

APPENDIX F

SOUTHWEST REGIONAL GAP ANALYSIS

PROJECT LANDCOVER TYPES AND DESCRIPTIONS FOR ARIZONA

The following are the Southwest Regional GAP Analysis Project landcover types and descriptions for Arizona. Descriptions were taken directly from Southwest Regional GAP Analysis Project – Land Cover Descriptions (USGS National GAP Analysis Program 2005).

Agriculture

An aggregated landcover type that includes both Pasture/Hay: areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle, where pasture/hay vegetation accounts for greater than 20 percent of total vegetation, and Cultivated Crops: areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards, where crop vegetation accounts for greater than 20 percent of total vegetation. Cultivated Crops also includes all land being actively tilled.

Apacherian-Chihuahuan Mesquite Upland Scrub

This ecological system occurs as upland shrublands that are concentrated in the extensive grassland-shrubland transition in foothills and piedmont in the Chihuahuan Desert. It extends into the Sky Island region to the west and the Edwards Plateau to the east. Substrates are typically derived from alluvium, often gravelly without a well-developed argillic or calcic soil horizon that would limit infiltration and storage of winter precipitation in deeper soil layers. *Prosopis* spp. and other deep-rooted shrubs exploit this deep soil moisture that is unavailable to grasses and cacti. Vegetation is typically dominated by *Prosopis glandulosa* or *Prosopis velutina* and succulents. Other desert scrub that may codominate or dominate includes *Acacia neovernicosa*, *Acacia constricta*, *Juniperus*

monosperma, or *Juniperus coahuilensis*. Grass cover is typically low. During the last century, the area occupied by this system has increased through conversion of desert grasslands as a result of drought, overgrazing by livestock, and/or decreases in fire frequency.

Apacherian-Chihuahuan Semi-Desert Grassland and Steppe

This ecological system is a broadly defined desert grassland, mixed shrub-succulent or xeromorphic tree savanna that is typical of the Borderlands of Arizona, New Mexico and northern Mexico [Apacherian region] but extends west to the Sonoran Desert, north into the Mogollon Rim and throughout much of the Chihuahuan Desert. It is found on gently sloping bajadas that supported frequent fire throughout the Sky Islands and on mesas and steeper piedmont and foothill slopes in the Chihuahuan Desert. It is characterized by typically diverse perennial grasses. Common grass species include *Bouteloua eriopoda*, *Bouteloua hirsuta*, *Bouteloua rothrockii*, *Bouteloua curtipendula*, *Bouteloua gracilis*, *Eragrostis intermedia*, *Muhlenbergia porteri*, *Muhlenbergia setifolia*, *Pleuraphis jamesii*, *Pleuraphis mutica*, and *Sporobolus airoides*, succulent species of Agave, *Dasyliirion*, and *Yucca*, and tall-shrub/short-tree species of *Prosopis* and various oaks (e.g., *Quercus grisea*, *Quercus emoryi*, *Quercus arizonica*).

Barren Lands, Non-specific

Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulation of earthen material. Generally, vegetation accounts for less than 15 percent of total cover.

Colorado Plateau Blackbrush-Mormon-tea Shrubland

This ecological system occurs in the Colorado Plateau on benchlands, colluvial slopes, pediments or bajadas. Elevation ranges from 560-1650 meters. Substrates are shallow, typically calcareous, non-saline and gravelly or sandy soils over sandstone or limestone bedrock, caliche or limestone alluvium. It also occurs in deeper soils on sandy plains where it may have invaded desert grasslands. The vegetation is characterized by extensive open shrublands dominated by *Coleogyne ramosissima* often with *Ephedra viridis*, *Ephedra torreyana*, or *Grayia spinosa*. Sandy portions may include *Artemisia filifolia* as codominant. The herbaceous layer is sparse and composed of graminoids such as *Achnatherum hymenoides*, *Pleuraphis jamesii*, or *Sporobolus cryptandrus*.

Colorado Plateau Mixed Bedrock Canyon and Tableland

The distribution of this ecological system is centered on the Colorado Plateau where it is comprised of barren and sparsely vegetated landscapes (generally less than 10 percent plant cover) of steep cliff faces, narrow canyons, and open tablelands of predominantly sedimentary rocks, such as sandstone, shale, and limestone. The vegetation is characterized by very open tree canopy or scattered trees and shrubs with a sparse herbaceous layer. Common species includes *Pinus edulis*, *Pinus ponderosa*, *Juniperus* spp., *Cercocarpus intricatus*, and

other short-shrub and herbaceous species, utilizing moisture from cracks and pockets where soil accumulates.

Colorado Plateau Mixed Low Sagebrush Shrubland

This ecological system occurs in the Colorado Plateau, Tavaputs Plateau and Uinta Basin in canyons, gravelly draws, hilltops, and dry flats at elevations generally below 1800 meters. Soils are often rocky, shallow, and alkaline. This type extends across northern New Mexico into the southern Great Plains on limestone hills. It includes open shrublands and steppe dominated by *Artemisia nova* or *Artemisia bigelovii* sometimes with *Artemisia tridentata* ssp. *wyomingensis* codominant. Semi-arid grasses such as *Achnatherum hymenoides*, *Aristida purpurea*, *Bouteloua gracilis*, *Hesperostipa comata*, *Pleuraphis jamesii*, or *Poa fendleriana* are often present and may form a graminoid layer with over 25 percent cover.

Colorado Plateau Pinyon-Juniper Shrubland

This ecological system is characteristic of the rocky mesatops and slopes on the Colorado Plateau and western slope of Colorado, but these stunted tree shrublands may extend further upslope along the low-elevation margins of taller pinyonjuniper woodlands. Sites are drier than Colorado Plateau Pinyon-Juniper Woodland. Substrates are shallow/rocky and shaley soils at lower elevations (1200-2000 meters). Sparse examples of the system grade into Colorado Plateau Mixed Bedrock Canyon and Tableland. The vegetation is dominated by dwarfed (usually less than 3 meters tall) *Pinus edulis* or *Juniperus osteosperma* trees forming extensive tall shrublands in the region along low-elevation margins of pinyon-juniper woodlands. Other shrubs, if present, may include *Artemisia nova*, *Artemisia tridentata* ssp. *wyomingensis*, *Chrysothamnus viscidiflorus*, or *Coleogyne ramosissima*. Herbaceous layers are sparse to moderately dense and typically composed of xeric graminoids.

Colorado Plateau Pinyon-Juniper Woodland

This ecological system occurs in dry mountains and foothills of the Colorado Plateau region including the Western Slope of Colorado to the Wasatch Range, south to the Mogollon Rim and east into the northwestern corner of New Mexico. It is typically found at lower elevations ranging from 1500-2440 meters. These woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Soils supporting this system vary in texture ranging from stony, cobbly, gravelly sandy loams to clay loam or clay. *Pinus edulis* and/or *Juniperus osteosperma* dominate the tree canopy. In the southern portion of the Colorado Plateau in northern Arizona and northwestern New Mexico, *Juniperus monosperma* and hybrids of *Juniperus spp* may dominate or codominate the tree canopy. *Juniperus scopulorum* may codominate or replace *Juniperus osteosperma* at higher elevations. Understory layers are variable and may be dominated by shrubs, graminoids, or be absent. Associated species include *Arctostaphylos patula*, *Artemisia tridentata*,

Cercocarpus intricatus, *Cercocarpus montanus*, *Coleogyne ramosissima*, *Purshia stansburiana*, *Purshia tridentata*, *Quercus gambelii*, *Bouteloua gracilis*, *Pleuraphis jamesii*, or *Poa fendleriana*. This system occurs at higher elevations than Great Basin Pinyon-Juniper Woodland and Colorado Plateau shrubland systems where sympatric.

Developed, Medium - High Intensity

The developed medium intensity category includes areas with a mixture of constructed materials and vegetation. Impervious surface accounts for 50-79 percent of the total cover. These areas most commonly include single-family housing units. Developed, high intensity includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total cover.

Developed, Open Space - Low Intensity

Developed Open Space of low intensity includes areas with a mixture of some construction materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. The developed, low intensity category includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single family housing units.

Great Basin Pinyon-Juniper Woodland

This ecological system occurs on dry mountain ranges of the Great Basin region and eastern foothills of the Sierra Nevada. It is typically found at lower elevations ranging from 1600-2600 meters. These woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Woodlands dominated by a mix of *Pinus monophylla* and *Juniperus osteosperma*, pure or nearly pure occurrences of *Pinus monophylla*, or woodlands dominated solely by *Juniperus osteosperma* comprise this system. *Cercocarpus ledifolius* is a common associate. Understory layers are variable. Associated species include shrubs such as *Arctostaphylos patula*, *Artemisia arbuscula*, *Artemisia nova*, *Artemisia tridentata*, *Cercocarpus ledifolius*, *Cercocarpus intricatus*, *Coleogyne ramosissima*, *Quercus gambelii*, *Quercus turbinella*, and bunch grasses *Hesperostipa comata*, *Festuca idahoensis*, *Pseudoroegneria spicata*, *Leymus cinereus* (= *Elymus cinereus*), and *Poa fendleriana*. This system occurs at lower elevations than Colorado Plateau Pinyon-Juniper Woodland where sympatric.

Great Basin Semi-Desert Chaparral

This system includes chaparral on sideslopes transitioning from low-elevation desert landscapes up into pinyon-juniper woodlands of the western and central Great Basin. There are limited occurrences extending as far west as the inner Coast Ranges in central California. These are typically fairly open-canopy shrublands with open spaces either bare or supporting patchy grasses and forbs. Characteristic species may include *Arctostaphylos patula*, *Arctostaphylos pungens*, *Ceanothus greggii*, *Ceanothus velutinus*, *Cercocarpus montanus* var. *glaber*, *Cercocarpus intricatus*, *Eriogonum fasciculatum*, *Garrya flavescens*, *Quercus turbinella*, *Purshia stansburiana*, and *Rhus trilobata*. *Cercocarpus ledifolius* is generally absent. Typical fire regime in these systems varies with the amount of organic accumulation.

Inter-Mountain Basins Active and Stabilized Dune

This ecological system occurs in Intermountain West basins and is composed of unvegetated to moderately vegetated (less than 10-30 percent plant cover) active and stabilized dunes and sandsheets. Species occupying these environments are often adapted to shifting, coarse-textured substrates (usually quartz sand) and form patchy or open grasslands, shrublands or steppe composed of *Achnatherum hymenoides*, *Artemisia filifolia*, *Artemisia tridentata* ssp. *tridentata*, *Atriplex canescens*, *Ephedra* spp., *Coleogyne ramosissima*, *Ericameria nauseosa*, *Leymus flavescens*, *Prunus virginiana*, *Psoralidium lanceolatum*, *Purshia tridentata*, *Sporobolus airoides*, *Tetradymia tetrameres*, or *Tiquilia* spp.

Inter-Mountain Basins Big Sagebrush Shrubland

This ecological system occurs throughout much of the western U.S., typically in broad basins between mountain ranges, plains and foothills between 1500 and 2300 meters elevation. Soils are typically deep, well-drained and non-saline. These shrublands are dominated by *Artemisia tridentata* ssp. *tridentata* and/or *Artemisia tridentata* ssp. *wyomingensis*. Scattered *Juniperus* spp., *Sarcobatus vermiculatus*, and *Atriplex* spp. may be present in some stands. *Ericameria nauseosa*, *Chrysothamnus viscidiflorus*, *Purshia tridentata*, or *Symphoricarpos oreophilus* may codominate disturbed stands. Perennial herbaceous components typically contribute less than 25 percent vegetative cover. Common graminoid species include *Achnatherum hymenoides*, *Bouteloua gracilis*, *Elymus lanceolatus*, *Festuca idahoensis*, *Hesperostipa comata*, *Leymus cinereus*, *Pleuraphis jamesii*, *Pascopyrum smithii*, *Poa secunda*, or *Pseudoroegneria spicata*.

Inter-Mountain Basins Greasewood Flat

This ecological system occurs throughout much of the western U.S. in Intermountain basins and extends onto the western Great Plains. It typically occurs near drainages on stream terraces and flats or may form rings around more sparsely vegetated playas. Sites typically have saline soils, a shallow water table and flood intermittently, but remain dry for most growing seasons. The water table remains high enough to maintain vegetation, despite salt accumulations. This system usually occurs as a mosaic of multiple communities,

with open to moderately dense shrublands dominated or codominated by *Sarcobatus vermiculatus*, *Atriplex canescens*, *Atriplex confertifolia*, or *Krascheninnikovia lanata* may be present to codominant. Occurrences are often surrounded by mixed salt desert scrub. The herbaceous layer, if present, is usually dominated by graminoids. There may be inclusions of *Sporobolus airoides*, *Distichlis spicata* (where water remains ponded the longest), or *Eleocharis palustris* herbaceous types.

Inter-Mountain Basins Juniper Savanna

This widespread ecological system occupies dry foothills and sandsheets of western Colorado, northwestern New Mexico, northern Arizona, Utah, west into the Great Basin of Nevada and southern Idaho. It is typically found at lower elevations ranging from 1500-2300 meters. This system is generally found at lower elevations and more xeric sites than Great Basin Pinyon-Juniper Woodland or Colorado Plateau Pinyon-Juniper Woodland. These occurrences are found on lower mountain slopes, hills, plateaus, basins and flats often where juniper is expanding into semi-desert grasslands and steppe. The vegetation is typically open savanna, although there may be inclusions of more dense juniper woodlands. This savanna is typically dominated by *Juniperus osteosperma* trees with high cover of perennial bunch grasses and forbs, with *Bouteloua gracilis*, *Hesperostipa comata*, and *Pleuraphis jamesii* being most common. In the southern Colorado Plateau, *Juniperus monosperma* or juniper hybrids may dominate the tree layer. Pinyon trees are typically not present because sites are outside the ecological or geographic range of *Pinus edulis* and *Pinus monophylla*.

Inter-Mountain Basins Mat Saltbush Shrubland

This ecological system occurs on gentle slopes and rolling plains in the northern Colorado Plateau and Uinta Basin on Mancos Shale and arid, wind-swept basins and plains across parts of Wyoming. Substrates are shallow, typically saline, alkaline, fine-textured soils developed from shale or alluvium and may be associated with shale badlands. Infiltration rate is typically low. These landscapes that typically support dwarf-shrublands composed of relatively pure stands of *Atriplex* spp. such as *Atriplex corrugata* or *Atriplex gardneri*. Other dominant or codominant dwarf-shrubs may include *Artemisia longifolia*, *Artemisia pedatifida*, or *Picrothamnus desertorum*, sometimes with a mix of other low shrubs such as *Krascheninnikovia lanata* or *Tetradymia spinosa*. *Atriplex confertifolia* or *Atriplex canescens* may be present, but do not codominate. The herbaceous layer is typically sparse. Scattered perennial forbs occur, such as *Xylorhiza glabriuscula* and *Sphaeralcea grossulariifolia*, and the perennial grasses *Achnatherum hymenoides*, *Bouteloua gracilis*, *Elymus elymoides*, *Elymus lanceolatus* ssp. *lanceolatus*, *Pascopyrum smithii*, or *Sporobolus airoides* may dominate the herbaceous layer. In less saline areas, there may be inclusions grasslands dominated by *Hesperostipa comata*, *Leymus salinus*, *Pascopyrum smithii*, or *Pseudoroegneria spicata*. In Wyoming and possibly elsewhere, inclusions of non-saline, gravelly barrens or rock outcrops dominated by cushion plants such as *Arenaria hookeri* and *Phlox hoodii* without dwarf-shrubs may be present. Annuals are seasonally present and may include

Eriogonum inflatum, *Plantago tweedyi*, and the introduced annual grass *Bromus tectorum*.

Inter-Mountain Basins Mixed Salt Desert Scrub

This extensive ecological system includes open-canopied shrublands of typically saline basins, alluvial slopes and plains across the Intermountain western U.S. This type also extends in limited distribution into the southern Great Plains. Substrates are often saline and calcareous, medium- to fine-textured, alkaline soils, but include some coarser-textured soils. The vegetation is characterized by a typically open to moderately dense shrubland composed of one or more *Atriplex* species such as *Atriplex confertifolia*, *Atriplex canescens*, *Atriplex polycarpa*, or *Atriplex spinifera*. Other shrubs present to codominate may include *Artemisia tridentata* ssp. *wyomingensis*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Ephedra nevadensis*, *Grayia spinosa*, *Krascheninnikovia lanata*, *Lycium* spp., *Picrothamnus desertorum*, or *Tetradymia* spp. *Sarcobatus vermiculatus* is generally absent, but if present does not codominate. The herbaceous layer varies from sparse to moderately dense and is dominated by perennial graminoids such as *Achnatherum hymenoides*, *Bouteloua gracilis*, *Elymus lanceolatus* ssp. *lanceolatus*, *Pascopyrum smithii*, *Pleuraphis jamesii*, *Pleuraphis rigida*, *Poa secunda*, or *Sporobolus airoides*. Various forbs are also present in this ecosystem.

Inter-Mountain Basins Semi-Desert Grassland

This widespread ecological system occurs throughout the intermountain western U.S. on dry plains and mesas, at approximately 1450 to 2320 meters (4750-7610 feet) elevation. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesatops, plateau parks, alluvial flats, and plains, but sites are typically xeric. Substrates are often well-drained sandy or loamy-textured soils derived from sedimentary parent materials but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks. When they occur near foothill grasslands they will be at lower elevations. The dominant perennial bunch grasses and shrubs within this system are all very drought-resistant plants. These grasslands are typically dominated or codominated by *Achnatherum hymenoides*, *Aristida* spp., *Bouteloua gracilis*, *Hesperostipa comata*, *Muhlenbergia* sp., or *Pleuraphis jamesii* and may include scattered shrubs and dwarfshrubs of species of *Artemisia*, *Atriplex*, *Coleogyne*, *Ephedra*, *Gutierrezia*, or *Krascheninnikovia lanata*.

Inter-Mountain Basins Semi-Desert Shrub Steppe

This ecological system occurs throughout the intermountain western U.S., typically at lower elevations on alluvial fans and flats with moderate to deep soils. This semi-arid shrub-steppe is typically dominated by graminoids (less than 25 percent cover) with an open shrub layer. Characteristic grasses include *Achnatherum hymenoides*, *Bouteloua gracilis*, *Distichlis spicata*, *Hesperostipa comata*, *Pleuraphis jamesii*, *Poa secunda*, and *Sporobolus airoides*. The woody layer is often a mixture of shrubs and dwarf-shrubs. Characteristic species include *Atriplex canescens*, *Artemisia tridentata*, *Chrysothamnus greenei*, *Chrysothamnus viscidiflorus*,

Ephedra spp., *Ericameria nauseosa*, *Gutierrezia sarothrae*, and *Krascheninnikovia lanata*. *Artemisia tridentata* may be present but does not dominate. The general aspect of occurrences may be either open shrubland with patchy grasses or patchy open herbaceous layer. Disturbance may be important in maintaining the woody component. Microphytic crust is very important in some stands.

Inter-Mountain Basins Shale Badland

This widespread ecological system of the intermountain western U.S. is composed of barren and sparsely vegetated substrates (less than 10 percent plant cover) typically derived from marine shales but also includes substrates derived from siltstones and mudstones (clay). Landforms are typically rounded hills and plains that form a rolling topography. The harsh soil properties and high rate of erosion and deposition are driving environmental variables supporting sparse dwarf-shrubs, e.g., *Atriplex corrugata*, *Atriplex gardneri*, *Artemisia pedatifida*, and herbaceous vegetation.

Inter-Mountain Basins Volcanic Rock and Cinder Land

This ecological system occurs in the intermountain western U.S. and is limited to barren and sparsely vegetated volcanic substrates (generally less than 10 percent plant cover) such as basalt lava (malpais), basalt dikes with associated colluvium, basalt cliff faces and uplifted "backbones," tuff, cinder cones or cinder fields. It may occur as large-patch, small-patch and linear (dikes) spatial patterns. Vegetation is variable and includes a variety of species depending on local environmental conditions, e.g., elevation, age and type of substrate. At montane and foothill elevations scattered *Pinus ponderosa*, *Pinus flexilis*, or *Juniperus* spp. trees may be present. Shrubs such as *Ephedra* spp., *Atriplex canescens*, *Eriogonum corymbosum*, *Eriogonum ovalifolium*, and *Fallugia paradoxa* are often present on some lava flows and cinder fields. Species typical of sand dunes such as *Andropogon hallii* and *Artemisia filifolia* may be present on cinder substrates.

Inter-Mountain Basins Wash

This barren and sparsely vegetated (generally less than 10 percent plant cover) ecological system is restricted to intermittently flooded streambeds and banks that are often lined with shrubs such as *Sarcobatus vermiculatus*, *Ericameria nauseosa*, *Fallugia paradoxa*, and/or *Artemisia cana* ssp. *cana* (in more northern and mesic stands). *Grayia spinosa* may dominate in the Great Basin. Shrubs form a continuous or intermittent linear canopy in and along drainages but do not extend out into flats. Typically it includes patches of saltgrass meadow where water remains for the longest periods. Soils are generally less alkaline than those found in the playa system. Desert scrub species (e.g., *Acacia greggii*, *Prosopis* spp.), that are common in the Mojave, Sonoran and Chihuahuan desert washes, are not present. This type can occur in limited portions of the southwestern Great Plains.

Invasive Annual and Biennial Forbland

Areas that are dominated by introduced annual and/or biennial forb species such as: *Halogeton glomeratum*, *Kochia scoparia*, or *Salsola* spp.

Invasive Annual Grassland

Areas that are dominated by introduced annual grass species such as: *Avena* spp., *Bromus* spp., or *Schismus* spp.

Invasive Perennial Grassland

Areas that are dominated by introduced perennial grass species such as: *Agropyron cristatum*, *Bromus inermis*, *Eragrostis lehmannianna*, *Pennisetum* spp., *Poa bulbosa*, *P. pratensis*, or *Thinopyrum intermedium*.

Invasive Southwest Riparian Woodland and Shrubland

Areas that are dominated by introduced riparian woody species such as: *Tamarix* spp. and *Elaeagnus angustifolius*.

Madrean Encinal

Madrean Encinal occurs on foothills, canyons, bajadas and plateaus in the Sierra Madre Occidentale and Sierra Madre Orientale in Mexico, extending north into Trans-Pecos Texas, southern New Mexico and sub-Mogollon Arizona. These woodlands are dominated by Madrean evergreen oaks along a low-slope transition below Madrean Pine-Oak Forest and Woodland and Madrean Pinyon-Juniper Woodland. Lower elevation stands are typically open woodlands or savannas where they transition into desert grasslands, chaparral or in some cases desertscrub. Common evergreen oak species include *Quercus arizonica*, *Quercus emoryi*, *Quercus intricata*, *Quercus grisea*, *Quercus oblongifolia*, *Quercus toumeyi*, and in Mexico *Quercus chihuahuensis* and *Quercus albocincta*. Madrean pine, Arizona cypress, pinyon and juniper trees may be present, but do not codominate. Chaparral species such as *Arctostaphylos pungens*, *Cercocarpus montanus*, *Purshia* spp., *Garrya wrightii*, *Quercus turbinella*, *Frangula betulifolia* (= *Rhamnus betulifolia*), or *Rhus* spp. may be present but do not dominate. The graminoid layer is usually prominent between trees in grassland or steppe that is dominated by warm-season grasses such as *Aristida* spp., *Bouteloua gracilis*, *Bouteloua curtipendula*, *Bouteloua rothrockii*, *Digitaria californica*, *Eragrostis intermedia*, *Hilaria belangeri*, *Leptochloa dubia*, *Muhlenbergia* spp., *Pleuraphis jamesii*, or *Schizachyrium cirratum*. This system includes seral stands dominated by shrubby Madrean oaks typically with a strong graminoid layer. In transition areas with drier chaparral systems, stands of chaparral are not dominated by Madrean oaks; however, Madrean Encinal may extend down along drainages.

Madrean Pine-Oak Forest and Woodland

This system occurs on mountains and plateaus in the Sierra Madre Occidentale and Sierra Madre Orientale in Mexico, Trans-Pecos Texas, southern New Mexico and Arizona, generally south of the Mogollon Rim. These forests and woodlands are composed of Madrean pines (*Pinus arizonica*, *Pinus engelmannii*, *Pinus leiophylla*, or *Pinus strobiformis*) and evergreen oaks (*Quercus arizonica*,

Quercus emoryi, or *Quercus grisea*) intermingled with patchy shrublands on most mid-elevation slopes (1500-2300 meters elevation). Other tree species include *Cupressus arizonica*, *Juniperus deppeana*, *Pinus cembroides*, *Pinus discolor*, *Pinus ponderosa* (with Madrean pines or oaks), and *Pseudotsuga menziesii*. Subcanopy and shrub layers may include typical encinal and chaparral species such as *Agave* spp., *Arbutus arizonica*, *Arctostaphylos pringlei*, *Arctostaphylos pungens*, *Garrya wrightii*, *Nolina* spp., *Quercus hypoleucoides*, *Quercus rugosa*, and *Quercus turbinella*. Some stands have moderate cover of perennial graminoids such as *Muhlenbergia emersleyi*, *Muhlenbergia longiligula*, *Muhlenbergia virescens*, and *Schizachyrium cirratum*. Fires are frequent with perhaps more crown fires than ponderosa pine woodlands, which tend to have more frequent ground fires on gentle slopes.

Mogollon Chaparral

This ecological system occurs across central Arizona (Mogollon Rim), western New Mexico and southern Utah and Nevada. It often dominates along the mid-elevation transition from the Mojave, Sonoran, and northern Chihuahuan deserts into mountains (1000-2200 meters). It occurs on foothills, mountain slopes and canyons in drier habitats below the encinal and *Pinus ponderosa* woodlands. Stands are often associated with more xeric and coarse-textured substrates such as limestone, basalt or alluvium, especially in transition areas with more mesic woodlands. The moderate to dense shrub canopy includes species such as *Quercus turbinella*, *Quercus toumeyii*, *Cercocarpus montanus*, *Canotia holacantha*, *Ceanothus greggii*, *Forestiera pubescens* (= *Forestiera neomexicana*), *Garrya wrightii*, *Juniperus deppeana*, *Purshia stansburiana*, *Rhus ovata*, *Rhus trilobata*, and *Arctostaphylos pungens* and *Arctostaphylos pringlei* at higher elevations. Most chaparral species are fire-adapted, resprouting vigorously after burning or producing fire-resistant seeds. Stands occurring within montane woodlands are seral and a result of recent fires.

Mojave Mid-Elevation Mixed Desert Scrub

This ecological system represents the extensive desert scrub in the transition zone above *Larrea tridentata* – *Ambrosia dumosa* desert scrub and below the lower montane woodlands (700-1800 meters elevations) that occurs in the eastern and central Mojave Desert. It is also common on lower piedmont slopes in the transition zone into the southern Great Basin. The vegetation in this ecological systems is quite variable. Codominants and diagnostic species include *Coleogyne ramosissima*, *Eriogonum fasciculatum*, *Ephedra nevadensis*, *Grayia spinosa*, *Menodora spinescens*, *Nolina* spp., *Opuntia acanthocarpa*, *Salazaria mexicana*, *Viguiera parishii*, *Yucca brevifolia*, or *Yucca schidigera*. Desert grasses, including *Achnatherum hymenoides*, *Achnatherum speciosum*, *Muhlenbergia porteri*, *Pleuraphis jamesii*, *Pleuraphis rigida*, or *Poa secunda*, may form an herbaceous layer. Scattered *Juniperus osteosperma* or desert scrub species may also be present.

North American Arid West Emergent Marsh

This widespread ecological system occurs throughout much of the arid and semi-arid regions of western North America, typically surrounded by savanna,

shrub steppe, steppe, or desert vegetation. Natural marshes may occur in depressions in the landscape (ponds, kettle ponds), as fringes around lakes, and along slow-flowing streams and rivers (such riparian marshes are also referred to as sloughs). Marshes are frequently or continually inundated, with water depths up to 2 meters. Water levels may be stable, or may fluctuate 1 m or more over the course of the growing season. Water chemistry may include some alkaline or semi-alkaline situations, but the alkalinity is highly variable even within the same complex of wetlands. Marshes have distinctive soils that are typically mineral, but can also accumulate organic material. Soils have characteristics that result from long periods of anaerobic conditions in the soils (e.g., gleyed soils, high organic content, redoximorphic features). The vegetation is characterized by herbaceous plants that are adapted to saturated soil conditions. Common emergent and floating vegetation includes species of *Scirpus* and/or *Schoenoplectus*, *Typha*, *Juncus*, *Potamogeton*, *Polygonum*, *Nuphar*, and *Phalaris*. This system may also include areas of relatively deep water with floating-leaved plants (*Lemna*, *Potamogeton*, and *Brasenia*) and submergent and floating plants (*Myriophyllum*, *Ceratophyllum*, and *Elodea*).

North American Warm Desert Badland

This ecological system is restricted to barren and sparsely vegetated (generally less than 10 percent plant cover) substrates typically derived from marine shale or mudstone (badlands and mudhills). The harsh soil properties and high rate of erosion and deposition are driving environmental variables supporting sparse shrubs and dwarf-shrubs e.g., *Atriplex hymenelytra*, and herbaceous vegetation.

North American Warm Desert Bedrock Cliff and Outcrop

This ecological system is found from subalpine to foothill elevations and includes barren and sparsely vegetated landscapes (generally less than 10 percent plant cover) of steep cliff faces, narrow canyons, and smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock types. Also included are unstable scree and talus slopes that typically occur below cliff faces. Species present are diverse and may include *Bursera microphylla*, *Fouquieria splendens*, *Nolina bigelovii*, *Opuntia bigelovii*, and other desert species, especially succulents. Lichens are predominant lifeforms in some areas. May include a variety of desert shrublands less than 2 ha (5 acres) in size from adjacent areas.

North American Warm Desert Lower Montane Riparian Woodland and Shrubland

This ecological system occurs in mountain canyons and valleys of southern Arizona, New Mexico, and adjacent Mexico and consists of mid- to low-elevation (1100-1800 meters) riparian corridors along perennial and seasonally intermittent streams. The vegetation is a mix of riparian woodlands and shrublands. Dominant trees include *Populus angustifolia*, *Populus deltoides* ssp. *wislizeni*, *Populus fremontii*, *Platanus wrightii*, *Juglans major*, *Fraxinus velutina*, and *Sapindus saponaria*. Shrub dominants include *Salix exigua*, *Prunus* spp., *Alnus oblongifolia*, and *Baccharis salicifolia*. Vegetation is dependent upon annual or

periodic flooding and associated sediment scour and/or annual rise in the water table for growth and reproduction.

North American Warm Desert Pavement

This ecological system occurs throughout much of the warm deserts of North America and is composed of unvegetated to very sparsely vegetated (less than 2 percent plant cover) landscapes, typically flat basins where extreme temperature and wind develop ground surfaces of fine to medium gravel coated with "desert varnish." Very low cover of desert scrub species such as *Larrea tridentata* or *Eriogonum fasciculatum* is usually present. However, ephemeral herbaceous species may have high cover in response to seasonal precipitation, including *Chorizanthe rigida*, *Eriogonum inflatum*, and *Geraea canescens*.

North American Warm Desert Playa

This system is composed of barren and sparsely vegetated playas (generally less than 10 percent plant cover) found across the warm deserts of North America, extending into the extreme southern end of the San Joaquin Valley in California. Playas form with intermittent flooding, followed by evaporation, leaving behind a saline residue. Salt crusts are common throughout, with small saltgrass beds in depressions and sparse shrubs around the margins. Subsoils often include an impermeable layer of clay or caliche. Large desert playas tend to be defined by vegetation rings formed in response to salinity. Given their common location in wind-swept desert basins, dune fields often form downwind of large playas. In turn, playas associated with dunes often have a deeper water supply. Species may include *Allenrolfea occidentalis*, *Suaeda* spp., *Distichlis spicata*, *Eleocharis palustris*, *Oryzopsis* spp., *Sporobolus* spp., *Tiquilia* spp., or *Atriplex* spp. Ephemeral herbaceous species may have high cover periodically.

North American Warm Desert Riparian Mesquite Bosque

This ecological system consists of low-elevation (less than 1100 meters) riparian corridors along intermittent streams in valleys of southern Arizona and New Mexico, and adjacent Mexico. Dominant trees include *Prosopis glandulosa* and *Prosopis velutina*. Shrub dominants include *Baccharis salicifolia*, *Pluchea sericea*, and *Salix exigua*. Vegetation, especially the mesquites, tap groundwater below the streambed when surface flows stop. Vegetation is dependent upon annual rise in the water table for growth and reproduction.

North American Warm Desert Riparian Woodland and Shrubland

This ecological system consists of low-elevation (less than 1200 meters) riparian corridors along medium to large perennial streams throughout canyons and the desert valleys of the southwestern United States and adjacent Mexico. The vegetation is a mix of riparian woodlands and shrublands. Dominant trees include *Acer negundo*, *Fraxinus velutina*, *Populus fremontii*, *Salix gooddingii*, *Salix lasiolepis*, *Celtis laevigata* var. *reticulata*, and *Juglans major*. Shrub dominants include *Salix geyeriana*, *Shepherdia argentea*, and *Salix exigua*. Vegetation is

dependent upon annual or periodic flooding and associated sediment scour and/or annual rise in the water table for growth and reproduction.

North American Warm Desert Volcanic Rockland

This ecological system occurs across the warm deserts of North America and is restricted to barren and sparsely vegetated (less than 10 percent plant cover) volcanic substrates such as basalt lava (malpais) and tuff. Vegetation is variable and includes a variety of species depending on local environmental conditions, e.g., elevation, age and type of substrate. Typically scattered *Larrea tridentata*, *Atriplex hymenelytra*, or other desert shrubs are present.

North American Warm Desert Wash

This ecological system is restricted to intermittently flooded washes or arroyos that dissect bajadas, mesas, plains and basin floors throughout the warm deserts of North America. Although often dry, the intermittent fluvial processes define this system, which are often associated with rapid sheet and gully flow. This system occurs as linear or braided strips within desert scrub- or desert grassland-dominated landscapes. The vegetation of desert washes is quite variable ranging from sparse and patchy to moderately dense and typically occurs along the banks, but may occur within the channel. The woody layer is typically intermittent to open and may be dominated by shrubs and small trees such as *Acacia greggii*, *Brickellia laciniata*, *Baccharis sarothroides*, *Chilopsis linearis*, *Fallugia paradoxa*, *Hymenoclea salsola*, *Hymenoclea monogyra*, *Juglans microcarpa*, *Prosopis* spp., *Psoralea argophylla*, *Prunus fasciculata*, *Rhus microphylla*, *Salazaria mexicana*, or *Sarcobatus vermiculatus*.

Open Water

Areas of open water, generally with less than 25 percent cover of vegetation or soil.

Recently Burned

Areas that have burned in the recent past that are clearly evident in the imagery (images acquired between 1999-2001).

Recently Mined or Quarried

Areas where open pit mining or quarries are visible in the imagery (images acquired between 1999-2001), and are 2 hectares or greater in size.

Rocky Mountain Alpine-Montane Wet Meadow

These are high-elevation communities found throughout the Rocky Mountains and Intermountain regions, dominated by herbaceous species found on wetter sites with very low-velocity surface and subsurface flows. They range in elevation from montane to alpine (1000-3600 meters). These types occur as large meadows in montane or subalpine valleys, as narrow strips bordering ponds, lakes, and streams, and along toeslope seeps. They are typically found on flat areas or gentle slopes, but may also occur on sub-irrigated sites with slopes up to 10 percent. In alpine regions, sites typically are small depressions located

below late-melting snow patches or on snowbeds. Soils of this system may be mineral or organic. In either case, soils show typical hydric soil characteristics, including high organic content and/or low chroma and redoximorphic features. This system often occurs as a mosaic of several plant associations, often dominated by graminoids, including *Calamagrostis stricta*, *Caltha leptosepala*, *Cardamine cordifolia*, *Carex illota*, *Carex microptera*, *Carex nigricans*, *Carex scopulorum*, *Carex utriculata*, *Carex vernacula*, *Deschampsia caespitosa*, *Eleocharis quinqueflora*, *Juncus drummondii*, *Phippsia algida*, *Rorippa alpina*, *Senecio triangularis*, *Trifolium parryi*, and *Trollius laxus*. Often alpine dwarf-shrublands, especially those dominated by *Salix*, are immediately adjacent to the wet meadows. Wet meadows are tightly associated with snowmelt and typically not subjected to high disturbance events such as flooding.

Rocky Mountain Aspen Forest and Woodland

This widespread ecological system is more common in the southern and central Rocky Mountains, but occurs throughout much of the western U.S. and north into Canada, in the montane and subalpine zones. Elevations generally range from 1525 to 3050 meters (5000-10,000 feet), but occurrences can be found at lower elevations in some regions. Distribution of this ecological system is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand, and secondarily is limited by the length of the growing season or low temperatures. These are upland forests and woodlands dominated by *Populus tremuloides* without a significant conifer component (less than 25 percent relative tree cover). The understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse, dominated by graminoids or forbs. Associated shrub species include *Symphoricarpos* spp., *Rubus parviflorus*, *Amelanchier alnifolia*, and *Arctostaphylos uva-ursi*. Occurrences of this system originate and are maintained by stand-replacing disturbances such as avalanches, crown fire, insect outbreak, disease and windthrow, or clearcutting by man or beaver, within the matrix of conifer forests.

Rocky Mountain Cliff and Canyon

This ecological system of barren and sparsely vegetated landscapes (generally less than 10 percent plant cover) is found from foothill to subalpine elevations on steep cliff faces, narrow canyons, and smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock types. It is located throughout the Rocky Mountains and northeastern Cascade Ranges in North America. Also included are unstable scree and talus slopes that typically occur below cliff faces. There may be small patches of dense vegetation, but it typically includes scattered trees and/or shrubs. Characteristic trees includes species from the surrounding landscape, such as *Pseudotsuga menziesii*, *Pinus ponderosa*, *Pinus flexilis*, *Populus tremuloides*, *Abies concolor*, *Abies lasiocarpa*, or *Pinus edulis* and *Juniperus* spp. at lower elevations. There may be scattered shrubs present, such as species of *Holodiscus*, *Ribes*, *Physocarpus*, *Rosa*, *Juniperus*, and *Jamesia americana*,

Mahonia repens, *Rhus trilobata*, or *Amelanchier alnifolia*. Soil development is limited, as is herbaceous cover.

Rocky Mountain Gambel Oak-Mixed Montane Shrubland

This ecological system occurs in the mountains, plateaus and foothills in the southern Rocky Mountains and Colorado Plateau including the Uinta and Wasatch ranges and the Mogollon Rim. These shrublands are most commonly found along dry foothills, lower mountain slopes, and at the edge of the western Great Plains from approximately 2000 to 2900 meters in elevation, and are often situated above pinyon-juniper woodlands. Substrates are variable and include soil types ranging from calcareous, heavy, fine-grained loams to sandy loams, gravelly loams, clay loams, deep alluvial sand, or coarse gravel. The vegetation is typically dominated by *Quercus gambelii* alone or codominant with *Amelanchier alnifolia*, *Amelanchier utahensis*, *Artemisia tridentata*, *Cercocarpus montanus*, *Prunus virginiana*, *Purshia stansburiana*, *Purshia tridentata*, *Robinia neomexicana*, *Symphoricarpos oreophilus*, or *Symphoricarpos rotundifolius*. There may be inclusions of other mesic montane shrublands with *Quercus gambelii* absent or as a relatively minor component. This ecological system intergrades with the lower montane-foothills shrubland system and shares many of the same site characteristics. Density and cover of *Quercus gambelii* and *Amelanchier* spp. often increase after fire.

Rocky Mountain Lower Montane Riparian Woodland and Shrubland

This system is found throughout the Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 900 to 2800 meters. This system often occurs as a mosaic of multiple communities that are tree-dominated with a diverse shrub component. This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. Occurrences are found within the flood zone of rivers, on islands, sand or cobble bars, and immediate streambanks. They can form large, wide occurrences on mid-channel islands in larger rivers or narrow bands on small, rocky canyon tributaries and well-drained benches. It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplains swales and irrigation ditches. Dominant trees may include *Acer negundo*, *Populus angustifolia*, *Populus balsamifera*, *Populus deltoides*, *Populus fremontii*, *Pseudotsuga menziesii*, *Picea pungens*, *Salix amygdaloides*, or *Juniperus scopulorum*. Dominant shrubs include *Acer glabrum*, *Alnus incana*, *Betula occidentalis*, *Cornus sericea*, *Crataegus rivularis*, *Forestiera pubescens*, *Prunus virginiana*, *Rhus trilobata*, *Salix monticola*, *Salix drummondiana*, *Salix exigua*, *Salix irrorata*, *Salix lucida*, *Shepherdia argentea*, or *Symphoricarpos* spp. Exotic trees of *Elaeagnus angustifolia* and *Tamarix* spp. are common in some stands. Generally, the upland vegetation surrounding this riparian system is different and ranges from grasslands to forests.

Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland

This is a highly variable ecological system of the montane zone of the Rocky Mountains. It occurs throughout the southern Rockies, north and west into

Utah, Nevada, Wyoming and Idaho. These are mixed-conifer forests occurring on all aspects at elevations ranging from 1200 to 3300 meters. Rainfall averages less than 75 cm per year (40-60 cm), with summer "monsoons" during the growing season contributing substantial moisture. The composition and structure of the overstory are dependent upon the temperature and moisture relationships of the site and the successional status of the occurrence. *Pseudotsuga menziesii* and *Abies concolor* are most frequent, but *Pinus ponderosa* may be present to codominant. *Pinus flexilis* is common in Nevada. *Pseudotsuga menziesii* forests occupy drier sites, and *Pinus ponderosa* is a common codominant. *Abies concolor*-dominated forests occupy cooler sites, such as upper slopes at higher elevations, canyon sideslopes, ridgetops, and north- and east-facing slopes which burn somewhat infrequently. *Picea pungens* is most often found in cool, moist locations, often occurring as smaller patches within a matrix of other associations. As many as seven conifers can be found growing in the same occurrence, and there are a number of cold-deciduous shrub and graminoid species common, including *Arctostaphylos uva-ursi*, *Mahonia repens*, *Paxistima myrsinites*, *Symphoricarpos oreophilus*, *Jamesia americana*, *Quercus gambelii*, and *Festuca arizonica*.

Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland

These are mixed-conifer forests of the Rocky Mountains west into the ranges of the Great Basin, occurring predominantly in cool ravines and on north-facing slopes. Elevations range from 1200 to 3300 m. Occurrences of this system are found on cooler and more mesic sites than Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland (CES306.823). Such sites include lower and middle slopes of ravines, along stream terraces, moist, concave topographic positions and north- and east-facing slopes which burn somewhat infrequently. *Pseudotsuga menziesii* and *Abies concolor* are most common canopy dominants, but *Picea engelmannii*, *Picea pungens*, or *Pinus ponderosa* may be present. This system includes mixed conifer/*Populus tremuloides* stands. A number of cold-deciduous shrub species can occur, including *Acer glabrum*, *Acer grandidentatum*, *Alnus incana*, *Betula occidentalis*, *Cornus sericea*, *Jamesia americana*, *Physocarpus malvaceus*, *Robinia neomexicana*, *Vaccinium membranaceum*, and *Vaccinium myrtillus*. Herbaceous species include *Bromus ciliatus*, *Carex geyeri*, *Carex rossii*, *Carex siccata*, *Muhlenbergia virescens*, *Pseudoroegneria spicata*, *Erigeron eximius*, *Fragaria virginiana*, *Luzula parviflora*, *Osmorhiza berteroi*, *Packera cardamine*, *Thalictrum occidentale*, and *Thalictrum fendleri*. Naturally occurring fires are of variable return intervals, and mostly light, erratic, and infrequent due to the cool, moist conditions.

Rocky Mountain Ponderosa Pine Woodland

This very widespread ecological system is most common throughout the cordillera of the Rocky Mountains, from the Greater Yellowstone region south. It is also found in the Colorado Plateau region, west into scattered locations in the Great Basin, and in the Black Hills of South Dakota and Wyoming. These woodlands occur at the lower treeline/ecotone between grassland or shrubland and more mesic coniferous forests typically in warm, dry, exposed sites.

Elevations range from less than 1900 meters in northern Wyoming to 2800 meters in the New Mexico mountains. Occurrences are found on all slopes and aspects; however, moderately steep to very steep slopes or ridgetops are most common. This ecological system generally occurs on igneous, metamorphic, and sedimentary material derived soils, with characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acid pH, an abundance of mineral material, rockiness, and periods of drought during the growing season. *Pinus ponderosa* (primarily var. *scopulorum* and var. *brachyptera*) is the predominant conifer; *Pseudotsuga menziesii*, *Pinus edulis*, and *Juniperus* spp. may be present in the tree canopy. The understory is usually shrubby, with *Artemisia nova*, *Artemisia tridentata*, *Arctostaphylos patula*, *Arctostaphylos uva-ursi*, *Cercocarpus montanus*, *Purshia stansburiana*, *Purshia tridentata*, *Quercus gambelii*, *Symphoricarpos oreophilus*, *Prunus virginiana*, *Amelanchier alnifolia*, and *Rosa* spp. common species. *Pseudoroegneria spicata* and species of *Hesperostipa*, *Achnatherum*, *Festuca*, *Muhlenbergia*, and *Bouteloua* are some of the common grasses. Mixed fire regimes and ground fires of variable return intervals maintain these woodlands, depending on climate, degree of soil development, and understory density.

Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland

Engelmann spruce and subalpine fir forests comprise a substantial part of the subalpine forests of the Cascades and Rocky Mountains from southern British Columbia east into Alberta, south into New Mexico and the Intermountain region. They are the matrix forests of the subalpine zone, with elevations ranging from 1275 meters in its northern distribution to 3355 meters in the south (4100-11,000 feet). They often represent the highest elevation forests in an area. Sites within this system are cold year-round, and precipitation is predominantly in the form of snow, which may persist until late summer. Snowpacks are deep and late-lying, and summers are cool. Frost is possible almost all summer and may be common in restricted topographic basins and benches. Despite their wide distribution, the tree canopy characteristics are remarkably similar, with *Picea engelmannii* and *Abies lasiocarpa* dominating either mixed or alone. *Pseudotsuga menziesii* may persist in occurrences of this system for long periods without regeneration. *Pinus contorta* is common in many occurrences, and patches of pure *Pinus contorta* are not uncommon, as well as mixed conifer/*Populus tremuloides* stands. In some areas, such as Wyoming, *Picea engelmannii*-dominated forests are on limestone or dolomite, while nearby codominated spruce-fir forests are on granitic or volcanic rocks. Xeric species may include *Juniperus communis*, *Linnaea borealis*, *Mahonia repens*, or *Vaccinium scoparium*. More northern occurrences often have taller, more mesic shrub and herbaceous species, such as *Empetrum nigrum*, *Rhododendron albiflorum*, and *Vaccinium membranaceum*. Disturbance includes occasional blow-down, insect outbreaks and stand-replacing fire.

Rocky Mountain Subalpine Mesic Meadow

This Rocky Mountain ecological system is restricted to sites in the subalpine zone where finely textured soils, snow deposition, or wind-swept dry conditions

limit tree establishment. It is found typically above 3000 m in elevation in the southern part of its range and above 1500 meters in the northern part. These upland communities occur on gentle to moderate gradient slopes. The soils are typically seasonally moist to saturated in the spring, but if so will dry out later in the growing season. Vegetation is typically forb-rich, with forbs contributing more to overall herbaceous cover than graminoids. Important taxa include *Erigeron* spp., *Asteraceae* spp., *Mertensia* spp., *Penstemon* spp., *Campanula* spp., *Lupinus* spp., *Solidago* spp., *Ligusticum* spp., *Thalictrum occidentale*, *Valeriana sitchensis*, *Balsamorhiza sagittata*, *Wyethia* spp., *Deschampsia caespitosa*, *Koeleria macrantha*, and *Dasiphora fruticosa*. Burrowing mammals can increase the forb diversity.

Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland

This is a high-elevation system of the Rocky Mountains, dominated by *Picea engelmannii* and *Abies lasiocarpa*. It extends eastward into the northeastern Olympic Mountains and the northeastern side of Mount Rainier in Washington. Occurrences are typically found in locations with cold-air drainage or ponding, or where snowpacks linger late into the summer, such as north-facing slopes and high-elevation ravines. They can extend down in elevation below the subalpine zone in places where cold-air ponding occurs; northerly and easterly aspects predominate. These forests are found on gentle to very steep mountain slopes, high-elevation ridgetops and upper slopes, plateau-like surfaces, basins, alluvial terraces, well-drained benches, and inactive stream terraces. In the Olympics and northern Cascades, the climate is more maritime than typical for this system, but due to the lower snowfall in these rainshadow areas, summer drought may be more significant than snowpack in limiting tree regeneration in burned areas. *Picea engelmannii* is rare in these areas. Mesic understory shrubs include *Menziesia ferruginea*, *Vaccinium membranaceum*, *Rhododendron albiflorum*, *Amelanchier alnifolia*, *Rubus parviflorus*, *Ledum glandulosum*, *Phyllodoce empetriformis*, and *Salix* spp. Herbaceous species include *Actaea rubra*, *Maianthemum stellatum*, *Cornus canadensis*, *Erigeron eximius*, *Gymnocarpium dryopteris*, *Rubus pedatus*, *Saxifraga bronchialis*, *Tiarella* spp., *Lupinus arcticus* ssp. *subalpinus*, *Valeriana sitchensis*, and graminoids *Luzula glabrata* var. *hitchcockii* or *Calamagrostis canadensis*. Disturbances include occasional blow-down, insect outbreaks and stand-replacing fire.

Rocky Mountain Subalpine-Montane Riparian Shrubland

This system is found throughout the Rocky Mountain cordillera from New Mexico north into Montana, and also occurs in mountainous areas of the Intermountain region and Colorado Plateau. These are montane to subalpine riparian shrublands occurring as narrow bands of shrubs lining streambanks and alluvial terraces in narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels. Generally it is found at higher elevations, but can be found anywhere from 1700-3475 m. Occurrences can also be found around seeps, fens, and isolated springs on hillslopes away from valley bottoms. Many of the plant associations found within this system are associated with beaver

activity. This system often occurs as a mosaic of multiple communities that are shrub- and herb-dominated and includes above-treeline, willow-dominated, snowmelt-fed basins that feed into streams. The dominant shrubs reflect the large elevational gradient and include *Alnus incana*, *Betula nana*, *Betula occidentalis*, *Cornus sericea*, *Salix bebbiana*, *Salix boothii*, *Salix brachycarpa*, *Salix drummondiana*, *Salix eriocephala*, *Salix geyeriana*, *Salix monticola*, *Salix planifolia*, and *Salix wolfii*. Generally the upland vegetation surrounding these riparian systems are of either conifer or aspen forests.

Sonora-Mojave Creosotebush-White Bursage Desert Scrub

This ecological system forms the vegetation matrix in broad valleys, lower bajadas, plains and low hills in the Mojave and lower Sonoran deserts. This desert scrub is characterized by a sparse to moderately dense layer (2-50 percent cover) of xeromorphic microphyllous and broad-leaved shrubs. *Larrea tridentata* and *Ambrosia dumosa* are typically dominants, but many different shrubs, dwarf-shrubs, and cacti may codominate or form typically sparse understories. Associated species may include *Atriplex canescens*, *Atriplex hymenelytra*, *Encelia farinosa*, *Ephedra nevadensis*, *Fouquieria splendens*, *Lycium andersonii*, and *Opuntia basilaris*. The herbaceous layer is typically sparse, but may be seasonally abundant with ephemerals. Herbaceous species such as *Chamaesyce* spp., *Eriogonum inflatum*, *Dasyochloa pulchella*, *Aristida* spp., *Cryptantha* spp., *Nama* spp., and *Phacelia* spp. are common.

Sonora-Mojave Mixed Salt Desert Scrub

This system includes extensive open-canopied shrublands of typically saline basins in the Mojave and Sonoran deserts. Stands often occur around playas. Substrates are generally fine-textured, saline soils. Vegetation is typically composed of one or more *Atriplex* species such as *Atriplex canescens* or *Atriplex polycarpa* along with other species of *Atriplex*. Species of *Allenrolfea*, *Salicornia*, *Suaeda*, or other halophytic plants are often present to codominant. Graminoid species may include *Sporobolus airoides* or *Distichlis spicata* at varying densities.

Sonoran Mid-Elevation Desert Scrub

This transitional desert scrub system occurs along the northern edge of the Sonoran Desert in an elevational band along the lower slopes of the Mogollon Rim/Central Highlands region between 750 and 1300 meters. Stands occur in the Bradshaw, Hualapai, and Superstition mountains, among other desert ranges. Sites range from a narrow strip on steep slopes to very broad areas such as the Verde Valley. Climate is too dry for chaparral species to be abundant, and freezing temperatures during winter are too frequent and prolonged for many of the frost-sensitive species, such as *Carnegia gigantea*, *Parkinsonia microphylla*, *Prosopis* spp., *Olneya tesota*, *Ferocactus* sp., and *Opuntia bigelovii*. Substrates are generally rocky soils derived from parent materials such as limestone, granitic rocks or rhyolite. The vegetation is typically composed of an open shrub layer of *Larrea tridentata*, *Ericameria linearifolia*, or *Eriogonum fasciculatum* with taller

shrub such as *Canotia holacantha* (limestone or granite) or *Simmondsia chinensis* (rhyolite). The herbaceous layer is generally sparse.

Southern Colorado Plateau Sand Shrubland

This large-patch ecological system is found on the south-central Colorado Plateau in northeastern Arizona extending into southern and central Utah. It occurs on windswept mesas, broad basins and plains at low to moderate elevations (1300-1800 meters). Substrates are stabilized sandsheets or shallow to moderately deep sandy soils that may form small hummocks or small coppice dunes. This semi-arid, open shrubland is typically dominated by short shrubs (10-30 percent cover) with a sparse graminoid layer. The woody layer is often a mixture of shrubs and dwarf-shrubs. Characteristic species include *Ephedra cutleri*, *Ephedra torreyana*, *Ephedra viridis*, and *Artemisia filifolia*. *Coleogyne ramosissima* is typically not present. *Poliomintha incana*, *Parryella filifolia*, *Quercus havardii* var. *tuckeri*, or *Ericameria nauseosa* may be present to dominant locally. *Ephedra cutleri* and *Ephedra viridis* often assume a distinctive matty growth form. Characteristic grasses include *Achnatherum hymenoides*, *Bouteloua gracilis*, *Hesperostipa comata*, and *Pleuraphis jamesii*. The general aspect of occurrences is an open low shrubland but may include small blowouts and dunes. Occasionally grasses may be moderately abundant locally and form a distinct layer. Disturbance may be important in maintaining the woody component. Eolian processes are evident, such as pediceled plants, occasional blowouts or small dunes, but the generally higher vegetative cover and less prominent geomorphic features distinguish this system from Inter-Mountain Basins Active and Stabilized Dune.

Southern Rocky Mountain Montane-Subalpine Grassland

This Rocky Mountain ecological system typically occurs between 2200 and 3000 meters on flat to rolling plains and parks or on lower sideslopes that are dry, but it may extend up to 3350 meters on warm aspects. Soils resemble prairie soils in that the Ahorizon is dark brown, relatively high in organic matter, slightly acid, and usually well-drained. An occurrence usually consists of a mosaic of two or three plant associations with one of the following dominant bunch grasses: *Danthonia intermedia*, *Danthonia parryi*, *Festuca idahoensis*, *Festuca arizonica*, *Festuca thurberi*, *Muhlenbergia filiculmis*, or *Pseudoroegneria spicata*. The subdominants include *Muhlenbergia montana*, *Bouteloua gracilis*, and *Poa secunda*. These large-patch grasslands are intermixed with matrix stands of spruce-fir, lodgepole, ponderosa pine, and aspen forests. In limited circumstances (e.g., South Park in Colorado), they form the "matrix" of high-elevation plateaus.