

Chapter 11. Terrestrial Vertebrates of Mesquite Bosques in Southwestern North America

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Introduction

The major emphasis of this chapter is to address the species richness and population densities of land vertebrates in riparian mesquite bosques (woodlands). We find no single publication that lists vertebrates—amphibians, reptiles, birds, and mammals—of riparian mesquites of the Southwest lowlands. These vertebrates are listed for a few river valleys, such as the Santa Cruz River (Webb et al. 2014) and San Pedro River (Stromberg and Tellman 2009), but not for the Southwest as a whole. This chapter presents a summary of the vertebrate fauna of mesquite bosques. Our lists of vertebrates of bosques and/or associated cottonwood-willow forests and riparian deciduous woodlands have been constructed from literature, historic records and specimens, and our first-hand knowledge.

Mesquite Bottomlands as Wildlife Habitat

A large number of the vertebrate species occurring as obligate and facultative riparian species in cottonwood-willow gallery forests also occur in mesquite bosques. These species inhabit riparian mesquites not only along streams but also along dry watercourses (tables 12–15). An amphibian or reptile species may often occur in cottonwood-willow or mixed deciduous forests, in mesquite bosques, or in upland ecosystems. A mammal species—except larger mammals and bats—may also often occur in one of these three watershed zones. Although an avian species may use one of those three zones, several species occur in all three zones. Some birds, especially larger species, roost and nest at distances from riparian ecosystems but spend parts of the day flying over and/or foraging in bosques and adjacent zones.

Some vertebrates are so ubiquitous in bosques that two of them are often called the “mesquite warbler” (Lucy’s Warbler; Gilman 1909; Johnson et al. 1997) and “mesquite mouse” (Merriam’s mouse; Hoffmeister 1986; IUCN 2015; see tables for scientific names). Several tropical species whose ranges extend no farther north than the extreme southwestern United States are now relatively rare in this region, having experienced drastic reductions in their U.S. populations, paralleling the losses of most mesquite bosques. Notable are the ferruginous pygmy-owl (Johnson et al. 2003; Phillips et al. 1964), gray hawk (Bibles et al. 2002; Glinski 1998), and brown vinesnake (Stebbins 1985). Although the species we list (tables 10 to 13) are mainly associated with perennial and larger intermittent streams, some species also maintain populations within xeroriparian ecosystems associated with desert washes.

Birds of mesquite bosques and xeroriparian ecosystems are the best studied of vertebrates. Recent surveys of Sonoran and Chihuahuan desert ecosystems have compared breeding birds of xeroriparian ecosystems along desert washes—most of them lined

with mesquites—with the surrounding uplands. Numbers of species and/or numbers of individual birds of these xeroriparian ecosystems are commonly 10 times or more compared to those of the surrounding uplands (Johnson and Haight 1985, 1988). Some of the larger drainages, such as Aguajita, Growler, and Vekol washes in southern Arizona, have small bosques with large mesquite trees that support nesting by numerous species of smaller birds and even larger birds, such as Cooper's hawks, red-tailed hawks, and great horned owls (Groschupf et al. 1988) and rare species such as the ferruginous pygmy-owl (Johnson et al. 2003). This small tropical owl was first discovered for the United States in a mesquite bosque along the Rillito River in 1872 by Major Charles Bendire (Bendire 1892; Proudfoot and Johnson 2000). In addition, large mammals often rely on xeroriparian habitat along these washes for food, shelter, and movement corridors, including species such as mule deer (Krausman et al. 1985), javelina, and coyotes (R.R. Johnson, numerous observations, Tucson, Arizona, during several decades).

Of particular interest is a group of amphibians in Vekol Valley in southwestern Arizona, just north of the United States-Mexico international boundary. The arid Vekol Valley is populated by three amphibian species that occur no farther north than southwestern Arizona—Sonoran green toad, lowland burrowing treefrog, and Sinaloa narrow-mouthed toad (Enderson and Bezy 2007; R. Babb, Biologist, Arizona Game and Fish Department, personal communication). These three tropical amphibians are among species that occur in mesquite grasslands of this region (Stebbins 1985). The vegetation of Vekol Valley is largely Sonoran desertscrub (Brown 1982) but has remains of more extensive semidesert grasslands that existed prior to heavy grazing by cattle. The valley is also transected by the large, mesquite-lined Vekol Wash that contains numerous earthen cattle tanks. Amphibians are generally considered inhabitants of at least moist conditions, often perennial water, but these three, as well as several other species, have adapted to more arid conditions. Like several other species of frogs and toads, these three amphibians aestivate during drier and colder parts of the year, emerging during summer rains to breed and lay eggs in resulting pools of water.

The Mesquite-Invertebrate-Vertebrate Foodweb

It is not surprising to find that avian and mammalian faunas of a region show a preference for mesquites and other riparian habitats because of access to food, shelter, and for some—water—associated with riparian ecosystems (see tables 13, 14, and 15). Most insects are herbivorous; thus insect populations are elevated in the increased vegetation in riparian ecosystems, compared to upland ecosystems of the Southwest lowlands. More than 700 species of insects associated with mesquites in the new world were reported by Ward et al. (1977). This is reflected in the large percentage of insectivorous riparian birds found in mesquite bosques and cottonwood-willow riparian forests (tables 11 and 12).

Lizards are also largely insectivorous (Jones and Lovich 2009; Stebbins 1985) and snakes that prey on lizards and mammals (Stebbins 1985) also occur along with their prey in riparian ecosystems. Some snakes, such as gartersnakes, are aquatic or semi-aquatic and often inhabit hydrioriparian or mesoriparian ecosystems along perennial or intermittent streams, feeding on frogs, toads, tadpoles, and other aquatic organisms (Stebbins 1985). Amphibians also commonly occur in riparian habitats

Table 12—Amphibians and reptiles (herpetofauna) occurring in lowland riparian ecosystems of the Southwest.^a

Common name	Scientific name	Santa Cruz ^b R. near Tucson	San Pedro R. ^c	LR ^d	MB ^e	CW ^f	ME ^g	MR ^h	SD ⁱ
Sonoran tiger salamander ^j	<i>Ambystoma mavortium stebbinsi</i>		X	L,S					
Couch's spadefoot [toad]	<i>Scaphiopus couchii</i>	A	X			X	X	X	X
New Mexico (Chihuahuan Desert) spadefoot [toad]	<i>Spea [Scaphiopus] multiplicata</i>	X	X						
Sonoran Desert (Colorado River) toad	<i>Ollotis alvaria</i>	A	X			X	X	X	X
Southwestern Woodhouse's toad	<i>Anaxyrus woodhousei australis</i>	A	X			X	X	X	X
Southwestern toad	<i>A. microscaphus</i>				X	X	X		
Red-spotted toad	<i>A. punctatus</i>	X	X		X	X	X	X	X
Great Plains toad	<i>A. cognatus</i>	X	X				X		
Green toad	<i>A. debilis</i>		X				X		
Texas toad	<i>A. speciosus</i>			B&B					
Sonoran green toad	<i>A. retiformis</i>			E&B					
Canyon treefrog	<i>Hyla arenicolor</i>		X		X			X	X
Lowland burrowing treefrog	<i>Smylisca fodiens</i>			E&B					
Tarahumara frog	<i>Lithobates [Rana] tarahumarae</i>			L, Ex					
Lowland leopard frog ^k	<i>L. yavapaiensis</i>	A, Ex ^l	X						
??Leopard frog?? ^m	<i>L.?? pipiens??</i>		?		X	X	X	X	X
American bullfrog ⁿ	<i>L. catesbeianus</i>	X	X				X		
Sinaloan narrow-mouthed toad ^o	<i>Gastrophryne mazatlanensis</i>	X		E&B					
Amphibians 18	AMPHIBIA	9	11+		4	6	8	6	6
Yellow mud turtle	<i>Kinosternon flavescens</i>			L,S					
Sonoran mud turtle	<i>K. sonoriense</i>	XEP	X		X	X	X		
Spiny softshell (turtle)	<i>Trionyx spiniferus</i> (introduced) <i>Apalone spinifera</i>		X				X		
Pond slider	<i>Pseudemys scripta</i> <i>Trachemys scripta</i> (introduced)		X				X		
Desert box turtle	<i>Terrapene ornata</i>	A	X						
Morafka's desert tortoise *Can	<i>Gopherus [agassizii] morafkai</i>	A	X			X	X	X	X
Turtles 6	TESTUDINES	3	5		1	2	4	1	1
Tucson banded gecko	<i>Coleonyx variegatus</i>	A	X			X	X	X	X
Desert iguana	<i>Dipsosaurus dorsalis</i>							X	X

Table 12—Continued.

Common name	Scientific name	Santa Cruz ^b R. near Tucson	San Pedro R. ^c	LR ^d	MB ^e	CW ^f	ME ^g	MR ^h	SD ⁱ
Common chuckwalla	<i>Sauromalus ater</i>					X		X	X
Common lesser earless lizard ^q	<i>Holbrookia maculata</i>	X	X	L ^r					
Greater earless lizard	<i>Cophosaurus texanus</i>		X	J ⁺	X	X	X	X	X
Eastern zebra-tailed Lizard	<i>Callisaurus draconoides</i>	A	X			X	X	X	X
Common collared lizard	<i>Crotophytus collaris</i>		X			X		X	X
Long-nosed leopard lizard	<i>Gambelia wislizenii</i>	AE ^s	X			X	X	X	X
Desert spiny lizard	<i>Sceloporus magister</i>	A	X		X	X	X	X	X
Twin-spotted spiny lizard	<i>S. bimaculosus</i>			J&L ^t					
Sonoran spiny lizard	<i>S. clarkii</i>	A	X		X	X		X	X
Southwestern fence lizard	<i>S. undulatus cowlesi</i>	X ^{vev}	X	J ⁺	X	X			
	<i>S. cowlesi</i>								
Western side-blotched lizard	<i>Uta stansburiana</i>	A	X			X	X	X	X
Long-tailed brush lizard	<i>Urosaurus graciosus</i>						X	X	X
Ornate tree lizard	<i>U. ornatus</i>	A	X		X	X	X	X	X
Desert horned lizard	<i>Phrynosoma (Anota) platyrhinos</i>			J&L ^w		J		X	X
Regal horned lizard	<i>P. (A.) solare</i>	A	X					X	X
Great plains skink	<i>Plestiodon obsoletus</i>			J,J&L, S ^x	X	X			
Many-lined skink	<i>P. multivirgatus</i>								
Gilbert's skink	<i>P. gilberti</i>			J,J&L, S ^y		J			
Madrean alligator lizard	<i>Elgaria kingi</i> ^z			J&L, S ^{aa}					
Giant spotted whiptail ^{bb}	<i>Aspidoscelis strictogramma</i>	X	X	J ⁺ J&L ^{cc}					
New Mexican whiptail	<i>A. neomexicana</i>			J&L,S ^{dd}					
Little striped whiptail	<i>A. inornata</i>			B&B ^{ee}					
Desert grassland whiptail	<i>A. uniparens</i>		X	J&L ^{ff}					
Plateau striped whiptail	<i>A. velox</i>			J ⁺	X	X			
Chihuahuan spotted whiptail	<i>A. exsanguis</i>			J&L,L ^{gg}					
Sonoran spotted whiptail ^{hh}	<i>A. sonora</i> ⁱⁱ	X	X	J&L ^{jj}					
Gila spotted whiptail	<i>A. flagellicaudatus</i>			J ⁺	X	X			
Marbled whiptail	<i>A. marmorata</i>			J&L ^{kk}					
Tiger whiptail	<i>A. tigris</i>	X	X		X	X	X	X	X
Checkered whiptail	<i>A. tessellata</i>			J&L ^{ll}					
Gray checkered whiptail	<i>A. dixonii</i>			B&B ^{mm}					

Table 12—Continued.

Common name	Scientific name	Santa Cruz ^b R. near Tucson	San Pedro R. ^c	LR ^d	MB ^e	CW ^f	ME ^g	MR ^h	SD ⁱ
Reticulate Gila monster	<i>Heloderma suspectum</i>	A	X			X	X	X	X
Lizards 34	REPTILIA: LARCERTILIA	14	17		9	18	10	16	16
Southwestern threadsnake (blind snake)	<i>Rena humilis</i>	A	X		X	X	X	X	X
New Mexico threadsnake	<i>R. dissectus</i>		X	S ^{mn}					
Rosy boa	<i>Lichanura trivirgata</i>					X			X
Ring-necked snake	<i>Diadophis punctatus</i>	A	X	J		X			X
Mexican hog-nosed snake	<i>Heterodon kennerlyi</i>		X	S ^{oo}					X
Spotted leaf-nosed snake	<i>Phyllorhynchus decurtatus</i>	A		L ^{pp}					
Saddled (Pima) leaf-nosed snake	<i>P. browni</i>	A	X					X	X
Red racer (coachwhip)	<i>Coluber flagellum</i>	A	X			X	X	X	X
Striped whipsnake	<i>C. taeniatus</i>			J ⁺	X	X			
Sonoran whipsnake	<i>C. bilineatus</i>	A	X	J ⁺	X	X			
Western patch-nosed snake	<i>Salvadora hexalepis</i>	A	X			X	X	X	X
Trans-Pecos rat snake	<i>Bogertophis subocularis</i>			B&B ^{qq}					
Great Plains rat snake	<i>Pantherophis emoryi</i>			B&B ^{rr}					
Arizona glossy snake	<i>Arizona elegans</i>	A	X					X	X
Sonoran gopher snake	<i>Pituophis catenifer affinis</i>	A	X		X	X	X	X	X
Desert kingsnake	<i>Lampropeltis getula, L. splendida</i>	A	X		X	X	X	X	X
New Mexican milk snake	<i>L. triangulum</i>			B&B ^{ss}					
Western long-nosed snake	<i>Rhinocheilus lecontei</i>	A	X		X	X	X	X	X
New Mexico gartersnake	<i>Thamnophis sirtalis dorsalis</i>			B&B, S					
Black-necked gartersnake	<i>T. cyrtopsis</i>		X		X	X	X	X	X
(Northern) Mexican [brown] gartersnake *Can	<i>T. eques</i>	E ^{tt}	X	L ^{uu}					
Marcy's checkered gartersnake	<i>T. marcianus</i>	A ^{vv} E ^{ww}	X	L ^{xx}			X		
Ground snake	<i>Sonora semiannulata</i>					X	X		X
Western shovel-nosed snake	<i>Chionactis occipitalis</i>						X	X	X
Chihuahuan hook-nosed snake	<i>Gyalopion canum</i>			IUCN ^{yy}					
Smith's black-headed snake	<i>Tantilla hobartsmithi</i>	X	X	J ⁺	X	X	X		X
Brown vine snake ^{zz}	<i>Oxybelis aeneus</i>	X		S ^{aaa}					
Lyre snake	<i>Trimorphodon biscutatus</i>		X			X		X	X
Banded sandsnake	<i>C. stramineus</i>	A	X			X	X	X	X
Sonoran nightsnake	<i>Hypsiglena torquata</i> <i>Hypsiglena chlorophaea</i>	A	X		X	X	X	X	X

Table 12—Continued.

Common name	Scientific name	Santa Cruz ^b R. near Tucson	San Pedro R. ^c	LR ^d	MB ^e	CW ^f	ME ^g	MR ^h	SD ⁱ
Sonoran coral snake	<i>Micruroides euryxanthus</i>		X ^{bbb}			X	X		X
Western diamond-backed rattlesnake	<i>Crotalus atrox</i>	A	X			X	X	X	X
Rock rattlesnake	<i>C. lepidus</i>			S, B&B ^{ccc}					
Speckled rattlesnake	<i>C. mitchellii</i>					X		X	X
Sidewinder	<i>C. cerastes</i>						X	X	X
Black-tailed rattlesnake	<i>C. molossus</i>				X	X		X	X
Tiger rattlesnake	<i>C. tigris</i>				ddd				
Northern Mojave rattlesnake	<i>C. scutulatus</i>	A	X				X	X	X
Snakes 38	REPTILIA: SERPENTES	19	22		10	20	17	18	24
TOTAL 96	ALL HERPS	45	55+		24	46	39	41	47

CW = Cottonwood-Willow, LR = Lowland Riparian, ME = Mesquite Bosque, MB = Mixed Broadleaf, MR = Mixed Riparian scrub (xeroriparian), SD = Sonoran Desertscrub; abbreviations—except LR—after Jones (1988).

A = Arnold (1940), B&B = Bartlett and Bartlett (2010), E&B = Enderson and Bezy (2007), J-Jones (1981), J+-Jones et al. (1985), J&L = Jones and Lovich (2009), Lowe (1964b), Stebbins (1985)
Ex = Extirpated

*Can = candidate species for Federally Threatened or Endangered

^a Nomenclature after SSAR (2012) and Jones and Lovich (2009); systematic order after Stebbins (1985); species may be obligate, preferential, or facultative riparian.

^b After Webb et al. (2014).

^c After Rosen (2009).

^d Lowland riparian records other than Arnold (1940), Jones (1988), Rosen (2009), or Webb et al. (2014).

^e Mixed Broadleaf (trees).

^f Cottonwood-Willow (trees).

^g Mesquite bosque (woodland).

^h Xeroriparian (Johnson et al. 1984; mixed riparian scrub along usually dry washes).

ⁱ Sonoran Desertscrub (Arizona Upland; Brown 1982).

Table 12—Continued.

j	Throughout much of the SW lowlands (Stebbins 1985), often introduced accidentally as fishing bait (Lowe 1964b); formerly occurred in San Pedro River (Rosen 2009); an endangered species (USFWS) listed in 1996 by Arizona Game and Fish Dept. in "Wildlife of Special Concern."
k	Special Status Species, Arizona Game and Fish Department.
l	Extinct by 1975 at latest (Rosen 2001, 2003).
m	<i>Rana pipiens</i> has been split into several species and it is uncertain which of those the older records represent.
n	Introduced species from the eastern United States (Stebbins 1985).
o	Although ITIS (no date) still uses <i>Gastrophryne olivacea</i> (Great Plains Narrow-mouthed Toad) our information suggests that <i>G. mazatlanensis</i> extends northward into extreme SW Arizona from Mexico (see text).
p	Widely inhabited perennial water along the Santa Cruz; extirpated (Rosen 2001).
q	Found on a "Tucson bajada adjoining West Branch floodplain" of Santa Cruz River (Rosen 2003:40).
r	"Bottomlands" in grasslands (Lowe 1964b:160) among other habitats.
s	Extirpated in Tucson area by 1950s or 1960s (Rosen 2008).
t	"In dry canyons and arroyos or along rivers and streams" (Jones and Lovich 2009:204) among other habitats.
u	"Downtown Tucson, 1995" (Rosen 2003:40).
v	Extirpated in Tucson area (Rosen 2008).
w	"Alluvial fans, washes" (Jones and Lovich 2009:192) among other habitats.
x	"Dense streamside growth" (Stebbins 1985) among other habitats.
y	"Riparian corridors" (Jones and Lovich 2009:450), "cottonwood, willow and mesquite bottomlands" (Stebbins 1985:150) among other habitats.
z	Formerly <i>Gerrhonotus kingii</i> .
aa	Along streams, such as "broad leaf stream-border habitats along major drainageways in desert and grassland" (Stebbins 1985:166) among other habitats.
bb	Formerly <i>A. burti stictogramma</i> now considered a separate species from <i>A. burti</i> (SSAR 2012).
cc	"Preferred thickets include Velvet Mesquite . . . Riparian woodland is also used" (Jones and Lovich 2009:332).
dd	A unisexual species in "floodplain habitats" (Stebbins 1985:154), and the "Rio Grande corridor" (Jones and Lovich 2009:367) among other habitats.
ee	"Along dry washes" (Bartlett and Bartlett 2013:200) among other habitats.
ff	"Common along lower-elevation riparian corridors" (Jones and Lovich 2009:399) among other habitats.
gg	A unisexual species in "riparian corridors" (Jones and Lovich 2009:339), "riparian situations" (Lowe 1964b:165).
hh	A triploid unisexual species; females reproduce parthenogenetically (Jones and Lovich 2009).
ii	Rosen (2003) discusses these parthenogenetically reproducing, single sex species and uses the Tiger Whiptail because of ongoing research into this complicated group of lizards.
jj	"Especially abundant along riparian corridors" (Jones and Lovich 2009:387).
kk	Chihuahuan Desert . . . [in] Desert willow, mesquites" (Jones and Lovich 2009:363) among other habitats.
ll	A unisexual species in "riparian corridors" (Jones and Lovich 2009:391) among other habitats.
mm	A unisexual species in "Dry washes, canyon bottoms" (Bartlett and Bartlett 2013:195) among other habitats.
nn	"Often frequents . . . canyon bottoms or washes near permanent or intermittent streams" (Stebbins 1985:172).
oo	"Occasionally in mountain canyon bottoms or on the floodplains of streams (Stebbins 1985:176-177).
pp	"Fossorial in sandy soil" (Lowe 1964b:170).
qq	"Often . . . along intermittent streams, or in riparian situations" (Bartlett and Bartlett 2013:109).
rr	"Within its range there is usually a spring, stock tank, stream, pond, or lake" (Bartlett and Bartlett 2013:111).
ss	"Found in . . . riparian areas" (Bartlett and Bartlett 2013:119) among others.
tt	Northern Mexican Gartersnake known from Rillito River, possibly also along Santa Cruz River; extinct in Tucson Basin by 1960s (Lowe 1985).

Table 12—Continued.

uu	"In or near water along streams" (Lowe 1964b:167).
vv	Apparently a tentative identification by Rosen (2003).
ww	Reported from several locations on Santa Cruz floodplain; extirpated by 1970s (Lowe 1985, Webb et al. 2014).
xx	"Near to, rivers, streams and ponds in arid and semi-arid habitats" (Lowe 1964b:167).
yy	"Occurs in lower desert communities (e.g., mesquite . . .)" (IUCN 2015), "slightly sandy habitats, near a permanent water source" Wikipedia online.
zz	First discovered for the U.S. in mesquites along the Santa Cruz River south of Tucson (Vorhies 1926), "also among grasses and reeds at the sides of streams and ponds" (Lowe 1964:171); now restricted in the United States to the Nogales, AZ, area (Van Devender et al. 1994).
aaa	"Stream bottoms grown to sycamore, oak, walnut and wild grape" (Stebbins 1985:220) among other habitats.
bbb	"Most abundant . . . along arroyos and river bottoms. A secretive species, abroad chiefly at night" (Stebbins 1985:223).
ccc	"Streambeds . . . may occur in the lowlands" (Stebbins 1985:228), "near rocky intermittent streams and rivers" (Bartlett and Bartlett 2013:144) among other habitats.
ddd	"Usually on rocky slopes or in washes" (Brennan 2008) among other habitats, "on the lower slopes" (Stebbins 1985:231).

Table 13—Riparian breeding birds^a of mesquite bosques and mixed deciduous woodlands.

		Mesquite			Mixed deciduous	
Location		Lower Verde R.	San Pedro R.	San Pedro R.	Dry Beaver Crk. ^b	West Clear Crk. ^c
Years of records		1975	1972-1973	2006-2015	1969-1974	1969-1974
Source		NES (1978)	TAG (1975)	IBA (2015) ^d	SWC (1974)	SWC (1974)
Common name	Scientific name ^e					
#Gambel's quail	<i>Callipepla gambelii</i>	X	XO	X		
Great blue heron	<i>Ardea herodias</i>			X		
Turkey vulture	<i>Cathartes aura</i>		F	X		
#Cooper's hawk	<i>Accipiter cooperii</i>		??	X		
#Gray hawk	<i>Buteo plagiatus</i>			X		
#Swainson's hawk	<i>Buteo swainsoni</i>		F	X		
Red-tailed hawk	<i>B. jamaicensis</i>			X		
#White-winged dove	<i>Zenaida asiatica</i>	X	XO	X		
#Mourning dove	<i>Z. macroura</i>	X	X	X	X	X
Inca dove	<i>Columbina inca</i>			??		
#Common ground-dove	<i>C. passerina</i>		X	X		
#Yellow-billed cuckoo ^f	<i>Coccyzus americanus</i>			X		
#Greater roadrunner	<i>Geococcyx californianus</i>		XO	X		
Barn owl	<i>Tyto alba</i>		??			
#Western screech-owl	<i>Megascops kennicottii</i>		??			
Great horned owl	<i>Bubo virginianus</i>		??	??		
#Elf owl	<i>Micrathene whitneyi</i>		??			
Lesser nighthawk	<i>Chordeiles acutipennis</i>		F	X		
#Black-chinned hummingbird	<i>Archilochus alexandri</i>	X		??	X	X
Anna's hummingbird	<i>Calypte anna</i>			X		
Hummingbird sp. ^g	????????		XO			
#Gila woodpecker	<i>Melanerpes uropygialis</i>	X	XO	X	X	X
#Ladder-backed woodpecker	<i>Picoides scalaris</i>	X	X	X	X	X
Northern flicker	<i>Colaptes auratus</i>					X
#Gilded flicker	<i>C. chrysoides</i>	X				
#Northern beardless-tyrannulet	<i>Camptostoma imberbe</i>		??	X		
Western wood pewee	<i>Contopus sordidulus</i>				X	X
#Willow flycatcher [gray flycatcher]	<i>Empidonax traillii</i> [<i>E. wrightii</i>]					X ^h
#Black phoebe	<i>Sayornis nigricans</i>			??		X
Say's phoebe	<i>S. saya</i>			??		
#Vermilion flycatcher	<i>Pyrocephalus rubinus</i>		X	X		
#Ash-throated flycatcher	<i>Myiarchus cinerascens</i>	X	X	X	X	X
#Brown-crested flycatcher	<i>M. tyrannulus</i>	X		X	X	X
Western kingbird	<i>T. verticalis</i>		XO	X		X
#Bell's vireo	<i>Vireo bellii</i>		X	X	X	X
#Chihuahuan raven	<i>Corvus cryptoleucus</i>		F			
Common raven	<i>C. corax</i>		F	X		
Violet-green swallow	<i>Tachycineta thalassina</i>					X
#Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>			X		
Bridled titmouse	<i>Baeolophus wollweberi</i>				X	X
#Verdin	<i>Auriparus flaviceps</i>	X	X	X	X	X
#Cactus wren	<i>Campylorhynchus brunneicapillus</i>			??		
#Bewick's wren	<i>Thryomanes bewickii</i>		X	X	X	X
#Black-tailed gnatcatcher	<i>Poliophtila melanura</i>			X		
#Curve-billed thrasher	<i>T. curvirostre</i>		??	??		
#Crissal thrasher	<i>T. crissale</i>	X				
#Northern mockingbird	<i>Mimus polyglottos</i>			??		X
European starling ⁱ	<i>Sturnus vulgaris</i>	X				
#Phainopepla	<i>Phainopepla nitens</i>		XO	X		X
#Lucy's warbler	<i>Oreothlypis luciae</i>	X	X	X	X	X
#Common yellowthroat	<i>Geothlypis trichas</i>			??		

Table 13—Continued.

Location		Mesquite			Mixed deciduous	
		Lower Verde R.	San Pedro R.	San Pedro R.	Dry Beaver Crk. ^b	West Clear Crk. ^c
Years of records		1975	1972-1973	2006-2015	1969-1974	1969-1974
Source		NES (1978)	TAG (1975)	IBA (2015) ^d	SWC (1974)	SWC (1974)
Common name	Scientific name ^e					
#Yellow warbler	<i>Setophaga petechia</i>		XO	X	X	X
#Yellow-breasted chat	<i>Icteria virens</i>		X	X	X	X
#Canyon towhee	<i>Melospiza fusca</i>			X		
#Abert's towhee	<i>M. aberti</i>	X		X		
#Rufous-winged sparrow	<i>Peucaea carpalis</i>			X		
#Black-throated sparrow	<i>Amphispiza bilineata</i>	X	X	X		
#Song sparrow	<i>Melospiza melodia</i>		X	X		
#Summer tanager	<i>Piranga rubra</i>		X	X	X	X
#Northern cardinal	<i>Cardinalis cardinalis</i>	X		X	X	X
#Pyrrhuloxia	<i>C. sinuatus</i>					
#Blue grosbeak	<i>Passerina caerulea</i>		X	X		X
#Brown-headed cowbird	<i>M. ater</i>	X	X	X		
#Hooded oriole	<i>Icterus cucullatus</i>			X	X	X
#Bullock's oriole	<i>I. bullockii</i>	X	??			
#Lesser goldfinch	<i>Spinus psaltria</i>		XO	X	X	X
#House finch	<i>Haemorhous mexicanus</i>	X	XO	X	X	X
Breeding species		19	30+	43+	19	27 ^j
Pairs/40 ha (100 A)		244	277+ ^k	???	332	312 ^l

= Mesquites found in our studies or specifically mentioned under breeding habitat in literature, especially by Corman and Wise-Gervias. (2005).

X = Known or presumed to be nesting on the plot.

XO = Recorded during breeding census in small numbers, presumed nesting in the general area but possibly not on plot.

F = Flying over the area during the breeding season; often large birds foraging.

?? = Species breeding in the region in riparian habitat and recorded on the study plot during the summer but status uncertain, e.g., records early and/or late but no or few mid-summer records.

Sources: IBA = Important Bird Areas, Arizona and Tucson Audubon Society (2015); NES = Stamp (1978); SWC = Carothers et al. (1974); TAG = Gavin and Sowls (1975).

^a Species may be obligate, preferential, or facultative riparian.

^b After Carothers et al. 1974.

^c After Carothers et al. 1974.

^d Website—http://aziba.org/?page_id=30 (accessed 20 August 2015).

^e After AOU (1998) and AOU Check-list (2015).

^f Yellow-billed cuckoo, a candidate for listing as a threatened or endangered species (USFWS online 2012, is the last breeding bird to arrive annually, generally in early June) (Phillips et al. 1964, Johnson and Simpson MS b).

^g Probably black-chinned hummingbird.

^h Misidentified in Carothers et al. (1974) as gray flycatcher, actually willow flycatcher.

ⁱ European starling introduced into United States from Europe, first reported for Arizona in 1946 (Phillips et al. 1964; Monson and Phillips 1981).

^j Includes all species on two sites but number of pairs only for site with greatest number.

^k Of the 36 species recorded during the breeding season, 16 were in numbers too small to be counted or numbers were not otherwise recorded (designated XO) thus are not included in the total.

^l A second mixed deciduous site along West Clear Creek with only 193 pairs was highly disturbed, largely by a large U.S. Forest Service campground.

Table 14—Riparian breeding birds of cottonwood-willow riparian gallery forests or cottonwood-willow in association with mesquite^a.

Location		Mesquite and c-w		Cottonwood-willow (c-w)		
		GMF Santa Cruz ^b	BPC Salt R. ^c	Verde ^d Valley	Lower Verde R.	Lower Rio Grande
Years of records		1902-1963	1930s-1980s	1969-1974	1975	1977
Source		RHW (2014)	RRJ (2000)	SWC (1974)	NES (1978)	RE-W (1979)
Common name	Scientific name ^e					
#Gambel's quail	<i>Callipepla gambelii</i>	XO	X		X	X
Pied-billed grebe ^f	<i>Podylimbus podiceps</i>	XO	X			
Least bittern	<i>Ixobrychus exilis</i>		X			
Great blue heron	<i>Ardea herodias</i>	XO	X	X ^g		
Green heron ^h	<i>Butorides virescens</i>	XO	X			
#Black-crowned night-heron	<i>Nycticorax nycticorax</i>	XO				
Black vulture ^{**i}	<i>Coragyps atratus</i>	F				
Turkey vulture	<i>Cathartes aura</i>	F	F			
Osprey ^j	<i>Pandion haliaetus</i>		F			
Bald eagle	<i>Haliaeetus leucocephalus</i>		X			
#Cooper's hawk	<i>Accipiter cooperii</i>	XO	X		X	
#Common black hawk ^{**}	<i>Buteogallus anthracinus</i>	XO	X		X	
#Harris's hawk	<i>Parabuteo unicinctus</i>	XO	X			
#Gray hawk ^{**}	<i>Buteo plagiatus</i>	XO				
#Swainson's hawk	<i>Buteo swainsoni</i>	XO				
Zone-tailed hawk ^{**}	<i>B. albonotatus</i>	XO				
Red-tailed hawk	<i>B. jamaicensis</i>	XO	X			
Sora	<i>Porzana carolina</i>		X			
Common moorhen	<i>Gallinula chloropus</i>		X			
American coot	<i>Fulica americana</i>		X			
Killdeer	<i>Charadrius vociferus</i>	XO	X	X		
Spotted sandpiper	<i>Actitis macularia</i>			X		
#White-winged dove ^k	<i>Zenaida asiatica</i>	XO	X		X	X
#Mourning dove	<i>Z. macroura</i>	XO	X	X	X	X
Inca dove	<i>Columbina inca</i>	XO				
#Common ground-dove	<i>C. passerina</i>	XO				
#Yellow-billed cuckoo ^{**l}	<i>Coccyzus americanus</i>	XO	X	X	X	X
#Greater roadrunner	<i>Geococcyx californianus</i>	XO	X			X
Barn owl	<i>Tyto alba</i>	XO	X			
#Western screech-owl	<i>Megascops kennicottii</i>	XO	X			
Great horned owl	<i>Bubo virginianus</i>	XO	X		X	
#Ferruginous pygmy-owl ^{**m}	<i>Glaucidium brasilianum</i>		X			
#Elf owl	<i>Micrathene whitneyi</i>	XO	X			
Burrowing owl ⁿ	<i>Athene cunicularia</i>	XO				
Lesser nighthawk	<i>Chordeiles acutipennis</i>	XO	X			
#Common poorwill	<i>Phalaenoptilus nuttallii</i>	XO	X			

Table 14—Continued.

		Mesquite and c-w		Cottonwood- willow (c-w)		
Location		GMF Santa Cruz ^b	BPC Salt R. ^c	Verde ^d Valley	Lower Verde R.	Lower Rio Grande
Years of records		1902- 1963	1930s-1980s	1969- 1974	1975	1977
Source		RHW (2014)	RRJ (2000)	SWC (1974)	NES (1978)	RE-W (1979)
Common name	Scientific name ^e					
#Black-chinned hummingbird	<i>Archilochus alexandri</i>	XO	X	X	X	X
Anna's hummingbird	<i>Calypte anna</i>				X	
#Costa's hummingbird	<i>C. costae</i>		X			
#Gila woodpecker	<i>Melanerpes uropygialis</i>	XO	X	X	X	
#Ladder-backed woodpecker	<i>Picoides scalaris</i>	XO	X	X	X	X
Northern flicker	<i>Colaptes auratus</i>			X		
#Gilded flicker	<i>C. chrysoides</i>	XO	X		X	
#Crested caracara	<i>Caracara cheriway</i>	XO				
American kestrel	<i>Falco sparverius</i>	XO	X	X		
#Northern beardless- tyrannulet	<i>Camptostoma imberbe</i>	XO				
Western wood pewee	<i>Contopus sordidulus</i>			X		
#Willow flycatcher [gray flycatcher]	<i>Empidonax traillii</i> <i>E. wrightii</i>	XO				
#Black phoebe	<i>Sayornis nigricans</i>	XO	X	X		
Say's phoebe	<i>S. saya</i>	XO				
#Vermilion flycatcher	<i>Pyrocephalus rubinus</i>	XO	X	X		X
#Ash-throated flycatcher	<i>Myiarchus cinerascens</i>	XO	X	X	X	X
#Brown-crested flycatcher	<i>M. tyrannulus</i>	XO	X	X	X	
#Tropical kingbird**o	<i>Tyrannus melancholicus</i>	XO	? ^p			
Cassin's kingbird	<i>T. vociferans</i>	XO		X		
Western kingbird	<i>T. verticalis</i>	XO	X	X		
#Rose-throated becard ^q	<i>Pachyramphus aglaiae</i>	XO				
#Loggerhead shrike	<i>Lanius ludovicianus</i>	XO				
#Bell's vireo	<i>Vireo bellii</i>	XO	X			X
#Chihuahuan raven	<i>Corvus cryptoleucus</i>					
Common raven	<i>C. corax</i>	XO	X			
Purple martin	<i>Progne subis</i>	XO				
Violet-green swallow	<i>Tachycineta thalassina</i>					
#Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>	XO	X		X	
Cliff swallow	<i>Petrochelidon pyrrhonota</i>		X			X
Bridled titmouse	<i>Baeolophus wollweberi</i>			X		
#Verdin	<i>Auriparus flaviceps</i>	XO	X		X	
#Cactus wren	<i>Campylorhynchus brunneicapillus</i>	XO	X			
Rock wren	<i>Salpinctes obsoletus</i>	XO	X			
Canyon wren	<i>Catherpes mexicanus</i>	XO				
#Bewick's wren	<i>Thryomanes bewickii</i>	XO	X	X	X	X
#Black-tailed gnatcatcher	<i>Poliophtila melanura</i>	XO	X			

Table 14—Continued.

		Mesquite and c-w		Cottonwood- willow (c-w)		
Location		GMF Santa Cruz ^b	BPC Salt R. ^c	Verde ^d Valley	Lower Verde R.	Lower Rio Grande
Years of records		1902- 1963	1930s-1980s	1969- 1974	1975	1977
Source		RHW (2014)	RRJ (2000)	SWC (1974)	NES (1978)	RE-W (1979)
Common name	Scientific name ^e					
American robin	<i>Turdus migratorius</i>			X		
#Curve-billed thrasher	<i>T. curvirostre</i>	XO	X			
#Bendire's thrasher	<i>Toxostoma bendirei</i>	XO				
#Crissal thrasher	<i>T. crissale</i>	XO	X			
#Northern mockingbird	<i>Mimus polyglottos</i>	XO		X		X
European starling ^f	<i>Sturnus vulgaris</i>	XO	X	X	X	
#Phainopepla	<i>Phainopepla nitens</i>	XO	X			
#Lucy's warbler	<i>Oreothlypis luciae</i> ^g	XO	X	X	X	X
#Common yellowthroat	<i>Geothlypis trichas</i>	XO	X			X
#Yellow warbler	<i>Setophaga petechia</i>	XO	X	X	X	
#Yellow-breasted chat	<i>Icteria virens</i>	XO	X		X	X
#Canyon towhee	<i>Melospiza fusca</i>	XO	X			
#Abert's towhee	<i>M. aberti</i>	XO	X	X	X	
#Rufous-winged sparrow	<i>Peucaea carpalis</i>	XO				
#Black-throated sparrow	<i>Amphispiza bilineata</i>	XO	X			
#Song sparrow ^{h,i}	<i>Melospiza melodia</i>	XO	X			
#Summer tanager	<i>Piranga rubra</i>	XO	X	X	X	X
#Northern cardinal	<i>Cardinalis cardinalis</i>	XO	X		X	X
#Pyrrhuloxia	<i>C. sinuatus</i>	XO				
#Blue grosbeak	<i>Passerina caerulea</i>	XO	X	X		X
Painted bunting	<i>P. ciris</i>					X
Red-winged blackbird	<i>Agelaius phoeniceus</i>	XO	X	X		X
Great-tailed grackle	<i>Quiscalus mexicanus</i>					X
#Bronzed cowbird ^j	<i>Molothrus aeneus</i>	XO	X			
#Brown-headed cowbird	<i>M. ater</i>	XO	X	X	X	X
#Hooded oriole	<i>Icterus cucullatus</i>	XO	X	X		
Orchard oriole	<i>Icterus spurius</i>					X
#Bullock's oriole	<i>I. bullockii</i>	XO	X	X	X	X
House finch	<i>Haemorhous mexicanus</i>	XO	X	X	X	X
#Lesser goldfinch	<i>Spinus psaltria</i> ^w	XO	X		X	X
#House finch	<i>Haemorhous mexicanus</i> ^v	XO	X	X	X	
House sparrow ^x	<i>Passer domesticus</i>	XO	X	X		
Breeding species		83 ^y	71	34 ^z	28	27 ^{aa}
Pairs/40 ha (100 A)		?? ^{bb}	611 ^{cc}	847 ^{dd}	684	354

= Mesquites found in our studies or specifically mentioned under breeding habitat in literature, especially by Corman and Wise-Gervias (2005).

X = Recorded on area.

XO = Recorded on area but numbers insufficient to count or numbers not otherwise recorded.

Table 14—Continued.

F = Flying over the area during the breeding season; often large birds foraging.

** = Locally extirpated after earlier observations.

Sources: NES = Stamp (1978); RE-W = Engel-Wilson and Ohmart (1979); RHW = Webb et al. (2014); RRJ = Johnson et al. (2000); SWC = Carothers et al. (1974).

^a Species may be obligate, preferential, or facultative riparian.

^b Great Mesquite Forest or San Xavier Bosque, Tucson mesquite forest (Phillips et al. 1964), or Grand Mesquite Forest (Brandt 1951), located on the Santa Cruz River on the San Xavier Indian Reservation, 10 miles s. of Tucson. This best known mesquite forest of the Southwest was destroyed by the 1970s through anthropogenic causes, including agricultural clearing by Native Americans, wood-cutting, and excessive groundwater withdrawal (Johnson and Carothers 1982, Webb et al. 2014).

^c Blue Point Cottonwoods, located on the Salt River approximately 2 mi upstream from its confluence with the Verde River.

^d The first quantitative riparian bird study for the Southwest, documenting some of the highest avian population densities for the United States and even the world.

^e After AOU (1998) and AOU Check-list (2015).

^f Vorhies saw pied-billed grebes at Indian Dam, GMF, frequently in the 1930s, including three calling on open water, April 15, 1934 (Vorhies et al. 1935). They may have been nesting here since the species begins nesting in December and January in Arizona lowlands (Corman and Wise-Gervais 2005).

^g Great blue heron rookery in cottonwoods off of plots but adults foraged on plots.

^h Vorhies saw green heron nests at Indian Dam, GMF, for “three years in a row” in the mid 1930s (Vorhies et al. 1935:244).

ⁱ “At least a dozen” black vultures were seen “in the bottom of a ditch” on 7 May 1922, along the Santa Cruz River, 12 miles south of Tucson (Kimball 1923:109).

^j Osprey was extirpated as a breeding species after being reported breeding nearby and foraging over BPC (Phillips et al. 1964).

^k The GMF was one of the most noted sites in Arizona for hunting white-winged doves in the early 1900s (Arnold 1941, 1943; Brown 1989). After visiting the GMF Bent (1937:259) wrote, “White-winged doves fairly swarmed through the thickets, and their tiresome notes were the dominant sounds.”

^l Yellow-billed cuckoo, a candidate for listing as a threatened or endangered species (USFWS 2015), is the last breeding bird to arrive annually, generally in early June (Phillips et al. 1964; Johnson and Simpson MS b).

^m Herbert Brown took a ferruginous pygmy-owl south of Tucson in 1884, the only Santa Cruz River record (Johnson et al. 2003). The Arizona population was listed as federally endangered in 1997 but delisted in 2007 and extirpated in the Tucson Basin by 2009.

ⁿ Western burrowing owl (*Athene cunicularia hypugea*) is a “Bird of Conservation Concern” (Klute et al. 2003).

^o Tropical kingbird was first reported as a breeding species for the United States along the Santa Cruz River between Tucson and GMF (Phillips 1940; Phillips et al. 1964). Brandt thought he saw one in the GMF but was uncertain. The species was first recorded in Arizona (and the United States) by a specimen taken by H.H. Kimball near Fort Lowell on May 12, 1905 (Peters 1936; Phillips et al. 1964). It is unknown if it was a solitary bird or a member of a breeding pair or colony.

^p One of a pair collected at BPC.

^q Rose-throated becard nest found in 1958 and calling male recorded in 1959 (Phillips et al. 1964).

^r European starling introduced into United States from Europe, first reported for Arizona in 1946 (Phillips et al. 1964; Monson and Phillips 1981).

^s From *Vermivora luciae* to *Oreothlypis luciae*.

^t Song sparrow, formerly a common riparian nesting species in the Tucson region (Bendire 1872a, 1872b), was extirpated from the region shortly after 1895 (Phillips et al. 1964). Records by Arnold and Marshall were probably migrating individuals.

^u Bronzed cowbird first reported arriving in Arizona from Mexico in 1909 (Visher 1909, Gilman 1914, Phillips et al. 1964).

^v From *Carpodacus mexicanus* to *Haemorhous mexicanus*.

^w From *Carduelis psaltria* to *Spinus psaltria*.

^x House sparrow introduced into United States from Europe, first reported in Tucson in 1902-1903 (Howard 1906, Phillips et al. 1964).

^y Includes total species breeding, foraging, and flying over area, during breeding season from 1902 to 1960s. It also includes species, especially those nesting, not recorded by listed ornithologists but for whom other records exist, e.g., Vorhies (1935) saw pied-billed grebes frequently at Indian Dam, GMF, in the 1930s and three calling on open water, April 15, 1934, as well as nesting green herons.

^z Includes all species on four sites but number of pairs only for site with greatest number.

^{aa} Excludes a non-breeding species, white-crowned sparrow (*Zonotrichia leucophrys*), observed during the census period.

^{bb} During the more than 60 years this plot was studied no one conducted a census to determine numbers of estimated breeding pairs.

^{cc} Censusing on this 250 acre plot was not as rigorous as for other plots included in this table.

^{dd} Of the four cottonwood plots censused in the Verde Valley, only one had not been modified either by cutting cottonwood trees (“phreatophyte control”) or other human intervention that impacted the number of trees/acre.

Table 15—Mammals of mesquite bosques and associated riparian vegetation in the Southwest.^a

Common name	Scientific name	Santa ^b Cruz R. ^c	San ^d Pedro R. ^e
Virginia opossum	<i>Didelphis virginiana</i>		X
Desert shrew	<i>Notiosorex crawfordi</i>		X
California leaf-nosed bat	<i>Macrotus californicus</i>		X
Yuma myotis	<i>Myotis yumanensis</i>	X ^f	
Cave myotis	<i>M. velifer</i>	X	X
Long-legged myotis ^g	<i>M. volans^h</i>	X	
California myotis	<i>M. californicus</i>	X	
Red bat ⁱ	<i>Lasiurus borealis</i>		X
Hoary bat	<i>L. cinereus</i>	X ^j	
Western pipistrelle	<i>Parastrellus hesperus</i>	X ^k	
Big brown bat	<i>Eptesicus fuscus</i>	X	X
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>		X
Pallid bat	<i>Antrozous pallidus</i>	X	X
Brazilian free-tailed bat	<i>Tadarida brasiliensis</i>	X	X
Pocketed free-tailed bat	<i>Nyctinomops femorosaccus</i>	X ^l	
Big free-tailed bat	<i>N. macrotis</i>	X ^m	
Western bonneted bat ⁿ	<i>Eumops perotis</i>		X
Desert cottontail	<i>Sylvilagus auduboni</i>	X	X
Antelope jackrabbit	<i>Lepus alleni</i>	X	X
Black-tailed jackrabbit	<i>L. californicus</i>	X	X
Harris' antelope squirrel	<i>Ammospermophilus harrisi</i>	X	X
Rock squirrel	<i>Otospermophilus variegatus</i>	X	X
Round-tailed ground squirrel	<i>Xerospermophilus tereticaudus</i>	X	X
Botta's pocket gopher	<i>Thomomys bottae</i>	X	X
Silky pocket mouse	<i>Perognathus flavus</i>	X	
Bailey's pocket mouse	<i>Chaetodipus baileyi</i>	X	X
Hispid pocket mouse	<i>C. hispidus</i>		X
Desert pocket mouse	<i>C. penicillatus</i>	X	X
Rock pocket mouse	<i>C. intermedius</i>		X
Merriam's kangaroo rat	<i>Dipodomys merriami</i>	X	X
Ord's kangaroo rat	<i>D. ordii</i>	X	X
American beaver	<i>Castor canadensis</i>		X
Plains harvest mouse	<i>Reithrodontomys montanus</i>		X
Fulvous harvest mouse	<i>R. fulvescens</i>	X	X
Western harvest mouse	<i>R. megalotis</i>	X	X
Cactus mouse	<i>Peromyscus eremicus</i>	X ^o	X
White-footed mouse	<i>P. leucopus</i>	X	X
Deer mouse	<i>P. maniculatus</i>		X
Merriam's mouse (mesquite mouse) ^p	<i>P. merriami</i>	X	
Northern grasshopper mouse	<i>Onychomys leucogaster</i>		X
Southern grasshopper mouse	<i>O. torridus</i>	X	X
Arizona cotton rat ^q	<i>Sigmodon arizonae</i>	X	X
Tawny-bellied cotton rat	<i>S. fulviventer</i>		X
Yellow-nosed cotton rat	<i>S. ochrognathus</i>		X
White-throated woodrat	<i>Neotoma albigula</i>	X	X
Common muskrat	<i>Ondatra zibethicus</i>		E
Common porcupine	<i>Erethizon dorsatum</i>		X
Coyote	<i>Canis latrans</i>	X	X
Gray wolf ^r	<i>C. lupus</i>	E	E
Kit fox	<i>Vulpes macrotis</i>	X	X
Common gray fox	<i>Urocyon cinereoargenteus</i>	X	X
American black bear	<i>Ursus americanus</i>		X
Grizzly bear	<i>U. arctos</i>		E
Ringtail	<i>Bassariscus astutus</i>	X	X

Table 14—Continued.

Common name	Scientific name	Santa ^b Cruz R. ^c	San ^d Pedro R. ^e
Northern raccoon	<i>Procyon lotor</i>	X	X
White-nosed coati	<i>Nasua narica</i>		X
Long-tailed weasel	<i>Mustela frenata</i>		E
American badger	<i>Taxidea taxus</i>	X	X
Northern river otter	<i>Lontra canadensis</i>		E
Western spotted skunk	<i>Spilogale gracilis</i>	X	X
Hooded skunk	<i>Mephitis macroura</i>	X	X
Striped skunk	<i>M. mephitis</i>	X	X
White-backed hog-nosed skunk	<i>Conepatus leuconotus</i>	X	X
Mountain lion (puma)	<i>Puma concolor</i>		X
Bobcat	<i>Lynx rufus</i>	X	X
Jaguar	<i>Panthera onca</i>		E
Collared peccary (javelina)	<i>Pecari tajacu</i>	X	X
Mule deer	<i>Odocoileus hemionus</i>		X
White-tailed deer	<i>O. virginianus</i>		X
Total species		44	60

E = Extirpated

^a List of mammals after Duncan (1988) and Soykan et al. (2007); systematic order after Baker et al. (2003) and Cockrum (1960); nomenclature after Baker et al. (2003) and ITIS (no date); species may be obligate, preferential, or facultative riparian.

^b Elevation along Santa Cruz River from 2,450± ft to 2,900± ft.

^c Records from the San Xavier bosque (Webb et al. 2014) unless otherwise noted.

^d Elevation along San Pedro River from 1,900± ft to 4,200± ft.

^e Mesquite bosques and cottonwood-willow riparian forests not separated by Soykan et al. (2007).

^f “Gravel Pit waterhole, S end Cottonwood Lane, Tucson” (Cockrum (1960:37).

^g This and some other species of bats that breed at higher elevations or in other geographic regions may be recorded during migration.

^h Not listed by Hoffmeister (1986), perhaps either a misidentification or a migrant, since breeding localities in Arizona are generally 5,000 ft elevation and higher (Cockrum 1960).

ⁱ “Probably statewide in riparian communities of the Upper Sonoran and Transitional Life Zones” (Cockrum 1960:53).

^j “Valencia Rd. and Santa Cruz R., Tucson” (Cockrum 1960:55), Hoffmeister (1986).

^k “Florida Canyon, 35 mi. S Tucson” (Cockrum 1960:50; Hoffmeister (1986).

^l “Gravel Pit, S end Cottonwood Lane, Tucson” (Cockrum (1960:64), Hoffmeister (1986).

^m “Mission Manor, 10 mi. S Tucson” (Cockrum (1960:65).

ⁿ Mesquite specifically mentioned in habitat for *Eumops perotis* (Best et al. 1996).

^o Specimen from Continental, on the Santa Cruz (Cockrum 1960).

^p *Peromyscus merriami* is so closely associated with mesquite bosques it is often called mesquite mouse.

^q Originally considered a subspecies of *Sigmodon hispidus*, *S. arizonae* is more likely the species here.

^r Extirpated; in 1850, Judge Benjamin Hayes of California wrote in his journal of the San Xavier bosque south of Tucson “they [wolves] were howling all around us, and one of very large size, was seen” (Davis 1982:51).

and lay their eggs in the adjacent water. In addition, numerous species of lizards and snakes inhabit sandy bottoms of desert washes and/or xeroriparian trees along their banks (Jones and Lovich 2009; Stebbins 1985). Mesquites are the first trees listed as habitat for the tree-dwelling ornate tree lizard (Hasse 2009) and Clark's spiny lizard (Schwalbe and Rosen 2009).

A group of lowland, broadleaf, winter deciduous obligate riparian trees termed the riparian "big five" by Lowe (1961, 1964a) consists of cottonwood (*Populus fremontii*), willow (*Salix* spp.), sycamore (*Platanus wrightii*), ash (*Fraxinus velutina*), and walnut (*Juglans major*). The importance of most of the riparian trees, especially to birds, is discussed in other parts of this paper. Lowe's riparian big five all produce flowers that are insignificant and generally not attractive to insects, other invertebrates, or vertebrates. Contrastingly, mesquite trees produce large, fragrant inflorescences in the spring and summer that attract insects and, in turn, insectivorous birds and amphibians and reptiles.

Numerous species of insects feed on wood, flowers, and fruits of mesquites. Mesquites also produce beans that are fed upon by a large number of animals while the only tree of the "big five" that produces large, edible fruit is the walnut with an outer shell so hard that few animals feed on it. By contrast, mesquite beans are fed on by insects, rodents (Phillips and Comus 2000), javelinas (Eddy 1961), coyotes (Lantz 1905), and even wild turkey (Bendire 1872). Mesquite beans are fed on so extensively by insects that suggestions have been made to use some species of insects in biological control of "undesirable" mesquites on rangelands (Smith and Ueckert 1974). At times, coyote scat (feces) consists almost entirely of mesquite beans (R.R. Johnson, numerous observations, Tucson, Arizona during several decades).

A number of vertebrate species extend northward from Mexico into extreme southwestern United States, often occurring in mesquite bosques, or narrow xeroriparian patches of mesquites and other small trees along washes. Some reptiles, such as the brown vinesnake and several amphibians, discussed earlier, extend northward from Mexico, occurring in the United States only in southern Arizona. Another previously mentioned species, the gray hawk, is an uncommon tropical species occurring in the United States largely in southern Arizona. It preferentially utilizes mesquites and "mesquite woodland occupies large proportion of home ranges (about 54 percent), and majority of foraging locations (about 80 percent) occur within mesquite woodland" (Bibles et al. 2002). The range of the previously mentioned mesquite mouse, or Merriam's mouse, extends northward from Mexico, occurring in the United States only in southern Arizona (Hall and Kelson 1959).

An arboreal food chain associated with mesquite bosques, illustrative of the importance of riparian mesquites, consists of arthropods, the ornate tree lizard, brown vinesnake, and gray hawk. This food chain extends northward from Mexican thornscrub (Brown 1982) into the mesquite bosques of the Santa Cruz Valley of extreme southern Arizona and has been documented through scientific records and by online photos. The ornate tree lizard, a resident of this region, forages preferentially in mesquite trees on "insects and other small arthropods" (Jones and Lovich 2009) and, in turn, this lizard is prey for the brown vinesnake. Recent photos show brown vinesnakes in mesquite trees, one eating an ornate tree lizard (Dancing Snake Nature Photography 2013).

Finally, completing the food chain, the gray hawk feeds "almost entirely on vertebrates, especially reptiles" (Bibles et al. 2002) and an online photo shows a

gray hawk grasping a brown vinesnake (Tucson Herpetological Society, no date). Both tropical species, the brown vinesnake and gray hawk, occur no farther north than southern Arizona. The gray hawk occurs in extreme southern Arizona and Texas (Bibles et al. 2002) and the brown vinesnake was first discovered for the United States in mesquites along the Santa Cruz River south of Tucson (Brown et al. 2015; Vorhies 1926; Webb et al. 2014). This small snake has now been pushed farther south and, due to riparian habitat loss, is now restricted in the United States to near Nogales, Arizona (Stebbins 1985; Webb et al. 2014).

Mesquite Bosques and Cottonwood-Willow Riparian Gallery Forests

The preferential use of riparian habitats by birds is well documented. Studies in both mesquite bosques and cottonwood-willow forests have reported some of the highest avian population numbers and greatest biodiversity in North America (Carothers et al. 1974; Johnson et al. 1977; Szaro 1980). Johnson et al. (1987) list 69 percent of the Southwest lowlands avifauna either as obligate riparian-nesting birds or showing a preference for riparian and other wetland habitats. Early in-depth studies in riparian ecosystems of the desert Southwest concentrated largely on birds of cottonwood-willow (*Populus-Salix*) forests with later studies conducted in bosques. The first quantitative analysis of avian populations in southwestern riparian habitats was by Carothers et al. (1974). That study and a following publication (Carothers and Johnson 1975) found that no other habitat in North America is more important to non-colonial nesting birds than Fremont cottonwood (*Populus fremontii*) forests along the Verde River in central Arizona. This same finding was later echoed by Szaro (1980) in an extensive survey of studies in southwestern riparian forests. Studies in both bosques and cottonwood-willow forests were later conducted by others, including Gavin and SOWLS (1975), Stamp (1978), and Engel-Wilson and Ohmart (1979) (see tables 13 and 14).

Especially important to birds are combinations of riparian mesquites and cottonwood-willow forests. Mesquite bosques constitute prime avian habitat (Johnson and Simpson 1971; Johnson et al. 2000). Cottonwood trees are generally taller than mesquites and provide additional structure for nesting and other avian activities. Bird species diversity (BSD) is directly related to foliage height diversity (FHD). FHD is determined by the arrangement of vegetation in three-dimensional space. A lack of taller trees (and thus reduction in the value of the dimension of height) also results in a reduction of BSD (Carothers et al. 1974; MacArthur et al. 1962). A combination of bosques and cottonwood-willow forests tend to support greater avian biodiversity than either alone (Johnson et al. 2000; Webb et al. 2014; table 14). In addition, the soft wood of cottonwood trees provides ideal nesting cavities in contrast to very dense mesquite wood, which is difficult for cavity-nesting birds to excavate.

Along larger rivers, notably the Lower Colorado River Valley and Rio Grande Valley, bosques and/or cottonwood-willow forests have been largely replaced by dense *Tamarix* (saltcedar or tamarisk) thickets. Some vertebrates, especially several avian species, have adapted to saltcedar, but many have not (Webb et al. 2014). Extensive changes to riparian ecosystems in general have also occurred with the advent of agricultural fields and rural and suburban areas that have developed in major river valleys, often replacing riparian ecosystems. Again, some species have adapted

to trees and shrubs planted in city parks and cemeteries, or to shade trees around housing areas, many have not.

Grazing has also been identified as a major impact to riparian ecosystems (Knopf et al. 1988). Krueper et al. (2003) found that populations of 40 species of riparian birds showed detectable increases within 3 years after cattle were removed from a section of the San Pedro River, Arizona.

In addition to birds, a large percentage of amphibians and reptiles and mammals have also been affected by deterioration of riparian vegetation. Most of these are ground dwellers, many of them living in burrows, and resulting changes on the ground include loss of shade, increasing temperatures, and even modification of chemical composition, such as increased soil salinity (Shafroth et al. 1995).

Summary

The importance of mesquite bosques to the riparian fauna and flora of lowlands of the western United States cannot be overemphasized and in recent times there has been an ever-increasing effort toward stream restoration (Appendix B; Carothers et al. 1974; Stanley et al., in prep.) and reestablishment of cottonwood-willow riparian gallery forests. There has, however, been a general lack of effort toward reestablishment of riparian mesquite bosques. An online search found several references to planting cottonwoods and willows to reestablish riparian forests, including a 22-page manual published by the Natural Resources Conservation Service (Hoag 2007). Contrastingly, the only online references to planting of mesquites was as ornamentals or as urban shade trees. Until there is equal emphasis on reestablishment of mesquite bosques as well as cottonwood-willow riparian gallery forests, there will be a continuing, and possibly increasing, loss in biodiversity of riparian vertebrate faunas of the lowlands of the western United States.

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