# Trees of the Gila Forest Region, New Mexico

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*to protect the forest is to know the trees*

## Abstract

We present information on the flora, distribution, and ecology of the trees of the Gila National Forest Region of New Mexico. We include their geographical affinities, abundances, adaptations to thrive in the region, and data on riparian trees at 49 sites, each with three plots, along the Gila River. The Gila Region is home to 67 tree species comprised of 17 conifers, 1 monocot, and 49 eudicot trees. Among these species 56 are native. Among the 11 nonnatives only *Tamarix chinensis* and *Ulmus pumila* are sometimes reproducing in natural habitats. The 1.4-million-hectare (3.5-million-acre) Gila National Forest appears amazingly intact but is not virgin—centuries of woodcutting for smelting ore, lumber, and cooking and heating, as well as overgrazing, destruction of top predators, fire suppression and subsequent crown fires, and invasive recreation have taken their toll. Yet many upland areas have old-growth characteristics, vibrant broadleaf gallery forests line rivers and tributaries, and conifers and broadleaf trees cover seemingly endless mountains. Downriver gallery forests are gone or dying and other southwestern U.S. forests are fearsomely diminishing. The Gila Region is an important reservoir of native tree species.

## Introduction

The Gila National Forest in southwestern New Mexico is world famous for conservation and natural magnificence. This wilderness and forest is where Aldo Leopold pioneered conservation in the early twentieth century, leading to the first federally designated wilderness area, the Aldo Leopold Wilderness, created in 1924. Perennial streams, fed by snowmelt and rainfall, tumble out of canyons in the higher elevations into the periodically dry rivers. Conifers and broadleaf trees cover seemingly endless mountains and canyons, and galleries of cottonwoods and willows are vibrant along the rivers and tributaries.

The 1.37-million-hectare (3.39-million-acre) Gila National Forest is located primarily in Catron and Grant counties with small portions in adjacent Hidalgo and Sierra counties. Our tree flora encompasses the Gila National Forest and adjacent areas, referred to here as the Gila Region (fig. 1). This region includes the proclaimed Gila National Forest (1,110,756 ha, or 2,744,664 acres); the proclaimed New Mexico portion of the Apache National Forest (261,294 ha, or 645,649 acres), which is administered by the Gila National Forest; and adjacent nonforest areas such as the vicinity of Silver City. The Gila and New Mexico Apache Forests extend continuously into the Apache-Sitgreaves National Forest of Arizona (853,996 ha, or 2,110,196 acres. National Forest areas calculated from the U.S. Forest Service GIS boundary layers by Marc Levesque [personal communication, 2010]). Elevation in the Gila Region ranges from about 4000 ft (1220 m) at the upper limits of Chihuahuan Desert to over 10,000 ft (3050 m) in mixed-conifer forests on the Mogollon and Black ranges. This geologically and topographically complex region straddles the Continental Divide. Lands on the west side are drained by the Gila River and its tributaries, including the San Francisco River. The Gila River eventually crosses into Arizona, where it once flowed on into the Colorado River at Yuma and ultimately the once mighty Río Colorado delta at the head of the Gulf of California. Drainages on the east side of the divide are to the Gulf of Mexico, but the Mimbres River, the main drainage system on the east side of the divide, seldom flows past the mountain ranges and ends in a closed basin in the Chihuahuan Desert along the Mexican borderlands.

The Gila National Forest, with its rich biodiversity, appears amazingly intact for so large an area in a developed county in the twenty-first century, but is no virgin—centuries of woodcutting for smelting ore, lumber, and cooking and heating, as well as overgrazing, destruction of top predators, fire suppression and subsequent crown fires, and invasive recreation have taken their toll. And prior to the major forest assaults beginning in the nineteenth century, people lived in the region for millennia, variously influencing the forest. Yet many upland areas have old-growth characteristics, and the Gila Region is an important reservoir of native tree species.

Other southwestern U.S. and northwestern Mexico forests are diminishing fearsomely fast. To the west and south of the Gila Region the rivers and their great gallery forests are dead or dying and the remaining forests are diminishing at an alarming rate. Many Gila Region rivers and tributaries still run but the flows are largely diminished as too many humans






**Figure 1. The Gila Region, southwestern New Mexico.** *Map by Marc Levesque, Acadia West LLC, Silver City.*

consume and covet their remaining water. The effects of climate change are already seen, such as increased bark beetle destruction and unwanted, hot crown fires (e.g., Breshears et al. 2005; McHugh et al. 2003). The multitude of human impacts must be regulated and decreased if the forests are to thrive.

The Gila Region is home to a tree diversity of 17 conifer species, 1 monocot (*Yucca*), and 49 eudicot species (includes 2 "hybrid species"; table 1). These 67 tree species represent about 4% of the total estimated vascular plant flora of the Gila Region, which might be about 1650 species (Russ Kleinman, personal communication, 17 March 2010; also see Kleinman 2009). The 67 species are distributed in 32 genera and 20 families; among these there are 11 species in 11 genera and 8 families that are not native to the region. Not included in these counts are species not considered actual trees, such as *Fouquieria splendens,* and nonnatives occasionally encountered but not reproducing, such as apple (*Malus pumila*) and peach (*Prunus persica*). The most diverse genera are *Quercus* (7 species), *Salix* (7 species), *Pinus* (6 species and 2 varieties), *Juniperus* (5 species), and *Populus* (4 species and 1 hybrid).

The Gila Region tree flora is largely wind pollinated like most temperate, higher-latitude or higher-elevation floras (e.g., Regal 1982). Probably only 10 native species are animal pollinated (mostly by insects), typical of regions of lower latitudes: *Chilopsis linearis, Cercocarpus breviflorus, Crataegus wootoniana, Forestiera pubescens, Prosopis glandulosa, Prunus serotina, Robinia neomexicana, Sambucus cerulea, Sapindus drummondii*, and *Yucca elata*. Others, such as *Populus* (cottonwoods) and *Salix* (willows), have flowers that may be visited by bees but are likely to be essentially wind pollinated.

## Vegetation of the Region

Rainfall and elevation, as well as minimum temperatures, especially for species of southern affinity, largely determine the vegetation. The topographically complex mountainous region of southern New Mexico has correspondingly complex vegetation. North- and south-facing slopes generally support quite different vegetation than each other, and interdigitating riparian areas and canyons further complicate the scene. Generalized distributions of the native and naturalized Gila Region trees are listed in table 1. A highly simplified synopsis of the Gila Region vegetation follows.

**Chihuahuan Desert**. A northern part of this great inland desert extends into the Gila Region below 4500 ft (1220 m). Rainfall is limited and many of the larger shrubs and trees are northern outliers of southern regions. These include desert willow (*Chilopsis linearis*), creosotebush (*Larrea divaricata* subsp. *tridentata*), mesquite (*Prosopis glandulosa* var. *torreyana*), catclaw acacia (*Acacia greggii*, = *Senegalia greggii*), and soaptree yucca (*Yucca elata*).

**Grasslands**. Valley plains and low hills, 4000–6500 ft (1220–1370 m), are typically dominated by vast expanses of perennial grasses, green during the summer rainy season and golden brown the rest of the year. This grassland has been called Plains Grassland or Short-grass Prairie (Brown 1982). Scattered trees, often along dry drainageways, include junipers (*Juniperus monosperma* and *J. deppeana*), gray oak (*Quercus grisea*), and desert willow.

Prominent among the rich diversity of perennial native grasses are *Aristida arizonica, A. divaricata, A. havardii, A. purpurea* var. *longiseta, A. schiedeana* var. *orcuttiana, A. ternipes* var. *ternipes, Bouteloua curtipendula, B. eriopoda, B. gracilis, B. hirsuta, Bothriochloa barbinodis, Eragrostis intermedia, Hilaria belangeri, H. mutica, Hopia obtusa* (*Panicum obtusum*), *Leptochloa dubia, Muhlenbergia alopecuroides* (*Lycurus setosus*), *M. arenicola, M. torreyi, Panicum hallii, Schizachyrium scoparium, Setaria leucopila, Sporobolus contractus, S. cryptandrus, and S. wrightii* (William Norris, personal communication, 2009).

**Woodland of pinyon, juniper, and oak**. This is the usual upland vegetation at 4500–7500 ft (1220–2285 m). The flora is surprisingly diverse. Characteristic species may include junipers (*Juniperus deppeana, J. monosperma,* and *J. osteosperma*), oaks (mostly *Quercus emoryi* and *Q. grisea*), and pinyons (*Pinus edulis* var. *edulis* and *P. discolor*). Shrubs and other large perennials are diverse and may include Parry agave (*Agave parryi*), mountain mahogany (*Cercocarpus breviflorus*), cholla (*Cylindropuntia spinosior*), silktassel (*Garrya wrightii*), beargrass (*Nolina microcarpa*), wait-a-minute bush (*Mimosa aculeaticarpa* var. *biuncifera*), and banana yucca (*Yucca baccata*). Grasses, mostly perennials, are numerous and diverse here and through most vegetation in the region.

**Pine forest**. Sparse to dense stands of pines occur at 5500–8500 ft (1675–2590 m). *Pinus ponderosa* var. *scopulorum* is often the dominant species, and *P. edulis* and *P. strobiformis* range from lower to higher elevations, respectively. Other common trees and shrubs include *Quercus gambelii*, *Juniperus deppeana*, *J. scopulorum*, *Ribes aureum, R. pinetorum,* and, more locally, *Quercus hypoleucoides*, *Q. rugosa*, *Pinus arizonica*, and *P. chihuahuana*.

**Mixed-conifer forest**. Tall forests generally above 8000 ft (2440 m) are characterized by Douglas fir (*Pseudotsuga menziesii*), white pine (*Pinus strobiformis*), and white fir (*Abies concolor*). Corkbark fir (*Abies lasiocarpa*), spruce (*Picea engelmannii* and *P. pungens*), aspen (*Populus tremuloides*), and Scouler willow (*Salix scouleriana*) are encountered at the higher elevations. Other trees include *Acer glabrum, A. grandidentatum, A. negundo*, *Alnus incana, Quercus gambelii*, and *Robinia neomexicana*.

"The *Picea engelmannii-Abies lasiocarpa* forest type, found at the highest elevations, being restricted by its habitat requirements, is so rare in the Southwest that I always find it an extraordinary place to visit. It must represent considerably less than 1% of the Gila and the neighboring Sky Islands" (Kevin Keith, personal communication, 13 September 2009).

**Riparian vegetation**. Water-loving trees and shrubs occur along the several rivers, their tributaries and streams, canyon bottoms, and lakesides—essentially wherever water flows or accumulates. Many trees descend into lower elevations along



**Table 1. Distribution of Gila Region trees**

| Family/Species | Chih. Desert | Grassland | Woodland | Pine Forest | Mixed conifer | Riparian |
|---|---|---|---|---|---|---|
| CUPRESSACEAE | | | | | | |
| *Cupressus arizonica | | | W | | | |
| Juniperus arizonica | | | W | | | |
| J. deppeana | | G | W | P | M | R |
| J. monosperma | | G | W | P | | |
| J. osteosperma | | | W | P | | |
| J. scopulorum | | | | P | M | R |
| PINACEAE | | | | | | |
| Abies concolor | | | | | M | |
| A. lasiocarpa | | | | | M | |
| Picea engelmannii | | | | | M | |
| P. pungens | | | | | M | |
| Pinus arizonica | | | | P | | |
| P. chihuahuana | | | W | P | | |
| P. discolor | | | W | P | | |
| P. edulis var. edulis | | | W | P | | |
| P. edulis var. fallax | | | W | | | |
| P. ponderosa | | | | P | | R |
| P. strobiformis | | | | P | M | |
| Pseudotsuga menziesii | | | | | M | |
| AGAVACEAE | | | | | | |
| Yucca elata | C | G | | | | |
| ADOXACEAE | | | | | | |
| Sambucus cerulea | | | W | P | M | R |
| BETULACEAE | | | | | | |
| Alnus incana | | | | | M | R |
| A. oblongifolia | | | W | P | M | R |
| BIGNONIACEAE | | | | | | |
| Chilopsis linearis | C | G | W | | | R |
| CANNABACEAE | | | | | | |
| Celtis reticulata | C | G | W | | | R |
| ELAEAGNACEAE | | | | | | |
| *Elaeagnus angustifolia | | | W | | | |
| FABACEAE | | | | | | |
| *Gleditsia triacanthos | | | W | | | R |
| Prosopis glandulosa | C | G | | | | R |
| Robinia neomexicana | | | W | P | M | R |
| *R. pseudoacacia | | | W | | | R |
| FAGACEAE | | | | | | |
| Quercus arizonica | | | W | | | R |
| Q. chrysolepis | | | W | | | R |
| Q. emoryi | | G | W | | | |
| Q. gambelii | | | W | P | M | R |
| Q. grisea | | G | W | P | | R |
| Q. hypoleucoides | | | W | P | M | |
| Q. rugosa | | | | P | | R |
| FOUQUIERIACEAE | | | | | | |
| *Fouquieria splendens* | | | W | | | |
| JUGLANDACEAE | | | | | | |
| Juglans major | | G | W | P | M | R |

(*continued*)

**Table 1 *(continued)***

| Family/Species | Chih. Desert | Grassland | Woodland | Pine Forest | Mixed conifer | Riparian |
|---|---|---|---|---|---|---|
| MORACEAE | | | | | | |
| *Maclura pomifera | | G | W | | | |
| *Morus alba | | | W | | | R |
| M. microphylla | | | W | P | | R |
| OLEACEAE | | | | | | |
| Forestiera pubescens | | | W | P | | R |
| Fraxinus anomala | | | W | | | R |
| F. velutina | | | W | | | R |
| PLATANACEAE | | | | | | R |
| Platanus wrightii | | | W | P | | R |
| ROSACEAE | | | | | | |
| Cercocarpus breviflorus | | | W | P | | |
| Crataegus wootoniana | | | | P | M | R |
| **Malus pumila* | | | | P | | |
| *Prunus americana | | | W | | | R |
| **P. persica* | | | | P | | |
| P. serotina | | | W | P | M | R |
| SALICACEAE | | | | | | |
| Populus angustifolia | | | W | P | | R |
| P. deltoides | | | | P | | R |
| P. fremontii | | | W | | | R |
| P. ×hinkleyana &/or P. ×acuminata | | | W | P | | R |
| P. tremuloides | | | | | M | R |
| Salix bonplandiana | | | W | | | R |
| S. exigua | | | W | | | R |
| S. gooddingii | | | W | P | | R |
| S. irrorata | | | W | P | | R |
| S. lucida | | | | P | | R |
| S. scouleriana | | | | | M | |
| *S. ×sepulcralis | | | W | | | R |
| S. taxilifolia | | | W | | | R |
| SAPINDACEAE | | | | | | |
| Acer glabrum | | | | P | M | R |
| A. grandidentatum | | | | P | M | R |
| A. negundo | | | W | P | M | R |
| Sapindus drummondii | C | G | W | | | R |
| SIMAROUBACEAE | | | | | | |
| *Ailanthus altissima | | | W | | | |
| TAMARICACEAE | | | | | | |
| *Tamarix chinensis | | | W | | | R |
| ULMACEAE | | | | | | |
| *Ulmus pumila | | | W | P | | R |



riparian corridors and other trees are restricted to riparian habitats. In a semiarid region such as the Gila Region, the largest trees, species and individuals, often grow in riparian habitats. Characteristic trees in our sampling plots, in the order of most commonly found, include Frémont cottonwood (*Populus fremontii*), bluestem willow (*Salix irrorata*), narrowleaf cottonwood (*P. angustifolia*), Goodding willow (*S. gooddingii*), box elder (*Acer negundo*), Arizona walnut (*Juglans major*), Arizona sycamore (*Platanus wrightii*), narrowleaf willow (*S. exigua*), and New Mexico alder (*Alnus oblongifolia*).

**Nonnative Trees**. We documented 11 nonnative tree species in the Gila Region that are now part of the local flora (table 1). Six are native to the Old World: *Ailanthus altissima* (Simaroubaceae), *Elaeagnus angustifolia* (Elaeagnaceae), *Morus alba* (Moraceae), *Salix* × *sepulcralis* (Salicaceae), *Tamarix chinensis* (Tamaricaceae), and *Ulmus pumila* (Ulmaceae); and four, *Gleditsia triacanthos* and *Robinia pseudoacacia* (Fabaceae), *Maclura pomifera* (Moraceae), and *Prunus americana* (Rosaceae), are native to eastern and northern regions of the United States. *Cupressus arizonica* is native in nearby regions of New Mexico. These trees generally occur in disturbed habitats including roadsides and other weedy places. Only *Ailanthus*, *Tamarix*, and *Ulmus* are common in the region, and only *Tamarix* and *Ulmus* are reproducing in relatively undisturbed habitats.

## Gila River Riparian Plots

Several rivers and their tributaries drain the mountains of the Gila Region. The Gila River, one of the last relatively untamed rivers in the West, supports a diverse gallery forest characteristic of the region. Vegetation data were collected during July 2007 from 49 riparian sites, with three one-hectare plots at each site, along the Gila River (Kindscher et al. 2008). The purpose of the data collection was to provide species and habitat data for a biodiversity study of the river. The plots were only established in the riparian areas, so the data do not include upland habitats. They were selected as representative of the area, and were at least 0.5 km from each other. Site selection was limited to areas that could be reached by hiking no more than 5 km from a trailhead. For additional methods and data analysis, see Kindscher et al. (2008). This data set provides a snapshot of the trees that occur along the river. The most common tree species in the plots (as determined by canopy-cover estimates) are shown in table 2. Sites upstream (in the vicinity of the Gila Hot Springs, 5000–6000 ft) had comparably more species per plot and less bare ground than downstream sites. The tree species in upstream plots with the most cover was narrow-leaved cottonwood (*Populus angustifolia*). For downstream plots (sites 5000–4000 ft and near the towns of Gila and Cliff to below Redrock), Frémont cottonwood (*Populus fremontii*) was the species with the greatest total cover.

## Species Accounts

Information included here is based on our field experience, herbarium records, the published record, and knowledge shared by colleagues. The trees are listed alphabetically by family, genus, and species, except that we have grouped the families of conifers (Coniferophyta, gymnosperms), monocots (Liliopsida), and eudicots (Magnoliopsida). The accepted names of trees established and reproducing or propagating in the region are in boldface. Species present but not reproducing (e.g., apple and peach), or ones not considered an actual tree (e.g., ocotillo), are listed in italics. Trees not native to the Gila Region are marked with an asterisk (*). Selected pertinent synonyms are listed, especially those appearing in the standard regional references. Synonyms are in brackets [—] following the accepted scientific name. Common names, when available, are listed first in English (not italicized), and in some cases then in Spanish (italicized). Etymology of the accepted scientific name follows in parentheses (for additional etymology see Allred 2009). The upper leaf surface is the adaxial side, the side closest to the stem axis; the lower leaf surface is the abaxial side or underside of the leaf.

We define a tree as (ideally) being at least 5 m tall with a well-formed trunk and free standing (thus excluding vines). Approximate height designations are: small trees, 5–8 m tall; medium-sized trees, 9–15 (18) m; and large trees, 15 or more m. Height designations, vegetation zones, elevations, and distributions represent our best current information or estimates. Plant family designations follow the APG III (Angiosperm Phylogeny Group) classifications, reflecting current knowledge of relationships (Stevens 2008).

The descriptions, measurements, and identification keys pertain only to plants and populations from the Gila Region and immediately adjacent areas. In the abbreviated descriptions we emphasize features that seem important to understanding the variation and adaptations in this generally arid region. For this reason there is more emphasis on vegetative characters and less on other features emphasized in other floras. Additional information and illustrations can be found in Carter (1997) and regional floras, the Vascular Plants of the Gila Wilderness website (Kleinman 2009), and Earle (2010) for conifers. Taxonomy presented in the species accounts is Felger's opinion, taxonomically conservative with interpretation as of April 2010, and mostly consistent with Allred's (2008) floristic listing for New Mexico. Biological, evolution-based taxonomy is dynamic—science moves on and new findings will generate new taxonomies and differences of opinion—sometimes allowing for more than one reality in classification.

We generally cite two or more herbarium vouchers for each tree species or infraspecific taxon, as well as some specific observations. All specimens cited are at the Dale A. Zimmerman Herbarium at Western New Mexico University (SNM) unless otherwise indicated (e.g., ARIZ, NMC). We

**Table 2. Most common species found in 147 plots (one hectare each) in the riparian area along the Gila River. The number of plots in which a species occurred is shown in "Count."**

| Species | Common Name | Count |
|---|---|---|
| *Populus fremontii* | Frémont cottonwood | 79 |
| *Salix irrorata* | bluestem willow | 60 |
| *Populus angustifolia* | narrowleaf cottonwood | 56 |
| *Salix gooddingii* | Goodding willow | 55 |
| *Acer negundo* | box elder | 51 |
| *Juglans major* | Arizona walnut | 48 |
| *Platanus wrightii* | Arizona sycamore | 48 |
| *Salix exigua* | narrowleaf willow | 43 |
| *Alnus oblongifolia* | New Mexico alder | 35 |
| *Pinus ponderosa* | ponderosa pine | 32 |
| *Juniperus monosperma* | one-seed juniper | 31 |
| *Forestiera pubescens* | New Mexico olive | 26 |
| *Celtis reticulata* | canyon hackberry | 25 |
| *Juniperus deppeana* | alligator-bark juniper | 16 |
| *Populus ×hinkleyana* | Hinckley cottonwood | 16 |
| *Juniperus scopulorum* | Rocky Mountain juniper | 15 |
| *Prosopis glandulosa* | honey mesquite | 15 |
| *Quercus gambelii* | Gambel oak | 14 |
| **Tamarix chinensis* | tamarisk | 12 |
| *Fraxinus velutina* | velvet ash | 11 |
| *Quercus grisea* | gray oak | 10 |

generally cite only enough label information to identify the specimen and only the primary collector. Additional information can be found on the actual labels and in databases such as Southwest Environmental Information Network (2009) and the New Mexico Biodiversity Collection Consortium (2009). All specimens have been seen and verified by Felger unless otherwise indicated.

## CONIFERS

Mostly trees of the mountains and foothills. Leaves evergreen. Cones of two kinds: pollen (male) cones, relatively small and herbaceous, numerous, and soon deciduous; seed (female) cones, much larger, firmer or woody, less numerous, and persisting one season to several or more years. Descriptions are for seed cones.

1. Leaves scalelike or slender to ca. 1 cm long; cones rounded, berrylike, and not more than 1.55 cm diameter (*Juniperus*), or woody and 2–3 cm diameter (*Cupressus*). **Cupressaceae**
1' Leaves needlelike, more than 2 cm long; cones not berrylike, mostly more than 3 cm long or wide. **Pinaceae**

## CUPRESSACEAE—CYPRESS FAMILY

1. Cones 2–3 cm diameter, woody, and persistent. **Cupressus**
1' Cones to 1.55 cm diameter, berrylike and fleshy or semifleshy, and not persistent. **Juniperus**

***Cupressus arizonica** Greene [*Callitropsis arizonica* (Greene) D.P. Little, 2006. *Hesperocyparis arizonica* (Greene) Bartel, 2009. *Neocupressus arizonica* (Greene) de Laubenfels, 2009] Arizona cypress (the classical name for cypress; of Arizona)

Medium-sized trees (sometimes large trees in cultivation). Bark scaly on twigs, furrowed and fibrous (or peeling) on older limbs and trunks. Leaves scalelike, variously with or without a dot or pitlike resin-producing gland. Pollen and seed cones on the same tree. Seed cones 2–3 cm diameter, woody, globose, persistent, the scales woody, broad and flattened at the apex with a short umbo (central projection). Seeds each with a small papery wing.

In New Mexico native only in the Cookes Range, where there is a substantial population (Columbus 1988). Southern Arizona to west Texas and northern Mexico, and widely cultivated in many regions of the world.

Arizona cypress is widely cultivated in New Mexico including the Gila Region. Once established the trees often thrive without further care, but are not known to reproduce in the Gila Region except at Fort Bayard. Well-established Fort Bayard trees are reproducing, with numerous seedling and juveniles, mostly shaded by the parent trees—at various times this site receives supplemental water or water from a natural spring. The original trees are said to have been brought from the Cookes Range, a likely scenario but one that has not been verified. A few of the Fort Bayard trees are more than 20 m tall (the tallest, measured with a clinometer by Kevin Keith on 9 November 2009, was 23.2 m tall).

Grant Co: 1.3 air mi W of Pinos Altos, 2 medium-size trees, planted decades earlier and thriving without care, 8 Oct 2009, *Felger 09-91*. Fort Bayard, grove of neglected but healthy and reproducing trees, 9 Nov 2009, *Felger, observation*. Leopold Vista, off Hwy 180, several young trees ca. 4 m tall, planted, producing cones, 22 Dec 2008, *Felger, observation and photos*. Luna Co: Cookes Range, 15 Oct 1977, *Zimmerman 2871*.

**Juniperus**—Juniper (Latin name for junipers)
Leaves scalelike or slender and pointed (subulate) to ca. 10 mm long on long shoots (whip shoots). Pollen and seed cones on separate trees (except *J. osteosperma*). Seed cones fleshy to semifleshy and berrylike, the cone scales not separating like other conifers in the region. The bark on *J. deppeana* (except forma *sperryi*) is checkered and on the others the bark is longitudinally furrowed and shreds in long strips (these are sometimes called shagbark junipers). One other juniper occurs in the region, *J. communis* Linnaeus var. *depressa* Pursh, a shrub about 1 m tall with sharp-pointed, subulate leaves ca. 15 mm long. It is not common in the Gila Region, mostly in moist places at fairly high elevations, this being its southernmost limit in North America.

1. Bark checkered (except forma *sperryi*); cones (8) 10–15 mm diameter, mostly with 4 or 5 seeds. **J. deppeana**
1' Bark longitudinally fissured, not checkered; cones 6–15 mm diameter, with 1 or 2 (3) seeds.
2. Leafy twigs drooping; leaves with entire margins (at 20× magnification); mature cones small and dark bluish black. **J. scopulorum**
2' Leafy twigs not drooping; leaves with denticulate (minutely toothed) margins (using 20× magnification, a subtle character that works best if you are familiar with the variation); mature cones light-colored.
3. Resin gland embedded in leaf and thus inconspicuous; pollen and seed cones on the same plant; seed cones 12–15.5 mm diameter. **J. osteosperma**
3' Most or many leaves with a conspicuous resin gland; pollen and seed cones on separate plants; seed cones 6–8 mm diameter.
4. Cones reddish orange, usually sweet and palatable; scarce in the Gila Region. **J. arizonica**
4' Cones bluish with a whitish glaucous surface (bloom); widespread in the Gila Region. **J. monosperma**

**Juniperus arizonica** R.P. Adams [*J. coahuilensis* (Martínez) Gaussen ex R.P. Adams var. *arizonica* R.P. Adams] Arizona juniper (of Arizona)

Mostly large shrubs and sometime small trees to about 6–8 m. Bark shredding in strips. Pollen and seed cones on separate plants. Seed cones maturing in one year, reddish or orange beneath the glaucous surface, juicy and sweet; seeds 1 (2) per cone.

Grassland–oak-juniper woodland ecotone. Arizona, New Mexico, and northern Mexico. Scattered populations and small groups of Arizona junipers are reported to occur in the Burro Mountains and elsewhere in the Gila River drainage area, often sympatric with *J. monosperma*. The seed-cone coloration and sweet-tasting flesh are distinctive. In his detailed work on junipers, Adams (1994) recognized part of the more broadly interpreted *J. coahuilensis* as the distinct species *J. arizonica*. This juniper replaces *J. monosperma* to the south and west of the Gila Region.

Grant Co: Gila River Valley, hills near Bill Evans Lake above mouth of Mangas Canyon, ca. 4300 ft, low tree, 20 Nov 1981, *McCormick s.n.* Ca. 10 mi N of Cliff at confluence of Mogollon Creek & Gila River, fairly common tree to 25 ft in sycamore woodland, berries reddish tinted, the bloom purplish pink, very different from blue of nearby *J. monosperma*, 24 Oct 1985, *Zimmerman 2985*. Gravelly, sandy soil along tributary to Steeple Creek, 0.5 mi into Steeple Rock Formations, S32, T17S, R20W, 4720 ft, 19 Jan 1992, *Carter 366*. Luna Co: SW corner of Florida Mts, 13 Mar 1974, *McCormick & Zimmerman 1429*.

**Juniperus deppeana** Steudel. Alligator-bark juniper (for Ferdinand Deppe, 1794–1861, German naturalist and artist who traveled to Mexico and California)

Small to medium-sized trees (a well-known tree at Fort Bayard, ranked as the second largest *J. deppeana* in the United States, is 63 ft tall with a 62-foot crown and a trunk 18 ft circumference [USDA Forest Service n.d.; USDA, NRCS 2009]). Bark checkered like an alligator back. Pollen and seed cones on separate plants. Seed cones about 10–15 mm diameter; (3) 4–6 seeds per cone.

The many interesting shapes of the trunks and limbs produce outstanding living sculptures. Pollen cones ripen in late winter and spring, and due to the enormous quantities the male trees can become brown or orange-brown, shedding clouds of pollen on warm, dry days. The seed cones ripen in their second year in fall and early winter and often remain on the trees for considerable lengths of time. During mast years the ground beneath seed-cone trees often becomes littered with the fallen cones and swamps the ability of the animals to consume them. The carbohydrate-rich cones provide food sources for many birds and mammals, including American robins, black bears, Cassin's finches, chipmunks, coyotes, deer, elk, evening grosbeaks, foxes, javelinas, squirrels, turkeys, Townsend's solitaires, western and mountain bluebirds, and many others, and are also relished by horses. Bears and coyotes eagerly gobble the fallen cones as evidenced in their scats along trails.

These junipers are often considered weedy and undesirable, spreading into open areas. When cut down they can resprout and form even more plants. The trees and limbs are

extensively harvested for firewood, and stumps and trees with missing limbs are commonplace, especially near roads. Dead stumps of trees harvested long ago, often larger than trunks of nearby existing trees, are often seen in the forests, even in remote places.

Abundant and widespread throughout the Gila Region above grassland into mixed-conifer forest (e.g., to ca. 9000 ft on Signal Peak). In our plots in the riparian area along the Gila River, it was found only at sites above 4700 ft.

Arizona to western Texas and southward in Mexico to the state of Puebla. Five weakly differentiated varieties are sometimes recognized, distinguished on DNA and growth habit. Arizona and New Mexico populations are var. *deppeana*.

A few individuals of the rare **J. deppeana** forma **sperryi** (Correll) R.P. Adams [*J. deppeana* var. *sperryi* Correll; for Omer Edison Sperry, 1902–1975, Texas botanist] have been found in the region. It is distinguished by having longitudinally furrowed bark that shreds in long strips rather than the usual checkered "alligator" bark.

Catron Co: Pie Town, 2350 m, 22 Sep 2004, *Johnson 15*. Grant Co: Saddle Rock Road, 16 Nov 2006, *Ward 85*. Adjacent to FS Road 853, 31 May 1995, *Villalba & Stevens 2169*. Sierra Co: Emory Pass, 8228 ft, 18 Apr 1989, *Wilson 10*. Forma *sperryi*: Grant Co., Rabb Park Trail, Black Range, 2 Jul 2009, *Felger 09-76*.

**Juniperus monosperma** (Engelmann) Sargent. One-seed juniper (one seed)

Large shrubs and small trees. Bark shredding in strips. Pollen and seed cones on separate plants. Seed cones maturing in one year, 6–8 mm diameter, with 1 (2 or 3) seeds. Pollen cones ripening in late winter, and like those of *J. deppeana* can produce staggering quantities of pollen with the result that male plants can become brown or orange in color, shedding clouds of pollen on warm, dry days.

Abundant and widespread, mostly grasslands into pine forest; a dominant in pinyon-juniper woodland. It was the most common juniper found in 32 of 147 plots we sampled in the riparian area along the Gila River and was found at sites above 4300 ft. Intermediate elevations from central Arizona to Colorado, New Mexico, Oklahoma, Texas, Chihuahua, and northern Sonora. *Juniperus monosperma* and *J. deppeana* are the most common junipers in the Gila Region.

Grant Co: Mangas Springs, 20 Nov 2003, *Kerwin 124*. 2 mi N of Silver City on Little Walnut Creek road, 20 Aug 1967, *Hess 1380*. Fort Bayard, 11 Oct 1995, *Zimmerman 4342*.

**Juniperus osteosperma** (Torrey) Little [*J. utahensis* Lemmon] Utah juniper (bone-seed)

Large shrubs and small trees. Bark shredding in strips. Scale leaves keeled; resin glands embedded in the leaf and inconspicuous. Pollen and seed cones on the same tree. Seed cones maturing in 1–2 years, large—often 12.3–15.5 mm diameter, the surfaces conspicuously bluish glaucous, the pulp rather dry and fibrous; seeds 1 (2) per cone.

Pinyon-juniper woodland and lower pine forest. Northwestern part of the Gila Region, including the vicinities of Glenwood and Reserve. Not found in the Gila River riparian area. Widespread in the Rocky Mountain region from California to New Mexico and north to Montana. Utah juniper is at its southern limit in southern New Mexico.

Catron Co: 8.4 mi N of Alma on Hwy 180, 5350 ft, 21 Jun 1991, *Carter 133*. FS [road] 141, 5.5 mi S of junction of Hwy 12 in Reserve, 30 May 1994, *Carter 1368*.

**Juniperus scopulorum** Sargent. Rocky Mountain juniper (growing on cliffs)

Small to medium-sized trees, rarely to ca. 15 m (an enormous one in Purgatory Chasm east of Lake Roberts is nearly 20 m tall and the uppermost part of the trunk is broken off). Bark shredding in thin strips. Leafy branchlets mostly drooping ("weeping") and notably slender, the scale leaves small and the resin gland inconspicuous. Pollen and seed cones on separate trees. Seed cones maturing in 2 years, small (5–8 mm diameter), bluish purple and glaucous especially when young, becoming darker when mature, the pulp soft. Seeds 1 (2) per cone.

Mostly in pine and lower mixed-conifer forests, especially in moist canyons. In our plots in the riparian area along the Gila River it was found only above 5600 ft. It has a patchy distribution and is not common in the southern part of the Gila Region, but is common at Lake Roberts and farther north.

Western, temperate North America from southwestern Canada to the borderlands of north-central Mexico. It is the fastest-growing juniper in the Southwest and has light, strong wood. This species is related to the red cedar, *J. virginiana* Linnaeus, of eastern United States and adjacent Canada to Texas. Rocky Mountain juniper is replaced southward in the Sierra Madre Occidental of Mexico by *J. mucronata* R.P. Adams.

Catron Co: Quemado Lake, Juniper Campground, pinyon-juniper transition into ponderosa pine woodland, 25 Sep 2004, *Johnson 17*. Grant Co: Sapillo Campground, 6300 ft, *Huff 1979*. Meerschaum Canyon, 2 Sep 1972, *Zimmerman 2084*.

## PINACEAE—PINE FAMILY

Almost all members of the family are native to the Northern Hemisphere and include some of the world's most commercially important trees, especially for timber and wood pulp. Pollen and seed cones on the same tree (ours, except *P. discolor*).

1. Pines; leaves (1) 2–6 in short-shoot fascicles, the fascicle bases with membranous sheaths; cones conspicuously woody, maturing in 2 or 3 years. **Pinus**
1' Leaves single, not in fascicles, without basal sheaths; cones not conspicuously woody, maturing in one season.
2. Spruce; twigs rough due to peglike projections persisting after the leaves fall; at highest elevations. **Picea**
2' Firs; twigs not rough, leaf scars at least partially flush with twig surface.
3. Branching of twigs mostly opposite; winter buds blunt and covered with sticky resin; leaf scars circular, nearly flush with the stem, or if slightly raised then evenly raised all around, not on a woody peglike base; cones erect, in tree tops, breaking up scale by scale and the cone axis persistent, the scale bracts much shorter than the mature scale and not 3-pronged. **Abies**
3' Branching of twigs mostly alternate; winter buds mostly pointed, not resinous or with thin, varnishlike resin; leaf scars usually oval, on a small woody peglike base, tilted slightly higher on the lower (proximal) side and nearly flush on the upper (distal) side; cones not all at tree tops, pendulous, falling intact, the scales persistent with a conspicuous 3-pronged bract longer than the scale. **Pseudotsuga**



**Abies**—Fir (Latin for firs)
Large, conical or spire-shaped trees, with whorled branching, the leafy branches usually flattened into a horizontal plane (flattened sprays). Leaves flattened and linear. Seed cones on upper branches near the tree tops, erect, cylindrical, rounded at the tip, and not bristly or spiny, maturing in one season and falling apart scale by scale while still attached to the tree, the scales fan shaped.

Temperate and cool regions of the Northern Hemisphere, mostly Eurasia and North America. Includes important timber trees and many horticultural selections in cool temperate and subarctic regions. The taxonomy of these and various other conifers can be confusing to nonspecialists, and closely related taxa (e.g., sister species and varieties or subspecies) are often distinguished by variation in such features as wood color, shape of basal bud scales, terpene patterns, and more recently DNA.

1. Bark not soft and corky; leaves often 3–6.5+ cm long; resin canals of leaves (seen in cross section) marginal (nearest the lower epidermis); cones greenish. **A. concolor**
1' Bark rather soft and corky; leaves often 1.7–4 cm long; resin canals of leaves in a medial position (not adjacent to the epidermis); cones purplish. **A. lasiocarpa**

**Abies concolor** (Gordon & Glendinning) Lindley ex Hildebrand. Rocky Mountain white fir (of one color)

Bark smooth, silvery gray on young branches, becoming dark gray and deeply fissured. Leaves 3.1–6 (7.5) cm long, (1.5) 2–3 mm wide, green or bluish glaucous (both colors may occur on the same or different trees). Cones pale green.

Widespread in mixed-conifer forest at elevations above 7600 ft. Western United States and the highest mountains in northernmost Mexico–Baja California (Norte), Sonora, and Chihuahua.

Catron Co: Catwalk, Whitewater Canyon, 2 Jun 1964, *Hubbard s.n.* Bead Spring Trail, Mogollon Mts, 14 Sep 2009, *Felger 09-84*. Sierra Co: 4 mi NW of Emory Pass, N slope, 24 Oct 1965, *Wright s.n.*

**Abies lasiocarpa** (Hooker) Nuttall var. **arizonica** (Merriam) Lemmon [*A. arizonica* Merriam] Corkbark fir (hairy fruit; of Arizona)

Bark silvery gray, smooth and rather soft like cork, with age darker gray and furrowed. Foliage generally bluish glaucous. Leaves 1.7–3 (4.5) cm long, 1.5–2 mm wide. Cones dark purple.

Mixed-conifer forest at higher elevations in the Black Range and Mogollon Mountains. *Abies lasiocarpa* is widespread in western North America from Arizona and New Mexico to Yukon and Alaska. Variety *arizonica* occurs in Arizona, Colorado, and New Mexico. Hunt (1993) restricts *A. lasiocarpa* to the Pacific Northwest and treats the inland populations, including those in New Mexico, as *A. bifolia* A. Murray. Allred (2008) recognizes the *arizonica* taxon at the species level. We follow Earle (2009) and others in a more conservative interpretation.

Catron Co: Mogollon Mts, 16 May 1964, *Hubbard s.n.* Grant Co: Black Range, McKnight Cabin, 9700 ft, 1 Jul 1968, *Hess s.n.* (NMC).

**Picea**—Spruce (Latin for pitch, and the name of a pitch pine)

Large, conical or spire-shaped trees occurring at highest elevations. Cones falling entire. Both New Mexico species are cultivated in Silver City.

1. Twigs finely pubescent; cones mostly less than 6 cm long, the cone scales extending 3–8 mm beyond the seed-wing impression. **P. engelmannii**
1' Twigs usually glabrous; cones mostly 6 cm or more in length, the cone scales extending 8–10 mm beyond the seed-wing impression. **P. pungens**

**Picea engelmannii** Parry ex Engelmann subsp. **engelmannii**. Engelmann spruce (for George Engelmann, 1809–1884, American botanist)

Bark on younger stems smooth, and on older, mature growth becoming scaly and peeling. Twigs and persistent leaf bases with small, short, and thick glandular hairs, best seen with magnification on fresh new growth. Leaves relatively flexible, not sharp pointed or spinescent (generally longer and a bit thinner than those of *P. pungens*). Seed cones mostly less than 6 cm long. Cone-scale margins toothed to erose at apex.

Mixed-conifer forest in the Mogollon Mountains, mostly above ca. 9300 ft. Notably common along the Bursum Trail, often growing with *P. pungens*. The mortality rate of the mature Engelmann spruce along this trail is high enough to be of concern (Kevin Keith, personal communication, 13 September 2009).

The main distribution of this species is in the interior coniferous forests of northwestern United States and southwestern Canada where it ranges to coastal areas. From the main body of its distribution this spruce occurs scattered southward in isolated pockets and finally reaches southern New Mexico and Arizona. Subspecies *engelmannii* is replaced by subsp. *mexicana* (Martínez) P.A. Schmidt in montane areas in Mexico and some areas in southeastern Arizona and southwestern New Mexico. Populations in the Gila Region are probably subsp. *engelmannii* (see Earle 2009). At its northern geographic limits this species passes freely (hybridizing and/or intergrading) into the north-temperate and arctic white spruce, *P. glauca* (Moench) Voss. Although Engelmann spruce has a relatively restricted range in the Gila Region, it is common and the only spruce on the Pinaleño Mountains in nearby southwestern Arizona (e.g., Southwest Environmental Information Network 2009).

Catron Co: Bursum Trail, 9700 ft, 14 Sep 2009, *Felger 09-80*. Mogollon Baldy Peak, barren area surrounded by spruce forest, in more exposed areas, 25 ft tall, near edge of forest, 10,700 ft, 25 Aug 1968, *Hess 2312* (ARIZ). Mogollon Mts, on or near the west fork of the Gila River, "approx. 11,000 ft" [highest peak is actually 10,770 ft], 20 Aug 1903, *Metcalfe 547* (ARIZ, NMC).

**Picea pungens** Engelmann. Colorado blue spruce (pungent, ending in a sharp, hard point, referring to the leaves)

Bark on younger stems slightly scaly, on older wood becoming fissured and not scaly. Twigs and leaf bases glabrous. Foliage varies from tree to tree, either green or bluish without apparent pattern. Leaves firm, with a sharp (often spinescent) tip; the leaves generally shorter and thicker than those of *P. engelmannii*. Seed cones mostly 6–7.7 cm long, the cone scales with wavy margins.

Mixed-conifer forest, mostly above 8000 ft. Common in the higher forested zones in the Mogollon Mountains, such as at Willow Creek. Blue spruce is more common and wider ranging in the Gila Region than Engelmann spruce. Blue spruce occurs in montane forests in interior, intermountain areas of western United States, and finds its southern limits in southern New Mexico. It is cultivated in Silver City and around the world in regions with cool or cold winters. There are many horticultural selections, especially for the attractive blue to silvery color. Juvenile blue spruce trees are widely sold as Christmas trees.

Edward Castetter's enigmatic 1939 specimen from the Black Range is the only known record for spruce in the Gila Region outside of the Mogollon Mountains. Iron Creek Trail no longer exists, although there might have been a trail along Iron Creek from the campground to just below Wrights Cabin. Since about 2000 there has been a considerable die-off of *Abies concolor* (Kevin Keith, personal communication 2009), and *Picea* would be even more vulnerable. Does *Picea* actually exist in the Black Range?

Catron Co: Willow Creek, 8000 ft, 29 Jun 1974, *Zimmerman 2668*. Mogollon Baldy Peak, barren top surrounded by spruce, 10,700 ft, 25 Aug 1968, *Hess 2311* (ARIZ). Mogollon Mts, 15 mi N of Mogollon in Indian Creek Drainage system, 8300 ft, 4 Sep 1968, *Hess 2389* (ARIZ). Grant Co: Black Range on Iron Creek Trail, Sierra County [sic], 9 Jul 1939, "coll. & determined by *E.F. Castetter 10713*" (UNM, image seen).

**Pinus**—Pines, pinyons; *pinos, piñones* (Latin name for pines)

Leaves needlelike (often called needles), (1) 2–5 in fascicles (bundles), the fascicle bases enclosed by a persistent or deciduous sheath of membranous scales. (The number of needles per bundle is convenient for general identification purpose, but exceptions may occur.) Pollen and seed cones on the same tree (ours, except *P. discolor*). Seed cones maturing in 2 years (or 3 for *P. chihuahuana*), falling intact, or the base remaining attached to the twig, or the cones persistent for a number of years. Cones woody, with spirally arranged scales; apex of scales conspicuously thickened or not, the apophysis (exposed part) commonly wide and generally rhombic in outline, usually transversely keeled and usually with a prominent terminal or dorsal umbo (protuberance), unarmed or ending in a spine or prickle (mucro). Each scale (except the few uppermost and lowermost ones) bears 2 ovules near its base. Seeds winged or not, the wings persistent or deciduous.

1. Pinyons; leaf sheaths deciduous; leaves mostly not more than 5 cm long; cones light brown, generally not persistent (falling at maturity), broader than long, without prickles or spines; seeds not winged.
 2. Leaves 1 per bundle. **P. edulis** var. **fallax**
 2' Leaves (1) 2 or 3 per bundle.
  3. Leaves usually 3 per bundle, usually to 1 mm wide. **P. discolor**
  3' Leaves (1) 2 per bundle, usually 1–1.5 mm wide. **P. edulis** var. **edulis**

1' Pines other than pinyons; leaf sheaths persistent or deciduous; leaves more than 5 cm long; cones of varying color, persistent or not, as broad as to mostly longer than wide, with or without prickles or spines; seeds winged (except *P. strobiformis*).
 4. Leaves 5 per bundle.
  5. Leaves (10) 12–25 cm long; cones 4–10 cm long, less than twice as long as wide. **P. arizonica**
  5' Leaves 5–9 cm long; cones 13–33 cm long, more than twice as long as wide. **P. strobiformis**
 4' Leaves usually 3 per bundle.
  6. Leaf sheaths soon deciduous; leaves 4–10 (11+) cm long; cones to ca. 5 cm long, blackish and persistent on the tree. **P. chihuahuana**
  6' Leaf sheaths persistent; leaves 9–22.5 cm long; larger cones 5–9 cm long, brown, not persistent. **P. ponderosa**

**Pinus arizonica** Engelmann var. **arizonica** [*P. ponderosa* var. *arizonica* (Engelmann) Shaw] Arizona pine (of Arizona)

Medium-sized to large trees. Similar to ponderosa pine but the leaves finer and 5 per fascicle, and the seed cones tend to be smaller.

Pine forest and lower mixed conifer forest. The most extensive Gila Region population known to us ranges across the northeastern portion of the Pinos Altos Range from the vicinity of Cherry Creek Canyon northward nearly to Sapio Campground. Elsewhere in the region it occurs in local pockets. This montane Mexican pine is at its northern limit in the Gila Region.

Southeast Arizona and southwest New Mexico, and the Sierra Madre Occidental of western Mexico southward to Durango. Two other varieties are usually recognized, both in northern Mexico. *Pinus arizonica* has often been treated as variety of *P. ponderosa* (e.g., Allred 2008), but most contemporary researchers recognize it as a distinct, polytypic species, with possible introgression in Arizona and New Mexico (Earl 2009; Farjon and Styles 1997; Gernanadt et al. 2009). Arizona pine and its varieties have been heavily exploited for lumber in Mexico (Felger et al. 2001; Perry 1991).

Grant Co: Sheep Corral Canyon, 0.9 mi W of Hwy 15, 7250 ft, 23 Jun 1993, *Carter 1057*. Pinos Altos Range, Tadpole Ridge, 9 Apr 1992, *Zimmerman 3583*. Frequent tree to 25 m height, with *Pinus ponderosa* var. *scopulorum*, N-facing slope, adjacent to FS 282, 0.9 mi W from junction with Hwy 15, 7300 ft, 17 Aug 1994, *Huff 1821*.

**Pinus chihuahuana** Engelmann [*P. leiophylla* Schiede ex Schlechtendal & Chamisso var. *chihuahuana* (Engelmann) G.R. Shaw] Chihuahua pine (of Chihuahua)



Medium-sized to large trees. Bark deeply fissured, scaly, and dark colored. Fascicle sheaths deciduous. Leaves 3 per fascicle, 4–11+ cm long. Seed cones persistent probably for several years, dark, rather small (3.5–5 cm long) and rounded, on a short stout stalk, the stalk falling with the cone. This is the only pine north of Mexico that needs three years, instead of two, to mature its cones. It is also one of the few *Pinus* species capable of sprouting from cut stumps.

Upper margin of pinyon woodland and in pine forest. Locally in the Gila Region, including sites on Bear Mountain, Mogollon Mountains, and Cherry Creek Canyon in the Pinos Altos Range. This Mexican montane pine reaches its northern limits in southwestern New Mexico and southeastern Arizona, and ranges southward to Jalisco and Zacatecas.

This pine is closely related to *P. leiophylla* and they are often treated as varieties of a single species. *Pinus leiophylla* ranges from northwestern Chihuahua to Oaxaca. In the northern part of their ranges, *P. leiophylla* generally occurs eastward and at higher elevations in the Sierra Madre Occidental than does *P. chihuahuana*, although they also occur sympatrically. Ecological and morphological information and evaluation of the flavonoid composition of the needles of these two taxa support the recognition of *P. chihuahuana* at the species level (e.g., Almaraz-Abarca et al. 2006).

Grant Co: Bear Mt, 4 mi NW of Silver City, 7000 ft, 25 Mar 1964, *Zimmerman s.n.* Pinos Altos Range, ridge above Cherry Creek Canyon, 12 Mar 1992, *Zimmerman 3557*.

**Pinus discolor** D.K. Bailey & Hawksworth [*P. cembroides*_ Zuccarini_var. *bicolor* Little] Border pinyon; *piñón* (of two different colors)

Small to medium-sized trees. Bark dark brown and fissured. Fascicle sheaths deciduous. Leaves mostly 3 per fascicle, often 3–5+ cm long, the inner surfaces whitish (due to longitudinal lines of white stomata). Pollen and seed usually on different trees (unique among regional pines and worthy of study for the Gila Region population; see Floyd 1983 and Felger et al. 2001). Cones maturing in fall, pale brown, often 2–4 cm long, broader than long, the scales ending in a blunt knob. Seeds edible and not winged.

Pinyon-juniper woodland and ponderosa-pine forest. Fairly common but localized in the Gila Region in western Grant County from Brushy Mountain northward nearly to the San Francisco River in Catron County. Sometimes growing intermixed or close to *P. edulis*, from which it is readily distinguished by (1) having leaves in 3's, more slender and flexible ("softer"), and often somewhat longer; (2) overall smaller cones; and (3) the seed coat or shell harder and thicker. Several specimens and apparent populations of 3-needle pinyons occur in scattered pockets elsewhere in the Gila Region; these intriguing pinyons warrant investigation.

*Pinus discolor* is primarily a Mexican species in borderland areas of southeast Arizona, southwest New Mexico, and mountains of northern Mexico to Queretero. The taxonomy is subject to debate and some authors consider *P. discolor* to be a synonym of *P. cembroides* (e.g., Allred 2008; Kral 1993), which in our opinion does not occur in New Mexico (e.g., Ferguson et al. 2001).

Grant Co: Brushy Mountain Road, 11 km S of Mule Creek, 6060 ft, tree 9 m tall, *Felger 09-25*. Big Lue Mts, Coal Creek, S8, T14S, R21W, 20 May 1995, *Hubbard s.n.* (UNM). Fort Bayard horse pasture, oak-juniper, 6200 ft, 26 Sep 1964, *Alford s.n.* Coniferous forest, ridgetop along Hwy 90, 1 mi S from Iron Creek Campground, 18 Apr 1986, *Rolph 13*. Foothills of Pinos Altos Range, N of Ft Bayard, ca. 0.75 mi NE of Signal Knob, juniper-pine savanna, fairly common low tree to 6 m, 10 Nov 1992, *Zimmerman 4236*.

**Pinus edulis** Engelmann var. **edulis**. Pinyon, *piñón* (edible)

Small to medium-sized trees. Bark blackish brown and fissured. Fascicle sheaths deciduous. Leaves 2 per fascicle (occasionally some fascicles with 1 leaf), 2.5–5 cm long, and rather firm. Cones pale brown, mostly 3.5–5 cm long, broader than long, the scales ending in a blunt knob. Seeds not winged. The cones and seeds mature in fall.

Pinyon-juniper woodland and pine forest, in diverse and mostly upland and nonriparian habitats. Not surprisingly, it is rare in our Gila riparian plots, only occurring in 2 of 147 plots, with the lowest occurrence at 5400 ft. This is one of the most common and widespread trees in the Gila Region. It is the state tree of New Mexico. Southwestern United States and Mexico in Chihuahua.

The seeds, or pinyon nuts, are commercially wild harvested. Significant harvests occur during mast years. Native Americans often obtained optimal harvests by gathering nearly ripe green cones just starting to open. Typically men would pull down the cones with a specific harvest-pole and women and children gathered the cones in baskets. The gummy exudate on the cones can make for caution in handling. The cones were roasted near hot coals, causing them to open. Threshing removed the seeds, which were toasted and then gently ground on a metate to crack open the hard shell. The seeds were separated from the seed coat by winnowing in baskets together with hot coals, which further parched or toasted the seeds. The fresh seeds are soft, white, and delicious.

Catron Co: Willow Creek Recreation Area, 8600 ft, dry ridges, 27 Jul 1968, *Demaree 48733*. Grant Co: Near Silver City, 5600 ft, 9 Apr 1936, *Stambaugh 962*.

**Pinus edulis** var. **fallax** Little (false or deceptive)

This pinyon differs from var. *edulis* by having a single leaf per fascicle and the leaves tend to be stouter than those of var. *edulis*.

Some pinyon populations at lower elevations in the Gila Region have 1 leaf per fascicle (sometimes some fascicles with 2 leaves). Populations of 1-needle pinyons are found in Grant County in Steeple Rock Canyon and Wildhorse Canyon region near Saddelrock. Several single-needle trees occur in the headwaters of Little Bear Canyon in the Burro Mountains (Kevin Keith, personal communication, 9 September 2009). Pinyons with 1- and 2-needle fascicles in Sycamore Canyon south of Cliff appear intermediate between var. *fallax* and var. *edulis*.

An extensive population of 1-needle pinyons grows in the Florida Mountain in Luna County. Similar pinyons are in sub-Mogollon regions in Arizona and the Grand Canyon region and had a much greater range during Ice Age times (Fel-

ger and Van Devender forthcoming). Taxonomy of the *fallax* pinyon is far from settled, with this taxon variously attached to *P. edulis* or *P. monophylla* Torrey & Frémont of California. The 1-needle condition seems to be an adaptation to drought or drier conditions, which is largely confirmed by chloroplast DNA studies (Cole et al. 2007; Zavarin et al. 1990).

Grant Co: Sycamore Canyon, S of Cliff, 8 Nov 2009, *Felger 09-98* (fascicles with 1 and 2 needles). Adjacent to Steeple Rock Canyon Creek, S29, R20W, T17S, 4720 ft, limestone and alluvial soil, 19 Jan 1992, *Carter 367*.

**Pinus ponderosa** Douglas ex Lawson & C. Lawson var. **scopulorum** Engelmann. Rocky Mountain ponderosa pine, western yellow pine (heavy; growing on cliffs)

Large trees. Bark often orange-brown and flaking in puzzlelike pieces, and smelling of vanilla when exposed to sun. Young trees (trunks less than ca. 30 cm diameter) are sometimes known as "blackjacks" due to their blackish, furrowed ridges. Leaves 3 per bundle (occasionally 2 per bundle on young trees), 9–22.5 cm long. Cones sessile, usually 5–9 cm long (sometimes 3–5 cm long under drought conditions), the cone scales with a prominent spine. The basal scales remain on the twig after the rest of the cone falls, so the lowermost scales of the cone are missing, and the same condition is seen on *P. arizonica* cones.

Abundant and widespread in the Gila Region, defining the pine forest; pinyon zones to mixed-conifer forest. It is a common riparian species in the vegetation plots along the Gila River above 5400 ft. Large, old-growth trees are found in many places with some remarkable stands that have never been logged, such as in McKenna Park along the West Fork of the Gila River. Ponderosa pine forest stretches continuously for about 300 miles from the Gila Region along the Mogollon Rim to northern Arizona near Flagstaff.

Variety *scopulorum* is widespread in the inland western United States from Arizona and New Mexico to southwestern Canada, and barely extends into northernmost Mexico in Chihuahua and Sonora. Variety *ponderosa* occurs along the Pacific Coast from California to British Columbia. Ponderosa pine is one of the most important timber trees in the western United States. The systematics of *Pinus* subsection *Ponderosae*, however, appears far from resolved, with molecular-genetic research revealing a more complex situation than the simplified but user-friendly taxonomy presented here (e.g., Gernanadt et al. 2009).

Catron Co: Quemado Lake, near Juniper Campground, 2350 m, 25 Sep 2004, *Johnson 18*. Grant Co: Cherry Creek campground, 7000 ft, 15 May 1966, *Rogers s.n.*

**Pinus strobiformis** Engelmann [*P. ayacahuite* Ehrenberg var. *strobiformis* (Engelmann) Lemmon. *P. ayacahuite* var. *brachyptera* G.R. Shaw] Southwestern white pine (cone shaped, *strobus* for cone and *formis* for formed)

Large trees. Bark grayish and smooth, becoming fissured with age. Leaves 5 per fascicle, relatively short, 5.5–9 cm long, slender, soft, and flexible, each leaf generally glaucous (whitish) on the inner surface giving the foliage a "two-tone" appearance. Fascicle sheaths deciduous (as in *P. chihuahuana*). Cones cylindrical and heavy, 13–25 cm long (the largest cones of any conifer in the region), with sticky, gummy exudate; cone scales recurved at the tip and without spines. Seeds wingless or nearly so.

Common and widespread in pine and mixed-conifer forests above 7000 ft. Arizona to Texas and southward to Zacatecas, San Luis Potosí, and Durango. This is a Mexican montane species, replaced northward by the closely related *P. flexilis* James, the limber pine, and in southern Mexico and Central America by *P. ayacahuite*. Opinions differ as to where to taxonomically slice apart the continuum in this clade of white pines.

Catron Co: South Fork of Negrito Creek, 8100 ft, 28 Apr 1994, *Huff 1266*. Grant Co: McKnight's Cabin, on top of Black Range Crest, 1 Jul 1968, *Hess 2044* (NMC).

**Pseudotsuga menziesii** (Mirbel) Franco var. **glauca** (Mayer) Franco. Rocky Mountain Douglas-fir (from the Greek *pseudos*, false, and Japanese *tsuga*, hemlock; for Archibald Menzies, 1754–1842, Scottish physician and naturalist; glaucous)

Large trees. Bark smooth and silvery gray, becoming brown, rough, and fissured. Leaves 1.5–4 cm long, the upper surfaces with a median groove or channel, the lower surfaces with 3 raised veins. Cones 2.8–8 cm long, pendulous, reddish brown, maturing in one year, falling intact, the scales broad, rather thin and with a 3-pronged bristly bract projecting well beyond the scale, the middle prong longest.

Common and widespread in the region. Pine and mixed-conifer forests, above 6000 ft. At low elevations, such as at Lake Roberts, it is generally restricted to north-draining canyons or steep north-facing slopes. Variety *glauca* occurs in inland western North America from Canada to Oaxaca, Mexico. It is replaced by var. *menziesii* westward towards the coast from northern California to British Columbia. Douglas fir is a valuable timber species and is often grown for Christmas trees. There are numerous horticultural selections.

Catron Co: South Fork of Negrito Creek, 8100 ft, 28 Apr 1994, *Huff 1266*. Sierra Co: North Percha Canyon, 4 May 2009, *Felger 09-38A*.

## ANGIOSPERMS—MONOCOTS

### ASPARAGACEAE—ASPARAGUS FAMILY (includes Agavaceae)

**Yucca elata** Engelmann. Soaptree yucca (Carib Indian name *yuca*, for manihot, erroneously applied; tall, apparently referring to the inflorescences)

Shrub-sized yuccas and occasionally approaching 5 m tall at lower elevations, plus the flowering stalk. Trunk single- to several-branched. Leaves narrow and flexible; leaf margins white with threadlike fibers. Flowering stalks 2–3 m tall. Flowers white, opening wide at night, with 6 petal-like tepals 4–7 cm long; May–July. Fruits of dry capsules. Seeds flattened, D-shaped, blackish, and numerous.

Abundant and widespread in desert and grassland, and open areas into lower pinyon-juniper woodland and sometimes into pine forest. Arizona to Texas, northeastern Sonora, Chihuahua, and Coahuila.



Grant Co: Hwy 35, Acklin Hill, 28 Oct 2006, *Ward 83*. Mill Canyon Road, 100 m W of Hwy 90, 5750 ft, 20 Jul 2001, *La Marca s.n.*

## ANGIOSPERMS—EUDICOTS

Unless otherwise mentioned, all eudicot trees in the Gila Region are winter deciduous and have simple leaves.

### ACERACEAE—Maples, see SAPINDACEAE

### ADOXACEAE—ADOXA FAMILY (includes Caprifoliaceae, in part)

**Sambucus cerulea** Rafinesque [*S. nigra* Linnaeus subsp. *cerulea* (Rafinesque) Bolli. *S. mexicana* C. Presl ex de Candolle. *S. cerulea* var. *mexicana* (C. Presl ex de Candolle) L.D. Benson. *S. neomexicana* Wooton. *S. cerulea* var. *neomexicana* (Wooton) Rehder. Different authors give *caerulea* or *cerulea*, and a case may be made for either spelling.] Blue elderberry (Latin name for elder, from Greek name for a musical instrument made from wood of plants in this genus; blue)

Shrubs to small trees. Leaves opposite, pinnately compound with 3–9 leaflets. Flowers cream-white, in dense, compound umbel-like cymes. Fruits small and berrylike, dark blue or blackish.

Widely scattered but seldom common in the Gila Region, low to high elevations, woodlands to mixed-conifer forest; riparian at lower elevations. Southwestern United States and northern Mexico. Elderberry trees have long been cultivated for the berries, which can be eaten fresh but mostly are made into preserves and jelly, and also wine, and used medicinally. The unripe fruits and the herbage can be poisonous.

Bolli's (1994) treatment of the genus recognizes *S. nigra* in Europe and the Americas with six geographic subspecies, including subsp. *cerulea*, that are sometimes difficult to distinguish. Eriksson and Donoghue (1997, 567) show that "our accessions of *Sambucus nigra* sensu Bolli (1994) form a clade with the exception of *S. cerulea*, which we conclude should be treated as a separate species." Two varieties are sometimes recognized for New Mexico: var. *mexicana*, characterized by 5–7 and smaller leaflets, smaller inflorescences, and occurring at lower elevations; and var. *neomexicana*, with 5–9 and larger leaflets, larger inflorescences, and occurring at higher elevations.

Catron Co: Mogollon, 26 Aug 1972, *Hunt 80*. Grant Co: Signal Peak, 8000 ft, 12 Jul 1960, *Zimmerman 1132*.

### BETULACEAE—BIRCH FAMILY

**Alnus**—Alder (Latin for alder)

Hardwood trees and shrubs, with nitrogen-fixing root nodules. Winter buds and young twigs resinous. Leaves alternate, the margins (ours) doubly serrated. Flowers inconspicuous, unisexual, the female flowers in woody, upright, semipersistent conelike catkins, the male flowers in drooping herbaceous catkins. Fruits of 1-seeded, minute, and winged nutlets.

1. Shrubs and small trees; leaf margins with sharp teeth. **A. incana**

1' Medium-sized to large trees; leaf margins with relatively blunt or rounded teeth. **A. oblongifolia**

**Alnus incana** (Linnaeus) Moench subsp. **tenuifolia** (Nuttall) Brietung [*A. tenuifolia* Nuttall] Thinleaf alder (gray; thin leaves)

Large shrubs and small trees. Bark gray or reddish brown; becoming scaly. Leaves broadly oblong to ovate.

Riparian habitats in pine forest and riparian and nonriparian in mixed-conifer forest, locally in the Black Range, Mogollon and San Francisco mountains. The species occurs in North America and northern Eurasia; subsp. *tenuifolia* ranges from Chihuahua and New Mexico to California and north to Alaska and Yukon.

Catron Co: Willow Creek at Willow Creek Campground, 8000 ft, small tree to 6 m, 1 Jul 1992, *Carter 739*. San Francisco River adjacent to FS 882, Apache Nat'l Forest, riparian with *Salix irrorata, Rosa woodsii, Populus angustifolia*, 3–4 m tall, 19 Jun 1995, *Huff & Stevens 2244*. Sierra Co: Turkey Run, Black Range, 33°20.37'N, 107°57.35'W, 7080 ft, riparian, Aug 2000, *Mertz s.n.* (NMCR).

**Alnus oblongifolia** Torrey. Arizona or New Mexico alder (oblong leaves)

Medium-sized to large trees. Bark light gray and fairly smooth, becoming checkered and furrowed on larger trunks. Leaves elliptic to ovate, generally thicker and not as broad as those of *A. incana*.

Widespread and common in riparian habitats; oak woodland, pine forest, and mixed-conifer forest. Common in the riparian plots above 4500 ft and also recorded as low as 4300 ft. There are numerous dead trees along Gallinas and Animas creeks in the Black Range resulting from the drought of 2005. New Mexico, Arizona, Chihuahua, and Sonora.

Catron Co: Upper Mineral Creek Canyon, 22 Oct 2009, *Felger 09-93*. Grant Co: Cherry Creek Campground near Pinos Altos, 2160 m, 6 Oct 2001, *Hill 39*.

### BIGNONIACEAE—BIGNONIA FAMILY

**Chilopsis linearis** (Cavanilles) Sweet subsp. **arcuata** (Fosberg) Henrickson. Desert willow (Greek, resembling lips, in reference to the corolla; narrow)

Shrubs to medium-sized trees, and occasionally large trees. Leaves opposite, whorled, or sometimes alternate, elongated and linear. Flowers attractive, bilateral, whitish to pale pink, mostly late spring and early summer. Fruits of slender, elongated, and persistent capsules. Seeds flattened and papery winged.

Widespread and common, mostly along drainageways in desert, grassland, and pinyon-juniper; mostly below 6000 ft. This species was only in the riparian plots below 4800 ft. It is especially common along sandy washes in the Burro Mountains. Widely cultivated in the region, including deep pink to purplish horticultural selections.

There are two subspecies—the western subsp. *arcuata* in Baja California (Norte) and California to Sonora, Utah, and western New Mexico; and the eastern subsp. *linearis* east of

the Gila Region in New Mexico, Texas, and adjacent northern Mexico to Zacatecas (Henrickson 1985).

Catron Co: Pleasanton, San Francisco River, 4600 ft, 23 Sep 2001, *Nordquist 107*. Grant Co: Bar Six Canyon, 2.4 mi W of junction Forest Service Road 825, 5800 ft, 18 Jun 1992, *Huff 695*.

## CANNABACEAE—HEMP FAMILY (includes Ulmaceae, in part)

**Celtis reticulata** Torrey. Canyon hackberry (Greek to Latin name for *C. australis*, adapted by Linnaeus; netlike)

Small to mostly medium-sized trees. Bark smooth or with large irregular corky warts. Leaves alternate, asymmetric at the base, and scabrous (rough, sandpaperlike surfaces); leaf margins entire or essentially so, or sometimes toothed on large leaves. Flowers small and inconspicuous, mostly unisexual and some bisexual. Fruits of rounded drupes, 1-seeded, orange or red-brown, soon becoming hard and dry. Flowering with new leaves in spring.

Widespread and common, mostly below 6000 ft, especially in riparian habitats and other drainageways and lower slopes. Common in the Gila riparian area plots. Western United States and northwestern Mexico.

Catron Co: Whitewater Canyon near Glenwood, 2 Jun 1964, *Hubbard s.n.* Grant Co: Saddlerock Area (Blackhawk Canyon), 1545 m, 20 Oct 2001, *Hill 58*.

## ELAEAGNACEAE—OLEASTER FAMILY

***Elaeagnus angustifolia** Linnaeus, Russian olive (Greek *elaia* for olive and *agnos* for pure; narrow leaved)

Shrubs to sometimes small trees; roots with nitrogen-fixing nodules. Twigs often armed with spines. Herbage with silvery scales. Leaves alternate, 4–9 cm long, lanceolate to elliptic, silvery, especially the lower surfaces; leaf margins entire. Flowers yellow with an intensely sweet fragrance not liked by some people. Fruits drupelike, 1+ cm long, dark reddish when ripe, edible and sweet but unpleasantly mealy.

Widely scattered localities in disturbed habitats, and rather rare and apparently not reproducing in natural areas in the Gila Region. Mostly lower to intermediate elevations. Also grown in the region as an ornamental tree, sometimes becoming medium-sized trees. This species was not observed in any of our riparian plots. It is listed as a noxious weed federally and in New Mexico. Native to Western and Central Asia, naturalized and weedy across nondesert regions of North America and elsewhere.

Grant Co: Cottage San Road [Silver City], 6300 ft, roadside, 21 Sep 2003, *Hotchkiss 57*. 8 mi NW of Silver City, Bear Mt, planted in roadside gully, 8 Jul 1960, *Zimmerman 1121*.

## FABACEAE—LEGUME FAMILY

The legume trees in the flora area have hardwood, compound leaves, and multi-seeded fruits (pods). Catclaw acacia (*Acacia greggii* A. Gray, = *Senegalia greggii* [A. Gray] Britton & Rose) at lower elevations in the Gila Region sometimes forms heavy, short trunks and limbs but does not attain tree size. Whitethorn acacia (*Acacia constricta* Bentham, = *Vachellia constricta* [Bentham] Siegler & Ebinger), also at lower elevations, may reach 4 m. Both acacias sometimes become tree size near the Gila Region.

1. Leaves once pinnate, with one terminal leaflet (odd-pinnate). **Robinia**

1' Leaves twice pinnate (at least on long shoots), the terminal leaflets paired.

2. Trunk and limbs with branched thorns, and some twigs with simple thorns; leaves twice pinnate with 3 or more pinnae on long shoots, and once pinnate on short (axillary) shoots; pods 15–40 cm long and ca. 1.5–3+ cm wide, flat, without mesocarp (dry at maturity). **Gleditsia**

2' Thorns or spines simple; all leaves twice pinnate with one pair of pinnae; pods often 1–20 cm long and ca. 1 cm wide, moderately compressed laterally but not flat, mesocarp present. **Prosopis**

***Gleditsia triacanthos** Linnaeus. Honey-locust (for Johann Gottleib Gleditsch, 1714–1786, director of the Berlin Botanic Garden; three thorned)

Medium-sized to large trees, locally spreading by root sprouts, and with large, sharp and variously branched thorns, largest on trunks and larger limbs. Twigs zigzag with simple spines and shiny reddish bark. Leaves of two kinds and with many leaflets: alternate and twice pinnate on long shoots, and clustered and once pinnate on short shoots. Inflorescences with unisexual or bisexual flowers. Flowers pea-shaped (papillionoid), small, yellowish green, fragrant, and in small hanging clusters; in late spring and summer. Pods flattened, dry at maturity and usually twisted, ripening in late summer and fall.

Sometimes planted in the region and rarely escaping or persisting long after cultivation. Riparian or semiriparian habitats in woodland areas. Native to eastern United States; widely planted and naturalized beyond its native range. Some cultivated forms can be thornless.

Grant Co: ca 2.5 mi W of entrance to Gila National Forest on Bear Mt Road, [32.82714ºN, 108.3422982ºW], ca. 100 m N of road, 23 Apr 2009, single tree ca. 9 m tall with 2+ m root sprouts, *Felger 09-24*.

**Prosopis glandulosa** Torrey var. **torreyana** (L.C. Benson) M.C. Johnston. Western honey mesquite (Greek name for a spiny plant, probably burdock, *Arctium lappa*, but the application is unclear; gland bearing or glandular; for John Torrey, 1796–1873, American botanist)

Low, broad shrubs to small trees, rarely medium-sized trees in protected, low-elevation canyons in the Gila Region. Smaller branches and twigs mostly with stout single or paired thorns, which tend to be larger on smaller plants and/or those stressed by salinity, drought, and perhaps winter cold, or thorns absent especially on larger or unstressed plants. Leaves alternate on long shoots, and clustered on short shoots, with one pair of pinnae, each pinna usually with 11–19 pairs of leaflets; leafstalks with a nectary gland between the pinnae. Flowers mimosoid, small, cream-white or pale yellow, crowded in spikelike racemes; April–June and sporadically through the summer. Pods often 8.5–18 cm long, with sweet, edible mesocarp (pulp).

Widespread in desert and grassland, and sometimes in woodland. It was found in numerous riparian area plots below



4800 ft. This species is found in the southwestern United States and northern Mexico. Variety *torreyana* occurs largely west of the Continental Divide and var. *glandulosa* ranges from New Mexico to Kansas and the northeastern Mexican states.

Grant Co: Sycamore Canyon, S of Gila, 22 Nov 2009, *Felger 09-99*. Near Willow Springs Canyon on Georgetown Road, 1 Sep 1992, *Zimmerman 4063*.

**Robinia**—Locust (for Jean Robin and his son Vespasian, 16th- and 17th-century gardeners and herbalists to the French courts during the reigns of Henry IV and Louis XIII)

Leaves odd-pinnate. Flowers pea-shaped (papilionoid).

1. Widespread; flowers pink to lavender; flowering stalks and pods usually glandular. **R. neomexicana**

1' Occasional in disturbed habitats; flowers white; flowering stalks not or only sparsely glandular, the pods not glandular. **R. pseudoacacia**

**Robinia neomexicana** A. Gray. New Mexico locust (of New Mexico)

Shrubs to medium-sized trees. Bark pale brown to gray, smooth, becoming moderately fissured and irregular on larger trees. Twigs and branches usually with sharp, paired stipular spines. Leaves odd-pinnate, often 8–25 (30) cm long, the leaflets ovate to oval, 9–23 per leaf. Flowers fragrant, pink to lavender and showy, in usually drooping racemes; mass flowering in late spring and early summer and diminishing through August. Pods 4–10 cm long, gradually dehiscent, with coarse, glandular, brown hairs or sometimes glabrate.

Widespread and common across the region, 4800–9500 ft. Pinyon-juniper and oak woodland to mixed-conifer forest. Often forming spiny thickets from root sprouts, especially on moist exposed or disturbed sites. California to west Texas, Nevada, Utah, Colorado, and northern Chihuahua and Sonora.

Two weakly differentiated varieties occur in the Gila Region, var. *neomexicana* and var. *rusbyi* (Wooton & Standley) Martin & Hutchins ex Peabody, the latter distinguished by reduced pubescence. New Mexico locust is an attractive garden tree often grown regionally and selected horticultural varieties are available.

Catron Co: 6 mi E of Glenwood, Whitewater Canyon, 4800 ft, 2 May 1972, *Patterson 54*. Grant Co: Route 15 between Cherry Creek campground and Ben Lilly Monument, 7000 ft, 31 May 1997, *Dunne-Brady 207*.

***Robinia pseudoacacia** Linnaeus. Black locust (false acacia)

Mostly medium-sized trees, sometimes propagating by root sprouts. Twigs mostly bearing large, sharp spines. Leaves becoming bright yellow in fall. Flowers white and fragrant; late spring and early summer. Pods smooth or nearly so.

Occasionally persisting from cultivation or rarely feral in disturbed habitats, especially riparian areas, 5800–8800 ft. Native to eastern United States and widely planted in temperate regions.

Grant Co: Infrequent, to 20 m in height, Signal Peak Road 0.3 mi from Hwy 15, 7500 ft, 10 Jul 2001, *Carter 1S04*. Mimbres River, near San Lorenzo, road near bridge, 5780 ft, 8 Jul 1977, *Boles s.n.* (NMC).

## FAGACEAE—BEACH FAMILY

**Quercus**—Oak; *encino*, *roble* (Latin name for oak)

Trees or shrubs with rough bark. Leaves alternate, with stellate and simple hairs and glands, with age the hairs may be shed, especially from the upper surfaces. Flowers unisexual, small and rather inconspicuous, although massive displays of yellowish, staminate inflorescences may occur in late spring and early summer. Acorns annual (maturing within one year) and located among the leaves of the current year; or biennial (maturing in two years) and the mature acorns on leafless parts of the twigs below the current year's leaves.

Oaks are grouped into two subgenera and New World oaks fall into three sections of subgenus **Quercus**:

Section **Quercus** (*Leucobalanus*), **white oaks**. Bark generally light gray and often scaly or checkered. Acorns annual; inner shell of the fruit case glabrous, the fresh seeds (cotyledons) whitish, pink, or purplish. Represented in the Gila Region by *Q. arizonica*, *Q. gambelii*, *Q. grisea*, *Q. rugosa, and Q. turbinella*.

Section **Lobatae** (*Erythrobalanus*), **red or black oaks**. Bark generally dark gray or blackish, with age becoming furrowed. Maturation time of the acorns is often diagnostic and ecologically significant, the acorns annual or biennial; inner shell of the fruit case woolly-pubescent, the fresh cotyledons whitish or yellow. Represented in the flora region by *Q. emoryi* and *Q. hypoleucoides*.

Section **Protobalanus**, **golden-cup oaks**. Bark light- to dark-colored. Acorns biennial and acorn shell woolly inside. One species, *Q. chrysolepis*, is found in New Mexico.

Although most oaks in the flora area are identifiable by general leaf characteristics, differences in pubescence and epidermal glands can be critical in sorting out difficult specimens. For this purpose high-power magnification may be necessary. These hairs are best seen on young leaves since older leaves tend to be glabrate. Otherwise, the best time to study oaks is at the end of the growing season, in late summer or early fall, when the leaves are mature. Leaf pubescence (hairs) discussed in the species accounts generally refers to mature leaves found from late summer or early fall until late spring before the new leaves emerge. It is best to work with sun leaves since shade leaves and "water sprouts" may present unusual features.

Oaks frequently form hybrid swarms and plants and populations with intermediate morphology are common, sometimes making identification an art form. The major difficulty in oak taxonomy comes from attempts to discriminate boundaries within a many-sided continuum. The five major oak species in the Gila Region, *Q. emoryi, Q. gambelii, Q. grisea, Q. hypoleucoides*, and *Q. rugosa*, are readily distinguished, but distinctions between *Q. arizonica* and *Q. grisea*, and *Q. grisea* and *Q. turbinella* sometimes can be problematic.

*Quercus gambelii* is the only oak in the flora area with a temperate affinity and the only one that is always winter

deciduous. *Quercus chrysolepis* seems to be evergreen and shows affinity with golden-cup oaks of the Pacific Coast. The remaining regional oaks show affinities with the highly diverse montane Mexican oak flora. These oaks, especially *Q. emoryi* and *Q. grisea*, tend to shed leaves towards the end of the spring dry season prior to summer rains. Thus, many of these oaks acquire yellow to yellowish orange "fall" colors during the pre-summer drought. In some cases the dry, dead leaves may remain on the trees for several months following winter damage or drought. The biggest flush of new foliage usually occurs with the beginning of summer rains, but may occur earlier if there is sufficient soil moisture. During the severe spring drought of 2006, *Q. emoryi* and *Q. grisea,* in many parts of the Gila Region, lost their leaves and did not leaf out until the July rains. *Quercus hypoleucoides* and especially *Q. rugosa* tend to be evergreen. Most oaks in the region survive low-intensity fires and most can root-sprout even after more severe fires.

It is difficult to construct an accurate key that is both user-friendly and covers the full variation among the oaks. A more accurate key might include technical characters of the pubescence (see Felger et al. 2001; Nixon and Muller 1997; Spellenberg 2001).

1. Leaf lobes large, rather evenly spaced, usually rounded at the tip, not spinose, and cleft more than halfway to midrib; wholly winter deciduous. **Q. gambelii**
1' Leaves not conspicuously lobed and if lobed then the lobes not rounded; evergreen or drought deciduous usually in spring or early summer.
2. Leaves evergreen, hollylike, rather thick and leathery, bicolored, the lower surfaces often waxy, the margins thickened and wavy, entire or with large, spine-tipped teeth; acorn shell woolly inside; known from Apache Box. **Q. chrysolepis**
2' Leaves drought deciduous or not, generally not thick and hollylike, or if hollylike then not as above; acorn shell glabrous or woolly inside; widespread.
3. Leaves green on both surfaces, the leaf blade with a small tuft or patch of hair at the base (proximal) of the lower (abaxial) surface, the leaf apex spinescent-pointed. **Q. emoryi**
3' Leaves various and without a hair tuft on the lower surface.
4. Lower leaf surfaces conspicuously white woolly, the upper surfaces dark green. **Q. hypoleucoides**
4' Lower leaf surfaces not white woolly.
5. Leaves moderately convex (cupped); upper leaf surfaces dark green, the lower surfaces with netlike, raised veins; acorns on long peduncles. **Q. rugosa**
5' Leaves not (or sometimes slightly) cupped; upper leaf surfaces gray- or blue-green or dull green, the lower surfaces without netlike raised veins; acorns sessile or on short to long peduncles.
6. Shrubs, usually at lower elevations, localized; leaf margins evenly spine-toothed; lower leaf surfaces with appressed stellate hairs, not felty or velvety. ***Q. turbinella***
6' Shrubs to medium-sized trees, widespread; leaf margins variously toothed or not; lower (abaxial) leaf surfaces with erect to semierect stellate hairs, often felty or velvety to the touch.
7. Leaf blades abaxially with prominent raised reticulum formed by ultimate venation; secondary veins often adaxially impressed (leaves generally larger, dull green, and thinner, and without large spinescent teeth; see text). **Q. arizonica**
7' Leaf blade without abaxially prominent raised reticulum formed by ultimate venation; secondary veins not strongly impressed adaxially (leaves generally smaller, grayish, thicker, and with large spine-tipped teeth or not toothed). **Q. grisea**

**Quercus arizonica** Sargent. Arizona white oak (of Arizona)

A white oak. Small to medium-sized trees. Bark pale gray, fissured. Leaves drought deciduous in late spring, relatively firm and variably obovate, oblanceolate, or oblong, the upper surfaces dull, dark gray- or blue-green, sparsely hairy to glabrate, the lower surfaces pale green, with short orange-brown hairs; margins with several short, spinescent teeth or sometimes entire. Acorns annual.

This oak resembles *Q. grisea* and is most easily distinguished by having generally larger and thinner, oblong to oblanceolate, dull green leaves, tends to grow in wetter, or more mesic, habitats in woodlands, and the trees have a more open growth form and are often larger in size. *Quercus arizonica* is sometimes treated as a synonym of *Q. grisea* (Landrum 1994). Other authors recognize them as distinct species and Nixon and Muller (1997) regard *Q. arizonica* and *Q. grisea* to be more closely related to other species than to one another. In some places, such as Sycamore Canyon south of Cliff, trees resembling *Q. arizonica* grow at the stream margin, and are few and of limited distribution, while *Q. grisea* is abundant and occurs immediately adjacent and extends onto arid slopes. Some trees appear intermediate in morphology, indicating reason to investigate the genetic and taxonomic relationships. Perhaps trees resembling *Q. arizonica* in the Gila Region are merely well-watered forms of *Q. grisea*.

Arizona to Trans-Pecos Texas and northern Mexico including Baja California Sur. *Quercus arizonica* is widespread in mountains in southern Arizona and Sonora and southward in Mexico it merges into *Q. laeta* Liebmann, which ranges from Sinaloa and Durango to Nuevo León and Michoacán (Felger et al. 2001).

Grant Co: Sycamore Canyon, S of Cliff: 13 Aug 1902, *Wooton s.n.* (NMC); 22 Nov 2009, *Felger 09-96*. Hidalgo Co: Peloncillo Mts, 17 Sep 1988, *Spellenberg 9734* (NMC).

**Quercus chrysolepis** Leibmann. Canyon live oak, golden oak (golden hair, referring to the golden-colored scales of the acorn cup)

A golden-cup oak. Shrubs to medium-sized trees. Leaves evergreen, highly variable, leathery and hollylike, the upper surfaces becoming smooth with age, the lower surfaces often golden yellow with dense pubescence; leaf margins thickened and wavy, entire or with large, spine-tipped teeth, even on the same tree. Acorns of this species are biennial, but no acorns were seen in April 2009.

In New Mexico known only from Apache Canyon south of Mule Creek in riparian and nonriparian oak woodland and pine forest. Two of the larger trees in the Apache Box measured 13.7 m (45 ft) and 14.6 m (48 ft) tall with trunk diameters 40–45 cm and basally to ca. 1 m. This deep box canyon supports an extensive forest of this oak, concentrated on steep north-facing canyon slopes and the shaded canyon bottom. Fewer, scattered, and mostly shrub-sized individuals extend onto dryer woodland slopes outside the main box canyon.

The most extensive populations occur in the Pacific coastal region of Baja California (Norte), California, and Oregon. Scattered, smaller, and apparently relict populations occur in Nevada, southern Arizona, and northeastern Sonora.

Grant Co: Apache Box, steep narrow canyon, 22 Jun 1987, *Muldavin 100* (NMC). Apache Box, ca. 5920 ft, 24 Apr 2009, *Felger 09-30.*

**Quercus emoryi** Torrey. Emory oak, blackjack oak; *bellota* (for William Emory, 1811–1887, American soldier and explorer)

A black oak. Small to mostly medium-sized trees, sometimes becoming large trees. Bark dark-colored. Leaves shiny green with a diagnostic tuft of hairs on the lower surface of the blade near its base. Drought deciduous in spring and early summer. Acorns annual, ripening with early summer rains.

Widespread at upper margins of grassland, woodlands, and lower pine forest; especially robust and well developed along sandy washes such as in the Burro Mountains. A Mexican–U.S. borderlands species of montane Mexican affinity. Southern Arizona to Trans-Pecos Texas, Chihuahua, and Sonora.

The acorns were a major food resource and continue to be wild-harvested by Apaches and others, especially during mast years. The shell is cracked open and the slightly sweet and astringent seed ("nut") is eaten fresh or can be ground into acorn meal or made into acorn stew. In early summer the acorns, or *bellotas*, are harvested in considerable quantity and sold in Sonoran markets and informally in southern Arizona. In Mexican borderland *cantinas* the floors are often littered with the empty shells. The acorns are important to many species of wildlife and are relished by black bears.

Grant Co: Tyrone, 4900 ft, 29 Jul 1960, *Zimmerman 1185*. Bear Mt, 5 mi NW of Silver City, 6500 ft, 21 Oct 1965, *Wright s.n.*

**Quercus gambelii** Nuttall. Gambel oak (for William Gambel, 1821–1849, American naturalist)

A white oak. Shrubs to medium-sized or sometimes large trees; often forming clonal thickets of shrubs—the larger trees tend to be in wetter habitats. Bark pale gray, fissured and checkered. This is the only fully winter-deciduous oak in the region. Leaves 6–26 cm long, with large, broad lobes, the lobes rounded or blunt and not toothed or bristle-tipped; leaf surfaces relatively soft and velvety pubescent, especially when young, the upper surfaces sometimes smooth late in the season. Acorns mature in a single season. Propagating clonally by root shoots from a lignotuber with adventitious buds as well as by seeds.

Pinyon-juniper woodland, pine forest, and mixed-conifer forest. Common in shaded areas, often near canyon walls in the riparian plots above 5400 ft. Inland southwestern United States and northwestern Mexico in Chihuahua, Coahuila, and Sonora.

Catron Co: Catwalk, Whitewater Canyon, 5600 ft, 2 Jun 1964, *Hubbard s.n.* Grant Co: Cherry Creek Campground, Pinos Altos Road, 22 Sep 2006, *Ward 46*.

**Quercus grisea** Liebmann. Gray oak (gray)

A white oak. Shrubs to mostly small or sometimes medium-sized trees. Bark light-colored, fissured. Leaves dull gray-green, highly variable, 3–6.5 cm long, lanceolate to ovate, often at first densely pubescent with yellow-brown hairs, especially below, often glabrate or glabrous with age; leaf margins entire or with several broad spinescent-tipped teeth. Leaves drought deciduous, especially in late spring or early summer; many or most of the leaves sometimes damaged or killed by severe winter freezes. Some leaf fall is typical in the fall and winter, especially during drought; following freezing weather in early 2009, many gray oaks in the Silver City region lost about 1/3 of their leaves even though there was ample soil moisture. The acorns mature in a single season and the seeds (cotyledons) are edible fresh or cooked. Propagating by root sprouts and by seeds.

Widespread above 5400 ft, in desert-grasslands, oak-juniper and pinyon-juniper woodland to conifer forests; this is the most common oak in the Gila Region; riparian areas, valleys, and slopes. This is a borderlands oak species of montane Mexican affinity. Arizona to Texas and northern Mexico including Chihuahua, Durango, and northeastern Sonora.

Grant Co: Above Little Cherry Creek Canyon, NE of Ben Lilly Memorial, 12 Sep 1991, *Zimmerman 3364*. Silver City, 19 Apr 1971, *Hunt 25*. Sycamore Canyon, S of Cliff, 22 Nov 2009, *Felger 09-97*.

**Quercus hypoleucoides** A. Camus. Silverleaf oak (white lower surfaces, referring to the leaf)

A black oak. Shrubs to mostly small or sometimes medium-sized trees. Bark dark gray to blackish, fissured with age. Leaves evergreen or sometimes drought deciduous in late spring to early summer, 3.5–12.5 (16) cm long, narrowly elliptic to lanceolate or oblanceolate, leathery, dark green and smooth above, densely white-woolly below; leaf margins moderately inrolled, entire or sometimes with a few small to stout teeth usually above the middle of the leaf. Acorns of this species are known to be both annual and biennial. Propagating by seeds and root sprouts, and readily sprouting after fire.

Common in scattered localities mostly above 6500 ft in pinyon-juniper woodland (as low as 5250 ft in Hell's Half Acre Canyon, Grant County) to mixed-conifer forest. A species of montane Mexican affinity. Southern Arizona to Trans-Pecos Texas, Chihuahua, Sonora, and Durango. In the mountains of the Sierra Madre Occidental of western Mexico, this silverleaf oak passes into a complex of larger- and smaller-leaved silverleaf oak species (Felger et al. 2001).

Catron Co: 0.5 mi S of Mogollon, 24 May 1964, *Hubbard s.n.* Grant Co: Emory Pass, 8000 ft, 6 Jul 1988, *Swetnam 154*.

**Quercus rugosa** Née [*Q. reticulata* Humboldt & Bonpland] Netleaf oak (wrinkled)

A white oak. Shrubs to small or sometimes medium-sized trees, often propagating clonally by root sprouts and readily sprouting after fire. Bark generally dark gray, becoming fissured with age. Leaves generally evergreen, 4–12 cm long, mostly broadly obovate and often cupped downward, dull, dark green above, with strongly impressed netlike venation, the lower surfaces pale green with orange or brown hairs; margins with small spinescent teeth. Acorns on slender stalks 3–13 cm long, maturing in a single season.

Locally common in scattered conifer forests mostly below ca. 8000 ft. A species of montane Mexican affinity. Arizona to West Texas and Guatemala.

Catron Co: Whitewater Creek, Catwalk Trail, 28 May 2009, *Felger 09-73*. Grant Co: Rain Creek Canyon, 7200 ft, 25 Sep 1992, *Carter 943*.

***Quercus turbinella*** Greene. Scrub oak (turban-shaped, referring to the acorn cup)

A white oak. Shrubs and rarely approaching a small tree in size in areas near the Gila Region, such as canyon bottoms near the Lower Box on the Gila River. Bark light-colored. Leaves dull grayish green, generally evenly spiny-toothed, often with golden glandular hairs on the lower leaf surface. Acorns annual, small, squat, and quickly deciduous.

Mostly localized in upper grassland and woodland areas. Inland southwestern United States and the Baja California Peninsula. This oak can be difficult to distinguish from drought-stressed shrubby *Q. grisea*; they perhaps hybridize.

## FOUQUIERIACEAE—OCOTILLO FAMILY

***Fouquieria splendens*** Engelmann subsp. ***splendens***. Ocotillo (for Pierre Eloi Fouquier, 1776–1850, Parisian professor of medicine; showy or splendid, referring to the flowers)

Mostly 2–3 m tall, occasionally 5 (7) m. Not forming a trunk and arguably not a tree. Leaves drought deciduous, appearing after rains during the warmer months. Long shoots with alternate, widely spaced nodes, producing petioled leaves with a rigid spine developing from the petiole midrib. Short shoots extremely reduced, in axils of the spines and bearing clusters of sessile to short-petioled leaves not developing spines. Flowers red-orange, in dense panicles at stem tips in early summer.

Rock outcrops, especially limestone, on arid slopes in a few places in the Gila Region, such as lower elevations in the Burro Mountains, Acklin Hill on the west side of the Mimbres Valley, and east slopes of the Black Range at about 5000 ft. Deserts from southern California to Trans-Pecos Texas and northern Mexico to Baja California Sur and Zacatecas. Subspecies *splendens* is the most wide-ranging of the three subspecies.

Larger plants may be more than a century old. Ocotillos are often transplanted bare-root from the wild for landscaping—smaller plants may reestablish, but larger plants seldom survive. Seed-grown plants are available and produce finer plants than bare-root transplants. Ocotillos are successfully grown in Silver City and should have full sun and well-drained soil.

Grant Co: Burro Mts, Buzzard Bay, 4 Jun 2008, *Felger 08-82*. 4 mi N of Red Rock, 9 May 1971, *Hunt s.n.*

## JUGLANDACEAE—WALNUT FAMILY

**Juglans major** (Torrey) Heller var. **major** [*J. major* var. *glabrata* Manning. *J. microcarpa* Berlandier var. *major* (Torrey) L.D. Benson] Arizona walnut (Latin name for walnut; greatest or largest)

Small to mostly medium-sized trees, sometimes with a substantial trunk. Bark brown and rough. Twigs and leaves at first densely pubescent with brown, stellate and simple hairs, becoming sparsely pubescent or glabrate with age. Leaves alternate or sometimes opposite, 17–31.5 cm long, pinnate with 9–17 large leaflets, the margins serrated. Flowers inconspicuous, unisexual, both on the same tree, the male flowers green to yellow in drooping catkins, the female flowers greenish and solitary to several in a cluster. Flowering with new leaves in late spring. The walnuts edible but scarcely worth the bother, with a very thick shell and a relatively small edible portion.

Widespread and common, especially in riparian areas, from grassland to about 8000 ft in mixed-conifer forest, and observed in our Gila River riparian plots above 4000 ft. Variety *major* ranges from Arizona to Texas and Oklahoma and Sonora, Sinaloa, Chihuahua, and northern Durango. It is replaced southward in Mexico by var. *glabrata*. The common cultivated walnut is *J. regia* Linnaeus, the Persian (English) walnut.

Catron Co: Mogollon, 31 May 1966, *Rogers s.n.* Grant Co: Saddle Rock Canyon, Big Burro Mts, 12 Oct 2005, *Zimmerman 5364*.

## MORACEAE—MULBERRY FAMILY

Leaves alternate. Male and female flowers on separate plants; individual flowers small and inconspicuous. Fruits fleshy, 1-seeded, and aggregated into a multiple-fruited structure. Fig trees, *Ficus carica* Linnaeus, are sometimes cultivated at lower elevations in the Gila Region.

1. Branches usually armed with spines, leaves shiny green and smooth. **Maclura**
1' Plants unarmed; leaves dull green, the surfaces rough. **Morus**

***Maclura pomifera** (Rafinesque) C.K. Schneider. Osage orange (for William Maclure, 1763–1840, American geologist and botanist; pome bearing)

Large shrubs to mostly small trees, sometimes medium-sized and forming a heavy trunk. (A cultivated tree at Fort Bayard measured 16.5 m in height with a trunk 1 m in diameter.) Bark yellow-brown, deeply fissured. Sap milky. Branches mostly with long, sharp, axillary spines. Young herbage with short hairs, becoming glabrous. Leaves 7–15 cm long, ovate to lanceolate or elliptic, shiny green, becoming bright yellow after the first frost in fall; leaf margins entire. Individual flowers small and green, male flowers in stalked axillary clusters, female flowers in sessile heads; late spring and early summer.



Aggregate fruits rounded, about the size of a large orange, yellow when ripe, with thick, warty, brainlike sculptured surfaces.

Persisting after cultivation and sometimes spreading along arroyos and ditches. Locally in widely scattered, disturbed habitats in grassland and woodland areas. Native to south-central United States.

Grant Co: Walnut Creek, S10, T17S, R14W, 6000 ft, 14 Jul 1994, *Huff 1640*. Gallinas Canyon, tall tree, along creek, 6500 ft, 22 Sep 1974, *Cole 203*. Pinos Altos Range, Georgetown site, tree 35 ft tall, along road, 1 Sep 1992, *Zimmerman 4069*.

**Morus**—Mulberry (Latin *morum*, for mulberry)

1. Leaves mostly more than 7.5 cm long, the petioles more than 1.2 cm long; fruits (the multiple, or aggregate, fruit) reportedly 1.5–2.5 cm long; rarely escaping from cultivation in disturbed habitats. **M. alba**
1' Leaves mostly less than 8 cm long, the petioles to 1.2 cm long; fruits mostly not more than 1.5 cm long; widespread in natural areas. **M. microphylla**

***Morus alba** Linnaeus. White mulberry (white)

Small trees, occasionally to 9 m tall. Resembling littleleaf mulberry but with much larger leaves and fruits; leaves probably 7.5–20+ cm long. Fruits probably 1–2.5 cm long.

Occasionally escaping from cultivation in disturbed areas, e.g., San Vicente Arroyo south of Silver City at about 5800 ft, and in two Gila River riparian plots below 4500 ft. Native to northern China and widely cultivated and naturalized. The fruits are edible and the leaves used in East Asia for raising silkworms.

Grant Co: Tree to 7 m, along Mimbres River, Nature Conservancy Mimbres River Preserve, 5900 ft, 28 May 1998, *Carter 2733*. Gila River Bird Area, riparian, cottonwood/willow, near old homestead, ca. 5000 ft, 22 May 1992, *Boucher 1020*.

**Morus microphylla** Buckley. Littleleaf mulberry; *mora* (small leaves)

Shrubs and small to sometimes medium-sized trees to ca. 10 m tall. Bark brown to gray, smooth, becoming fissured. Young twigs and leaves pubescent. Leaves often 3–8 (10+) cm long, broadly ovate, sometimes deeply 3-lobed, scabrous on both surfaces; leaf margins toothed. Flowers small and inconspicuous, in catkins; male flowers white, female flowers green. Multiple fruits small, red or blackish red at maturity and edible, but too small to be more than trail snacks.

Widely scattered, mostly in riparian habitats and canyon slopes; desert, woodland, and lower pine forest. Arizona to Texas, Oklahoma, Chihuahua, Durango, and Sonora.

Catron Co: Whitewater Creek, Catwalk, 5200 ft, 6 Jul 1994, *Huff 1594*. Grant Co: Big Burro Mts, Saddle Rock Canyon, 5400 ft, tree 25–30 ft tall, canyon bottom, 13 Jul 1992, *Zimmerman 3858*.

## OLEACEAE—OLIVE FAMILY

Leaves and branches opposite and decussate, stipules none.

1. Leaves simple; fruits fleshy. **Forestiera**
1' Leaves compound (*F. anomala* occasionally with some unifoliolate leaves); fruits dry and flattened (samaras). **Fraxinus**

**Forestiera pubescens** Nuttall var. **parviflora** (A. Gray) Nesom [*F. neomexicana* A. Gray] New Mexico olive (for Charles Le Forestier, French physician and naturalist, died 1820; pubescent; small flowered)

Hardwood shrubs, sometimes 3–4 m tall, and rarely small trees 5+ m tall in riparian canyons. Leaves 1.5–4 (6) cm long, ovate to oval, relatively thick, glabrous or less commonly with short hairs. Flowers minute; male and female flowers on separate plants or with some bisexual flowers. Fruits fleshy, 5–10 mm long, ellipsoid, bluish black and glaucous. Flowering in spring before or with the new leaves, the fruits maturing in summer.

Valley margins, rocky slopes, canyons, and riparian areas in pinyon-juniper woodland to conifer forests; protected locations in canyons in the Gila River riparian area above 4400 ft and mostly below 7000 ft. Two varieties: var. *parviflora* in Baja California (Norte) and California to Utah, Colorado, Texas, Sonora, and Chihuahua; replaced by var. *pubescens* eastward in southeastern New Mexico, Texas, and Oklahoma (Nesom 2009).

Grant Co: First main canyon above mouth of Rocky Canyon, S5, T15S, R12W, 6250 ft, montane riparian, *Quercus grisea, Pinus ponderosa, Pseudotsuga menziesii*, locally common shrub to 5 m, 31 Jul 1995, *Williams 2380*. Pinos Altos Range, Sapillo Creek, 5700 ft, 19 Sep 2004, *Zimmerman 5166*.

**Fraxinus**—Ash; *fresno* (Latin for ash tree)

Branches with conspicuous lenticels. Leaves opposite, odd-pinnate or sometimes with a single leaflet. Flowers small. Fruits in pendulous clusters of samaras with an elongated, flat wing.

1. Twigs conspicuously 4-angled, the angles formed by thin but narrow wings; leaflets 1–7. **F. anomala**
1' Twigs more or less round in cross section (terete) and not at all winged; leaflets (3) 5–9. **F. velutina**

**Fraxinus anomala** Torrey ex S. Watson var. **lowellii** (Sargent) Little [*F. lowellii* Sargent] Anomalous ash, Lowell ash (deviating from the usual; for Percival Lawrence Lowell, 1855–1916, astronomer who established the Lowell Observatory at Flagstaff, promoted the idea of canals on Mars, pioneered research leading to the discovery of Pluto, and helped launch pioneer dendrochronologist Andrew Ellicot Douglass' career).

Large shrubs, often multiple stemmed, or small trees; bark dark brown. Young twigs 4-angled with thin, narrow wings. Herbage sparsely pubescent or glabrous. Leaves 4–17 cm long, the leaflets (1) 3–7 per leaf, 5.5–7.5 cm long; leaflet margins toothed or entire. Flowers bisexual or sometimes unisexual, the calyx persistent, petals none.

Locally on riparian canyon sides in woodlands and pine forest, best known from near Glenwood along Mineral Creek and Whitewater (Catwalk) Canyon. Two varieties: var. *lowellii*, with predominantly 3–7 leaflets, southeast California and southernmost Nevada across central Arizona to the Gila Region in New Mexico; replaced northward by var. *anomala*, with predominantly 1 leaflet, from southeastern California

to extreme northwestern New Mexico, and also occurring in Colorado and Utah (Nesom 2010).

Catron Co: Whitewater Canyon, 5 mi E of Hwy 180 at Glenwood, not common, 10 ft tall, 6000 ft, 20 Aug 1973, *Hess 3100* (ARIZ). Catwalk Canyon, 2 Feb 2009, *Felger 09-2*. Grant Co: Gila River Valley, 3 mi downstream from mouth of Turkey Creek, 5200 ft, rare in side canyons near the river, with *Pinus leiophylla, P. edulis, Platanus* and oaks, 8 May 1971, *Zimmerman 1547*.

**Fraxinus velutina** Torrey [*F. pennsylvanica* subsp. *velutina* (Torrey) G.M. Miller. *F. velutina* var. *coriacea* (S. Watson) Rehder. *F. papillosa* Lingelsheim, shown to be a synonym of *F. velutina* by Williams and Nesom (forthcoming)]. Velvet ash; *fresno* (velvety, referring to the pubescence)

Small to large trees. Bark gray and furrowed into many forking ridges. Young twigs and leaves densely hairy, the leaves often glabrate with age. Leaves 8–21 cm long; leaflets (3) 5–9 per leaf, green on both surfaces; margins minutely toothed. Male and female flowers on separate trees, or some flowers may be bisexual; calyx persistent on female flowers, the male flowers with 2 stamens; petals none; flowering mostly in spring before and with new leaves.

Widely scattered in riparian areas at lower and intermediate elevations, especially along riverbanks and larger canyons. Southwestern United States and northwestern Mexico.

Catron Co: Whitewater Creek, Catwalk, 3 Feb 2009, *Felger 09-12*. Grant Co: Gila River bottom at Redrock, 4000 ft, 6 May 1967, *Uhli 68*.

## PLATANACEAE—SYCAMORE FAMILY

**Platanus wrightii** Nuttall. Arizona sycamore (Greek *platanos*, perhaps from platys, broad, for the leaves; for Charles Wright, 1811–1885, American botanical explorer and collector)

Medium-sized to large handsome trees with irregular trunks and limbs. Bark flaking in irregular, puzzlelike thin plates, smooth and whitish or greenish beneath the plates, becoming darker, fissured and not flaking at base of larger trees. Twigs and young leaves woolly-tomentose, with dendritic hairs, becoming glabrate or glabrous with age. Leaves alternate, 24–38 cm long, palmately cleft with several large, narrowly triangular lobes; stipules leafy and often fused around the stem. Flowers in dense, globose, unisexual heads on pendulous racemes; spring and early summer; individual flowers and fruits minute; sepals scalelike, petals minute on male flowers and none on female flowers.

Common along the Gila and San Francisco rivers and their tributary streams and canyons, the Silver City drainage system, and one of the more common species in our Gila River plots. Not known from the Mimbres River system, but in the Animas Creek on the east side of the Black Range—its eastern extent. Arizona, New Mexico, Chihuahua, Sonora, and Sinaloa.

Catron Co: Whitewater Creek, Catwalk Natl. Recreation Trail, 5200 ft, 6 Jul 1994, *Huff 1599*. Grant Co: Birding Area near Bill Evans Lake, near Gila River, 1334 m, 20 Oct 2001, *Hill 73*. Sierra Co: Animas Creek, 8000 ft, gravelly waterways, 13 Jul 1904, *Greene 1111* (UNM).

## ROSACEAE—ROSE FAMILY

Tree species in the flora region with leaves alternate and clustered on short shoots; stipules usually present. There are many herbaceous and nonarborescent species. This large family includes almonds, apples, apricot, blackberries, cherries, pears, peaches, plums, raspberries, strawberries, and temperate-climate garden plants including roses.

1. Plants armed with thorns to 3+ cm long; leaves coarsely and irregularly toothed; fruits fleshy and bright red. **Crataegus**
1' Plants unarmed (twigs perhaps thorn-tipped in *P. americana*); leaves entire or serrated but the teeth small and regularly spaced; fruits dry or fleshy.
 2. Leaves mostly 1–2 cm long, evergreen, dull green and conspicuously pubescent; leaf veins conspicuously impressed; petals none; fruits dry and with a long, twisted feathery awn. **Cercocarpus**
 2' Leaves usually more than 3 cm long, winter deciduous, dull or shiny; petals present but often soon deciduous; fruits fleshy, not awned.
  3. Apples; fruits 4+ cm diameter, multiple-seeded (pomes). ***Malus***
  3' Cherries, peaches, and plums; fruits generally less than 2.5 cm diameter (except peaches), 1-seeded (drupes). **Prunus**

**Cercocarpus breviflorus** A. Gray. Mountain mahogany (Greek *cerco*, tail, and *carpus*, fruit; with short flowers)

Large shrubs and occasionally small trees especially along canyon bottoms. Bark smooth, gray to reddish brown. Leaves evergreen, alternate on long shoots and clustered on short shoots, 1–2+ cm long, ovate to obovate, or oblanceolate; margins toothed towards the tip. Flowers small, the sepals deciduous; petals none; style enlarging as a plumose awn; flowering after rains in late summer. Fruits of small achenes; fruiting awns to 3 cm long.

Widespread and abundant, mostly woodlands and lower conifer forest on dry slopes, ridges, canyon sides, and sometimes canyon bottoms. Arizona to Texas and northeastern Sonora to Tamaulipas, San Luis Potosi, and Queretero.

Grant Co: Cherry Creek Canyon, 7150 ft, shrub to 15 ft, 30 Jul 1967, *Hess 1317*. Near Silver City, mile 105, Hwy 180 near Continental Divide, 6400 ft, 19 Oct 2004, *Johnson 40*. Apache Canyon, ca. 1 km upstream from Apache Box, tree ca. 20 ft tall with a well-formed trunk 11 cm diameter, 24 Apr 2009, *Felger*, observation.

**Crataegus wootoniana** Eggleston. Wooton hawthorn (from the Greek *kratos*, strong or powerful, referring to the hard wood; for Elmer Otis Wooton, 1865–1945, intrepid pioneer New Mexico botanist)

Shrubs to small trees, spreading by root shoots and seeds. Bark brown, irregularly shallowly fissured and with conspicuous lenticels. Long shoots armed with stout, straight to mostly slightly curved sharp thorns, the larger ones 2.8–4.5 cm long. Leaves alternate on long shoots, clustered on short shoots; petioles 1.6–2.7 cm long; leaf blades 3.6–5.6 cm long, often ¾ to about as wide as long, irregularly lobed and serrated.



Flowers ca. 1–1.2 cm wide; petals white, clawed, the blade orbicular with serrated margins. Stamens about 5–10, the filaments white, the anthers purple. Fruits ca. 1 cm diameter, fleshy (pomes), bright red. Flowering late April, the fruits ripe in late summer and early fall.

Riparian canyon bottoms in pine forest and shrubs on xeric sites in mixed-conifer forest, probably 6560–8040 ft. Southwestern and central New Mexico, in widely scattered and apparently highly localized sites. Endemic to New Mexico and listed as a USFS Sensitive Species, USFWS Species of Concern, and a State of New Mexico Species of Concern. Reported to be closely related to *C. erythropoda* Asche and *C. macracantha* Loddiges ex Loudon, and the distinction between *C. wootoniana* and C. *macracantha* var. *occidentalis* (Britton) Eggleston deserves further study.

Catron Co: Mogollon Mts, on or near the West Fork of Gila River, head of Little Creek, 8000 ft, shrub 10 ft high, 23 Aug 1903, *Wooton 584* (isotype, NMC). Grant Co: 0.25 mi along McMillan trail from campground, 22 May 1994, *Huff 1307*. Mimbres River, S8, T14S, R10W, NW bank in fir/aspen zone, 7400 ft, 7 Jul 1977, *Boles s.n.* (NMC).

****Malus pumila*** Miller. Apple (bad or wicked; small)

Apple trees sometimes persist from cultivation in forest sites. Also occasionally growing from seeds of discarded apple cores (such as adjacent to a fishing site at Lake Roberts) and seeds washed downstream from orchards.

Catron Co: Rest stop, S of Reserve on Hwy 180, 2.7 mi S of junction with Hwy 12, pinyon/ponderosa transition, around old dwellings, 29 Jun 2004, *Allred 9211* (NMCR). Grant Co: Lake Roberts, 10 Aug 2008, *Kindscher*, observation.

**Prunus** (Latin for plum)
This genus of trees and shrubs includes almonds, apricots, cherries, peaches, and plums.

1. Not native and not widespread; flowers usually fewer than 6 in clusters; fruits 2 cm or more in diameter.
 2. Plums; leaves more or less flat; fruits ca. 2–2.5 cm diameter. **P. americana**
 2' Peaches; leaves arched; fruits more than 3 cm diameter. ***P. persica***
1' Native and widespread; flowers usually 6 to many on racemose inflorescences; fruits to 1 cm diameter.
 3. Leaves shiny, the margins with blunt teeth; calyx lobes persistent; petals ca. 3 mm long. **P. serotina**
 3' Leaves dull green, the margins sharply toothed; calyx lobes deciduous long before fruit ripens; petals ca. 5 mm long (shrubs, apparently not attaining tree size in the Gila Region). ***P. virginiana*** Linnaeus var. ***melanocarpa*** (A. Nelson) Sargent (western chokecherry)

***Prunus americana** Marshall. American plum, wild plum, hog plum (of America)

Thicket-forming large shrubs and sometimes small trees, the short shoots sometimes thornlike. Leaves broadly elliptic to ovate, 6–10 cm long, shiny green, becoming red-purple or yellow in fall. Flowers white and fragrant, in small fascicles on short shoots or from axillary buds, appearing in late April before the leaves. Fruits rounded, 2–2.5 cm long, fleshy, reddish to purplish, sweet and edible (often made into preserves), ripening in late summer.

Known from a few localities in the Gila Region; along small creeks in woodland and pine forest; apparently persisting from earlier plantings and moderately spreading by root sprouts. Temperate North America east of the Rocky Mountains and reaching its geographic limit in New Mexico, but apparently not native in the southern part of the state. There are various horticultural varieties.

Grant Co: 0.5 mi N of Little Walnut Picnic area, Walnut Creek, 6800 ft, shrub to 4 m, forming large dense thicket in and along creek bed, fruit dark purplish red with bloom, exocarp fleshy, 22 Apr 1992, *Zimmerman 4141*. Bear Mt, junction Forest Road 858 & Bear Mt Road, locally common in arroyo at base of hill, 25 Apr 1992, *Zimmerman 3633*.

****Prunus persica*** (Linnaeus) Batsch. Peach (of Persia)

Leaves conspicuously arched. Flowers pink, appearing in spring before the leaves. Peaches and other fruit trees are occasionally encountered, mostly at roadsides in forested areas, recreational areas (such as Lake Roberts), and abandoned orchards, but are apparently not reproducing.

Grant Co: Tree near a popular fishing area at Lake Roberts, 10 Aug 2008, *Kindscher,* observation.

**Prunus serotina** Ehrhart subsp. **virens** (Wooton & Standley) McVaugh [*P. virens* (Wooton & Standley) Shreve ex Sargent] Black cherry, southwestern chokecherry (developing late in the season; green)

Shrubs to small or sometimes medium-sized trees. Bark on young branches shiny with horizontal lenticels. Leaves usually shiny green; leaf margins finely serrated with gland-tipped teeth. Flowers white, in dense racemes at ends of short, leafy stems; flowering on new growth primarily in late spring. Fruits ca. 1 cm diameter, dark purple.

Woodland to mixed-conifer forest, primarily along streams and canyon bottoms. This species occurs in a few of our riparian plots above 5400 ft. The species in southwestern United States to South America. Subsp. *virens* in Arizona, southern New Mexico, Trans-Pecos Texas, and the northern states of Mexico. The fruits are edible, usually cooked but bitter unless sweetened. These cherries are a favorite food of bears.

Grant Co: Hell's Half Acre, 26 Mar 2009, *Felger 09-14*. Sierra Co: North Percha Canyon, 4 May 2009, *Felger 09-37*.

## SALICACEAE—WILLOW FAMILY

Leaves alternate, simple. Male and female flowers on different trees. Flowers in catkins, small, green to yellow-green, without sepals and petals. Fruits of small capsules. Seeds minute, each with a tuft of long silky hairs adapted for wind dispersal.

1. Leaf blades less than twice as long as wide (except *P. angustifolia*); leaf and floral buds resinous, with several scales; catkins drooping; stamens 6–80. **Populus**
1' Leaf blades more than twice as long as wide (except *S. scouleriana*); leaf and floral buds not resinous, with a single scale; catkins mostly upright; stamens 1–8. **Salix**

**Populus**—Cottonwood, aspen; *álamo* (Latin *populus*, the people, many fanciful allusions but none certain—the Latin name for the European poplar)

Vegetative and floral buds with several scales, resinous (slightly so in *P. tremuloides*). Early-season leaves different from late-season leaves; petioles laterally compressed, especially near the blade, or dorso-ventrally compressed and often channeled above. Catkins drooping, appearing in spring on twigs of previous year, before or with the first new leaves; female flowers yellow-green, the male flowers yellow. Eckenwalder's (1992, 2010) work is the basis of the following discussion.

This genus has six well-marked sections, three of which occur in the Gila Region: balsam poplars, sect. **Tacamahaca** (*P. angustifolia*); cottonwoods, sect. **Aigeiros** (*P. deltoides* and *P. fremontii*); and aspen, sect. **Populus** (*P. tremuloides*). Species within a section usually have separate distributions but intergrade or hybridize freely where they come in contact. Species of different sections do not hybridize, except members of sect. *Aigeiros*, which hybridize with species of sect. *Tacamahaca* where they occur together. These hybrids are not self-perpetuating, but because they can persist for decades by clonal growth they can often be found in the absence of one or both parents.

All poplars are capable of clonal propagation, producing new trees from root sprouts. The cottonwoods (*P. deltoides* and *P. fremontii*) seldom produce root sprouts, with most clonal suckers developing from buried branches. Aspens (*P. tremuloides*) regularly form large clonal groves. Other species fall between these extremes. As a result of clonal growth, whole stands of trees may be solely staminate or pistillate and have uniform leaf morphology and phenology.

Identifying poplars can be complicated by seasonal variation in leaves, including size, shape, and marginal teeth. Early leaves (preformed leaves) overwinter in buds as rolled up leaves before expanding with spring flush following flowering. Late leaves (neoformed leaves) develop during the growing season on long shoots after spring flush. As a result of this seasonality and unisexuality, individual staminate and pistillate trees should be marked and studied or collected on three separate occasions: (1) at flowering; (2) when preformed leaves are mature (and when capsules are just opening on pistillate trees); and (3) with formation of mature winter buds, but before leaves have turned color and developed their abscission layer.

Some neoformed leaves of rapidly growing suckers and young trees are the largest produced by each species, often more than twice as large as the largest leaves of mature trees. Species with large teeth on preformed leaves, such as *P. deltoides* and *P. fremontii*, are often strongly heterophyllous, with smaller and more numerous teeth on neoformed leaves.

1. Leaf blades more than twice as long as wide; petioles less than one third as long as the blade, not more than 1.5 cm long. **P. angustifolia**
1' Leaf blades less than twice as long as wide, mostly about as wide as long; petioles more than half as long as the blade, more than 1.5 cm long.
2. Petioles not laterally compressed. **P. ×acuminata/ P. ×hinckleyana**
2' Petioles laterally compressed (perpendicular to the leaf blade).
3. Aspen; leaf blades mostly widest at about the middle, the margins finely toothed. **P. tremuloides**
3' Cottonwoods; leaf blades mostly widest below the middle (near base), the margins often coarsely toothed.
4. Branchlets usually glabrous, sometimes pubescent; stamens usually 30–40 (55) per flower; pistillate pedicels (5) 8–12 (15 in fruit) mm long; ovaries ovoid; floral discs on fruits saucer-shaped, 1–3 (4) mm wide; capsules 8–15 mm long, ovoid. **P. deltoides**
4' Branchlets on young shoots and petioles pubescent or sometimes glabrate or glabrous; stamens usually 40–60; pistillate pedicels 1–4 (5.5 in fruit) mm long; ovaries spherical; floral discs on fruits cup-shaped, (2.5) 4–7 (9) mm diameter; capsules spherical, 6–10 mm long. **P. fremontii**

**Populus ×acuminata** Rydberg (*P. angustifolia* × *P. deltoides*) Lanceleaf cottonwood (acuminate, with a long tapering point)

**Populus ×hinckleyana** Correll (*P. angustifolia* × *P. fremontii*) Hinkley poplar (for Leon Carl Hinkley, 1891–1953, a botanist from Texas)

Large trees. Leaves ovate and somewhat intermediate in shape between the parent species. The newest growth and bud scales on *P. ×hinckleyana* are minutely puberulent, while those of *P. ×acuminata* tend to be glabrate or glabrous.

Locally common in riparian habitats in scattered localities in the Gila Region, generally within the range of the parent species. Common in the riparian plots along the Gila River above 5400 ft and as low as 4550 ft elsewhere on the river.

The Gila Region intersectional hybrid cottonwoods have been called *P. ×acuminata*, but at least most of them are likely to be hybrids with *P. fremontii* and therefore should be *P. ×hinckleyana*. Trees identified as *P. ×acuminata* occur on the east side of the Black Range. Hybrid cottonwoods, sold as *P. ×acuminata*, are often cultivated in the region.

*P. ×acuminata*: Sierra Co: Kingston campground, 4 May 2009, *Felger 09-40*. *P. ×hinckleyana*: Grant Co: Cliff, Lichty Center, The Nature Conservancy, 1400 m, adjacent to Gila River, 21 Jul 2008, *Norris 2008-07-21-26*.

**Populus angustifolia** James. Narrowleaf cottonwood (narrow leaf)

Large, handsome trees developing a tall bole and often a high, rather thin crown. Bark light-colored, often whitish and rather smooth, and often dotted with woodpecker holes. Vegetative buds elongate-conical and conspicuously resinous. Leaves moderately bicolored, 4–14 cm long, with willowlike lanceolate blades; petioles short and often channeled above; leaf margins finely serrated, the teeth often gland-tipped.

Widespread and common in riparian habitats about 5400–8000 ft. Western North America: Canada to northernmost Mexico.

Catron Co: Mouth of Big Dry Creek near San Francisco River, 4500 ft, 31 Mar 1970, *Hunt s.n.* Grant Co: Cherry Creek Canyon, 7000 ft, 30 Aug 1967, *Hess & Massey s.n.*



**Populus deltoides** Bartram ex Marshall subsp. **wislizeni** (S. Watson) Eckenwalder [*P. fremontii* var. *wislizeni* S. Watson] Rio Grande cottonwood (triangular; for Frederick Adolphus Wislizenus, 1810–1889, German-born physician and naturalist who traveled in Mexico and the American West)

Large trees. Branchlets of young shoots and leaves usually glabrous. Leaf blades generally broader than long. Winter buds pubescent, hairs relatively short, stiff. Riparian areas within woodland and pine forest. Eastern margin of the Gila Region on the east side of the Black Range.

These trees resemble *P. fremontii*, differing in subtle features. Intermediate morphologies are expected where these cottonwoods meet along the eastern margin of the Gila Region. This species, with three subspecies, ranges across North America from Canada to northern Mexico except the western states of United States and Mexico. Subsp. *wislizeni* occurs in the Colorado Plateau region (Arizona, New Mexico, Utah) to trans-Pecos Texas and north-central Mexico.

Sierra Co: Kingston, approx. 7000 ft, 6 Jun 1904, *Metcalfe 962*. North Percha Creek, 4 May 2009, *Felger 09-36*.

**Populus fremontii** S. Watson subsp. **fremontii**. Frémont cottonwood (for John Frémont, 1813–1890, American explorer, soldier, and politician)

Large trees, to 30 m tall, developing a high, massive trunk and large limbs, and a broad crown. Bark on trunk and older branches gray-brown and deeply fissured. Winter leaf and floral buds resinous and often pubescent. New shoots and leaves often sparsely pubescent, becoming glabrate with age. Leaves broadly ovate to more or less triangular or somewhat diamond shaped; margins toothed.

Widespread in riparian habitats, especially at lower elevations. This is the most common tree in our riparian plots, 3900–5700 ft. This species occurs in southwestern United States and the central plateau and northwest of Mexico. Subspecies *fremontii* occurs mostly west of the Continental Divide, primarily New Mexico to California, Idaho, Utah, both states of Baja California, and Sonora. Subspecies *mesetae* Eckenwalder is largely a tree of the Chihuahuan Desert Region, from Texas to the Valley of Mexico (Eckenwalder 1992, 2010).

Catron Co: Mile 40, Hwy 180 and San Francisco River, 5000 ft, 2 Apr 2005, *Johnson 2005-04-02-07*. Grant Co: Gila River bottom near Cliff, 7 Apr 1903, *Metcalfe 6* (NMC). Silver City, 9 Jul 1900, *Wooton s.n.* (NMC).

**Populus tremuloides** Michaux. Quaking aspen; *álamo temblón* (resembling *P. tremula*, the aspen of Eurasia—Latin *tremulus*, trembling, referring to the tendency of the leaves to flutter in a breeze)

Medium-sized to large trees, generally tall and slender. Bark mostly whitish and smooth with blackish scars and blackish or dark and furrowed at the base of larger trees. Herbage glabrous, the buds shiny and moderately resinous. Leaves 4–13 cm long; leaf blades somewhat circular to broadly ovate; petioles laterally compressed, allowing the leaves to quake or flutter in the wind. The foliage famously becomes brilliant yellow in fall. Propagating mostly by root sprouts, generally after fires or openings in the forest.

Patchy but common at higher elevations in mixed-conifer forest above 7000 ft. Cold and cool-temperate regions, north of the Arctic Circle in Alaska to Labrador and southward in North America to high elevations in Mexico as far south as mountains above Mexico City. This is the most widespread tree species in North America.

"Clonal aspen groves develop rapidly following fires and other disturbances and may quickly decay in their absence as infections are transmitted through the connecting root system. . . . Groves are often occupied by single clones and show no sexual reproduction but persist and spread by root suckers. Clone formation commonly results also in striking differences in appearance" (Eckenwalder 2010, 22).

Catron Co: Bursum Road, 0.25 mi E from Silver Creek Divide, 9000 ft, 19 Jul 1994, *Huff 1655*. Grant Co: 6 mi on Signal Peak Road, 8700 ft, 30 Aug 1967, *Hess 1452*.

**Salix**—Willow (Latin name for willow)

Vegetative and floral buds with a single scale and not resinous. Catkins mostly upright. *Salix bonplandiana* and *S. gooddingii* develop into substantial trees with a well-developed woody trunk, while the other native willows in the region are mostly large shrubs and sometimes become small trees. The following key covers the usual or most commonly encountered conditions and probably will not work for exceptional specimens.

1. Leaves broadly elliptic to obovate, less than twice as long as wide; conifer forests. **S. scouleriana**
1' Leaves usually linear to lanceolate, at least twice as long as wide; various habitats.
2. Trees forming a substantial, heavy trunk, not forming clonal colonies.
3. Leafy stems long and drooping; petioles not glandular; stamens 2. **S. ×sepulcralis**
3' Leafy stems not drooping; petioles glandular or not; stamens 4–8.
4. Leaves bicolored, conspicuously lighter on the lower surface. **S. bonplandiana**
4' Leaves uniformly green on both surfaces. **S. gooddingii**
2' Shrubs to slender-stemmed trees forming clonal colonies.
5. Leaves mostly less than 4 cm long, silvery with silky hairs, with age becoming glabrate or glabrous and dull-colored, not conspicuously bicolored, the petioles 0.2–1.5 mm long. **S. taxifolia**
5' Leaves more than (3.5) 4 cm long, bicolored (paler below), the petioles often longer.
6. Leaves less than 3 mm wide. **S. exigua**
6' Leaves more than 3 mm wide.
7. Stems usually conspicuously bluish glaucous/whitish; petioles velvety; male flowers with 3 stamens. **S. irrorata**
7' Stems not markedly bluish; petioles not velvety; male flowers with 3 or more stamens. **S. lucida**

**Salix bonplandiana** Kunth. Bonpland's willow (for Aimé Jacques Alexandre Bonpland, 1773–1858, French explorer and famous botanist who accompanied Alexander von Humboldt to the Americas)

Small to medium-sized trees to ca. 10 m tall, often with a substantial, thick trunk; not spreading clonally. Bark dark brown and fissured. Younger branches and twigs conspicuously reddish. Winter buds with scale margins free and overlapping (not coalescent). Leaves narrowly ovate to lanceolate, 7–15.5 cm long, conspicuously glaucous below, shiny green above; leaf margins serrulate-crenate and/or gland-dotted, often minutely so. Male flowers with 4–7 stamens. Flowering in spring, mostly with the leaves.

*Salix bonplandiana*, documented from a riparian canyon in Grant County, is a new record for the state. A second New Mexico collection, from Catron County, has not been critically examined. Southwestern New Mexico and southern and central Arizona southward to Guatemala. This Mexican willow reaches its geographic limit in the Gila Region. *Salix laevigata* Bebb (*S. bonplandiana* var. *laevigata* [Bebb] Dorn), a more northerly and often shrubby willow, is known from San Juan County in northwestern New Mexico (Dorn 2002), and western United States and the Baja California Peninsula.

Catron Co: Mogollon Mountains, near mouth of Water Canyon, tributary of Negrito Creek, center S8, T9S, R17W, 7300 ft, *Pinus ponderosa* riparian, infrequent,19 Jul 1984, *Fletcher 7658* (UNM, specimen not seen). Grant Co: Sycamore Canyon S of Cliff, 22 Nov 2009, *Felger 09-101*.

**Salix exigua** Nuttall. Narrowleaf willow (short, small)

Slender shrubs and sometimes small, slender trees 5–7+ m tall with a narrow trunk. Spreading clonally by root suckers to form many-stemmed thickets. Winter buds with the scale margins coalescent. Bark often reddish brown, or yellow-brown especially when young. Leaves linear, mostly 3.5–12.5 cm × 0.8–2.8 mm, often silvery to grayish green on the lower surfaces, pale green above, the midrib prominent; leaf margins entire to small-toothed. Male flowers with 2 stamens. Flowering spring and sporadically until fall.

Abundant below 7000 ft along riverine gallery forests, streams, and roadside ditches. Western North America from Canada to northwestern Mexico. The closely related sandbar willow, *S. interior* Rowlee (*S. exigua* subsp. *interior* [Rowlee] Cronquist) replaces *S. exigua* eastward and northward in North America.

Grant Co: Gila River Valley, Redrock, 4050 ft, shrub 20 ft tall, 7 May 1967, *Mathis 420-35*. Walnut Creek north of Silver City, 6800 ft, 22 Apr 1992, *Zimmerman 3616*.

**Salix gooddingii** C.R. Ball. Goodding willow; *sauz* (for Leslie Goodding, 1880–1967, western American botanist)

Small to mostly medium-sized trees, generally with a well-formed and often large trunk. Bark pale brownish gray, becoming fissured. Winter buds with scale margins free and overlapping (a character shared regionally only with *S. bonplandiana*). Leaves 5.5–14 cm long, linear-lanceolate, uniformly green on both surfaces; leaf margins minutely serrated. Male flowers with 4–8 stamens. Flowering spring through summer.

This is the only large, widespread willow in the region. River and stream banks, canyon bottoms, irrigation ditches, and other wetland habitats, especially at lower elevations. It was the most common willow in our riparian plot data. The deep roots help anchor stream banks against erosion. California to west Texas, Baja California (Norte), Chihuahua, Coahuila, Sinaloa, and Sonora.

Catron Co: Catwalk, Whitewater Canyon, 5000 ft, 29 Apr 1964, *Hubbard s.n*. Grant Co: Gila River near Gila, 4500 ft, 25 Apr 1967, *Mathis 369-272*. Lake Roberts, 6000 ft, 15 Jun 1991, *Carter 128*.

**Salix irrorata** Anderson. Bluestem willow, dewystem willow (dewy)

Multiple-stem, thicket-forming shrubs and sometimes small trees. Stems usually bluish-white glaucous. Winter buds with the scale margins coalescent. Leaves 5–12 cm long, the lower surfaces pale, usually bluish glaucous, the upper surfaces dark green. Male flowers with 2 stamens.

Widespread and common in riparian habitats to 8500 ft. It was abundant in the plots above 4300 ft. Wyoming to Arizona and New Mexico and north-central Mexico.

Grant Co: Gila River Valley near Cliff, 4000 ft, shrub 18–20 ft tall, 10 Apr 1967, *Mathis 277*. Cherry Creek Canyon, 14 Sep 2002, *Zimmerman 4882*.

**Salix lucida** Muhlenberg subsp. **lasiandra** (Bentham) E. Murray. Shining willow, Pacific willow (shining; shaggy stemmed)

Mostly multiple-stem shrubs to sometimes small trees. Younger stems reddish or yellowish. Winter buds with the scale margins coalescent. Leaves dark green, shiny above and paler green and often glaucous below. Male flowers with 3 or more stamens.

Riparian habitats, mostly in coniferous forest. This species is widespread across temperate and arctic North America; subsp. *lasiandra* is in the western half of the continent.

Catron Co: Gila Valley 3 mi below [Cliff] Dwellings, 5550 ft, *Mathis 428-387*. Hwy 32, 6 mi N from junction of Hwy 12, 6650 ft, 30 May 1994, *Carter 1346*.

**Salix scouleriana** J. Barratt ex Hooker. Scouler willow, black willow, fire willow, mountain willow (for John Scouler, 1804–1871, Scottish naturalist)

Shrubs and small trees. Winter buds with the scale margins coalescent. Bark gray-brown, becoming fissured. Herbage pubescent. Leaves 3.5–10 cm long, broadly elliptic or obovate (notably broader than other tree willows in the region); upper surfaces dull, yellow-green, and sparsely hairy; lower surfaces white-hairy; leaf margins entire or slightly wavy. Male flowers with 2 stamens.

Riparian habitats and mostly nonriparian forests at higher elevations; locally common in mixed-conifer forest above 7000 ft. Arctic shores of Alaska and western Canada to western United States and Mexico in Chihuahua and Sonora.

Catron Co: Adjacent to Bursum Road, 3 mi E [actually W, not E] from junction with FS 153, 9000 ft, 21 Jun 1995, *Villalba 2262*. Grant Co: Pinos Altos Mts, N slope of Black Peak, 8900 ft, 1 Jul 1991, *Zimmerman 3189*.

***Salix* ×sepulcralis** Simonkai. Weeping willow (maybe from *sepulcrum* for grave or tomb and *pulcher* for beautiful)

Medium-sized trees with stout trunks; fast growing with long, pendulous, leafy branches. Leaves green above, pale glaucous below. Male flowers with 2 stamens.



About a dozen or more trees occur along the stream in San Vicente Arroyo below Silver City; perhaps propagating from broken branches buried in floods. Widely cultivated in the Gila Region and in temperate regions worldwide. It is probably a hybrid between Chinese and European willows. Argus (2010) discusses the tangled taxonomic trail of weeping willows, which includes *S. babylonica* Linnaeus.

Grant Co: Riparian habitat, San Vicente Creek, city [Silver City] property, 6000 ft, 6 May 2003, *Carter 3661*.

**Salix taxifolia** Kunth [*S. exilifolia* Dorn] Yew-leaf willow (leaves like those of the yew tree, *Taxus*)

Shrubs or sometimes small trees 5–8 m tall, forming clonal colonies by root suckers. Bark grayish, rough, and flaking. Winter buds with the scale margins coalescent. Leaves 1.2–3.5 (4.2) cm long, linear, same color on both surfaces, sessile or with very short petioles, silvery with dense pubescence of fine silky hairs when young, often glabrate or glabrous and dull olive- to gray-green with age; leaf margins entire or with a few, minute gland-tipped teeth. Male flowers with 2 stamens. Flowering spring to fall.

Locally in a few places in the Gila Region; riparian or semiriparian washes and canyon bottoms surrounded by woodland. Arizona to Texas and adjacent Mexico southward to Chiapas and Baja California Sur. Dorn (1998) segregated the U.S. and northern Mexico populations as *S. exilifolia* (see Argus 2010, 54).

Grant Co: White Signal, NE ¼ S23, T20S, R15W, sandy draw, infrequent tree to 6 m, 19 Mar 1999, *Carter 2961*. Silver City, intermittent pond area, Cottonwood and Arrowhead Roads, upstream ca. 500 ft, bottom of arroyo, 6000 ft, with *Quercus grisea* etc, 4 May 1997, *Dunne-Brady 65*. Hidalgo Co: Blue Creek 0.3 mi upstream from confluence with Gila River, canyon with intermittent flow, Arizona sycamore, canyon hackberry, *Salix gooddingii*, locally common trees 15–25 ft tall, 6 Nov 2008, *Schultz s.n*.

## SAPINDACEAE—SOAPBERRY FAMILY
(includes Aceraceae)

1. Leaves opposite, simple or with 3–5 leaflets; fruits flattened and winged (samaroid schizocarps, "samaras"). **Acer**
1' Leaves alternate, pinnate with 5–19 leaflets; fruits rounded and leathery (drupes). **Sapindus**

**Acer**—Maple (classical Latin name for maple, from *acer, aceris*, meaning sharp)

Leaves opposite; winter buds with deciduous scales leaving ringlike scars on the twigs. Flowers small, usually unisexual, at least the female flowers and fruits in hanging clusters. Fruits 2-winged, separating at maturity into 2 single-seeded samaras (samaroid schizocarps). Flowering with new leaves in late spring and early summer. Maple syrup is obtained from *A. saccharum* Marshall.

The three New Mexico species are distinctive. Two to four varieties of each species are variously recognized or regarded as synonyms (Allred 2008; Cronquist et al. 1997; Felger et al. 2001; Landrum 1995), but their features are not necessarily distinctive and we do not venture an opinion except to list some as possible synonyms.

1. Leaves simple.
  2. Leaf margins with numerous small, sharply pointed teeth. **A. glabrum**
  2' Leaf margins with few large, blunt teeth. **A. grandidentatum**
1' Leaves compound with 3 or 5 large leaflets.
  3. Stems not glaucous; leaflets sessile, the marginal teeth numerous and sharply pointed. **A. glabrum**
  3' Stems glaucous; leaflets stalked, the marginal teeth few and blunt, mostly on the distal part of the leaflet. **A. negundo**

**Acer glabrum** Torrey [*A. glabrum* var. *neomexicanum* (Greene) Kearney & Peebles] Rocky Mountain maple, dwarf maple (glabrous—smooth, without hairs)

Large shrubs and small trees, sometimes medium-sized trees to ca. 10 m, with multiple stems or trunks. Bark gray and smooth. Leaves and twigs glabrous, the younger stems reddish. Leaves thin, 7–23 cm long, often with 3 large lobes (sometimes with 2 smaller, additional lobes) or with 3 sessile leaflets; leaf or leaflet margins with numerous small teeth. Flowers unisexual, male and female flowers on different or perhaps sometimes the same trees; flowers yellow-green, with small sepals and petals.

Widely scattered, mostly in riparian habitats and on moist slopes in pine and mixed-conifer forests. New Mexico to California to Alaska.

Catron Co: Mogollon Mts, Bursum Camp, 9100 ft, 11 Jun 1964, *Baad s.n*. Grant Co: Signal Peak, 8800 ft, 30 ft tree, 23 Jul 1992, *Zimmerman 3935*.

**Acer grandidentatum** Nuttall [*A. grandidentatum* var. *sinuosum* (Rehder) Little] Bigtooth maple (large toothed)

Small to medium-sized trees. Bark gray, granular to slightly rough, becoming checkered with age. Twigs and leaves finely pubescent when young and on lower leaf surfaces, otherwise glabrate or essentially glabrous. Leaves 6–17 cm long, palmately 3 or 5 lobed; margins of lobes with a few large, blunt teeth. Foliage famously becomes yellow, orange, or pinkish red in fall. Flowers mostly unisexual, yellow-green, without petals; late spring and early summer.

Riparian canyon bottoms and slopes in pine and mixed-conifer forests, mostly 6000–9000 ft. Montana and Idaho to Chihuahua, Coahuila, and Sonora.

Grant Co: Sheep Corral Canyon, 7000 ft, 16 Jul 1992, *Boucher 1014*. Black Range at Emory Pass, 2 Jun 1965, *Campbell s.n*.

**Acer negundo** Linnaeus [*A. negundo* var. *arizonicum* Sargent. *A. negundo* var. *interius* (Britton) Sargent] Box elder (from Sanskrit, *nirgundi*, the name for *Vitex negundo*, and given to *Acer negundo* due to the supposed similarity of the leaves)

Medium-sized trees (a cultivated tree at Fort Bayard measured 18.9 m tall). Bark pale gray-brown, fissured, with age becoming checkered. Twigs and leaves essentially glabrous at maturity. Leaves 12–24 cm long, pinnately compound with 3 or 7 large, stalked leaflets; leaflet margins coarsely toothed. Male and female flowers on different trees, the flowers green, without petals.

Riparian habits across the Gila Region from woodland to mixed-conifer forest, 4300–7500+ ft and common in the Gila River riparian plots. This fast-growing tree has rather weak wood and the branches tend to break in storms. Southern Canada to Guatemala.

Catron Co: Mogollon, 31 May 1966, *Rogers s.n*. Grant Co: 2.5 mi S of Cliff, river bank surrounded by cottonwood trees, 12 Apr 1971, *Hunt 37*. Pinos Altos Road, Cherry Creek Campground, 30 Sep 2006, *Ward 66*. Sierra Co: Hwy 152, 0.5 mi E center Kingston, 17 July 2001, *Moseley 118*.

**Sapindus drummondii** Hooker & Arnott [*S. saponaria* Linnaeus var. *drummondii* (Hooker & Arnott) L.D. Benson] Western soapberry (Latin for soap of the Indies, or Indian soap; for Thomas Drummond, 1780–1835, Scottish botanist)

Slender-stemmed, spindly shrubs to small or sometimes medium-sized trees; commonly propagating by root sprouts to form colonies. Leaves once pinnate with 10–19 leaflets. Flowers unisexual and probably some bisexual, white, 4–5 mm wide, numerous in terminal panicles; in early summer. Fruits single or often 2-lobed, somewhat fleshy and amber colored; poisonous and producing soap when crushed.

Widely scattered trees and colonies; mostly riparian habitats along arroyos, river banks, and stream courses, and also roadsides, canyons, and slopes. Grasslands to conifer forests. It was encountered at only one location in the riparian vegetation surveys (about 3 miles downstream from the Grapevine Campground). An exceptional soapberry tree near a spring on the Ladder Ranch, east of the Black Range, may be more than 15 m tall. Northern Mexico and Arizona to southern Colorado, Kansas, Missouri, and east to Florida, Georgia, and South Carolina.

*Sapindus drummondii* is a temperate-climate, frost-hardy species markedly distinct from the tropical, frost-sensitive *S. saponaria* (Felger et al. 2001).

Grant Co: Gila Bird Habitat, Billings Vista turnoff, 1300 m, 3 Jul 2004, *Kline 19-3-7-04*. Near Cliff, Hwy 180 bridge over Gila River, 1403 m, roadside, 20 Oct 2001, *Hill 70*. 1.6 mi S of Mule Creek Post Office, 5490 ft, tree 7.5 m tall, 45 cm dbh, unusually large trees scattered on open grassy slope with *Quercus emoryi* and a few *Yucca elata*, 27 May 2002, *Ferguson 2619* (ARIZ).

## SIMAROUBACEAE—QUASSIA FAMILY

***Ailanthus altissima** (Miller) Swingle. Ailanthus, tree of heaven (from *ailanto*, an Ambonese word probably meaning "tree of the gods" or "tree of heaven"; the tallest)

Weedy, small to medium-sized trees, fast growing, often forming thickets from rhizomes as well as reproducing by seed. Wood soft, the stems thick with a large pith. Leaves alternate, with an acrid, unpleasant odor, odd-pinnate, the larger leaves often 30–60 cm long; leaflets lanceolate, the larger leaflets 8–15+ cm long; leaflet margins nearly entire except mostly with 1 to few gland-tipped basal teeth. Mostly with male and female flowers on different plants, the flowers in panicles, small and numerous. Fruits of winged samaras, 4–5.5 cm long, produced in prodigious quantities, papery, and wind dispersed.

Abundant along roadsides such as around Silver City, Bayard, Glenwood, and Kingston, and other disturbed habitats including arroyos and canyons. We have not found it established in truly natural habitats in the Gila Region. It is common and reproducing on Boston Hill adjacent to Silver City, an area extensively mined until the mid-20th century, although the vegetation has partially recovered. It was not found in any plots in the riparian surveys.

Native to China, Taiwan, and Korea and now naturalized in many temperate regions of the world. The weedy, naturalized populations are probably var. *altissima*, native to mainland China. Betty Smith's famous novel *A Tree Grows in Brooklyn* refers to this tree. There are two other varieties in the Orient.

Grant Co: Boston Hill, trailside, 3 May 2003, *Bullington 83*. 3 mi N of Hwy 180, Cottage San Road, 6000 ft, 23 Jun 1994, *Villalba 1505*.

## TAMARICACEAE—TAMARISK FAMILY

***Tamarix chinensis** Loureiro [*T. ramosissima* Ledebour] Tamarisk, shrub tamarisk (for the Tamaris River in Spain; of China)

Shrubs or sometimes small trees somewhat resembling a conifer. Bark gray to reddish gray, smooth, becoming dark gray and furrowed on older limbs and trunks. Branchlets winter and drought deciduous. Leaves alternate, sessile, small and scalelike, with salt-excreting glands. (Scale leaves and salt-excreting glands are unique among the Gila Region flowering trees.) Flowers 4-merous, white or pink, 1.5–2 mm long on short stalks, in densely flowered panicles; flowering during the warmer months. Fruits of tiny capsules produced in profusion through the summer with feathery-haired, windborne seeds.

Mostly in lower elevations in the Gila Region, especially in disturbed, riparian habitats and sometimes at roadsides. So far adult plants are not very common in the Gila Region although it is well established and seedlings and young plants are often locally abundant. As of 2008 it was only moderately common along the Gila River and only eight percent of the riparian plots, all below 5500 ft, had tamarisk, and only as scattered individuals (Kindscher 2008).

*Tamarix chinensis* and *T. ramosissima* are genetically and morphologically inseparable in North America and are treated as a single species (Allred 2002; Gaskin and Schaal 2003). It is listed as a federal and state noxious weed. This entity is the only common, naturalized, and widespread invasive shrubby/small tree tamarisk from Canada to northern Mexico. Native to the Old World, it is now widespread, weedy, and invasive in many warm, dry parts of the world. (**Tamarix parviflora* DC., a shrub with pink, 5-merous flowers is occasionally cultivated and rarely feral in or near urban areas.)

Grant Co: Redrock Game Preserve, roadside, 4300 ft, 11 Apr 1974, *Reese s.n*. Birding Area, near Bill Evans Lake, 1362 m, 20 Oct 2001, *Hill 79*. Hwy 152, ca. 1 km W of Acklin Hill, ca. 6365 ft, solitary roadside tree ca. 6+ m tall with a thick trunk, 4 May 2009, *Felger 09-41*.

## ULMACEAE—ELM FAMILY

***Ulmus pumila** Linnaeus. Siberian elm (Latin name for elm; small)



Small to mostly medium-sized trees, or large trees in well-watered areas, with a well-developed trunk, the wood weak and brittle. Bark gray and deeply fissured. Young twigs and leaves moderately pubescent, becoming glabrate or glabrous. Leaves alternate, 4–8.5+ cm long, elliptic to lanceolate, dull green and prominently veined with serrated margins. Flower buds globose, forming in late fall and early winter, the scales purple-brown with long hairs on their margins. Flowers in small clusters on the previous year's leafless branches; flowers ca. 4.5 mm long including the exserted stamens; calyx green and bell-shaped with short lobes; petals none; flowering in early spring before leaf-out, one of the earliest flowering trees in the region. Fruits 11.5–13 mm wide, thin, papery, and wind dispersed, of 1-seeded disk-shaped, winged samaras.

Siberian elms are widely planted, well established, and sometimes locally abundant in disturbed places nearly throughout the region except at the highest elevations. Elms are fairly common along most of the mainstem of the Gila River. They occur in natural areas as scattered few individuals, such as along arroyos and canyons in grasslands, pinyon-juniper woodland, pine forest, and sometimes in mixed conifer forest, often near abandoned home sites and mines. Some seedlings have established at Lake Roberts from the original trees planted for landscape purposes. Solitary, usually young elm trees are occasionally encountered along streamways in isolated and sometimes remote canyons among natural vegetation. Siberian elm was in 7 plots at various elevations in the riparian surveys. Will Siberian elm become a serious invasive species in remote, natural areas of the Gila Region? This elm is widely planted and weedy across much of temperate United States. Native to Central Asia.

Catron Co: Adjacent to dry wash at Bighorn Campground, S23, T11S, R20W, 4800 ft, 24 Apr 2001, *Carter 3177*. Grant Co: Juniper woodland at Pinos Altos, 7040 ft, 25 Apr 1990, *Wilson 89*.

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## Literature Cited

Adams, R. P. 1994. Geographic variation and systematics of monospermous *Juniperus* from the Chihuahuan desert based on RAPDs and terpenes. *Biochemical Systematics and Ecology* 22:699–710.

Allred, K. W. 2002. Identification and taxonomy of *Tamarix* (Tamaricaceae) in New Mexico. *Desert Plants* 18(2): 26–32.

———. 2008. *Flora Neomexicana I: The vascular plants of New Mexico*. Available at http://www.lulu.com

———. 2009. *Flora Neomexicana II: Glossarium nominum;a lexicon of New Mexico names*. Available at http://www.lulu.com

Almaraz-Abarca, N., M. S. González-Elizondo, J. A. Tena-Flores, J. A. Ávila-Reyes, J. Herrera-Corral, and N. Naranjo-Jiménez. 2006. Foliar flavonoids distinguish *Pinus leiophylla* and *Pinus chihuahuana* (Coniferales: Pinaceae). *Proceedings of the Biological Society of Washington* 119:426–36.

Argus, G. W. 2010. *Salix*. In *Flora of North America*, vol. 7: Magnoliophyta, Salicaceae to Brassicaceae, ed. Flora of North America Editorial Committee, 23–162. New York: Oxford University Press.

Bolli, R. 1994. Revision of the genus *Sambucus*. *Dissertationes Botanicae* 223:1–227.

Breshears, D. D., N. S. Cobb, P. M. Rich, K. P. Price, C. D. Allen, R. G. Balice, W. H. Romme, et al. 2005. Regional vegetation die-off in response to global-change-type drought. *Proceedings of the National Academy of Sciences of the United States of America* 102:15144–48.

Brown, D. E., ed. 1982. Biotic communities of the American Southwest—United States and Mexico. *Desert Plants* 4(1–4): 1–315.

Carter, J. L. 1997. *Trees and shrubs of New Mexico*. Silver City: Mimbres Publishing.

Cole, K. L., J. Fisher, S. T. Arundel, J. Cannella, and S. Swift. 2007. Geographical and climatic limits of needle types of one- and two-needled pinyon pines. *Journal of Biogeography* DOI: 10.1111/j.1365–2699.2007.01786.x

Columbus, J. T. 1988. *Flora of Cooke's Range, southwestern New Mexico*. Master's thesis, New Mexico State University.

Cronquist, A., N. H. Holmgren, and P. K. Holmgren. 1997. *Intermountain flora*, vol. 3, part A. New York: New York Botanical Garden.

Dorn, R. D. 1998. A taxonomic study of *Salix* section *Longifoliae* (Salicaceae). *Brittonia* 50:193–210.

———. 2002. Plant distribution reports (*Salix bonplandiana laevigata*, *S. fragilis*). *The New Mexico Botanist* 22:7.

Earle, C. J. 2010. Gymnosperm database. http://www.conifers.org (accessed April 10, 2010).

Eckenwalder, J. E. 1992. Salicaceae, willow family, part one, *Populus*, vascular plants of Arizona. *Journal of the Arizona-Nevada Academy of Science* 26:29–33.

———. 2010. *Populus*. In *Flora of North America*, vol. 7: Magnoliophyta, Salicaceae to Brassicaceae, ed. Flora of North America Editorial Committee, 5–22. New York: Oxford University Press.

Eriksson, T., and M. J. Donoghue. 1997. Phylogenetic analyses of *Sambucus* and *Adoxa* (Adoxoideae, Adoxaceae) based on nuclear ribosomal ITS sequences and preliminary morphological data. *Systematic Botany* 22:555–73.

Farjon, A., and B. T. Styles. 1997. *Pinus* (Pinaceae). *Flora Neotropica Monograph* 75. New York: New York Botanical Garden.

Felger, R. S., M. B. Johnson, and M. F. Wilson. 2001. *Trees of Sonora, Mexico*. New York: Oxford University Press.

Felger, R. S., and T. R. Van Devender. Forthcoming. A Chronoflora flora of Tinajas Altas, Arizona: A century of botanical forays and forty thousand years of *Neotoma* chronicles. *Proceedings of the San Diego Society of Natural History.*

Ferguson, G. M., R. S. Felger, and M. B. Johnson. 2001. Conifers. In *Trees of Sonora, Mexico,* Felger et al., 35–58. New York: Oxford University Press.

Floyd, M. E. 1983. Dioecy in five *Pinus edulis* populations in the southwestern United States. *American Midland Naturalist* 110:405–11.

Gaskin, J. F., and B. A. Schaal. 2003. Molecular phylogenic investigation of U.S. invasive *Tamarix*. *Systematic Botany* 28:86–95.

Gernanadt, D. S., S. Hernández-León, E. Salgado-Hernández, and J. A. Pérez de la Rosa. 2009. Phylogenetic relationships of *Pinus* subsection *Ponderosae* inferred from rapidly evolving cpDNA regions. *Systematic Botany* 34:481–91.

Henrickson, J. 1985. A taxonomic revision of *Chilopsis* (Bignoniaceae). *Aliso* 11:179–97.

Hunt, R. S. 1993. *Abies*. In *Flora of North America*, vol. 2: Pteridophytes and Gymnosperms, ed. Flora of North America Editorial Committee, 354–362. New York: Oxford University Press.

Kindscher, K., R. Jennings, W. Norris, and R. Shook. 2008. Birds, reptiles, amphibians, vascular plants, and habitat in the Gila River Riparian Zone in southwestern New Mexico. *Kansas Biological Survey Open-File Report* No. 151, Lawrence, Kansas.

Kleinman, R. 2009. Vascular plants of the Gila Wilderness. http://www.gilaflora.com (accessed May 1, 2009).

Kral, R. 1993. *Pinus*. In *Flora of North America*, vol. 2: Pteridophytes and Gymnosperms, ed. Flora of North America Editorial Committee, 373–398. New York: Oxford University Press.

Landrum, L. R. 1994. Fagaceae, oak family [vascular plants of Arizona]. *Journal of the Arizona-Nevada Academy of Sciences* 29:2–5.

———. 1995. Aceraceae, maple family [vascular plants of Arizona]. *Journal of the Arizona-Nevada Academy of Sciences* 27:203–14.

McHugh, C. W., T. E. Kolb, and J. L. Wilson. 2003. Bark beetle attacks on ponderosa pine following fire in northern Arizona. *Environmental Entomology* 32:510–22.

Nesom, G. L. 2009. Taxonomy of *Forestiera pubescens* and *Forestiera neomexicana* (Oleaceae). *Lundellia* 12:8–14.

———. 2010. Geography of unifoliolate taxa of *Fraxinus* (Oleaceae). *Phytoneuron* 2010-17:1–6.

New Mexico Biodiversity Collection Consortium. http://nmbiodiversity.org (accessed May 3, 2009).

Nixon, K. C., and C. H. Muller. 1997. *Quercus* Linnaeus sect. *Quercus*. In *Flora of North America*, vol. 3: Magnoliophyta, Magnoliidae and Hamamelidae, ed. Flora of North America Editorial Committee, 471–506. New York: Oxford University Press.

Perry, J. P. 1991. *The pines of Mexico and Central America*. Portland: Timber Press.

Regal, P. J. 1982. Pollination by wind and animals: ecology of geographic patterns. *Annual Revue of Ecology and Systematics* 13:497–524.

Southwest Environmental Information Network (SEINET). 2009. Southwest Biodiversity Consortium, http://swbiodiversity.org/seinet/index.php

Spellenberg, R. W. 2001. Oaks of La Frontera. In *Changing plant life of La Frontera: Observations on vegetation in the U.S./Mexico borderlands,* ed. G. L. Webster and C. J. Bahre, 176–86. Albuquerque: University of New Mexico Press.

Stevens, P. F. 2008 onwards. Angiosperm phylogeny website. Version 9, June 2008 (and more or less continuously updated since), http://www.mobot.org/MOBOT/research/APweb/. (Accessed April 10, 2010).

USDA Forest Service. n.d. Fort Bayard Big Juniper Tree Trail—#103. http://fs.usda.gov/wps/portal/fsinternet/!ut/p/c4/04_SB8K8xLLM9MSSzPy8xBz9CP0os3gDfxMDT8MwRydLA1cj72BTJw8jAwjQL8h2VAQAzHJMsQ!!/?ss=110306&navtype=BROWSEBYSUBJECT&cid=null&navid=110290000000000&pnavid=110000000000000&position=BROWSEBYSUBJECT&recid=2016&actid=24&ttype=recarea&pname=Gila%20National%20Forest%20-%20Fort%20Bayard%20Big%20Juniper%20Tree%20Trail%20 (accessed December 6, 2009).

USDA, NRCS. 2009. The PLANTS Database (http://plants.usda.gov, December 4, 2009). Baton Rouge: National Plant Data Center.

Williams, J. K., and G. L. Nesom. Forthcoming. The status of *Fraxinus papillosa* (Oleaceae): SEM study of epidermal features. *Lundellia* 13.

Zavarin, E., K. Snajberk, and L. Cool. 1990. Chemical differentiation in relation to the morphology of the single-needle pinyons. *Biochemical Systematics and Ecology* 18:125–37.



# Mammals of the Upper Gila River Watershed, Arizona and New Mexico: Patterns of Diversity and Species of Concern

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## Abstract

The mammal fauna of the upper Gila River region is exceptionally diverse. I documented 107 species of non-human mammals in the region. Rodents constituted almost half the species while bats and carnivores made up an additional 38%. Most species exhibited habitat specialization, with 42% of species using only one or two biotic communities. Most species that used only one biotic community were associated with riparian habitats. The current fauna included only one well-established exotic species, the house mouse (*Mus musculus*), although there are isolated reports of feral goats (*Capra hircus*) and feral pigs (*Sus scrofa*), and others are possible. Ten species of native mammals were extirpated from the region. I identified species at risk of population loss in the study area as those that were determined to be rare and facing potential threats. Species were classified into eight rarity classes and four rarity ranks. Only 8% of the fauna was in the most common category, while 16% of the fauna was in the most rare category. The high proportion of rare species in the Gila mammal fauna likely is a function of the disjunct distribution of biotic communities and a high degree of habitat specialization within the fauna. More than half of species were facing potential threats, and species in the rarest ranks also had a higher incidence of threats. In total, 50% of the mammal fauna was found to be at risk of population loss in the region. Although at-risk species were identified in each order of mammals, rodents made up half the at-risk species. Species at risk were more likely to be associated with higher-elevation biotic communities, particularly subalpine conifer forest. General conservation and management efforts in the upper Gila region may be most successful in maintaining mammal diversity by focusing on riparian and high-elevation conifer forest habitats. However, management to maintain or enhance diversity will be challenging because specific species, habitats, and geographic areas are likely to require independent considerations. Formal conservation lists that guide management do not fully reflect the scope of species' risk of population loss in this region. The methods developed in this paper provide a quantitative approach for developing formal conservation lists, such as Species of Greatest Conservation Need in state wildlife conservation plans.

The process of extinction is fundamentally a biological phenomenon that is inherent to a species' natural history and its context in the world, which includes its environmental associations and relationships with humans and other species. Thus, a species' risk of extinction is largely a function of the species' rarity and the threats it is facing (Kunin and Gaston 1997). In order to most accurately protect and enhance biological diversity, formal lists of species of conservation priority should be compiled based on a species' actual risk of extinction or extirpation in a region of interest. However, many formal lists of species requiring conservation actions likely are influenced by nonbiological factors, such as political expediency, economics, and human social choice. For example, grizzly bears (*Ursus arctos horribilis*) are a federally threatened species that historically occurred throughout most of the American Southwest and yet there are no formal plans for the restoration of this species in this region.

Because formal conservation lists may not accurately portray actual conservation needs, agencies and land managers wishing to manage resources to maintain or enhance biodiversity can be crippled by a lack of complete and reliable information needed to direct management actions. This may be particularly true for groups of organisms, such as nongame mammals, that lack well-organized conservation planning efforts by nongovernmental conservation organizations such as the Partners in Flight Land Bird Plan. Further, for groups such as mammals, synthesis of conservation-relevant information can be hampered because there are scant published natural history data and there are very few biologists with firsthand expertise on the vast majority of species. Consequently, the purpose of this study was to provide an assessment of mammal diversity in the upper Gila River watershed region and to evaluate each species' propensity for population loss in the region using objective methods.

## Methods

***Study area.*** The study area, hereafter referred to as the upper Gila region, included the upper Gila River watershed downstream through the confluence of the San Francisco River and the Mimbres River watershed downstream to Luna County. It also included adjacent areas that share strong biogeographic connections including mountain slopes in contiguous watersheds. The area included portions of Catron, Sierra, Grant, and Hidalgo counties in New Mexico and portions of Apache and Greenlee counties in Arizona. The vast majority of the study area was contained within the Gila and Apache national forests. Most of this region is characterized by a rugged and mountainous topography. The lowest elevation is 1,008 m