

Sonoran Riparian Deciduous Forest and Woodlands

Centered in the Sonoran biotic province are streamside associations of tropic-subtropical subspecies of willow (*Salix gooddingii* var. *variabilis*), cottonwood or alamo (*Populus fremontii* var. *macdougalii*), *P. dimorpha*, and/or Velvet Mesquite (*Prosopis velutina*). Winter deciduous, these biomes are nonetheless subtropical riparian where they are restricted to streams and springs below 1,100 to 1,200 m elevation in and immediately adjacent to, the Sonoran Desert. While now much reduced in extent, these forests are still represented by impressive examples and may contain individual trees of great size (Fig. 180).

Willow and cottonwood forests were, and remain, largely restricted to the immediate flood plains of perennial, or at least spring-flowing streams, where they are maintained by periodic winter-spring flooding (Fig. 181). As such, southwestern tropic-subtropical examples are largely restricted to the lower Colorado River and Arizona Upland subdivisions of the Sonoran Desert, which possess watersheds of sufficient winter precipitation and hence the spring discharges necessary to support them. Mesquite "bosques" (Spanish for woodlands) attain their maximum development on alluvium of old dissected flood plains, especially those laid down at the confluence of major watercourses and their larger tributaries (Fig. 182).¹ Consequently, these higher "secondary" flood plains are commonly 1.5 to 6.0 m above the river channel.

Many of the more famous bosques referred to in the literature are today mostly of historical interest—e.g., the mesquite forests at San Xavier, Komatke (New York Thicket), and the mesquite and cottonwood forests along the lower Gila and Colorado rivers. Nonetheless, some excellent examples still occur as scattered remnants along the Santa Maria, Verde, middle Gila, San Pedro, San Miguel, Magdalena, Sonora, and other "desert" river systems. These remaining bosques are, however, all threatened by a variety of human-related causes,—clearing for agriculture and pasture, water diversion, flood control and water storage projects, cutting of trees for fuel, and most importantly, the lowering of groundwater tables. Because mesquite cannot reach groundwater much below 14 m, this last factor has been responsible for the almost total ruin of mesquite forests at San Xavier, Casa Grande Ruins National Monument, Komatke, and elsewhere in Arizona where live streams no longer persist as a result of groundwater pumping. Conversion to agriculture continues to greatly reduce the once extensive bosques along the lowermost Colorado, San Pedro, and Gila rivers. While several thousands of acres of mesquite woodlands have been withdrawn for purposes of preservation, high demands for fuel wood and groundwater threaten all remaining bosques both north and south of the U.S. and Mexican border.

With some notable exceptions, willow-cottonwood forests have been reduced to isolated groves and are now scattered along the Colorado River where they once were extensive (see

¹Although mesquite bosques have been described as occurring in riparian situations within the Mohave and Chihuahuan deserts (e.g. Wauer, 1973), the tall (to over 15 m) tree-forming Velvet Mesquite is lacking in these biomes, mesquite being represented here by the shorter-statured and multi-trunked Western Honey Mesquite (*P. glandulosa* var. *torreyana*), Screwbean (*P. pubescens*) or Texas Honey Mesquite (*P. glandulosa* var. *glandulosa*). Moreover many of the subtropical plants and animal associates of the bosques are lacking in these warm temperate scrublands. Both Fremont Cottonwood and Goodding Willow also occur in warm temperate biomes; again, however, different plants and animal associates are to be expected.

e.g. Ohmart et al., 1977] (Fig. 183). In many places, such areas now are vegetated by *Sonoran riparian scrubland*. Often, the remaining groves are open woodlands of over-mature individuals that are lacking in reproduction and may be expected soon to disappear because of stream regulation. Gallery forest of willow and cottonwood can nonetheless still be found along reaches of undammed and more "natural" portions of the Verde River, middle Gila River, the Hassayampa River below Wickenburg, Arizona, the San Pedro River, and the Río Bavispe and Río Yaqui, all flood-prone ecosystems where Goodding Willow frequently outnumbers cottonwood 100 to 1. Understories may be a tangle of young trees, especially mesquite, or be relatively open.

Historically, annual and perennial grasses (e.g., Vine-mesquite Grass, *Panicum obtusum*), forbs (e.g., Careless Weed, *Amaranthus palmeri*), and in more saline areas, saltbushes (*Atriplex polycarpa*, *A. lentiformis*, *Suaeda torreyana*) constituted the understory in mature bosques. The interior of mesquite bosques was typically open and park-like. Old, fire-scarred trees predominated. Today, because of grazing and other disturbances, a number of introduced forbs and grasses such as Filaree (*Erodium cicutarium*), mustards (Cruciferae), including Yellow Rocket (*Sisymbrium irio*), Red Brome (*Bromus rubens*), and in more open places, Schismus (*Schismus barbatus*) and Bermuda Grass, are frequently encountered understory species. Vines are the climbing milkweeds (*Sarcostemma* spp.), gourds (*Cucurbita* spp.), and Canyon Grape are often common and conspicuous constituents where grazing has not been too severe. Hackberry or Cumero (*Celtis reticulata*), Mexican Elder (*Sambucus mexicana*), and Screw-bean Mesquite may be important arboreal associates, at least locally. At higher elevations (760 to 1,100 m), an individual Velvet Ash (*Fraxinus pennsylvanica* var. *velutina*) or other temperate species, e.g., sycamore, may occupy a particular site, and Blue Paloverde, Catclaw, and Ironwood (*Olneya tesota*) can be common in more arid locations. Graythorn (*Zizyphus obtusifolia*) or one or more of the allthorns (*Lycium fremontii*, *L. andersonii*, *L. berlandieri*) frequently occupy an occasional opening or sunny place along with young mesquites.

The continued clearing of riparian communities along the lower Gila and Colorado Rivers (and in other areas) has resulted in type conversions other than to farmland. It has been noted that where intermittent flooding occurs during the long Southwestern growing season, Saltcedar or Tamarisk (*Tamarix chinensis*) tends to replace mesquite and other native riparian vegetation (Horton, 1977). This tendency is particularly prevalent in saline areas after the native woodlands have been cleared or burned and the water table is at or near the surface. Saltcedar duff is highly flammable and fire initiates a cycle to a disclimax scrub populated only by Saltcedar. Whether this replacement is partially dependent on changes in water and soil chemistry, or entirely a result of the inherent ability of Saltcedar to rapidly repopulate floodplains, is imperfectly known (Everitt, 1980), but the aggressive ability of Saltcedar to displace native riparian species has been well demonstrated by Horton et al. (1960), Turner (1974c), and Warren and Turner (1975). It suffices to say that Saltcedar continues to replace willows, cottonwoods and Mesquite in those bosques where these trees are destroyed, spring floods are controlled, and a saline water table is at or near the surface.

Nesting use of these riparian communities by colonies of White-winged Dove (*Zenaida asiatica*) and Mourning Dove (*Zenaida macroura*) is well documented (Neff, 1940; Arnold, 1943; Wigal, 1973; Brown, 1977). Their importance to other avian species as Lucy's Warbler, Vermilion Flycatcher (*Pyrocephalus rubinus*), Abert's Towhee (*Pipilo aberti*), Cardinal (*Cardinalis cardinalis*), Pyrrhuloxia (*Cardinalis sinuatus*), Phainopepla, Varied Bunting (*Passerina versicolor*) and others has been discussed by Brandt (1951), Phillips et al. (1964) and more recently by Hubbard (1977b), Anderson et al. (1977), and Clark (1979). Cottonwood-willow forests where they still occur, determine the northern nesting distribution of a number of Neotropical raptors, such as the Gray Hawk (*Buteo nitidus*), in addition to a number of other tropic-subtropical species e.g., Rose-throated Becard and Thick-billed Kingbird (*Tyrannus crassirostris*); these trees also provide nesting sites for the southernmost Bald Eagles. Other localized nesting species are the Yellow-billed Cuckoo, Great Blue Heron, and Mississippi Kite.

Although the few mammals here are not distinctive, numerous bats are characteristic of streambanks in this region. The Silver-haired Bat (*Lasiurus noctivagus*) and Big Brown Bat (*Eptesicus fuscus*) often roost in trees such as cottonwood. The Desert Pocket Mouse often occupies mesquite bosques as a result of its preference for deep, sandy, rock-free soils (Porter, 1962). Beaver crop cottonwood-willow communities heavily when abundant, and the Raccoon is locally common. It is hypothesized that the former limited occurrence and incursions of Jaguar (*Felis onca*) into Arizona were largely through these subtropical riparian woodlands.

Several other species of tree-requiring vertebrates, such as the Sonoran Spiny Lizard (*Sceloporus clarki*) and Tree Lizard are well represented in riparian woodlands, although not centered there. Open places support whiptail lizards, and some all-female "species" of that complex extend far into deserts along permanent streams. Streamside amphibians other than frogs of the *Rana pipiens* complex, which are common, include the unusual Colorado River Toad (*Bufo alvarius*), a large species that is the scourge of smaller animals in mesquite bosques on rainy summer nights.

The original fish community of the lowermost Colorado and Gila River mainstems was small, consisting of four minnows, two suckers, two or three marine species, a cyprinodontid and a poeciliid. Of these, Woundfin (*Plagopterus argentissimus*), Roundtail Chub, and Flannelmouth Sucker (*Catostomus latipinnis*) were rare, being recorded only a few times in the reach from the present Hoover Dam to the Colorado Delta. The marine Machete (*Elops affinis*) and Striped Mullet (*Mugil cephalus*), and the Desert Pupfish and Sonoran Topminnow (*Poeciliopsis occidentalis*) were only in the lowermost parts of the two rivers (the last only in the Gila). Both of the last species must have inhabited only margins and backwaters. This left a unique assemblage of riverine fishes, consisting only of Colorado Squawfish (*Ptychocheilus lucius*), Razorback Sucker (*Xyrauchen texanus*) and Bonytail Chub (*Gila elegans*), in the main channel of the largest river of the American Southwest.

Backwater sloughs and marshes along the rivers also are known to have been used by Squawfish and Razorback, both of which moved as adults from the channel into such ancillary habitats (Miller, 1961; Minckley, 1965; Seethaler, 1978). Such places also provided refuge areas for protection,



Figure 180. Sonoran riparian deciduous forest of Fremont Cottonwood (*Populus fremontii* var. *macdougalii*) and Goodding Willow (*Salix gooddingii* var. *variabilis*) with Common Reed (*Phragmites australis*) and Saltcedar (*Tamarix chinensis*) at the immediate water's edge. Once extensive, these forests have been reduced to "island" remnants as this one on the Colorado River 20 km west of Yuma, Yuma County, Arizona. Elevation ca. 40 m.



Figure 181. Sonoran riparian deciduous forest of *Populus dimorpha*, *Salix gooddingii*, *Celtis reticulata*, and *Prosopis velutina* along the Rio Yaqui near Highway 15, Sonora, Mexico.

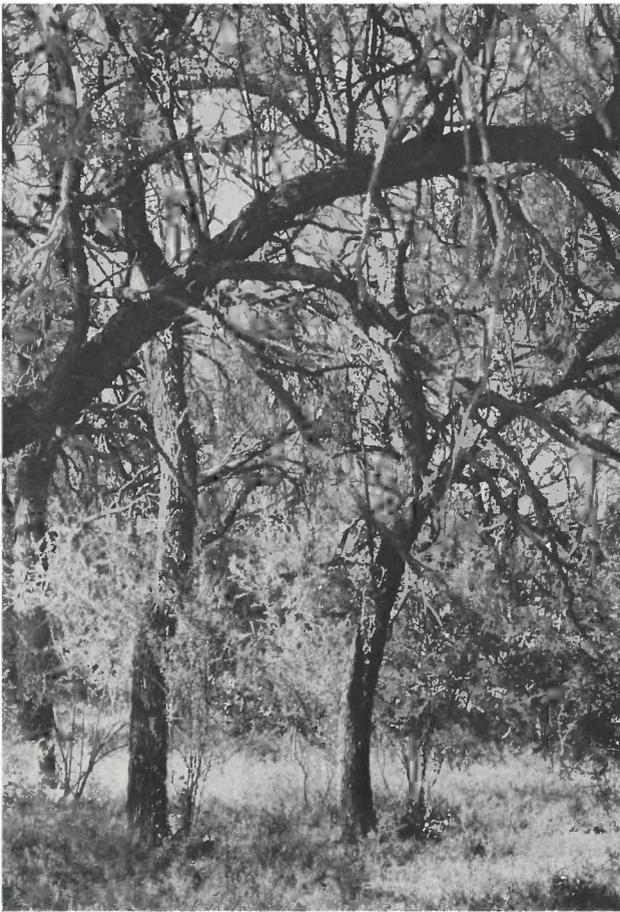


Figure 182. Sonoran riparian deciduous woodland (interior view) – a Mesquite (*Prosopis velutina*) bosque along the San Pedro River near Redington, Pima County, Arizona. Such examples of these magnificent woodlands are becoming rare with declining water tables and increasing demands for cooking and heating fuel. The recent absence of fire is indicated by the abundant presence of young Mesquite. Elevation 900 m.

feeding, and growth by young of these fishes, if such were required, and adults of these and Bonytail Chub used such areas to avoid floods (Minckley, 1973). All evidence indicates a great abundance of Colorado Squawfish and Razorback Sucker, and that Bonytail were common and widespread (Minckley, 1973, 1979). These fishes are now almost gone from the area, or in the case of the sucker and Bonytail persist as large adults in reservoirs, with little evidence of successful reproduction.

Minor backwaters, shallows, and shoals over sandbars once available for young native fishes now are occupied by a myriad of introduced predators. Where young squawfish, suckers, or chubs once might have been preyed upon only by water birds such as Great Blue Heron, a host of young Large- and Smallmouth Bass (*Micropterus salmoides*, *M. dolomieu*), lesser sunfishes (e.g., *Chaenobryttus gulosus*, *Lepomis cyanellus*, *L. macrochirus* and *L. microlophus*), cichlids (*Tilapia zilli*, *T. mossambicus*, *T. aureum*), and the voracious Mosquitofish (Meyers, 1965) now occur. The channel and deeper back-

waters are occupied by adults of these species, plus large and specialized predators such as Flathead Catfish (*Pylodictis olivaris*) and Striped Bass (*Morone saxatilis*). Additional fishes, although perhaps not capable of predation on native forms, certainly increase competitive interactions. Threadfin Shad (*Dorosoma petenense*) feed on plankton and detrital materials, and a bit on benthic invertebrates. Red Shiner (*Notropis lutrensis*) swarms in currents, feeding on drifting and surface materials. Exotic mollies (*Poecilia latipinna* and *P. mexicana*) eat detrital materials and algae. These pressures, accompanied by dewatering of the lower Gila River, channelization which reduced the shallow, quiet backwaters within the strand zone, dredging, and construction of reservoirs and other stabilizing features which enhanced the predominantly lentic-adapted introduced fishes, all have contributed to extinction of this remarkable component of the Southwest's aquatic communities.

Filling of the Salton Sea (Pluvial Lake Cahuilla or LeConte) in 1905-07 by flood flows of the Colorado River, after it broke through frontworks of irrigation channels and was diverted from its normal distributaries to the Gulf of California, created an artificial condition worthy of our treatment.¹ Initially (Evermann, 1916), native fishes from the Colorado River, Bonytail Chub (*Gila elegans*), Razorback Sucker (*Xyrauchen texanus*), Striped Mullet (*Mugil cephalus*), a few trout (*Salmo clarki*), and the introduced Carp were present. Desert Pupfish (*Cyprinodon macularius*) may have entered from the river, or may have spread from springs in the basin that were inundated by rising waters. Machete (*Elops affinis*) appeared later (Dill and Woodhull, 1942).

Evaporative concentration of the Salton Sea gradually increased salinity to exceed seawater (> 35 g/l) in 1945 (Carpelan, 1961), perhaps accelerated by diversion of saline irrigation return waters to the basin. Freshwater fishes disappeared prior to the 1950s, with the exception of Pupfish; marine fishes also failed to reproduce and began to disappear. From 1929 through the late 1940s, numerous invertebrates and fishes were introduced in an attempt to create an inland marine fishery, but by 1949, only pupfish, Mosquitofish, a few Striped Mullet and Longjaw Mudsucker (*Gillichthys mirabilis*) remained. After 1950, introductions of Sargo (*Anisotremus davidsoni*), Bairdiella (*Bairdiella icistius*), and predatory Orangemouth Corvina (*Cynoscion xanthalmus*) spawned successfully (Walker et al., 1961). This fishery persists today, but introductions of numerous salt-tolerant freshwater fishes such as Red Shiner, African cichlids (*Tilapia mossambicus*, *T. zilli* and others), and a myriad of Central American poeciliids (*Poecilia latipinna*, *P. mexicana*, *Poeciliopsis gracilis*, *Xiphophorus variatus*, *X. helleri*) is now endangering the native

¹This situation obviously happened before, since Wilke (1980) has demonstrated that a Neolithic fishing culture existed on the shores of the Cahuilla Basin ca. 1,500 years before present. Rock wiers were constructed annually along shorelines to intercept aggregations of Razorback Sucker and Bonytail Chub, both of which were recovered from middens in the area. Wiers were progressively constructed downslope, at a rate commensurate with projected annual evaporative decline in water levels, and the fishery collapsed in about 55-60 years, at a time when salinities would likely have resulted in decreased populations of freshwater fishes.



Figure 183. Riparian deciduous forest of cottonwood (*Populus fremontii* var. *macedougali*) along the Colorado River near Yuma, Yuma County, Arizona, near the turn of this century. The river and its magnificent riparian ecosystem are still "untamed" as construction of the Imperial Canal is underway. Elevation ca. 100 m. Photograph courtesy of the U.S. Bureau of Reclamation and Robert D. Ohmart.

pupfish (Schoenherr, 1979) and the valuable game fishes as well.

The few, smaller streams of lowlands draining into the Gila River once supported a simple community of Longfin Dace, Sonoran Topminnow, and occasionally Desert Pupfish. Pupfish populations now are extinct throughout the vast basin, and are approaching extinction in the Río Sonoyta in northern Sonora as a result of pumping along that stream; a remnant is protected at Organ Pipe Cactus National Monument in Quitobaquito Spring. The Sonoran Topminnow has been destroyed in the Gila River basin except for a few populations in springs, isolated stream segments, or artificial refugia (Minckley et al., 1977); however, as noted above, it remains abundant in the Río Yaqui and lesser drainages of northwest Sonora.

Coastal rivers between the Colorado and Río Yaqui generally enter sands at their lower reaches before entering the sea; their fauna is thus restricted to middle and highland portions. Longfin Dace is the only species that has succeeded in occupying all these desert rivers, from the Río Sonora to the Río Sonoyta; Sonoran Topminnow is found in all but the latter stream. The Yaqui Chub (*Gila purpurea*) occurs in the ríos Matape and Sonora along with Mexican Stoneroller. The Opata Sucker (*Catostomus wigginsi*) is restricted to Río Sonora and Sonora Chub (*Gila ditaenia*) holds forth in the Río Concepción. Desert Pupfish is shared by Río Sonoyta and the lower Colorado-Gila rivers, reflecting in its presence the intimate relationships of the first stream to the Colorado River delta prior to its diversion south by the Pinacate lava flows (Hubbs and Miller, 1948).