 60% cover) (including sod or mixed sod-bunch graminoids). Code: V.A.3.b/VIII.C.2.b

Bouteloua eriopoda Herbaceous Alliance
Bouteloua gracilis Herbaceous Alliance
Bouteloua hirsuta Herbaceous Alliance
Hilaria jamesii Herbaceous Alliance
Muhlenbergia filiculmis Herbaceous Alliance
Agropyron dasystachyum Herbaceous Alliance
Bouteloua eriopoda Herbaceous Alliance
Carex douglasii Herbaceous Alliance
Hilaria jamesii Herbaceous Alliance
Poa secunda Herbaceous Alliance

References:

Brown, D. E. 1982d.
Sawyer, J. O. and T. Keeler-Wolf. 1995.
Warren, P. L., J. E. Bowers, B. D. Treadwell, and K. L. Reichhardt. 1980.
Warren, P. L., M. S. Hoy, and W. E. Hoy. 1992.
Wentworth, T. R. 1985.

Great Basin Desertscrub: Sagebrush

Nearctic Upland, Cold Temperate Desertland, Great Basin Desertscrub, Sagebrush Series (1152.10a0----)

Distribution: Found adjacent to Sonoran Desertscrub and Mohavian Desertscrub at lower elevations, and Mogollon Chaparral, Juniper Woodland, or Pinyon - Juniper Woodland at higher elevations. Found in northern and central Arizona between 1,070 and 2,130 m. Soils are usually fine-grained, moderately well drained, and not necessarily saline. In fact, most of these soils are deep and not saline.

Physiognomy: Open stand of evenly distributed gray-green evergreen scrub. Vegetation is 0.3–3.1-m tall. Perennial grasses, if present, are patchy. Annual grasses may be abundant in wet years.

Floristics: Series level communities are characterized by *Artemisia tridentata* and sometimes *Gutierrezia sarothrae*, *Ephedra viridis*, *E. torreyana*, and sometimes *Atriplex canescens*, *A. confertifolia*, and *Artemisia filifolia*. Accessory perennials include *Bouteloua gracilis*, *B. curtipendula*, *Pascopyrum smithii*, *Poa* spp., *Oryzopsis hymenoides*, *Chrysothamnus nauseosus*, *Senecio flaccidus* var. *douglasii*, *Chrysothamnus viscidiflorus*, and *Opuntia whipplei*.

Dominance type example:

- Artemisia tridentata* Association (1152.10a0a0--)
- Artemisia tridentata*—Mixed Scrub-Grass Association (1152.10a0a1--)
- Artemisia nova* Association (1152.10a0a2--)
- Artemisia tridentata*—*Atriplex* spp. Association (1152.10a0a3--)
- Artemisia bigelovii*—*Ephedra torreyi*—Mixed Scrub (1152.10a0a4--)
- Chrysothamnus nauseosus* Association (1152.10a3a0--)

FGDC '96 type: Microphyllous evergreen shrubland. Code: IIIA4a

NVCS (USGS-NPS-TNC) type: Microphyllous evergreen shrubland (e.g., sagebrush)/Facultatively deciduous subdesert shrubland (e.g., sagebrush). Code: IV.A.3/ IV.C.3.b

- Artemisia tridentata* Shrubland Alliance
- Artemisia tridentata* ssp. *wyomingensis* Shrubland Alliance
- Aloysia wrightii* Shrubland Alliance
- Atriplex canescens* Shrubland Alliance
- Atriplex hymenelytra* Shrubland Alliance
- Atriplex polycarpa* Shrubland Alliance
- Chrysothamnus nauseosus* Shrubland Alliance
- Flourensia cernua* Shrubland Alliance

References:

Brown, D. E. 1982d.

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Sawyer, J. O. and T. Keeler-Wolf. 1995.

Great Basin Desertscrub: Shadscale Series

Nearctic Upland, Cold Temperate Desertland, Great Basin Desertscrub, Shadscale Series (1152.10a1----)

Distribution: This series is a transitional community and is thus not assigned to a single biome. The center of its distribution lies within the Great Basin. This series occurs between the Great Basin and Mohavian Desert Scrubs where the associations shift from 1 biome to the other as dictated by soil conditions, topography, and the ecological amplitude of the indicator species. Shadscale vegetation is best represented adjacent to Great Basin Desertscrub along the drainages of the Colorado River, including the Little Colorado River, at elevations between 990 and 1,520 m.

Physiognomy: Very open stand of microphyllous evergreen gray-green scrub, 0.3–0.6-m tall. Perennial grasses, if present, are widely scattered. Total plant cover is 10–25%. Species diversity is low.

Floristics: In addition to shadscale (*Atriplex confertifolia*), *A. polycarpa*, *A. lentiformis*, *A. canescens*, *Artemisia spinescens*, *Chrysothamnus nauseosus*, *C. viscidiflorus*, *Sarcobatus vermiculatus*, *Krascheninnikovia lanata*, *Ephedra nevadensis*, *Grayia spinosa*, *Tetradymia canescens*, *Gutierrezia sarothrae*, and *Sarcobatus vermiculatus* are frequently found shrubs. Common grasses are *Hilaria jamesii*, *Oryzopsis hymenoides*, *Elymus elymoides*, *Stipa speciosa*, and *Sporobolus airoides*.

Dominance type examples:

Atriplex confertifolia Association (1152.10a1a0--)

Atriplex confertifolia—Mixed Scrub Association (1152.10a1a1--)

FGDC '96 type: Facultatively deciduous extreme xeromorphic subdesert shrubland. Code: IIIA5b.

NVCS (USGS-NPS-TNC) type: Facultatively deciduous subdesert shrubland (e.g., saltbush). Code: IV.C.3.b

Atriplex confertifolia Shrubland Alliance

Facultatively deciduous subdesert shrubland (e.g., saltbush)

References:

Beatley, J. C. 1975.

Brown, D. E. 1982.

Sawyer, J. O. and T. Keeler-Woolf. 1995.

Turner, R. M. 1982.

Great Basin Desertscrub: Blackbrush

Nearctic Upland, Cold Temperate Desertland, Great Basin Desertscrub, Blackbrush Series (1152.10a2----)

Distribution: The series is most widely distributed in northcentral Arizona at elevations between 1,070 and 1,590 m. The best known blackbrush communities are those of the Tonto Platform and Esplanade of the Grand Canyon. It grows on gentle slopes and well-drained soils.

Physiognomy: Microphyllous evergreen gray-green scrub with succulents. The evenly spaced scrubs give total cover of 15–30%. Grasses and forbs are patchy but occasionally abundant.

Floristics: Characteristic species are *Coleogyne ramosissima* (blackbrush), *Yucca baccata*, *Ephedra viridis*, *Agave utahensis*, and *Gutierrezia sarothrae*. Associated species are *Chrysothamnus nauseosus*, *Atriplex canescens*, *Opuntia phaeacantha*, *O. erinacea*, *Bromus rubens*, and *Echinocereus triglochidiatus*.

Dominance type example: *Coleogyne ramosissima* Association (1152.10a2a0--)

FGDC '96 type: Facultatively deciduous extremely xeromorphic subdesert.
Code: IIIA5b.

NVCS (USGS-NPS-TNC) type: Facultatively deciduous subdesert shrubland (e.g., saltbush). Code: IV.C.3.b
Coleogyne ramosissima Shrubland Alliance

References:

Turner, R. M. 1982.
Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.

Great Basin Desertscrub: Winterfat Series

Nearctic Upland, Cold Temperate Desertland, Great Basin Desertscrub, Winterfat Series (1152.10a4----)

Distribution: Distribution within Arizona is restricted. The Winterfat Series is more important in the Great Basin Deserts of Utah, Wyoming, and Nevada. Elevation range is 1,670 and 1,980 m where it is found adjacent to Saltbush and Sagebrush Series communities. The Winterfat Series occurs in depressions and swales on well-drained soils. Arizona communities often have a limestone substrate.

Physiognomy: Microphyllous evergreen gray-green scrub of shrubs and half-shrubs with scattered understory plants. Overall height of the Arizona communities is less than 0.6 m and total cover is between 20 and 30%.

Floristics: The more prominent species are *Krascheninnikovia lanata*, *Atriplex canescens*, *Artemisia tridentata*, *A. nova*, *Ephedra viridis*, *Gutierrezia sarothrae*, *Coleogyne ramosissima*, *Chrysothamnus nauseosus*, *C. viscidiflorus* and *Opuntia* spp.

Dominance type examples:

- Krascheninnikovia lanata* Association (1152.10a4a0--)
- Krascheninnikovia lanata*—Mixed Scrub Association (1152.10a4a1--)
- Krascheninnikovia lanata*—*Atriplex* spp. Association (1152.10a4a2--)
- Krascheninnikovia lanata*—*Atriplex canescens*—*Ephedra viridis* Subassociation (1152.10a4a2a0)

FGDC '96 type:

Mixed evergreen-deciduous subdesert shrubland. Code: IIIC3b.

NVCS (USGS-NPS-TNC) type: Facultatively deciduous subdesert shrubland (e.g., saltbush. Code: IV.C.3.b

Krascheninnikovia lanata Shrubland Alliance

References:

- Brown, D. E. 1982.
- Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.
- Brown, D. E., C. H. Lowe, and C. P. Pase. 1980.
- Sawyer, J. O. and T. Keeler-Woof. 1995.
- Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.

Great Basin Desertscrub: Mixed Scrub

Nearctic Upland, Cold Temperate Desertland, Great Basin Desertscrub, Mixed Scrub Series (1152.10a5----)

Distribution: Details regarding this Series are known only for northcentral Arizona. Found at elevations between 1,070 and 1,710 m within the Grand Canyon along the Esplanade and on soils derived from sandstone.

Physiognomy: Mixed evergreen sclerophyll and microphyll desertscrub with deciduous shrubs and succulents. Shrubs up to 1.5-m tall with undershrubs and succulents to 0.6-m tall. Total cover is 10–25%.

Floristics: Characteristic species are *Quercus turbinella*, *Gutierrezia sarothrae*, *Nolina microcarpa*, *Coleogyne ramosissima*, *Shepherdia rotundifolia*, *Cercocarpus intricatus*, and *Rhus trilobata*. Associated species are *Yucca angustissima*, *Y. baccata*, *Ceanothus greggii*, *Chrysothamnus* spp., *Artemisia* spp., *Acacia greggii*, and *Thamnosma montana*.

Dominance type examples:

- Ephedra viridis*—*Eriogonum* spp.—Mixed Scrub Association (1152.10a5a0--)
- Mixed Scrub Association (1152.10a5a1--)
- Quercus turbinella*—*Gutierrezia sarothrae*—*Nolina microcarpa*—*Coleogyne ramosissima* Subassociation (1152.10a5a1a0)
- Ephedra viridis*—Mixed Scrub Association (1152.10a5a3--)
- Yucca baccata*—*Agave utahensis* Association (1152.10a5a4--)
- Atriplex confertifolia*—*Gutierrezia sarothrae*—*Chrysothamnus viscosa* Association (1152.10a5a5--)

FGDC '96 type: Facultatively deciduous extremely xeromorphic subdesert shrubland. Code: IIIA5b.

NVCS (USGS-NPS-TNC) type: Broad-leaved evergreen sparse shrubland with short graminoids/Facultatively deciduous subdesert shrubland (e.g., saltbush, *Eriogonum* spp.) Sparse Shrubland Alliance/Mixed evergreen-deciduous subdesert shrubland/Deciduous subdesert shrubland with succulents. Code:

V.A.1.c/V.A.3.b/IV.C.3.a/IV.C.3.b/IV.C.3.c

- Lycium berlandieri* Shrubland Alliance
- Prosopis glandulosa* Shrubland Alliance
- Prosopis velutina* Shrubland Alliance
- Aloysia wrightii* Shrubland Alliance
- Atriplex canescens* Shrubland Alliance
- Atriplex confertifolia* Shrubland Alliance
- Atriplex polycarpa* Shrubland Alliance
- Krascheninnikovia lanata* Shrubland Alliance
- Chrysothamnus nauseosus* Shrubland Alliance
- Coleogyne ramosissima* Shrubland Alliance

Microphyllous evergreen sparse shrubland with medium tall graminoids
Artemisia tridentata Sparse Shrubland Alliance
Artemisia tridentata ssp. *wyomingensis* Sparse Shrubland Alliance

References:

- Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.
Brown, D. E., C. H. Lowe, and C. P. Pase. 1980.
Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.

Great Basin Desertscrub: Saltbush Series

Nearctic Upland, Cold Temperate Desertland, Great Basin Desertscrub, Saltbush Series (1152.10a6----)

Distribution: Occurs in northwest and northcentral Arizona at elevations between 1,220 and 2,130 m. The series occurs on level floodplains and valley bottoms. Soils are usually shallow and derived from limestone substrate. The Toroweap Valley vegetation near Grand Canyon provides an excellent example of the type.

Physiognomy: Microphyllous evergreen gray-green desertscrub with scattered half-shrubs and occasional succulents. Perennial grasses are usually present but patchy. Overall shrub height is less than 1.2 m. Total cover is 20–30%.

Floristics: Characteristic species are *Atriplex canescens*, *A. polycarpa*, *A. lentiformis*, *A. confertifolia*, *Artemisia tridentata*, *Gutierrezia sarothrae*, *Opuntia whipplei*, *Lycium andersonii*, *Yucca baccata*, *Ephedra viridis*, *Hilaria rigida*, *Bouteloua gracilis*, *Oryzopsis hymenoides*, and *Stipa comata*. Often present and less important are *Krascheninnikovia lanata*, *Opuntia phaeacantha*, *Opuntia echinocarpa*, and *Coleogyne ramosissima* (blackbrush). Inhabitants of adjacent communities such as *Juniperus osteosperma*, *Quercus turbinella*, and *Thamnosma montana* may be present.

Dominance type examples:

Sarcobatus vermiculatus Association (1152.10a6a0--)

Atriplex canescens Association (1152.10a6a1--)

Atriplex canescens—*Yucca baccata*—*Gutierrezia sarothrae* Subassociation (1152.10a6a1a1)

Atriplex canescens—*Krascheninnikovia lanata*—*Ephedra viridis* Subassociation (1152.10a6a1a2)

Atriplex canescens—*Bouteloua gracilis*—*Hilaria jamesii* Subassociation (1152.10a6a1a3)

Atriplex jonesii—*Sporobolus airoides*—*Eragrostis lehmanniana* Association (1152.10a6a2--)

Suaeda moquinii Association (1152.10a6a3--)

Atriplex confertifolia—*Grayia spinosa* Association (1152.10a6a4--)

FGDC '96 type: Tropical or subtropical broad-leaved extremely xeromorphic facultatively deciduous subdesert shrubland. Code: IIIA5b.

NVCS (USGS-NPS-TNC) type: Microphyllous evergreen sparse shrubland with medium tall graminoids/Cold-deciduous sparse shrubland with medium tall graminoids.

Code: V.A.3.b/V.B.2.b

Artemisia tridentata Sparse Shrubland Alliance

Artemisia tridentata ssp. *wyomingensis* Sparse Shrubland Alliance

Sarcobatus vermiculatus Sparse Shrubland Alliance
Chrysothamnus viscidiflorus Sparse Shrubland Alliance
Sarcobatus vermiculatus Sparse Shrubland Alliance

Reference:

Sawyer, J. O. and T. Keeler-Wolf. 1995.

Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.

Mohave Desertscrub: Creosotebush

Nearctic Upland, Warm Temperate Desertland, Mohavian Desertscrub, Creosotebush Series (1153.p0a0----)

Distribution: Found in northwestern Arizona, including the lower Grand Canyon, south to Kingman. To the south the Mohavian Creosotebush vegetation gradually merges with the Sonoran Desertscrub, the transition being complete at the latitude of Davis Dam.

Most extensively developed in adjacent California and Nevada. The creosotebush of the Mohavian Desertscrub is triploid (N=39), giving them a characteristically shaped crown (Brown 1982, p.172).

Physiognomy: Very open microphyllous evergreen scrub with deciduous shrubs and very open lower layers of half shrubs, deciduous perennial and ephemeral herbs. Plants average 1.2 m in height except for *Fouquieria* which may reach 7 m. Total cover is from 5–15%.

Floristics: *Larrea tridentata*, *Fouquieria splendens*, *Encelia farinosa*, *Ambrosia dumosa*, *Opuntia basilaris*, *Ferocactus cylindraceus* var. *cylindraceus*, *Ephedra nevadensis* (rough joint-fir), *Krameria grayi*, and *Eriogonum inflatum* are among the characteristic species.

Dominance type examples:

Larrea tridentata—*Opuntia basilaris*—*Fouquieria splendens* Subassociation
(1153.p0a0a0a0)

Larrea tridentata—*Ambrosia dumosa*—*Ephedra nevadensis* Subassociation
(1153.p0a0a1a0)

FGDC '96 type: Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland. Code: IIIA5a.

NVCS (USGS-NPS-TNC) type: Extremely xeromorphic evergreen shrubland. Evergreen subdesert shrubland (e.g., creosote bush). Code: IV.A.4.a

Ephedra nevadensis—*Ephedra viridis* Shrubland Alliance

Ephedra viridis Shrubland Alliance

Eriogonum fasciculatum Shrubland Alliance

Larrea tridentata Shrubland Alliance

References:

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Sawyer, J. O. and T. Keeler-Wolf. 1995.

Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.

Mohave Desertscrub: Blackbrush Series

Nearctic Upland, Warm Temperate Desertland, Mohavian Desertscrub, Blackbrush Series (1153.p0a1---)

Distribution: Found in northwestern Arizona and on the Tonto Platform within Grand Canyon. Elevation range is 850 and 1,680 m. Found on gentle slopes and rolling terrain with well-drained shallow to deep soils. Limestone soils are tolerated.

Physiognomy: Open evergreen microphyll desertscrub with succulents, half-shrubs, and arborescent leaf-succulents. Shrubs are generally less than 1-m tall. Total cover is 5–30%.

Floristics: *Coleogyne ramosissima* (blackbrush), *Yucca brevifolia*, *Y. baccata*, *Ephedra viridis*, *Opuntia acanthocarpa*, *Agave utahensis*, *Gutierrezia sarothrae*, *Atriplex canescens*, *Encelia frutescens*, and *Bromus rubens* are characteristic species.

Dominance type examples:

Coleogyne ramosissima—*Yucca utahensis* Association (1153.p0a1a0--)
Coleogyne ramosissima—*Ephedra* spp.—*Yucca baccata* Association
(1153.p0a1a1--)

FGDC '96 type: Facultatively deciduous extremely xeromorphic subdesert shrubland.
Code: IIIA5b.

NVCS (USGS-NPS-TNC) type: Evergreen subdesert shrubland/Facultatively deciduous subdesert shrubland with succulents. Code: IV.C.3.a./V.A.4.a
Coleogyne ramosissima Shrubland Alliance

References:

Brown, D. E. C. H. Lowe, and C. P. Pase. 1979.
Sawyer, J. O. and T. Keeler-Wolf. 1995.
Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.

Mohave Desertscrub: Joshuatree

Nearctic Upland, Warm Temperate Desertland, Mohavian Desertscrub, Joshuatree Series (1153.p0a4----)

Distribution: Not widely distributed in Arizona. The series is confined to valleys within Mohave County. Soils are well-drained sandy loam or fine gravel. These communities are believed to have relatively high moisture requirements.

Physiognomy: Microphyllous evergreen desertscrub with arborescent semi-succulent aspect dominants with graminoid and succulent understory. Total cover between 10 and 30%.

Floristics: *Yucca brevifolia*, *Salazaria mexicana*, *Ephedra nevadensis*, *Hymenoclea salsola*, *Muhlenbergia porteri*, *Hilaria rigida*, and *Opuntia basilaris*.

Dominance type examples:

Yucca brevifolia—*Acamptopappus sphaerocephalus*—*Larrea tridentata* Mixed Scrub Association (1153.p0a4a0--)

Yucca brevifolia—*Coleogyne ramosissima* Association (1153.p0a4a1--)

Yucca brevifolia—*Larrea tridentata* Association (1153.p0a4a2--)

Acamptopappus sphaerocephalus Association (1153.p0a4a3--)

FGDC '96 type: Facultatively deciduous extremely xeromorphic subdesert shrubland. Code: IIIA5b.

NVCS (USGS-NPS-TNC) type: Broad-leaved evergreen sparse shrubland with tall graminoids⁵/Evergreen sparse shrubland with medium tall graminoids (e.g. *Larrea tridentata*/*Hilaria mutica*). Code: V.A.1.a/V.A.4.a

References:

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Rowlands, P. G. 1978.

Sawyer, J. O. and T. Keeler-Woolf. 1995.

⁵ Joshua trees are here understood to be tall tufted graminoids.

Mohave Desertscrub: Catclaw

Nearctic Upland, Warm Temperate Desertland, Mohavian Desertscrub, Catclaw Series (1153.p0a5----)

Distribution: Found along washes, xeroriparian drainages, and on adjacent flats in west-central Arizona at elevations between 460 and 900 m. This vegetation is patchy in distribution, however it is occasionally found in pure stands.

Physiognomy: Linear stands of facultatively deciduous leguminous thorn scrub with open half-shrub understory. Total cover is 20–60%.

Floristics: *Acacia greggii*, *Ambrosia deltoidea*, *Lycium* sp., *Ziziphus obtusifolia*, and annual grasses.

Dominance type example:

Acacia greggii Association (1153.p0a5a0--)

Acacia greggii—*Eriogonum fasciculatum*—Mixed Cactus Association (1153.p0a5a1--)

FGDC '96 type: Microphyllous evergreen shrubland. Code: IIIA4a.

NVCS (USGS-NPS-TNC) type: Extremely xeromorphic deciduous shrubland
Deciduous subdesert shrubland without succulents. Code: IV.B.3.a

Acacia neovernicosa Shrubland Alliance

Eriogonum corymbosum Shrubland Alliance

Grayia spinosa Shrubland Alliance

Psorothamnus polydenius var. *polydenius* Shrubland Alliance

Rhus microphylla Shrubland Alliance

Sarcobatus vermiculatus Shrubland Alliance

Acacia greggii Shrubland Alliance

References:

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Hunt, C. B. 1966.

Mohave Desertscrub: Saltbush

Nearctic Upland, Warm Temperate Desertland, Mohavian Desertscrub, Saltbush Series (1153.p0a6----)

Distribution: Found in northwestern Arizona at elevations between 300 and 610 meters. Two types of communities are recognized: (1) a halophytic phase occupying saline sites, and (2) a xerophytic phase occupying sites of extreme aridity owing to topography, climate, or physical soil properties.

Physiognomy:

Halophytic associations: Low (< 0.6-m tall) gray-green evergreen scrub (mostly) with soft succulent nanophyll leaves or with evergreen half-shrubs and/or perennial herbs with swollen succulent leaves. Graminoids are either patchy or absent. Total cover is between 2 and 15%.

Xerophytic associations: Low (> 0.6-m tall) gray-green evergreen scrub with leptophyll leaves that become dry and hardened in the drought seasons. Total cover is between 10 and 25%.

Floristics:

Halophytic associations: *Atriplex polycarpa*, *A. confertifolia*, *A. hymenelytra*, *Allenrolfea occidentalis*, *Nitrophila* spp., *Salicornia* spp., *Suaeda moquinii*, and *Sarcobatus vermiculatus*. The most prominent grass species present is *Distichlis spicata*.

Xerophytic associations: *Atriplex* spp. as above with the exception of *A. hymenelytra*. Low succulents are lacking. Graminoids, particularly annuals such as *Schismus barbatus*, are present and widespread.

Dominance type examples:

Halophytic associations:

Suaeda moquinii Association (1153.p0a6a0--)

Xerophytic associations:

Atriplex spp. Association (1153.p0a6a0--)

Atriplex confertifolia Association (1153.p0a6a4--)

Atriplex confertifolia—*Opuntia erinacea*—*Prosopis glandulosa* var. *torreyana*
Subassociation (1153.p0a6a4a0)

Atriplex confertifolia—*Ephedra nevadensis*—*Opuntia basilaris*
Subassociation (1153.p0a6a4a0)

Atriplex hymenelytra Association (1153.p0a6a2--)

Atriplex canescens Association (1153.p0a6a3--)

FGDC '96 type: Facultatively deciduous extremely xeromorphic subdesert shrubland. Code: IIIA5b.

NVCS (USGS-NPS-TNC) type: Facultatively deciduous subdesert shrubland (e.g., saltbush). Code: IV.C.3.b

Aloysia wrightii Shrubland Alliance
Atriplex canescens Shrubland Alliance
Atriplex confertifolia Shrubland Alliance
Atriplex hymenelytra Shrubland Alliance
Atriplex polycarpa Shrubland Alliance
Ceratoides lanata Shrubland Alliance
Chrysothamnus nauseosus Shrubland Alliance
Coleogyne ramosissima Shrubland Alliance
Flourensia cernua Shrubland Alliance
Poliomintha incana Shrubland Alliance

References:

- Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.
Sawyer, J. O. and T. Keeler-Woolf. 1995.
Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.

Mohave Desert Scrub: Brittlebush

Nearctic Upland, Warm Temperate Desertland, Mohavian Desert Scrub, Brittlebush Series (1153.p0a8---)

Distribution: Found in northwestern Arizona and eastward into Grand Canyon. Warm south-facing slopes, often with volcanic soils, at elevations between 460 and 1,220 m. Soils thin, rocky, and well drained. Brittlebush communities do not occur in large patches.

Physiognomy: Mixed evergreen and deciduous desertscrub with evenly distributed half shrubs and stem succulents. Deciduous forbs uncommon but therophytes are abundant in season. Total cover is 5–20%. Shrub height is generally 0.3–0.9 m with widely scattered taller plants (2–3 m).

Floristics: *Encelia farinosa*, *Larrea tridentata*, *Ephedra nevadensis*, *E. viridis*, *Fouquieria splendens*, *Opuntia basilaris*, *Acacia greggii*, and *Ferocactus cylindraceus* var. *cylindraceus*.

Dominance type examples:

Encelia farinosa Association (1153.p0a8a0--)

Encelia farinosa—*Larrea tridentata*—*Ferocactus cylindraceus* var. *cylindraceus*
Subassociation (1153.p0a8a0a0)

Encelia farinosa—*Ephedra* spp.—*Acacia greggii* Subassociation (1153.p0a8a0a1)

FGDC '96 type: Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland. Code: IIIA5a.

NVCS (USGS-NPS-TNC) type: Evergreen sparse shrubland with medium tall graminoids (e.g. *Larrea tridentata*/*Hilaria mutica*). Code: V.A.4.a

Encelia farinosa Shrubland Alliance

References:

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982.

Mohave Desertscrub: Mixed Scrub

Nearctic Upland, Warm Temperate Desertland, Mohavian Desertscrub, Mixed Scrub Series (1153.p0b0----)

Distribution: Widely scattered in northeastern and west-central Arizona, including Grand Canyon. Occurs at elevations between 460 and 1,220 m on gentle slopes which include drainages. Where the community occurs along drainages, it is not structurally different than that of the interfluves. Codominance is usually shared by 3 or more species. Species diversity is high.

Physiognomy: Mixed evergreen and deciduous xeromorphic desertscrub with half-shrubs and stem succulents. Deciduous herbaceous species and therophytes are widespread and important.

Floristics: *Larrea tridentata*, *Ambrosia dumosa*, *Atriplex canescens*, *A. polycarpa*, *Opuntia basilaris*, *Acacia greggii*, *Ephedra nevadensis*, *E. viridis*, *Encelia farinosa*, Mesquite (*Prosopis velutina*, *P. torreyana*), *Baccharis sergiloides*, *Atriplex polycarpa*, *Acacia greggii*, *Fouquieria splendens*, and *Suaeda moquinii* are widespread. Except for creosotebush and mesquite, these shrubs rarely form extensive stands.

Dominance type example:

Fouquieria splendens—Mixed Scrub Association (1153.p0a0a0--)

Larrea tridentata—*Ambrosia dumosa*—*Encelia farinosa* Subassociation
(1153.p0b0a0a0)

FGDC '96 type: Facultatively deciduous extremely xeromorphic subdesert shrubland.
Code: IIIA5b.

NVCS (USGS-NPS-TNC) type: Deciduous subdesert shrubland with succulents/
Facultatively deciduous subdesert shrubland/ Evergreen subdesert shrubland.
Code: IV.C.3.a/IV.A.4.a

Prosopis velutina Shrubland Alliance
Atriplex hymenelytra Shrubland Alliance
Atriplex canescens Shrubland Alliance
Atriplex confertifolia Shrubland Alliance
Atriplex polycarpa Shrubland Alliance
Encelia farinosa Shrubland Alliance
Ephedra nevadensis Shrubland Alliance
Eriogonum fasciculatum Shrubland Alliance
Larrea tridentata Shrubland Alliance

Reference:

Annable, C. R. 1985.
Bradley, W. G. 1970.
Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Hunt, C. R. 1966.

Sawyer, J. O. and T. Keeler-Wolf. 1995.

Chihuahuan Desertscrub: Creosotebush—Tarbush

Nearctic Upland, Warm Temperate Desertland, Chihuahuan Desertscrub, Creosotebush-Tarbush Series (1153.r0a0----)

Distribution: The Chihuahuan Desert is the largest on the continent and this series is the best represented in Arizona. The most representative stands are found in the southeastern part of the state along the New Mexico border between 1,220 and 1,520-m elevation.

Physiognomy: Vegetation is approximately 0.9-m tall with a scattering of taller plants. Although floristically rich, the Chihuahuan Desertscrub gives the impression of uniformity and simplicity. Relatively low precipitation (23 cm per year, mostly falling in the summer) and cooler temperatures favor growth of scrub rather than arborescent vegetation.

Floristics: The few scrub species that are widespread and define the Chihuahuan Desert in Arizona are: *Larrea tridentata* (monoploid form, N=13, see Brown 1982), *Flourensia cernua*, *Parthenium incanum*, *Mortonia sempervirens scabrella*, *Prosopis glandulosa*, and *P. glandulosa* var. *torreyana* (western honey mesquite) are common.

Although succulents are not as abundant as where the climate is warmer and more moist, they are an important element in the vegetation. *Opuntia chlorotica*, *O. phaeacantha*, and *O. macrocentra* are rather common.

Aristida adscensionis, *Bouteloua aristidoides*, *B. barbata*, *Brachiaria arizonica*, *Bromus hordeaceus* ssp. *hordeaceus*, *Eragrostis pectinacea* var. *pectinacea*, *E. mexicana*, *Eriochloa lemmonii*, *Panicum hirticaule*, and *Vulpia octoflora* the most commonly encountered grasses. *Gaillardia pulchella* and *Lasthenia californica* are common therophytes.

Diagnostic characteristics: The preponderate presence of the Chihuahuan form of creosotebush and the presence of *Flourensia cernua*, *Parthenium incanum*, and *Mortonia sempervirens scabrella* are indicators of this community. However, ecotones between the shrub-scrub (semidesert grassland) grasslands and the Chihuahuan desertscrub are particularly difficult to classify since the diagnostic Chihuahuan plants are often absent but creosotebush, a desert species, is often present.

Dominance type examples:

Larrea tridentata—*Parthenium incanum*—Mixed Scrub Association (1153.r0a0a0--)

Larrea tridentata—*Flourensia cernua* Association (1153.r0a0a1--)

Flourensia cernua Association (1153.r0a0a2--)

Larrea tridentata Association (1153.r0a0a3--)

FGDC '96 type: Evergreen extremely xeromorphic subdesert shrubland.

Code: IIIA5a.

NVCS (USGS-NPS-TNC) type: Evergreen subdesert shrubland/ Facultatively deciduous subdesert shrubland. Code: IV.A.4.a/IV.C.3.b

Larrea tridentata Shrubland Alliance

Mortonia scabrella Shrubland Alliance
Fouquieria splendens Shrubland Alliance
Prosopis glandulosa Shrubland Alliance
Atriplex canescens Shrubland Alliance
Flourensia cernua Shrubland Alliance

References:

Brown, D. E. 1982e.
Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.
Brown, D. E., C. H. Lowe, and C. P. Pase. 1980.
Warren, P. L., M. S. Hoy, and W. E. Hoy. 1992.

Chihuahuan Desertscrub: Whitethorn Series

Nearctic Upland, Warm Temperate Desertland, Chihuahuan Desertscrub, Whitethorn Series (1153.r0a1----)

Distribution: In Arizona this series is found at elevations between 1,370 and 1,870 m in the southeastern part of the state. Typical stands may be seen along U.S. Highway 80 between Rodeo, New Mexico, and Douglas, Arizona.

Physiognomy: Open scrubland 0.9-m tall with a scattering of taller leguminous plants. Succulents, though present, are not prominent. Forb layer is open and patchy. Total perennial vegetation cover is 25–55%.

Floristics: Common shrubs are: *Larrea tridentata* (monoploid form), *Acacia neovernicosa*, *Prosopis glandulosa* var. *torreyana*, and *P. velutina*. Understory perennial species are *Dyssodia* spp., *Viguiera stenoloba*, *Krameria erecta*, *Condalia* spp., *Gutierrezia sarothrae*, *Opuntia spinosior*, *Bouteloua eriopoda*, *B. hirsuta*, and *Aloysia wrightii*.

Dominance type example:

Acacia neovernicosa (1153.r0a1a0--)

Acacia neovernicosa—*Larrea tridentata* Association (1153.r0a1a1--)

FGDC '96 type: Evergreen extremely xeromorphic shrubland. Code IIIA5a.

NVCS (USGS-NPS-TNC) type: Evergreen subdesert shrubland/ Temperate deciduous shrubland/Deciduous subdesert shrubland without succulents.

Code: IV.A.4.a/ IV.B.2.a/IV.B.3.a

Larrea tridentata Shrubland Alliance

Mortonia scabrella Shrubland Alliance

Acacia neovernicosa Shrubland Alliance

Rhus microphylla Shrubland Alliance

Acacia greggii Shrubland Alliance

Reference:

Brown, D. E. 1982e.

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Brown, D. E., C. H. Lowe, and C. P. Pase. 1980.

Warren, P. L.; M. S. Hoy, and W. E. Hoy. 1992.

Chihuahuan Desertscrub: Mesquite Series

Nearctic Upland, Warm Temperate Desertland, Chihuahuan Desertscrub, Mesquite Series (1153.r0a3----

Distribution: This vegetation is found on valley fill in southeastern Arizona at 1,370-m elevation. The soils are erosion prone and silty. Such erosion has left the shrubs perched on low soil mounds.

Physiognomy: Microphyll shrub communities with perennial vegetation cover of 15–30%. Ephemeral herb cover may approach 100% in wet years. Shrub height 0.2–1.5 m.

Floristics: *Larrea tridentata*, *Prosopis velutina*, *Parthenium incanum*, *Rhus microphylla*, *Opuntia spinosior*, and *O. phaeacantha* are prominent in the shrub layer. Lower layers are *Bouteloua eriopoda*, *B. aristidoides*, *Gutierrezia sarothrae*, *Lycium* spp., *Aloysia wrightii*, *Aristida adscensionis*, *Bromus hordeaceus* ssp. *hordeaceus*, *Eragrostis pectinacea* var. *pectinacea*, *E. mexicana*, *Eriochloa lemmonii*, *Panicum hirticaule*, and *Vulpia octoflora* are those most commonly encountered.

Dominance type examples:

Prosopis velutina—*Artemisia filifolia* Association (1153.r0a3a1--)

Prosopis velutina Shrub Hummock Association (1153.r0a3a0--)

FGDC '96 type: Extremely xeromorphic deciduous subdesert shrubland without succulents. Code: IIIB3a.

NVCS (USGS-NPS-TNC) type: Deciduous subdesert shrubland with succulents/Drought-deciduous thorny sparse shrubland with medium tall graminoids. Code: IV.C.3.a/ V.B.1.a

Prosopis glandulosa Shrubland Alliance

Prosopis velutina Shrubland Alliance

Prosopis glandulosa Sparse Shrubland Alliance

Fouquieria splendens Shrubland Alliance

Lycium berlandieri Shrubland Alliance

References:

- Brown, D. E. 1982e.
Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.
Brown, D. E., C. H. Lowe, and C. P. Pase. 1980.
Sawyer, J. O. and T. Keeler-Wolf. 1995.
Warren, P. L, M. S. Hoy, and W. E. Hoy. 1992.

Chihuahuan Desertscrub: Mixed Scrub Series

Nearctic Upland, Warm Temperate Desertland, Chihuahuan Desertscrub, Mixed Scrub Series (1153.r0a5----)

Distribution: This vegetation is found on rocky south and west facing foothill slopes with shallow rocky soil between 1,280 and 1,590-m elevation. Soil is derived from tuffs or other acidic extrusive volcanics. This series may also occur on limestone in the extreme southeastern corner of the state.

Physiognomy: Open stand of microphyllous shrubs of uneven height (0.2–2-m tall). Shrub cover is 10–40%. Herbaceous cover is 20–40%. The series includes xeroriparian associations which are limited in extent but of great importance to vertebrates whose density and diversity is 2–3 times greater than in the surrounding desert.

Floristics: *Fouquieria splendens*, *Isocoma laricifolia*, *Calliandra eriophylla*, *Agave palmeri*, *Opuntia spinosior*, *O. phaeacantha*, *Prosopis velutina*, and *Acacia greggii*. The latter 2 species are most prominent in xeroriparian washes. Herbaceous cover is a mixture of bunch-grasses (*Bouteloua hirsuta*, *B. eriopoda*, *B. gracilis*, and *Heteropogon hirsuta*).

Dominance type examples:

Fouquieria splendens—Mixed Scrub Association (1153.r0a5a0--)

Prosopis velutina—*Acacia greggii* (Xeroriparian) Association (1153.r0a5a1--)

Larrea tridentata—Mixed Scrub (1153.r0a5a2--)

FGDC '96 type: Extremely xeromorphic deciduous subdesert shrubland without succulents. Code: IIIB3a.

NVCS (USGS-NPS-TNC) type: Deciduous subdesert shrubland with succulents/
Facultatively deciduous subdesert shrubland. Code: IV.C.3.a/ IV.C.3.b

Prosopis velutina Shrubland Alliance

Atriplex canescens Shrubland Alliance

Flourensia cernua Shrubland Alliance

References:

Brown, D. E. 1982f.

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Warren, P. L, M. S. Hoy, and W. E. Hoy. 1992.

Sonoran Desertscrub: Creosotebush—Bursage Series

Nearctic Upland, Tropical-Subtropical Desertland, Sonoran Desertscrub, Creosotebush—Bursage Series ("Lower Colorado River Valley") (1154.u0a0---)

Distribution: This series occurs in southwestern and westcentral Arizona and develops on level to gently sloping soils of generally silty or sandy texture. In Arizona the Creosote—Bursage Series is found at elevations between 330 and 980 m. This vegetation lies in large patches crossed by desert washes and floodplains. Because these washes and floodplains support desert vegetation and not riparian obligate vegetation, they are considered to be uplands rather than riparian and are classified that way. A similar situation is encountered in other desertscrub series.

The Creosotebush—Bursage Series abuts the Paloverde—Mixed Cacti (1154.u0a1----) and the Saltbush Series (1154.u0a6----). Distribution of these 3 series is largely edaphically controlled.

Physiognomy: Very open evenly spaced low diversity stands of microphyll shrubs 0.3–0.9-m tall, containing a few scattered trees and cactus species. Perennial cover is usually 10–20%, but in wet years annual plants may provide 100% cover.

Floristics: *Larrea tridentata*, *Ambrosia dumosa*, *A. deltoidea*, *Opuntia fulgida*, *Carnegiea gigantea*, *Parkinsonia microphylla*, *Fouquieria splendens*, and *Lycium* spp. are the most important community dominants. These dominants combine singly or severally to form distinctive communities.

Communities along washes and floodplains do not qualify as riparian since many of the species encountered are also found in non-riparian situations and differ in stature rather than composition. Such vegetation is watered by infrequent and irregular events, i.e., scattered thundershowers, but true riparian vegetation requires continuous or frequent and regular watering. Compare these with Tropical-Subtropical Sonoran Mesquite Riparian and Oasis Forest (1224.u0a1----) and allied communities.

Dominance type examples:

Larrea tridentata Association (1154.u0a0a0--)

Larrea tridentata with Annuals Subassociation (1154.u0a0a0a2)

Larrea tridentata—*Ambrosia dumosa* Association (1154.u0a0a1--)

Ambrosia dumosa Association (1154.u0a0a2--)

Parkinsonia florida—*Olneya tesota*—*Psoralea argophylla* "Riparian" Association (1154.u0a0a4-)

Larrea tridentata—*Prosopis velutina* Floodplain Subassociation (1154.u0a0a0a4)

Ambrosia dumosa—*Parkinsonia microphylla* Association (1154.u0a0a5--)

Ambrosia deltoidea—*Parkinsonia microphylla*—Mixed Scrub Association (1154.u0a0a6--)

FGDC '96 type: Evergreen extremely xeromorphic subdesert shrubland.
Code: IIIA5a.

NVCS (USGS-NPS-TNC) type: Evergreen subdesert shrubland Alliance/Shrub dune Alliance. Code: IV.A.4.a

Encelia farinosa Shrubland Alliance

Larrea tridentata Shrubland Alliance

Ambrosia dumosa Sparsely Vegetated Alliance

References:

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Brown, D. E., C. H. Lowe, and C. P. Pase. 1980.

Sawyer, J. O. and T. Keeler-Woolf. 1995.

Turner, R. M. and D. E. Brown. 1982.

Warren, P. L., J. E. Bowers, B. D. Treadwell, and K. L. Reichhardt. 1980.

Sonoran Desert Scrub: Paloverde—Mixed Cacti Series

Nearctic Upland, Tropical-Subtropical Desertland, Tropical-Subtropical Sonoran Desert Scrub, Paloverde—Mixed Cacti Series ("Arizona Upland") (1154.u0a1----)

Distribution: This series occurs in southwestern and westcentral Arizona at elevations between 328 and 1,070 m and develops on rock piles and middle and upper bajadas where soils are well-drained and of cobbley, gravelly texture. Incised drainages are frequently encountered. Because these washes and floodplains support desert vegetation and not riparian obligate vegetation, they are considered to be uplands rather than riparian lands and are classified that way. similar situation is encountered in other desertscrub series.

The Paloverde—Mixed Cacti (1154.u0a1----) abuts the Creosotebush—Bursage Series and the Saltbush Series (1154.u0a6----). Distribution of all 3 is largely edaphically controlled. *Carnegiea gigantea* tend to be confined to coarse textured soils on rocky slopes where they find firm footing. When growing on fine-textured soils they tend to blow over particularly after soaking rains.

Physiognomy: A diverse mixture of evergreen and deciduous leguminous trees, shrubs, and cacti with cover from 15 to 45 percent. The height of the trees ranges from 3 to 6 m, the cacti from 15 cm to 9 m, the shrubs 0.6 to 2 m, and the half-shrubs 0.2 to 0.6 m.

Floristics: Diagnostic plants are: *Parkinsonia microphylla* (Foothills paloverde), *Ambrosia deltoidea* (Triangle-leaf bursage), *A. dumosa* (White bursage), *Carnegiea gigantea* (Saguaro), *Mammillaria grahamii* var. *grahamii* (Fish-hook pincushion), *Fouquieria splendens* (Ocotillo), *Opuntia fulgida* (Chain-fruit cholla), *O. acanthocarpa* (Buck-horn cholla), *O. bigelovii* (Teddybear cholla), *Olneya tesota* (Desert ironwood), *Encelia farinosa* (Brittlebush), *Simmondsia chinensis* (Jojoba), *Acacia greggii* (Catclaw acacia), *Prosopis velutina* (Velvet mesquite), and *Jatropha* spp. (limberbush). *Larrea tridentata* (creosotebush), although commonly present, is rarely in pure stands. *Lamprocarum thurberi* (Organ pipe cactus), and *Pachycereus schottii* (Senita cactus) are columnar cactus species limited to essentially frost-free environments.

Diagnostic characteristics: The presence of *Parkinsonia microphylla* and cacti, especially *Mammillaria grahamii* and *Carnegiea gigantea* are diagnostic. Bursage, usually *Ambrosia deltoidea*, also *A. dumosa*., Ironwood, and ocotillo are often present also.

Dominance type examples:

Parkinsonia microphylla—*Ambrosia deltoidea* Association Mixed Scrub
(1154.u0a1a0--)

Ambrosia dumosa—*Parkinsonia microphylla* Association (1154.u0a1a9--)

Ambrosia deltoidea—*Carnegiea gigantea* Mixed Scrub Association
(1154.u0a1a1--)

Encelia farinosa Association (1154.u0a1a5--)

Encelia farinosa—*Olneya tesota* Association (1154.u0a2a0--)
Larrea tridentata—*Canotia holacantha* Association (1154.u0a1a3--)
Acacia greggii—*Ambrosia ambrosioides* Riparian Subassociation (1154.u0a1a0a3)
Prosopis velutina—*Parkinsonia florida* Riparian Subassociation (1154.u0a1a0a4)
Simmondsia chinensis—Mixed Scrub Association (1154.u0a1a2--)
Simmondsia chinensis—*Celtis pallida*—*Acacia greggii* Riparian Subassociation
 (1154.u0a1a0a4)
Canotia holacantha—Mixed Scrub Association (1154.u0a1a8--)
Larrea tridentata—Mixed Scrub (1154.u0a1a4--)
Parkinsonia microphylla—*Stenocereus thurberi* Association (1154.u0a1a6--)
Parkinsonia microphylla—*Olneya tesota*—Mixed Scrub Association
 (1154.u0a1a7--)
Parkinsonia microphylla—*Opuntia bigelovii*—*Fouquieria splendens* Association
 (1154.u0a1b0--)
Parkinsonia microphylla—*Eriogonum fasciculatum* Association
 (1154.u0a1b1--)

FGDC '96 type: Extremely xeromorphic mixed evergreen-deciduous subdesert shrubland with succulents. Code: IIC3a

NVCS (USGS-NPS-TNC) type: Deciduous subdesert shrubland with succulents (e.g., paloverde). Code: IV.C.3.a

Parkinsonia florida Shrubland Alliance
Parkinsonia microphyllum Shrubland Alliance
Fouquieria splendens Shrubland Alliance

References:

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.
 Sawyer, J. O. and T. Keeler-Wolf. 1995.
 Turner, R. M. and D. E. Brown. 1982.
 Warren, P. L., J. E. Bowers, B. D. Treadwell, and K. L. Reichhardt. 1980.

Sonoran Desertscrub: Saltbush Series

Nearctic Upland, Tropical-Subtropical Desertland, Sonoran Desertscrub, Saltbush Series (1154.u0a6----

Distribution: Widely distributed over the southwestern and western portions of Arizona, cover by this vegetation has been greatly reduced by conversion to agriculture. This series is frequently found in scattered patches and mixtures within the Creosotebush—Ambrosia Series (1154.u0a1----). Saltbush communities are found on finer textured soils than are the Creosote—Bursage or Paloverde—Mixed Cactus Series. These soils are easily detached and severe erosion is frequently seen in grazed stands. Water penetration of such fine soils is poor making them prone to collect salt. However, many well developed saltbush communities have developed on non-saline soils showing that the plants are not obligate halophyte.

The Saltbush Series often lies adjacent to the Creosotebush—Ambrosia Series and less commonly to the Paloverde—Mixed Cacti Series.

The plant families Chenopodiaceae and Amaranthaceae are prominent in this series and also contain plants that are notorious indicators of disturbance (*Salsola* [Russian thistle], *Suaeda* [seepweed], *Atriplex* [saltbush], and *Amaranthus* [amaranth]). Farming and grazing are widespread in this vegetation, and weedy species may be expected.

Physiognomy: Uniform stands of microphyllous gray-green evergreen or annual shrubs 0.6–1-m tall with 10–20% cover. Disturbed or disclimax communities may have total cover near 100%. Species diversity is usually low.

Floristics: *Atriplex polycarpa*, *A. linearis*, *A. confertifolia*, *Suaeda moquinii*, *Sporobolus airoides*, *Distichlis spicata*, and *Lycium* spp., are common. *Larrea tridentata*, *Opuntia fulgida*, *O. leptocaulis*, *O. acanthacarpa*, *Ambrosia dumosa*, and *A. deltoidea* are frequently seen members of adjacent vegetation types.

Dominance type examples:

Suaeda moquinii Association (1154.u0a6a0--)

Allenrolfea occidentalis Association (1154.u0a6a1--)

Atriplex spp.—*Prosopis velutina* Association (1154.u0a6a2--)

Atriplex polycarpa Association (1154.u0a6a4--)

Atriplex polycarpa—*A. linearis*—*Larrea tridentata* Subassociation (1154.u0a6a5a0)

Atriplex polycarpa—*A. linearis*—*Suaeda moquinii* Subassociation (1154.u0a6a5a1)

Atriplex polycarpa—*A. linearis*—*Prosopis velutina* Subassociation (1154.u0a6a5a2)

Atriplex confertifolia Association (1154.u0a6a6--)

Atriplex canescens Association (1154.u0a6a7--)

FGDC '96 type: Facultatively deciduous extreme xeromorphic subdesert shrubland.
Code: IIIA5b.

NVCS (USGS-NPS-TNC) type: Facultatively deciduous subdesert shrubland (e.g., saltbush). Code: IV.C.3.b

Atriplex canescens Shrubland Alliance
Atriplex confertifolia Shrubland Alliance
Atriplex cuneata Shrubland Alliance
Atriplex polycarpa Shrubland Alliance
Aloysia wrightii Shrubland Alliance
Atriplex confertifolia Shrubland Alliance
Atriplex hymenelytra Shrubland Alliance
Ceratoides lanata Shrubland Alliance
Chrysothamnus nauseosus Shrubland Alliance
Coleogyne ramosissima Shrubland Alliance
Flourensia cernua Shrubland Alliance
Poliomintha incana Shrubland Alliance

Reference:

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.
Sawyer, J. O. and T. Keeler-Wolf. 1995.

Rocky Mountain Deciduous: Cottonwood—Willow Series

Nearctic Wetland, Cold Temperate Riparian Deciduous Forest, Rocky Mountain Deciduous, Cottonwood—Willow Series (1222.k0a0---)

Distribution: This series occupies the canyons draining the Coconino and Kaibab Plateaus in central and eastcentral Arizona. Soils are azonal, deep, rocky, and gravelly. This series is of limited extent in Arizona between 1,520 and 2,130-m elevation.

Physiognomy: Deciduous broadleaf narrow crowned obligate riparian forest with a closed deciduous shrub lower layer and grasses. Maximum crown height is 15 m but more often 11 m. Shrub layer is 5–6-m tall. At higher elevations some conical crowned conifers may intrude. Total cover is 50–80%.

Floristics: *Populus angustifolia*, *Alnus oblongifolia*, *Salix bonplandiana*, *S. amygdaloides*, *Acer negundo*, *Quercus gambelii*, *Prunus* spp., *Juglans major*, and *Fraxinus velutina* are the usual community dominants. At higher elevations *Abies concolor*, *Pseudotsuga menziesii*, and *Pinus ponderosa* intrude from adjacent coniferous communities. Understory plants are *Salix exigua*, *S. irrorata*, *S. bebbiana*, *Robinia neomexicana*, *Ribes cerium*, *R. inerme*, *R. leptanthum*, *Amorpha fruticosa*, *Frangula betulifolia*, *Rhus glabra*, *R. aromatica*, *Tamarix* spp., and *Toxicodendron radicans*.

Dominance type examples:

Populus angustifolia—*Salix* spp. Association (1222.k0a0a0--)

Populus angustifolia—*Salix* spp.—*Tamarix* spp. Disclimax Subassociation (1222.k0a0a0a1)

FGDC '96 type: Seasonally temporarily flooded cold-deciduous open woodland.
Code: IB2d/IIB2b.

NVCS (USGS-NPS-TNC) type: Cold-deciduous seasonally/temporarily flooded forest.
Code: I.B.2.e

Acer negundo Forest Alliance

Alnus rhombifolia Forest Alliance

Populus fremontii Forest Alliance

Populus angustifolia Forest Alliance

Alnus rhombifolia Forest Alliance

Platanus wrightii Forest Alliance

References:

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979.

Larson, M, and W. H. Moir. 1987.

Mogollon: Cottonwood—Willow Series

Nearctic Wetland, Warm Temperate Riparian Deciduous Forest and Woodland, Interior Southwestern, Cottonwood—Willow Series (1223.q0a0---)

Distribution: Canyons and washes draining the Mogollon Rim of central Arizona and the mountains of the Basin and Range Province to the south. Typically found in open mesoriparian canyons or on bajadas, the community is exposed to full sunlight and warm, dry air. Elevational range is between 1,220 and 1,680 m.

Physiognomy: Open to very open broadleaf deciduous broad crowned forest or woodland with lower shrub and forb layers. Total vegetation cover is 30–70%.

Floristics: *Populus fremontii*, *P. angustifolia*, *Salix gooddingii*, *S. bonplandiana*, *Morus microphylla*, *Celtis pallida*, *C. laevigata* var. *reticulata*, *Fraxinus velutina*, and *Juglans major*. Smaller trees are *Prosopis velutina* and *Chilopsis linearis*. Shrubs are *Salix exigua*, *S. lasiolepis*, *Hymenoclea monogyra*, *Baccharis salicifolia*, and *Ziziphus obtusifolia*. *Sporobolus airoides* and *Bouteloua curtipendula* are common grasses.

Dominance type examples:

Populus fremontii—*Salix* spp. Association (1223.q0a0a0--)

Populus fremontii Association (1223.q0a0a1--)

FGDC '96 type: Seasonally temporarily flooded cold-deciduous open woodland.
Code: IIB2b.

NVCS (USGS-NPS-TNC) type: Cold-deciduous seasonally temporarily flooded forest.
Code: I.B.2.e

Populus fremontii Forest Alliance

Populus angustifolia Forest Alliance

References:

Bassett, D., M. Larson, and W. H. Moir. 1987.

Brown, D. E. 1982.

Mogollon: Mixed Broadleaf

Nearctic Wetland, Warm Temperate Interior Southwestern Riparian Deciduous Forest and Woodland, Mixed Broadleaf Series (1223.q0a1----)

Distribution: Canyons and washes draining the Mogollon Rim of central Arizona and the mountains of the Basin and Range Province to the south. Typically found in hydro- and mesoriparian canyons where the communities are sheltered and humidity is higher. Occurs between elevations of 1,220 and 1,830 m. Species diversity is very high. These communities are very important wildlife habitat.

Physiognomy: Deciduous broadleaf broad crown trees with abundant shrub and forb layers.

Floristics: *Platanus wrightii*, *Juglans major*, *Salix gooddingii*, *Fraxinus velutina*, and *Populus fremontii* are the most important trees. Important accessory species are *Pinus engelmannii*, *Arbutus arizonica*, *Quercus rugosa*, *Q. hypoleucoides*, *Q. arizonica*, *Q. emoryi*, *Cornus sericea* ssp. *sericea*, *Acer glabrum*, *A. grandidentatum*, *Juniperus deppeana*, *Pinus discolor*, and *Cupressus arizonica*.

Shrubs are *Amorpha fruticosa*, *Frangula betulifolia*, *Frangula californica* ssp., *Cercocarpus montanus*, *Ceanothus integerrimus*, *Ptelea trifoliata* var. *angustifolia*, *Salix lasiolepis*, *Toxicodendron rydbergii*, and *Sideroxylon lanuginosum*. The herb and grass layer is *Brickellia eupatorioides* var. *chlorolepis*, *Erigeron vreelandii*, *Lactuca graminifolia*, *Viguiera triloba*, *Gentianella microcalyx*, *Hypericum scouleri*, *Monarda fistulosa* var. *menthifolia*, *Stachys coccinea*, *Allophyllum gilioides*, *Ranunculus arizonicus*, *Diodia teres*, *Galium wrightii*, *Mimulus guttatus*, *Glandularia bipinnatifida*, *Cyperus squarrosus*, *Agrostis scabra*, *Aristida purpurea* var. *longiseta*, and *Echinochloa crus-galli*.

Dominance type examples:

Platanus wrightii—*Fraxinus velutina*—*Populus fremontii*—Mixed Deciduous Association (1223.q0a1a0--)

Platanus wrightii—Mixed *Quercus* spp. Subassociation (1223.q0a1a1a0)

Juglans major Association (1223.q0a1a4--)

FGDC '96 type: Temporarily flooded cold-deciduous forest/Temporarily flooded cold deciduous woodland (IB2d/IIB2b).

NVCS (USGS-NPS-TNC) type: Cold-deciduous seasonally/temporarily flooded forest/ Temperate deciduous shrubland. Code: I.B.2.e/IV.B.2.a

Platanus wrightii Forest Alliance

Populus angustifolia Forest Alliance

Populus fremontii Forest Alliance

Juglans major Alliance

References:

Bassett, D., M. Larson, and W. H. Moir. 1987.
Brown, D. E. 1982.

Sonoran Riparian and Oasis Forest: Cottonwood—Willow

Nearctic Wetland, Tropical-Subtropical Swamp Riparian and Oasis Forests, Sonoran Riparian and Oasis Forest, Cottonwood-Willow Series (1224.u0a2----)

Distribution: Found along hydro- and mesoriparian drainages in the southern half of the state at elevations between 328 and 760 m. These gallery forests formerly lined drainages throughout southern Arizona, including the Colorado River. Today, approximately 90% of this vegetation has been cut or is in poor condition owing to lowering of the water table by groundwater pumping or stream entrenchment. They are of particular interest because they are highly diverse and have high value to wildlife.

Physiognomy: Closed stands of deciduous broadleaf trees and pinnate leguminous short trees with lower shrub and forb layers. Total vegetation cover is between 70 and 100%.

Floristics: *Populus fremontii*, *Acacia greggii*, *Brickellia* spp., *Salix gooddingii*, *S. exigua*, *Fallugia paradoxa*, *Cercis canadensis* var. *texensis*, *Baccharis* spp. *Vitis arizonica*, *Mimulus cardinalis*, and *Bromus rubens*.

Dominance type examples:

- Populus fremontii*—*Salix gooddingii* Association (1224.u0a2a0--)
- Populus fremontii* Association (1224.u0a2a1--)
- Salix gooddingii* Association (1224.u0a2a2--)

FGDC '96 type: Temporarily Flooded Cold Deciduous Forest/Woodland.

Code: IB2d/IIB2d

NVCS (USGS-NPS-TNC) type: Cold-deciduous seasonally or temporarily flooded forest/Cold-deciduous intermittently flooded forest (e.g., woody draws).

Code: I.B.2.e/IB2d/IIB2a

- Populus fremontii* Forest Alliance
- Populus fremontii* Woodland Alliance
- Populus angustifolia* Woodland Alliance
- Populus tremuloides* Woodland Alliance
- Salix amygdaloides* Woodland Alliance
- Salix laevigata* Woodland Alliance
- Fraxinus pennsylvanica* Forest Alliance

References:

- Brown, D. E. 1982.
- Warren, P. L., J. E. Bowers, B. D. Treadwell, and K. L. Reichhardt. 1980.

Sonoran Deciduous Swamp and Riparian Scrub: Mixed Scrub

Nearctic Wetland, Tropical-Subtropical Swamp and Riparian Scrub, Sonoran Deciduous Swamp and Riparian Scrub, Mixed Scrub Series (1234.u0a0----)

Distribution: Widely scattered in southwestern Arizona. These communities are confined to places with abundant moisture which may not be associated with obvious riparian features. In the southwest, these communities are called “bosques.” The soils periodically reach field moisture capacity and have moisture near the surface. We classify the mesquite-seepwillow-coyote willow forming the “bathtub ring” along the Colorado River within Grand Canyon as belonging here instead of in the strand series of Brown, Lowe, and Pase. These habitats are becoming less common as riparian lands are converted to agriculture. One of the largest bosques in Arizona (The Grand Bosque) is found just south of Tucson along the Santa Cruz River. Approximately 90% of the bosques have been cut for firewood, charcoal, or converted to agricultural use.

Physiognomy: Closed or nearly closed stands of microphyll and nanophyll deciduous, facultative deciduous shrubs. Herbs, if present, are patchy and scattered. Shrub height is 1.2–2.1 m with scattered plants to 3.7 m. Total vegetation cover is 50–100%.

Floristics: The community is floristically rich. Among the most important plants *Hymenoclea monogyra*, *Acacia greggii* (Catclaw acacia), *Celtis pallida* (Desert hackberry), *Baccharis sarothroides* (Desert broom), *Pluchea sericea* (Arrow-weed), *Prosopis pubescens*, *P. velutina*, *P. glandulosa* var. *torreyana* (Western honey mesquite), *Suaeda moquini*, *Salix gooddingii*, *Tamarix* spp., *Isocoma acradenia*, *Atriplex* spp., *Scirpus americanus*, *Scirpus* spp., *Eleocharis* spp., *Distichlis spicata*, and *Sporobolus airoides*, and *Chilopsis linearis*. *Tamarix* spp. is often present, if dominant see the community is considered disclimax.

Dominance type examples:

Prosopis pubescens-*Prosopis glandulosa* var. *torreyana*-*Pluchea sericea*
Association (1234.u0a0a0--)

Hymenoclea monogyra-*Prosopis velutina* Association (1234.u0a0a1--)

FGDC '96 type: Mixed evergreen cold deciduous shrubland. Code: IIIC2a.

NVCS (USGS-NPS-TNC) type: Deciduous subdesert shrubland with succulents.
Code: IV.C.3.a

Lycium berlandieri Shrubland Alliance
Prosopis pubescens Shrubland Alliance
Prosopis velutina Shrubland Alliance

Reference:

Brown, D. E. 1982.

Mohave Emergent: Marshland: Cattail

Nearctic Wetland, Warm Temperate Marshland, Mohavian Interior Marshland, Cattail Series (1243.p0a0----)

Distribution: Found widely scattered in the state along major (hydroriparian) waterways and in old oxbows, silt-laden reservoirs, lakes, cattle tanks, and even a few springs or cienegas. They occur at elevations between 328 and 1,830 m. Extensive stands occur along the Colorado River.

Physiognomy: Closed single-layer stand of perennial graminoids, often bearing rhizomes, bulbs, or fibrous roots with shorter grasses and forbs. Vegetation 5 cm–1.5 m in height.

Floristics: *Scirpus americanus*, *S. acutus*, *Cyperus esculentus*, *Bulbostylis capillaris*, *Eleocharis rostellata*, *Phragmites australis*, *Juncus* sp., and *Carex* spp. Other plants such as *Distichlis spicata*, *Cynodon dactylon* (Bermuda grass), *Typha* spp. (cattail), *Pluchea* sp. (arrow-weed), etc. that belong in other vegetation series may be found sparingly.

Dominance type examples:

Juncus cooperi Association (1243.p0a0a0--)

Juncus mexicanus Association (1243.t0a0a0--)

Phragmites australis Association (1244.u0a1a0--)

FGDC '96 type: Semipermanently flooded temperate or subpolar grassland.
Code: VA5l.

NVCS (USGS-NPS-TNC) type: Saturated tall grassland. Code: VIII.A.2.e
Typha spp. Herbaceous Alliance

Reference:

Brown, D. E. 1982.

Sawyer, J. O. and T. Keeler-Wolf. 1995.

Sonoran Interior Marshland: Cattail

Nearctic Wetland, Tropical-Subtropical Marshland, Sonoran Interior Marshland, Cattail Series (1244.u0a0----)

Distribution: Widely distributed mostly along the shores of ponds or lakes with a stable water level. They are found less frequently around springs and seeps (ciénegas) where the soil is soft and at or above field capacity. Cattail communities are found at all elevations between 328 and 1,830 m or above.

Physiognomy: Generally closed single-layer stands of tall perennial graminoids, bearing rhizomes or fibrous roots. Emergent communities may be more open than those in shallow water or around seeps. Drier habitats may have a lower layer of graminoid plants. Vegetation is 0.9–5 m in height. Total cover is 30–100%.

Floristics: *Typha latifolia* or *T. domingensis* are dominant but may be mixed with *Scirpus americanus*, *S. acutus*, *Cyperus esculentus*, *Bulbostylis capillaris*, *Eleocharis rostellata*, *Phragmites australis*, *Juncus* sp., and *Carex* spp. Other plants such as *Distichlis spicata*, *Cynodon dactylon* (Bermuda grass), *Typha* spp. (cattail), *Pluchea* sp. (arrow-weed), *Cyperus esculentus*, *Eleocharis* spp., *Juncus* sp., and *Carex* spp., etc. that belong in other vegetation series may be found sparingly. Grasses such as *Distichlis spicata*, *Cynodon dactylon*, etc. may occur on drier sites.

Dominance type examples:

Typha domingensis Association (1244.u0a0a0--)

Typha domingensis—*Scirpus americanus* Subassociation (1244.u0a0a0a0)

Juncus cooperi Association (1243.p0a0a0--)

Juncus mexicanus Association (1243.t0a0a0--)

Phragmites australis Association (1244.u0a1a0--)

FGDC '96 type: Semipermanently flooded temperate or subpolar grassland.

Code: VA5l.

NVCS (USGS-NPS-TNC) type: Saturated tall grassland. Code: VIII.A.2.e/VIII.A.2.f

Typha spp. Herbaceous Alliance

Scirpus spp.—*Typha* spp.—*Sparganium* spp.—*Juncus* spp. Herbaceous Alliance

Reference:

Brown, D. E. 1982.

Sawyer, J. O. and T. Keeler-Wolf. 1995.

References

This list includes references to all literature cited in the Arizona Gap program. In

most cases conventional brief citations appear in the text, for example: Abrams 1940. However some citations that appear in spreadsheet format, notably the JBK modification of the BLP vegetation classification, use concatenated references, for example: Alexander, B. G., F. Ronco Jr., E. L. Fitzhugh, and J. A. Ludwig. 1984 is shortened to ARFL84. These abbreviated citations appear below enclosed within brackets at the end of the full citation.

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