

122.3 Rocky Mountain (Petran) and Madrean Montane Conifer Forests

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Included here are both the pine (Transition zone) and fir (Canadian zone) forests of Merriam (1894a), Gentry (1942), Lowe (1964) and others. Appropriately named montane, these forests on high plateaus and mountains extend southward from the Rocky Mountains to the Southwest in Colorado and Utah through New Mexico and Arizona to the Sierra Madre Occidental and Sierra Madre Oriental and outlying mountains in Mexico. Some of these stands are extensive; others are confined to isolated summits and canyons. A number of disjunct ranges in adjacent states—the Spring Valley (Charleston) Mountains, Sheep Mountains and Virgin Mountains in Nevada; the Clark and Kingston mountains within the Mojave Desert in California; the Davis Mountains in extreme southwest Texas; and the Sierra del Pino and other high mountains in Coahuila also possess montane conifer forests at higher elevation. Elevations range from ca. 2,000 m at the colder, wetter sites (uncommonly lower to 1,700 m) to as high as 3,050 m on south slopes, and in the Sierra Madres. More often the forest comes in at 2,200-2,300 m, and in the Southwest reaches its best and most characteristic development between 2,300 and 2,650 m.

Mean annual precipitation ranges from a low of just above 460 mm to as high as 760 mm or more (Table 2). In contrast to the wetter Sierran montane forest, half or more of this precipitation falls during the growing season. This permits forests to exist on less than 640 mm per year, and some of these stands are among the driest forests in North America. All fasciations of this montane forest are uniformly cold, nighttime freezing temperatures usually beginning by mid-September and not ending until sometime in May.

Based on overstory dominants, both Rocky Mountain and Madrean fasciations can be conveniently divided into two major communities or series—a Ponderosa Pine forest (Fig. 18), generally at lower elevations; and at higher elevations, in canyons and on north slopes—a cooler mixed conifer forest of Douglas-fir (*Pseudotsuga menziesii*), White Fir (*Abies concolor*), Limber Pine (*Pinus flexilis*), and Aspen (*Populus tremuloides*) (Fig. 19). At its upper limits (ca. 2,600-2,900 m) in the northern Southwest, the mixed conifer series merges, and then gives way, to the Spruce-Alpine Fir and Bristlecone-Limber Pine series of the boreal Rocky Mountain subalpine forest. Although at least three summits in Chihuahua are reported to exceed 3,050 m, true subalpine forests are lacking in the Mexican half of the Southwest. These summits are capped by montane communities of Mexican White Pine (*Pinus ayacahuite*), with some Douglas-fir, Aspen, and Ponderosa Pine. At least one locale above 3,000 m, on the north slopes of Cerro Mohinora in southwestern Chihuahua, contains small stands of the relict and endemic spruce (*Picea chihuahuana*) found usually only further south in Durango.¹

Generally from north to south, the lower limits of pine forest are typically in contact with pinyon-juniper woodland, interior chaparral, and Madrean evergreen woodland. Grassland (often now composed of sagebrush or invading composites) provides a major lower elevational contact almost throughout.

Ponderosa Pine Forest

This widespread yellow pine is the Southwest's most common montane tree and often grows in pure stands. On the

¹Personal communication with Dirk Lanning, Nature Conservancy, San Bernardino Ranch, P.O. Box 695, Douglas, Ariz.

Table 2. Precipitation within or adjacent to Rocky Mountain and Madrean Montane Conifer Forest

| Station | Elevation (in m) | Mean Monthly Precipitation in mm | | | | | | | | | | | | Total |
|--|---------------------|----------------------------------|----|----|----|----|----|-----|-----|-----|----|----|----|-------|
| | | J | F | M | A | M | J | J | A | S | O | N | D | |
| Chama, NM 36°55' 106°35' | 2,393 | 44 | 29 | 39 | 36 | 29 | 26 | 47 | 65 | 45 | 40 | 28 | 43 | 471 |
| Jacob Lake, AZ 36°43' 112°13' | 2,414 | 36 | 34 | 52 | 37 | 29 | 13 | 66 | 61 | 30 | 27 | 33 | 53 | 471 |
| Chacon, NM 36°10' 105°23' | 2,590 | 25 | 19 | 28 | 30 | 37 | 39 | 79 | 97 | 33 | 32 | 21 | 25 | 465 |
| Wolf Canyon, NM 35°58' 106°46' | 2,506 | 38 | 38 | 47 | 36 | 29 | 29 | 84 | 88 | 40 | 42 | 29 | 38 | 538 |
| Fort Valley, AZ 35°16' 111°44' | 2,239 | 55 | 42 | 54 | 41 | 18 | 16 | 75 | 88 | 43 | 36 | 34 | 57 | 559 |
| Williams, AZ 35°15' 112°11' | 2,057 | 47 | 40 | 50 | 35 | 18 | 13 | 71 | 93 | 45 | 32 | 36 | 59 | 539 |
| Groom Creek, AZ 34°29' 112°27' | 1,859 | 54 | 48 | 49 | 32 | 12 | 15 | 97 | 113 | 47 | 31 | 32 | 63 | 593 |
| Crown King, AZ 34°12' 112°20' | 1,829 | 76 | 57 | 67 | 35 | 11 | 12 | 94 | 129 | 49 | 36 | 45 | 91 | 701 |
| Lakeside, AZ 34°12' 109°59' | 2,042 | 49 | 33 | 48 | 24 | 11 | 14 | 79 | 86 | 46 | 48 | 39 | 50 | 527 |
| Greer, AZ 34°01' 109°28' | 2,588 | 55 | 42 | 42 | 21 | 12 | 22 | 115 | 108 | 51 | 46 | 28 | 67 | 609 |
| Mt. Lemmon, AZ 32°27' 110°45' | 2,371 | 59 | 39 | 62 | 25 | 7 | 23 | 147 | 139 | 51 | 40 | 38 | 51 | 681 |
| Ruidoso, NM 32°22' 105°40' | 2,084 | 27 | 27 | 33 | 17 | 22 | 50 | 109 | 76 | 64 | 27 | 17 | 40 | 509 |
| Yecora, Son. 28°22' 108°57' | 1,662 | 69 | 34 | 27 | 8 | 10 | 87 | 301 | 272 | 125 | 38 | 22 | 48 | 1041 |
| Creel, Chih. 27°45' 107°38' | 2,716 | 59 | 27 | 17 | 9 | 9 | 68 | 179 | 156 | 87 | 39 | 15 | 27 | 692 |
| Guadalupe y Calvo, Chih., 26°06' 106°59' | 2,400 | 60 | 57 | 35 | 6 | 24 | 84 | 257 | 221 | 157 | 64 | 29 | 83 | 1076 |

mountains, plateaus, and mesas of central and northern New Mexico and Arizona, forests of Ponderosa Pine total about 3.4 million ha and provide the most important commercial timber (Choate, 1966; Spencer, 1966). There and in southern Colorado and Utah, one finds the typically three-needled and large cone Rocky Mountain form, *P. ponderosa* var. *scopulorum*. In southern Arizona *P. ponderosa* var. *scopulorum* is joined by the five-needled Arizona subspecies, *P. ponderosa* var. *arizonica*—with the latter usually dominating in the lower portions of the forest. *P. ponderosa* var. *arizonica* extends southward into the Sierra Madre where it is both the dominant montane conifer and commercial tree (Fig. 20).

Old growth Ponderosa Pine forests are often park-like, with the scattered yellow-barked older trees interspersed with occasional groups of their descendants. Otherwise, understories are grassy or at least herbaceous. Frequent light fires, to which older pines are relatively immune, probably kept the forests more open in pre-settlement times. Crown cover of the more open, mature stands may range from 50% to 75%, but that of younger well-stocked stands, sometimes with thickets of “dog-hair” (dense stands of stunted, young trees) may be much higher. Ponderosa Pine forests grow on a wide variety of soils and geologic parent materials, including andesite, basalt, granite, diabase, limestone, and sandstone (Pearson, 1931).

While Ponderosa Pine is the unquestioned dominant over most of the forest, such associated forest trees as Southwestern White Pine (*Pinus strobiformis*), Douglas-fir, White Fir, and Quaking Aspen are frequent participants in the forest at middle and higher elevations. In the Rocky Mountain

fasciation, Gambel Oak (*Quercus gambelii*) and the New Mexican Locust (*Robinia neomexicana*) are locally common and may dominate some of the lower and rockier locations. The deciduous Gambel Oak is of great importance and affects the distribution of several species of wildlife. White Fir is a frequent understory component at higher elevations within older undisturbed pine forests. Understory shrubs are few, rarely dense, and not especially common, but may include scattered populations and plants of Fendler Ceanothus (*Ceanothus fendleri*), Creeping Mahonia (*Berberis repens*), Smooth Sumac (*Rhus glabra*), Golden and Sticky Currant and Orange Gooseberry (*Ribes aureum*, *R. viscosissimum*, and *R. pinetorum*), Arizona Rose (*Rosa arizonica*), Blue Elderberry and Velvet Elder (*Sambucus cerulea* and *S. velutina*), Longflower, Mountain, Utah, and Roundleaf Snowberries (*Symphoricarpos longiflorus*, *S. oreophilus*, *S. utahensis*, and *S. rotundifolius*), Bush Rockspirea (*Holodiscus dumosus*), and Ninebark (*Physocarpus monogynus*) (Castetter, 1956).

Under more open stands, grasses and grass-like plants may prevail and include montane-centered grasses and sedges such as Mountain and Screwleaf Muhly (*Muhlenbergia montana* and *M. virescens*), Pine Dropseed (*Blepharoneuron tricholepis*), Nodding and Fringed Brome (*Bromus anomalus* and *B. ciliatus*), Arizona Fescue (*Festuca arizonica*), Prairie Junegrass (*Koeleria cristata*), Littleseed Muhly (*Muhlenbergia minutissima*), Bulb Panicum (*Panicum bulbosum*), Mutton and Kentucky Bluegrass (*Poa fendleriana* and *P. pratensis*), Squirreltail (*Sitanion hystris*), Pringle Needlegrass (*Stipa pringlei*), Dryland Sedge (*Carex geophila*), and Fendler Flatsedge (*Cyperus fendlerianus*). Depending on location, some of the



Figure 18. *Ponderosa Pine (Pinus ponderosa var. scopulorum)* forest near Chimney Rock on the San Juan National Forest east of Durango, Colorado, ca. 1,980 m elevation. The single-species dominance, interspersed age classes and grassy understory is characteristic of thousands of acres of today's "multiple use" managed forests in Colorado, Utah, New Mexico, and Arizona. Increased timber sales are resulting in the gradual elimination of older age classes over increasingly large tracts, however.



Figure 19. Mixed conifer series (Canadian zone) of Douglas-fir (*Pseudotsuga menziesii*), White Fir (*Abies concolor*), Rocky Mountain Maple (*Acer glabrum*) and Quaking Aspen (*Populus tremuloides*) on trail to Flys Peak, ca. 2,770 m elevation, Chiricahua Mountains, Coronado National Forest, Arizona. This north slope community, while superficially resembling subalpine conifer forest (see Fig. 15), differs from that biome in the absence of numerous subalpine species (e.g., Engelmann Spruce and Alpine Fir) as well as in the presence of montane dominants.

more characteristic and common forbs include Yarrow (*Achillea lanulosa*), Mountain Parsley (*Pseudocymopterus montanus*), New Mexico Groundsel (*Senecio neomexicanus*), Bracken Fern (*Pteridium aquilinum*), Pinedrops (*Pterospora andromeda*), Rusby Clover (*Trifolium rusbyi*), Mountain Bluebell (*Mertensia franciscana*), American Vetch (*Vicia americana*), Arizona and Grassleaf Peavine (*Lathyrus arizonicus* and *L. graminifolius*), Lupines (*Lupinus*), Trailing and Spreading Fleabane (*Erigeron flagellaris* and *E. divergens*), *Erigeron macranthus*, *E. concinnus*, and *E. formosissimus*, Dandelion (*Taraxacum officinalis*), Meadowrue (*Thalictrum fendleri*), Elegant Cinquefoil (*Potentilla concinna*), Sawatch Knotweed (*Polygonum sawatchense*), Purple Geranium (*Geranium caespitosum*), and Wild Strawberry (*Fragaria ovalis*).¹ In dog-hair thickets or under the high canopy of some mature stands, a heavy litter may develop, with little or no understory herbaceous cover.

In the more southern Ponderosa Pine forests in southeastern Arizona, southwestern New Mexico, and in the highlands of

Chihuahua and Sonora, aboreal associates commonly include Mexican White Pine and Douglas-fir at higher elevations. Apache Pine (*Pinus engelmannii* [= *P. latifolia*]), Chihuahua pine (*P. leiophylla* var. *chihuahuana*), Alligatorbark Juniper (*Juniperus deppeana*), and evergreen oaks such as *Quercus fulva*, *Q. pennivenia*, *Q. arizonica*, *Q. grisea*, and *Q. viminea* enter the forest at the lower elevations adjacent to Mexican oak-pine woodland. Species such as Silverleaf and Netleaf Oak (*Quercus hypoleucoides*, *Q. rugosa*), as well as Buckbrush (*Ceanothus huichugore*) and Madrone (*Arbutus arizonica*), may occur locally on the drier sites.

Mixed Conifer (=Douglas-fir—White Fir) Forest

Douglas-fir dominated forests cover more than 600,000 ha in the Southwest, mostly in southern Colorado, in New Mexico, on the White Mountains and Kaibab Plateau in Arizona, and the higher slopes and canyons in the Sierra Madre Occidental (Choate, 1966; Spencer, 1966). General elevation range is usually from 2,450 to 2,900 m, often forming a discontinuous belt between the warmer, drier, more extensive pine forests below and the colder, wetter boreal spruce-fir forests above. Douglas-fir may occur in pure stands but more often it is mixed with firs and/or Engelmann Spruce (*Picea engelmannii*) near its upper limit and with Ponderosa and Mexican White Pine and Blue Spruce (*Picea pungens*) elsewhere.

Mature mixed conifer forests (the most common condition) are often dense, with high canopy cover and heavy litter accumulation that restricts undergrowth. Where openings in the canopy are caused by blowdowns, road construction, fires or other disturbances, a rather depauperate understory flora may develop, including such common species as Mountain Snowberry, Raspberry, Strawberry, Nodding and Mountain Brome (*Bromus marginatus*), Tufted Hairgrass (*Deschampsia caespitosa*), Rough Bentgrass (*Agrostis scabra*), and Figwort (*Scrophularia parviflora*). Where litter buildup is not too great, the undisturbed forest floor may contain such shade tolerant species as Feather Solomonseal (*Smilacina racemosa*), Pipsissewa (*Chimaphila umbellata*), Pyrola (*Pyrola virens*), Western Rattlesnake Plantain (*Goodyera oblongifolia*), alumroots (*Heuchera rubescens* and *H. versicolor*), Mountain-lover (*Pachystima myrsinites*), Hook and Canada Violet (*Viola adunca* and *V. canadensis*), and *Valeriana arizonica*.

Aspen Subclimax Communities

Quaking aspen is an important—though numerically minor—associate throughout the more mesic montane conifer forests of the Southwest. Close examination of the forest floor in even the most dense pine or Douglas-fir—White Fir stands usually reveals scattered greatly suppressed aspen sprouts, probably holdovers from a previous period of forest disturbance. The shade-intolerant aspen, which reproduces chiefly from root sprouts, produces a flourishing colony in such stands once the overstory conifers have been removed by fire, blowdown, or logging.

¹McLaughlin, Steve, and R.F. Wagle. *Changes in herbaceous understory, productivity accompanying prescribed burning of Ponderosa Pine forests in Arizona.* School of Renewable Natural Resources. University of Arizona, Tucson. Work done under a cooperative agreement with Research Work Unit RM-2108, Rocky Mountain Forest and Range Experiment Station. USDA Forest Service, Tempe, Ariz.



Figure 20. Ponderosa Pine (*Pinus ponderosa* var. *arizonica*) forest in the high Sierra Madre Occidental, Madero Campo Cinco Taco (5 Taco Lumber Camp), between Yepachic and Tutuaca, Chihuahua, ca. 2,280 m elevation. These “second growth” forests are more typical of today’s pine forest—both north and south of the border. Such was not the case just one generation ago when the Southwest boasted the largest forests of virgin pine in the world. Photograph by R.L. Todd.

Of the 200,000 ha of aspen in the United States portion of the Southwest, 75% is in New Mexico. Most of the remainder lies in the Mogollon Rim-White Mountain area of Arizona, with small colonies of mostly sterile individuals in the highest mountains of Chihuahua and Sonora (Standley, 1920-26), an alder (*Alnus firmifolia*) being the more prevalent successional tree (Lesuer, 1945).

Aspen stands are rich wildlife communities, providing abundant food and cover (when not heavily grazed) for a wide variety of mammals and birds (Patton and Jones, 1977). Common understory shrubs include gooseberries and currants, Arizona Rose, Mountain and Roundleaf Snowberry, and Arizona and Bearberry Honeysuckle (*Lonicera arizonica* and *L. involucrata*). The normally rich mixture of grasses and forbs include Nodding, Mountain, and Fringed Brome, wheatgrasses (*Agropyron* spp.), Kentucky Bluegrass, asters (*Aster* spp.), Bracken Fern, fleabanes (*Erigeron* spp.), Missouri and Few-flowered Golden-rod (*Solidago missouriensis* and *S. sparsiflora*),

Grassleaf Peavine (*Lathyrus graminifolius*), American Vetch, Rocky Mountain Iris (*Iris missouriensis*), lupines, Sneezeweed (*Helenium hoopesii*), Cutleaf Coneflower (*Rudbeckia laciniata*), Yarrow, Mintleaf Beebalm (*Monarda menthaefolia*), False Mountain-bluebell (*Mertensia* spp.) and geraniums (*Geranium* spp.). Poisonous plants include Carrotleaf Larkspur (*Delphinium tenuisectum*), and Columbia Monkshood (*Aconitum columbianum*).

A number of mammals make their home within Rocky Mountain montane forests including bats such as the Southwestern Myotis (*Myotis auriculus*), Long-eared Myotis (*M. evotis*), Long-legged Myotis (*M. volans*), and Big Brown Bat (*Eptesicus fuscus*). Species such as the Vagrant, Dwarf, and Merriam Shrews (*Sorex vagrans*, *S. nanus*, *S. merriami*); Chickaree (*Tamiasciurus hudsonicus*); and Nuttall’s Cottontail (*Sylvilagus nuttalli*) reach their greatest abundance within mixed conifer communities, while others, such as the Tassel-eared Squirrel (*Sciurus aberti*) and Porcupine (*Erethizon*

dorsatum), are most abundant in yellow pine forests. The former is particularly tied to these habitats, and the life cycles of this species is closely interwoven with that of Ponderosa Pine. Also indicative of these montane environments are several species of chipmunks—Colorado Chipmunk (*Eutamias quadrivittatus*), Gray-collared Chipmunk (*E. cinereicollis*), Gray-footed Chipmunk (*E. canipes*), Uinta Chipmunk (*E. umbrinus*), depending on regional fasciation. Also depending on locale is the presence of such montane denizens as the Montane Vole (*Microtus montanus*), Long-tailed Vole (*M. longicaudus*), and Mexican Vole (*M. mexicanus*). Other species centered elsewhere, but likely to be encountered in at least some of these Petran or Rocky Mountain forests are the Eastern Cottontail (*Sylvilagus floridanus*), Golden-mantled Ground Squirrel (*Citellus lateralis*), Deer Mouse (*Peromyscus maniculatus*), Mexican Woodrat (*Neotoma mexicana*), Long-tailed Weasel (*Mustela frenata*), and Mule Deer (*Odocoileus hemionus*). White-tailed Deer (*O. virginianus*) are generally found in the Madrean fasciation. Once restricted to a much smaller distribution in the Southwest, the Rocky Mountain Elk (*Cervus elaphus*) now occupies southwestern montane conifer forests in Colorado, New Mexico, and Arizona. The Merriam Elk (*C.e. merriami*), once found in the the White Mountains of Arizona and the Mogollon Mountains of New Mexico, is now extinct. The Gray Wolf (*Canis lupus*), once widespread in these forests, is now extirpated; the last wolves on the North Kaibab were eradicated during the mid-1920's.

The list of characteristic nesting avifauna is large and contains such typically montane conifer forest species as the Goshawk (*Accipiter gentilis*), Flammulated Owl (*Otus flammeolus*), Pygmy Owl (*Glaucidium gnoma*), Spotted Owl (*Strix occidentalis*), Saw-whet Owl (*Aegolius acadicus*), Broad-tailed Hummingbird (*Selasphorus platycercus*), Western Flycatcher (*Empidonax difficilis*), Steller Jay (*Cyanocitta stelleri*), Pygmy Nuthatch (*Sitta pygmaea*), Brown Creeper (*Certhis familiaris*), Western Bluebird (*Sialia mexicana*), Townsend's Solitaire (*Myadestes townsendi*), Solitary Vireo (*Vireo solitarius*), Warbling Vireo (*V. gilvus*), Yellow-rumped Warbler (*Dendroica coronata*), Western Tanager (*Piranga ludoviciana*), Evening Grosbeak (*Hesperiphona vespertina*), Pine Siskin (*Carduelis pinus*), Red Crossbill (*Loxia curvirostra*), juncoes, and Chipping Sparrow (*Spizella passerina*); all of which extend southward to or through the Southwest. Southward these are

complemented or replaced by Madrean species reaching northward; examples, several of which are analogous species, are the Wild Turkeys (*Meleagris gallopavo mexicana*, *M. gallopavo merriami*), Band-tailed Pigeon (*Columba fasciata*), Rivoli's Hummingbird (*Eugenes fulgens*), Coues' Flycatcher (*Contopus pertinax*), Pine Flycatcher (*Empidonax affinis*), Mexican Chickadee (*Parus sclateri*), Aztec Thrush (*Ridgwayia pinicola*), Brown-backed Solitaire (*Myadestes obscurus*), Olive Warbler (*Peucedramus taeniatus*), Grace's Warbler (*Dendroica graciae*), Red-faced Warbler (*Cardellina rufrifrons*), Hepatic Tanager (*Piranga flava*), and Yellow-eyed Junco (*Junco phaeonotus*). Several rare, and in some cases vanishing, species peculiar to Madrean montane forests occur in the Southwest—the Thick-billed Parrot (*Rhynchopsitta pachyrhyncha*), Imperial Woodpecker (*Campephilus imperialis*), Eared Trogon (*Euptilotes neoxenus*), Russet Nightingale Thrush (*Catharus occidentalis*), and Red Warbler (*Ergaticus ruber*).

Amphibians are limited to the Tiger Salamander (*Ambystoma tigrinum*), and locally in mixed-conifer forests within their mountain namesakes, the Jemez and Sacramento Mountain Salamanders (*Plethodon neomexicanus* and *Aneides hardyi*), and various frogs and toads. Skinks—in the southern Rockies, the Southern Many-lined Skink (*Eumeces multivirgatus epipleurotus*); in Great Basin fasciations, the Western Skink (*E. skiltonianus*) and in Madrean fasciations, the Mountain Skink (*E. callicephalus*)—are representative lizards. As with the birds, some of the reptiles occur throughout both Rocky Mountain and Madrean fasciations with only change in subspecies rank—Short-horned Lizard (*Phrynosoma douglassi*), Arizona Alligator Lizard (*Gerrhonotus kingi*), Ringneck Snake (*Diadophis punctatus*), Gopher Snake (*Pituophis melanoleucus*), and a number of subspecies of the Western Rattlesnake (*Crotalus viridis*). Madrean and Mogollon fasciations have a proportionately larger number of herptiles than more northern forests because of the warmer biomes downslope. The Bunchgrass Lizard (*Sceloporus scalaris*), Striped Plateau Lizard (*S. virgatus*), Yarrow's Spiny Lizard (*S. jarrovi*), Mountain Patch-nosed Snake (*Salvadora grahamiae*), Sonoran Mountain Kingsnake (*Lampropeltis pyromelana*), Western Terrestrial Garter Snake (*Thamnophis elegans*), and Twin-spotted Rattlesnake (*Crotalus pricei*) are all species that reach well into montane conifer forest within their regional distributions.